FOXTROT – Control your house!

Design manual for CFox, RFox and Foxtrot

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Teco a.s. Havlíčkova 260, 280 58 Kolín,
www.tecomat.cz, **www.ovladejsvujdum.cz**

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1 The philosophy of the system, components, working with the manual

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1.1 Working with the manual

The manual for CFox, RFox system design is primarily intended for control systems designers; it should help them select suitable HW solutions for control, management, measurement and monitoring technologies and events that should be solved by their projects.

The examples in this manual are overwhelmingly tested and proven solutions that can recommend; however, they are not the only correct solutions. It is always possible to find other, even better solutions and all depends on the designers´ knowledge and possibilities, whether they choose from the solutions listed here or apply their own.

The text and the examples incorporate a number of references (**hypertext link** in case of electronic PDF version) for additional information, so if you wish to get more comprehensive information regarding the given issue, it is advisable to go through multiple locations in the manual (e.g. information on the relays and terminals in the module that interests you, etc.)

The manual is divided into several parts:

- **Chapter 2** contains information on power supply of the entire system, including the sources, the connection of the basic module, information on communication interfaces and submodules, detailed information on all the Foxtrot basic modules and peripheral modules on the TCL2 bus.

- **Chapter 3** provides detailed information on the CIB buses, TCL2 and RF network RFox.
- **Chapters 4 to 12** are divided by technologies, for which there are subsequently listed examples of connection, presented recommendations, principles and warnings about possible problems.Each chapter includes other subchapters, which divide more specifically the topic described.

- **Chapter 13** contains common information, power inputs of CFox modules (consumption from CIB), detailed parameters of relay outputs, terminal blocks and connectors, analogue and digital inputs. Parameters of recommended cables, mechanical dimensions of modules, principles and recommendations for increasing the resistance of applications - interference suppression, power surge protection.

- **Chapter 14** contains an overview of CFox and RFox modules, it complements the technical parameters necessary for their design - isolation voltage, brief descriptions of internal connections, especially of analogue and digital inputs, etc. ...

You also have at your disposal a discussion forum on the web portal elektrika.cz.

This manual should serve you, designers and users of our control systems, as help and a guide. It certainly does not contain all the necessary and useful information, and you may find a number of imperfections and mistakes in it. Should you have any comments, reservations or ideas, or if you find a mistake or if you have *any questions or requests, I'll be happy for any - both positive and negative - information.*

Jindřich Kubec
kubec@tecomat.cz

1.2 The Foxtrot system structure

The central element of the system is the Foxtrot basic module **(the CP-1000 and other variants).** In installations where no inputs (such as temperature sensors, etc.) or outputs (such as lighting or heating control) are expected to be connected to the basic module, and also in installations programmed by FoxTool parameterising programme, the CP-1000 central module is used, or its variant CP-1001 with expanded memory capacity (for more complex applications with a larger number of integrated technologies supported by special FB, etc.).
In installations where a part of the inputs and outputs of controlled applications (regulation of more complex sources of heating, etc.) are to be directly connected to the basic module (its AI, AO, DI and DO) and the Mosaic environment will be used in programming, it is advantageous to make use of any Foxtrot basic module (see the documentation [4]), mostly the CP-1006 or the CP-1008.

The scanned inputs (temperature, control buttons, etc.) and controlled outputs (lights, shutter motors, heating valve drives, ventilation fan motors, etc.) are connected to the peripheral modules, which are connected to the Foxtrot basic module by one of the three buses:

The TCL2 bus
This is a system bus with a limited range of peripheral modules; it is strictly linear and rather strictly defined. For a more detailed description of the TCL2 bus, see Chapter 3.3 TCL2 bus – the principles of design and installation. Peripheral modules on this bus are only in a rail design. In household installations, this bus is most commonly used for connecting the external master modules CFox (CF-1141) and RFox (RF-1131), or modules for controlling boilers with the OpenTherm protocol and Belimo actuators with the MP-Bus protocol.

The CIB bus (CFox network):
The largest number of peripheral modules are connected by the CIB installation bus.These peripheral modules supplied under the overall designation CFox are available in various designs - on a DIN rail, in an installation/flush box, on the wall in the interior, inside other devices, with higher protection, etc. For a detailed description of CIB buses see Chapter 3.1 The CIB bus – principles of design and installation.

The RFox network (bus):
Another installation bus for the Foxtrot system is the RFox wireless network (there is no bus in its physical form, but logically the RFox elements function as buses). Peripheral wireless modules RFox are also available in multiple forms of housing - for a DIN rail mounting (with 230VAC or 24VDC power supply), for a flush box (battery powered or powered by 230V AC), on an interior wall (mainly battery powered), with higher protection, etc. For a detailed description of the RFox bus see the following Chapter 3.2 The RFox bus – principles of design and installation.

Inputs and outputs connected to any of the above-mentioned buses are equal from the perspective of programming, visualization and operation. Only RFox elements powered from the battery have minor specific features (longer recovery interval values, monitoring the battery status ...).
So for example when switching the relay output that controls the light, it makes no difference if the relay output is on the module connected by a TCL2 bus, by a CIB, in an RFox network, or whether the relay output on the Foxtrot basic module is used directly. Except for their own configuration in the programming environment, programmers do not even recognize what the physical connection of the relay actually is.

2 FOXTROT – the basic and peripheral modules, power supply

Contents of the chapter

The Foxtrot basic module is an independent control system equipped with power circuits, communication channels, inputs and outputs.The development tools used for its programming include the Mosaic environment, and in the case of the basic CP-1000 module, the FoxTool environment can also be used.

In addition to the Ethernet interface terminal/socket, the front panel contains an indicating section, which is available in several variants:

A seven-segment display, which shows the basic module status; when the button below the display is held, it shows the current IP address of the Ethernet interface (for more information see [2]). There is also a LED signal display that shows the basic status of the module and the status of the relevant I/O.

The there is a design with a backlit 4x20 character display and buttons (it can be used as a standard ID panel in the target application).

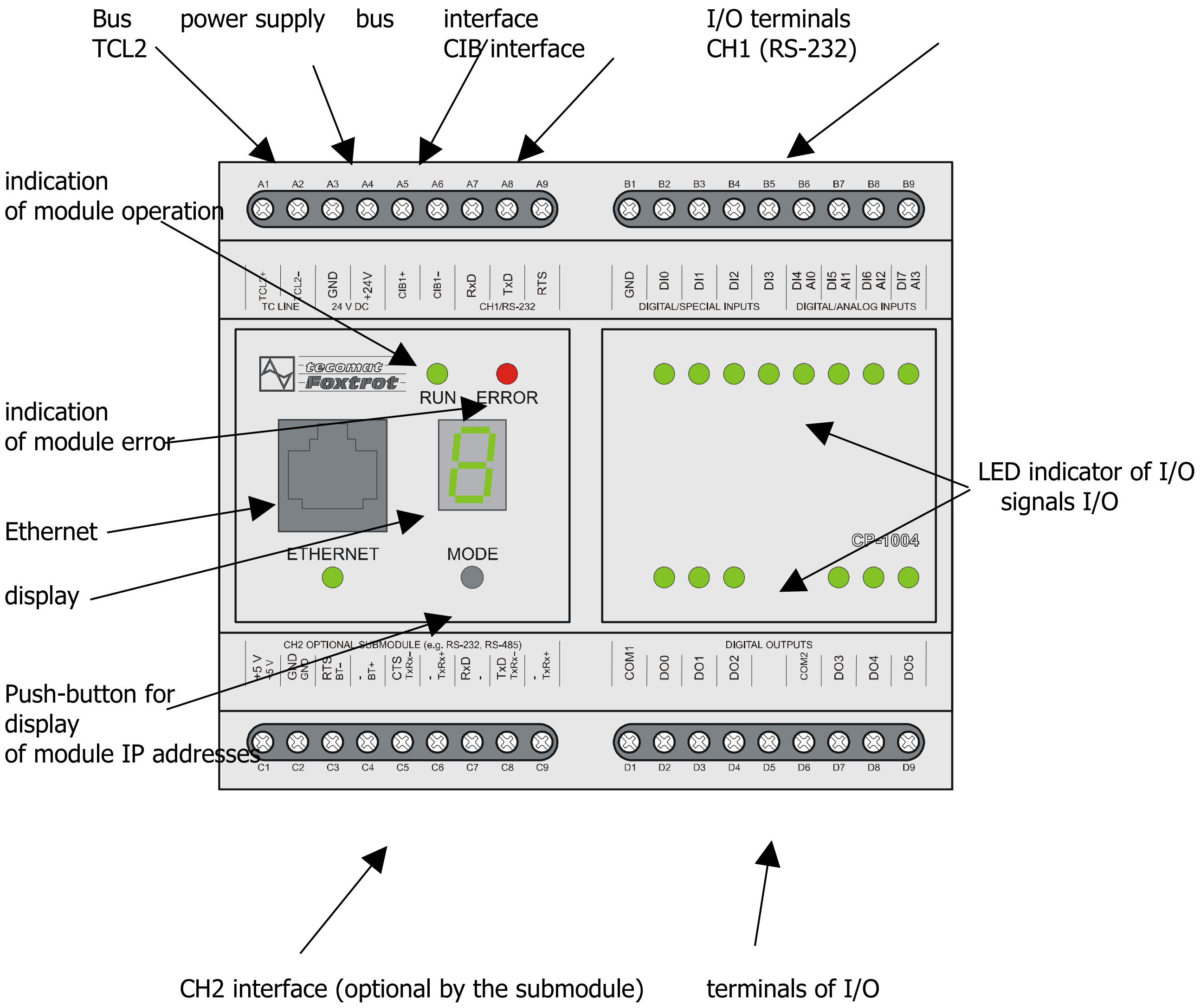
The table below shows a current overview of variants of the Foxtrot basic module, including a simplified input and output tables:

	CP-100y	CP-101y		AI	DI	DI 230 V	HDO	AO	RO	DO (SSR)	CIB
CP-10x0	CP-1000			4		1	1		2		2
CP-10x3	CP-1003	CP-1013		8	8			4	7	4+1	
CP-10x4	CP-1004	CP-1014		4	4				6		1
CP-10x5	CP-1005	CP-1015		6				2	6		1
CP-10x6	CP-1006	CP-1016		13 + 1HSC			1	2	10	2	1
CP-10x8	CP-1008	CP-1018		10 + 2			1	4	6 (7)	2 + 2	1
LED ind.	ANO										
4x20 LCD		ANO									

CP-10xy

x – definuje indikační část (horní panel – LED diody, ovládací panel s LCD displejem 4x20 znaků)
y – definuje periferní část (spodní část s konektory – velikost modulu, počty a typy vstupů a výstupů)

The front view of the basic module (an example - the CP-1004):



The **CP-1004** represents the simplest variant of the Foxtrot basic module.
The basic module is supplied from a 24VDC source.

The basic module includes a low power internal source for the CIB power supply (max.100mA current).

The A connector contains a terminal of TCL2 system bus (for connecting peripheral Foxtrot modules, control panels and external master modules CF-1141 and RF-1131) and the serial communication channel CH1 (usually for GSM modem connection).

The C connector contains a terminal of the second communication channel, on which another interface can be implemented using additional submodules, such as the RS-485, M-bus master, CAN, RS-232, and others, or up to 3 additional communication channels (CH2 to CH4) can be implemented using special submodules.

The inputs and outputs of the controlled technology are connected to B and D connectors.

More detailed information on individual groups of inputs, outputs and other signals, including peripheral modules, can be found further in this documentation.

2.1 System power supply – power sources

The Foxtrot system and the CIB buses are powered by 24VDC or DC27.2VDC (in case of a battery backup). Tolerance limits of supply voltage are given in Chapter 3.1.1 CIB bus characteristics.

The power supply parameters:
We recommend to use the power sources specified in this documentation. If necessary, other sources can also be used to power the system. Most sources with stabilized voltage output of 27.2VDC or 24VDC usually meet the requirements. The power supply used must meet the conditions of SELV, the 27V source must be specifically designed for direct battery charging. You can also use a non-stabilized 24VDC (without a backup), but you must be careful about the output voltage (with markedly excessive power supply, the output voltage can rise above the permitted value).

Determination of the power source output:
The power supply alone (without the CIB buses) of the CP-1000 can utilize a supply with the power output of min. 15W (we recommend the DR-15-24). If other circuits are also powered from the same source, its power output must be proportionately increased. Regarding the power supply to the central module and both CIB buses (see Chap.2.2.1.Power supply without a backup) we recommend the DR-60-24 or the DR-100-24 sources, and as to the power supply from a backup battery we recommend the PS2-60/27 supply (see Chap.2.2.2.Power supply with a backup).

Protection of power supply:
The power supply input (27V + terminal) is protected by an internal electronic fuse. We recommend to install upstream from the power supply a front-end external fuse with a recommended nominal value of T3 15L250V (for the central CP-10x0 module and both fully fitted CIB buses).

SELV:
If the power supply meets the parameters of the SELV source in accordance with the EN 60 950 (ČSN 33 2000-4-41) standard, then
all I/O circuits of the system meet the SELV requirements. This also applies if the relay outputs switch low voltage circuits
(the isolation of relay outputs from the internal circuits of the system is 4kVAC). The power sources required by the Foxtrot system meet the SELV parameters.

Increasing the endurance of the power sources:
In order to ensure trouble-free operation even in emergency situations (the effects of a lightning strike, generally poor
quality of the power grid or influence of other devices with negative impact on the grid) it is recommended to install a suitable surge protection equipment at the 230VAC power supply (see the examples of connections in Chapter 13.5. Surge Protection.

2.1.1 The power supply PS2-60/27

The power supply PS2-60/27 (order. no.: TXN 070 40) is a mains switch-mode power supply with stabilized output voltage at 27.2VDC/2.2A and 12VDC/0.3A with a total power output of 60 W. It is designed to supply power to the Foxtrot control systems with a direct backup option from 24V batteries charged from this source.

The output voltage of 12VDC serves for powering security and fire alarm detector units and it is active even during a power outage, provided charged batteries are connected to the 27.2V source output.

The module does not require active cooling, it is powered from a standard TN-S or TN-C 230VAC grid.
The input of 230VAC power supply is equipped with an internal thermal fuse 2.5A/35 type T, MT series, with breaking capacity at 35A.

The input of 230V power supply should always have surge protection. In Chapter 13.5 are described the basic principles of surge protection, including examples of connection of SPD type 3 and the power supply.

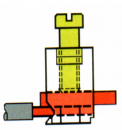
The PS2-60/27 power supply meets the requirements for safety transformers and is a source of safety extra low voltage (SELV).

Table 2.1.1.1 Basic parameters of the PS2-60/27 power supply

Input voltage	230 VAC +15% -25% 1)
Power consumption	max. 106VA
Input voltage - level 1	27.2VDC ±0.5%
Output current - level 1	max. 2.2A
Output voltage - level 2	12 V DC ±0.5 %
Output current - level 2	max. 0.3A
Total continuous power output	max. 60W
Short-circuit protection of outputs	electronic
Electrical endurance of input/output isolation	3,000VAC
Operating temperature	from -10 °C up to +60 °C (for loading characteristics see Fig.2.1.1.1.)
Dimensions	150 x 90x 58 mm (6M housing for a DIN rail TS-35)

1) The power supply is capable of operating from 110VAC mains with power output reduced by 25%.

Table 2.1.1.2 The parameters of terminal block of 230V PS2-60/27 power supply

Spacing of terminals		7.5
The type of terminal		Screw cage
		
Wire stripping length	mm	6
Tightening torque for the terminal screws		0.5Nm
Conductor sizes		
Clamping range, a solid conductor	mm^2	0.15 ÷ 2.5
Clamping range, a cable	mm^2	0.15 ÷ 1.5
Nominal voltage	V	750
Nominal current	A	16
Material - the connector plastic	PA6.6 UL94V0	
The screw of the connector terminal	M3	

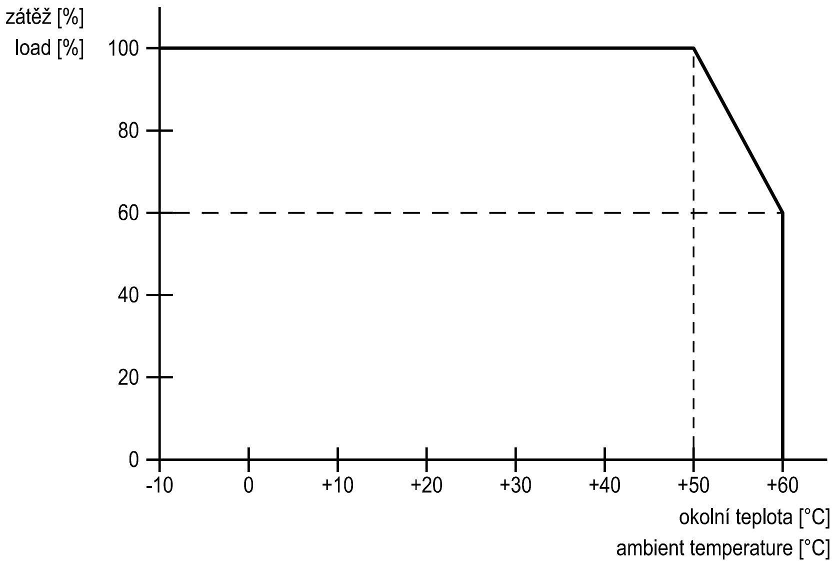


Fig. 2.1.1.1. The PS2-60/27 power supply loading characteristics

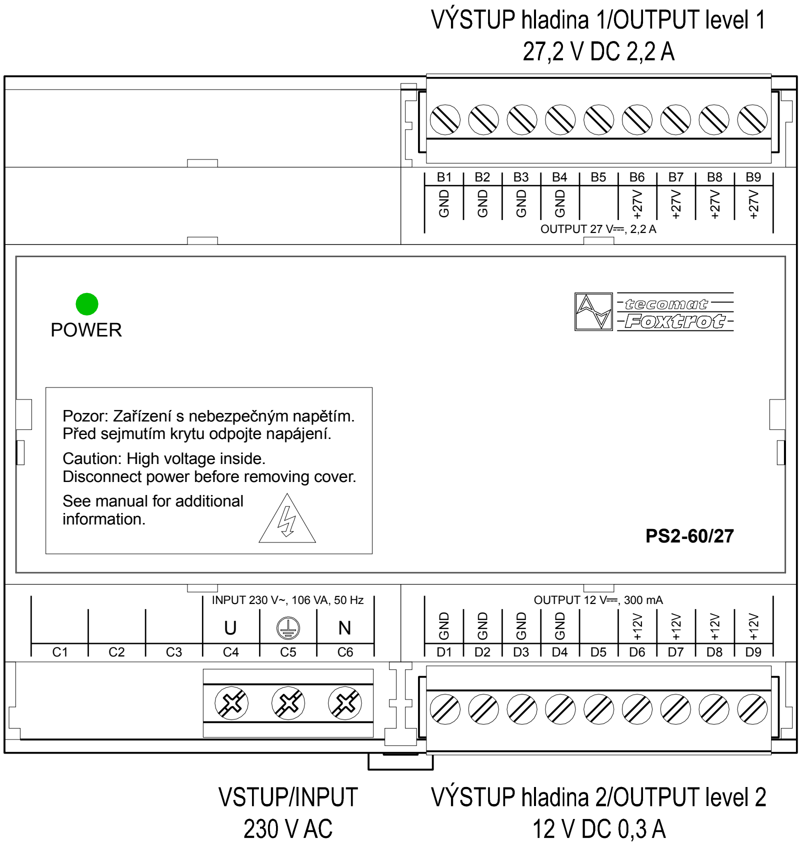


Fig. 2.1.1.2. Front view of the PS2-60/27 supply, the arrangement of B and D connectors and the C terminal block

Notes:

1) For B and D connectors parameters see Chapter 13.3.1.
2) For C terminal block parameters see table 2.1.1.2.
3) B connector contains the output from the 27.2VDC, max. 2.2A
4) D connector contains 12VDC, 300mA output level

5) C terminal block is connected to 230VAC mains voltage. The supply is a Class I electrical appliance and the terminal C5 must be connected to protective earth (PE).

2.1.2 The DR-60-24 power supply

The DR-60-24 power supply is a mains switch-mode power supply with 24V continuous output voltage and 2.5A. It is designed to supply power to the Foxtrot control systems without a backup. Basic properties are identical with the DR-60-12 power supply (the dimensions, the network part), which is used e.g. for powering of LED strips and chips.

The module does not require active cooling, it is powered from a standard 230VAC grid.
When switching the power supply input it is necessary to take into account a maximum inrush current of up to 36A (for more information see Chapter 6.1.1). It is recommended to use the F 3.15A thermal fuse as protection.

The input of 230V power supply should always have surge protection. In Chapter 13.5 are described the basic principles of surge protection, including examples of connection of SPD type 3 and the power supply.

The DR-60-24 power supply meets the transformers safety requirements and is a source of safety extra low voltage (SELV).

Table 2.1.2.1 Basic parameters of the DR-60-24 power supply

Input voltage	88 ÷ 264VAC
Input current	0.8A / 230VAC
Inrush current	max. 36A/230VAC (max. 30ms)
Output voltage	24VDC
Output current	max. 2.5A
Total continuous power output	max. 60W
Output protection against a short circuit	electronic
Electrical endurance of input/output isolation	3,000VAC
Operating temperature	from -20 °C up to +60 °C (for loading characteristics see Fig. 2.1.2.1.)
Dimensions	78 x 93 x 56 mm (4.5M housing for a DIN rail TS-35)

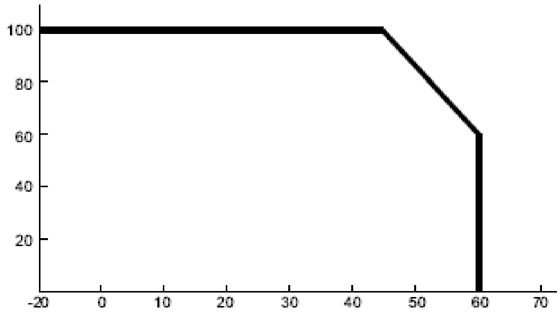


Fig.2.1.2.1. The PS2-60/24 power supply loading characteristics

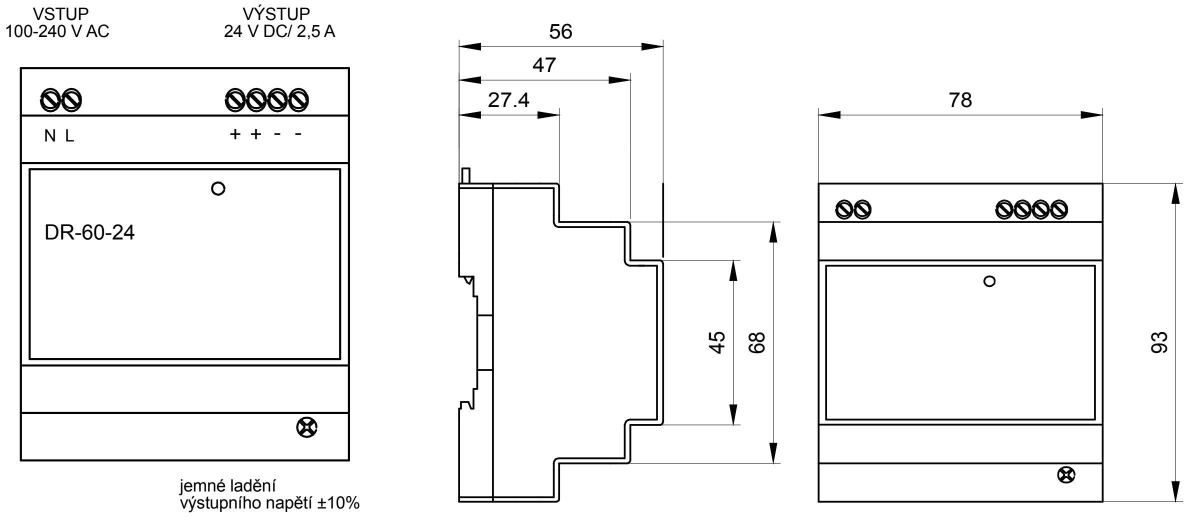


Fig.2.1.2.2. Front view of the DR-60-24 power supply, the dimensions of the supply module

2.2 The Foxtrot basic module power supply

For its proper function the module requires smoothed 24VDC power supply. If a battery backup is required, the system can be supplied from a 27.2VDC source. It is recommended to use the PS2-60/27 power supply. For detailed information regarding the source, see Chapter 2.1.1 The PS2-60/27 power supply . Maximum power consumption of the system (at the full load - with switched relay outputs, an additional submodule fitted and with active communication) is about 6 ÷ 10 W(depending on the type of basic module); without the fitted submodule it is around 2 ÷ 6W. This does not apply to the basic CP-1000 and CP-1001 modules; for information on their power supply, see Chapter 2.7.1.

A table with the power consumption of the Foxtrot basic modules

The basic module type	Max. power consumption 1)	Typical power consumption 2)
CP-1004, CP-1014	8W	4W
CP-1005, CP-1015	8W	4W
CP-1006, CP-1016	10W	6W
CP-1008, CP-1018	10W	6W

1) All inputs and outputs are energized (closed inputs, connected sensors, closed relays, etc.), fitted with a submodule with a maximum permissible power consumption.
2) All inputs and outputs are energized (closed inputs, connected sensors, closed relays, etc.), no submodule is fitted, or a conventional submodule is fitted with the RS-232, RS-485, RS-422 interface.

There is a galvanic connection between the power supply voltage and the CH1 and CIB1 communication interfaces, and the TCL2 system channel, and mostly also with DI/AI inputs on the basic module (typically connectors on the top side of the module); this does not apply to the CP-1003 - see Chapter 2.7.2. These circuits are also galvanically connected with the power supply of the system, if the CH2 channel is fitted with a submodule with I/O circuits without galvanic isolation.
The common terminal is the GND (e.g. the A3 terminal in CP-1004).

During the application of this system it is necessary to take into account the common terminal (galvanic connection) of the above-mentioned I/O module parts - especially when powered from multiple locations, multiple power sources or if there is a risk of ground loops.

SELV:
If the power source meets the parameters of the SELV source in accordance with the EN 60 950 (ČSN 33 2000-4-41) standard, then all I/O circuits of the system meet the SELV requirements. This also applies if the relay outputs switch low voltage circuits (the isolation of relay outputs from the internal circuits of the system is 4kVAC).

Determination of the power source output:
An optimal source to supply power to the control system itself has an output of minimum 15W (which does not apply to the CP-1000). If other circuits are also powered from the same source, its power output must be proportionately increased. If a source with an unstabilized output is used, it is necessary to fully comply with the load permissible by the application's supply voltage range, especially in the case of using sources with a large excess capacity.
If you want to power the central module without a backup (a wiring example see Chapter 2.7.1.1, we recommend the DR-60-24 or DR-100-24 sources (depending on the total power consumption of the powered circuits).
If you want to power the central module with a backup battery we recommend the PS2-60/27 source (see Chapter 2.2.1 Backup power supply CP-1004, the PS2-60/27 source).

Protection of power supply:
The power input (A4 terminal) is not protected by an internal fuse. We recommend to install an upstream

external fuse with a nominal value of T500L250V. This does not apply to basic CP-1000 and CP-1001 modules; for information on their power supply, see Chapter 2.7.1.

2.2.1 Backup power supply CP-1004, the PS2-60/27 source

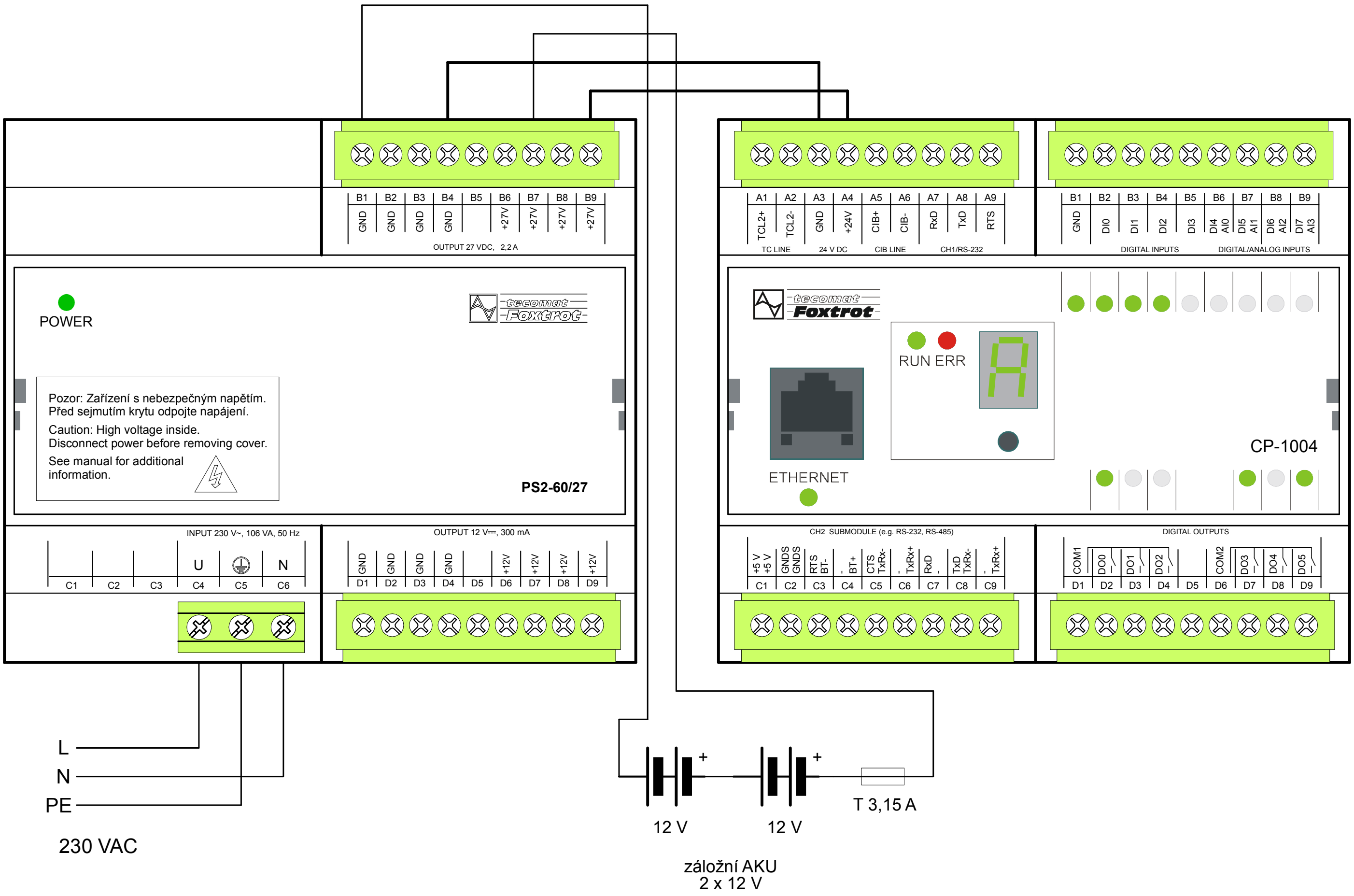


Fig.2.2.1.1 An example of a backup power supply of the CP-1004 basic module

Notes:

1) The power supply must be stabilized 27.2VDC, complying with SELV requirements, and it must be designated for charging the connected batteries; as a standard it is recommended to use the PS2-60/27.
2) The batteries are sealed 12V lead-acid type (2 pcs connected in series) with a capacity of 1.3 to 17Ah (depending on the requirements for backup time and the power consumption of the assembly).
3) The battery lifetime is approx. 3-4 years, but it decreases significantly with increasing ambient temperature, so it is advisable to place the batteries in a cooler location. It should be placed in the lowest possible location in the distribution cabinet (e.g. on the bottom of the housing).

2.3 Communication interface of the Foxtrot basic module

The Foxtrot basic CP-10xx modules are equipped with asynchronous serial channels (CH1, CH2), the CIB1 interface, the TCL2 system channel and the ETHERNET interface. Each serial port and logical data channel LCH (one Ethernet interface can serve up to four LCHs) can be set to one of the communication modes and implement various networks and interconnections. Any of the channels CH1 to CH4 in PC mode and Ethernet can be used for programming the PLC, but only one at a time!

2.3.1 Communication interface CH1 of the basic modules CP-10xx, RS232

The serial interface of the basic CH1 module of basic modules (except for the CP-1003) is firmly fitted with the RS232 interface without galvanic isolation (i.e. the interface signals have galvanic connection with the module power supply by the CIB interface, the TCL2 and the analogue inputs in the basic CP-10xx module). A view of the terminal block (in standard operating position of PLC on the control panel) is shown in Fig. 2.3.1.1.

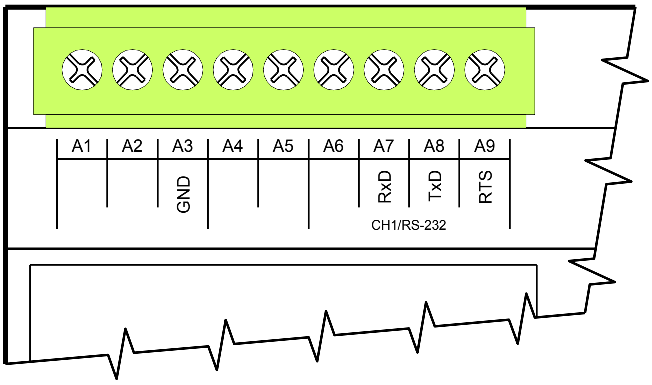


Fig.2.3.1.1 Terminal block A – connection of the interface CH1, RS232.

Notes:

1. Signal ground GND of the interface is a common terminal for the module power supply, the CIB bus and the TCL2 (it is also common with the negative common terminal of DI/AI inputs).
2. The basic CP-1000 module has the GND terminal also available at A6 terminal.
3. RTS is a control signal (output), which is used by some devices (interface converters, etc.). Using the signal is described in the manual Serial communication of TXV 001 06 programmable control units.

2.3.2 The CH1 communication interface of the CP-1003 and CP-1091, RS485 basic modules

The serial interface of the basic CH1 module CP-1003 and CP-1091 is firmly fitted with the RS485 interface without galvanic isolation (i.e. the interface signals have galvanic connection with the module power supply, with the CIB interface, the TCL2 and the analogue inputs in the basic CP-1003 and CP-1091) modules. A view of the terminal block (in standard operating position of PLC on the control panel) is shown in Fig. 2.3.2.1.

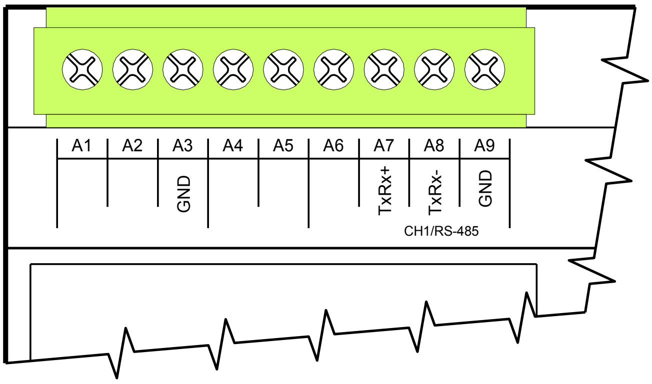


Fig.2.3.2.1 The terminal block A – connection of the interface CH1, RS485.

Notes:

1. The signal ground GND of the interface is a common terminal for the module power supply, the CIB bus and the TCL2 (it is also common with the negative common terminal of AI inputs).
2. Using interfaces is described in the manual [3].
3. The RS-485 (CH1) interface is firmly terminated in the module with appropriate impedance and it must always be at the end of the RS-485 line (the same applies for the TCL2 interface in the Foxtrot basic module).

2.3.3 Communication interface CH2, using optional submodules

The output from the CH2 communication interface is located on the terminal block C or D, depending on the basic module type. The layout of signals in the terminals is available in several variants, in accordance with the basic module type:

Fig.2.3.3.1 for the basic modules CP-1000 -1001 and CP-1091

Fig.2.3.3.2 for the basic module CP-1003

Fig.2.3.3.3 for the basic modules CP-10x4, CP-10x5.

Fig.2.3.3.4 for the basic modules CP-10x6, CP-10x8.

The CH2 interface is not fitted with any submodule as a standard. The customer can choose - depending on the required interface (RS232, RS485, CAN, M-bus, etc.) an appropriate submodule and fit it in a free position/slot within the module (the procedure how to fit the submodule is described in the manual) [3].

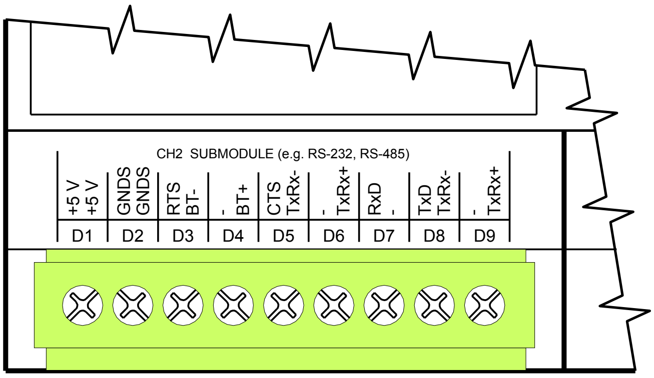


Fig.2.3.3.1 The D connector of the CP-1000/1001 modules – connection of the CH2 interface, an optional interface.

Notes:

1) The descriptions on the terminals correspond to the two most common submodules - the RS232 and the RS485 interfaces; in other submodule variants the significance of terminals is naturally different - see the description on the specific submodule.
2) The terminal block is galvanically isolated from all circuits of the basic module. When a submodule with galvanic isolation is fitted, its inputs and outputs lead to the D connector and are galvanically isolated from other circuits of the basic module (the signal ground of the galvanically isolated interface is marked GNDS).

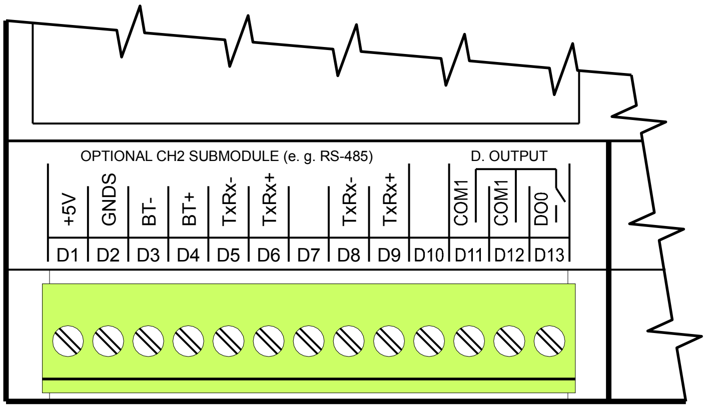


Fig.2.3.3.2 The D connector of the CP-1003 modules – connection of the CH2 interface, an optional interface.

Notes:

1) The descriptions on the terminals correspond to the RS485 interface; in other submodule variants the significance of terminals is naturally different - see the description of the specific submodule.
2) The terminal block is galvanically isolated from all circuits of the basic module. When a submodule with galvanic isolation is fitted, its inputs and outputs lead to the D connector and are galvanically isolated from other circuits of the basic module (signal ground of the galvanically isolated interface is marked GNDS).

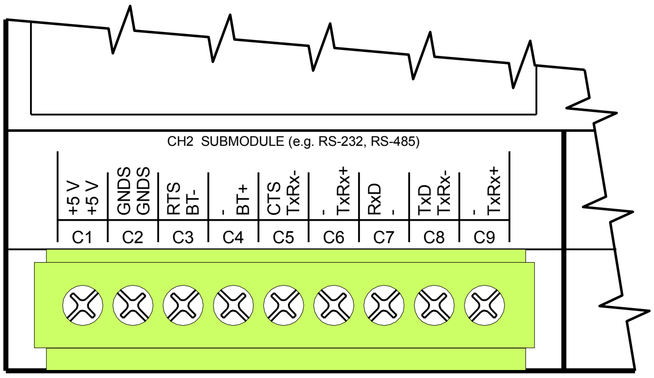


Fig.2.3.3.3 The C connector of the CP-10x4, CP-10x5 modules – the connection of the CH2 interface, an optional interface.

Notes:

1) The older variants of the basic modules were fitted with fixed terminal blocks, but the numbering and the significance of all terminals is the same.
2) The descriptions on the terminals correspond to the two most common submodules - the RS232 and the RS485 interfaces; in other submodule variants the significance of terminals is naturally different - see the description on the specific submodule.
3) The terminal block is galvanically isolated from all circuits of the basic module. When a submodule with galvanic isolation is fitted, its inputs and outputs terminated on the C connector are galvanically isolated from other circuits of the basic module (the signal ground of the galvanically isolated interface is marked GNDS).

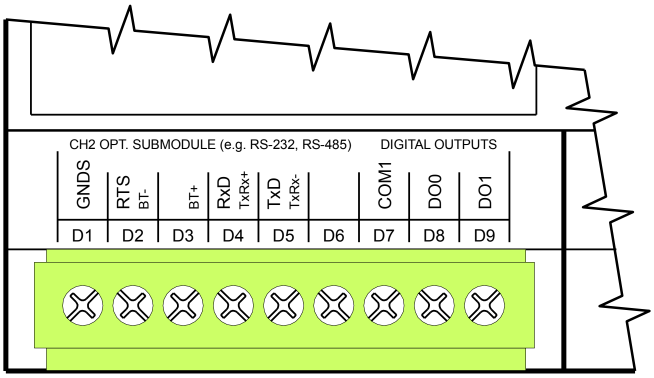


Fig.2.3.3.4 The D connector of the CP-10x6, CP-10x8 modules – connection of the CH2 interface, an optional interface.

Notes:

1) The CH2 interface in these basic modules is only terminated on D1 to D5 terminals (the descriptions on the box again describe the signals for RS232 and RS485 interfaces). N.B: Some submodules have limited use, and some cannot be fitted at all in these basic modules.
2) The DO0 and DO1 outputs are terminated on D7 to D9 terminals - the SSR outputs 230VAC, 1A outputs are galvanically isolated from all other circuits of the basic module.
3) The terminals of the CH2 D1 up to D5 interfaces are galvanically isolated from all other circuits of the basic module. When a submodule with galvanic isolation is fitted, its inputs and outputs terminated on the C connector are galvanically isolated from other circuits of the basic module (the signal ground of the galvanically isolated interface is marked GNDS).

2.3.3.1 The MR-0104 - the RS-232 interface, with galvanic isolation

The MR-0104 submodule provides the conversion of TTL signals from serial interface to the RS-232 interface, including galvanic isolation. This interface is intended only for interconnection of two participants (point-to-point). It is suitable e.g. for connecting a TECOMAT PLC and PC for short distances (up to 15m). Galvanic isolation of the serial interface is provided by a built-in converter and no external supply is required. More details concerning the submodule, its internal connection and settings are specified in the documentation [4].

Table 2.3.31: Wiring of the CH2 serial channel connector fitted with the MR-0104 submodule.

	CP-10x4 **CP-10x5**	**CP-10x6** **CP-10x8**	**CP-1000** **CP-1003** **CP-1091**	**Signal**	**Type of signal**	**Usage**
Terminals	C1	-	D1	+ 5V	power output	
	C2	D1	D2	GNDS	signal ground	signal ground of the isolated interface
	C3	D2	D3	RTS	output	control signal 1)
	C5	D3	D5	CTS	input	control signal 1)
	C7	D4	D7	RxD	input	data signal
	C8	D5	D8	TxD	output	data signal

1) Using the signal is described in the manual [3]. The idle signal level corresponds to logical level 1.

2.3.3.2 The MR-0114 - RS-485 interface, with galvanic isolation

The MR-0114 submodule provides the conversion of the serial interface TTL signals to the galvanically isolated RS-485 interface. This interface operates in a half-duplex mode, and makes multipoint (multidrop) linking of participants possible. Proper function requires correct termination of the communication line (see below). Galvanic isolation of the serial interface is provided by a built-in converter and no external supply is required. More details concerning the submodule, its internal connection and settings are specified in the documentation [5].

Table 2.3.32: Wiring of the CH2 serial channel connector fitted with the MR-0114 submodule.

	CP-10x4 **CP-10x5**	**CP-10x6** **CP-10x8**	**CP-1000** **CP-1003** **CP-1091**	**Signal**	**Type of signal**	**Usage**
Terminals	C1	-	D1	+ 5V	power output	
	C2	D1	D2	GNDS	power supply, common terminal	signal ground
	C3	D2	D3	BT–	– output termination	RS-485 bus termination
	C4	D3	D4	BT+	+ termination output	RS-485 bus termination
	C5, C8	D5	D5, D8	TxRx–	– input/output RS-485	data signal
	C6, C9	D4	D6, D9	TxRx+	+ input/output RS-485	data signal

2.3.3.3 The MR-0124 - RS-422 interface, with galvanic isolation

The MR-0124 submodule provides the conversion of the serial interface TTL signals to the galvanically isolated RS-422 interface. The interface allows a connection of two cooperating devices (point to point). Every single line (RxD and TxD) must be terminated at the end of the line with 120 Ohm terminating resistors. Galvanic isolation of the serial interface is provided by a built-in converter and no external supply is required. More details concerning the submodule, its internal connection and settings are specified in the documentation [6].

Table2.3.3 3: Wiring of the CH2 serial channel connector fitted with the MR-0124 submodule.

	CP-10x4 CP-10x5	**CP-10x6 CP-10x8**	**CP-1000 CP-1091**	**Signal**	**Type of signal**	**Usage**
Terminals	C1	Cannot be used	D1	+5V	power output +5V	
	C2		D2	GNDS	signal ground	
	C3		D3	CTS–	input	control signal 1)
	C4		D4	CTS+	input	control signal 1)
	C5		D5	RxD–	input	data signal
	C6		D6	RxD+	input	data signal
	C8		D7	TxD–	output	data signal
	C9		D8	TxD+	output	data signal
			D9			

1) Using the signal is described in the manual [3]. The idle signal level corresponds to logical level 1.

2.3.3.4 The MR-0160 - 2x CAN interface, with galvanic isolation

The MR-0160 submodule allows the connection of PLC TECOMAT Foxtrot to two CAN networks with data transfer rates of 500, 250, 125, 50, 20 or 10kBd. It can only be used in the CAN, CAS and CAB modes. The CAN line is terminated only for one channel (arbitrary). The second channel must be terminated by externally connected 120Ω resistor.

Table2.3.3.4: Connection of the serial channel C or D connector, when the MR-0160 submodule is fitted.

	CP-10x4 CP-10x5	**CP-10x6 CP-10x8**	**CP-1000 CP-1091**	**Signal**	**Type of signal**
Terminals	C1	Cannot be used	D1	+5V	power output +5V
	C2		D2	GNDS	signal ground
	C3		D3	BT1–	– CAN line termination output
	C4		D4	BT1+	+ CAN line termination output
	C5		D5	TxRx1–	channel 1 received and transmitted data (level -)
	C6		D6	TxRx1+	channel 1 received and transmitted data (level +)
	C8		D8	TxRx2–	channel 2 received and transmitted data (level -)
	C9		D9	TxRx2+	channel 2 received and transmitted data (level +)

2.3.3.5 The MR-0161 - CAN interface, with galvanic isolation

The MR-0161 submodule allows the connection of PLC TECOMAT Foxtrot to CAN network with data transfer rates of 500, 250, 125, 50, 20 or 10kBd. It can only be used in the CAN, CAS and CAB modes (further see [2]).

Table2.3.3.5: Connection of the serial channel C or D connector when the MR-0161 submodule is fitted.

	CP-10x4 **CP-10x5**	**CP-10x6** **CP-10x8**	**CP-1000** **CP-1003** **CP-1091**	**Signal**	**Type of signal**
Terminals	C1	-	D1	+5V	power output +5V
	C2	D1	D2	GNDS	signal ground
	C3	D2	D3	BT–	– CAN line termination output
	C4	D3	D4	BT+	+ CAN line termination output
	C5, C8	D5	D5, D8	TxRx–	received and transmitted data (level -)
	C6, C9	D4	D6, D9	TxRx+	received and transmitted data (level +)

2.3.3.6 The MR-0152 - PROFIBUS DP interface, with galvanic isolation

The MR-0152 submodule allows the connection of PLC TECOMAT Foxtrot to the PROFIBUS DP network as a slave station (subordinate) at the data transfer rate up to 12MBd. It can only be used in the DPS mode (further see [2]).

Since the PROFIBUS physical interface corresponds with the RS-485 standard, the serial channel connection is the same as in the case of the submodule MR-0114 (see Table2.3.3.2), including the possibility of termination.

2.3.3.7 The MR-0158 – M-Bus slave interface, with galvanic isolation

More details concerning the M-Bus interface, including examples of the MR-0158 submodule connection, can be found in Chapter 11.7.2 Connecting a slave device with an M-bus interface, MR-0158 submodule

2.3.4 Communication interface CH2 ÷ CH4, using multiple submodules

If more communication channels with interfaces are needed (up to 4 RS-232, RS-485 communication channels), the submodules fitted with three communication channels, CH2 to CH4, can be used in the CH2 slot. The CH2 communication interface is terminated in C or D connectors (for details see 2.3.3) and as a standard it is not fitted with any submodule. The customer can select - depending on the required combination of interfaces (RS232, RS485) - an appropriate submodule and fit it into the free slot inside the basic module (submodule installation procedure is described in the manual [3]).
If four communication channels (some basic modules have three) are not enough, it is possible to add several serial channels RS-232, RS-485 or CAN via the SC-1101 and SC-1102 external communication modules.

Table2.3.4.1: Interface combination for individual channels in accordance with the fitted submodule in CH2 position

Submodule	CH1	CH2	CH3	CH4 (CH3[1])
not fitted	RS-232	none	none	none
MR-0104	RS-232	RS-232	none	none
MR-0114	RS-232	RS-485	none	none
MR-0124	RS-232	RS-422	none	none
MR-0105	RS-232	RS-232	RS-485	RS-232
MR-0106	RS-232	RS-232	RS-485	RS-485
MR-0115	RS-232	RS-485	RS-485	RS-485
galvanic isolation	NO	YES, always	YES, always	YES, always
CP variants	CP-10xx	CP-10xx	CP-10x4, CP-10x5, CP-10x0	CP-10xx

[1] The basic modules CP-10x6 and CP-10x8 have this communication channel (in the Table CH4) terminated as CH3 (the channel marked as CH3 in this Table is not terminated in the connector in these CPs).

2.3.4.1 The MR-0105, MR-0106, MR-0115, fitted with the CP-10x4, CP-10x5

Table2.3.4.2: Terminating of the CH2, CH3 and CH4 communication channels for the CP-10x4, CP-10x5

	Terminal	**MR-0105**		**MR-0106**		**MR-0115**	
Terminal block C	C1	-		-		-	
	C2	GNDS		GNDS		GNDS	
	C3	TxD4	**CH4** **RS-232**	TxRx4–	**CH4** **RS-485**	TxRx4–	**CH4** **RS-485**
	C4	RxD4		TxRx4+		TxRx4+	
	C5	TxRx3–	**CH3** **RS-485**	TxRx3–	**CH3** **RS-485**	TxRx3–	**CH3** **RS-485**
	C6	TxRx3+		TxRx3+		TxRx3+	
	C7	-		-		-	
	C8	TxD2	**CH2** **RS-232**	TxD2	**CH2** **RS-232**	TxRx2–	**CH2** **RS-485**
	C9	RxD2		RxD2		TxRx2+	

2.3.4.2 The MR-0105, MR-0106, MR-0115, fitted with CP-1000, CP-1001, CP-1003, CP-1091

Table2.3.4.3: Terminating of CH2, CH3 and CH4 communication channels for CP-10x0

	Terminal	**MR-0105**		**MR-0106**		**MR-0115**	
Terminal block D	D1	-		-		-	
	D2	GNDS		GNDS		GNDS	
	D3	TxD4	**CH4** **RS-232**	TxRx4–	**CH4** **RS-485**	TxRx4–	**CH4** **RS-485**
	D4	RxD4		TxRx4+		TxRx4+	
	D5	TxRx3–	**CH3** **RS-485**	TxRx3–	**CH3** **RS-485**	TxRx3–	**CH3** **RS-485**
	D6	TxRx3+		TxRx3+		TxRx3+	
	D7	-		-		-	
	D8	TxD2	**CH2** **RS-232**	TxD2	**CH2** **RS-232**	TxRx2–	**CH2** **RS-485**
	D9	RxD2		RxD2		TxRx2+	

Notes:

1) In the CP-1003 - using the DO0 outlet - the D10 terminal must remain free in order to provide safe galvanic isolation of DO0 power output circuits from the communication interface circuits.

2.3.4.3 The MR-0105, MR-0106, MR-0115, fitted with the CP-10x6, CP-10x8

Table2.3.4.4: Terminating of the CH2,CH4 and DO0-1 communication channels for CP-10x6, CP-10x8

	Terminal	**MR-0105**		**MR-0106**		**MR-0115**	
Terminal block D	D1	GNDS		GNDS		GNDS	
	D2	TxD4	**CH3** **RS-232**	TxRx4–	**CH3** **RS-485**	TxRx4–	**CH3** **RS-485**
	D3	RxD4		TxRx4+		TxRx4+	
	D4	RxD2	**CH2** **RS-232**	RxD2	**CH2** **RS-232**	TxRx2+	**CH2** **RS-485**
	D5	TxD2		TxD2		TxRx2–	
	D6	-					
	D7	COM1					
	D8	DO0					
	D9	DO1					

Notes:

1) The D6 terminal must remain unconnected, as it provides safe galvanic isolation of communication channel circuits from the DO0 and DO1 binary outputs.

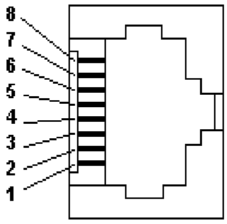
2.4 The Ethernet interface on the PLC Foxtrot (interface, cables)

As a standard, the basic module is fitted with the Ethernet interface, 10/100 Mbit, RJ-45 connector, see Chapter 2.4.1.
Each physical Ethernet interface (i.e. one physical connection to PLC) can host up to six logical data channels (also labelled LCH1 to LCH6), which can be configured in several modes, allowing various interconnections of systems (for more information see [2]) and they are fully independent of the other PLC communication interfaces (with the exception of system services in PC+ mode, which can be active at one time only on one (physical and logical) communication channel.
The Ethernet PLC Foxtrot interface automatically recognizes connections (straight or cross) and automatically adapts to them.

2.4.1 The ETHERNET PLC Foxtrot physical interface

The Ethernet interface is fitted with a standard RJ-45 connector with a standard layout of signals. The connector is ready to use with common UTP patch cables (for connecting cables see Chapter 2.4.1.2)

Table2.4.1.1: The connection of the Ethernet interface on the basic module (front view of the PLC connector)

	Pin	Signal	The colour of the wire
	8	not used	brown
	7	not used	white/brown
	6	RD–	green
	5	not used	white/blue
	4	not used	blue
	3	RD+	white/brown
	2	TD–	orange
	1	TD+	white/orange

2.4.2 Connecting straight-through and crossover UTP cables in the ETHERNET

TP cables (twisted pair) are either straight-through (UTP patch cable) or crossover cables.

The straight-through TP cable is the most common cable intended primarily for connections between the switch and the terminal device (network interface control unit on PC, PLC TC700, etc.), and it can also be used for direct connection of the Foxtrot systems. It is commonly produced and generally available. The cable is fitted with the RJ-45 (8 pins) connectors on both ends. Only four signals are functional (in the commonly used 10 Base-T interface), while the other wires are not used (in Fig. 2.4.21 they are indicated by a dashed line). Only the twisted pair cable must be used (untwisted phone cable cannot be used!), and one twisted pair must always be used for one direction of flow (e.g. RD). The colour-code of wires applicable for the Ethernet cables and most widely used is based on the TIA568B set of telecommunication standards; see Table 1.3.1.1 (valid for straight-through cables).
The data UTP (unshielded) and STP cables (shielded - shielding is not connected on the side of the PLC) are produced in several grades, numbered from 3 to 6. Any grade can be used for the 10/100 Mbit Ethernet (10Base-T), but the minimum recommended grade is 5.
A basic assortment of straight-through cables is supplied under the order number TXN 102 05.xx (the last digits represent the cable length in accordance with the product range - see the TC700 catalogue). The maximum length of the TP cable is limited to 100m.

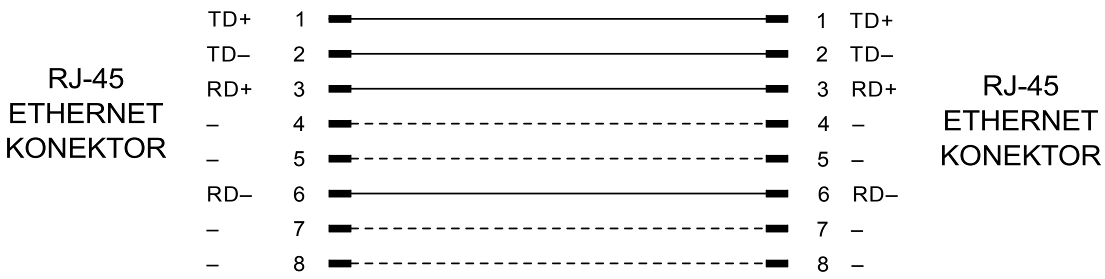


Fig.2.4.2.1 Wiring a straight-through cable (the ETHERNET UTP patch cable)

The crossover cable is used for a direct connection of two equivalent devices (e.g. HUB - HUB, without using an uplink port on the hubs). It is not so easily available and it must be ordered with an explicit specification for a crossover cable. The cable is fitted with the RJ-45 (8 pins) connectors on both ends. Only four signals are functional (in the commonly used 10 Base-T interface), while the other wires are not used (in Fig. 2.4.22 they are indicated by a dashed line). Only the twisted pair cable must be used (untwisted phone cables cannot be used!), and one twisted pair must always be used for one direction of data flow (e.g. RD).
A basic assortment of cross cables is supplied under the order number TXN 102 06.xx (the last digits represent the cable length in accordance with the product range - see the TC700 catalogue).

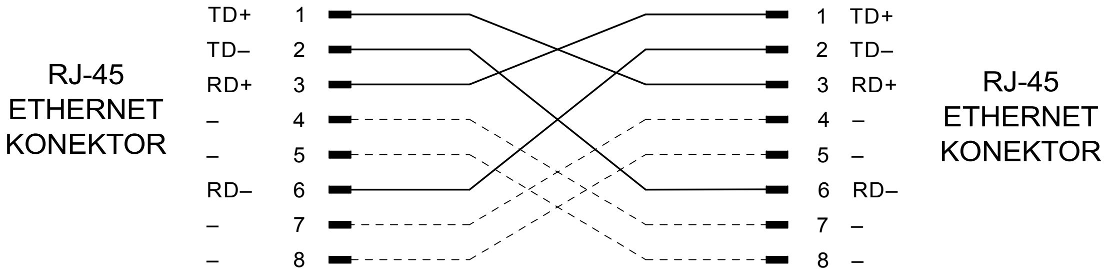


Fig.2.4.2.2 The wiring of the crossover TP cable in the ETHERNET

2.4.3 Recommended UTP (FTP) cables for the ETHERNET

Standard indoor installations, inside the control panel, etc., only require common UTP cables, which are a standard for structured networks.

Both unshielded (UTP) and shielded (FTP) twisted pair cables can be used. The shielded FTP cables can be well applied in the RS485 power distribution systems.

The UTP cables, examples of possible types:
The PCEY 4x2x0,5 (PCEY 4x2x0,6), manufacturer VUKI a. s. (distributor ISOKAB s.r.o.)
The UTP Data cable – grade 5, manufacturer KABLO ELEKTRO, a. s. Vrchlabí
The UTP Cat. 5, manufacturer PRAKAB

The FTP cables, examples of possible types:
The PCEHY 4x2x0,5 (PCEHY 4x2x0,6), manufacturer VUKI a. s. (distributor ISOKAB s.r.o.).
The FTP Data cable – Category 5, manufacturer KABLO ELEKTRO, a. s. Vrchlabí
The UNITRONIC EtherLine-H CAT.5, manufacturer LAPP KABEL
The FTP Cat. 5, manufacturer PRAKAB

2.4.4 The principles of wiring the ETHERNET

General principles of UTP cables installation:
During the installation of cables, sharp bends should be avoided; the cable must not be broken e.g. in the corners. The manufacturers specify the minimum bend radius for each type of cable, which typically corresponds to its diameter multiplied by 6. The cables must not be bent more than 90° and they must not be subjected to mechanical pressure. When handling cables (pulling them trough holes or bars), you must not exceed the permitted tensile limits. Pulling the cables with a force exceeding about 10 kg causes their damage by stretching the twisting => susceptibility to a higher error rate! When the cables are laid, they should be mechanically protected, not laid freely. Rather than keeping them under tension, they should be kept loose. The cables are also damaged by frequent manipulation.
A failure to comply with the principles of laying cables can cause deterioration in data transfer and even an interruption of cable routes. Due to the high frequencies, a blockage of data can be caused by mere rearrangement of geometric setting of wires in the cable, although it can be in order from the point of view of its ohmic resistance. The transition places between the cable and the connector are particularly sensitive to mechanical damage, so the cable must be protected from forceful bending and axial tension.
In the case of outdoor installations, the cables should be placed in metal, well-earthed channels, and both ends of the cable should be fitted with surge protection (like in TP computer networks).
In the case of a higher risk of interference, parallel cabling, etc., it is advisable to use the FTP (STP, see Chapter 1.1.5.3) shielded cables and use active network devices (HUB, switch, etc.) with shielding of the cable connected to protective earth (only on one side of the cable!).

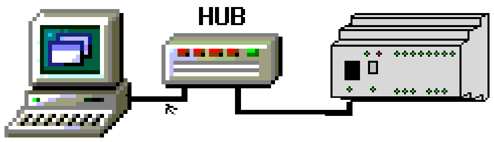
Parallel cabling:
It is not permissible to route UTP cables close to power lines. If you cannot keep the minimum distance (0.15 m), especially in DIN rails and plastic ducts, shielded distribution channels must be used for data cabling (galvanized sheet metal ducts). These ducts must have good conductive interconnection in the whole distribution network and they must be connected to the ground conductor of the power distribution network. The UTP cables must be in a sufficient distance (50mm) from any part of the low voltage (230VAC) circuits.

2.4.5 Examples of the ETHERNET network connections

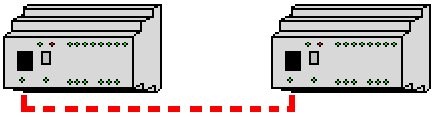
2.4.5.1 Basic connection, the ETHERNET network implementation

basic connection PC-PLC
e.g. using a notebook
it is possible to use a crossover cable TXN 102 06 (for wiring see Fig. 2.4.5.2), or a straight-through cable (for wiring see Fig. .2.4.5.1)
max. 100m

connection via HUB (commonly used HUBs or SWITCHes)
it is possible to use a crossover cable or a straight-through cable



direct connection between 2 PLC
it is possible to use a crossover cable or a straight-through cable



max. 100m

2.4.6 Connecting Foxtrot to a fibre-optic network

In order to integrate Foxtrot into a fibre-optic network (singlemode 9/125µm, multimode 62.5/125µm), media converters should be used, such as the N-TRON 102MC-ST.
The converter is powered from 24VDC (consumption max. 140mA, it can be powered from a common supply with the Foxtrot system), it is equipped with a single-port 100Base-TX (standard Ethernet RJ-45, for connecting the Ethernet connector of the Foxtrot system) and a single-port 100BaseFX, ST or a SC Duplex port - for connecting to the fibre-optic network.
The optical connector and the optic fibre must be specified in the order. Depending on the port (SC or ST) there are appropriate connectors on the module front panel:

The 102MC module is equipped with a redundant power supply. It is sufficient to connect any input (V1 or V2) to the 24VDC power supply:

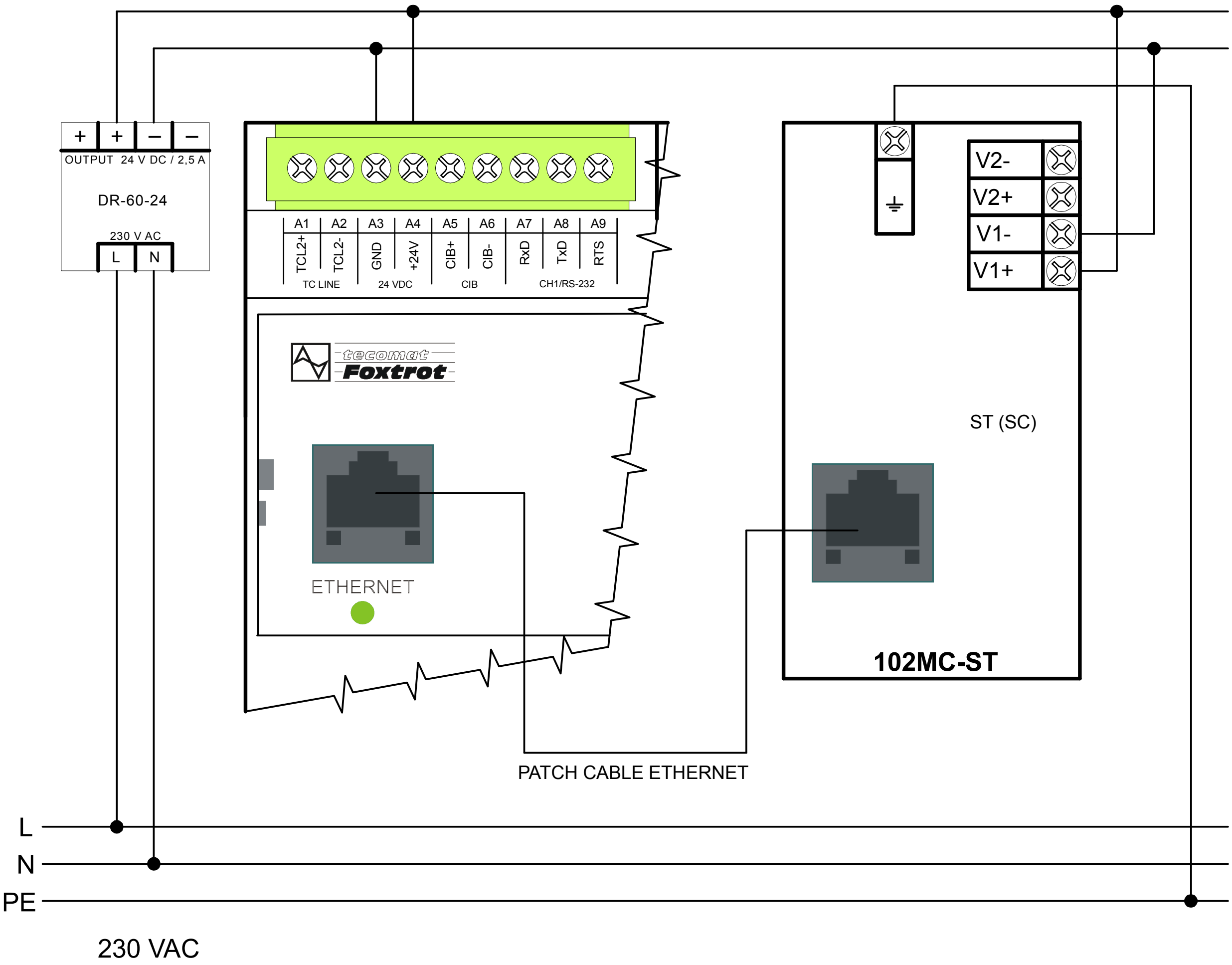


Fig.2.4.6.1 Connecting the 102MC media converter to the Foxtrot basic module

2.4.7 The SX-1162, an Ethernet switch on a DIN rail

The SX-1162 module includes a standard 5-port Ethernet switch. The ports are terminated with the RJ-45 connectors and they support the 10Base-T and 100Base-TX interface (rate 10 or 100 Mbit). They are also equipped with the automatic cable crossover function (Auto-MDIX). The status of each port is indicated by a LED diode on the front panel of the module. After connecting the terminal equipment, the LED indicator of the relevant port lights, and during a data exchange it flashes.

The module is placed in a 2M housing on a DIN rail, 4 Ethernet ports are terminated on the bottom board of the module (two up and two down), the fifth port is on the front panel of the module (the same as the Ethernet port on the Foxtrot basic modules).

An advantage of this switch is its mechanical implementation (for placement in standard distribution cabinets, etc.) and the operating design, because - unlike ordinary commercial switches - it is intended for continuous operation in the construction of the control panel (there is no risk of overheating, etc.).

Basic parameters of the SX-1162 module

The connection of power supply	screw terminals, max. 2.5mm^2 wire cross-section
Ethernet connection	5x RJ-45 connector
The type of equipment	built-in
Supply voltage	typically 24VDC -15% + 25%
Internal protection	resettable electronic fuse
Typical power consumption	1.3 W
Maximum power consumption	2W
Galvanic isolation of power supply from the Ethernet ports	yes, even ports between one another
Type of interface	10Base-T or 100Base-TX in accordance with IEEE802.3
Maximum data transfer rate	100Mbit
Maximum length of the cable	100m 1)

1) The maximum length is valid for the UTP (STP) cable in accordance with the specifications.

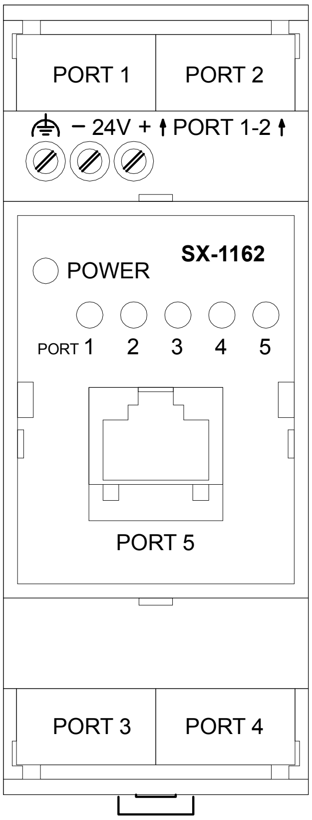


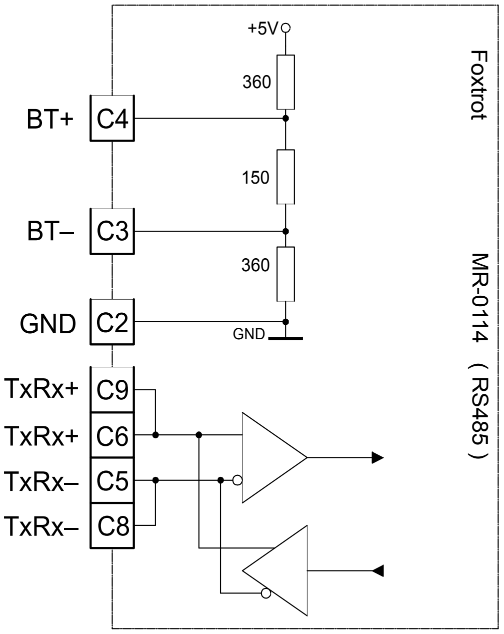
Fig.2.4.7.1 The layout of connectors (the Ethernet ports) on the SX-1162 module

2.5 **Examples of connection** of **Foxtrot communication interfaces**

The examples show the basic recommended connections, which are naturally not the only possible options.

2.5.1 The RS485 interface (the MR-0114 submodule) of the CH2 communication interface, characteristics

The RS-485 serial interface submodule (the MR-0114 type, order no. TXN 101 14) is fitted with a complete circuit of bus termination, terminated at C4 (signal BT +) and C3 (signal BT) terminals, see Fig.2.5.1.1. The termination is connected to the bus by connecting BT+ and TxRx+ terminals, or BT- and TxRx- (for an example, see Fig. 2.5.2.1).



BT+	positive terminal of the bus termination circuit
BT-	negative terminal of the bus termination circuit
GND	signal ground (a common terminal) interface
TxRx+	positive interface signal terminal RS-485
TxRx-	negative interface signal terminal RS-485

Note:

1 The terminals (signals) with identical marking are interconnected inside the submodule.

2 Terminating bus impedance is implemented with the resistance of 150 □.

Fig.2.5.1.1. The connection of the RS-485 interface in the MR-0114 submodule and its termination on the C terminal block.

2.5.2 Connection of two Foxtrot systems using the RS-485 interface (the MR-0114 submodule).

Interconnection of two Foxtrot systems using a serial channel with the RS-485 interface is shown in Fig.2.5.2.1. The connection assumes two systems and thus the bus terminator is connected on both sides. If there are several systems on the bus, the terminator (terminals BT+ and BT-) is only connected at the endpoint systems on the bus. Further parameters (conductors, installation principles) are applied in accordance with previous chapters relating to the RS-485.

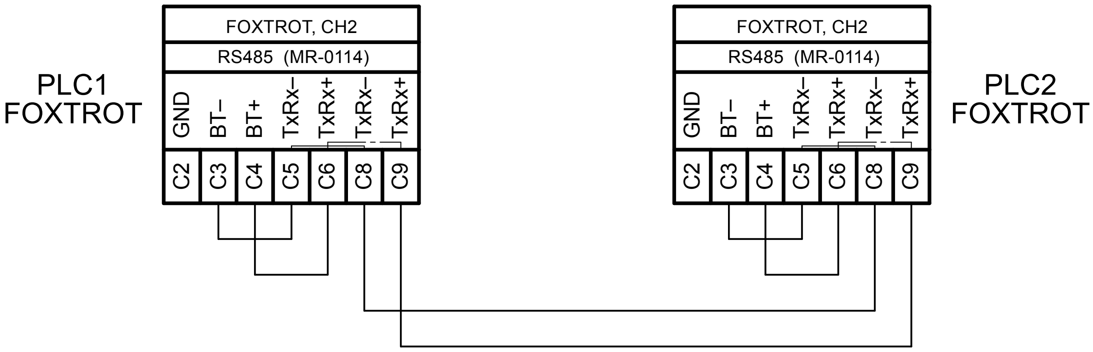


Fig.2.5.2.1 The diagram of interconnection of two Foxtrot systems with the RS-485 interface (the MR-0114 submodule).

2.5.3 Connection of the TC700 and Foxtrot systems using the RS-485 interface

Interconnection of the TC700 and NS950 systems using a serial channel with the RS-485 interface is shown in Fig.2.5.31. The connection assumes two systems and thus the bus terminator is connected on both sides. If there are several systems on the bus, the terminator is only connected at the endpoint systems on the bus.

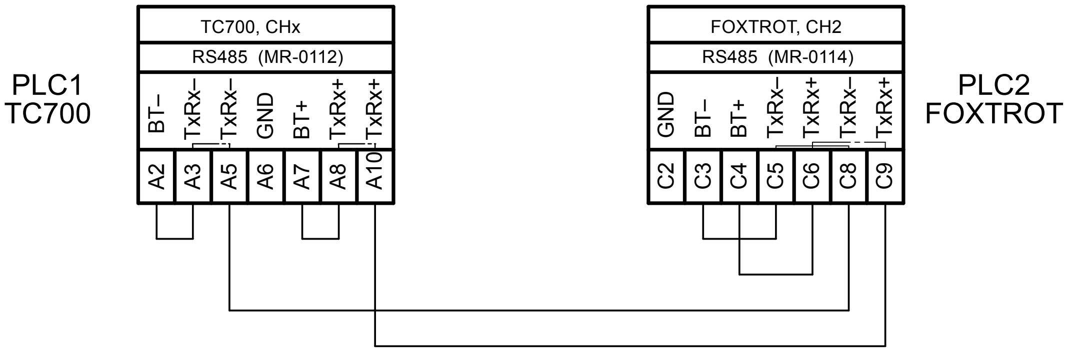


Fig.2.5.31 The diagram of interconnection of the TC700 and the Foxtrot systems with the RS-485 interface.

2.5.4 Connection of the Foxtrot system to the PC, RS-232 interface, CH1

If you want to connect Foxtrot to a PC using a serial channel (e.g. for programming - and you do not want or cannot use the Ethernet port), you can apply the RS-232 interface and a cable,which is connected as shown in Fig.2.5.41. The CH1 interface of the Foxtrot basic module is firmly fitted with the RS-232 interface. This type of connection is standard for peer-to-peer connection of two devices, so the data signals have to be crossed (TxD on one end is connected to RxD on the other end).

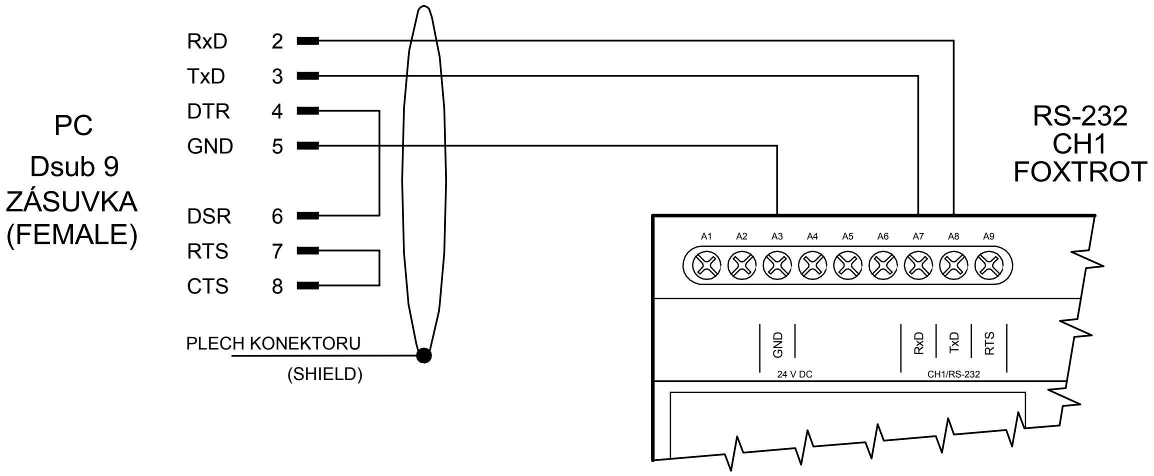


Fig.2.5.4.1 The diagram of connection of Foxtrot to PC, the RS-232 interface, CH1.

2.5.5 The XL-0471 module – an example of Foxtrot connection, the RS-485 interface

If you require an interconnection of the Foxtrot communication channels (e.g. an implementation of PLC network with the RS-485 interface), or if you want to conveniently connect other devices to the Foxtrot communication interface, or if you want to increase the resistance to surge, you can use the XL-0471 module. The module contains a hub of the RS-485 interface, and the straight-through connection (A and B terminal blocks) goes directly through the module, while the branching (C terminal block) is protected by a surge protection (lightning arrester, transil). For an example of the module connection see Fig.2.5.5.1. The module also allows direct connection of the cable shielding. Shielding of straight-through branches is interconnected and terminated on the G1 terminal (e.g. in a straight-through cable the shielding does not have to be earthed in the module); the shielding of the branch is connected to the G2 terminal, to which the surge protection is also connected and its connection to the switchboard earthing is assumed (the functional earthing).

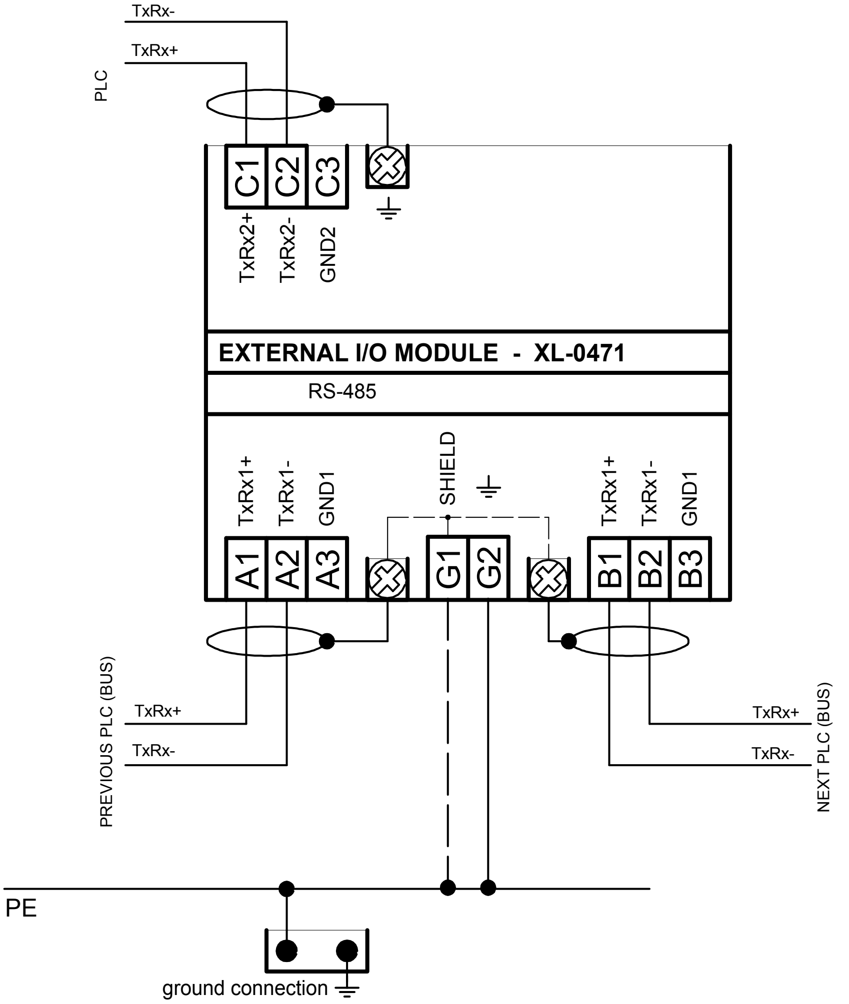


Fig.2.5.5.1 The diagram of connection of the XL-0471 module (interconnection of the Foxtrot systems, RS-485).

2.6 The PX-7811, PX-7812 submodules (CH2 Foxtrot fitted with DI and DO)

If you want to expand the Foxtrot basic modules CP-10x4, 10x5-CP and CP-1000 with several binary inputs, or possibly also outputs, and at the same time the CH2 is not used, then you can use the PX-7811 and 7812 submodules.
N.B.: The PX-7811 and PX-7812 submodules cannot be used in the CP-10x6 and the CP-10x8 basic modules.

The PX-7811 submodule fitted in the CH2 position of the Foxtrot basic module makes it possible to capture up to seven 24VDC binary signals with a common negative terminal, type 3 (the DI5 input is not used - it is not terminated on the terminal block). The submodule contains intelligent input circuits, which require 24VDC external supply voltage. It is connected to the connector terminals of the basic module.

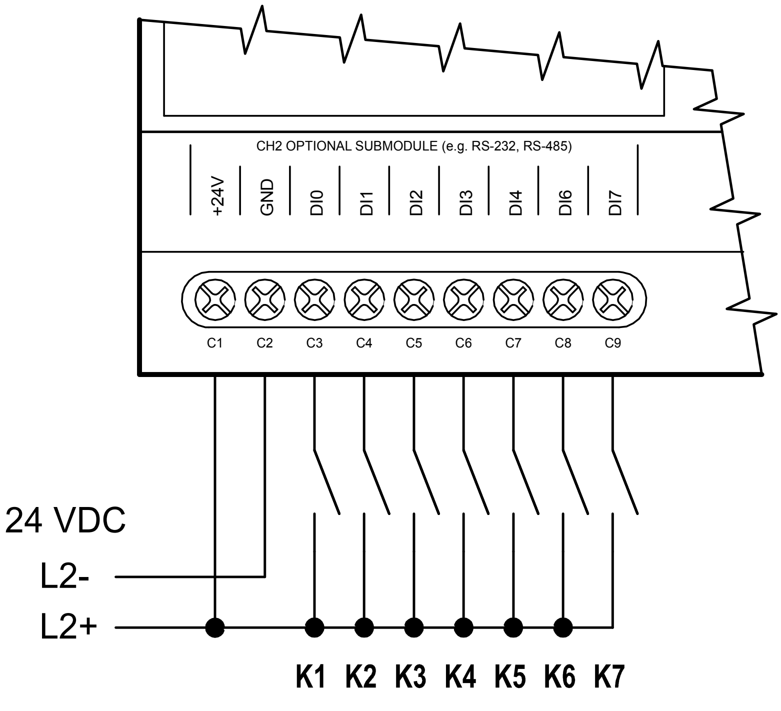


Fig.2.6.1 The wiring diagram of the PX-7811 submodule inputs

The PX-7812 submodule fitted in the CH2 position of the Foxtrot basic module makes it possible to capture up to four 24VDC binary signals with a common negative terminal, type 3 and switching up to three 24VDC digital outputs with a common terminal +24V (the DO1 output is not used - it is not terminated on the terminal block). The submodule contains intelligent input and output circuits, which require 24VDC external supply voltage. It is connected to the connector terminals of the basic module.
There are semi-conductor outputs, with a maximum switching-current of 0.5A for each output.

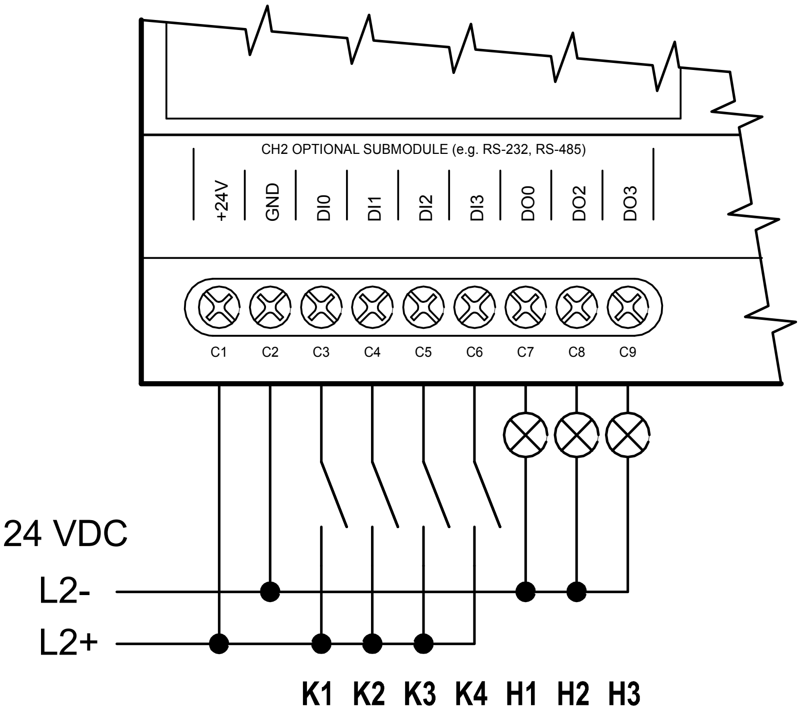


Fig.2.6.2 The wiring diagram of the PX-7812 submodule inputs and outputs

2.7 The FOXTROT basic modules

The CP-10xx analogue inputs, ranges, basic information

The analogue inputs in basic modules make it possible to connect a number of sensors and measured signals. Each CP-10xx variant is fitted with various numbers of inputs with different parameters - ranges, types of sensors and signals.

Tables 2.71 up to 2.74 list possible ranges and types of attachable sensors for each input (AI0, AI1, etc.), depending on the Foxtrot basic module variant. This overview should enable you to get an idea about possible combinations of sensors and signals that can be connected to a particular Foxtrot basic module.

For details on the temperature sensors, their characteristics and a selection of recommended sensors in accordance with the technologies, see Chapter 10. This documentation also includes a number of examples of connections and recommended sensors for measurement or metering of various parameters.

Basic examples of connections of sensors and signals to the CP-10xx inputs are given in the relevant chapters describing the Foxtrot basic modules.

The tables always list on each line all available ranges of a particular basic module (for detailed information on sensors, see Chapter 10). It is shown in the Table, which specific ranges (of sensors) can be connected to individual module inputs.

Table2.71: An overview of ranges of the **CP-10x4** module analogue inputs

CP-10x4	AI0	AI1	AI2	AI3	ïn total
0 ÷ 10V	yes	yes	yes	yes	4
0 ÷ 20mA	1)	1)	1)	1)	4
4 ÷ 20mA	1)	1)	1)	1)	4

1) Only with external resistance of 500Ω (MT-1690 module) with manual recalculation from the voltage

Table 2.72: An overview of ranges of the **CP-10x5** module analogue inputs

CP-10x5	AI0	AI1	AI2	AI3	AI4	AI5	ïn total
Pt100	yes	yes	yes	yes	yes	yes	6
Pt1000	yes	yes	yes	yes	yes	yes	6
Ni1000	yes	yes	yes	yes	yes	yes	6
OV1000	yes	yes	yes	yes	yes	yes	6
NTC 12k	yes	yes	yes	yes	yes	yes	6
0 ÷ 2 kΩ	yes	yes	yes	yes	yes	yes	6
0 ÷ 200 kΩ	yes	yes	yes	yes	yes	yes	6
0 ÷ 20mA	yes	yes	yes	yes	yes	yes	6
4 ÷ 20mA	yes	yes	yes	yes	yes	yes	6
0 ÷ 10V	yes	yes	yes	yes	yes	yes	6

0 ÷ 5V	yes	yes	yes	yes	yes	yes	6
0 ÷ 2V	yes	yes	yes	yes	yes	yes	6
0 ÷ 1V	yes	yes	yes	yes	yes	yes	6
0 ÷ 0.5V	yes	yes	yes	yes	yes	yes	6

Table2.73: An overview of ranges of the **CP-10x6** module analogue inputs

CP-10x6	AI0	AI1	AI2	AI3	AI4	AI5	AI6	AI7	AI8	AI9	AI10	AI11	AI12	ïn total
Pt1000	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13
Ni1000	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13
OV1000	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13
KTY81-121	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	13
0 ÷ 20mA							yes	yes	yes	yes	yes	yes	yes	7
4 ÷ 20mA							yes	yes	yes	yes	yes	yes	yes	7

Table2.74: An overview of ranges of the **CP-10x8** module analogue inputs

CP-10x8	AI0	AI1	AI2	AI3	AI4	AI5	AI6	AI7	AI8	AI9	AI10	AI11	AI12	ïn total
Pt1000	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes			Internal temperature sensor	10
Ni1000	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes				10
0 ÷ 2 kΩ	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes				10
KTY81-121	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes				10
NTC 12k					yes	yes	yes	yes	yes	yes				6
0 ÷ 200 kΩ					yes	yes	yes	yes	yes	yes				6
0 ÷ 20mA					yes	yes	yes	yes	yes	yes				6
4 ÷ 20mA					yes	yes	yes	yes	yes	yes				6
TC											yes	yes		2
0 ÷ 2V											yes	yes		2
0 ÷ 1V											yes	yes		2
-0.02 ÷ 0.1V											yes	yes		2
-0.02 ÷ 0.05V											yes	yes		2
Lambda probe											yes	yes		2

The CP-10xx internal data and time backup during a power failure.
When the power supply for the CP-10xx is off, some selected user data and the real-time clock is backed up. The backup is provided by a Li-Ion battery. After power supply is restored, the battery recharges and is

ready to back up again. The battery requires no maintenance. A Li-Ion battery backup lasts about 500 hours.

Additional internal backup battery
If for some reason you need to extend the backup time (e.g. to bridge the power outage for more than 500 hours), an additional CR2032 lithium battery can be fitted into the prepared holder. After the main battery is discharged, it will start supplying power and thus extend the backup time up to 20,000 hours.
It is recommended to replace the backup battery (CR2032 or similar, 3V, 20mm diameter, 3.2mm thickness) every 2-3 years. The battery lifetime is typically 5 years. The battery is inserted into the holder located in the middle board of the basic module and it is accessible after removing the boards from the plastic cover (for detailed information see the basic documentation for the individual modules).

2.7.1 The **CP-1000, CP-1001**

To control the installation of an intelligent home, the heating system, etc., any Foxtrot basic module can be used. Individual basic module types vary in the number and type of inputs and outputs, fitted internal communication interfaces and indications.

Selection of the basic module depends mainly on the application size (the number of peripheral modules on buses CFox, RFox and TCL2), its topology (placement of the basic module and, controlled systems in the installation, etc. ...) and on the controlled technologies (heat sources, their complexity, etc.).

E.g. if the system includes solar water heating, heat sources control, charging the storage tanks, etc., it is advantageous to use the basic CP-1006 or CP-1008 modules, which have a higher number of inputs for connecting temperature sensors, outputs for continuous speed control of circulation pumps and a direct input for the ripple control signal.

In applications where the basic module is located far from the controlled technology and where is a higher number of peripheral modules on CIB buses, it is preferable to use the CP-1000 basic module.

In extensive applications, where complex application software is expected, as well as multiple devices control via a communication interface, etc., it is recommended to use the CP-1001 basic module. This basic module has twice as much memory for the program and three times more for registers (application data) than the CP-1000. In terms of inputs and outputs, which are important properties for the project itself, both basic modules (the CP-1000 and the CP-1001) are identical.

2.7.1.1 The CP-1000 power supply without a backup

The CP-1000 represents the simplest variant of the basic module for home installations.
The basic module is supplied from a 24VDC source.
Both CIB branches (B connector) are supplied from the basic modules, which means that no decoupling module is used for powering the CIB buses; isolation circuits for power supply to both buses are integrated directly in the CP-1000 basic module.
On the A connector is terminated the system TCL2 bus (primarily for connecting the external CF-1141 and RF-1131) master modules, and the serial communication channel CH1 (usually for GSM modem connection).

On the D connector is terminated the second communication channel, in which additional interfaces can be implemented, such as the RS485, the M-bus master, CAN, the RS232 and others, using additional submodules. Possible options of fitting the submodules with interfaces are described in Chapter Communication interface of the Foxtrot basic module.

The E and F connectors serve for inputs and outputs: 4 universal AI/DI (contact, NTC, Pt1000, Ni1000), 2 separate 3A relay outputs, the ripple control input and IN 230VAC input (a standard binary 230 VAC input).

The CP-1000xx internal data and time backup during a power failure.
When the power supply for the CP-1000 is interrupted, some selected user data and the real-time clock are backed up. The backup is provided by a Li-Ion battery. After power supply is restored, the battery recharges and is ready to back up again. The battery requires no maintenance.

A Li-Ion battery backup lasts about 500 hours.

Additional internal backup battery
If for some reason you need to extend the backup time (e.g. to bridge the power outage for more than 500 hours), an additional CR2032 lithium battery can be fitted into the prepared holder. After the main battery is discharged, it will start supplying power and thus extend the backup time up to 20,000 hours.
It is recommended to replace the backup battery (the CR2032 or similar, 3V, 20mm diameter, 3.2mm thickness) every 2-3 years. The battery lifetime is typically 5 years. The battery is inserted into the holder located in the middle board of the basic module and it is accessible after removing the boards from the plastic housing (for detailed information see the basic documentation for the individual modules). The battery status is monitored and signalled in the system registers of the basic module.

An additional battery is mounted only if a really long backup time is needed, because the basic module then ceases to be maintenance-free and the battery must be changed regularly.

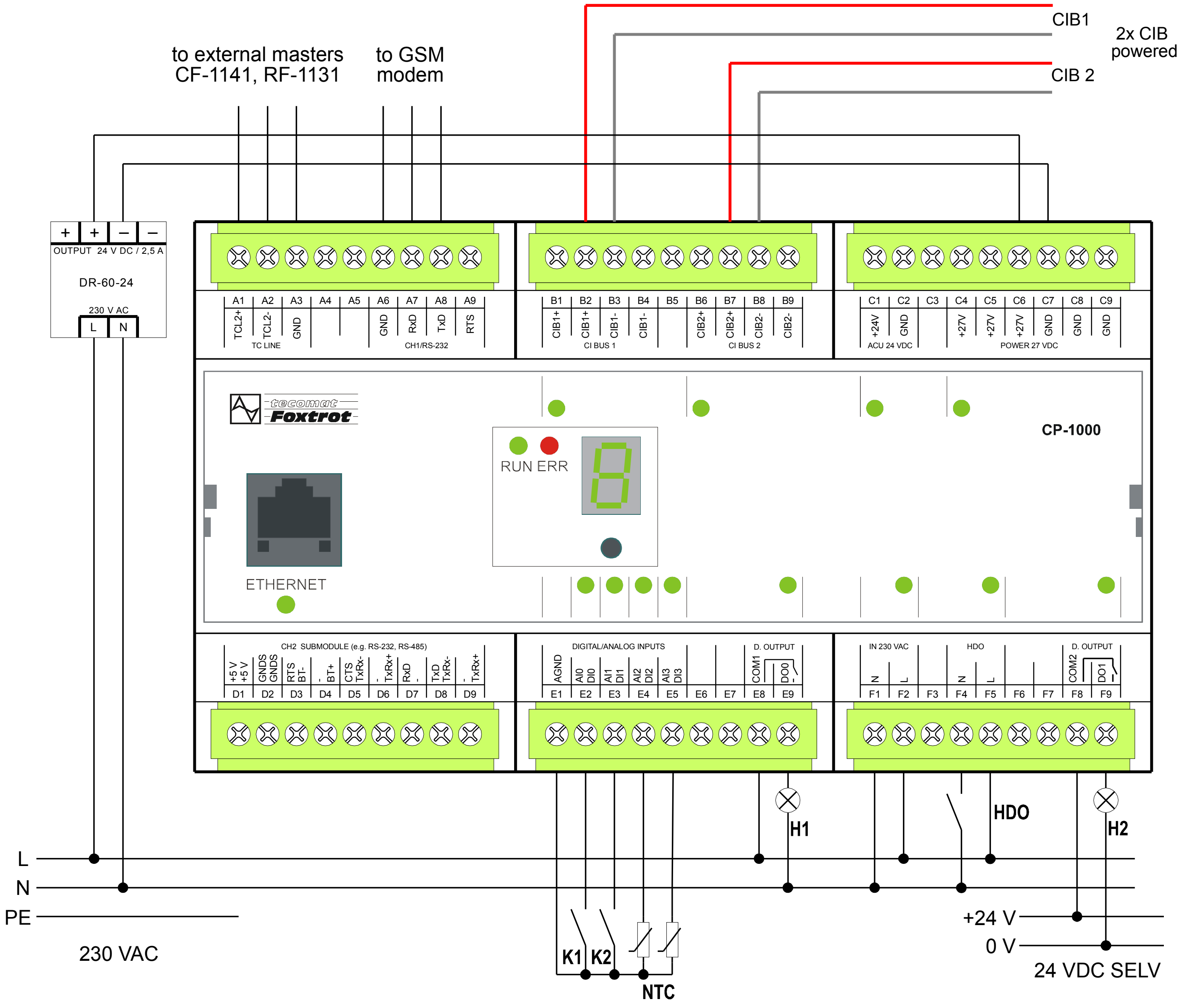


Fig. 2.7.1.1. An example of power supply connection to the CP-1000 without a backup

Notes:

1) We recommend a stabilized 24VDC power supply, complying with SELV requirements, and the PS2-60/27 is our standard recommendation. Power consumption of the CP-1000 is the sum of its own power (typically 3W) and the total power consumption of all CFox modules connected to both CIB branches.
2) In the terminal block B there is an output of both CIB branches including the power supply with a maximum current of 1A for each branch.
3) The AI/DI0 to AI/DI3 inputs are universal (contact, NTC temperature sensor, Pt1000, Ni1000), the inputs do not have the function of "capturing short pulses", which means that the evaluated input status length must exceed that of the programme cycle (200 ms is usually enough)
4) The IN 230VAC input (F1 and F2 terminals) is designed to monitor the presence of 230V mains power supply. It is a standard 230VAC input, with galvanic isolation.
5) The ripple control input (F4 and F5 terminals) is for the ripple signal coming from the utility distribution grid. This input can withstand - without being damaged - even badly connected ripple control in the household installation.
6) The DO0 and DO1 outputs are standard electromechanical 3A contact relays, with galvanic isolation from other circuits.

2.7.1.2 The CP-1000, a power supply with a backup

If the Foxtrot control system is also utilized for electronic security signalization, it is vital to use a battery backup. The power supply must be able to supply power to the electronic security system in all its modes for the required time, while the power supply must provide charging of the connected backup batteries. The PS2-60/27 power supply with 27.2VDC output voltage is specified to power the whole system and to charge the backup batteries. The supply is also fitted with a 12VDC output, with max. 300mA, for powering the detectors of the electronic security system. This supply voltage is active even when the application is running from the connected batteries. For a backup, it is necessary to use two 12VDC sealed lead-acid type batteries (typically with a capacity of 7Ah up to 18 Ah), connected in series – see the figure below.
The presence of 230VAC mains voltage is monitored by the IN 230VAC input (the mains voltage is connected to F1 and F2 terminals). The basic module also measures the value of the main power supply voltage (i.e. the voltage at the C connector). The state of the IN 230VAC input and the level of supply voltage are indicators of both the presence of the mains 230VAC voltage and the state of the batteries (if they are used) by measuring their voltage; a warning signal will be sent in time before their discharge (as an SMS message , etc.).

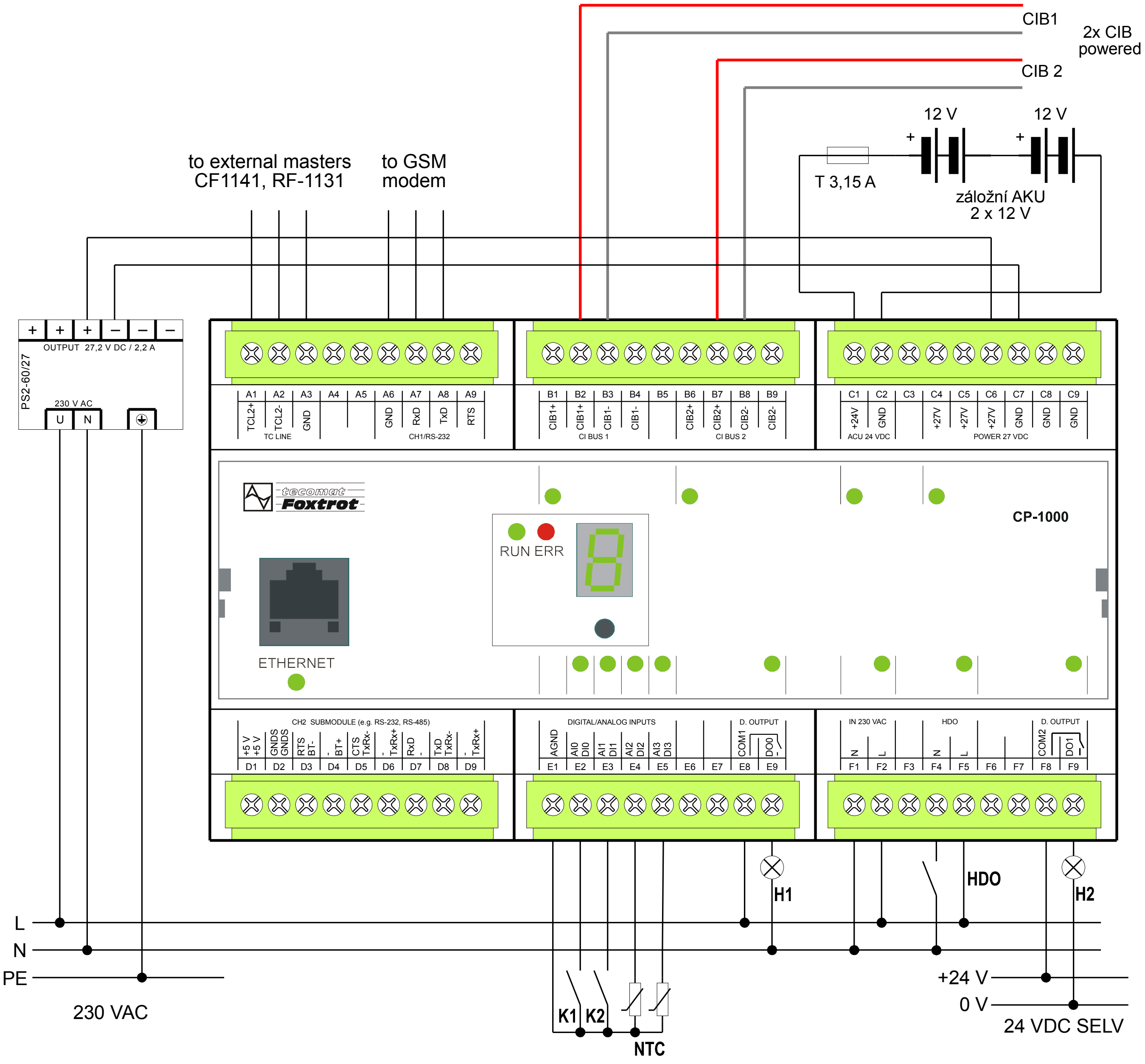


Fig. 2.7.1.2. An example of the CP-1000 power supply connection with a backup of the system supply voltage.

Notes:

1) The power supply must be stabilized 27.2 VDC, fulfilling the SELV requirements and designed to charge the connected batteries, usually the PS2-60/27. The power consumption of the CP-1000 is the sum of its own consumption (typically 4W) and the total power consumption of all CFox modules connected to both CIB branches.
2) The battery lifetime is approx. 3-4 years, but it decreases significantly with increasing ambient temperature, so it is advisable to place the batteries in a cooler location. It should be placed in the lowest possible location in the distribution cabinet (e.g. on the bottom of the housing).
3) In the terminal block B there is an output of both CIB branches including the power supply with a maximum current of 1A for each branch.
4) The AI/DI0 to AI/DI3 inputs are universal (contact, NTC temperature sensor, Pt1000, Ni1000), the inputs do not have the function of "capturing short pulses", which means that the evaluated input state length must exceed that of the programme cycle (200 ms is usually enough).
5) The IN 230 VAC input (F1 and F2 terminals) is designed to monitor the presence of 230V mains power supply. It is a standard 230VAC input, with galvanic isolation.
6) The ripple control input (F4 and F5 terminals) is for the ripple signal coming from the utility distribution grid. This input can withstand even a badly connected ripple control (ripple signal coming from the grid) in the household installation without being damaged.
7) The DO0 and DO1 outputs are standard electromechanical 3A contact relays, with galvanic isolation from other circuits.

Wiring according to Fig. 2.7.1.2. does not permit using a more powerful type of power supply, because during a power outage and the battery discharge, the supply (and charging) current increases to a point when the fuse on the power supply lead to the CP-1000 blows. Subsequently, the system works further only powered by batteries, which are not being recharged.

2.7.2 The **CP-1003**

The CP-1003 basic module features eight multi-purpose inputs, each of which can be used either as an analogue input (voltage, current or a passive temperature sensor) or a binary 24V input, with eight fast binary inputs featuring adjustable decision level, four analogue outputs ± 10V, eight relay outputs and four high-speed transistor outputs allowing direct connection of DC or stepper motors.

The basic CP-1003 module is fitted with the Ethernet interface, with up to 4 serial ports (the first one with a fixed RS-485 interface, others with an additional slot for an optional submodule) and two TCL2 system interfaces for connecting expansion modules, which increase the number of I/O in the system.

A standard configuration of the module is in a 9M housing on a DIN rail (for the housing dimensions, see Chapter 13.2.1 9M housing on a DIN rail), and it is fitted with six removable terminal blocks.

The **I/O layout**:

Power supply	24VDC, power consumption max. 10W (information on power supply see Chapter 2.2)
AI0 ÷ AI7	7 analogue inputs, galvanically isolated with optional binary input: for the ranges see the Table below
DI8 ÷ DI15	8 binary inputs, with galvanic isolation, for the ranges see the Table below
AO0 ÷ AO3	4 analogue outputs with galvanic isolation, range -10 ÷ 10 V
DO0	semiconductor output, galvanically isolated from other circuits, 1 A, 230V, SSR, the output can be set to PWM mode
DO1 ÷ DO6	6 relay outputs, with galvanic isolation from other circuits, 3 A on the output
DO7	relay output for continuous 10A (16 A contact)
DO8 ÷ DO11	4 semi-conductor 24 V outputs, for the parameters see the Table below

The Ethernet 10/100 Mbit (a standard RJ-45 connector), with galvanic isolation from other circuits, see Chapter 2.4.1

CH1 Serial channel, with fixed RS-485interface, without galvanic isolation see Chap. 2.3.1

CH2 Serial channel, with a possibility of fitting with standard submodules, see Chapter 2.3.3

Basic parameters

Supply voltage (SELV)	24VDC, +25%, –15%
Power consumption of the module	max. 10W
Connection/max. wire cross-section	removable terminal blocks, max. 2.5mm2 (power supply, DO, CH1, TCL2), max. 1.5mm2 (DI, AI, AO, CH2)

The analogue inputs	**AI0 ÷ AI7**
Galvanic isolation from internal circuits	yes (galvanic connection only with analogue outputs)
Temperature sensor Pt1000, W_{100}=1,385 or 1,391	-90 °C ÷ +400 °C
Temperature sensor Ni1000, W_{100}=1.500 or 1.617	-60 °C ÷ +200 °C
Temperature sensor NTC 12k	-40 °C ÷ +125 °C
Temperature sensor KTY81-121	-55 °C ÷ +125 °C
Resistance ranges	0 ÷ 1kΩ 0 ÷ 2kΩ 0 ÷ 200kΩ
Voltage ranges	0 ÷ 0.5V 0 ÷ 1V 0 ÷ 2V 0 ÷ 5V 0 ÷ 10V
Current ranges	0 ÷ 20mA 4 ÷ 20mA
Input resistance for current ranges	100Ω
Input resistance for voltage ranges	> 20kΩ (ranges 10V, 5V) > 50kΩ (ranges 2V, 1V, 0,5V)
Internal voltage for power supply of resistance sensors	7.27V
Conversion time of channel	typically 80μs
Recovery time of each channel value	typically 480μs

Analogue outputs	**AO0 ÷ AO3**
Output range	-10 ÷ 10V
Maximum output value	105% of the output range upper limit
Maximum output current	10mA
Maximum load capacity	50nF
Galvanic isolation from internal circuits	yes [1]

[1] The AO0 - AO3 outputs have a common ground with the DI0/AI0 - DI7/AI7 inputs.

Binary inputs	**DI0 ÷ DI7**	**DI8 ÷ DI15**
Galvanic isolation from internal circuits	yes (galvanic connection only with analogue outputs)	
External power supply	-	Yes, VDI = 5 ÷ 30VDC
Input voltage for log. 0	max. +5VDC	max. 0.25 * VDI
Input voltage for log. 1	min. +15 VDC typically +24VDC max. +30 VDC	min. 0.6 * VDI typically VDI max. +30VDC
Input current in log. 1	typically 5mA	typically 5mA at 24V
The minimum width of the captured pulse	-	5μs

Notes:

1. The DI0 - DI7 inputs, which can also be used as analogue inputs AI0 - AI7, are galvanically isolated from the internal PLC circuits; they have a common ground with the AO0 - AO3 analogue outputs. The DI0 - DI7 inputs work as binary only when they are not used for analogue measurements (valid for each input independently of the others).
2. The DI8 - DI15 inputs can be used as inputs for counters. These inputs are arranged in two groups of four with separately terminated power supply for each galvanically isolated tetrad. Each of these four inputs can thus operate with different voltage levels in the range of 5-24V, which makes it possible also to connect IRC sensors with 5 or 12V power supply. Even when they are used as inputs for counters, the DI8 - DI15 inputs can be concurrently used as binary.
3. The DI8 - DI15 inputs make it possible to switch on the function of capturing short pulses. This function extends the selected level of input signal up to the PLC cycle. In this way you make sure that no single pulse shorter than the PLC cycle will be lost in the input.
4. If any of the four inputs is used for an object of the relevant counter, the function of capturing short pulses cannot be used in any of the four inputs.

The DI8 ÷ DI15 counter inputs

Input frequency – a fast unidirectional counter	100kHz
Input frequency – a standard counter	5kHz
The IRC symmetric frequency sensor (tracks V, G)	100kHz
Maximum metering rate	400,000 increments
Pulse width	min. 5μs
Pulse length, period and phase shift measurement: input frequency Pulse width	 0.1 ÷ 5,000Hz 50 to 10,000,000μs

Notes:

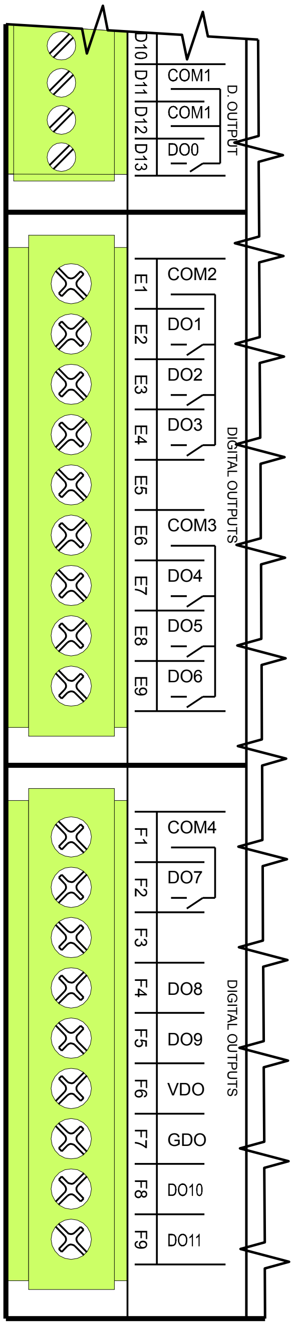
1. Conventional counters can be operated with the signal frequency of 5kHz. In an unidirectional counter and IRC modes, the hardware support is enabled and the counter can be operated at a high speed mode with the signal frequency of up to 100kHz.

The DO8 ÷ DO11 binary outputs

The number of outputs	4 (in one group)
Galvanic isolation from internal circuits	yes
Outputs type	Semiconductor output, a half-bridge (push-pull)
Switching voltage	10 - 32V
Switching current	each output continuously 2.7A, in pulse mode 4A
at 25 °C ambient temperature at about 50 °C ambient temperature	$I_{DO8} + I_{DO9} + I_{DO10} + I_{DO11} < 6A$ $I_{DO8} + I_{DO9} + I_{DO10} + I_{DO11} < 4A$
Residual current (blocked outputs)	max. 2 mA
Output resistance	typically 0.3Ω max. 0.6Ω
Switching/opening duration	typically 1.6/0.6μs
Short-circuit protection	yes

The PWM DO8 ÷ DO11 outputs
The DO8 - DO11 binary transistor outputs can also be operated in the pulse-width modulation (PWM) mode. It is possible to set a common pulse repetition periodfor these outputs as a part of the initialization. The pulse width itself is variable and is determined separately for each output by the value of the corresponding object variable PWM output These four outputs can be blocked in pairs from the user program.

The relay outputs of the CP-1003 module



The **DO0** SSR (semiconductor relay) output, continuous current in the output 0,7 A, inrush 1 A. The output is fitted with an SSR relay switching at zero It can be used as a PWM output to control e.g. the revolutions of small asynchronous motors (fans, circulation pumps)

Isolation voltage between the output and other circuits is 3750 VAC, i.e. safe isolation of circuits.

The **DO1 ÷ DO3** outputs with a common terminal, continuous current in the 3 A output, inrush 5A, max.continuous current in the common terminal COM2 is 10A, more detailed information on the relay contacts.

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits

The **DO4 ÷ DO6** outputs with a common terminal, continuous current in the 3A output, inrush current 5A, max.continuous current in common terminal COM3 is 10 A, more detailed information on relay contacts.

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits

The **DO7** relay continuous current 10A, inrush overloading 160 A < 20 μs, detailed information about relays in Chapter 13.4.2

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits

The **DO8 ÷ DO11** semiconductor outputs with common power supply on VDO a GDO terminals, continuous current in the output 2.7A, the outputs require power supply for their proper function (typically 24VDC).

For principles of protection and usage for capacitive and inductive loads, see Chapter 13.7.1 Protection of output elements (relays,...).

Terminal blocks of the basic module are connectors witha cage terminal with spacing 5.08 mm. Detailed parameters of the terminals are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail

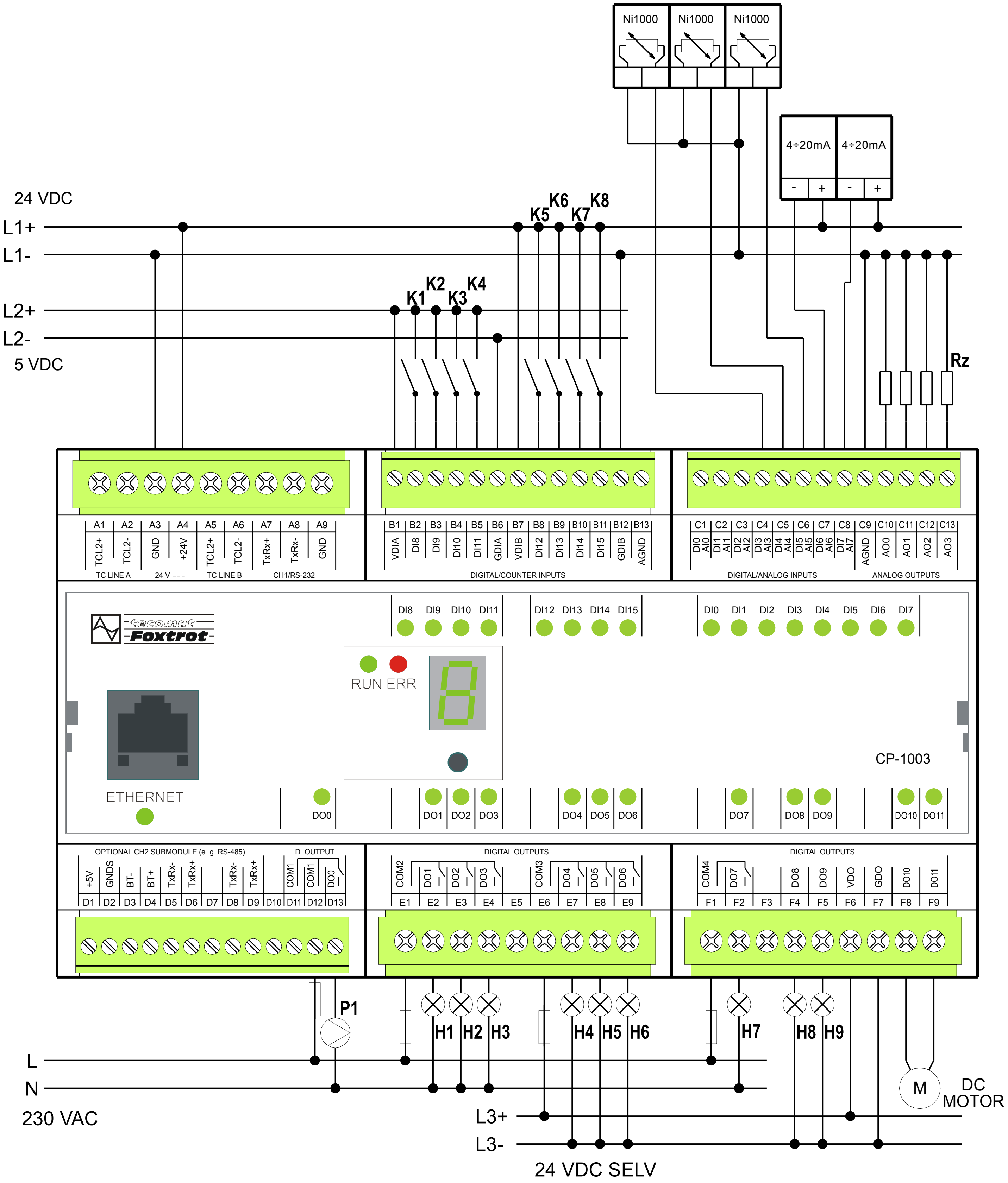


Fig. 2.7.2.1 Example of connecting the CP-1003module.

Notes:

1. The RS-485 (CH1) interface is firmly terminated in the module with appropriate impedance and it must always be at the end of the RS-485 line (the same applies for the TCL2 interface in the Foxtrot basic module).

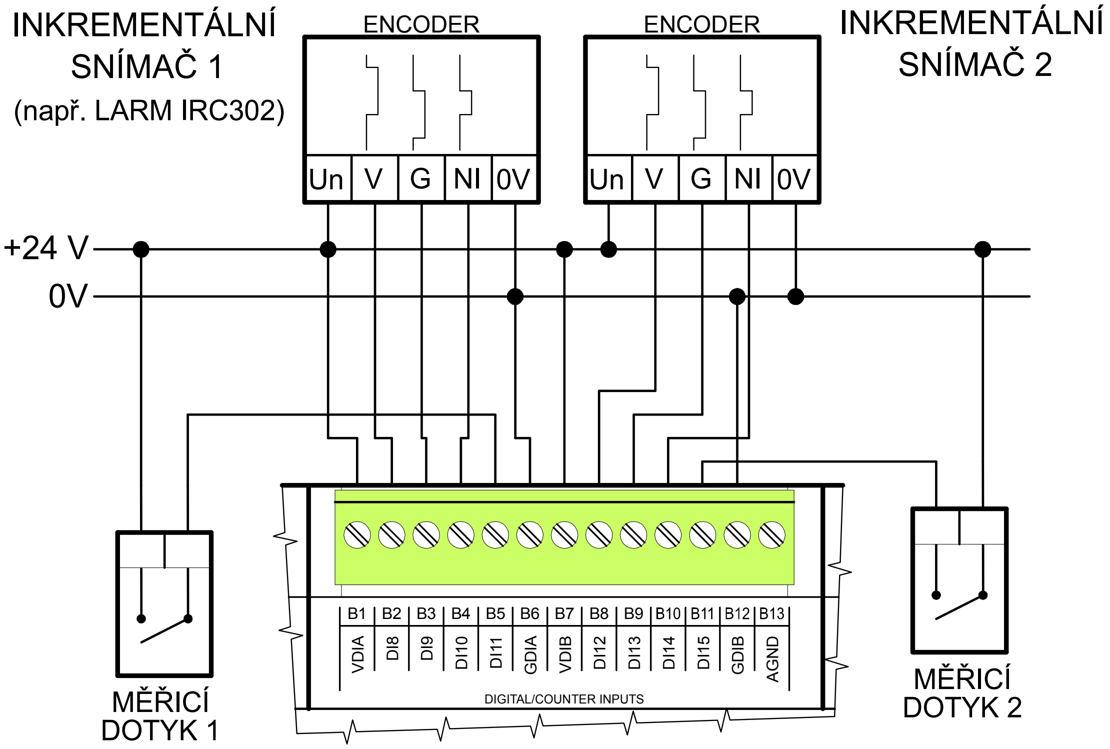


Fig. 2.7.2.2 An example of connecting incremental encoders to the CP-1003

2.7.3 The **CP-1004**

The CP-1004 basic module is the smallest independent control system in the Foxtrot series. A standard configuration of the module is in a 6M housing on a DIN rail (for the housing dimensions, see Chapter 6M housing on a DIN rail), and it is fitted with six removable terminal blocks.

The layout:

Power supply	24VDC, power consumption typically 3 W, max. 8W (see Chapter 2.2)
DI0 ÷ 7	8 binary inputs, without galvanic isolation: DI0 ÷ DI3 optional special functions (see Chapter 2.7.3.1), DI4 ÷ DI7 optional analogue inputs 0÷10V (positive input terminal AI0÷AI3)
DO0 ÷ DO5	6 relay outputs, with galvanic isolation from other circuits

ETH Ethernet 10/100 Mbit (a standard RJ-45 connector), with galvanic isolation from other circuits, see Chapter 2.4.1

CH1 Serial channel, with fixed RS232 interface, without galvanic isolation, see Chap. 2.3.1

CH2 Serial channel, with a possibility of fitting with standard submodules, see Chapter 2.3.3

The AI0 ÷ AI3 analogue inputs

Range	0 ÷ 10V
Input resistance	about 6.9 kΩ
Conversion time	20 µs

The DI0 ÷ DI7 binary inputs

Input type	Type 1
Input voltage for Log. 0	max. +5VDC
Input voltage for log.1	min. +15VDC, typically +24DC, max. +30VDC
The minimum width of the captured pulse	50 µs
Max. input frequency (DI0 ÷ DI3 inputs)	5kHz

The relay outputs

The **DO0 ÷ DO2**, outputs with a common terminal, continuous current in the 3A output, inrush 5A, max.continuous current in common terminal COM1 is 10A, detailed information on relay contacts.

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits.

The **DO3 ÷ DO5** outputs with a common terminal, continuous current in 3 A output, inrush 5A, max.continuous current in common terminal COM2 is 10A, detailed information on relay contacts.

The principles of protection and application for capacitative and inductive loads are defined in Chapter 13.7.1 Protection of output elements (relay, ...).

The terminal block of the basic module is made up of connectors witha cage terminal with spacing 5.08 mm. Detailed parameters of the terminal are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail

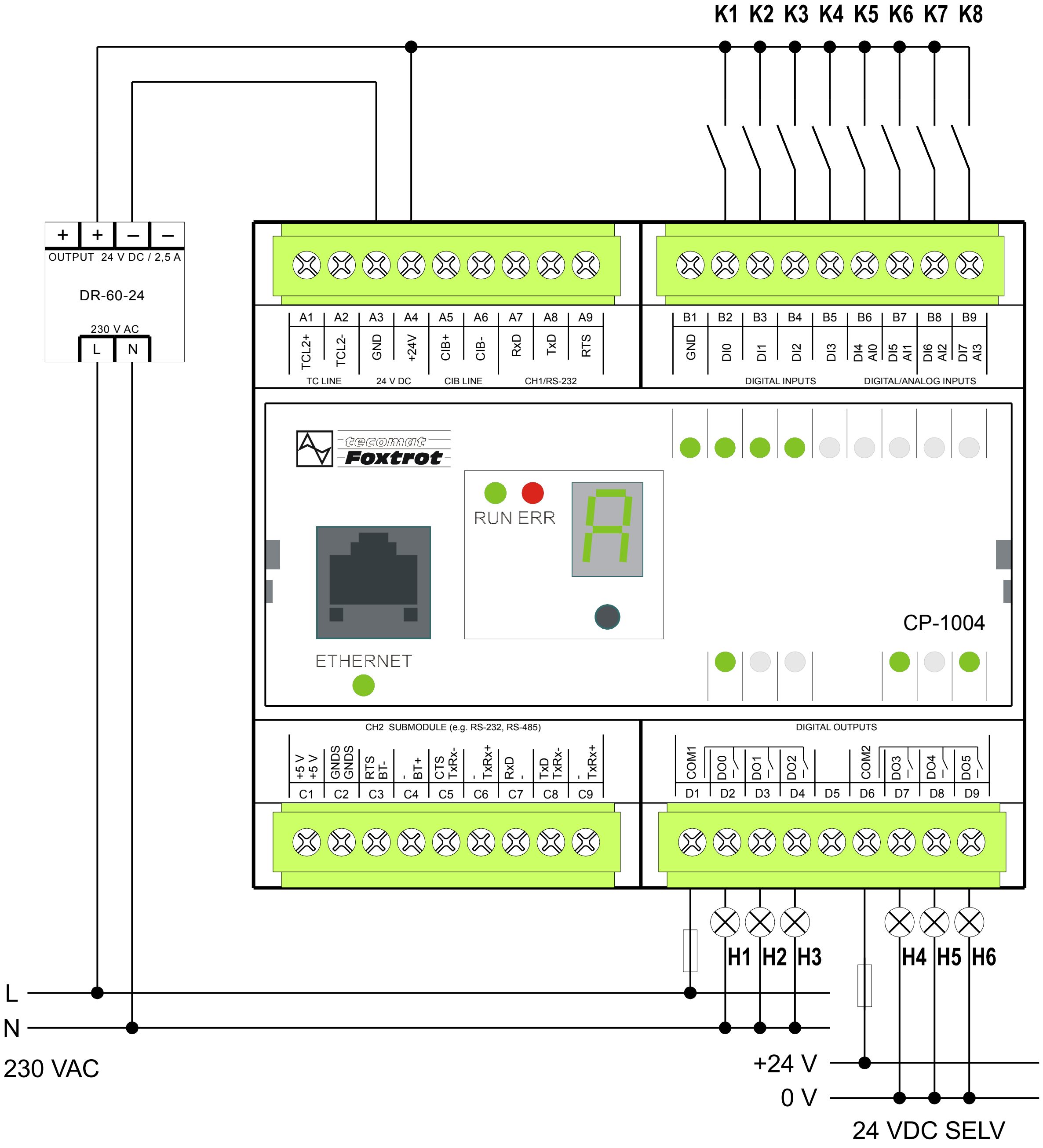


Fig. 2.7.31 A standard example of the CP-1004 basic module wiring

Wiring notes:

1. Groups of relay outputs (DO0 ÷ 2 and DO3 ÷ 5) can switch circuits powered by different sources. The groups are separated by isolation corresponding to a safe circuit isolation.
2. Optional functions of the DI/AI inputs are set from the programming environment, and the wiring examples are shown in the following chapters.
3. The TCL2 bus is firmly terminated in the basic module and it must always be at the end of the bus line (see Chapter 3.3 The TCL2 bus – principles of design and installation).
4. The module power supply, the TCL2 interface, the CIB and the CH1 have a common signal ground, a GND terminal (the A3 terminal). This terminal is connected to a common terminal DI/AI (the B1 terminal).

5. The analogue inputs AI0÷AI3 are configured as inputs with a common negative terminal GND.
6. The A3 and B1 terminals (GND) should not be connected with each other (they are connected via internal circuits). In powering CP and the input circuits from one source (see the example), the B1 terminal is not used at all. When powering the DI input circuits from a separate source, then the negative terminal of the source should be connected to the B1 terminal (see Fig. 2.7.3.2).

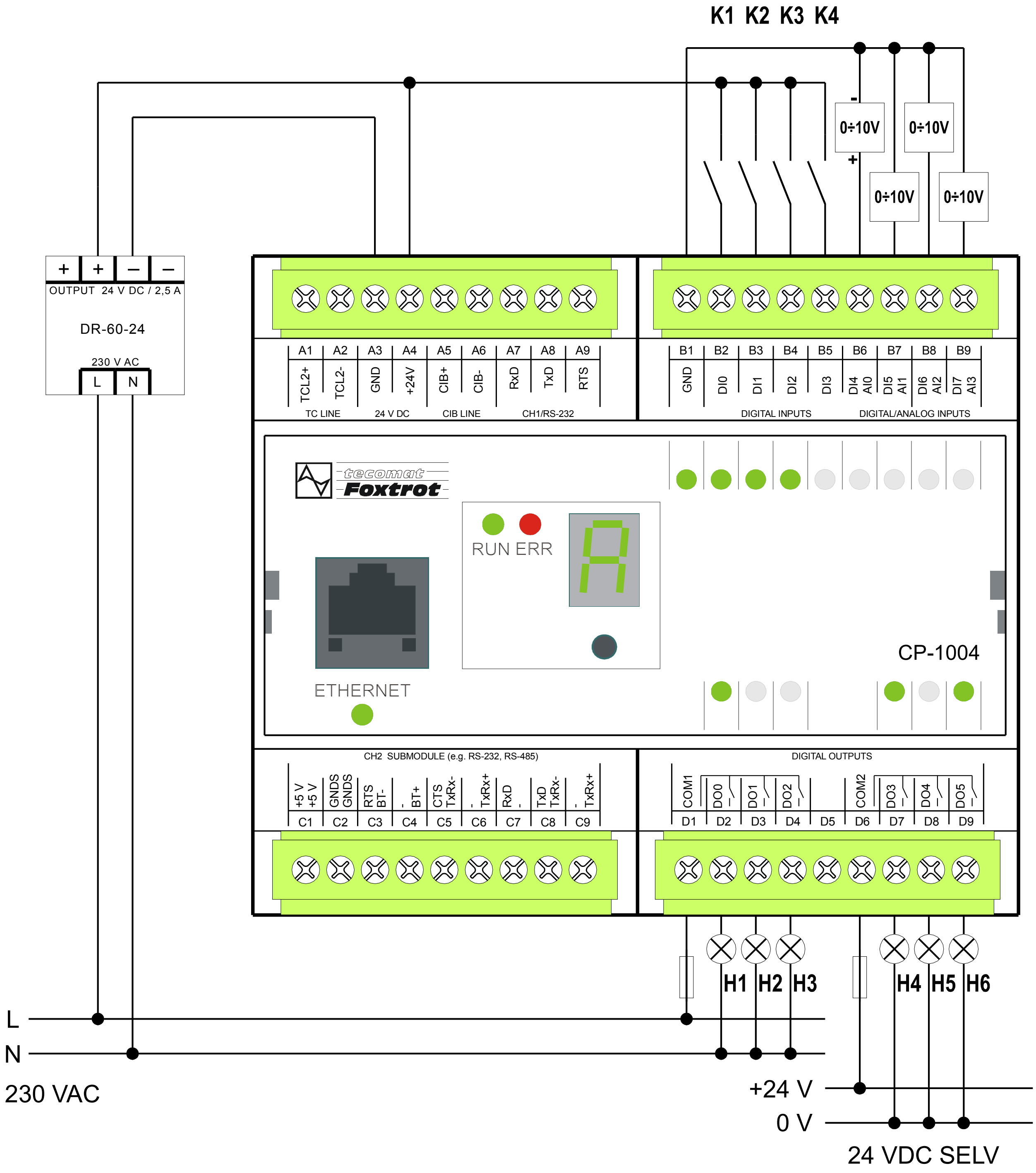


Fig. 2.7.3.2 An example of wiring the CP-1004 module analogue inputs

2.7.3.1 Special functions of the CP-1004 module binary inputs

The DI0, DI1 (counter 1) and the DI2, DI3 (counter 2) binary inputs can be set - in addition to the function of standard inputs - to one of the special functions, allowing the connection of a positioning incremental encoder, application of fast counters, measuring the period and phase shift (e.g. for the phase-locking of a generator in small hydro plants), etc.
Individual functions are described in detail in the documentation [2], here is a Table with an overview of examples of specific terminal connections.

Counter 1

mode	**function**	**DI0**	**DI1**	**DI2**	**DI3**	**An example**
00	The counter is off (inputs DI0 and DI1 – standard binary inputs)	DI0	DI1	According to counter 2		
01	One unidirectional counter	CI1	-	According to counter 2		2.7.3.1.1
02	Two unidirectional counters	CI1	CI2	According to counter 2		2.7.3.1.2
04	Bidirectional counter	UP1	DN1	According to counter 2		
05	Counter with direction control	CI1	U/D1	According to counter 2		
08	Incremental encoder (without zeroing and capturing)	V1	G1	According to counter 2		2.7.3.1.3
14	Bidirectional counter with zeroing and capturing	UP	DN	RES	MEM	
15	Counter with direction control with zeroing and capturing	CI	U/D	RES	MEM	
18	Incremental encoder with zeroing and capturing	V	G	NI	MD	2.7.3.1.4
1C	Pulse length measurement	IN1	IN2	IN3	IN4	
1D	Period and phase shift measurement	PER1	PER2	PER3	PER4	

Counter 2

mode	**function**	**DI0**	**DI1**	**DI2**	**DI3**	**An example**
00	The counter is off (inputs DI0 and DI1 – standard binary inputs)	According to counter 1		DI2	DI3	

01	One unidirectional counter	According to counter 1	CI2	-	2.7.3.1.1
02	Two unidirectional counters	According to counter 1	CI3	CI4	2.7.3.1.2
04	Bidirectional counter	According to counter 1	UP2	DN2	
05	Counter with direction control	According to counter 1	CI2	U/D2	
08	Incremental encoder (without zeroing and capturing)	According to counter 1	V2	G2	2.7.3.1.3

The DI0 ÷ D I3 counter inputs

Max. Input frequency	5kHz
The minimum width of the captured pulse	50 μs
Incremental sensor:	
Max. frequency of symmetric signal V, G	5kHz
Pulse width (V, G, NI, MD)	min. 50 μs
Pulse length, period and phase shift measurement:	
Input frequency	0.1 ÷ 5,000Hz
Pulse width	50 ÷ 10,000,000μs

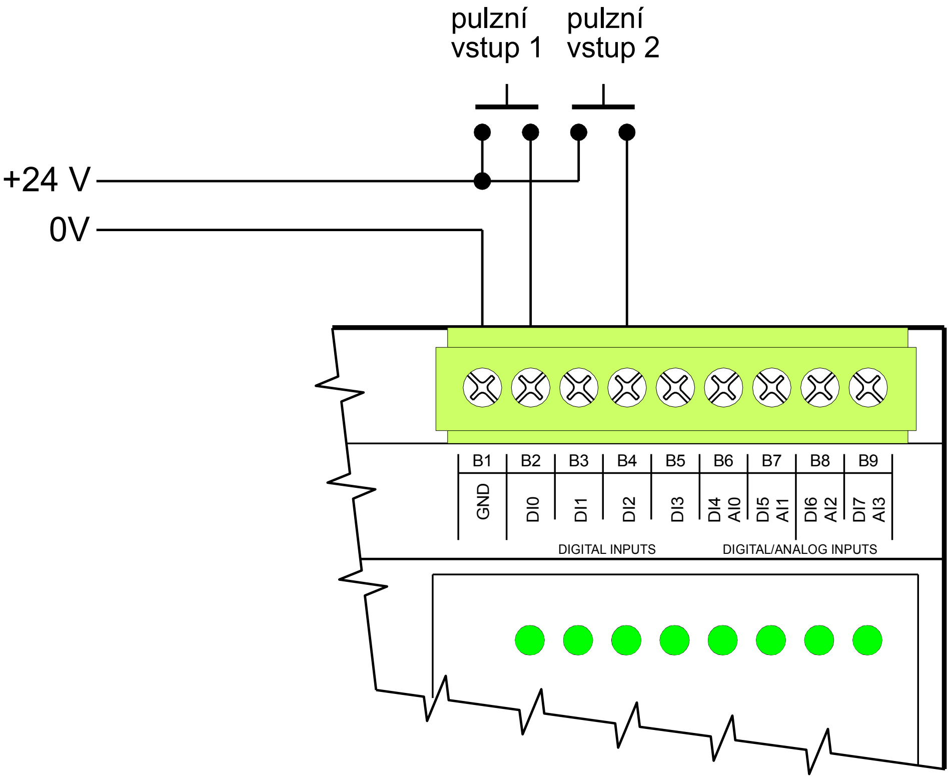


Fig. 2.7.3.1.1 An example of connecting a sensor with a pulse output (for counter 1 and counter 2)

Wiring notes:

1. The inputs are implemented with a common terminal - (N.B.: the GND terminal!). The terminal is galvanically connected with the negative power supply terminal and the signal ground of the TCL2, CIB and CH1 interface).
2. The inputs require a connection of the sensor with the pulse output (eliminating flickers).

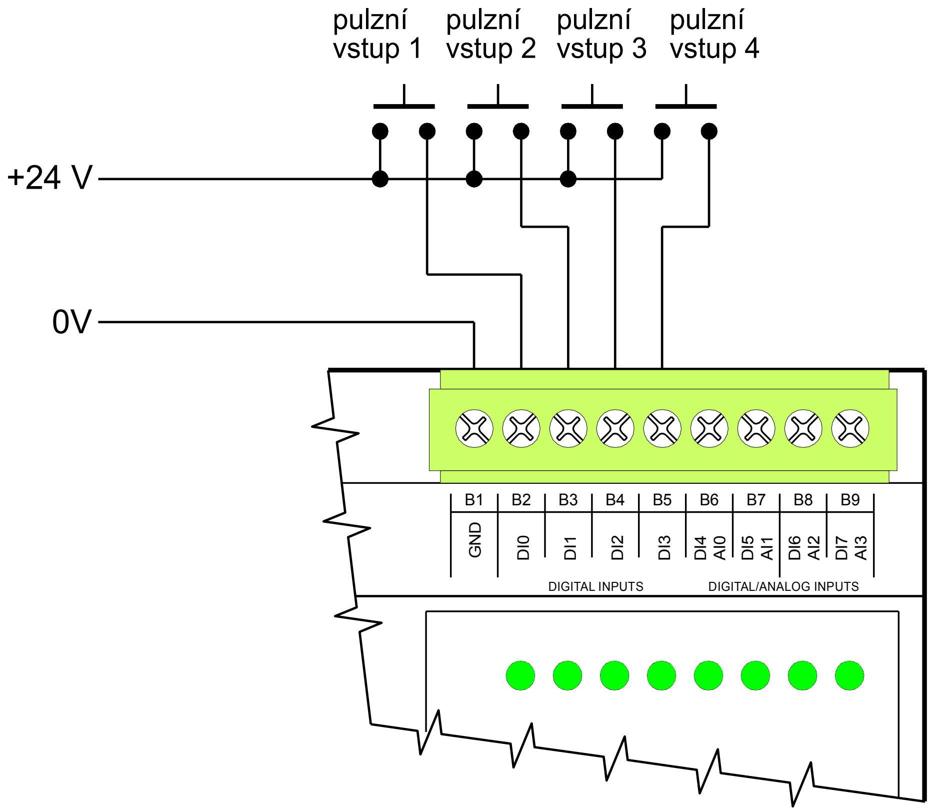


Fig. 2.7.3.1.2 An example of connecting a sensor with the pulse output (for counters 1 up to counter 4)

Wiring notes:

1. The inputs are implemented with a common terminal - (N.B.: the GND terminal!). The terminal is galvanically connected with the negative power supply terminal and the signal ground of interface TCL2, CIB and CH1).
2. The inputs require a connection of the sensor with the pulse output (with avoiding flickers).

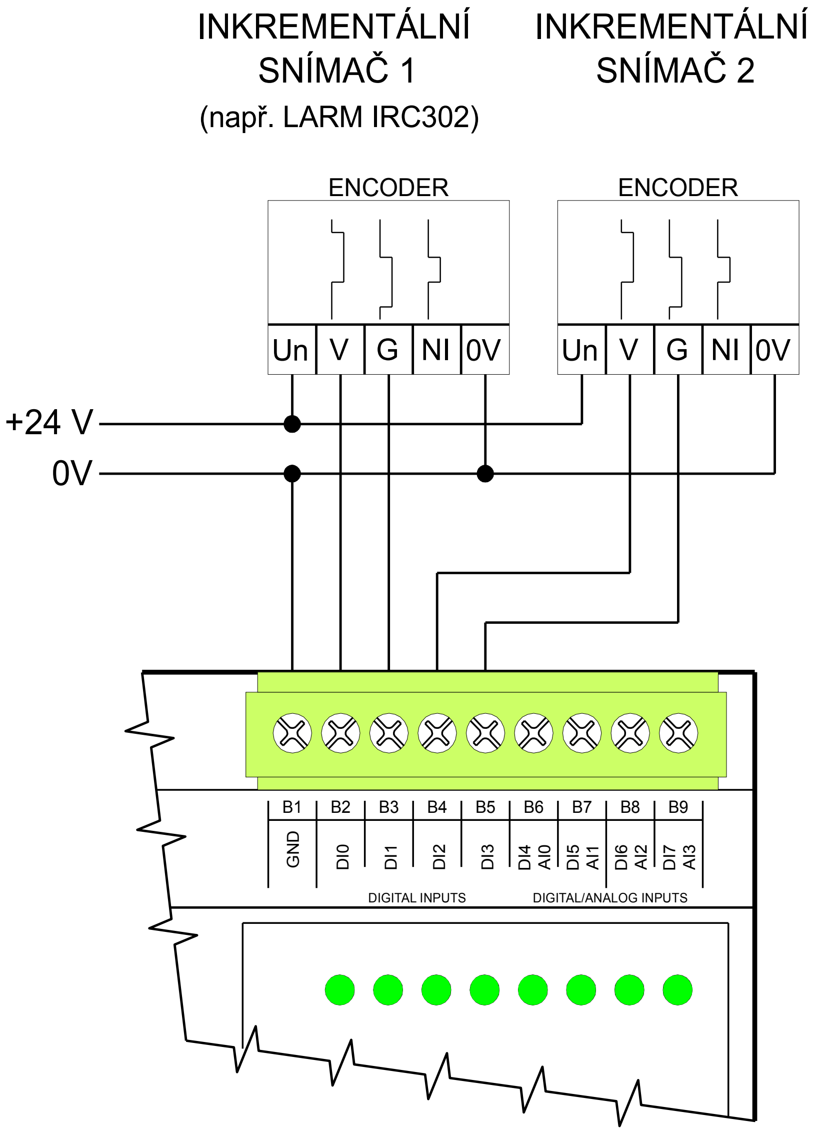


Fig. 2.7.3.1.3 An example of connecting incremental encoders (counter 1 and counter 2)

Wiring notes:

1. The inputs are implemented with a common terminal - (N.B.: the GND terminal!). The terminal is galvanically connected with the negative power supply terminal and the signal ground of interface TCL2, CIB and CH1).
2. The module is designed to connect incremental encoders (rotary, linear) with an output of 24V (it cannot be connected to sensors with 5V output!). In this mode, only both tracks of the sensor are captured. A zero pulse and the measuring probe (the capture input) cannot be evaluated.

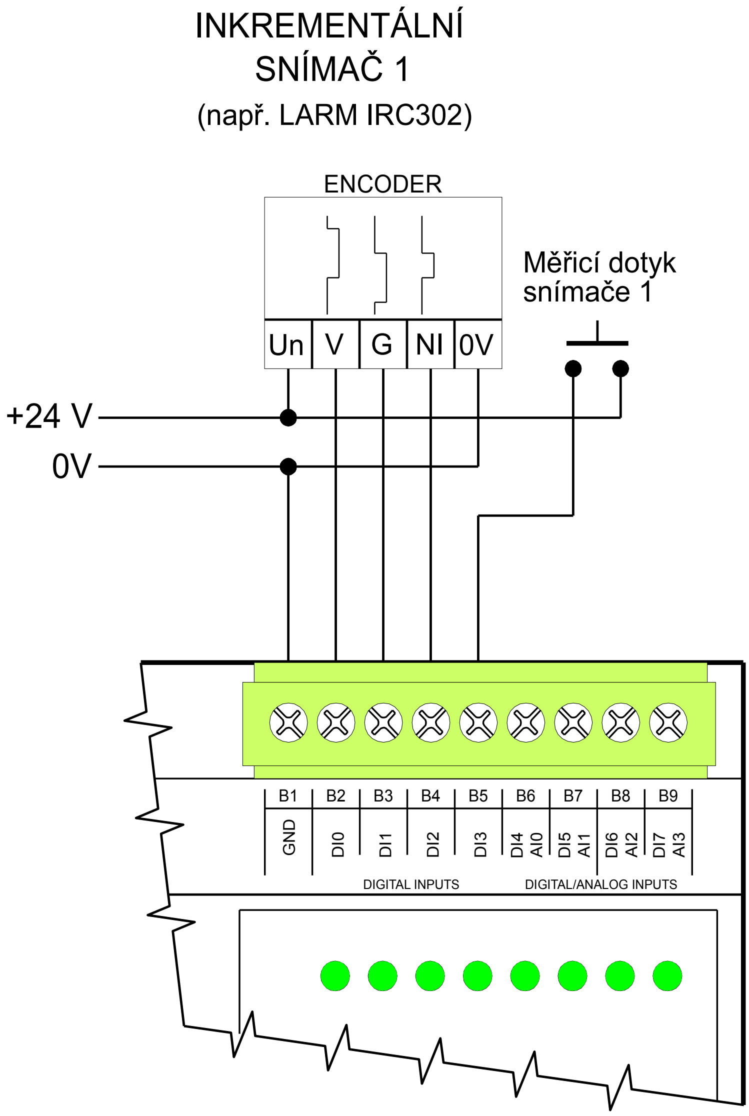


Fig. 2.7.3.1.4 An example of connecting an incremental encoder with zeroing and capturing

Wiring notes:

1. The inputs are implemented with a common terminal - (N.B.: the GND terminal!). The terminal is galvanically connected with the negative power supply terminal and the signal ground of interface TCL2, CIB and CH1).
2. The module is designed to connect incremental encoders (rotary, linear) with an output of 24V (it cannot be connected to sensors with 5V output!). In this mode, both tracks, zero pulse and the measurement probe of the connected sensor are captured.

2.7.3.2 The analogue inputs, metering the current 0 ÷ 20 mA

The binary inputs from DI4 to DI7 can be configured in the mode of analogue inputs (then they are processed as analogue inputs AI0 to AI3) with an input range of 0 ÷ 10VDC, or with a 500 Ω shunt wired in parallel with the respective input allows the measurement of current 0 ÷ 20mA or 4 ÷ 20mA.
The voltage signals 0 ÷ 10V are connected directly to the terminals (positive terminal to AIx and negative to GND).
The current inputs require an external shunt 500 Ω, which can be implemented using the shunt MT-1690 (see Fig.2.7.3.2.1), which can be ordered separately. The outlets of the MT-1690 shunt are inserted directly in the terminals together with the connecting cables. The unused outlets of the shunt can be broken off and the respective inputs can be used as binary or voltage inputs.
The SW configuration is performed in the Mosaic programming environment. The shunt outlets for those inputs, which are not required for the measurement of current signals, should be broken off. The inputs are passive, i.e. they must be connected to an external power supply of current loops (again see Fig.2.7.3.2.1).

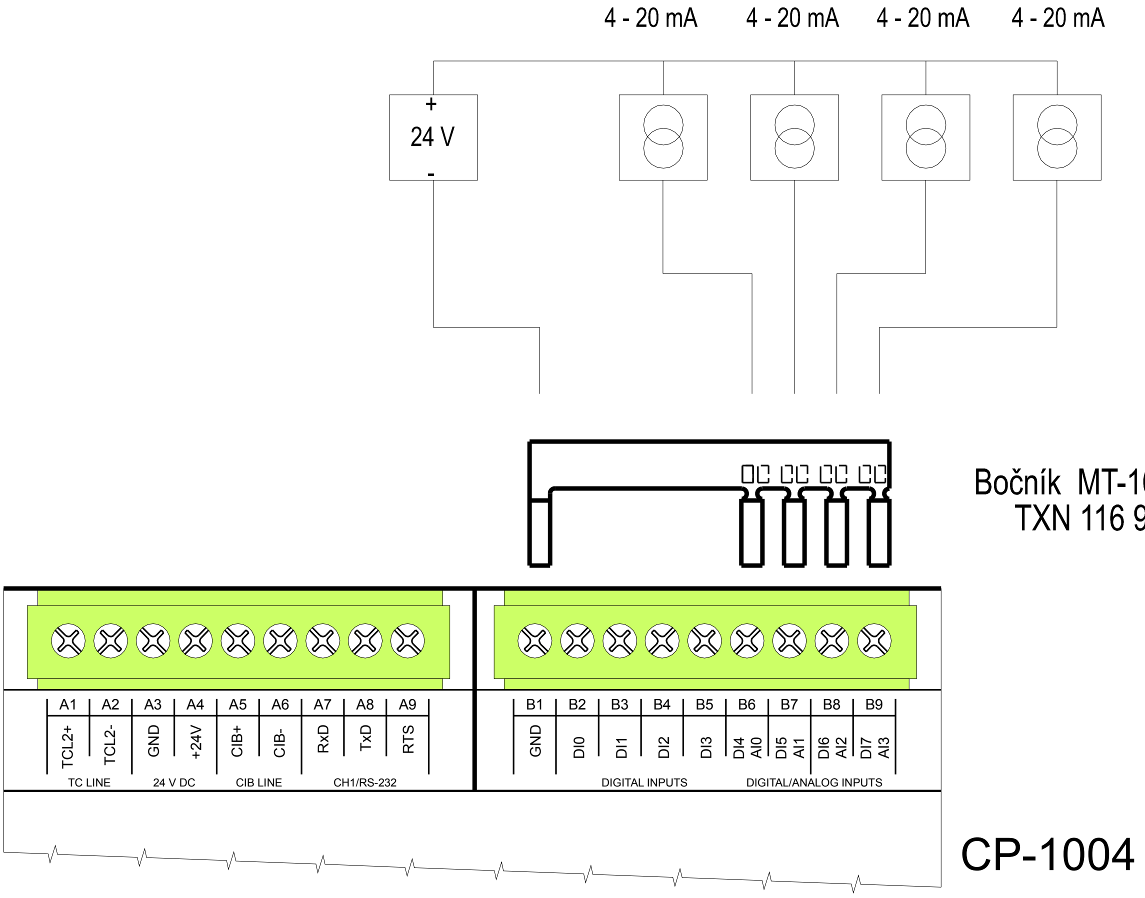


Fig. 2.7.3.2.1 An example of the MT-1690 shunt connection to the CP-1004 (current analogue inputs).

2.7.4 The **CP-1014**

The CP-1014 I/O layout (inputs, outputs, power supply, communication interface) is identical with the CP-1004 module (for detailed information see Chapter 2.7.3 CP-1004).

The front panel is different: instead of indication LEDs and a small seven-segment indicator there is a larger display with 4x20 characters and 7 buttons. The display with the buttons provides the operator panel functions (similar to e.g. ID-14) and it is internally connected to TCL2 bus and in the configuration (Mosaic) it is identified and operated as a stand-alone peripheral "operator's panel".

The alphanumeric display is backlit, and it also acts as a system display - it shows the system status (Run, Halt, IP address, etc.), IO indication (instead of LED indicators), etc. (for further information see [2]).

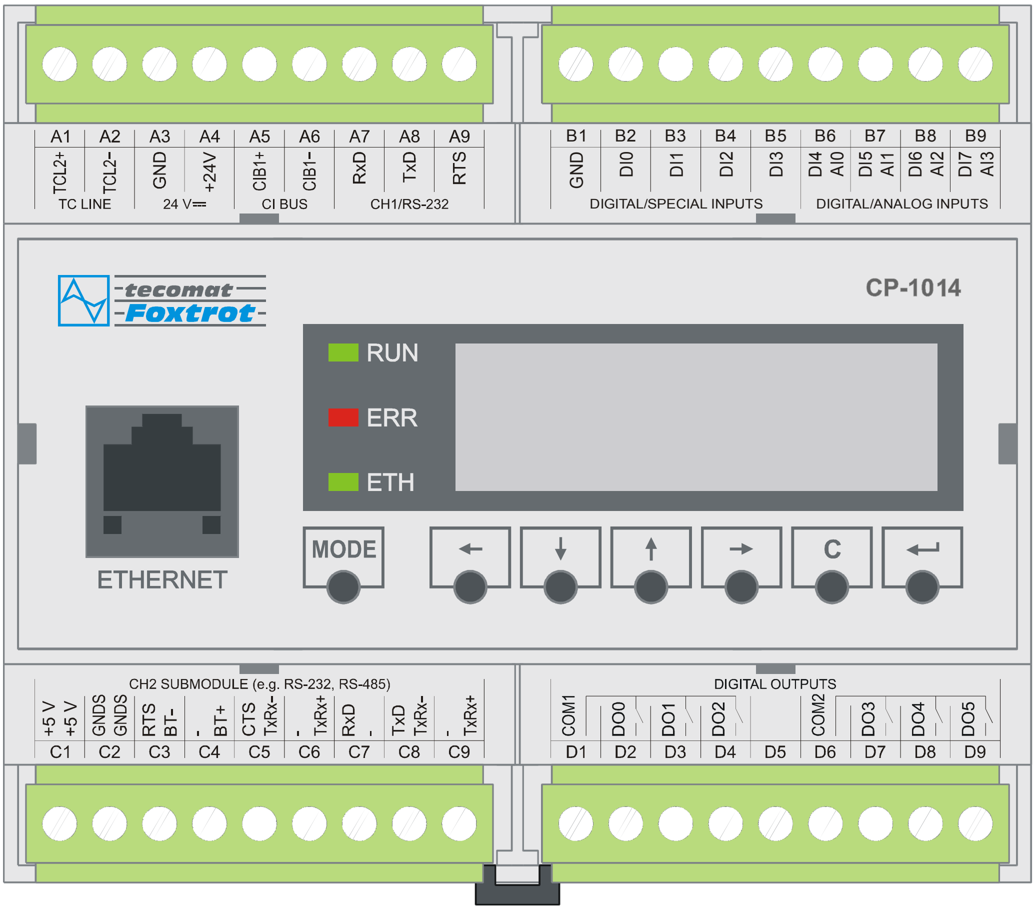


Fig.2.7.4.1 The front view of the basic module CP-1014

2.7.5 The **CP-1005**

The CP-1005 is the basic module of the Foxtrot control system. A standard configuration of the module is in a 6M housing on a DIN rail (for the housing dimensions, see Chapter 6M housing on a DIN rail), and it is fitted with six removable terminal blocks.

The layout:

Power supply	24VDC, power consumption typically 3 W, max. 8W (see Chapter 2.2)
AI0 ÷ AI5	6 analogue inputs, without galvanic isolation, with an optional function of a binary input: ranges: 10V, 0÷20mA, 4÷20 mA, Ni1000, Pt100, OV1000, OV100, DI 24 VDC
AO0 ÷ AO1	2 analogue outputs, without galvanic isolation, range 0 ÷10V
DO0 ÷ DO5	6 relay outputs, with galvanic isolation from other circuits

ETH Ethernet 10/100 Mbit (a standard RJ-45 connector), with galvanic isolation from other circuits, see Chapter 2.4.1

CH1 Serial channel, with fixed RS232 interface, without galvanic isolation, see Chap. 2.3.1

CH2 Serial channel, with a possibility of fitting with standard submodules, see Chapter 2.3.3

The analogue inputs AI0 ÷ AI5

Voltage ranges	0 ÷ 0.5V 0 ÷ 1V 0 ÷ 2V 0 ÷ 5V 0 ÷ 10V
Temperature sensor Pt100, W_{100}=1.385 or 1,391	-90 °C ÷ +400 °C
Temperature sensor Pt1000, W_{100}=1.385 or 1.391	-90 °C ÷ +400 °C
Temperature sensor Ni1000, W_{100}=1.500 or 1.617	-60 °C ÷ +200 °C
Temperature sensor NTC 12k	-40 °C ÷ +125 °C
Temperature sensor KTY81-121	-55 °C ÷ +125 °C
Resistance ranges	0 ÷ 1kΩ 0 ÷ 2kΩ 0 ÷ 200kΩ
Current ranges	0 ÷ 20mA 4 ÷ 20mA
Input resistance for voltage ranges	> 20kΩ (ranges 10V, 5V) > 50kΩ (ranges 2V, 1V, 0.5V)
Input resistance for current ranges	100Ω
Internal voltage for power supply of resistance sensors	7.27V
Conversion time of channel	typically 80μs
Recovery time of each channel value	typically 480μs
Binary inputs	
Input voltage for Log.0	max. +5VDC
Input voltage for Log.1	min. +15VDC typically +24DC max. +30VDC

Input current in log. 1	typically 5mA
The minimum width of the captured pulse	500 µs

The analogue output AO0, AO1

Output range	0 ÷ 10V
Maximum output value	105% of the output range upper limit
Maximum output current	10mA
Maximum load capacity	50nF

The relay outputs

DO0 ÷ DO2, outputs with a common terminal, continuous current in the 3A output, inrush 5A, max.continuous current in common terminal COM1 is 10A, detailed information on relay contacts

Isolation voltage among groups of outputs and from other circuits is 3,750 VAC, i.e. safe isolation of circuits

DO3 ÷ DO5, outputs with a common terminal, continuous current in 3 A output, inrush 5A, max.continuous current in common terminal COM2 is 10A, detailed information on relay contacts

For principles of protection and usage for capacitive and inductive loads, see Chapter 13.7.1 Protection of output elements (relays,...).

The terminal block of the basic module is made up of connectors with a cage terminal with the spacing of 5.08 mm. Detailed parameters of the terminals are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail

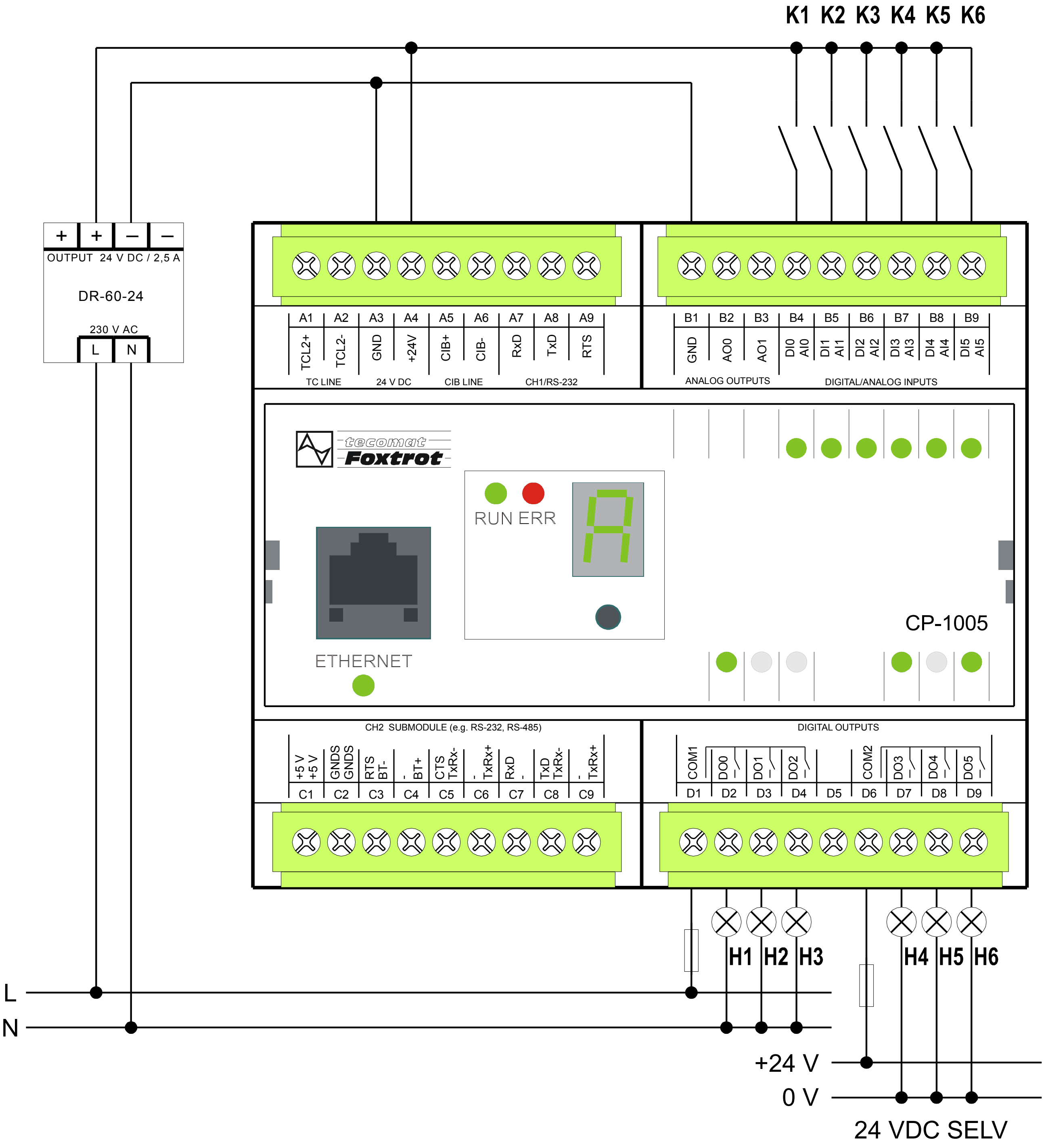


Fig. 2.7.5.1 A standard example of the CP-1005 basic module wiring

Wiring notes:

1. Groups of relay outputs (DO0 ÷ 2 and DO3 ÷ 5) can switch circuits powered by different sources. The groups are separated by isolation corresponding to a safe circuit isolation.
2. Optional functions of AI inputs are set from the programming environment and the jumpers located in the bottom of the box (above a DIN-rail holder), wiring examples are shown in the following chapters.

3. The TCL2 bus has fixed termination inside the basic module so it must always be located at the end of the bus line (see Chapter 3.2)
4. The module power supply, the TCL2 interface, the CIB and the CH1 have a common signal ground, a GND terminal (A3 terminal). This terminal is connected with a common terminal AI/AO (terminal B1).
5. The analogue inputs AI0÷AI5 are configured as inputs with a common negative terminal GND.
6. The terminals A3 and B1 (GND) should not be interconnected (they are connected by internal circuits). When the power to CP and input circuits is supplied from one source (see the example), the B1 terminal is not used. When powering the DI input circuits from a separate source, then the negative terminal of the source should be connected to the B1 terminal.

The following diagram2.7.5.2 shows the connection of various analogue sources and sensors, as well as potential free contacts:

The AI0 input voltage - e.g.. 0÷10V voltage is connected, positive terminal on AI0, negative terminal on GND,
The AI1 current input, i.e. the source of current is connected, e.g. 4÷20mA (powering the loop must be provided by an external source, see an example in Chapter 11.3.9),
The AI2 , AI3 inputs are passive – two-wire resistance sensors (RTD) are connected, or resistive transmitters,
The AI4 and AI5 inputs are digital (i.e. they are evaluated as DI4 and DI5), standard 24V inputs with common negative terminal GND,
the AO0 and AO1 voltage outputs 0÷10V, the diagrams show the connected loads Rz (controlled circuits).

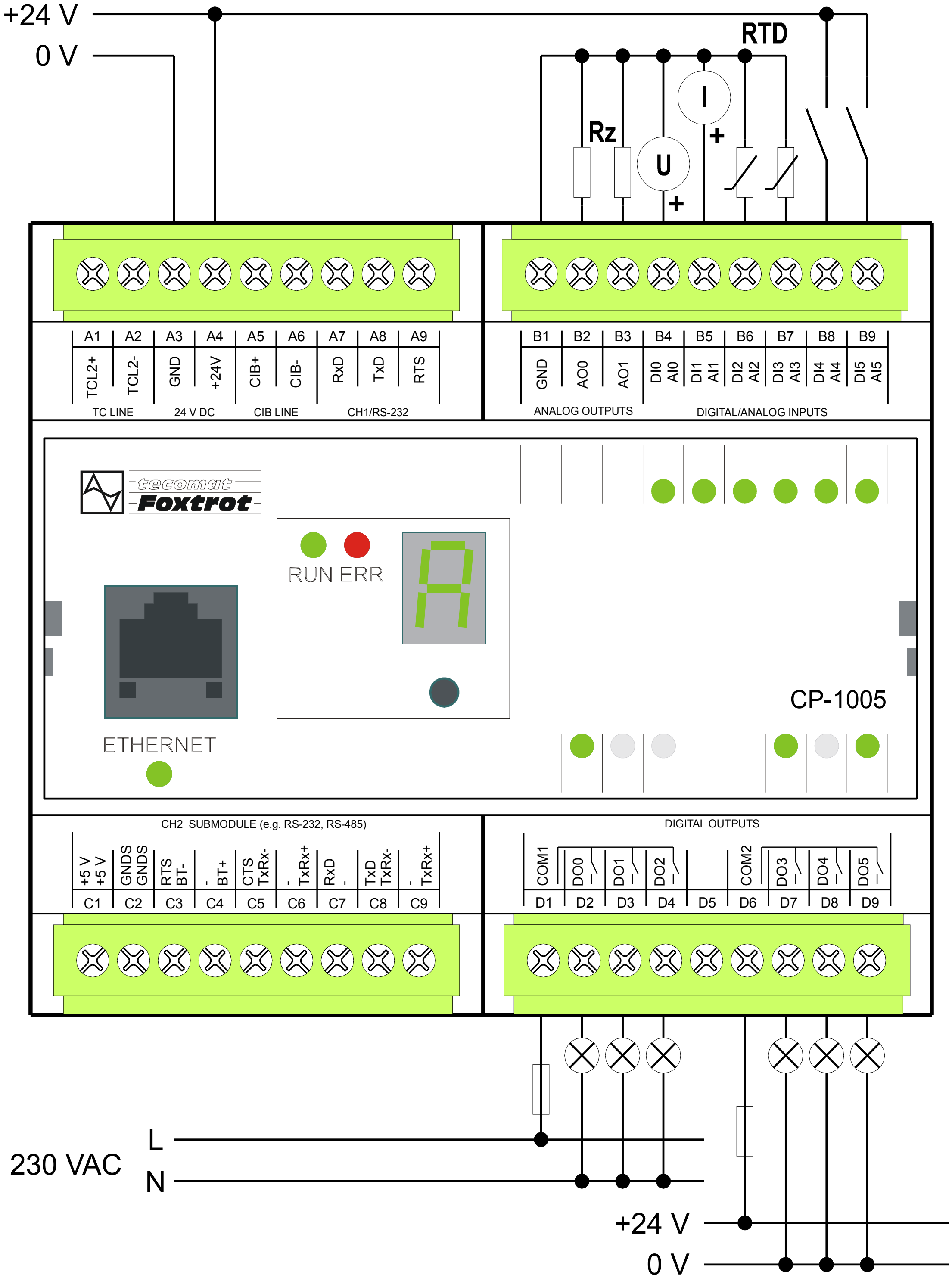


Fig. 2.7.5.2 An example of wiring the basic module CP-1005 analogue inputs and outputs.

2.7.5.1 Connecting two-wire sensors 4 ÷ 20mA

The following figure shows the connection of two current sensors 4 to 20 mA in a two-wire version. In the same way up to six sensors can be connected to one CP-1005 module. The 24V power supply can be a separate device, or a common power supply can be used for powering of both the CP-1005 and the current loops with measured sensors.
An example of connecting current sensors with an active output (with separate power supply) is shown in Chapter 11.3.9 and RH for HVAC applications, a sensor with 4 to 20mA output.

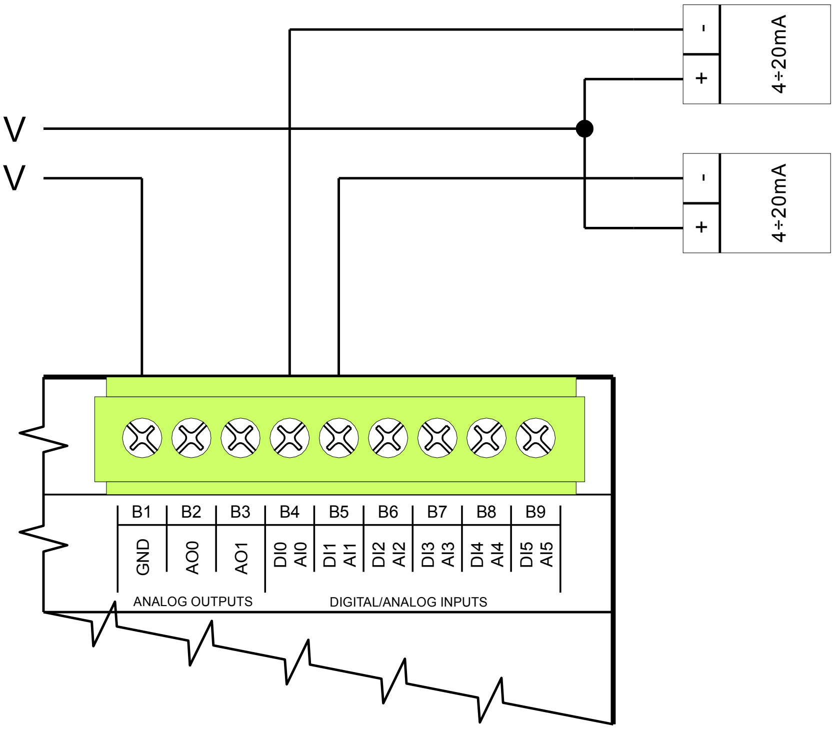


Fig.2.7.5.1.1 An example of the basic module CP-1005 current inputs connection (a connection of two-wire 4 ÷ 20mA sensors)

Notes

1. The CP-1005 module input is fitted with an internal sensing resistor 100Ω, which also defines the internal input resistance for current ranges. The resistor is connected to the module terminals electronically (unlike the older version of the CP-1005 with fixed terminals, where it was connected by jumpers). When the CP-1005 is turned off, or the relevant input is not configured for the current range, the resistor is disconnected and the input has a high internal resistance – which results in disconnecting the loop!

2.7.6 The **CP-1015**

The CP-1015 I/O layout (inputs, outputs, power supply, communication interface) is identical with the CP-1005 module (for detailed information see Chapter 2.7.5 CP-1005).
The front panel is different: instead of LED indicators and a small seven-segment indicator there is a larger display with 4x20 characters and 7 buttons. The display with the buttons provides the operator panel functions (similar to e.g. ID-14) and it is internally connected to TCL2 bus and in the configuration (Mosaic) it is identified and operated as a stand-alone peripheral "operator’s panel".
The alphanumeric display is backlit, and it also acts as a system display - it shows the system status (Run, Halt, IP address, etc.), IO indication (instead of LED indicators), etc. (for further information see [2]).

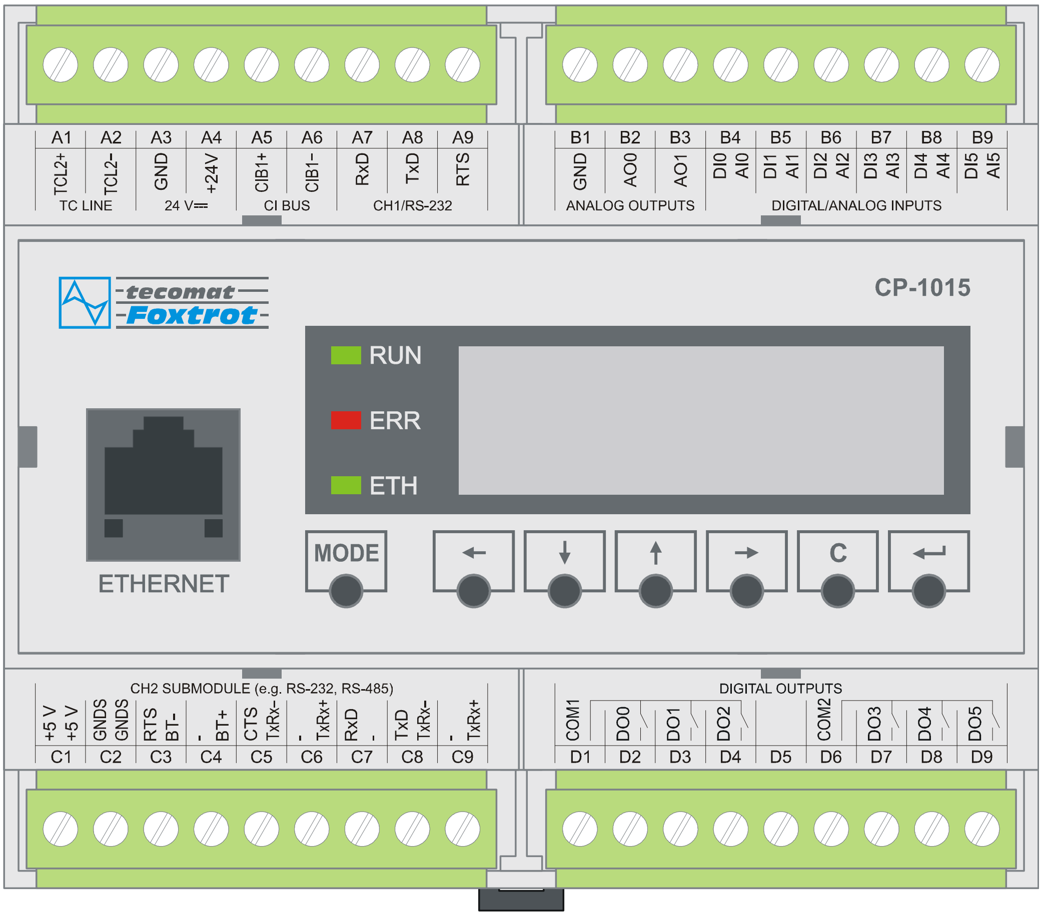


Fig.2.7.6.1 The front view of the basic module CP-1015

2.7.7 The **CP-1006**

The CP-1006 I/O layout (inputs, outputs, power supply, communication interfaces) is identical with the CP-1016 module (for detailed technical information see Chapter 2.7.8 CP-1016).
The front panel is different: instead of LED indicators and a small seven-segment indicator there is a larger display with 4x20 characters and 7 buttons. The display with the buttons provides the operator panel functions (similar to e.g. ID-14) and it is internally connected to TCL2 bus and in the configuration (Mosaic) it is identified and operated as a stand-alone peripheral "operator’s panel".
The alphanumeric display is backlit, and it also acts as a system display - it shows the system status (Run, Halt, IP address, etc.), IO indication (instead of LED indicators), etc. (for further information see [2]).

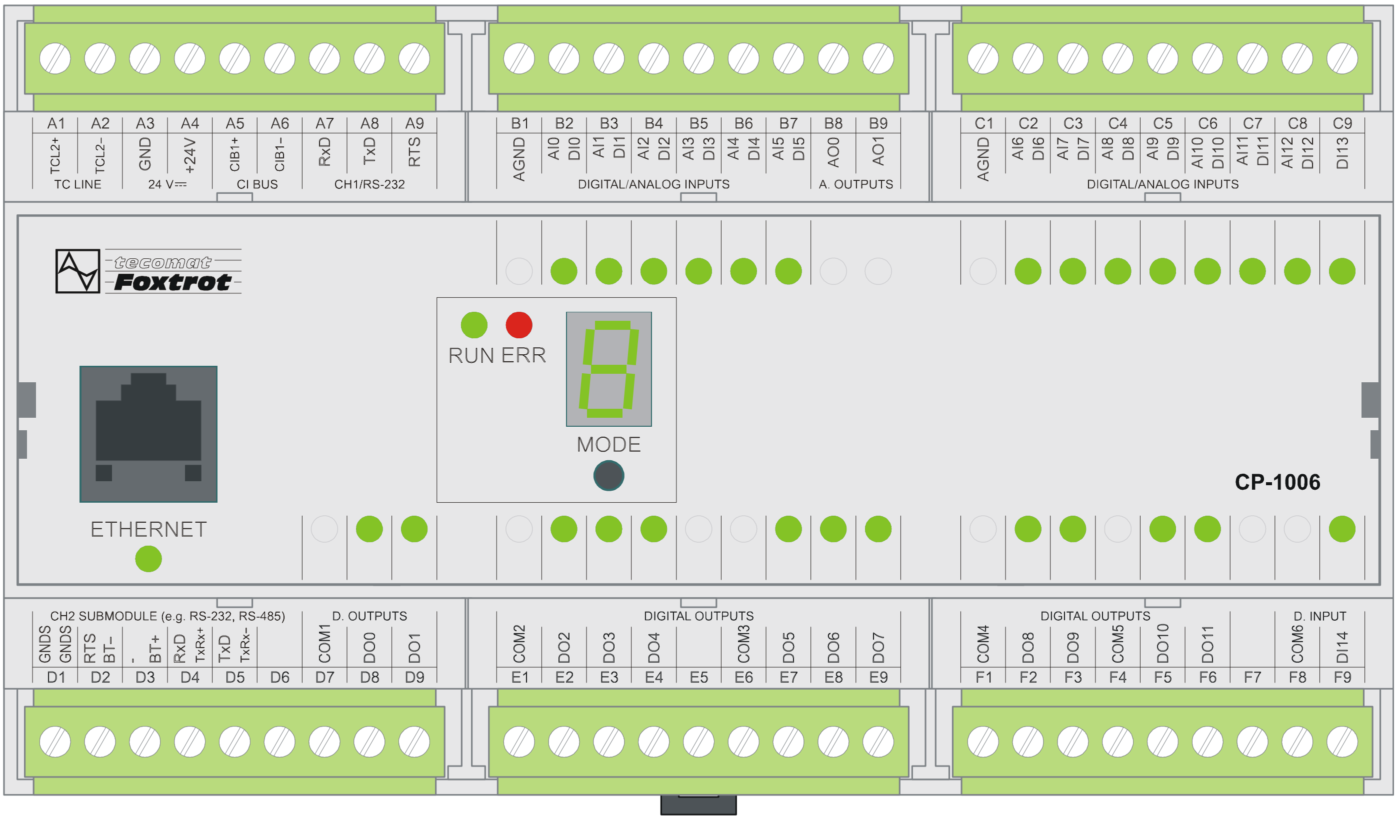


Fig.2.7.7.1 The front view of the basic module CP-1006

2.7.8 The **CP-1016**

The CP-1016 is the basic module of the Foxtrot control system. The standard version is in a 9M housing on a DIN rail (for the housing dimensions, see Chapter 13.2.1 9M housing on a DIN rail), and it is fitted with six removable terminal blocks.

The **I/O layout**:
Power supply 24VDC, power consumption max. 10W (information on power supply see Chapter 2.2)
AI0 ÷ AI5 6 analogue inputs, without galvanic isolation, with an optional function of a binary input:
ranges: Ni1000, Pt1000, OV1000, binary input potential free contact
AI6 ÷ AI12 7 analogue inputs, without galvanic isolation with an optional function of a binary input:
ranges: 0÷20mA, 4÷20mA, Ni1000, Pt1000, OV1000, binary input potential free contact
DI13 pulse input (for a flow-meter, etc.), potential free contact
DI14 binary input 230VAC (e.g. ripple control), with galvanic isolation
AO0-1 2 analogue outputs, without galvanic isolation, range 0 ÷ 10V
DO0, DO1 2 semiconductor outputs, galvanically isolated from other circuits, 1 A, 230V, SSR, outputs can be set to PWM mode
DO2 ÷ DO11 10 relay outputs, galvanically isolated from other circuits, 3A on the output,
ETH Ethernet 10/100 Mbit (a standard RJ-45 connector), with galvanic isolation from other circuits, see Chapter 2.4.1
CH1 Serial channel, with fixed RS232 interface, without galvanic isolation, see Chap. 2.3.1
CH2 Serial channel, with a possibility of fitting with standard submodules, see Chapter 2.3.3

The analogue inputs	**AI0 ÷ AI5**	**AI6 ÷ AI12**
Temperature sensor Pt1000, W_{100}=1.385 or 1.391	-90 °C ÷ +270 °C	-90 °C ÷ +270 °C
Temperature sensor Ni1000, W_{100}=1.500 or 1.617	-60 °C ÷ +155 °C	-60 °C ÷ +155 °C
Temperature sensor KTY81-121	-55 °C ÷ +125 °C	-55 °C ÷ +125 °C
Resistance ranges	0 ÷ 1kΩ (OV1000)	0 ÷ 1kΩ (OV1000)
Current ranges	- -	0 ÷ 20mA 4 ÷ 20mA
Input resistance for current ranges	-	100Ω
Internal voltage for power supply of resistance sensors	8.34V	
Conversion time of channel	typically 50μs	
Recovery time of each channel value	typically 650μs	

Notes:
1. The current ranges require inserting a jumper for the relevant input. The jumpers are located under the cap with the numbers and names of terminals (above the C connector).

Binary inputs	**DI0 ÷ DI12**	**DI13**	**DI14**
Input voltage for log. 0	min. +2.3 VDC max. +12VDC		max. 120VAC
Input voltage for log. 1	max. +1VDC		min. 200VAC max. 250VAC
Input current in log. 1	typically 1.7mA		typically 5mA
A The minimum width of the captured pulse	20ms	50μs	-
Max. frequency	-	5kHz	-

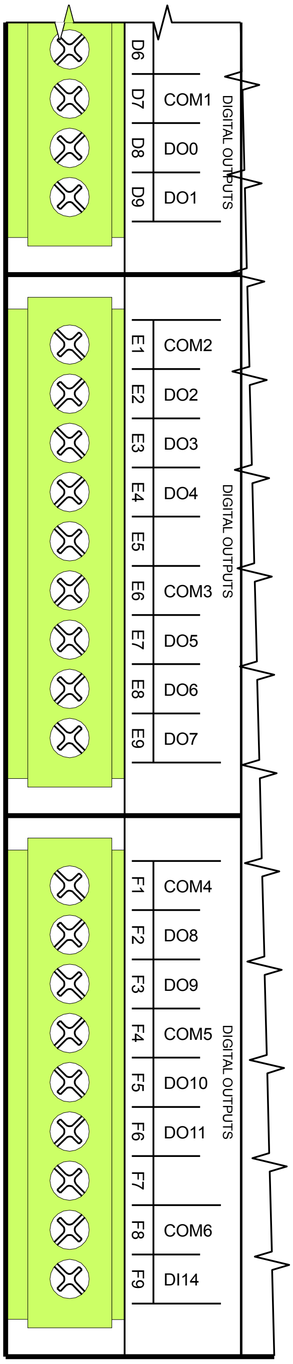
Notes:

1. The DI0 ÷ DI3 and DI13 inputs allow to switch on the function of capturing short pulses. This function checks the input signal level to ensure that no pulse shorter than the cycle of the programme will be lost (e.g. for connecting pulse outputs of flowmeters, etc.).
2. The DI13 input can be set in the counter mode, e.g. for pulse outputs of flowmeters, and such like.

The analogue output AO0, AO1

Output range	0 ÷ 10V
Maximum output value	105% of the output range upper limit
Maximum output current	10mA
Maximum load capacity	50nF

The relay outputs of the CP-1016 module



The **DO0, DO1,** SSR (solid state relay) outputs with a common terminal, continuous output current 1 A, inrush 1A, max.continuous current in common terminal COM1 is 2A. The outputs are fitted with an SSR relay switching at zero. They can be used as PWM outputs to control e.g. revolutions of small asynchronous motors (fans, circulation pumps).

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits.

The **DO2 ÷ DO4**, outputs with a common terminal, continuous current in the 3A output, inrush 5A, max.continuous current in common terminal COM2 is 10A, more detailed information on relay contacts.

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits.

The **DO5 ÷ DO7**, outputs with a common terminal, continuous output current is 3A, inrush 5A, max.continuous current in common terminal COM3 is 10 A, more detailed information on relay contacts.

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits.

The **DO8 ÷ DO9**, outputs with a common terminal, continuous output current is 3 A, inrush 5A, max.continuous current in common terminal COM4 is 6 A, more detailed information on relay contacts.

There is only 1750 VAC working isolation among these groups.

The **DO10 ÷ DO11**, outputs with a common terminal, continuous output current is 3 A, inrush 5A, max.continuous current in common terminal COM5 is 6 A, more detailed information on relay contacts.

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits.

The **DI14**, 230VAC input, suitable mainly for connecting ripple control signal, for an example of connection see Chapter 12.4.1 Scanning ripple signal, basic module CP-1006.

For principles of protection and usage for capacitive and inductive loads, see Chapter 13.7.1 Protection of output elements (relays,...).

The terminal block of the basic module is made up of connectors with a cage terminal with the spacing of 5.08 mm. Detailed parameters of the terminals are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail

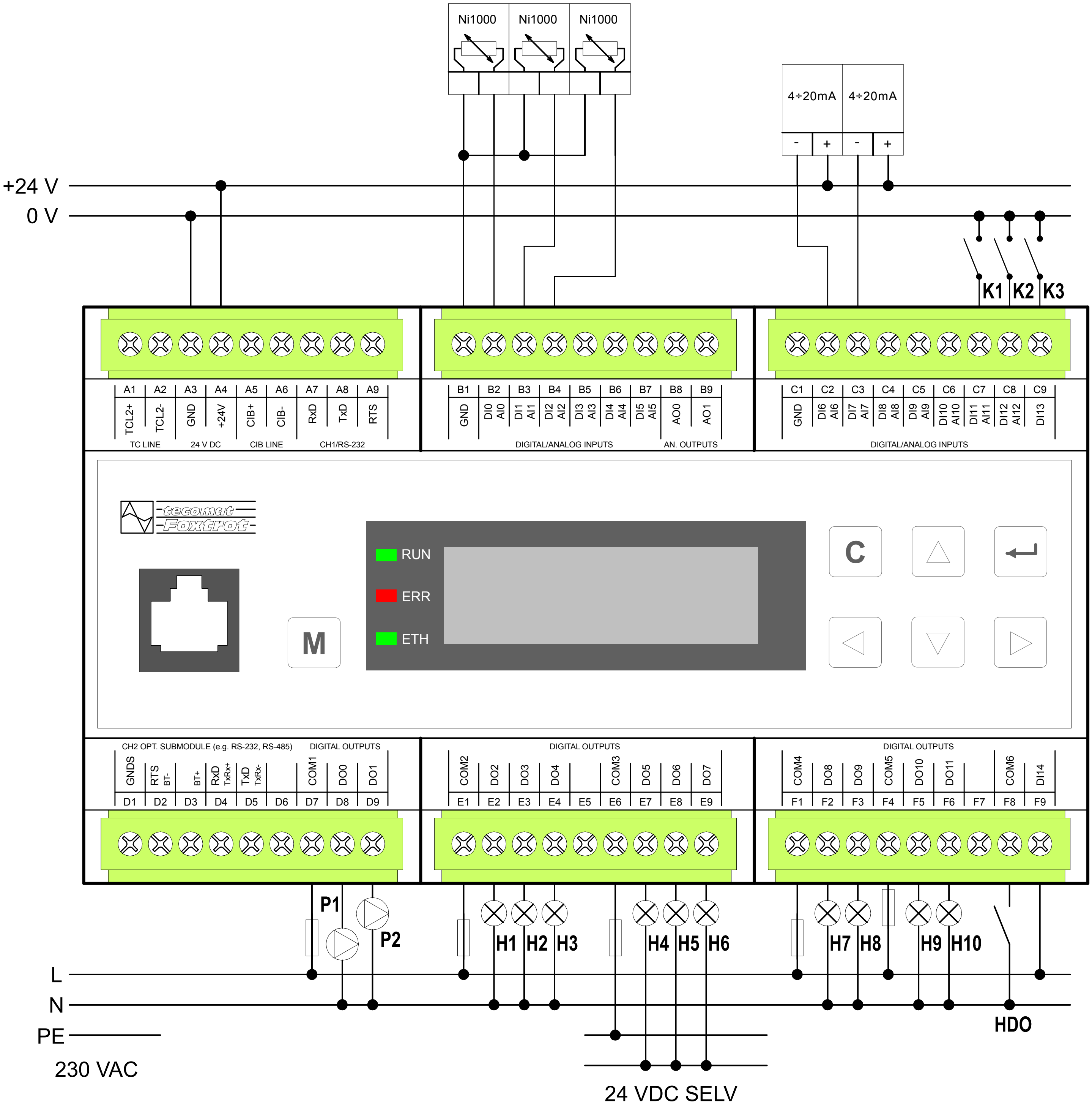


Fig.2.7.8.1 An example of standard connection of the basic module CP-1016

Wiring notes:

1. Groups of relay outputs (DO0 ÷ DO1, DO2 ÷ DO4, DO5 ÷ DO7) can switch circuits powered from different sources. The groups are separated by isolation corresponding to a safe circuit isolation.
2. The output groups DO8 ÷ DO9 and DO10 ÷ DO11 are mutually separated only by working isolation. The isolation from other circuits is in accordance with the principles of safe isolation of circuits.
3. Optional functions of AI inputs are set from the programming environment, only the current ranges 20mA (AI 6 to AI12) have to be set by jumpers located under the top right cap (above the terminal

block).

4. The TCL2 bus is firmly terminated in the basic module and it must always be at the end of the bus line (see Chapter 3.3 TCL2 bus – principles of design and installation).
5. The module power supply, the TCL2 interface, the CIB and the CH1 have a common signal ground, a GND terminal (A3 terminal). This terminal is galvanically connected with the common terminal AI/AO (terminal B1 a C1).
6. The analogue inputs are configured as inputs with a common negative terminal GND.
7. The A3 and B1 terminals and C1 (GND) in the application should not be connected. The C1 terminal is used in the case of 0 to 20mA or 4 to 20mA current loops supplied from another 24VDC source galvanically isolated from the source powering the basic module itself.
8. The DI0 to DI12 inputs are designed to connect a potential free contact. The common signal of binary inputs should be connected to the GND (A3) terminal.
9. The DI13 input is designed to process the pulse outputs, e.g. from a flow-meter or a water meter; the input is intended for potential free contact (minimum captured pulse width is 50μs.
10. DI14 is a 230VAC input, it is also rated for 400VAC phase-to-phase voltage (e.g. for processing ripple control signal). The input isolation from other circuits is in accordance with the principles of safe isolation of circuits.

2.7.9 The **CP-1008**

The CP-1008 is the basic module of the Foxtrot control system. The standard version is in a 9M housing on a DIN rail (for the housing dimensions, see Chapter 13.2.1 9M housing on a DIN rail), and it is fitted with six removable terminal blocks.

The **I/O layout**:

Power supply 24VDC, power consumption max. 10W (information on power supply see Chapter 2.2)

AI0 ÷ AI3 4 analogue inputs, without galvanic isolation with an optional function of a binary input: ranges: Ni1000, Pt1000, OV1000, KTY81-121, binary input (potential free contact)

AI4 ÷ AI9 6 analogue inputs, without galvanic isolation with an optional function of binary input: ranges: 0 ÷ 20mA, 4 ÷ 20mA, Ni1000, Pt1000, OV1000, NTC 12k, NTC (measuring resistance up to 200 kΩ), KTY81-121, binary input (potential free contact)

AI10 ÷ AI11 2 analogue inputs, without galvanic isolation ranges: thermocouples J, K, R, S, B, T, N, Lambda probe, voltage inputs (50 mV, 100 mV, 1 V, 2 V)

DI10 binary input 230VAC (e.g. ripple control), with galvanic separation

AO0 ÷ AO3 4 analogue outputs, without galvanic isolation, range 0 ÷10 V

DO0, DO1 2 semiconductor outputs, galvanically isolated from other circuits, 0.7 A, 230V AC, SSR, optional PWM function

DO2 relay 5A isolation 4kV from other circuits

DO3 ÷ DO5 3 relay 3A continuous current, 5A inrush current, with a common terminal E4 (current common terminal max. 10A)

DO6 relay, continuous current 15A, inrush overloading 160A < 20 ms

DO7, DO8 semiconductor relay (triac output with switching at zero), max. switching current 2A, 230VAC, for detailed outputs wiring (in a group with DO9, DO10) see Fig.2.7.9.2

DO9, DO10 electromechanical relay with a changeover contact, continuous switching current 2A, inrush switching current 5A; for detailed outputs wiring (in a group with DO7, DO8) see Fig.2.7.9.2

ETH Ethernet 10/100 Mbit (a standard RJ-45 connector), with galvanic isolation from other circuits, see Chapter 2.4.1

CH1 Serial channel, with fixed RS232 interface, without galvanic isolation, see Chap. 2.3.1

CH2 Serial channel, with a possibility of fitting with standard submodules, see Chapter 2.3.3

Binary inputs	**DI0 ÷ DI9**	**DI10**
Input voltage for log. 0	min. +2.3VDC max. +12VDC	max. 120VAC
Input voltage for log. 1	max. +1VDC	min. 200VAC max. 250VAC
Input current in log. 1	typically 1.7mA	typically 5mA
The minimum width of the captured pulse	20ms	-

The analogue inputs	**AI0 ÷ AI3**	**AI4 ÷ AI9**	**AI10, AI11**
Temperature sensor Pt1000, W_{100}=1.385 or 1.391	-90 °C ÷ +270 °C		x
Temperature sensor Ni1000, W_{100}=1.500 or 1.617	-60 °C ÷ +155 °C		x
Temperature sensor KTY81-121	-55 °C ÷ +125 °C		x
Temperature sensor NTC 12k	x	-40 °C ÷ +125 °C	x
Resistance ranges	0 ÷ 2kΩ		x
	x	0 ÷ 200kΩ	x
Current ranges	x	0 ÷ 20mA 4 ÷ 20mA	x
Voltage ranges	x	x	-20 ÷ +50mV -20 ÷ +100mV 0 ÷ +1V 0 ÷ +2V
Thermocouples	x	x	J (–210 ÷ +1,200 °C) K (–200 ÷ +1,372 °C) R (–50 ÷ +1,768 °C) S (–50 ÷ +1,768 °C) B (+250 ÷ +1,820 °C) T (–200 ÷ +400 °C) N (–200 ÷ +1,300 °C)
Lambda probe			2.85 ÷ 21.21% O_2
Input resistance for current ranges		100Ω	
Internal voltage for power supply of resistance sensors	8.34V		
Conversion time of channel	typically 50μs		
Recovery time of each channel value	typically 650μs		

Notes:

1. The current ranges require inserting a jumper for the relevant input. The jumpers are located under the cap with the numbers and names of terminals (above the C connector).

Analogue outputs AO0 ÷ AO3	
Output range	0 ÷ 10V
Maximum output value	105% of the output range upper limit
Maximum output current	10mA
Maximum load capacity	50nF

Binary outputs, SSR	**DO0, DO1**	**DO7, DO8**
Switching voltage	max. 260V min. 20V	max. 260V min. 180V
Switching current	max. 0.7A	max. 4A
With ambient temperature 25 °C	max. 0.7A	$I_{DO7} + I_{DO8} < 4A$ [1.]
With ambient temperature 50 °C	max. 0.5A	$I_{DO7} + I_{DO8} < 2A$ [1.]
Overload protection	none	Thermal protection

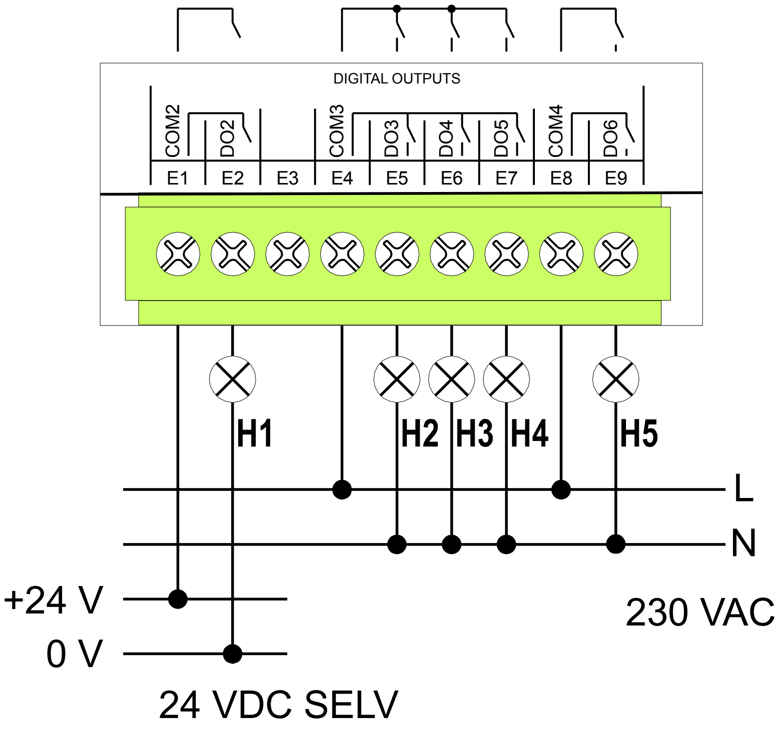
Notes:

1. Maximum continuous current which does not activate thermal protection. Exceeding these values results in periodic disconnecting both outputs due to thermal protection.
2. The DO7 and DO8 outputs are connected to a group with relay outputs DO9 and DO10; for exact wiring see Fig.2.7.9.2

The relay outputs:

The **DO0, DO1,** SSR (solid state relay) outputs with a common terminal, continuous output current 1 A, inrush 1A, max.continuous current in common terminal COM1 is 2A. The outputs are fitted with an SSR relay switching at zero. They can be used as PWM outputs to control e.g. revolutions of small asynchronous motors (fans, circulation pumps). For more detailed information about the switching element see Chapter 13.4.5 Semiconductor relay 1 A.

Internal connection of outputs on the E connector



The **DO2 -** relay, continuous 3A output current, inrush 5A, detailed information on relay contacts.

Isolation voltage among groups of outputs and from other circuits is 3750 VAC, i.e. safe isolation of circuits.

The **DO3 ÷ DO5**, outputs with a common terminal, continuous current in 3 A output, inrush 5A, max.continuous current in common terminal COM3 is 10A, detailed information on relay contacts.

The isolation between DO6 output and the group DO3 ÷ DO5 is only the working isolation – it cannot be used for safe isolation of circuits!

The **DO6** - relay continuous current 10A, inrush overloading 160 A < 20 µs, detailed information about relays in

Chapter 13.4.2

Fig. 2.7.9.1 An example of wiring the E connector of the CP-10x8 basic module - DO2 up to DO6 relay outputs.

Internal connection of outputs on the F connector:

The **SSR1, SSR2** - semiconductor relays (triac output with switching at zero), maximum switching current 4A, 230VAC.

The **RE1, RE2** – an electromechanical relay with a changeover contact, continuous switching current 2A, inrush switching current of 5A, for more information on the relay see Chapter 13.4.4

The isolation voltage between the group of outputs and the input on the F connector is only the working isolation 1750VAC.

The isolation voltage between the F connector and other circuits is 3750 VAC, i.e. safe isolation of circuits

The **DI10** – a 230VAC input, ready for scanning ripple control – i.e. voltage up to 400VAC can be connected (with improperly wired ripple control circuits).

An example of outputs wiring for controlling of three-phase motors, single-phase powered, with a possibility of reverse run. Triac outputs allow pulse control (inrush operation, speed control of e.g. a fan).

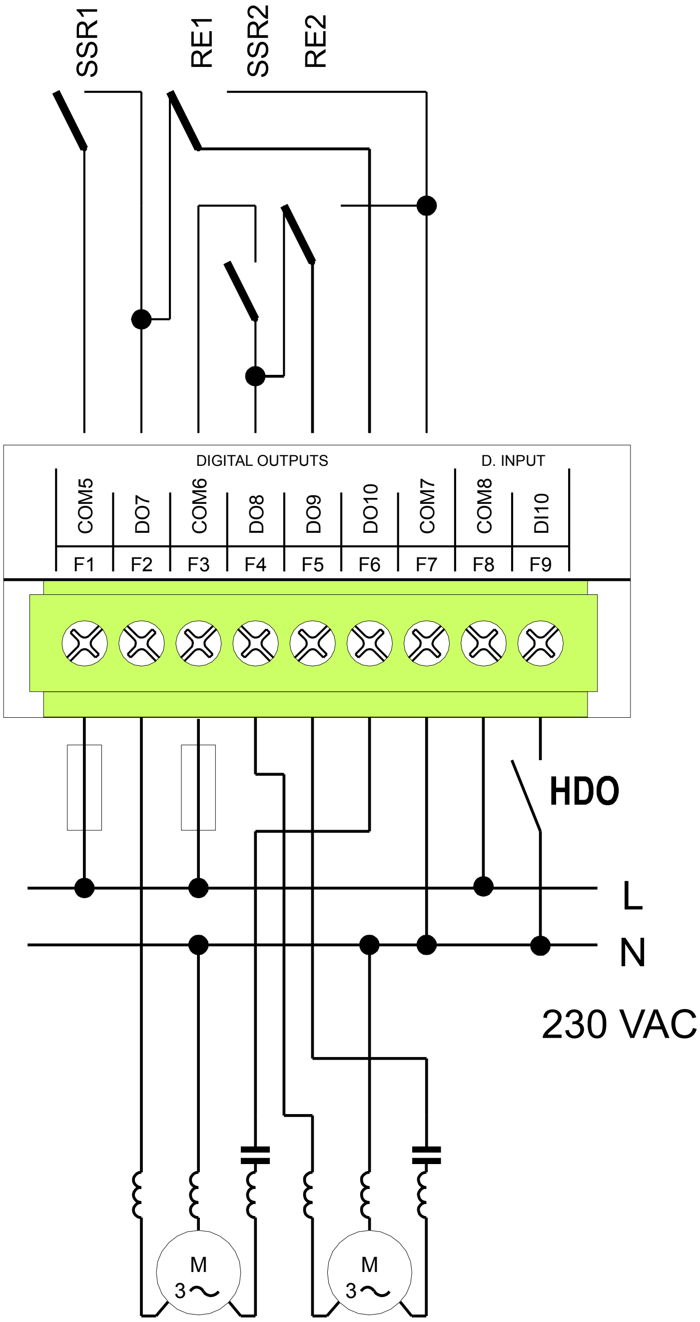


Fig.2.7.9.2 An example of wiring the F connector of the CP-10x8 basic module – controlling a three-phase motor and internal wiring of the DO7 up to DO10 outputs.

The connectors of the basic module are standard removable ones with a cage terminal in the removable part with 5.08mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. More detailed parameters of the terminals are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail

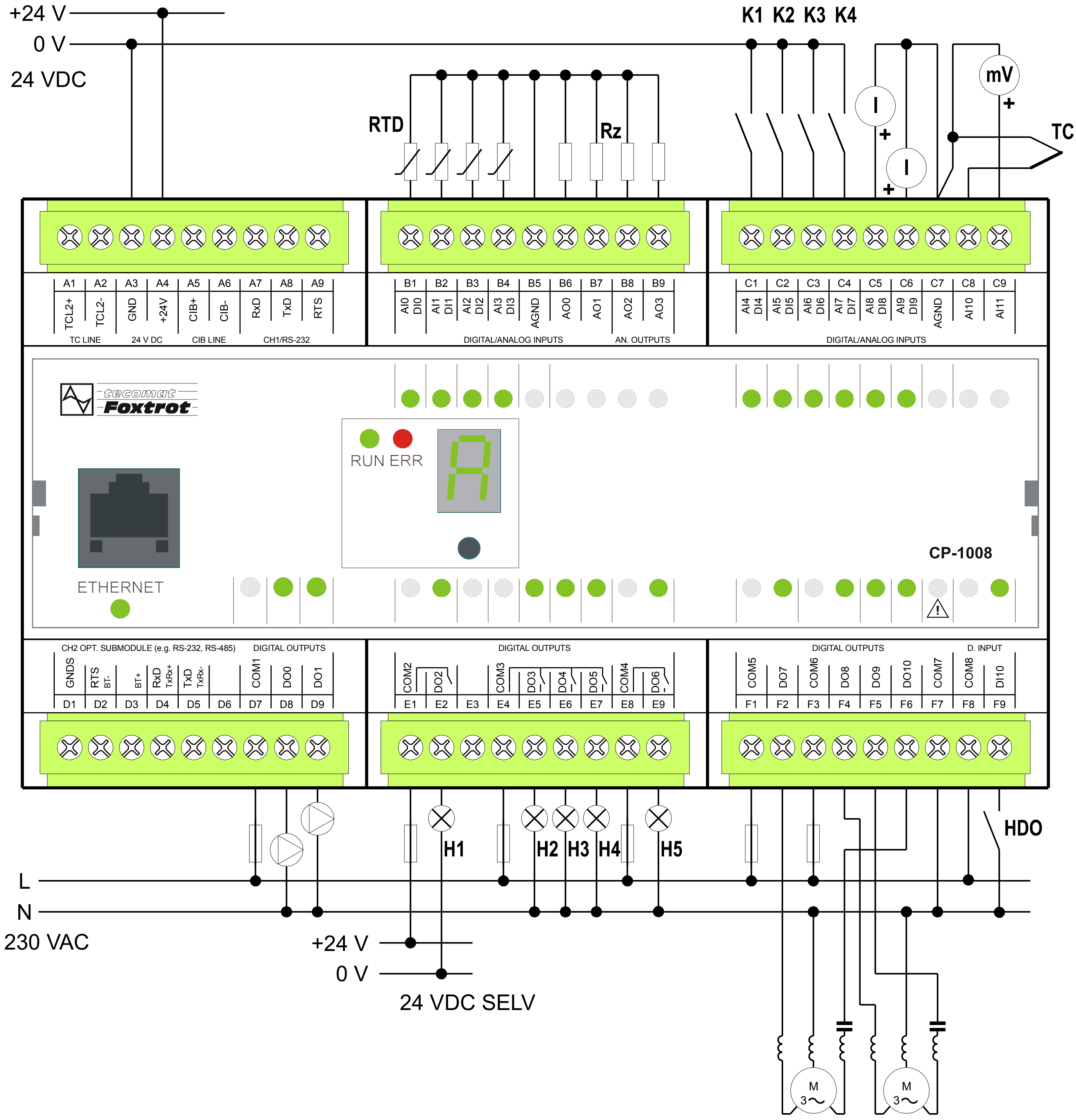


Fig. 2.7.9.3 An example of wiring the CP-1008 basic module

2.7.10 The **CP-1091**

The CP-1091 is the basic module of the Foxtrot control system. The standard version is in a 9M housing on a DIN rail (for the housing dimensions, see Chapter 13.2.1 9M housing on a DIN rail), and it is fitted with six removable terminal blocks.

The **I/O layout**:
Power supply 24VDC, power consumption max. 8W (information on power supply see Chapter 2.2)
AI0 ÷ AI5 6 analogue inputs, without galvanic isolation with an optional function of binary input: ranges: Ni1000, Pt1000, OV1000, KTY81-121, binary input (potential free contact)
DI6 ÷ DI11 6 binary inputs, without galvanic isolation: a standard binary 24VDC input, counter input (e.g. connecting the S0 signals)
DI12 (HDO) binary input 230VAC, galvanically isolated (e.g. ripple control)
AO0 ÷ AO1 2 analogue outputs, without galvanic isolation, range 0 ÷10V
DO0 ÷ DO8 9 semiconductor output switches with 24VDC, 0.5A, optional PWM function and functions for controlling power SSR relays (electrical heating control)
DO9 ÷ DO11 3 relay 16 A continuous current, 80 A inrush current, each output is individually terminated
ETH Ethernet 10/100 Mbit (a standard RJ-45 connector), with galvanic isolation from other circuits, see Chapter 2.4.1
CH1 Serial channel, with fixed RS-485, without galvanic isolation, see Chap. 2.3.1
CH2 Serial channel, with a possibility of fitting with standard submodules, see Chapter 2.3.3

Binary inputs	**DI0 ÷ DI5**	**DI6 ÷ DI11**	**DI12**
Input voltage for log. 0 (open contact)	min. +2.3VDC max. +12VDC	max. 10V	max. 120VAC
Input voltage for log. 1 (switched contact)	max. +1VDC	min. 12V	min. 200VAC max. 250VAC
Input current in log. 1	typically 1.7mA	typically 5mA	typically 5mA
The minimum width of the captured pulse	20ms	2ms	-

The analogue inputs	**AI0 ÷ AI5**
Temperature sensor Pt1000, W_{100}=1.385 or 1.391	-90 °C ÷ +270 °C
Temperature sensor Ni1000, W_{100}=1.500 or 1.617	-60 °C ÷ +155 °C
Temperature sensor KTY81-121	-55°C ÷ +125 °C
Temperature sensor NTC 12k	-40 °C ÷ +125 °C
Resistance ranges	0 ÷ 2kΩ
	0 ÷ 200 kΩ
Internal voltage for power supply of resistance sensors	8.34V
Conversion time of channel	typically 50μs
Recovery time of each channel value	typically 650μs

Analogue outputs AO0 ÷ AO1	
Output range	0 ÷ 10V
Maximum output value	105% of the output range upper limit

Maximum output current	10mA
Maximum load capacity	50nF

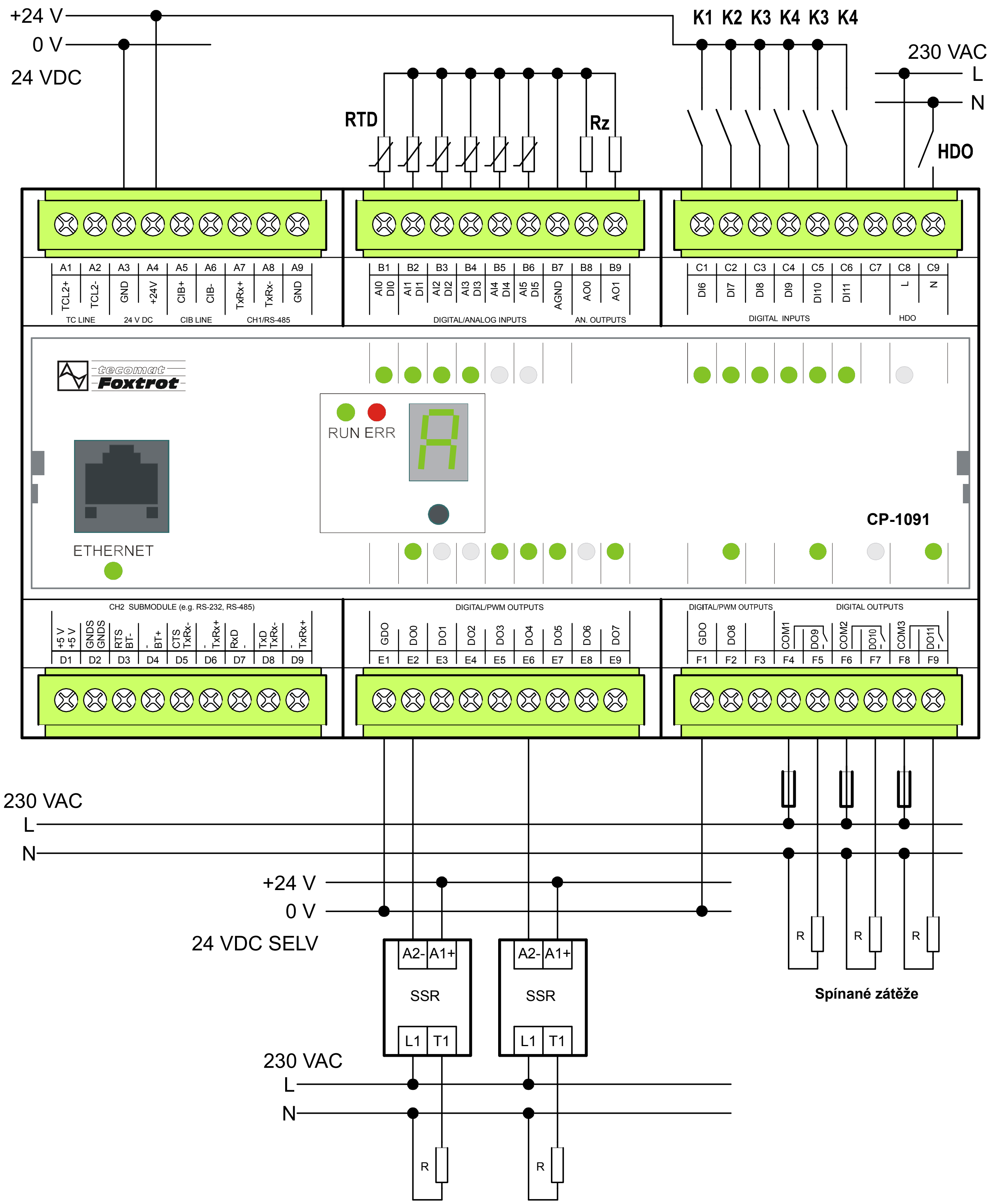


Fig.2.7.10.1 A basic example of wiring the CP-1091 module and external SSR relays

Notes:

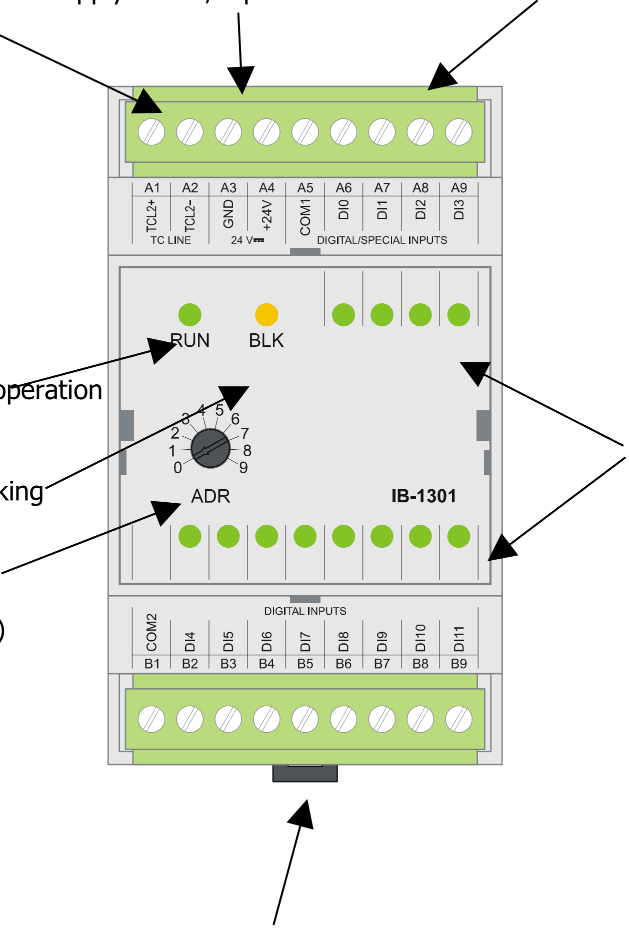
1. Identical wiring of the outputs (SSR relays) applies to DO0 up to DO8 (in the example it is only indicated in DO0 and DO4 for the sake of clarity)

2.8 The FOXTROT peripheral modules

The Foxtrot basic module can be expanded in accordance with the requirements of the application to include several peripheral and special modules. Up to 10 peripheral modules can be connected to the TCL2 bus on the central module.
Furthermore, the CF-1141 (dual external CIB) master modules can be connected to the central module via the TCL2 bus, as well as other special modules - such as the ID-14 text panel, etc.
Each group of modules (i.e. the peripheral modules, master modules and special modules) has a dedicated separate address space, so their addresses cannot overlap (e.g. the IB-1301 peripheral module, the CF-1141 external master module and the ID-14 panel can have a set identical address 0).

The front panel features signal LED diodes and a rotary switch for setting the module address. Each peripheral module connected to the basic module must have a unique address (in the range from 0 to 9). The address can be adjusted with a screwdriver by turning the rotary element with the arrow against the required number.

The front view of the peripheral module :



Connecting TCL2 bus power supply the I/O part of the A terminal block

Indication of the module operation

Indication of outputs blocking

Module address setting
(the 0 address is set here)

I/O state signal

I/O terminal block B

2.8.1 The **IB-1301, a module of 24V binary inputs**

The expansion module IB-1301 is designed to scan up to twelve 24VDC binary signals with a common terminal (plus or minus, according to the wiring), type 1 (in accordance with EN 61131).

The DI0 ÷ DI3 inputs allow the implementation of special functions identical with the inputs of the CP-1004 basic module (the functions and input modes are identical with the DI0 ÷ DI3 inputs of the CP-1004 module). For detailed information and examples of connections, see Chapter 2.7.3.1 Special functions of binary inputs in the CP -1004 module.
The DI4 ÷ DI11 inputs are standard binary inputs with a 5ms input filter.
The inputs are galvanically isolated from the internal circuits (power supply and communication to the basic module) and groups of inputs are separated from one another; the status of each input is indicated on the front panel of the module.

The DI0 ÷ DI7 binary inputs

	DI0 ÷ DI3	**DI4 ÷ DI7**
Input type	Type 1	
Input voltage for Log. 0	max. +5VDC	
Input voltage for log.1	min. +15VDC, typically +24DC, max. +30VDC	
Input current in log. 1	typically 10mA	typically 5mA
The minimum width of the captured pulse	50μs	-

The DI0 ÷ DI 3 counter inputs

Max. input frequency	5kHz
The minimum width of the captured pulse	50μs
Incremental sensor:	
Max. frequency of symmetric signal V, G	1.25kHz
Pulse width (V, G, NI, MD)	min. 50 μs
Pulse length, period and phase shift measurement:	
Input frequency	0.1 ÷ 5,000Hz
Pulse width	50 ÷ 10,000,000μs

Basic parameters

Supply voltage	24VDC, +25%, –15%
Typical power consumption	1W
Maximum power consumption	2W

The connectors of the module are standard removable ones with a cage terminal in the removable part with 5.08mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. Detailed parameters of the terminals are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail.

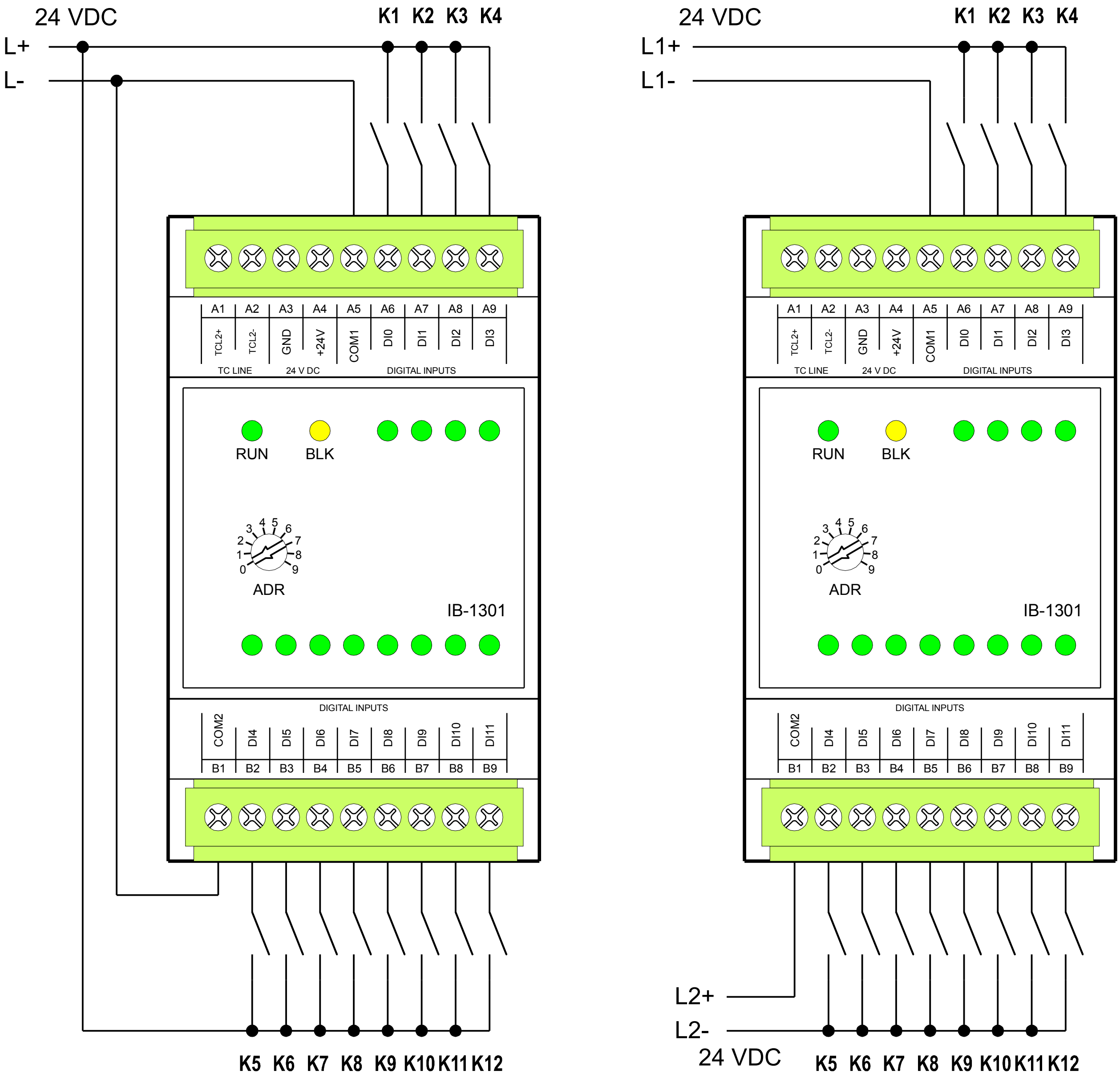


Fig.2.8.1.1 The basic wiring diagram of the IB-1301 module

Wiring notes:

1. The DI0 ÷ DI3 inputs make it possible to implement special functions (connection of incremental encoders, counters, etc.); for detailed information, see Chapter 2.7.3.1
2. Groups of inputs (the DI0 ÷ 3 and the DI4 ÷ 11) are galvanically isolated from each other.
3. In the left example, the inputs are connected with a common negative terminal, the right diagram shows a connection via a common negative terminal for the DI0 ÷ DI3 inputs and a common positive terminal for the DI4 ÷ DI11 inputs.

2.8.2 The **OS-1401, the module of 24V binary outputs**

The OS-1401 expansion module contains 12 semiconductor outputs with a switching contact and a common positive terminal (VDO+).
The DO0 ÷ DO3 outputs allow switching max. 24VDC, 2A per output (total current load of all four outputs must not exceed 4.4A), the DO4 ÷ DO11 outputs allow switching max. 24VDC, 0.5A per output. The outputs are galvanically isolated from the internal circuits (power supply and communication to the basic module) and groups of outputs are galvanically connected, they have common power supply and shared a positive terminal (VDO +); the status of each output is indicated on the front panel of the module.

The Binaryoutlets D00 ÷ DO11

	DO0 ÷ DO3	**DO4 ÷ DO11**
The type of output	Transistor	
Common cable	plus	
The range of switching voltage	9.6 ÷ 28.8VDC	
Switching current	max. 2 A	max. 0.5 A
The current via a common terminal	max. 4.4A	max. 4.5A
Initial peak current limitation	typically 7.5A (switching off time typically 4 ms)	
Short circuit current limitation	typically 4A	
Reverse polarity protection	yes	

Basic parameters

Supply voltage	24VDC, +25%, –15%
Typical power consumption	1W
Maximum power consumption	2W

The connectors of the module are standard removable ones with a cage terminal in the removable part with 5.08mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. Detailed parameters of the connectors are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail.

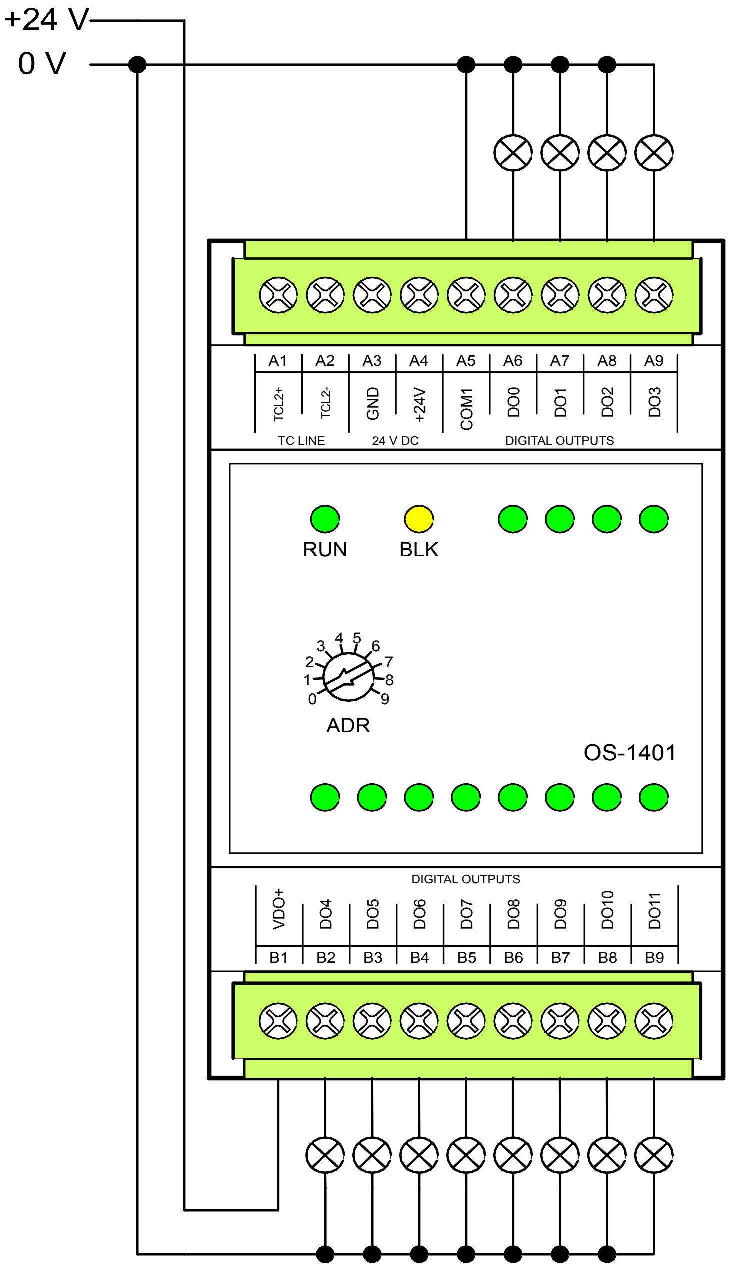


Fig.2.8.2.1 The basic wiring diagram of the OS-1401 module

Wiring notes:

1. The outputs are switched against a common VDO + terminal (max. current via 9 A terminal)
2. The outputs are implemented via semiconductor switches with internal protection against current and temperature overloading. To increase the resistance and lifetime of the system, it is important to treat the switching loads by appropriate interference suppressors (see Chapter 13.7.3 Interference suppression, application of suppression measures).
3. A 24VDC power supply connected to the VDO+ and the COM1 terminals is necessary for proper function of the output sensors!

2.8.3 The **IR-1501, the module of relay outputs**

The IR-1501 expansion module is designed to scan up to four 24VDC binary signals with a common terminal (plus or minus, according to the wiring), type 1. The module contains 8 relay outputs with a switching contact and a common terminal.

The DI0 ÷ DI3 inputs allow the implementation of special functions identical with the inputs of the CP-1004 basic module (the functions and input modes are identical with the DI0 ÷ DI3 inputs of the CP-1004 module). For detailed information and examples of connections, see Chapter 2.7.3.1 Special functions of binary inputs in the CP -1004 module.
The relay outputs can switch max. 230VAC, 3A (the current via a common terminal is max. 10A).
The inputs are galvanically isolated from the internal circuits (power supply and communication to the basic module) and the inputs are separated from the outputs; the status of each input and output is indicated on the front panel.

The binary inputs DI0 ÷ DI3

	DI0 ÷ DI3
Input type	Type 1
Input voltage for Log. 0	max. +5VDC
Input voltage for log.1	min. +15VDC, typically +24DC, max. +30VDC
Input current in log. 1	typically 10mA
The minimum width of the captured pulse	50µs

The counter inputs DI0 ÷ DI3

Max. input frequency	5kHz
The minimum width of the captured pulse	50µs
Incremental sensor:	
Max. frequency of symmetric signal V, G	1.25kHz
Pulse width (V, G, NI, MD)	min. 50 µs
Pulse length, period and phase shift measurement:	
Input frequency	0.1 ÷ 5,000Hz
Pulse width	50 ÷ 10,000,000µs

Basic parameters

Supply voltage	24VDC, +25%, –15%
Typical power consumption	2.2 W
Maximum power consumption	3 W

The relay outputs DO0 ÷ DO7
Outputs with a common terminal, continuous 3A output current, inrush 5 A, max. continuous current via a common terminal COM2 is 10 A, for more detailed information on relay contacts, see Chapter 13.4.1 Relay 5A, the Foxtrot basic module and peripheral modules CFox

The connectors of the module are standard removable ones with a cage terminal in the removable part with 5.08mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. Detailed parameters of the connectors are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail

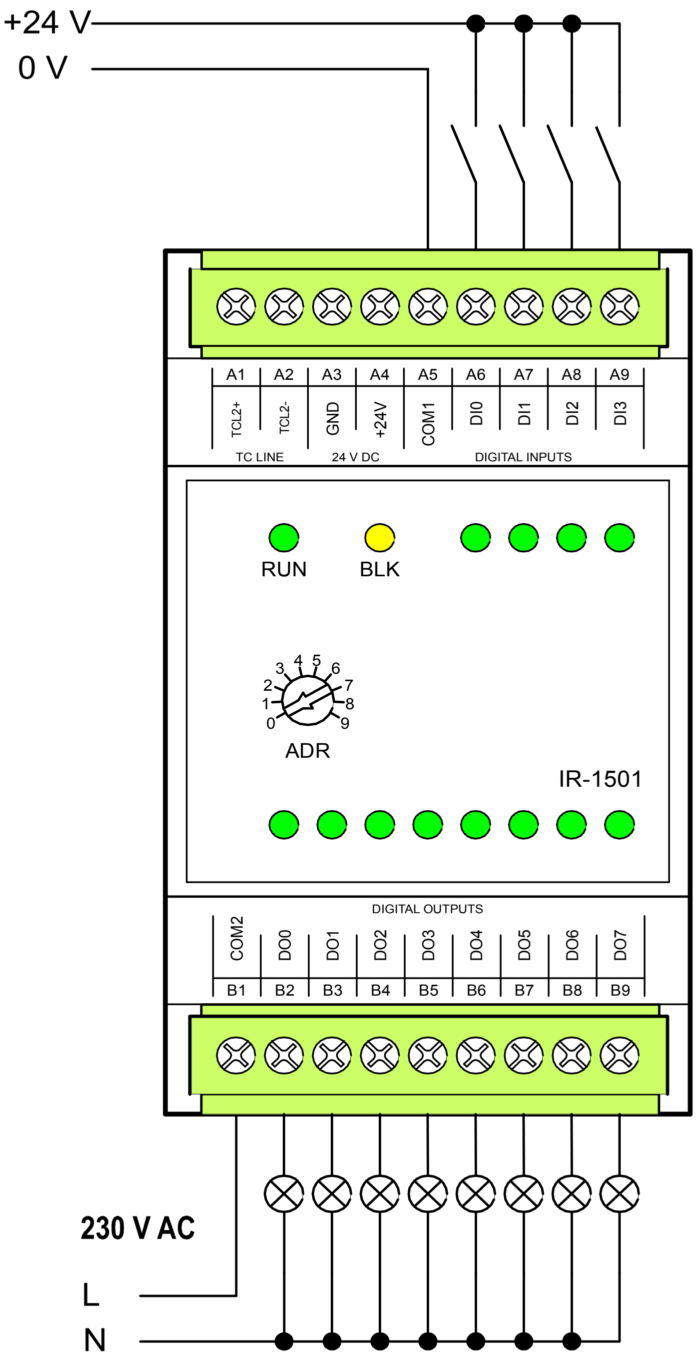


Fig.2.8.3.1 The basic wiring diagram of the IR-1501 module

Wiring notes:

1. The DI0 ÷ DI3 inputs enable the implementation of special functions (connection of incremental encoders, counters, etc.); for detailed information, see Chapter 2.7.3.1
2. The relay outputs are separated from other circuits by 4kV isolation.
3. The inputs in the example are connected with a common negative terminal.

2.8.4 The IT-1604, a module of universal analogue inputs

The IT-1604 expansion module has substituted the previous IT-1601 module.
The module contains 8 analogue inputs with a common terminal and 2 analogue outputs with a common terminal. The inputs are universal, independently configurable as voltage, current inputs, two-wire connection of passive resistance sensors. With 16-bit resolution, the module provides the processing of the values measured, conversion to engineering units, etc. The analogue outputs have 10-bit resolution, the voltage is 0 ÷ 10V. The analogue inputs and outputs are galvanically isolated from the internal circuits and the status of each input is indicated on the module panel.

The analogue inputs AI0 ÷ AI7

Voltage ranges	0 ÷ +10V 0 ÷ +5V 0 ÷ +2V 0 ÷ +1V 0 ÷ +0.5V	
Current ranges	0 ÷ 20mA 4 ÷ 20mA 0 ÷ 5mA	
Passive temperature sensors	Pt100, W_{100} = 1.385 and 1.391	–90 ÷ +400°C
	Pt1000, W_{100} = 1.385 and 1.391	–90 ÷ +400°C
	Ni1000, W_{100} = 1.617 and 1.500	–60 ÷ +200°C
	KTY81-121	–40 ÷ +125°C
	NTC thermistor 12 kΩ	–40 ÷ +125°C
Resistance ranges	0 ÷ 100 Ω (the OV100 resistance transmitter) 0 ÷ 1kΩ (the OV1000 resistance transmitter) 0 ÷ 2kΩ 0 ÷ 200kΩ	
Input impedance in signal range:	> 100kΩ (ranges 0.5V, 1V and 2V) > 50kΩ (ranges 5V and 10V)	
Reference voltage (Vref)	10V	
Internal resistance for current ranges	100Ω	
Measurement time of one channel	typically 65ms (70ms for measurement of temperature sensors)	
Recovery time value of each channel	typically 500ms (600ms for measurement of temperature sensors)	

The analogue outputs AO0, AO1

Output range	0 ÷ 10V
Maximum output value	105% of the output range upper limit
Maximum output current	10mA
Maximum load capacity	50nF

Basic parameters

Supply voltage	24VDC, +25%, –15%
Typical power consumption	2.2W
Maximum power consumption	2.4W

The connectors of the module are standard removable ones with a cage terminal in the removable part with 5.08mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. Detailed parameters of the connectors are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail

Wiring notes regarding the following figure 2.8.4.1:

1. The analogue inputs and outputs have a common AGND terminal.
2. In order to improve measurement accuracy, it is recommended to connect the input signals (sensors) in accordance with the example, i.e. to use the A8 terminal as a common AGND terminal for the measurement of passive resistance sensors.
3. There is an exact +10.0V voltage in the Vref terminal, which is available for powering passive resistance sensors (using an external serial resistor).
4. The passive resistance sensors with a two-wire connection are powered by an internal 10V supply via serial resistors 7K5 fitted inside the module. (N.B.: This is a change compared to the IT-1601). For backward compatibility with the IT-1601 module it is also possible to use external power supply of sensors via 7K5 serial resistors from the Vref terminal. In this case, the resistor is mounted outside the module in the control panel. The other end of the sensor should be connected to AGND terminal no. A8(!) (It is recommended to use the MT-1691 module), and set

a mode compatible with the IT-1601 in the configuration.

5. The precision of the 7K5 resistor (if fitted outside) has a key impact on the accuracy of measurement of resistive sensors. The resistors used in the MT-1691 module have a basic accuracy of 0.1% and the minimum temperature coefficient is 25ppm.
6. The current ranges (20mA, etc.) are switched from the Mosaic programming environment (the module is not fitted with internal jumpers).

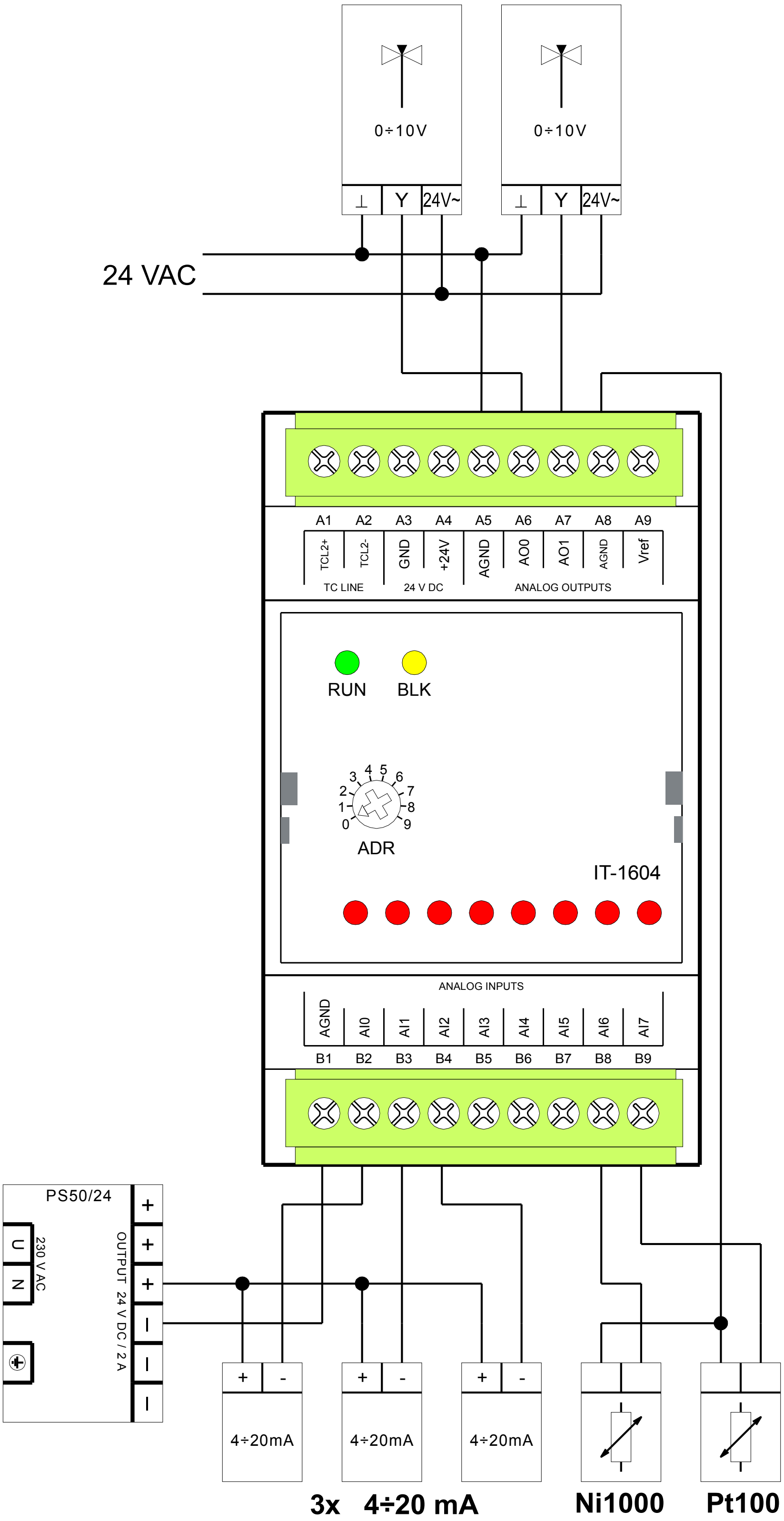


Fig.2.8.4.1 The basic wiring diagram of the IT-1604 module

For the wiring notes see the previous page

2.8.4.1 The Pt100 sensors connected by three wires to the IT-1604 module

If a 3-wire Pt100 measurement is required (reducing the influence of the sensors supply cable resistance), external 7K5 resistors can also be used and the sensors should then be connected in accordance with the following diagram.

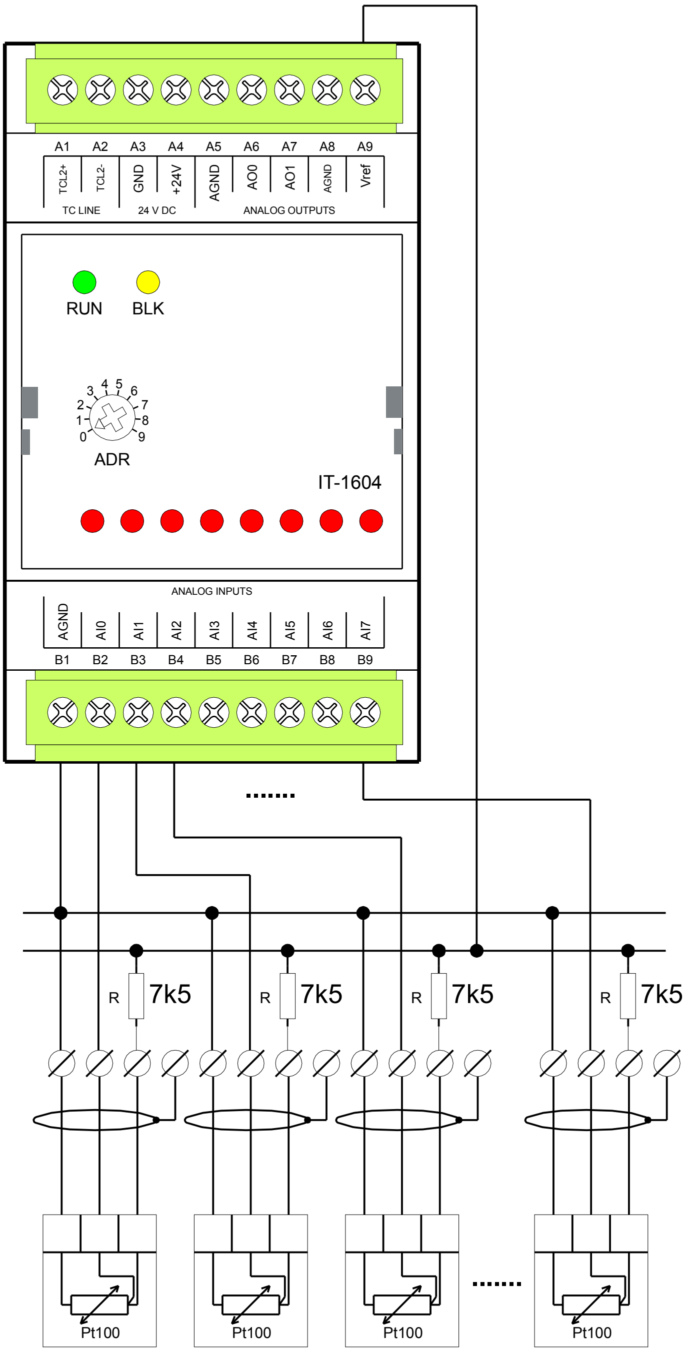


Fig.2.8.4.2 An example of a three-wire connection of the Pt100 sensors to the IT-1604 module.

Notes:

1) All sensors are powered via serial resistors (a 7k5 resistor, ideally with 0.1% accuracy) from the Vref terminal of reference voltage. A9 The accuracy of the 7K5 resistor has a key impact on the accuracy of measurement of resistive sensors.
2) To maintain the accuracy in accordance with the module specification, it is necessary to use resistors with the basic accuracy of 0.1% and the minimum temperature coefficient of 25ppm.

3) The resistors must be fitted outside the module into the control panel.

2.8.4.2 The MT-1691 submodule with resistors for powering passive sensors (for IT-1601).

The R resistors for powering passive sensors do not have to be obtained and manually fitted in the application; the ready-to-use MT-1691 module can be inserted in the bottom terminal block in accordance with Fig.2.8.4.3 and the free end of the wire should then be fastened in the A9 terminal of the IT-1604 module (like with the older IT-1601).
The outlets of the MT-1691 resistive element should be inserted directly into the terminal, along with connecting cables. (We recommend to insert the connecting wires under the pins of the resistive element.)
The unused outlets of the resistive element can be broken off and these inputs can then be used as analogue inputs with a different range. However, the only pins that can be broken off are those at the end where no wire with a reference voltage is terminated. The SW configuration is performed in the Mosaic programming environment.

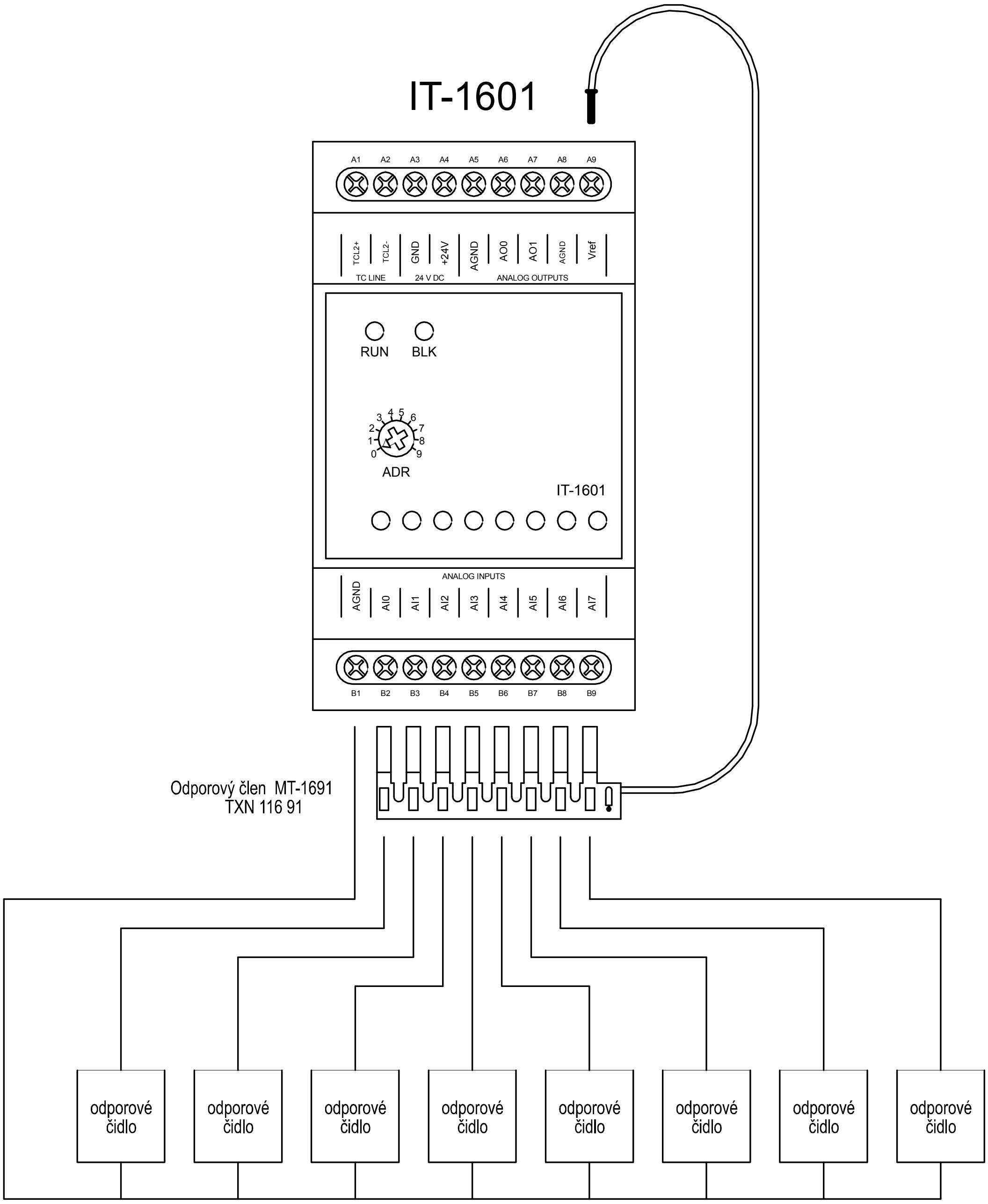


Fig.2.8.4.3 Connecting the MT-1691 resistive element to the IT-1601 module.

Notes:

1) This connection can also be used for backward compatibility with the IT-1604 module (e.g. fora service exchange, etc.)

2.8.5 The **IT-1602 module for the measurement of thermocouples and mV signals**

The IT-1602 expansion module contains 8 analogue inputs with a common terminal and 2 analogue outputs with a common terminal. The inputs are universal, independently configurable as voltage inputs or for direct connection of thermocouples. A compensation of the cold end is implemented by an external sensor Ni1000 connected to the CJC input (the cold junction compensation). The sensor needs to be placed on the terminal block, where the compensating cables are terminated (the equipotential terminal block). With 16-bit resolution, the module provides the processing of the values measured, convertion to engineering units, etc. The analogue outputs have a 10-bit resolution, bipolar -10 to + 10V voltage. The analogue inputs and outputs are galvanically isolated from the internal circuits and the status of each input is indicated on the module panel.

The analogue inputs AI0 ÷ AI7

Voltage ranges	-0.1 ÷ +0.1V -1 ÷ +1V	
Thermocouples	J K R S B T N	–210 ÷ +1200 °C –200 ÷ +1372 °C –50 ÷ +1768 °C –50 ÷ +1768 °C +250 ÷ +1820 °C –200 ÷ +400 °C –200 ÷ +1300 °C
Input impedance in signal range:	> 1MΩ	
Measurement time of one channel	typically 65ms (100ms for thermocouples)	
Recovery time value of each channel	typically 500ms (800ms for thermocouples)	
Cold junction compensation sensor (CJC)	Ni1000, W_{100} = 1.617	

The analogue outputs AO0, AO1

Output range	-10 V ÷ 10V
Maximum output value	105% of the output range upper limit
A minimum output value	-105% low limits of the output range
Maximum output current	10mA
Maximum load capacity	50nF

Basic parameters

Supply voltage	24VDC, +25%, –15%
Typical power consumption	1.7W
Maximum power consumption	2.5W

The connectors of the module are standard removable ones with a cage terminal in the removable part with 5.08mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. Detailed parameters of the connectors are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail.

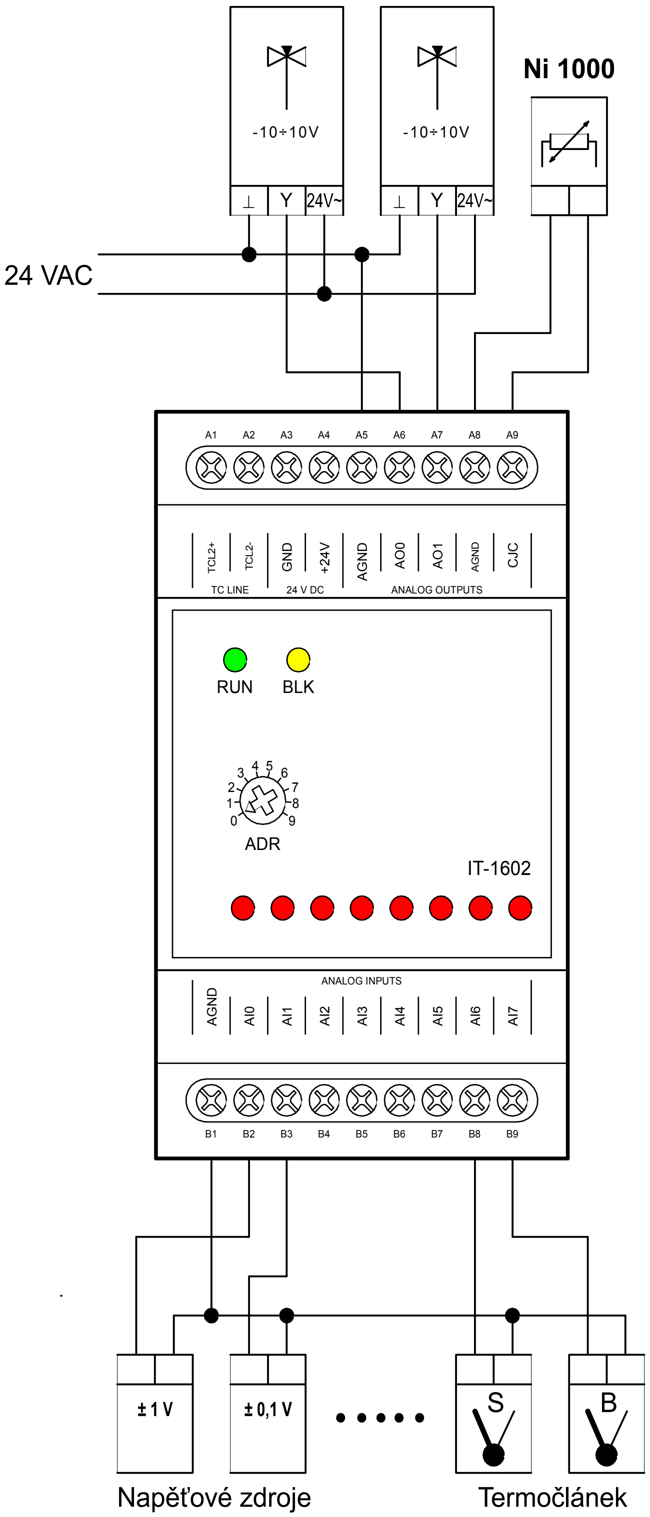


Fig.2.8.5.1 The basic wiring diagram of the IT-1602 module

Wiring notes:

1. The analogue inputs and outputs have a common AGND terminal.
2. To improve the accuracy of measurement, it is recommended to connect the input signals (sensors) in accordance with the example, i.e. to use the B1 terminal as a common AGND terminal for the analogue inputs (the A5 for the analogue outputs and the A8 for the cold junction compensation).
3. The CJC input is designed only to measure the cold junction during direct measurement of thermocouples. The connected sensor must be the Ni1000 type.

2.8.6 The OT-1651, a module with 4 analogue outputs

The OT-1651 expansion module contains four unipolar analogue outputs. Each can be used either as a voltage or a current output. Both types of loads are connected against the common terminal - signal ground (AGND). The resolution is 12 bits. The analogue outputs are galvanically isolated from the module power supply and the TCL2 communication. The output circuits require for their function a separate external 24V DC power supply. The current loop status is indicated on the module panel.

The analogue outputs AO0 ÷ AO3

The type of output	voltage active	current active
Output range	0 ÷ 10V	0 ÷ 20mA
Maximum output value	105% of the output range upper limit	
Maximum output current	10mA	-
The short circuit current	12mA	-
The current loop resistance	-	0 ÷ 600 □

Basic parameters

Supply voltage (communication part, the A4 terminal)	24VDC, +25%, –15%
A typical power consumption (communication part)	0.3W
The supply voltage of output circuits (A6 terminal)	24VDC, - 25%, + 20% [1.]
The consumed current of the output section	max. 135mA
Max. total module power loss	4.4W

Notes:

1. When only current outputs are used, lower supply voltage + VAO can be applied to reduce the power losses of the module. The voltage value is calculated from the largest current loop resistance x maximum current (21mA) +6V

The connectors of the module are standard removable ones with a cage terminal in the removable part with 5.08mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. Detailed parameters of the connectors are specified in Chapter 13.3.1 Connectors with screw terminals, spacing 5.08mm, modules on a DIN rail.

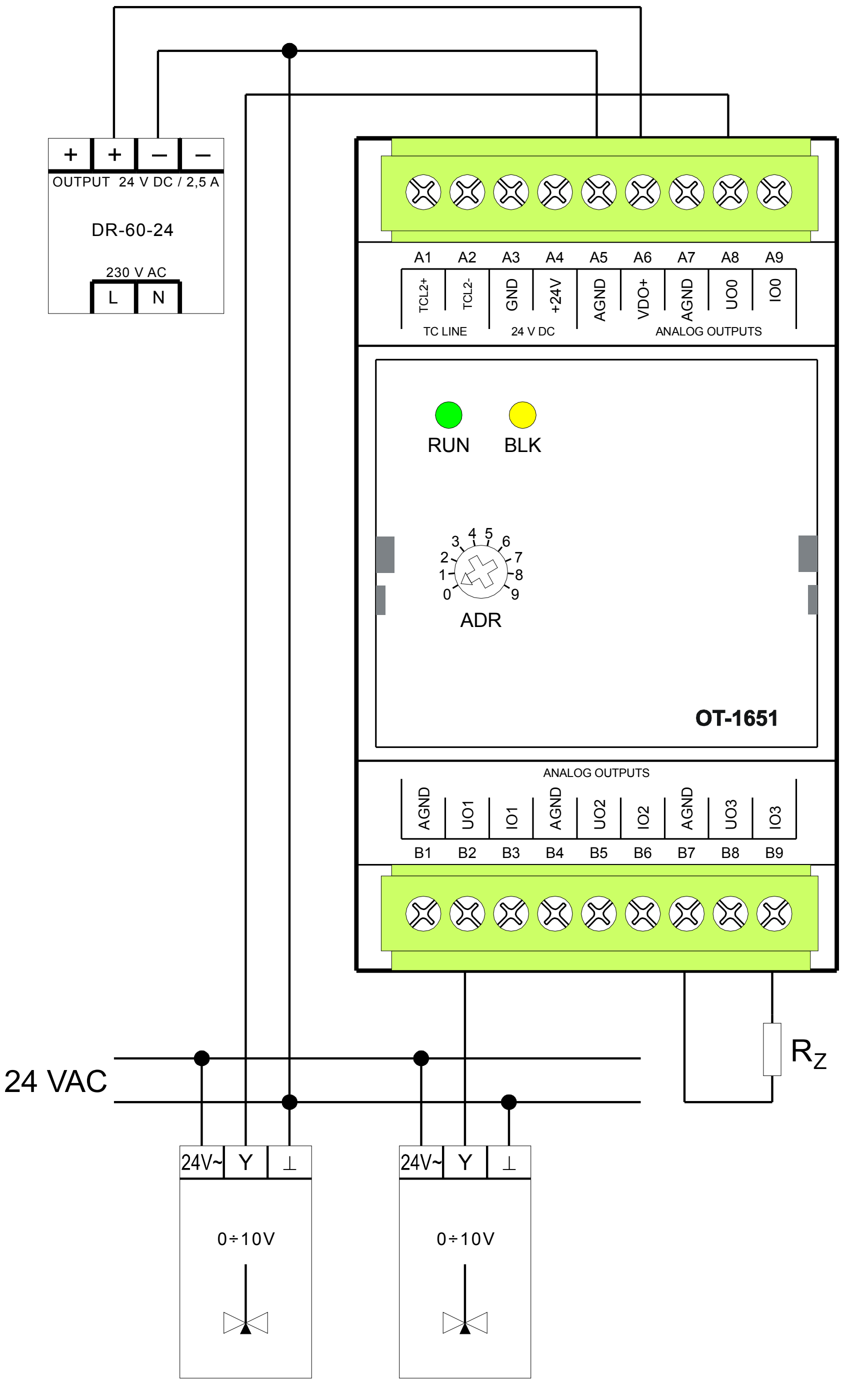


Fig.2.8.6.1 An example of the OT-1651 module wiring.

Wiring notes:

1. The analogue outputs (voltage and current) have a common AGND terminal.
2. A power supply for output circuits must always be used; the source in the example is DR-60-24. When galvanic isolation is not applied, it is possible to use for i output circuits a power supply source for powering the system (then you should connect terminals A4 with A6 and A3 with A5).

2.8.7 The **UC-1203, a module for connecting the MP-Bus actuators**

The UC-1203 module is used for connecting Belimo regulating actuators via the MP-Bus (a Belimo company product). The module makes it possible to connect up to 8 regulating actuators (globe valves actuators, and regulating ball valves actuators) on the MP-Bus. Some actuators can also be connected to an external sensor (active/passive), which is also processed by the UC-1203 module. It takes approximately 700ms to operate one of the connected actuators, which means that it takes about 5.5s to operate all eight actuators. When operating the actuators, it is necessary to take into account this delay in the application program.
The module is powered by an external 24VDC power supply, which is not galvanically isolated from the internal circuitry, but it is galvanically isolated from the MP-Bus interface.
The module is fitted with screw terminals for a maximum wire cross-section of 2.5mm2 per terminal.The terminal block serves for connecting the TCL2 communication line, for powering the module and for connecting the MP-Bus.
The module is in a plastic 1M box (17.5 mm wide); the dimensions are listed in Chapter 13.2.4.

Basic parameters of the UC-1204 module

System bus	TCL2
Supply voltage	20.4 ÷ 28.8VDC
Maximum power consumption	2.5W
Galvanic isolation from the MP-Bus	yes
Operating temperature	-20 ÷ +55 °C
Working position	free
Installation	on a DIN rail
Connection/wires cross-section	screw terminals / max. 2.5mm^2
MP-Bus level high	min. 11V typically 15V max. 18V
MP-Bus level low	max. 2.5V
MP-Bus current to short circuit	max. 10mA
Communication speed / byte structure	1200 baud / 1 start, 8 data, 1 stop, no parity
Data transfer	bidirectional, half duplex
The number of connected slaves	8

Brief information on the MP-Bus

The MP-Bus is a master-slave bus designed by Belimo. Up to 8 slave actuators can be controlled by one master module (UC-1203) - flap actuators, valve actuators (MP/MFT). One actuator can be connected to one sensor - e.g. with 0 to 10V output, contact, Pt1000, Ni1000 or NTC temperature sensor.
The MP-Bus consists of three wires - 24VAC or DC power supply, common GND signal and communication wire called MP. All three wires are in one cable. There is no need for any special cable or bus termination. The bus topology is arbitrary. Permissible topologies include star, ring, tree and mixed configurations. Maximum cable length is determined by the wire diameter, power consumption of the actuators (depending on the type) and by the power supply (AC or DC); for more calculation details see the Belimo company documents.
E.g. for 4 actuators with a total power consumption of 13.5W distributed in a single cable, 24VDC power supply, with 1.5 mm^2 cross-section, the maximum cable length is 110m; with the cross-section 2.5mm^2 the maximum length is 190m.

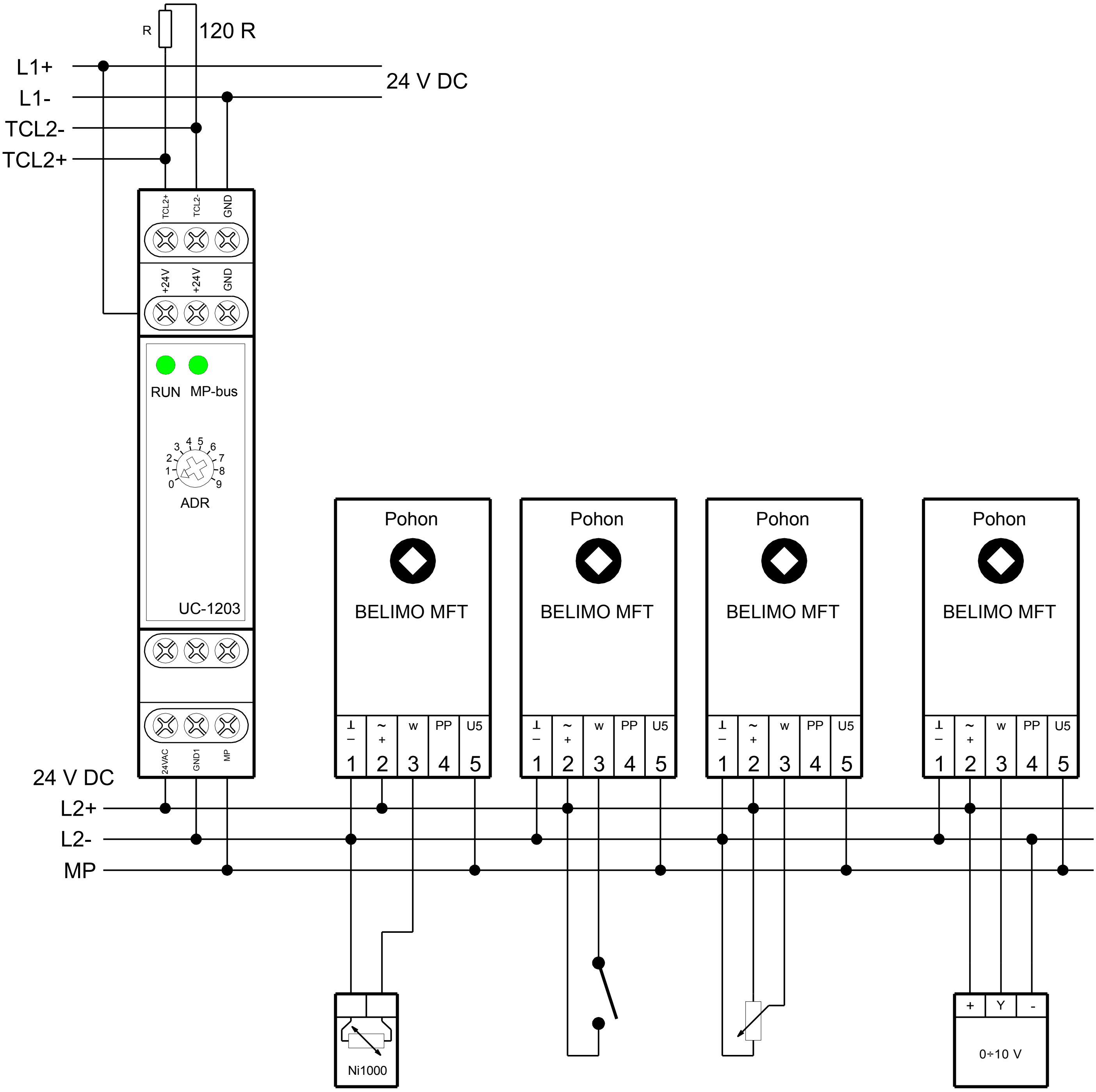


Fig.2.8.7.1 A basic example of Belimo actuators connection to the UC-1203 module

Notes:

1. Connecting Belimo actuators to the UC-1203 module is done using the 24V ~ / GD / MP terminals. The UC-1203 module does not supply power for the controlled actuators; they must be powered from a 24VAC/DC external source.
2. In order to select the capability of power supplies, you should calculate the maximum bus length and the cross-section of wires for the MP-Bus, see the Belimo company documentation; for a brief description see higher up in this text.

2.8.8 The UC-1204, communication with the boiler with the OpenTherm interface

The UC-1204 module is designed to connect the equipment (a boiler) communicating via a two-way protocol OpenTherm with the Foxtrot basic module.
The module is designed for "point-to-point" connections, i.e. it allows to connect a single OpenTherm device. The UC-1204 module operates in the OpenTherm communication as a master (control unit), so the connected equipment must be a slave. The module supports devices in accordance with a complete OpenTherm (v.2.2) specification named OpenTherm Plus (OT / +), and also in accordance with the basic specification referred to as OpenTherm Lite (OT/-).
The module is powered by an external 24VDC source, which is not galvanically isolated from internal circuits. The module is fitted with screw terminals for a maximum wire cross-section of 2.5mm2 per terminal.The terminal block is used for connecting the communication line TCL2, for powering the module and for connecting the OpenTherm bus.

Basic parameters of the UC-1204 module

Connection	screw terminals, max. 2.5mm^2 wire cross-section
The type of equipment	built-in
Supply voltage	typically 24VDC -15% + 25%
Internal protection	resettable electronic fuse 24VDC
Typical power consumption	0.25W
Maximum power consumption	0.4W
galvanic isolation of OpenTherm interface	yes

The OpenTherm

It is a communication interface designed primarily for communication of boilers with a master control system.. The protocol is available in two versions:
The OpenTherm Lite - a basic version which communicates via PWM - only to set the required temperature of water.
The OpenTherm Plus - a complete specification, two-way communication allows transmission of more information - the boiler status, its configuration, resetting, information such as pressure and temperature, ignitions counter, burning durations, running of the pumps, etc.

The communication protocol does not permit detailed boiler control, but the control unit transmits data to the boiler on the required heating water temperature, but it is not concerned with how this is achieved. The control unit (the Foxtrot system with the UC-1204 module) operates as a master. The master transmits information by a voltage change in the communication wires, and the boiler responds by changing the current:

	Log.”0”	Log.”1”
master	max.7V	15 - 18V
slave	5 - 9mA	17 - 23mA

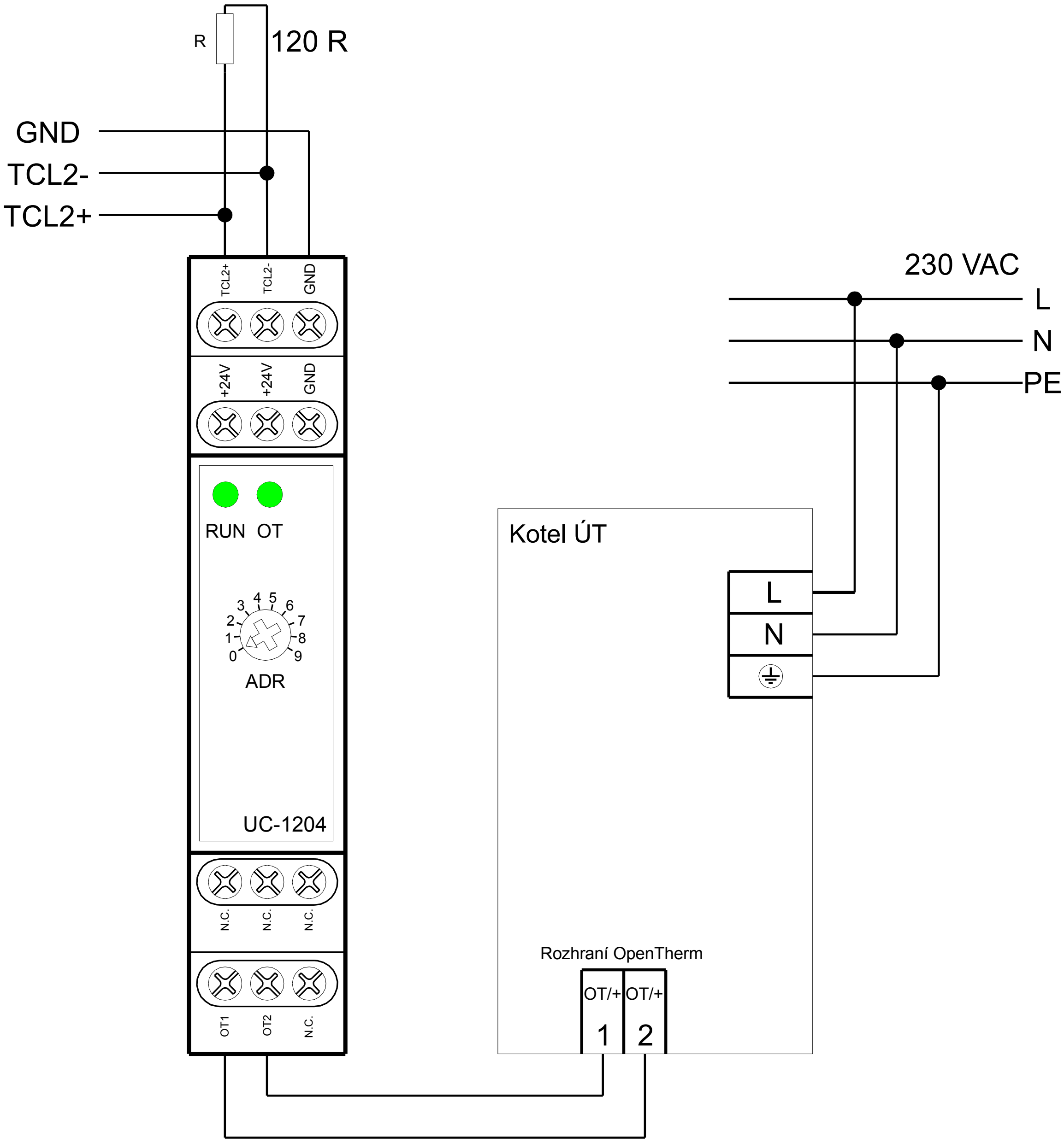


Fig.2.8.8.1 A general example of the UC-1204 module connection to a boiler with OpenTherm interface

Notes:

1) Cables suitable for the OpenTherm interface include the SYKFY 2x2x0.5 (a cable with one shielded pair, which does not have to be twisted). The polarity is arbitrary, maximum length is 50mm and the resistance is 2 x 5 Ω.
2) The OpenTherm bus is only the point-to-point type, which means that only one UC-1204 module can be connected to a single boiler. A cascade of boilers must be dealt with either by connecting boilers among each other (so the cascade is then controlled by themselves - e.g. Thermona boilers with the RS-485 interface), or by using multiple UC-1204 modules (one module per boiler, maximum 10 UC-1204 peripheral modules can be connected to one Foxtrot basic module).

2.8.8.1 Connecting Thermona boilers with the OpenTherm interface

An example of connecting a Thermona boiler fitted with the IU05 interface module. This interface makes it possible to implement a boiler cascade via its own bus.

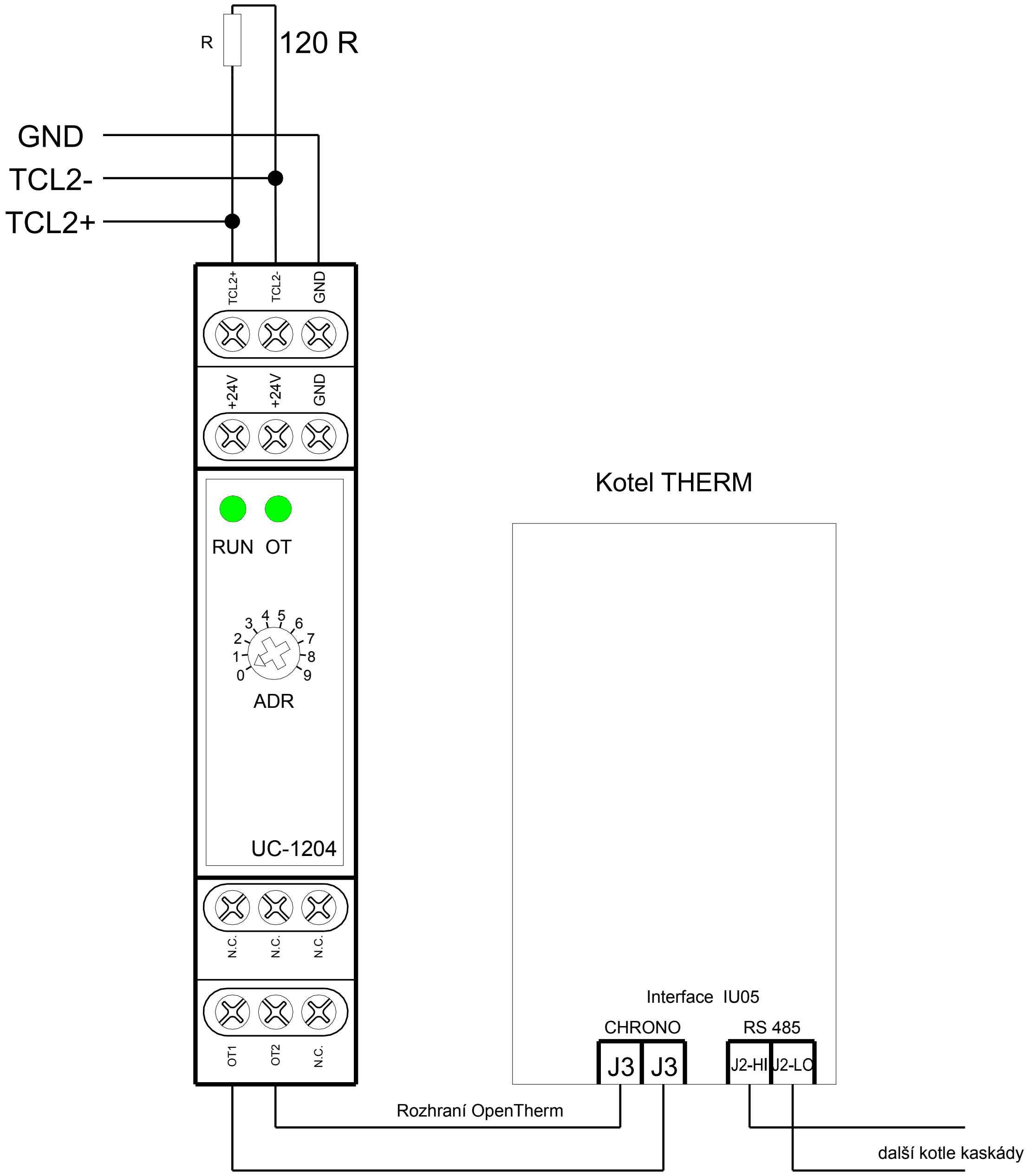


Fig.2.8.8.1 An example of connection of the UC-1204 module to a Thermona boiler (the IU05 interface)

2.8.9 The SC-1101, an additional RS-232 and RS-485 interfaces

The SC-1101 is a system communication module for the extension of the central unit by another serial communication channel supporting the UNI and PC modes; it contains 1 serial port with parallel terminated interfaces RS-232 and RS-485 (only one of the interfaces can be used simultaneously!). A more detailed description of serial communication and its usage is specified in the manual Serial communication of the PLC TECOMAT - a 32 bit model (order No. TXV 004 03.01).
The Foxtrot basic module allows the connection of up to 6 system communication modules SC-1101 and SC-1102, which occupy the CH5 - CH10 channels. One should bear in mind that due to the transmission capacity of the TCL2 bus, these serial channels are suitable for slow and low capacity data communication.

Basic parameters of the SC-1101 module

Connection	screw terminals, max. 2.5mm^2 wire cross-section
The type of equipment	built-in
Supply voltage	typically 24VDC -15% + 25%
Internal protection	resettable electronic fuse 24VDC
Maximum power consumption	0.8W
Interface with galvanic isolation of the interface	1000VDC
The number of serial channels	1
The RS-232 interface	
Input resistance of the receiver	min. 7kΩ
The output signal level	typically ± 8V
Maximum length of the cable	15m
The RS-485 interface	
The sensitivity of the receiver	min. ± 200mV
The output signal level	typically 3.7V
Maximum length of the cable	1,200m*

* The maximum length is valid for a shielded twisted pair cable with communication rate of max. 120kBd.

Termination of the RS-485 line
Termination of the RS-485 line is provided by the external terminator by switching both BT switches on the front panel to the ON position (to the right). The RS-485 line has to be terminated on both ends of the line. If the device is connected in the middle of the line, internal terminator is not used. In this case both BT switches should be switched to the left.

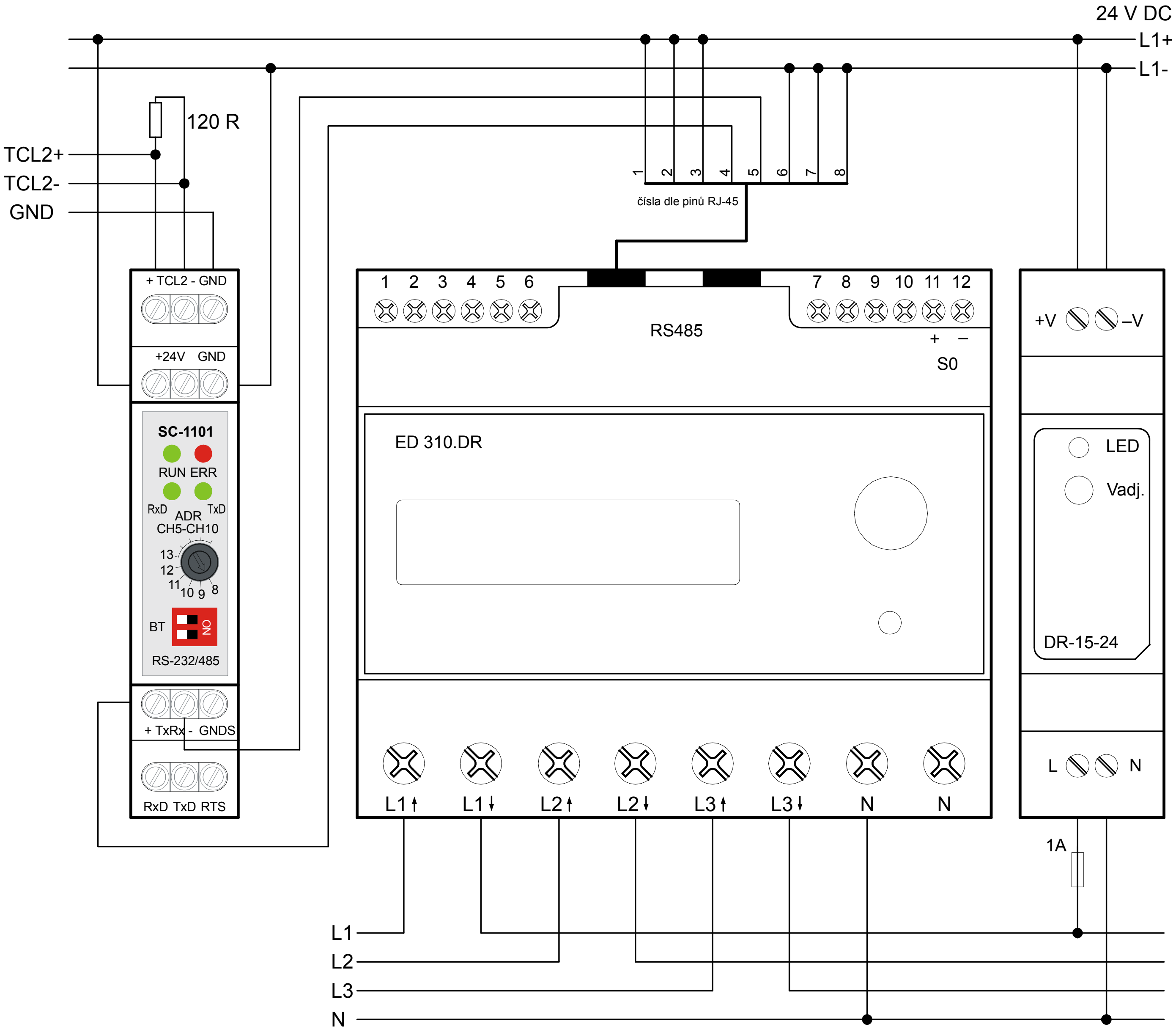


Fig. 2.8.9.1 An example of connecting the electricity meter ED310 to the SC-1101 module

2.8.10 The SC-1102, an additional interface CAN module

The SC-1102 module is a system communication module for expansion of the central unit by an additional port with CAN interface; the module contains one CAN bus control unit operating in the CSJ mode.
A more detailed description of CAN serial communication and its usage is specified in the manual Serial communication of programmable controllers PLC TECOMAT - a 32 bit model (order No. TXV 004 03.01).
The Foxtrot basic module allows the connection of up to 6 system communication modules SC-1101 and SC-1102, which occupy CH5 - CH10 channels. One should bear in mind that due to the transmission capacity of the TCL2 bus, these serial channels are suitable for slow and low capacity data communication.

Basic parameters of the SC-1102 module

Connection	screw terminals, max. 2.5mm^2 wire cross-section
The type of equipment	built-in
Supply voltage	typically 24VDC -15% + 25%
Internal protection	resettable electronic fuse 24VDC
Maximum power consumption	0.8W
Interface with galvanic isolation of the interface	1000VDC
The number of CAN buses	1

Termination of the communication line
Termination of the CAN bus communication line is executed by internal terminator by switching both BT switches on the front panel to the ON position (to the right). The line must be terminated in each device, which is located at either end of the line. If the device is connected in the middle of the line, internal terminator is not used. In this case both BT switches should be switched to the left.

Please note: Both BT switches must be set identically, i.e. both either on the right, or both on the left. Other settings may result in a communication error.

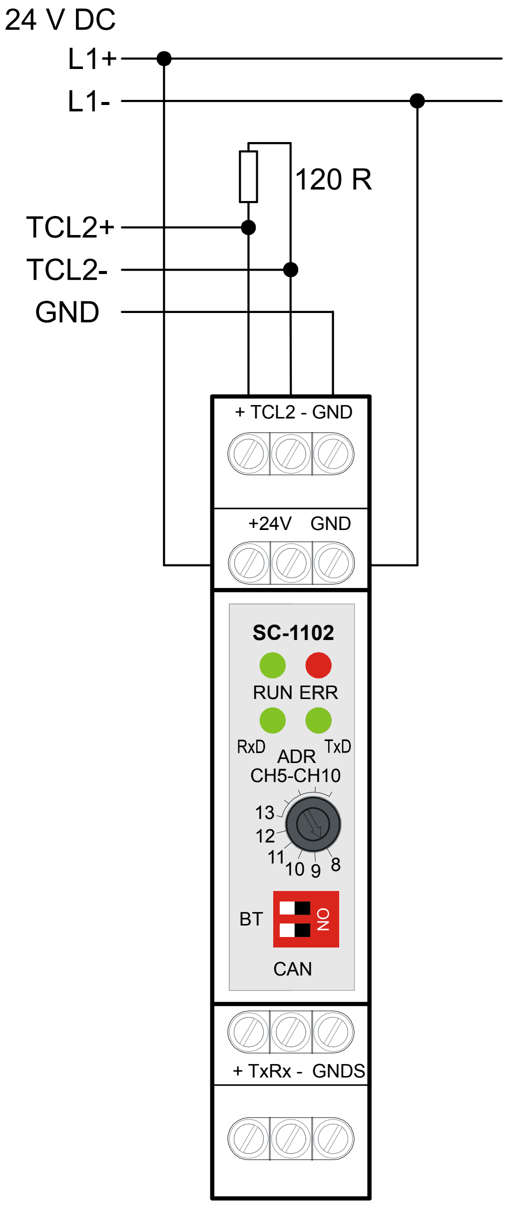


Fig. 2.8.10.1 An example of the SC-1102 module connection

2.8.11 The IT-1605, a module for the measurement of thermocouples and mV signals

The IT-1605 expansion module contains 8 analogue inputs with a common terminal and 2 analogue outputs with a common terminal. The inputs are universal and they can be configured independently as voltage inputs for small values or for measurement of thermocouples; with a 16-bit resolution, the module processes the values measured, conversion to engineering units, etc. The analogue outputs have a 10-bit resolution, the voltage is -10 up to +10V. The analogue inputs and outputs are galvanically isolated from the internal voltage and the TCL2 communication, and the status of each input is indicated on the module panel.The module is fitted with removable screw connectors.

The module is in a 4M box.

The connectors of the module are removable standard ones with a cage terminal in the removable part, with 3.5 mm spacing. Detailed parameters of the connectors are specified in Chapter 13.

The analogue inputs AI0 ÷ AI7

Voltage ranges	-0.1 ÷ +0.1V -1 ÷ +1V	
Thermocouples	J K R S B T N	–210 ÷ +1200 °C –200 ÷ +1372 °C –50 ÷ +1768 °C –50 ÷ +1768 °C +250 ÷ +1820 °C –200 ÷ +400 °C –200 ÷ +1300 °C
Input impedance in signal range:	> 1 MΩ	
Measurement time of one channel	typically 65ms (100ms for thermocouples)	
Recovery time value of each channel	typically 250 ms (400ms for thermocouples)	
Cold junction compensation sensor (CJC)	Ni1000, W_{100} = 1.617	

The Analogue outputs AO0, AO1

Output range	-10 V ÷ 10V
Maximum output value	105% of the output range upper limit
A minimum output value	-105% low limits of the output range
Maximum output current	10mA
Maximum load capacity	50nF

Basic parameters

Supply voltage	24VDC, +25%, –15%
Typical power consumption	1.7W
Maximum power consumption	2.5W

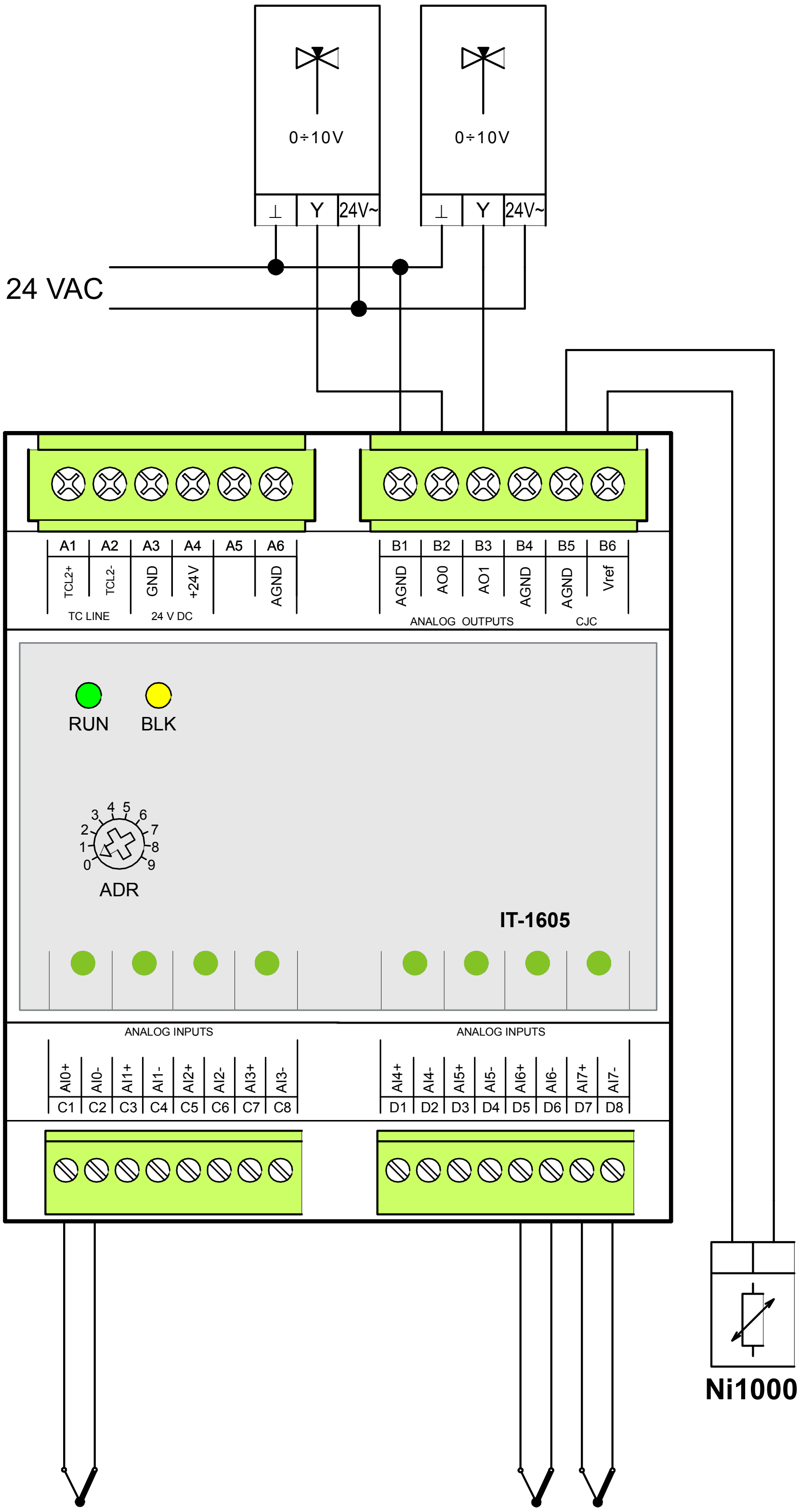


Fig.2.8.11.1 The basic wiring diagram of the IT-1605 module

Wiring notes:

1. The analogue inputs and outputs have a common AGND terminal.
2. When measuring the analogue signals (1V, 0.1 V) it is recommended to connect the AI-terminals with signal ground AGND (the A6 terminal).
3. The CJC input is designed only to measure the cold junction during direct measurement of thermocouples. The connected sensor must be the Ni1000 type.

2.9 The operator panels

2.9.1 Graphic panels with 4.3" display, the ID-31, ID-32

The operator´s panels ID-31 and ID-32 are designed to cooperate with the TECOMAT TC700 systems and Foxtrot.
User screens are created in the Mosaic programming environment with the Webmaker tool, and are therefore identical with the sites accessible via the web server.
The panel has a backlit LCD touch screen with the resolution of 480x272 pixels. The power supply voltage of the panel is 24VDC and it is connected either to terminals A3, A4, or the panel can be powered via the Ethernet interface cable; the 24V supply should be connected to the unused pairs 4/5 and 7/8. In this case, the polarity is irrelevant.
Communication between the control system and the ID-3 panel takes place via the Ethernet 100Base-TX interface, or via a serial line with the RS-485 interface using the EPSNET protocol.
The ID-31 panel is designed to be mounted on the wall; it should be attached on the KU 68 wiring box.
The ID-32 panel is designed for built-in mounting in the switchboard door, and the like.

Basic parameters of the ID-31 and ID-32 panels

Protection (after assembly) in accordance with ČSN EN 60529	the front panel IP50, the whole product IP20
Supply voltage	power supply SELV typically 24VDC
Internal protection	No
Power consumption	maximum 4W
Galvanic isolation of power supply from internal circuits	No
Maximum weight	0.3kg
Dimensions of ID-31	135 x 91mm
ID-32	133 x 91mm
Display	colour TFT LCD
Diagonal	4.3"
Resolution	480 × 272 pixels
The number of colours	16.7 million
Back light	LED
Lifetime	typically 20,000 hours
Touch screen	ID-31 capacitive
	ID-32 resistive
Power supply connector 24V and RS-485	Wire cross-section 0.5 ÷ 1.5mm^2, removable connector

The ID-31 panel is designed for wall mounting in the KU 68 flush-box.
On the rear side the panel has a metal cover with IP20 protection. On the bottom side of the panel are placed two
screws. If you loosen them, a sheet metal support will be released - it should be screwed on the flush box. Then the panel can be hung on the metal sheet support from the top, pushed to the wall and secured by lightly tightening the two screws.

Connecting the cables (Ethernet, 24VDC power supply) is identical with the ID-32 panel (see the figure below).

The ID-32 panel is designed for built-in mounting, the front panel is made of plastics. The rear of the panel is protected by a cover metal sheet with IP20 protection.Four metal clamps with fastening screws serve for mounting. They are incorporated in the panel, which they fasten by turning 90 degrees and then tightening the screws.

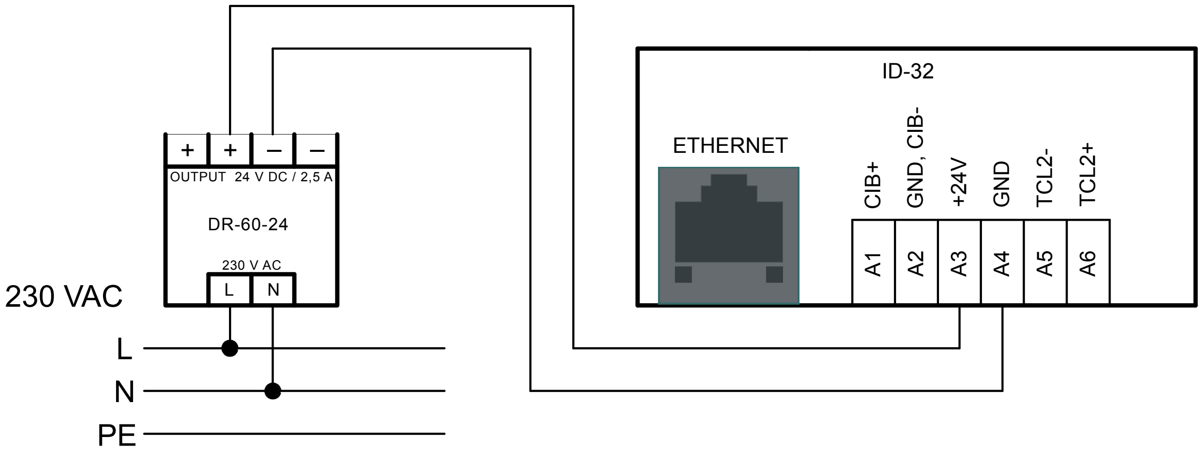


Fig. 2.9.1.1 Wiring the connectors and connecting the power supply to panels ID-32, ID-31 and ID-36.

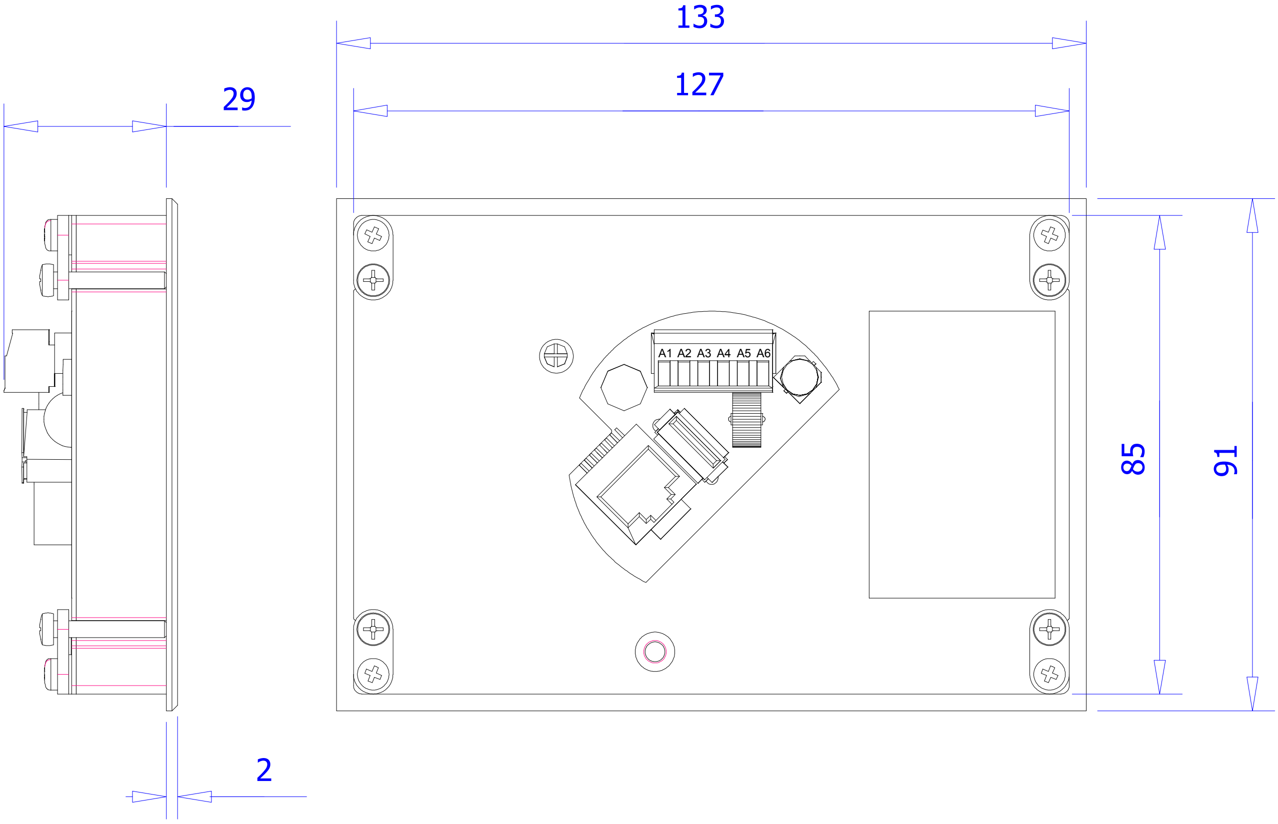


Fig. 2.9.1.1 Mechanical dimensions and placement of the ID-32 module connectors

Notes:

1. On the rear side of the panel is the RJ-45 connector for connecting a standard patch cable and the RS-485 (TCL2) removable connector with 24VDC power supply and a variable interface.

2. Alternatively, the panel can be powered via the Ethernet interface cable: the 24V supply voltage should be connected to the unused pairs 4/5 and 7/8, and the polarity in this case is irrelevant.Suitable passive modules for power supply injection l (or Splitter) can be obtained in computer shops (they are often referred to as PoE modules, although they don´t represent the standard Power over the Ethernet).
3. The mounting hole dimensions should be 128 x 86mm.
4. The operators´ panels must not be exposed to direct sunlight.

2.9.2 Graphic panels with a 10" display, the ID-36

The operators panel ID-36 is designed for cooperation with TECOMAT TC700 systems and Foxtrot.
User screens are created in the Mosaic programming environment with the Webmaker tool, and are therefore identical with the sites accessible via the web server.
The panel has a backlit LCD touch screen with the resolution of 800x600 pixels. The power supply voltage of the panel is 24VDC and it is connected either to terminals A3, A4, or the panel can be powered via the Ethernet interface cable; the 24V supply should be connected to the unused pairs 4/5 and 7/8. In this case, the polarity is irrelevant.
Communication between the control system and the ID-3 panel takes place via the Ethernet 100Base-TX interface, or via a serial line with the RS-485 interface with the EPSNET protocol.
The ID-36 panel is designed for built-in mounting in the switchboard door, and the like.
Connecting the cables (Ethernet, 24VDC power supply) is identical with the ID-32 panel.

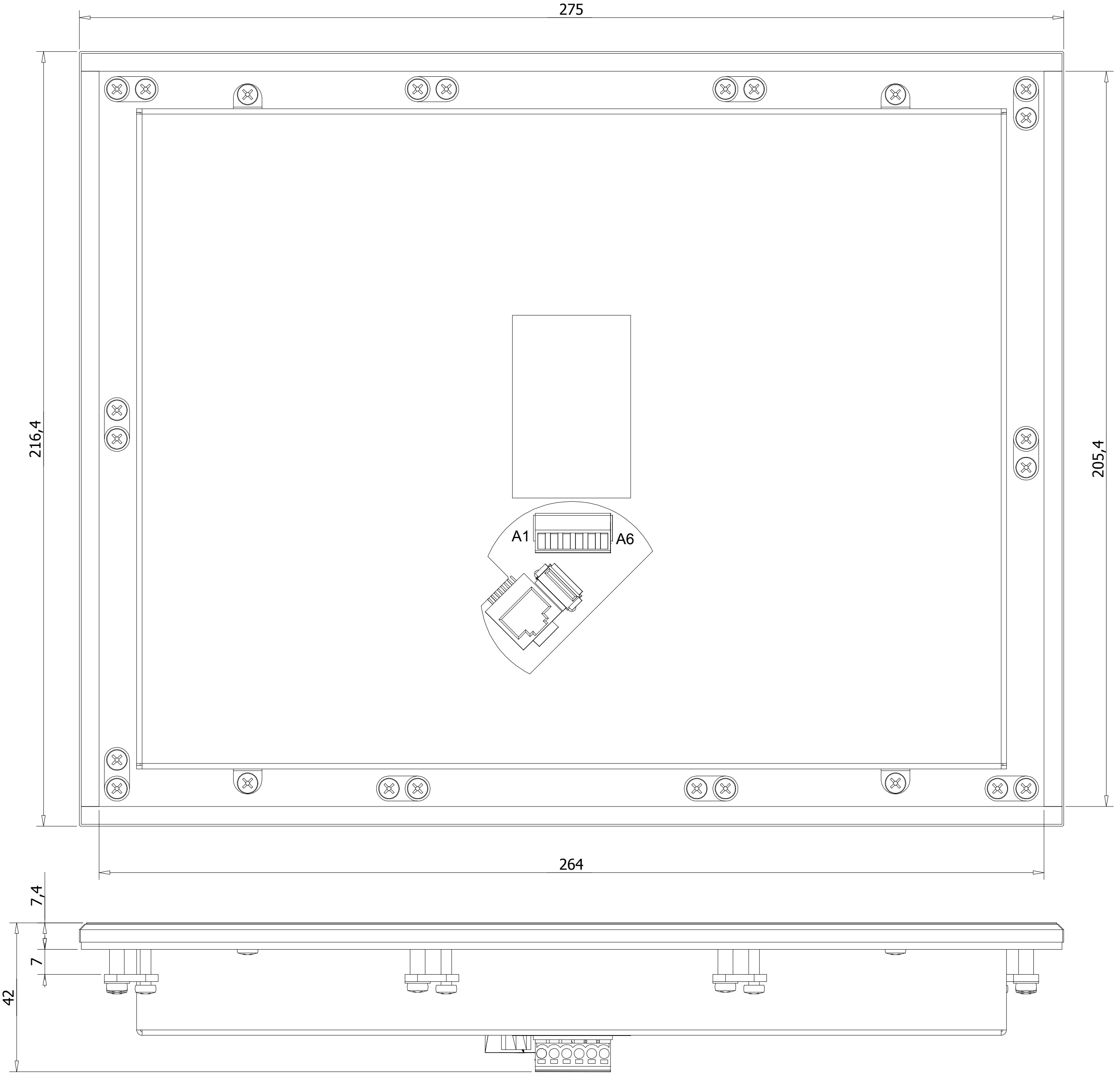


Fig. 2.9.2.1 Mechanical dimensions and placement of the ID-36 module connectors

Notes:

1. On the rear side of the panel is the RJ-45 connector for connecting a standard patch cable and the RS-485 (TCL2) removable connector with 24VDC power supply and a variable interface.
2. Alternatively, the panel can be powered via the Ethernet interface cable: the 24V supply voltage should be connected to the unused pairs 4/5 and 7/8, and the polarity in this case is irrelevant.Suitable passive modules for power supply injection l (i.e. Splitter) can be obtained in computer shops (they are often referred to as PoE modules, although they don´t represent the standard Power over the Ethernet).
3. The mounting hole dimensions should be 265x207mm.
4. The operators´ panels must not be exposed to direct sunlight.

3 The CIB bus, the RFox network, the TCL2 bus

Table of contents

This chapter describes all buses allowing the connection of the Foxtrot system peripheral modules. There are listed the basic features, parameters, principles of usage, variants of the connection, wiring diagrams, etc.

3.1 The CIB bus – principles of design and installation

The **CIB** is a bus developed by Teco a. s., which also owns the rights to the trademark "CIB Common Installation Bus". The CIB is intended primarily for highly durable and flexible connection of peripheral modules to the Foxtrot basic module, mostly in the area of the so-called "smart homes" and MaR. It represents a good solution of a two-wire bus with free topology and a variety of useful programme functions - e.g. the reload of modules firmware over the bus (it can also be executed remotely, if the system is connected to the Internet), etc.

The CIB bus makes it possible to connect to the Foxtrot system bus peripheral modules manufactured under the brand **CFox** (the CFox bus peripheral modules are designed primarily for the building automation, for controlling utilities and distribution of heat and ventilation, but they can also be used as standard peripheral units of the Foxtrot system, provided their characteristics are taken into consideration).
One branch (CIB bounded by one master) allows a maximum of 32 peripheral modules to be connected.
The basic modules CP-10x4, 10x5-CP, CP-10x6 and 10x8-CP are fitted with one master CIB; additional modules can be connected via external CIB master modules CF-1141 (maximum 4 master modules CF-1141 to one basic module).
Each external master module CF-1141 permits two branches of CIB (2 x 32 units) to be connected.
The modules CF-1141 are connected to the basic module by a TCL2 bus (see Chapter 3.3).

3.1.1 The CIB characteristics

The CIB is a two-wire bus with free topology. The communication itself is modulated on DC supply voltage. Powering the bus is provided by a standard 27.2VDC or 24VDC source connected to the bus via internal separation circuits (CP-1000, CF-1141) or an external decoupling module C-BS-0001M. The power supply can also be used for powering the Foxtrot system.
In addition to data transfer, the bus facilitates powering the connected modules (units); however, maximum consumption of all powered units and maximum drops of supply voltage must be considered, so that all parts of the bus would comply with the conditions of the supply voltage tolerance.

Nominal voltage of the bus power supply (with a backup)	27.2VDC	+ 10%, - 25%
Nominal voltage of the bus power supply (without a backup)	24VDC	+ 25%, - 15%
Topology	free	
Maximum distance of the master to the farthest unit [1)]	about 500m	

[1)] Maximum length of the entire installation of one branch is mainly limited by the voltage drops in the bus cable. Even the farthest unit supply voltage must be within the permissible tolerance.

Any two-wire cables can be used for the installation of the CIB.
We recommend using cables with shielded twisted pair and with the wire diameter at least 0.6 mm, preferably 0.8 mm (the wire resistance approx. 7Ω /100m), e.g. the J-Y(St)Y1x2x0,8, YCYM 2x2x0,8.
The wire cross-section and topology must be selected primarily with respect to voltage drops in the cables - in accordance with the number and type of installed CFox modules.

Basic rules for the CIB installation:

- The CIB allows almost any installation topology (a line, a star, a tree), except for a circle!
- It is recommended not to lay cables side by side with power cables (230VAC) – depending on the specific possibilities of implementation; there are no other special requirements for the placement of the cables.
- In larger installations, it is necessary to calculate the supply voltage drops in the cables: in all locations of the installation the minimum CIB power supply must be guaranteed.
- During the installation it is necessary to take into account the galvanic connection of input and output circuits of all bus components - except for low-voltage circuits (relay outputs, dimmers, ripple control inputs, etc.)– they are always galvanically isolated (safe isolation of circuits).
- The CIB must always be designed and implemented to meet the SELV or PELV requirements.
- Incorrect shielding of the CIB cable must be avoided..

3.1.2 The CIB power supply – principles , optimization

The number of peripheral modules on the CIB (a branch).
The maximum number of CFox peripheral modules in one CIB is 32.
This number must NEVER be exceeded. In the case of modules supplied from the CIB (e.g. the C-HM-1113M) with a higher maximum power consumption, the total number of modules connected to the bus must be decreased, to avoid exceeding the total maximum current provided by the given CIB master configuration and the power supply (see the parameters of the configuration used - master module, or a CIB separation module).
Therefore it is always advisable to calculate the total power consumption of all modules in accordance with the documentation, and to verify if the bus is not overloaded.
In order to calculate the total power consumption of all modules on one CIB bus (branch), there is an auxiliary table in Chapter 13 with the CFox peripheral modules power consumption. The table shows both the minimum power consumption (with all relays switched off, minimum power take-off from other inputs and outputs) and the maximum consumption (with all relays activated, all inputs and outputs loaded to 100%). Based on the real synchronous operation of the relay outputs, a proportional reduction of maximum power consumption can be estimated and thus extra power can be obtained for other modules, etc.

Decreasing the CIB load (take-off from power supply).
Most peripheral modules are powered from CIB. However, there are modules, e.g. the C-HM-1121M, which are powered from 230VAC, or the C-OR-0008M, C-OR-0011M-800, C-JC-0006M and C-IB-1800M, which can be optionally powered from a 24 or 27 VDC external power supply, in which case they do not load the CIB and allow installation of several modules with inputs and outputs, without overloading the CIB.

Dividing larger applications among multiple CIB buses (branches).
In larger applications (with several CIB buses), power consumption of individual peripheries should be taken into account when designing the cabling topology. You should avoid e.g. fitting one bus only with modules with relay outputs, and another bus only with wall control units and temperature sensors (the first bus branch will be significantly more loaded, while in the other one the capacity will not be utilized). It is always advisable to split and mix the elements to achieve a reasonable balance of line cabling topology, number of modules and the load distribution on each CIB branch. It is not recommended to exploit the full capacity of each bus branch - it is appropriate to leave a reserve for later extension or modification of the application configuration.

Fusing and protection of the CIB bus power supply
The CF-1141 external master as well as the CIB internal master, and in fact the whole Foxtrot basic module, which contains an internal master (e.g. the CP-1000) and an external decoupling module,the C-BS-0001M, should be connected directly in the power supply output (PS2-60/27 or e.g the DR-60-24).

No element must be inserted between the supply source output and the CIB master or decoupler, which would affect the circuit inductance.

A thermal fuse can be used (but it is not necessary, as the source outputs and module outputs contain electronic resettable fuses), but you **MUST NOT** use e.g. a DC circuit breaker or other than recommended surge protection. Surge protection (only where needed!) can be implemented by the DTNVE(M) 1/CIB protection.

3.1.3 Internal CIB master at the CP-10xx

The CP-10xx Foxtrot basic modules are as a standard fitted with an internal master of CIB (except for CP-1003). Depending on the type of basic module there are several options of power supply to the CIB with an internal master:

The basic modules CP-10x4 and CP-10x5, in the version with the fixed terminal block, are no longer available - they have no power supply to CIB of the internal master. Whenever the CIB is used, the external separation module C-BS-0001M must be connected (maximum total current of the elements on bus 1A).

The basic modules CP-10x4 and CP-10x5 (the version with removable connectors)**, CP-10x6 and CP-10x8**, have limited capacity of 100 mA to power the CIB branch from the internal source over an internal decoupler.
If there is a demand for more power, additional power supply and the C-BS-0001M external decoupling module must be connected to the CIB (maximum total current of modules on the bus 1A).

The basic modules CP-1000 and CP-1001 are equipped with two CIB internal masters, including an internal decoupling circuit with full power output (i.e. maximum total current in modules on each CIB is 1A). In this case no external decoupling circuits are required.

An overview of the CIB power supply in the Foxtrot basic modules:

	Internal CIB power supply	External CIB power supply
CP-1000	2 x 1A	NO
CP-1001	2 x 1A	NO
CP-1003	It has no CIB master	It has no CIB master
CP-1004, CP-1014	100mA	1 A (module C-BS-0001M)
CP-1005, CP-1015	100mA	1 A (module C-BS-0001M)
CP-1006, CP-1016	100mA	1A (module C-BS-0001M)
CP-1008, CP-1018	100mA	1A (module C-BS-0001M)

For detailed information on the Foxtrot basic modules see the documentation [4].

3.1.4 The CF-1141 external CIB master

The CF-1141 master module provides the power for and operation of two CIB buses (branches), each with a maximum of 32 connected peripheral modules (units). The CF-1141 provides identification, addressing, configuration and operation of connected peripheral modules; it also provides data processing and their transmission to the Foxtrot basic module. It is connected by the TCL2 system bus to the basic module. Up to 4 external CF-1141 master modules can be connected to the Foxtrot basic module. The configurations and any module settings is provided from the Mosaic programming environment, or from the parametrization environment FoxTool, both running on PC. The master module is equipped with diagnostics, which makes it possible to obtain information about the communication status of each bus module, as well as about the number of communication errors, etc. The CF-1141 is also equipped with terminals for connecting the backup battery ensuring power supply to its own master module and both CIB buses during a power failure of the main source. All inputs and outputs are protected by a reversible electronic fuse against short circuits. The front panel of the module contains a two-colour LED indicator (green LED indicates the bus operation, red means bus communication errors) and a rotary switch, which serves for setting master module address. The master module is powered from a 24VDC or 27.2VDC source (for backup). It also includes power supply decoupling circuits for powering both CIB buses, so no external decoupling modules are required. The module power input is the sum of power inputs of all peripheral modules in both CIB buses. The same requirements should be applied to power supply of the CP-1000 basic modules.
Maximum load of each CIB bus (branch) is 1A.
The power supply has to be chosen with respect to the consumption of the master module plus both CIB branches full of modules. Both the master module power supply and the total consumption of all connected and powered CFox peripheral modules must have a big enough capacity for this consumption of power.
If the CF-1141 is located in the same control panel as the basic module, it can be powered from a common (and jointly backed) source (then the backup battery should be connected only to one of the modules - e.g. the Foxtrot basic module).
The CF-1141 module is connected to the Foxtrot basic module by the TCL2 system bus (Chapter 3.3).
The CF-1141 basic connection is shown in the following figure.

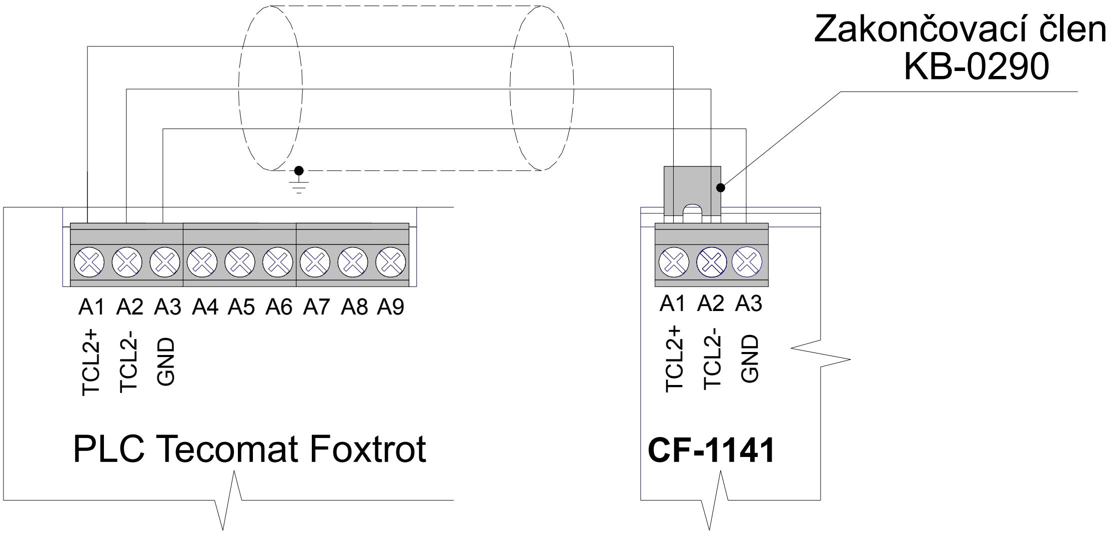


Fig. 3.1.4.1. Connecting the CF-1141 to the Foxtrot basic module

A complete example of the CF-1141 connection to the CP-1004 is presented in Chapter 3.3.4.

A backup battery can also be connected to the CF-1141 module, as shown in the Fig. below. It is then possible to power the basic module from the output BACKUP (terminals B8 and B9), but only if the total power consumption of the assembly conforms to the PS2-60/27 source.
It is also possible to power and provide backup to the CF-1141 module and the Foxtrot basic module (e.g. the CP-1000) separately and independently - then both modules are connected only by the TCL2 system

bus.

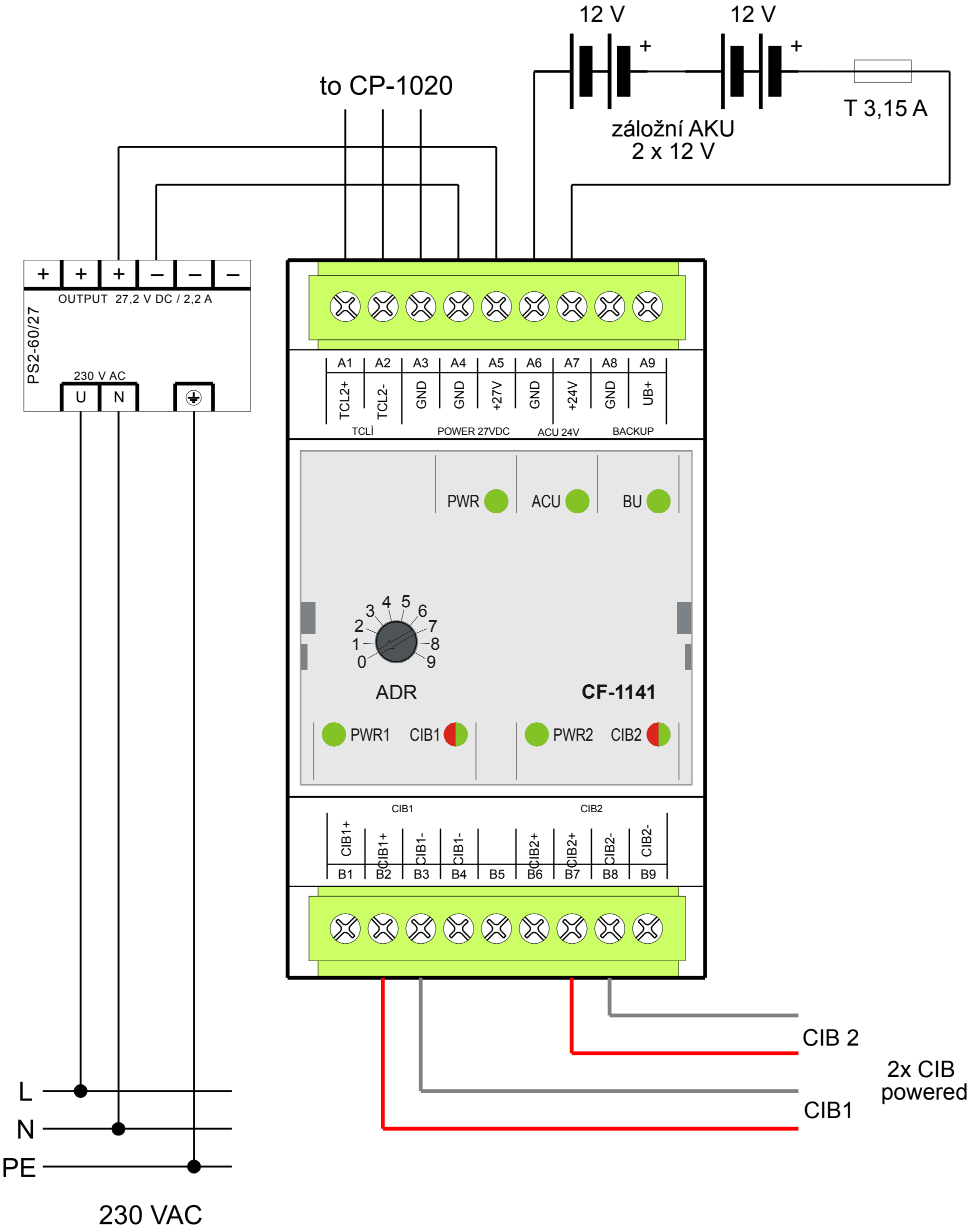


Fig. 3.1.4.2. The basic CF-1141 connection with a backup

Notes:

1) The power supply must be stabilized 27.2 VDC, fulfilling the SELV requirements and designed to charge the connected batteries, usually the PS2-60/27. The CF-1141 power consumption is the sum of the module’s circuits (typically 0.5W) and the total power consumption of all CFox modules connected to both CIB branches.
2) In the terminal block B there is an output of both CIB branches including the power supply with a maximum current of 1A for each branch.
3) The backup batteries that we recommend are sealed lead-acid type, typically with a capacity from 7Ah to 28Ah (depending on the desired backup time and backup power system components).
4) The BACKUP output (terminals A8, A9) can be used for powering the basic module, if it is in the same distribution cabinet as the backed-up master CF-1141 (the backup battery is in this case connected only to the CF-1141, and at the same time it is a backup for the basic module). Total consumption of the whole assembly must not be exceeded, and it must conform to the power output of the PS2-60/27 source with a maximum total power take off at 2.2 A)

3.1.5 Decoupling power supply to CIB – the C-BS-0001M decoupling module

The C-BS-0001 decoupling module provides proper power supply of one CIB. The module decouples the bus power supply source from peripheral modules and the bus master, in order to secure powering of the bus and at the same time separating the communication from the power source. The module is implemented in 1M housing on a DIN rail; green LED on the front panel indicates correct voltage at the module output. The output is protected by a resettable electronic fuse against a short circuit on the CIB. This module is designed to boost the CIB power circuitry of the basic modules fitted with a CIB power supply circuit only with a limited output (e.g. CP-1004, CP-1006), or for older versions of the Foxtrot basic modules, which had no CIB supply circuits installed.

Maximum load of CIB supplied from this module is 1A.

For this load it is necessary to rate both the C-BS-0001 power supply source and the total consumption of all connected and powered CFox peripheral modules.

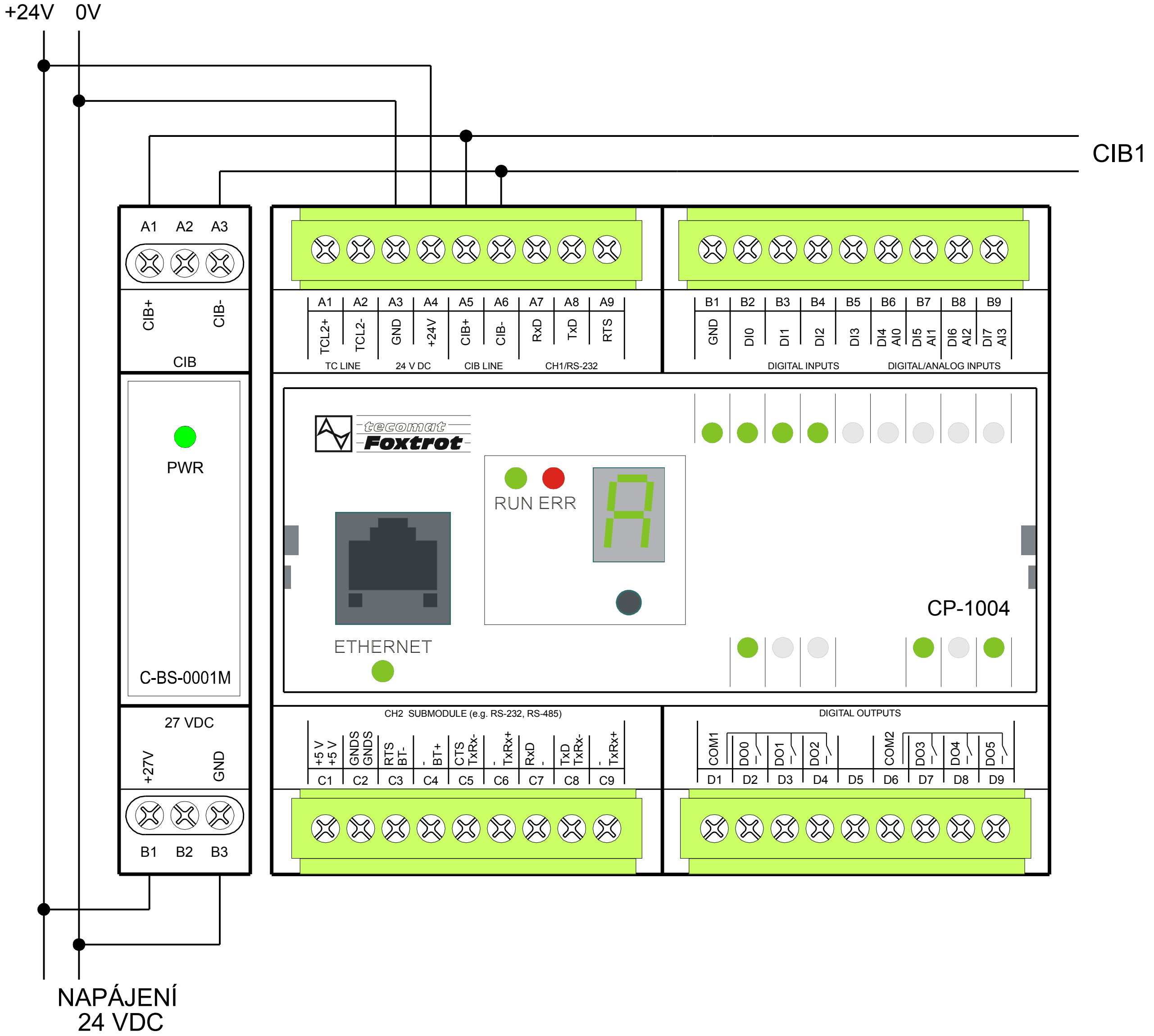


Fig. 3.1.5.1. The basic C-BS-0001M connection with the Foxtrot basic module CP-1004

Notes:

1) The power supply must be stabilized 24VDC, complying with SELV requirements.
2) CIB is powered by a maximum current of 1A (the sum of all connected CFox peripheral modules).

3.1.6 The CIB surge protection

3.1.6.1 The SPD module Type 1+2+3 (the lightning surge suppressor) and Type 2+3

We are preparing information on other surge protection device (SPD) elements
also suitable as a lightning surge suppressor (Type 1)

3.1.6.2 The SPD module of Type 2 DTNVEM 1/CIB and DTNVE 1/CIB

If the CIB bus is installed with a risk of excess voltage influence either in the bus itself or in the connected elements (e.g. concurrence with the lightning rod, a partial installation outside the building, etc.), then surge protection MUST be used in the correct way. Only specified types of CIB surge protection are allowed. Using any other types can significantly reduce the reliability and functionality of the application.

There are two recommended types of CIB surge protection devices.
Both have identical electrical characteristics and only differ in their mechanical design:
The DTNVEM 1/CIB the 1M version on a DIN rail with screw terminals.
The DTNVE 1/CIB built-in design (e.g. in a recessed flush box) with insulated conductors outlets about 10cm long.

The DTNVE 1/CIB surge protection represents an essential element of the protection of the CIB itself. It only protects against surges that can enter the CIB installation itself. It does not replace protection of the entire control system. The main protection of each application is always the protection of the main power supply - that means a correctly designed and installed protection of the 230V power supply voltage. Protecting the system power supply should be an integral part of each control system application. To protect the grid power supply voltage of 230VAC, there should be applied all principles of installation of surge protection as they are commonly known and used as a "good practice".

The DTNVEM 1/CIB is a surge protection device (SPD) in accordance with EN 61643-21 (categories A2, B2, C2, C3, D1) designed to protect the CIB against lightning currents and surges. The recommended placement is at the input line from outside into the building, as well as at interfaces to other LPZ (in accordance with EN 62305) and close to the protected equipment, so that the length of cable between the surge protection device and the protected equipment does not exceed 10m.
The DTNVE 1/CIB consists of a base and a replaceable module, which contains the protection circuits. The base is constantly connected and in case of an audit inspection or damage only the removable module is manipulated with. The base remains connected in the bus even without the removable module (the circuit is not interrupted).
The protection is designed for continuous current flow of up to 0.5A. During the project design stage it is necessary to make sure that this current is not exceeded.

The DTNVE 1/CIB is connected from the output towards the protected equipment.

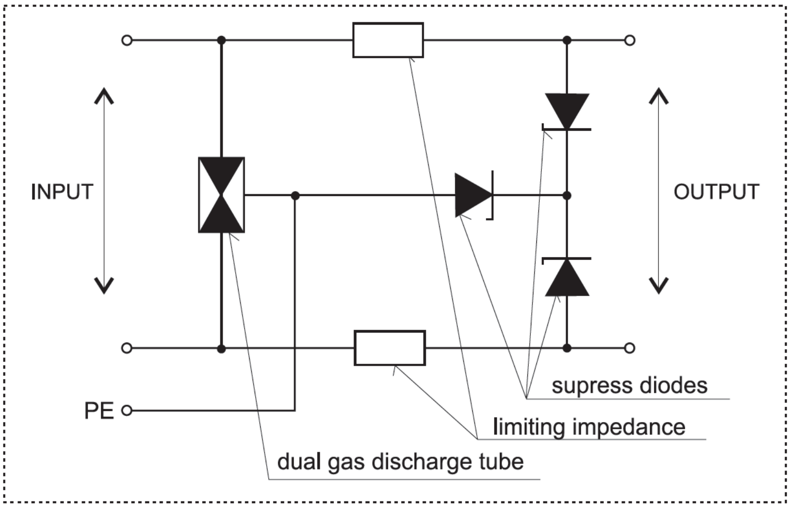


Fig. 3.1.6.1. Internal wiring of the DTNVE1 /CIB surge protection (it is also applicable to the DTNVE 1/CIB)

The DTNVE 1/CIB protection is always connected in front of the part of the bus that needs to be protected (i.e. you must take care of all parts of the installation leaving the ZBO1 zone or those that are in concurrence with large metal parts of the building that are in zone 0, for example the lightning conductor). All parts of the installation that the above-mentioned statement concerns must always be protected individually.

Fig. 3.1.6.2 shows an example of the system installation with the CIB in a house.

The main part of the installation ③ is located inside a protected building and its protection is implemented at the 230VAC power supply input of the entire system (protection of the entire application - the central unit and the bus units).

Part ② of the units is located in the annex building (a garage), where the bus is lead by a cable buried in the ground. Here it is always necessary to install protection at each entry of cable in the building, and both parts of the installation must be protected against surges that may occur in the ground line.

One unit ① is located under the roof (e.g. a connection to an anemometer) and the corresponding bus line is positioned in parallel with the lightning conductor fixed on the outer wall. In this case, surge protection is located in a suitable place (the end of the parallel part - the example shows an unprotected unit ①,but the rest of the application is properly protected.

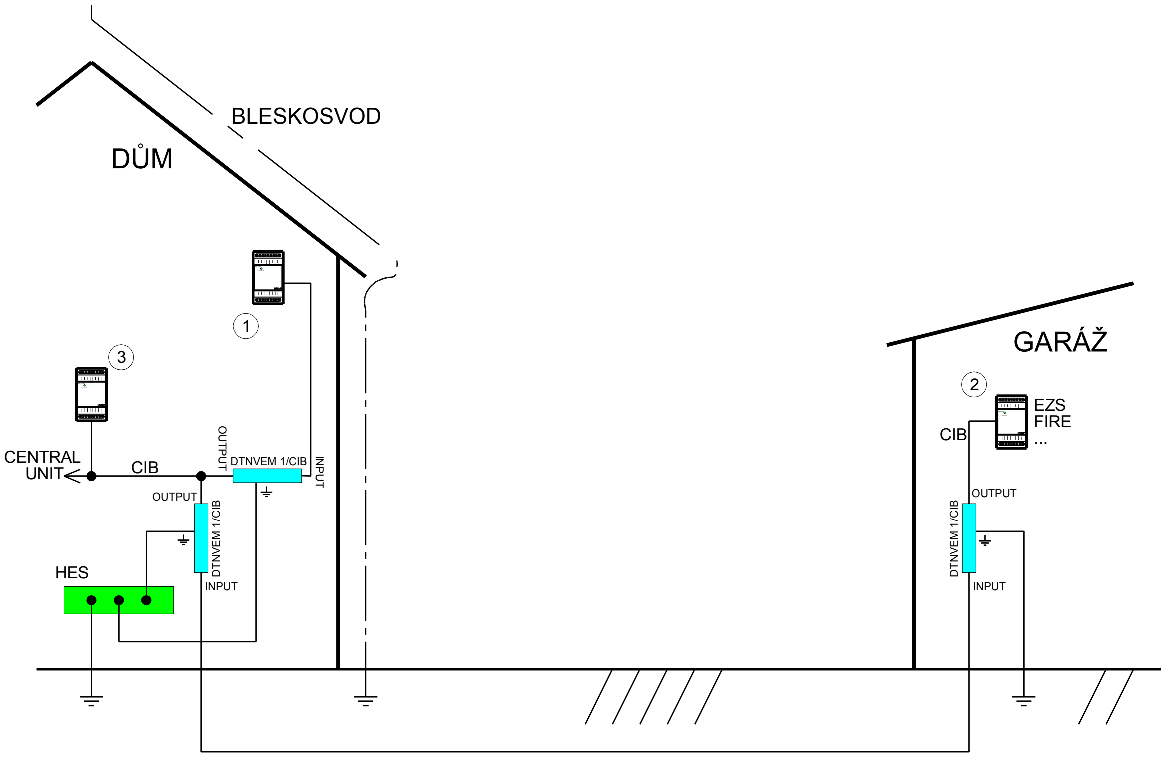


Fig. 3.1.6.2. Typical wiring of DTNVEM 1/CIB protection

3.2 The RFox bus – principles of design and installation

The RFox bus is a wireless radio bus. It is operated in accordance with the general authorization No. VO-R/10/09.2010-11 on the usage of radio frequencies and operation of short range devices in the unlicensed 868 MHz radio band; no other permission is required to operate it.
The RFox bus is always made up of one control bus master and up to 64 slave peripheral modules. The master is always implemented as an external module for assembly on a DIN rail. The RFox peripheral modules are implemented in several versions (for interior installations, a design for rail mounting in control panels, for hand-held remote controls, etc.).

3.2.1 The RFox bus basic parameters

The RFox bus (network) is designed to fully comply with the above-stated general authorization. The system is designed to minimize the already massive pollution of the environment with radio signals. The transmission power is about 3.5mW (a permitted maximum is 25mW) and the system is designed to limit radio communication to a minimum. The low power output extends the battery lifetime in battery-powered modules. The minimum power output also excludes any negative impact on human health.
In standard configuration, the system meets the requirement for a maximum 1% duty cycle, although in respect to LBT implementation it is not restricted in this case.
It uses the option of multiple channels; the standard is 8 available channels in the g1 frequency range (868.000 to 868.600 MHz under the general authorization).

3.2.2 The system functions, configuration, characteristics

The communication between the RF master and RF peripheral module is supported for star and mesh topologies.

The star topology represents a direct communication range between the master and the RF module; master always has a direct communication range with all slave RF modules.

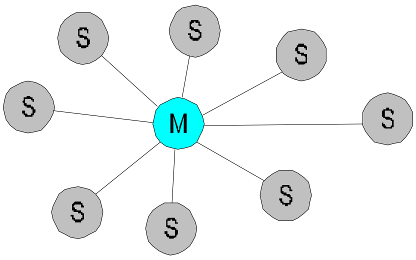


Fig. 3.2.2.1 An example of star topology.

The mesh topology means such placement of slaves, where the master has direct access only to some slaves, whereas other units are accessible only through the so-called routers. The router (repeater) is a device that receives an incoming RF packet, amplifies it and sends it further. By using routers it is possible to increase the master's basic communication range.

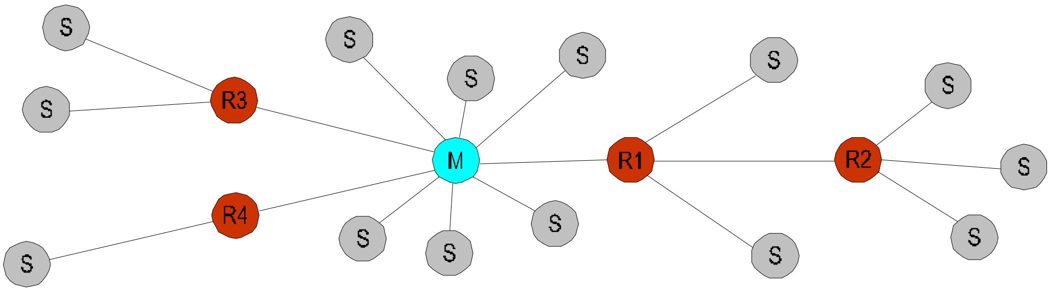


Fig. 3.2.2.2 An example of mesh topology.

A maximum of 4 routers can be used in one mesh network. The transmitted RF packet must reach its recipient after making no more than 5 hops. Each hop represents an increase in the time lag between sending and delivering an RF packet (the reaction time between a command and an action is extended).

Either a dedicated RF router, or any RF module in continuous operation can be selected for the function of the router (this function is assigned to the module during its configuration to the RFox network).

In terms of operation of RFox network, there may be used modules in permanent operation and modules with intermittent operation.
The modules with continuous operation are always able to respond to commands from the master (they are mostly permanently powered modules).
The modules with intermittent operation go into the "sleep mode", during which they do not respond to master's commands (they are usually battery-powered modules).
A user action (pressing the button on the module) can bring the module from the sleep mode to the active mode, or it can be activated on the basis of expiration of the timeout.

3.2.3 The RF master RF-1131

The RF master implements communication with RF peripheral modules and transmits the acquired data via the system communication bus (TCL2) to the superior basic module.
The master is implemented as an external peripheral module of the system communication bus TCL2, labelled as RF-1131.

One RF master can serve up to 64 peripheral RF modules. The Tecomat Foxtrot basic module serves one internal RF master and up to 4 external RF masters.

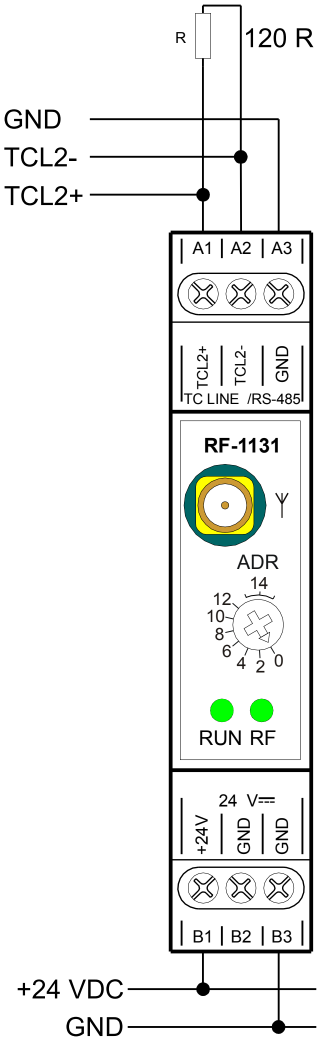


Fig. 3.2.3.1 A terminal connection of the external RFox master RF-1131

The RF-1131 external master is connected to the PLC Tecomat Foxtrot via binding interface circuits terminated at A1 to A3 terminal blocks labelled as the TC LINE.

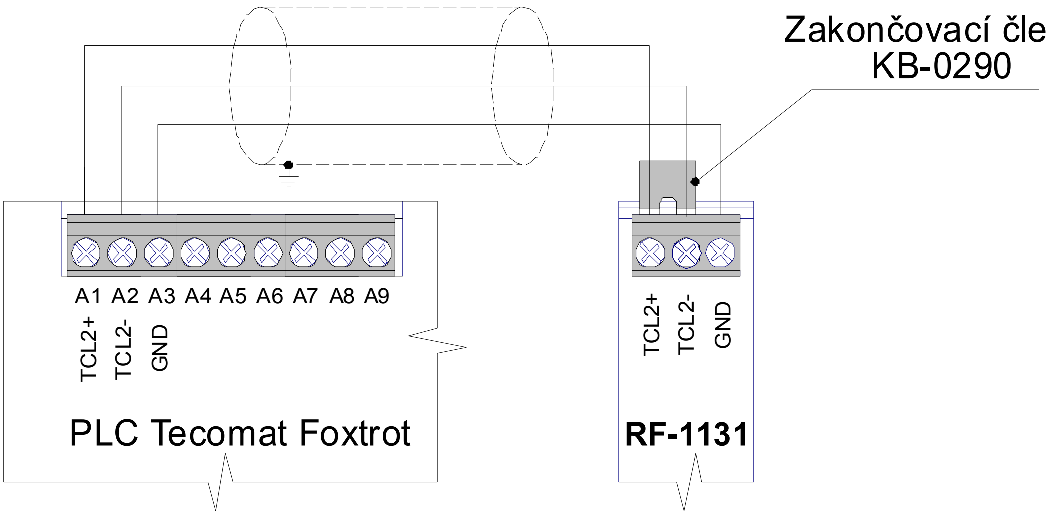


Fig. 3.2.3.2 Connecting the RF-1131 module to the PLC TECOMAT Foxtrot

On the side of the PLC, the TCL2 communication line has impedance termination inside the PLC. On the side of the RF-1131 module, it is necessary to execute the impedance termination of the line. The termination is executed using the KB-0290 (TXN 102 90, 120Ω) terminating element, which is connected between the TCL2+ and TCL2- terminals. This terminating element is included in the Tecomat Foxtrot package. If there are other modules on the TCL2 communication line; the termination is always carried out at the end of the whole line!

Powering the module
The RF master requires a 24VDC power supply for the operation. The power supply source used for powering the CPU can also be used for the RF master. The internal RF master is powered directly by the CPU internal circuits; external master power supply is connected to + 24V and GND terminals.

An antenna for the RF master
The RFox master requires for its function an external antenna, which should be plugged in the SMA connector on the front panel. Either an antenna directly screwed in the module can be used, or an antenna with a shielded cable to be located outside the control panel. For more information about antennas suitable for an RF master (and also for RFox peripheral modules with a SMA connector for external antenna connection) see Chapter Antennas for SMS modem and RFox.

3.2.4 The RFox router R-RT-2305W

The R-RT-2305W router interior module is designed to increase the basic communication range of each radio module. The router is in a plug-in version for the mains 230VAC socket and it contains one green LED indicator.
The function of the router is to receive the RF packet and subsequently forward it on. A maximum of 4 routers can be used in one RFox line.
The router is designed as a plug adapter for 230VAC socket and besides the power supply plug it has no further connection elements.

3.3 The TCL2 bus – the principles of design and installation

The peripheral modules on the TCL2 bus (e.g. IB-1301) of one PLC Foxtrot configuration (i.e. all peripheral modules controlled by one basic module) must be interconnected via a bus connection, which is plugged in the terminals in the upper left edge of the module (of TCL2 bus, and perhaps also the power supply). The interconnection of the modules **MUST** be done in a linear fashion (i.e. the modules are connected in series to one after another with no branching), the central module **MUST** be at one end of the bus, and the other end **must** be fitted with a terminating resistor 120Ω or with the KB-0290 bus termination module (it is included in the package of each Foxtrot basic module).

The modules on the TCL2 bus are divided into several groups. Any combination of modules from each group can be connected to one TCL2 bus (with one master), but their total number is limited:

Group	Types of modules	Maximum number of modules per bus TCL2 (TCL2A)	Maximum number of modules per bus TCL2B (only for CP-1003)
Peripheral modules	IB, OS, IR, IT, OT, UC	10	10
Communication modules	SC	6 (the sum of both CP-1003 buses)	
External master modules	CF-1141, RF-1131	4 (the sum of both CP-1003 buses)	
The operator panels	ID	4 (the sum of both CP-1003 buses)	

Modules from all groups (for their maximum number see the Table) can be connected to one TCL2 master (the Foxtrot basic module) simultaneously.

An exception is the CP-1003 basic module, which is fitted with two TCL2 masters. Ten peripheral modules can be simultaneously connected to the first (TCL2A) and the second (TCL2B) bus; there can be peripheral modules with the same address on both buses. Modules from the other groups can be arbitrarily connected to both buses, but regarding the number and addresses they act as one bus.

3.3.1 The TCL2 bus installation

Individual Foxtrot modules should be connected with cables intended for the RS-485 bus, the minimum of 2 pairs (for the connection of the communication bus, see Chapter 3.3.3), or with cables that include the power supply. Regarding the TCL2 bus, a cable designed for the RS-485 bus must be used. (For connections including the power supply, see Chapter 3.3.2).

In the case of larger distances (typically over 10m), only the communication bus is always connected, without the power supply (see Chapter 3.3.3). A good quality shielded cable must always be used, and the shield **MUST** always be connected to the main ground terminal at only one end of the cable!

The TCL bus interconnected with metallic cables (RS-485) should always be terminated at both ends. On the side of the basic module there is a firm termination right inside the basic module - the basic module **MUST** always be at one end of the bus!

The other end of the bus should be terminated with an external resistor with about 120Ω mounted between the TCL2 + and TCL2- signals. For easy installation there is included in the package of the basic module a

KB-0290 terminator (a separate order number TXN 102 90), which contains the required 120Ω terminating resistor, which is fitted to be inserted into the TCL2 terminals (usually A1, A2). During the assembly, insert the terminator into the terminals, insert also the installed wire for the connection of the bus, and tighten the terminals.

The modules can also be interconnected via fibre-optic cables or a combination of fibre-optic and metallic cables. For fibre-optic cable connection it is necessary to use the KB-0552 optical converter (for the wiring see Chapter 3.3.5). The modules should be connected via standard ST-ST patch cables..
The fibre-optic cable provides galvanic isolation and therefore an independent power supply of the next module is necessary.

The table below provides a summary of characteristics of possible ways how to link the Foxtrot modules into assemblies. Naturally, the listed possibilities of linking can be combined:

Table 3.3.1.1: Possibilities of linking the Foxtrot modules - a summary.

Solution	**1**	**2**	**3**
HW (additional)	-	-	KB-0552
Transmission medium	Cable (2x twisted pair)	Twisted pair + GND (2x twisted pair)	Fibre-optic cable
Distribution of power supply	yes	NO	NO
Galvanic isolation of the bus	NO	NO	yes
The cable used	According to specification RS-485	According to specification RS-485	Standard patch cable ST-ST
Connector	Screw terminals	Screw terminals	2x ST
Attenuation (about)	-	-	3.5 dB/km
Wavelength	-	-	820nm
The type of fibre	-	-	glass multimode 62.5/125 mm
Maximum number of I/O modules to one CP	10	10	10
Maximum length of one bus segment	10 m	400 m	Maximum 1.7 km
Maximum bus total length	10 m	400 m	According to the number of segments
For detailed information see	3.3.2	3.3.3	[2]

Notes on the individual solutions:

1. The basic method of interconnection including the power supply. Suitable for assemblies with multiple modules in a single control panel. This solution is limited by a maximum bus length (power supply).
2. This interconnection is suitable for longer distances between modules - the control system is distributed in several panels in technology, etc. Each module (or several modules together) must have its power source. The TCL2 bus connection allows the use of any cable that meets the requirements for the RS-485 bus, and it can run through channels, bushings of control panels.

3. Long-distance connections (the highest quality solution). As the lengths of each segment are added together, the total bus length of the entire system can reach a kilometre. The fibre-optic cable provides galvanic isolation and therefore the module (or a set of modules) connected with an fibre-optic cable must contain power supply.

3.3.2 Connecting expansion modules to the FOXTROT system (the TCL2 buses with power supply)

The following figure 3.3.2.1 shows the basic connection of the expansion modules to the basic module. Peripheral modules are interconnected including the power supply. The last module on the bus (the furthest from the basic module) must always be fitted with a terminating resistor of the TCL2 bus (see the resistor in Fig. 3.3.3.1).

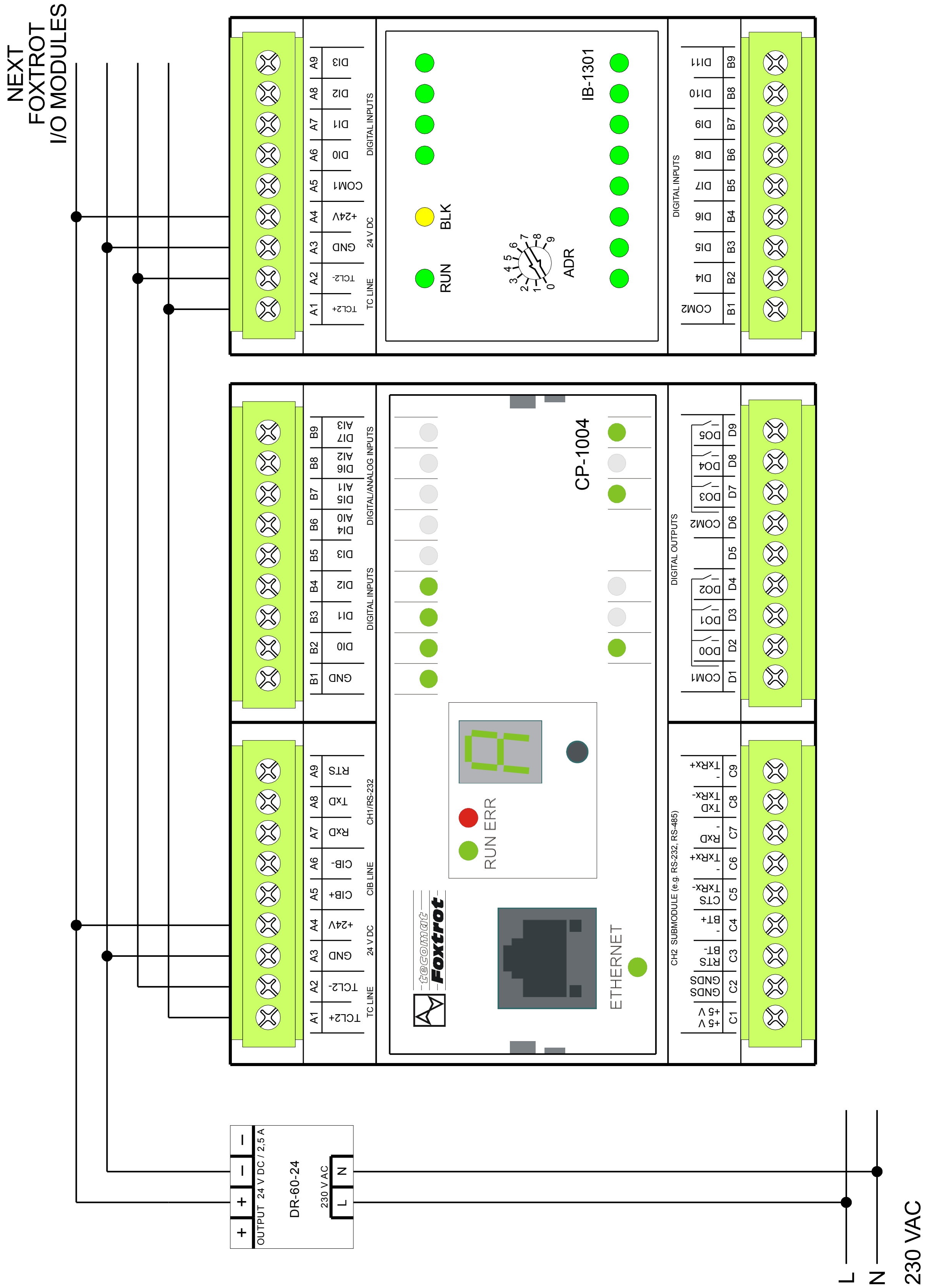


Fig.3.3.2.1 The basic wiring diagram of the TCL2 bus with power supply

3.3.3 The connection of distant FOXTROT peripheral modules (the TCL2 BUS without power supply)

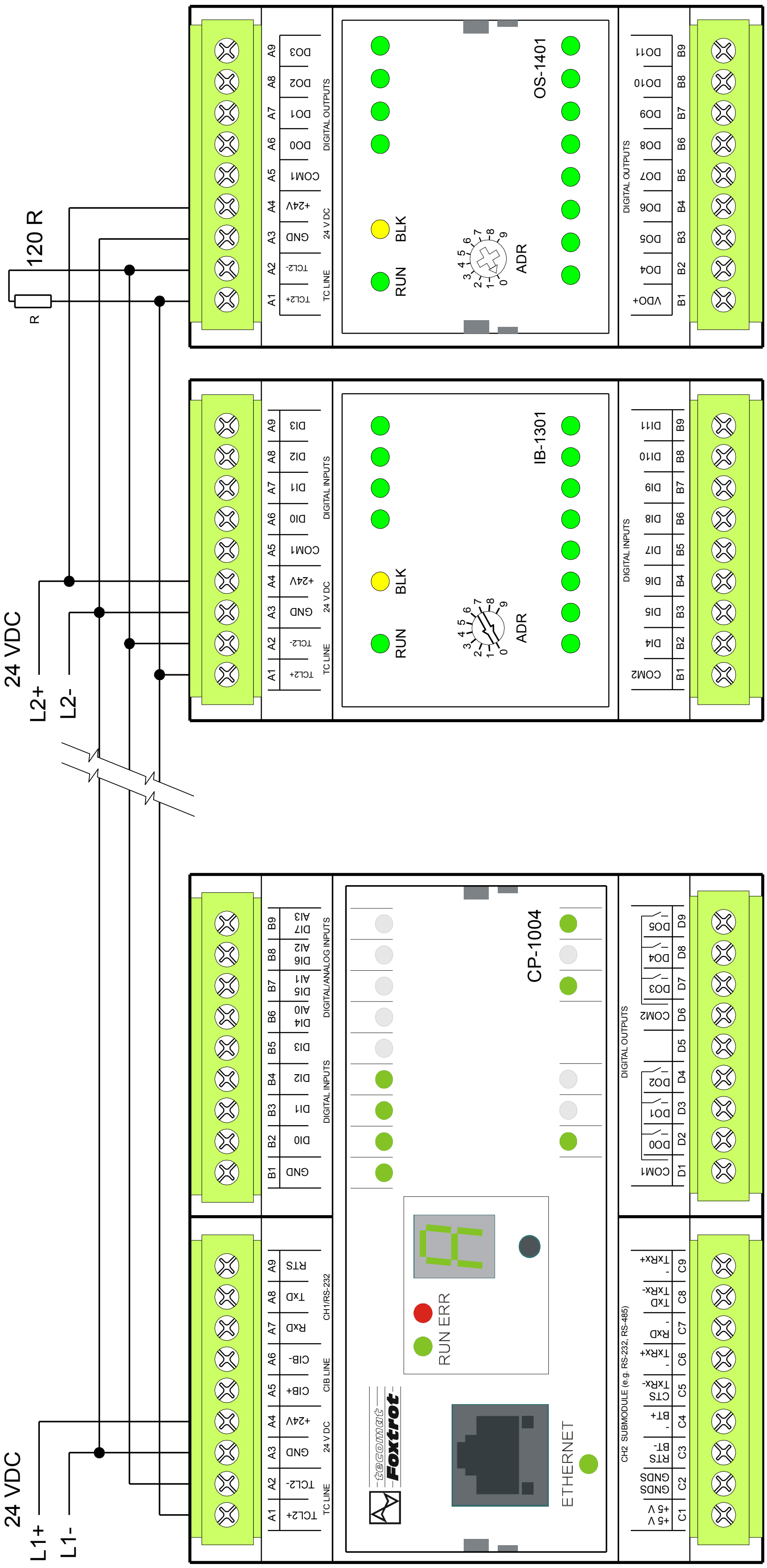
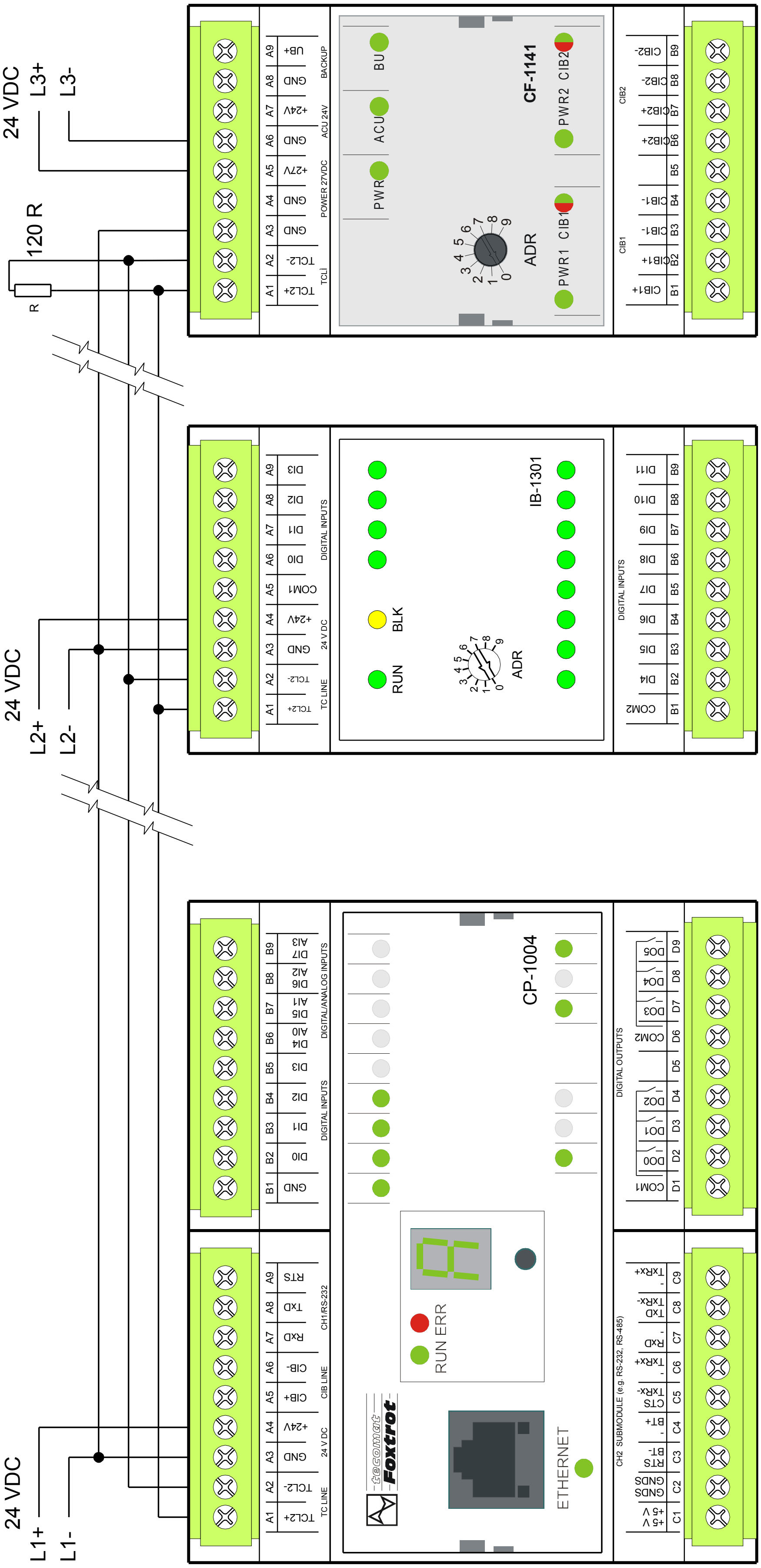


Fig. 3.3.3.1 The basic wiring diagram of the TCL2 bus without power supply.

3.3.4 Connecting distant FOXTROT peripheral modules and the CIB MASTER module


24 VDC
L1+
L1-
24 VDC
L2+
L2-
24 VDC
L3+
L3-
120 R
R
CP-1004
tecomat Foxtrot
RUN
ERR
ETHERNET
TC LINE
24 V DC
CIB LINE
CH1/RS-232
TCL2+
TCL2-
GND
+24V
CIB+
CIB-
RxD
TxD
RTS
A1
A2
A3
A4
A5
A6
A7
A8
A9
B1
B2
B3
B4
B5
B6
B7
B8
B9
DIGITAL INPUTS
DIGITAL/ANALOG INPUTS
DI0
DI1
DI2
DI3
DI4
AI0
DI5
AI1
DI6
AI2
DI7
AI3
CH2 SUBMODULE (e.g. RS-232, RS-485)
+5 V
GNDS
RTS
BT-
BT+
CTS
TxRx-
TxRx+
C1
C2
C3
C4
C5
C6
C7
C8
C9
DIGITAL OUTPUTS
COM1
DO0
DO1
DO2
COM2
DO3
DO4
DO5
D1
D2
D3
D4
D5
D6
D7
D8
D9
IB-1301
RUN
BLK
ADR
0
1
2
3
4
5
6
7
8
9
TC LINE
24 V DC
DIGITAL INPUTS
TCL2+
TCL2-
GND
+24V
COM1
DI0
DI1
DI2
DI3
COM2
DI4
DI5
DI6
DI7
DI8
DI9
DI10
DI11
CF-1141
PWR
ACU
BU
ADR
PWR1
CIB1
PWR2
CIB2
TCL
POWER 27VDC
ACU 24V
BACKUP
TCL2+
TCL2-
GND
GND
+27V
GND
+24V
GND
UB+
CIB1
CIB2
CIB1+
CIB1+
CIB1-
CIB1-
CIB2+
CIB2+
CIB2-
CIB2-

3.3.5 Connecting peripheral FOXTROT modules by fibre-optic cable, the KB-0552 module

The KB-0552 modules for fibre-optic connection are designed to connect fibre-optic cables with the ST type of optical connectors. The module does not contain termination of the TCL2 metallic bus (the 120 □ resistor), so it does not have to be located at the end of the metallic line. If it is located at the end of a metallic line, the KB-0290 terminator must be used.

The optical interconnection KB-0552 modules should be connected with a duplex 62.5/125 micron or 50/125 micron fibre-optic cable (with two fibres - one for each direction of transmission) up to the distance of 1,750 m. Alternatively, two single-fibre optic cables can be used. The parameters of the KB0552 module are stated in Table3.3.5.1.

The order number of the KB-0552 module is TXN 105 52.

Table3.3.5.1: Basic parameters of optical connection modules of the KB-0552 bus

The type of modules		**KB-0552**		
The product standard		ČSN EN 61131-2		
Electric item protection level in accordance with ČSN 33 0600		III		
Connection		Screw terminals		
		Duplex 2×ST		
Power supply		24VDC		
Power consumption		1.2W		
The wavelength of the optical radiation		820nm		
Operating temperature		0 °C up to +55 °C		
Surpassed attenuation		min. 8dB, typically 15dB		
Average lifetime at an ambient temperature of 55 °C (–3dB power)		33 years		
Average lifetime at an ambient temperature of 40 °C (–3dB power)		68 years		
Transmitter		**min.**	**Typical**	**max.**
		[dBm]		
Transmitter optical power at 25 °C	$P_{T\ (max)}$	–15,0	–12,0	–10.0
The total optical power		0.355 mW		
Receiver		**min.**	**Typical**	**max.**
		[dBm]		
The input optical power "log.0" 0 up to +70 °C	$P_{RL(max)}$	–24.0		–10.0
The input optical power „log.0‟ at 25 °C	$P_{RL(max)}$	–25.4		–92
The input optical power "log.1"	P_{RH}			–40,0

Fibre-optic cable, parameters and requirements

Table3.3.5.2: The basic parameters of fibre-optic cables with fibreglass multimode fibre

Optical connection connector	Duplex 2× ST
The wavelength of the optical radiation	820nm
The type of fibre	multimode fibreglass 62.5/125µm or 50/125µm
Operating temperature	–40 °C up to +85 °C
Installation temperature	0 °C up to +70 °C
Typical attenuation of 1km of cable □	3.5dBm
Maximum short-term tensile load (< 30 min.)	500 N
A delay caused by the speed of propagation	5 ns/m
Maximum permanent tensile load	1 N
Maximum permanent bend radius	35 mm
External diameter of one fibre jacket (2x)	3 to 6 mm

The maximum cable length depends on the power of the transmitted optical signal, receiver sensitivity, and attenuation of the cable used:

$$L_{(max)} = (P_{T\ (max)} - P_{RL(max)}) / \alpha \ [m]$$

$L_{(max)}$	maximum length
$P_{T\ (max)}$	minimum value of the optical power of the transmitter
$P_{RL(max)}$	maximum value of input optical power for log.0
α	the value of cable attenuation per 1 m of length

The transmitter power also depends on the temperature.

$$P_{T\ (t)} = P_{T\ (25°C)} + \Delta P_T/\Delta T \text{ x } (t - 25°C)$$

The cable attenuation also depends on the temperaturte.

$$\alpha_{(t)} = \alpha + \Delta\alpha_T/\Delta T \text{ x } (t - 25° C)$$

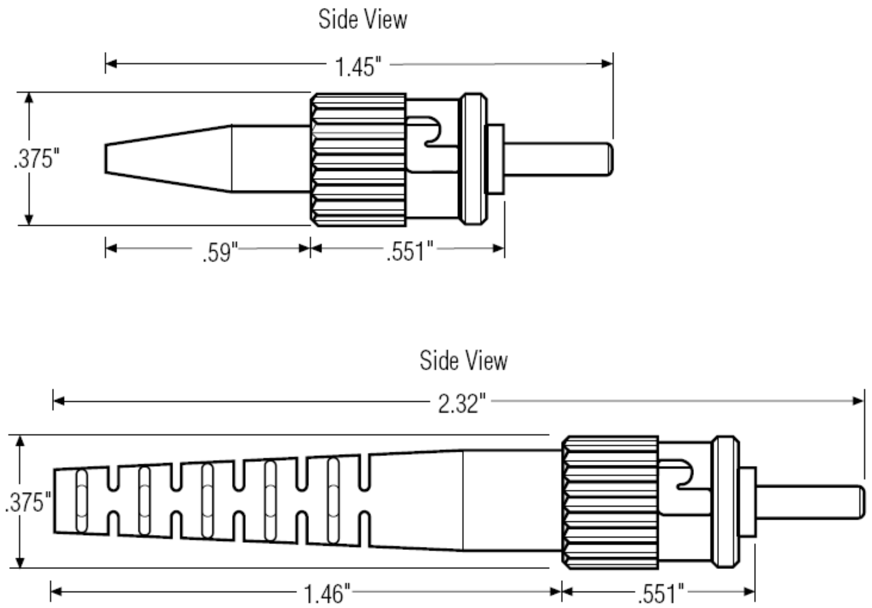
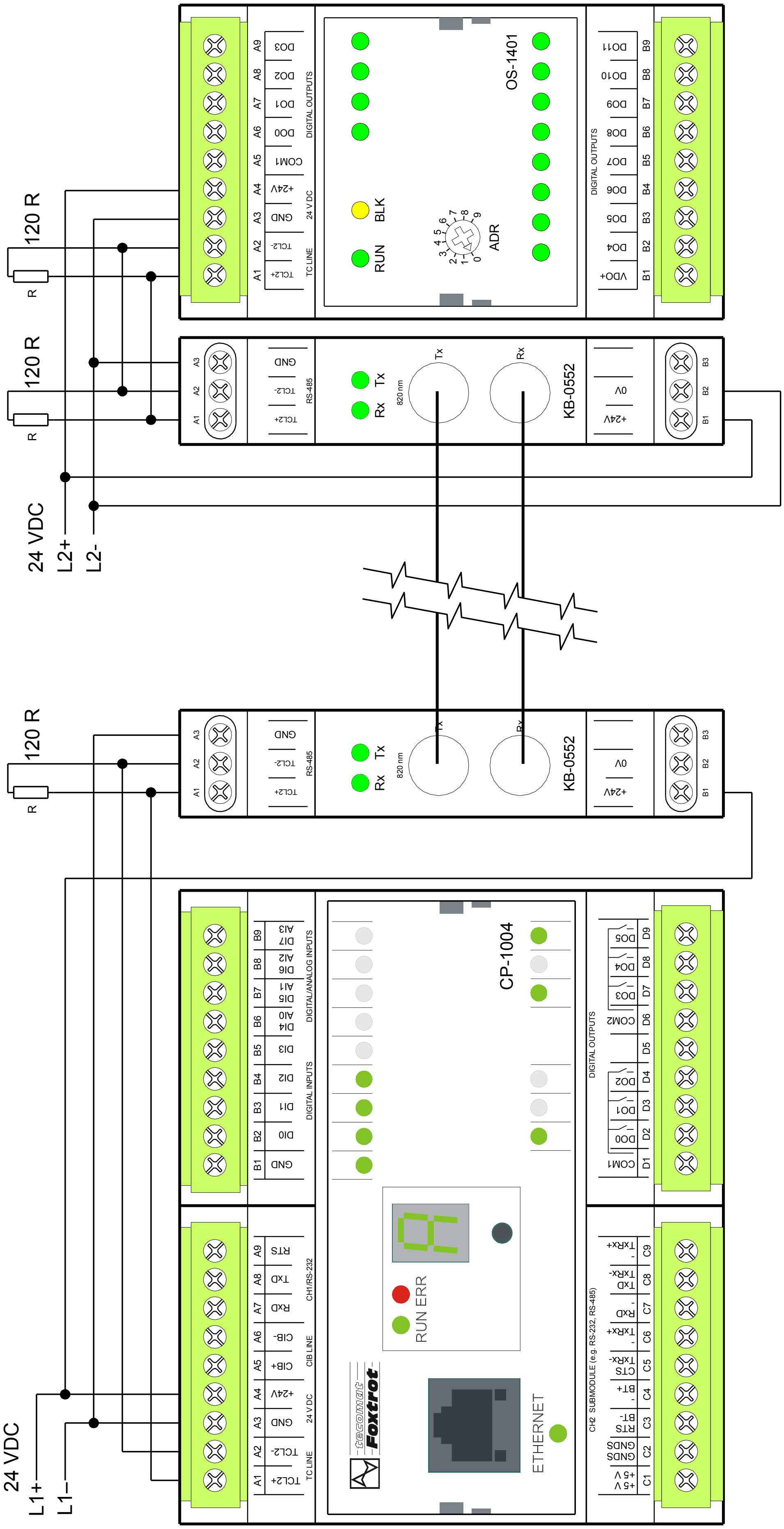


Fig.3.3.5.1 Mechanical dimensions of the ST optical connector

Fig.3.3.5.2 An example of the Foxtrot system TCL2 wiring with an fibre-optic cable (see the next page).


24 VDC
L1+
L1–
L2+
L2-
120 R
R
CP-1004
Foxtrot
tecomat
RUN ERR
ETHERNET
TC LINE
24 V DC
CIB LINE
CH1/RS-232
DIGITAL INPUTS
DIGITAL/ANALOG INPUTS
DIGITAL OUTPUTS
CH2 SUBMODULE (e.g. RS-232, RS-485)
TCL2+
TCL2-
GND
+24V
CIB+
CIB-
RxD
TxD
RTS
DI0
DI1
DI2
DI3
DI4 AI0
DI5 AI1
DI6 AI2
DI7 AI3
COM1
DO0
DO1
DO2
COM2
DO3
DO4
DO5
+5 V
GNDS
BT-
BT+
CTS
TxRx-
TxRx+
KB-0552
RS-485
Tx
Rx
820 nm
0V
OS-1401
RUN
BLK
ADR
DIGITAL OUTPUTS
COM1
DO6
DO7
DO8
DO9
DO10
DO11
VDO+
A1
A2
A3
A4
A5
A6
A7
A8
A9
B1
B2
B3
B4
B5
B6
B7
B8
B9
C1
C2
C3
C4
C5
C6
C7
C8
C9
D1
D2
D3
D4
D5
D6
D7
D8
D9

3.4 Serial communication interfaces RS-232, RS-485, RS-422, CAN and others...

The CP-1000 basic module (similarly to other Foxtrot basic modules, e.g. CP-1006) is always fitted with the RS-232 communication interface terminated on the CH1 channel; there is also an option to fit replaceable submodules to the channel CH2, where a number of other interfaces can be implemented, including up to 3x RS-485, etc. (channels CH2 to CH4). For detailed information on possible interfaces, suitable submodules and examples of wiring, see in the documentation.

Basic information on the RS-485 interface, including the recommended cables, is given in the following chapter.
Information on the RS-485 interface surge protection is given in Chapter 13.5.

Some special interfaces or devices connected to serial communication channels are described in this documentation, e.g.:

Connecting measuring instruments with an MBus interface
The DMX interface for lighting control
Connecting electricity meters with the RS-485 communication interface

3.4.1 Basic information on the interface RS-485

This type of interface makes it possible to connect up to 32 devices (some types of interfaces can be connected to several network participants) and it is sometimes referred to as a multi-drop interface.
It uses a half-duplex system, which means using less wires in the cable. It is resistant to interference and allows a serial line as long as 1.2 km to be built (without a repeater). In order for this interface to function properly it is necessary to provide 120Ω terminating resistors at either end of the cable.
Any 120 Ω minimum 0.25W resistor can serve as a terminating resistor; it must always be located at terminals at both ends of the network. In FOXTROT systems this requirement addressed by termination circuits mounted on the RS485 serial interface submodules, which contain a 120Ω resistor and circuits for correct definition of the idle state of the line.
The line must maintain the character of the bus, i.e. the cable must always be routed from the station to the next station. If it is necessary to make a branch, its length must not exceed 25 cm (there must be no termination resistor on this branch!).

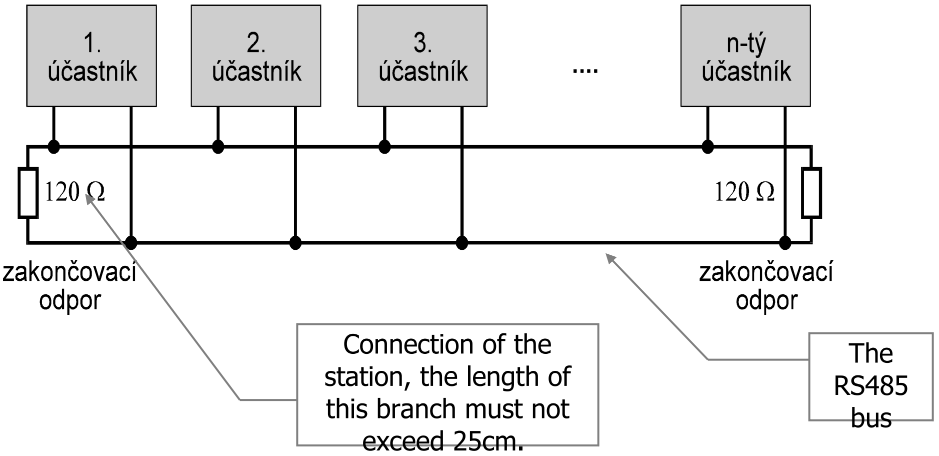


Fig. 3.4.1.1 The basic connection of the RS-485 communication line

Notes:

1) The shielding is always connected only on one side of the line.
2) The last control system on the bus should be fitted with a 120 Ω resistor (if connecting only two systems, the resistors or termination circuits should be connected at both ends of the cable).
3) You should always interconnect identically marked terminals TxRx + (somewhere TxRx), also TxRx- (TxRxB).

In large networks a shift of communication interfaces potentials can occur due to improper installation. This problem can be partly removed by connecting the GND terminals of individual network participants (but this only deals with the consequences, not the causes). A better solution is to use a galvanic isolation of individual network participants (the MR interface submodules always provide galvanic isolation of the line); an alternative solution is to find and eliminate the cause of the potential shift.

Technical parameters of the RS-485 interface

Maximum data transfer rate	about 1Mb/s
Maximum length of the line	1,200m [1)]
Output level (differential levels)	Maximum ± 6V

[1)] The maximum rate of data transfer is not reached with the maximum length of the line.

The cables for communications networks should always be routed away from direct contact with power cables (the minimum recommended distance is 15cm), they should avoid places with strong interference or

with a risk of discharges. Communication interfaces can be lead together with cables for analogue signals, other data networks, etc.
When laying cables in an environment with a risk of interference, or when the distances are greater, you should use shielded cables (for the principle of shielding see the relevant chapter).

3.4.2 Recommended cables for the RS-485 communication

For the RS-485 interface and small distances (dozens of meters up to a 100 m) similar cables can be used, with at least two wires (preferably twisted):

SYKFY 1x2x0.5

For the RS-485 interface and a maximum distance it is necessary to use the twisted pair cable with the 0.5mm to 0.8mm diameter, shielded, with an impedance close to 120 Ω. There are often special foreign cables offered for these purposes, but their costs tend to be extremely high. We can recommend more competitively priced cables that meet the requirements:

PCEHY 1x2x0.5 (manufactured by VÚKI a.s.)

For the RS-485 with interconnected signal GNDs (in large networks at risk of potential differences between the stations - the parasitic potential) and interfaces. We can recommend more competitively priced cables that meet the requirements:

SYKFY 2x2x0.5
PCEHY 4x2x0.6

For the RS-232 interface, most cables with 4 wires and minimum 0.4mm diameter, shielded with PVC insulation, are sufficient. Recommended cables:

SYKFY 2x2x0.5

Technical characteristics of the PCEHY cables

Type of cable		**PCEHY 1x2x0.5**	**PCEHY 4x2x0.5**	**PCEHY 4x2x0.6**
Wave impedance	[Ω]	100 ± 15	100 ± 15	100 ± 15
Electrical resistance of cores	[Ω.km]	97,8	97,8	67,9
Isolation resistance	[GΩ.km]	5	5	5
Specific attenuation 256kHz 1Mhz 4Mhz 10Mhz 20	[dB/100m]	2.0 3.5 6.2 9.0 11.9	2.1 2.1 4,3 4,3 6.6 7.2 9.2 10.2 22.0 -	2.1 4.3 6.6 9.2 22.0
Near-end crosstalk damping min. at 1 MHz 10Mhz 100Mhz	[dB]	-	62 56 47 41 32 -	62 47 32
The temperature range	[°C]	-30 ÷ +70 °C	-30 ÷ +70 °C	-30 ÷ +70 °C
Minimum bend radius	[mm]	15	15	15
Cat. EIA/TIA-568		-	CAT. 5 CAT. 4	CAT. 5

4 Heating, cooling, ventilation

The contents of the chapter

The Foxtrot system enables implementation of simple solutions, such as regulation and control of gas boilers with plate radiators,
as well as more complex assemblies with heating floors, underfloor heating and controlled combinations of multiple sources of heat (heat pumps, boilers for gas or liquid fuels, and automatic solid fuel boilers, solar hot water systems)
up to comfortable sets for heating, cooling (fan-coil units, ceiling cooling, remote-controlled air conditioning units, etc.) and controlled recuperative ventilation (centralized and decentralized).

4.1 Hot water heaters, panel radiators

The standard radiator valves have electrically-controlled actuators, which are produced in a variety of types (different sizes, power consumption, opening and closing time, control mode, supply voltage, idle position, possibilities of various types of screwed fitting, and the price).

For standard applications (hot water panel radiators) the following drives can be used:

The CFox drive **C-HC-0201F-E** or the C-HC-0101F (in preparation) and if the wireless option is required, it is possible to use
an RFox battery-powered drive R-HC-0101F.
The first two drives are powered directly from the CIB, they are motoric with continuous opening from 0 to 100%.
The R-HC-0101F drive is powered by one or two AA 3.6V batteries.
The C-HC-0101F drive has an extremely small power consumption (about 0.6 W in motion); mechanically it is identical with the RFox drive R-HC-0101F.
The C-HC-0201F-E drive is smaller, in motion it has a higher power consumption, it enables the connection of 2 external sensors (temperature, window contact) and there are a number of adapters available for various valves and valve inserts.

Another option is to use electrically controlled drives switched by relay outputs or controlled by 0 ÷ 10V analogue output.
Due to electrical safety (children's access to the drive) we prefer 24V power supply, in spite of the inconvenience of having to obtain a 24V power source and provide the distribution.
230V voltage is available at any place of installation, and it is not necessary to provide a 24V power source and the power distribution.
Continuous control 0 ÷ 10V regulation is more comfortable, but the prices are the highest.

We recommend **the Alpha AA** drives. These drives have a very wide range of adapters for common and less common radiator valves, their design looks good and there are several variants of powering and control. In addition to the drive it is necessary to order a valve adapter depending on the specific manufacturer and the type of radiator valve.For detailed information on AA drives and valve adapters see Chapter 4.1.3

When designing the heating control system, a specialist must assess the following:

- The types of valves, the method of fixing the drive and adapting the dimensions.
- The condition of the valves, provided they have already been in operation (before fixing electrical drives, it is necessary to verify whether impurities in the heating medium have not caused stiffening of the valve cone).
- Limitation of maximum differential pressure in the heating system in situations, when all or almost all valves are closed and the circulation pump is still running. A possible remedial measure can be installation of a bypass valve or a pump with electronic speed control and a suitable characteristics of pressure versus flow.

4.1.1 The CFox motor drive C-HC-0201F-E

The C-HC-0201F-E motor drive can be used for continuous control of radiator valves. The drive is powered from CIB and it is fitted with 2 analogue inputs and internal temperature sensor.
The drive is fitted with a quiet motor with a transmission; it has a typical stroke for most types of valves, which is approximately 1.5mm (max. 2.5mm). The exact value of the stroke can be set during the module configuration in the Mosaic environment. The drive enables manual or automatic adaptation to the valve.
The C-HC-0201F-E module is mounted onto the valve to an arbitrary position using an adapter. However, is not recommended to mount the drive to the valve from the bottom, as the water leaking from the valve can cause damage to the drive.
An internal temperature sensor provides frost protection (when the temperature falls below 5°C, then, regardless of the communication, the drive opens the valve). The drive also provides an automatic turning of the valve (after 30 days of standstill).

When making an order, you should always include an adapter for attaching the drive onto the controlled valve.There are adapters available for a variety of valves and valve inserts, see the Table below (an adapter consists of several parts, which are specified in the second Table).

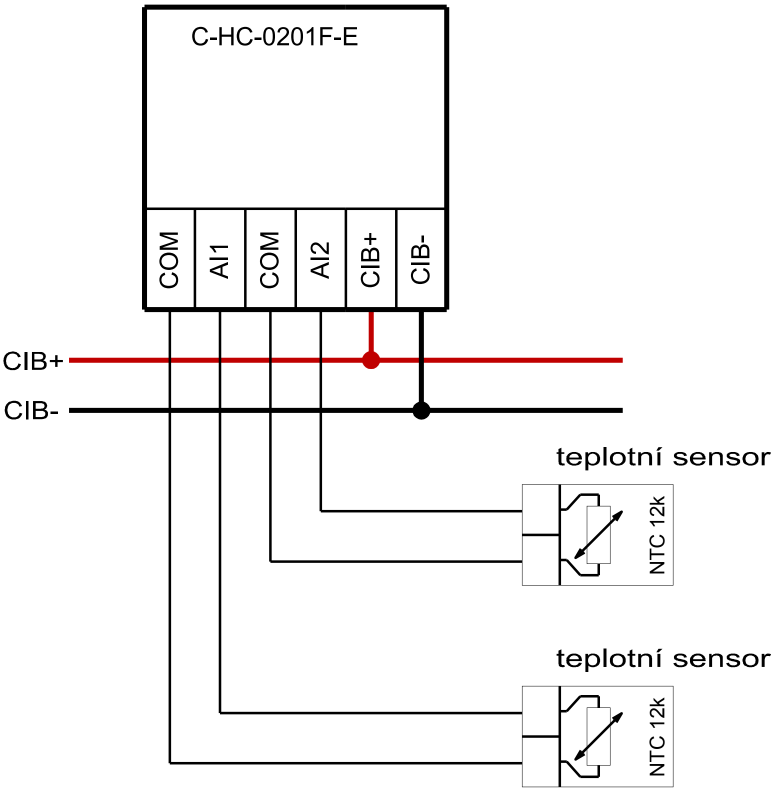


Fig. 4.1.1.1 An example of connection – the CIB motor drive for the radiator valves C-HC-0201F-E

Notes:

1) The motor drive is fitted with two inputs configurable as analogue (for temperature sensors), or as a binary potential free inputs (a window contact). So it is for instance possible to connect to the drive an ambient temperature sensor and a window contact simultaneously.
2) The cables for outdoor sensors should be connected to the terminal block under the drive housing, and the cable outlet is in the bottom part of the drive cover (see Fig. 4.1.1.2)
3) In addition to the drive it is necessary to order a relevant adapter for the specific valve (for an overview see the following Table).
4) For connecting outdoor temperature sensors or contact inputs, there are push-in terminals for wire cross section 0.14 ÷ 1.5mm^2

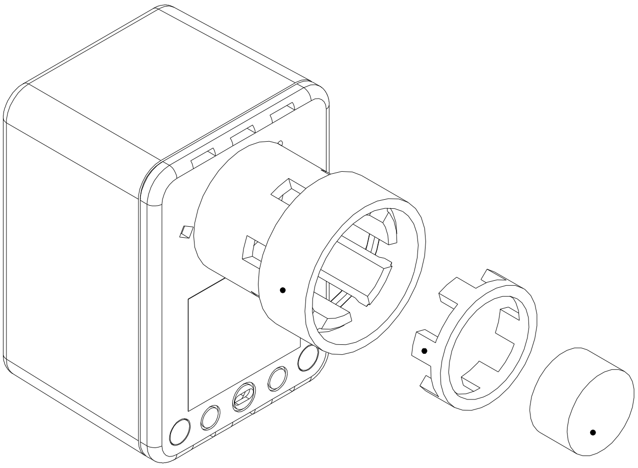


Fig. 4.1.1.2 Placement of the holes for the cables and an illustration of the fitting of the drive adapter parts

The electronic drive C-HC-0201F-E adapter must correspond with the type of thermostatic valve, on which the drive will be mounted. There are a large number or various types of thermostatic valves available on the market. On most of them the C-HC-0201F-E drives can be applied.

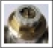
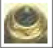
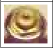
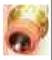
The basic variants of drives, including adapters for commonly used valves, are listed in the following table:

Order number	the adapter of the drive	internal thread	usable for the valves
TXN 133 48.01	HS-Heimeier	M30x1.5mm	Heimeier, Oventrop, Ivar, Honeywell, Siemens, Jaga, Landis&Gyr etc.
TXN 133 48.02	HS-Comap	M28x1.5mm	Comap, Herz
TXN 133 48.03	HS-Danfoss RA	clip	Danfoss RA, insert Brugman (OV)
TXN 133 48.04	HS-Giacomini	clip	Giacomini

A more detailed list of the applicable valves, including the necessary elements for their connection, is listed in the following summary.

An overview of adapters or the connecting elements for valves and valve inserts

For an overview of valve types (including their images) and the appropriate adapters, see the following Table (click on the thumbnail to display a detailed image). As design changes in valve fittings are made continuously, the presented data may not be up-to-date.

	valve	marks on the valve	Notes	Adapter	A breakdown of items for connection
	Comap M28	"sar"	5	HS-Comap	EA006+RK+DV
	Comap M30	"sar"	1,6	HS-Heimeier	EA007+RK+DV
	Danfoss RA			HS-Danfoss RA	EA008+2xM4
	Danfoss RTD				EA007+RKx
	Heimeier		1	HS-Heimeier	EA007+RK+DV
	Giacomini-clip			HS-Giacomini	EA009+DV+2xM4
	Giacomini-- a screw		3	HS-Heimeier	EA007+RK+DV
	Honeywell type SL	"MNG"	1	HS-Heimeier	EA007+RK+DV
	Honeywell type THV-NF-V	"MNG"		HS-Heimeier	EA007+RK+DV
	Landis&Gyr - Siemens	"L&G"	1	HS-Heimeier	EA007+RK+DV
	Siemens - KOMBI			HS-Heimeier	EA007+RK+DV
	Oventrop	"OV"	1, 2	HS-Heimeier	EA007+RK+DV
	Jaga		1	HS-Heimeier	EA007+RK+DV
	Coterm	"CTM", "RD"			EA006+RKx
	Herz			HS-Comap	EA006+RK+DV
	SAM				EA006+RK+DV+DVx
	IVAR valve - new IVAR valve - older		1	HS-Heimeier	EA007+RK+DV
	IVAR insert in the splitter		1	HS-Heimeier	EA007+RK+DV
	Kermi			HS-Heimeier	EA007+RK+DV
	Watts Catania			HS-Heimeier	EA007+RK+DV
	Schlösser	"JS"	1	HS-Heimeier	EA007+RK+DV
	TA Hydronics			HS-Heimeier	EA007+RK+DV
	Rehau, Gabotherm insert in the splitter				EA007+RK+DVx
	Brugman insert in the splitter	"OV" - red plastic		HS-Danfoss RA	EA008+2xM4
	CONECTERM			HS-Heimeier	EA007+RK+DV
	Meibes			HS-Heimeier	EA007+RK+DV
	ICMA insert in the splitter		4	HS-Comap	EA006+RK+DV

Notes:

1) An assembly problem: **The hex nut over the connecting thread of the valve does not have chamfered edges.**. The plastic reducing ring must be hammered in by force. When the protrusions of the flange fit closely on the edges, they slightly open, which may impede screwing on the cap nut.The installation: The plastic reducing ring should be hammered in carefully to **avoid contact** between the flange protrusions and the edges of the valve metal nut. The cap nut should be screw in, so that the drive can still be turned. Only now the drive should be turned to the correct position and the cap nut can be completely tightened. The edges of the nut will cut into the plastic material of the reducing ring or the nut flange, but this will have no impact on its tight contact with the valve abutment surface.

2) What is meant here are the OVENTROP valves with an M30x1.5mm thread for thermostatic drives.

3) In 2008 the Giacomini valves appeared on the market, with threaded mounting of the drive (M30x1.5). They are (at least for now) the R401H and R402H valves. The type of screw fitting is identical with the type for Heimeier.

4) A problem may occur when deploying the RK plastic ring on the cylindrical part of the valve head. If the ring cannot be pushed in place, you can somewhat increase the inner diameter of the ring by scraping a delicate chip, using a suitable tool.

5) The M28x1.5 thread is the following valves: 809, 808, 908, 933, 3809, 3808, 3908

6) The M30x1.5 thread is in these valves: COMAP: D3805E, D3804E, D3908E, D3809EBC, SF3805, SF3804, SF3908

An overview of adapter parts for valves (they can be ordered separately):

- EA006 is a cup nut with the thread M28x1.5mm
- EA007 is a cup nut with the thread M30x1.5mm
- EA008 is an adjustment ring for Danfoss RA valves
- EA009 is an adjustment ring for Giacomini-clip valves
- RK is a plastic (toothed) adapter ring; the ring tabs fit into the grooves of the drive flange
- RKx is a plastic (toothed) RK ring lowered in its cylindrical (full) part by about 2mm.
- DV is a spacer (cylindrical) with 10mm in length
- DV is a spacer (cylindrical) with 7.5mm in length

An overview of heating radiators fitted with valve inserts:
On the market there are hot water radiators from various manufacturers, which are fitted with valve inserts of various designs. In determining the specifications of the valve inserts, a partial guidance may be found in the following table.

Radiators fitted with valve inserts with the M30x1.5 thread (as with valves produced by Heimeier, Oventrop, etc.)			Radiators with valve inserts with bayonet connection (as with valves produced by Danfoss RA)
ACOVA Alarko Aluplan **Arbonia (i bajonet!)** Bemm Borer Bremo Caradon-Stelrad Cetra Cöskünöz Concept Dekatherm DEF Delta DemirDökum Demrad DiaNorm Dia-therm	Dunaferr DURA Ferroli Ferro-Wärmetechnik Gerhard+Rauh Hagetee Heatline Henrad HM-Heizkörper Hoval IMAS Itemar/Biasi Jaga JOCO Kaitherm Kermi Kalor Korad	Korado Manaut Merriott Neria Purmo Radson Rettig Runtal Starpan Stelrad Superia Univa Vasco VEHA Winkels Zehnder Wärmekörper Zehnder Zenith	Agis **Arbonia (i M30x1)** Baufa Brötje Brugman Buderus CICH De'Longhi Finimetal Hudevad Radel Ribe/Rio Schäfer TERMO TEKNIK Thor Vogel&Noot

Compiled in accordance with [9] and [10]. Subject to change!

4.1.2 The battery-powered RFox drive R-HC-0101F

For continuous control of radiator valves, a battery-powered R-HC-0101F drive can be used. The drive is powered by 1 or 2 pcs of primary AA battery Li-SOCl$_2$ 3.6V, 2.4Ah (the ER14505 type).

A standard usage of this drive is for valves with M30x1.5 screwing (Heimeier and others).

The drive is fitted with a very quiet and economical drive and an internal temperature sensor. The slew rate of the motor (0 ÷ 100%) is about 42s. There is also a version with the ability to connect an outdoor temperature sensor or the window contact R-HC-0201F. The outdoor sensor is connected to a cable about 0.5m long, which is brought out from the lower part of the drive.
The drive is mounted onto the valve in arbitrary position. However, is not recommended to mount the drive to the valve from the bottom, as the water leaking from the valve can cause damage to the drive. An internal temperature sensor provides frost protection (when the temperature falls below 5°C, then, regardless of the communication, the drive opens the valve). The drive also provides an automatic turning of the valve (after 30 days of standstill).

The thread (the valve connection)	M30x1.5 (Heimeier and others)
Dimensions	75 × 85 × 50mm
Colour	White

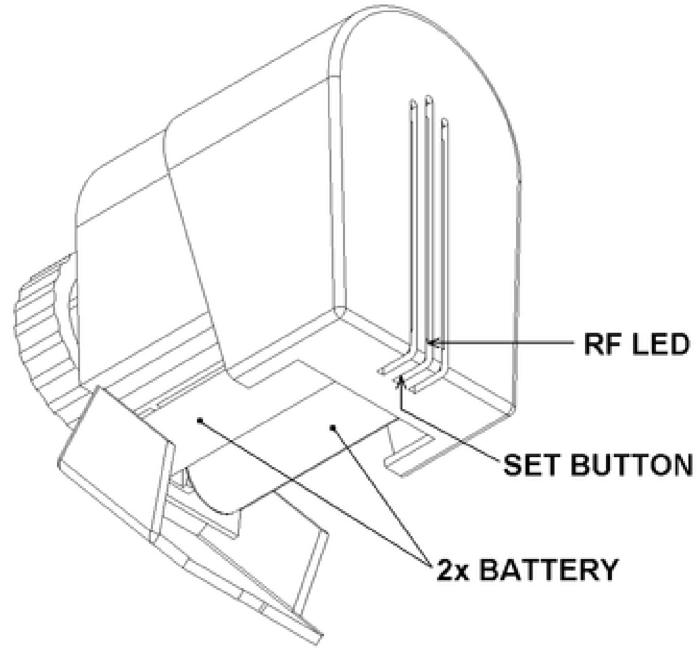


Fig. 4.1.2.1 The mechanical configuration of the drive for the R-HC-0101F radiator valves

4.1.3 On-off drives (Alpha AA) controlled by a relay output

Any relay output of the system can be used for switching the drive (typical power consumption of the drive is about 3W). It is recommended to use the C-IR-0202S module for switching at the drive location; the module is fitted with a 3A relay output with a relatively quiet relay (the switching noise needs to be considered e.g. in the bedroom) and two inputs (e.g. for room temperature and a window contact).
Any relay output can be used for switching using an element in the control panel, e.g. the outputs in the C-HM-1113M, etc.

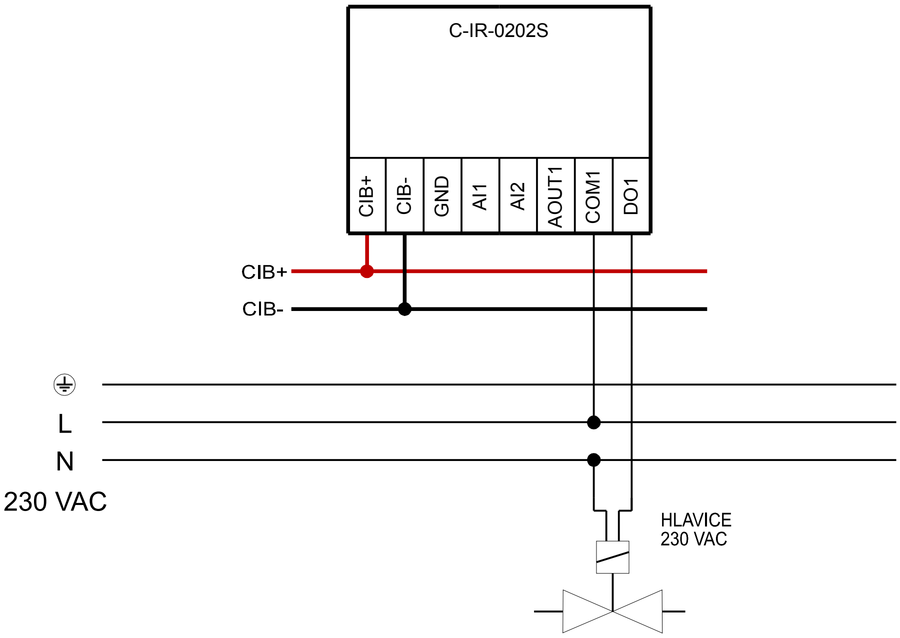


Fig. 4.1.3.1 An example of connection – a two-position drive (actuator) for radiator valves

Notes:

1) The Alpha AA drives (230VAC and 24VDC/AC) have continuous power consumption about 1.8W. The power supply (protection) must have big enough capacity for a higher short-term inrush current after switching (up to 300mA per actuator for up to 2 minutes). Similar values are also common in electrically controlled actuators of most manufacturers. The drive should always include a separately ordered **VA valve-adapter** (see below).

Basic parameters of two-position controlled Alpha AA drives:
Selection of the operating voltage is determined by the customer.

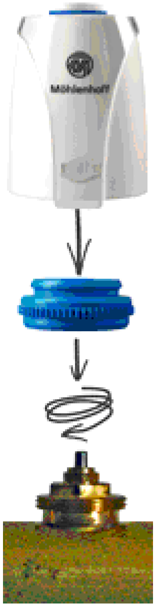
Termopohon ALPHA AA	napájecí napětí	funkce	Spínací proud max.	Provozní proud
AA 2004 / 230 V NC	230 V AC, +10% .. -10% 50 až 60 Hz	Bez napětí zavřeno	300 mA pro max 200 ms	8 mA
AA 2104 / 230 V NO		Bez napětí otevřeno		
AA 4004 / 24 V NC	24 V AC, +20% .. -10% 0 (DC) až 60 Hz	Bez napětí zavřeno	250 mA na max 2 min.	75 mA
AA 4104 / 24 V NO		Bez napětí otevřeno		

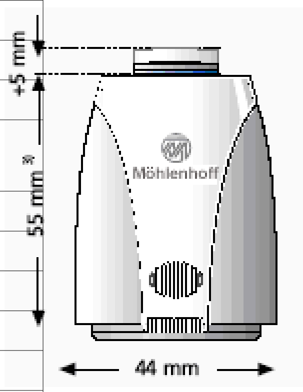
The voltage-free state (open or closed) depends on whether you prefer minimizing power consumption (controlled radiators in an insulated house will be closed most of the year and it is therefore preferable to keep them normally closed), or if you prefer for the valves to stay open in a power outage, so that the heating would remain functional (the voltage-free state is open).
This actuator is one of the smallest. Installation and removal is easy. The Alpha actuator can be used for a wide range of commercially available thermostatic valves due to its fitting on the valve-adapter VA. A simple visual indicator shows precisely what position the actuator is in. The actuator includes a safeguard against

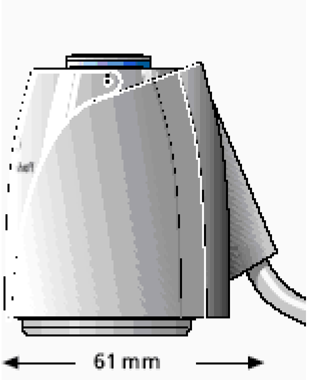
theft.

An overview **of VA valve-adapters** according to manufacturers on the market of available valves:

 **THE LOW VERSION**			
The rod :	Type:	Manufacturer:	
M 30 x 1.5 White-grey	VA80	Heimeier Herb MNG (od 1998) Onda Oventrop (od 1997) Schlosser Siemens Simplex	Beluco (od 2005) Bohnish-BK (od 1998) Cazzaniga Dumser Honeywell&Braukmann Ivar Reich (rozdělovač) Taco
M 30 x 1.5 Dark grey	VA50	Honeywell&Braukmann Reich (rozdělovač) Landys&Gyr Gazzaniga	
M 30 x 1.5 light grey	VA10	Beluco Dumser Simplex	
M 30 x 1 White	VA39	Oventrop (before 1997)	
M 28 x 1.5 Red	VA16	Herz	Polytherm
M 28 x 1.5 Dark grey	VA54	MMA	
M 28 x 1.5 Light green	VA32	Tour & Andersson	
Ashen	VA26	Giacomini (not applicable as a corner valve)	
M 30 x 1.5 Red	VA02	Velta	
 **THE HIGHER VERSION**			
White	VA78	Danfoss RA	Flasch
Light grey	VA59	Danfoss RAVL/L	Flasch
Ashen	VA72	Danfoss RAV	Flasch
M 30 x 1 Light blue	VA 04 H	Baluco (before 2005)	
M 28 x 1.5 Red	VA 16 H	Herz	
M 30 x 1.5 Chocolate	VA 19 H	Viega	
Ashen	VA 26 H	Giacomini (a corner valve)	
white-grey	VA 80 H	Bohnisch (SBK) (H) (since 1998)	
M 30 x 1.5	VA 81 H	Kermi (radiators) Strawa (before 2003)	
M 28 x 1.5 Yelow	VA 70 H	Comap , Universa (before 1999)	
M 30 x 1.5 Orange	VA 63 H	Universa (since 1999)	
M 30 x 1.5 Crimson red	VA02	Velta	
M 30 x 1 Light yellow	VA94	Rotex	
Light blue	VA 97 H	Temset	







The drive (the NC model) takes about 2 minutes to open after power supply is switched on (there is a delay the first minute without any visible activity); the delay of the signalling ring is about 3 minutes. It takes about 5 minutes for the drive to close (first the signalling ring is inserted, and then the actual mechanism controlling the valve).

4.1.4 Continuously controlled drives by the 0 ÷ 10V signal (Alpha AA 5004)

The drive can be controlled by any 0 ÷ 10V analogue output of the Foxtrot system. It is recommended to use the C-IR-0202S module for control at the drive location; the module is fitted with a 0 ÷ 10V analogue output, and also with two inputs (e.g. the temperature in the room and the window contact). When multiple drives are powered from a common 24VAC supply, it is necessary to take care of the galvanic connection of analogue outputs of individual CIB modules with the CIB communication and 24V powering of the drives. The negative terminal of the power supply and the negative CIB terminal are interconnected via the analogue output circuits - it is important to keep the minimum voltage difference between both signals (the same topology of cables, sufficient CIB cables cross-section and 24VAC power supply for the drives).

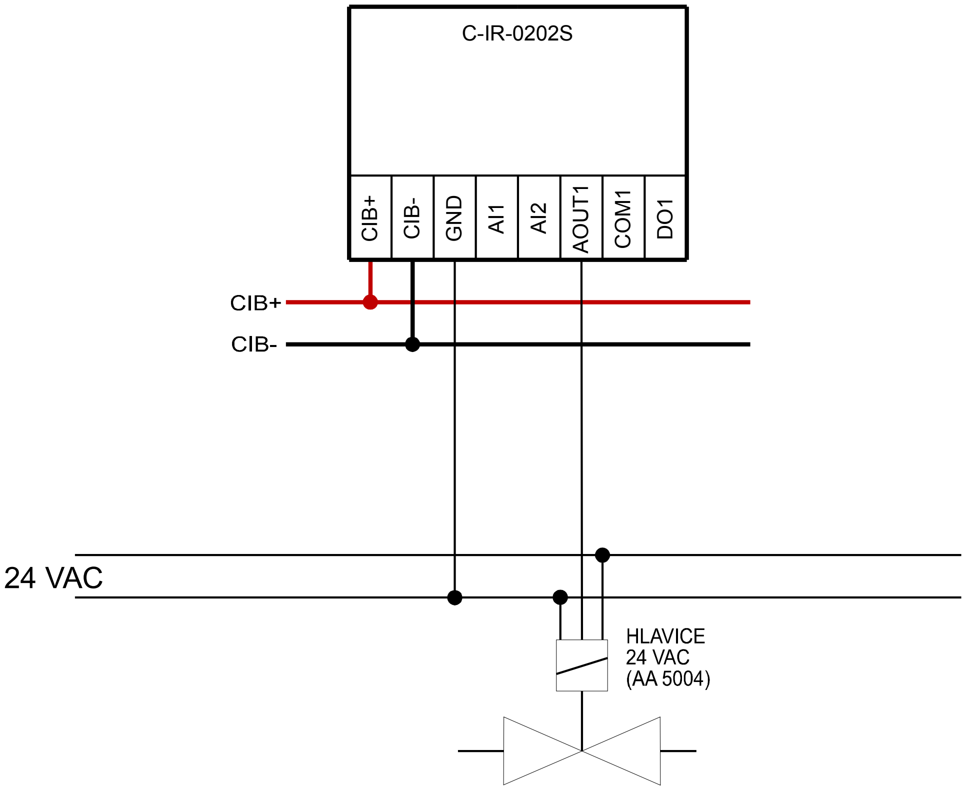


Fig. 4.1.4.1 An example of connection – a two-position drive (actuator) for radiator valves

Notes:

1) When multiple AA 5004 drives are controlled, constant consumption of about 1.8W per drive must be considered (the switching current up to 200 mA for maximum two minutes per each drive).
2) The input resistance of the AA 5004 drive analogue input is 100k.
3) If multiple drives are to be powered from a common 24VAC source, you must take into account the galvanic connection of the source and the CIB (via the drive analogue input) - the CIB bus and the 24VAC supply must always be lead in stronger wires and along the same route.
4) With greater cable lengths (dozens of meters), it is recommended to use the motor CIB drives or on-off actuators.

4.1.5 Two-position drives (Alpha AA) controlled by the RCM2-1 module output

The RCM2-1 module is fitted with a semiconductor output (SSR), which makes it possible to switch an on-off drive (e.g. Alpha AA) with 24VAC/DC voltage. Maximum switching current is 600mA. The output is galvanically isolated form other circuits of the RCM2-1 module.

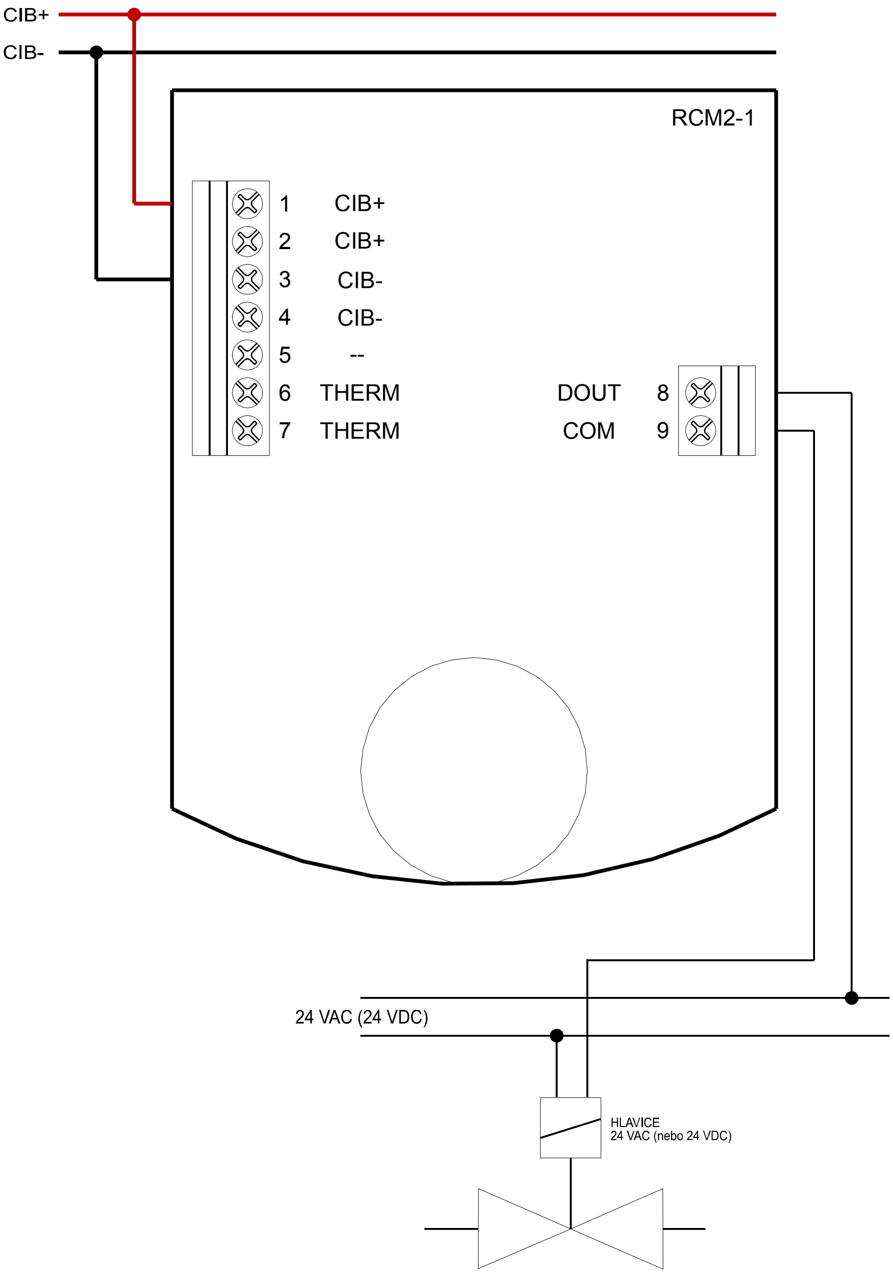


Fig. 4.1.5.1 A wiring example – a two-position drive (actuator) controlled by the RCM2-1 module.

Notes:

1) The output is intended only for switching safe low voltage of 24V AC/DC. The output has arbitrary polarity (we treat it as a common stand-alone relay).
2) When switching higher loads than 600mA (e.g. multiple drives), it is possible to switch with this output a standard electromechanical relay placed e.g. in a flush box, which then can switch more powerful loads.

4.2 Water underfloor heating

Water underfloor heating is a comfortable low-temperature system for heating rooms. It ensures optimal room temperature profile approaching the ideal recommended values.
Individual loops are brought together into the so-called manifold, which sets the flow in individual branches (loops). Underfloor heating is one of the slow-reacting systems with high inertia, but it can be implemented in such a way that after about 45 minutes there is a distinct change in the room temperature, and it is possible to control the temperature in individual rooms reasonably well. Underfloor heating is advantageous both because of savings on heating costs, but mainly because comfortable temperature can be reached in individual rooms, which are influenced in time by solar gains, heat dissipation from domestic appliances and also in accordance with the wishes of the occupants.

In order to control heating in individual rooms, you should mount the manifold valves with powered drives. The drives (mostly two-position) located in the manifold can be switched by several types of modules (depending on the number of branches and possibly other requirements for the measurement or control); any relay outputs of the system can be used for the control function. The following figure demonstrates the control of 6 actuators in the manifold. The C-HM-0308M module used in the example can be mounted directly in the manifold.
For detailed information on suitable drives and their parameters, see Chapter Hot water heaters, panel radiators.

For effective utilization of maximum floor temperature (high power for temperature increase) it is appropriate to fit in the floor a temperature sensor, which allows you to monitor the maximum floor temperature - about 29 °C for the living quarters, and 33 °C for bathroom floors and up to 35 °C for floors around the pool. Then you can regulate the temperature of heating water so as to utilize the maximum permissible temperature in the system (e.g. 45 °C), but not exceed the maximum temperature of the floor. Suitable sensors for measuring floor temperature are listed in Chapter Measuring floor temperature, the temperature sensors with cable outlets, where detailed information is presented on the assembly and placement of the temperature sensor in the floor.

The temperature in a heated room is measured either by an independent temperature sensor located on the wall, which is usually included in the design of electrical installation elements (switches, sockets) in the room,
or you can use a control unit with a display, which also measures the ambient temperature, and it is also connected with the floor temperature sensor.

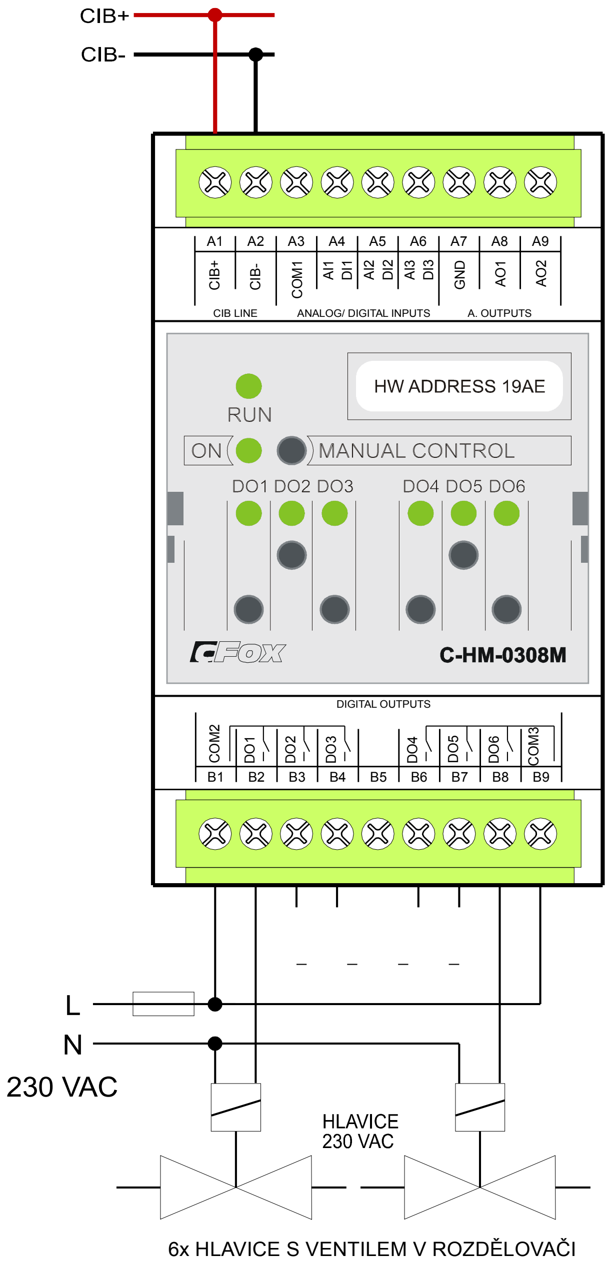


Fig. 4.2.1 An example of the C-HM-0308M hydronic floor heating module control.

4.3 Ceiling hydronic heating and cooling (capillary systems)

The ceiling heating and cooling is a very efficient way of heating and cooling rooms. As this is a radiating heat source, the heat transfer to the floor and objects and temperature distribution in the room is not very different from that of the floor heating. It is a low temperature system with the heating water temperature between 28 and 35°C; compared with the underfloor heating it has an advantage of faster rise in temperature.
Using the system for cooling offers a very comfortable and draft-free cooling of the rooms. For effective cooling it is necessary to watch the relative humidity of the ceiling so as to avoid condensation.
The temperature of cooling water is about 16 to 19 °C.

The ceiling systems, often referred to as capillary, are controlled in the same way as the underfloor heating; an example of manifold connection is given in Chapter Underfloor heating - hot water.

Monitoring relative humidity (the dew point) of the ceiling is specified in the Chapter Measuring of dewing (protection against dewing of cooling ceilings, etc.).

Maximum temperature of the heating water is determined by the technical specifications of the system (the technological limitations - material properties of the distribution system, etc.); usually it is around 40 °C.

4.4 Electric underfloor heating

The direct electric underfloor heating can be designed similarly to hot water underfloor heating. The heating elements are in this case electric heating cables (the installation is similar to hot water systems), heating mats (a more convenient installation), and heating foils (under floating floors, etc.). All variants are equivalent from the perspective of control. Standard installation systems are fitted with 60 to 100W/m^2 (for bathrooms up to 160W/m^2), the switching power for each individually controlled part of the installation is based on the total area and the electrical connection.
Depending on the installation, fast temperature increase is an advantage, and it is possible to make better use of controlling room temperature in relation to time and other conditions.

The heating cables or heating mats are switched by relay outputs in accordance with the switching power. You can make use of the relay output directly to the flush box (C-OR-0202B with a possibility of simultaneously measuring the floor temperature), or the C-OR-0008M module, which can switch up to 8 branches and can be placed in the distribution cabinet next to circuit breakers of individual heating branches. The module can also be used in the RFox design under the name R-OR-0008M, it can be powered from a 24VDC supply (e.g. DR-15-24) and the RFox wireless network can be used for communication.
Very exceptionally a higher power needs to be switched; in that case, either an external contractor switched by the Foxtrot system relay output can be used, or - if the load can be divided into several outputs - e.g. two 16A relay outputs can be used and each part will be switched by an individual output.

In standard installations it is necessary to monitor the maximum floor temperature; installing a floor temperature sensor allows you to measure the temperature and ensure compliance with the maximum of about 29 °C in the living quarters, 33 °C in the bathrooms and up to 35 °C in the floors around the swimming pool.
Suitable sensors for measuring floor temperature are listed in Chapter Measuring floor temperature, the temperature sensors with cable outlets, where detailed information is presented on the assembly and placement of the temperature sensor in the floor.

The temperature in a heated room is measured either by an independent temperature sensor located on the wall, which is usually included in the design of electrical installation elements (switches, sockets) in the room,
or you can use a control unit with a display, which also measures the ambient temperature, and it is also connected with the floor temperature sensor.

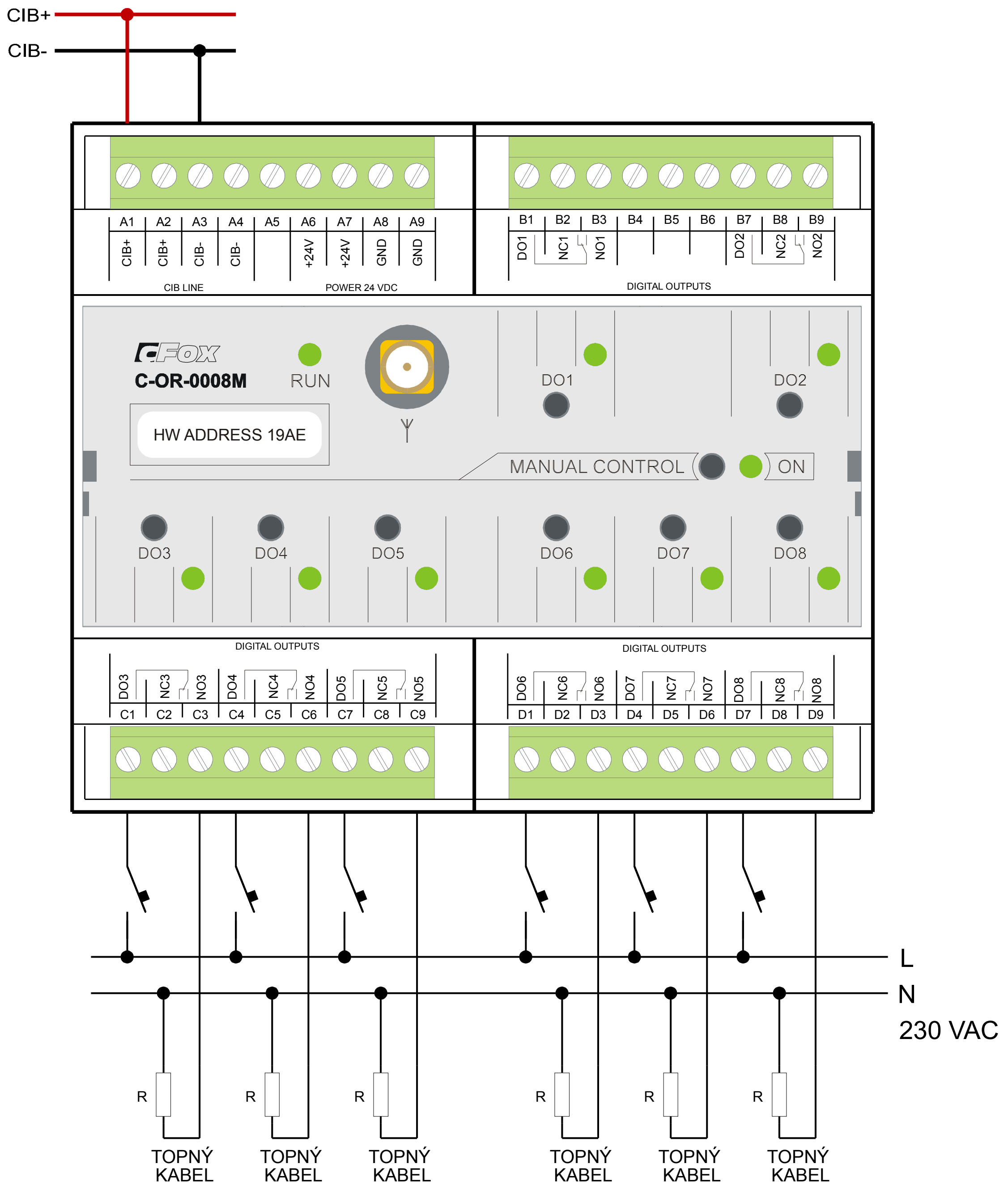


Fig.4.4.1 An example of electric underfloor heating controlled by the C-OR-0008M module.

Notes:

1) The protection level must correspond with the power output of the heating branches, maximum 16A per branch.

4.5 The floor convector – control

4.5.1 Control of floor convectors (e.g. ISAN) with the EC 24 VDC motors.

The C-FC-0024X enables controlling of several convectors fitted with 24V EC motors (analogue 0 ÷ 10V control or PWM), controlling up to two electric drives (hot and cold water), measuring up to 3 temperatures (each input can be configured for temperature measurement, or as a contact - e.g. a window contact).

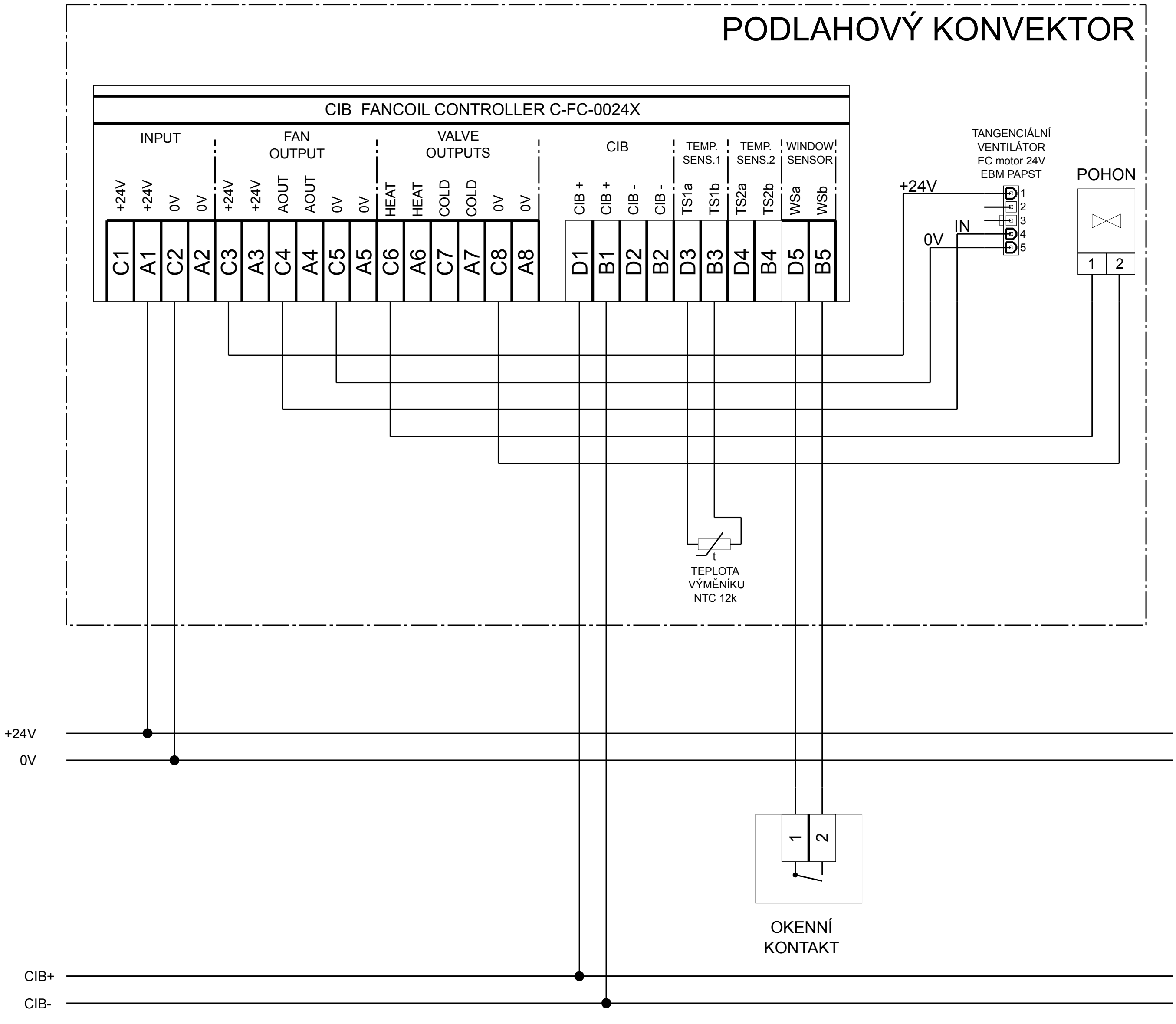


Fig. 4.5.1.1 Fig. .1 An example of a two-pipe ISAN convector with an EC motor EBM Papst

4.5.2 An example of connecting the MINIB convector to the Foxtrot system.

The convector is only fitted with an EB control block; the heating valve is mounted in the manifold (it can also be mounted directly in the convector); the convector is not equipped with additional sensors (frost protection). The convector (EB control block) is powered by 12VAC from the TT100 transformer (230 V/12 VAC, 100VA). The AA4104 drive (24V, NO) is used in the example.

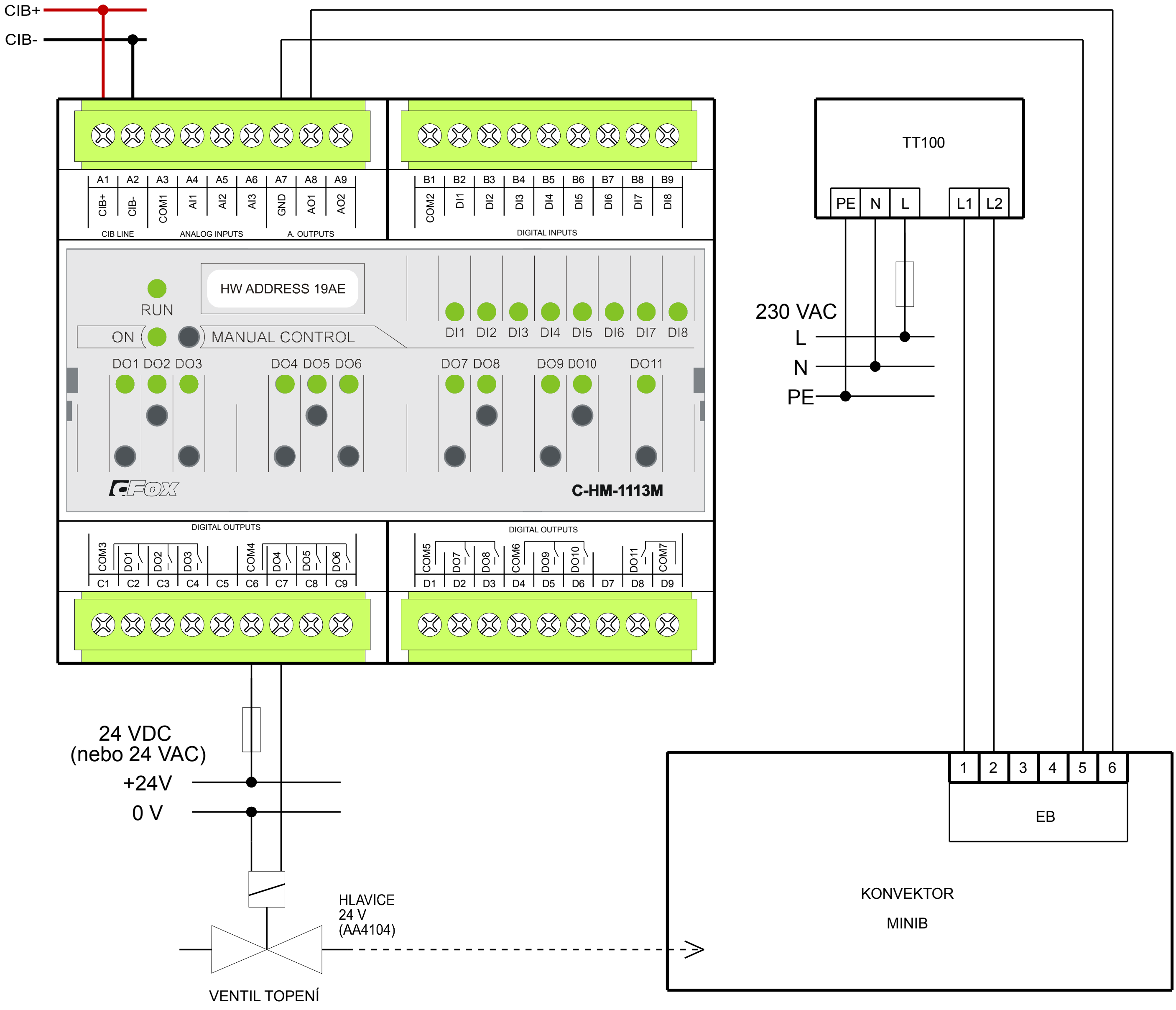


Fig. 4.5.2.1 An example of control by MINIB convector fitted with an EB control block.

4.6 Fan-coils - control

From the control perspective, fan coil units are manufactured in various versions. The following figure shows an example of a typical connection with a three-speed fan, two-position heating drives and cooling, with an example of connection of a condensation sensor and two temperature sensors. The C-HM-0308M module used in this case offers a possibility of controlling e.g. analogue-controlled drives, or controlling the revolutions of the EC motor, scanning the condensation sensor, etc.

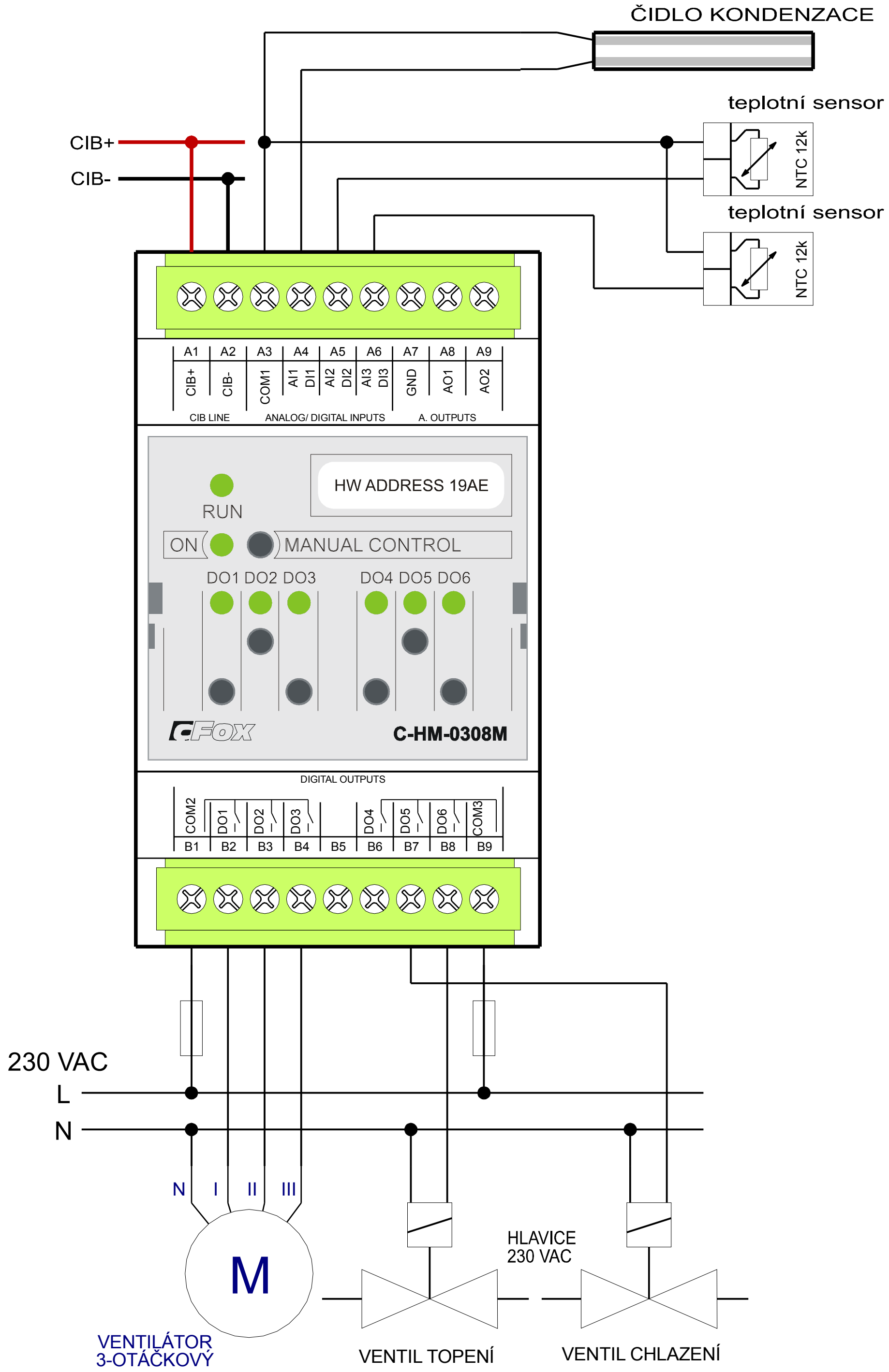


Fig. 4.6.1 An example of controlling a four-pipe fan coil unit with a three-speed fan

4.6.1 An example of AERMEC FCXI fan coils connection

The AERMEC inverter fan-coils FCXI and FCLI are available in a two-pipe and a four-pipe versions. The offer also includes the FCXI-P version without a casing suitable for mounting onto the air duct within false ceilings or walls, or in a combination with accessories in the parapet niche. The AERMEC FCXI fan coils and the FCLI cassette fan coils allow smooth control of fan motor revolutions (0-100%), and thus also smooth control of the air flow and the cooling capacity, or the heating capacity.

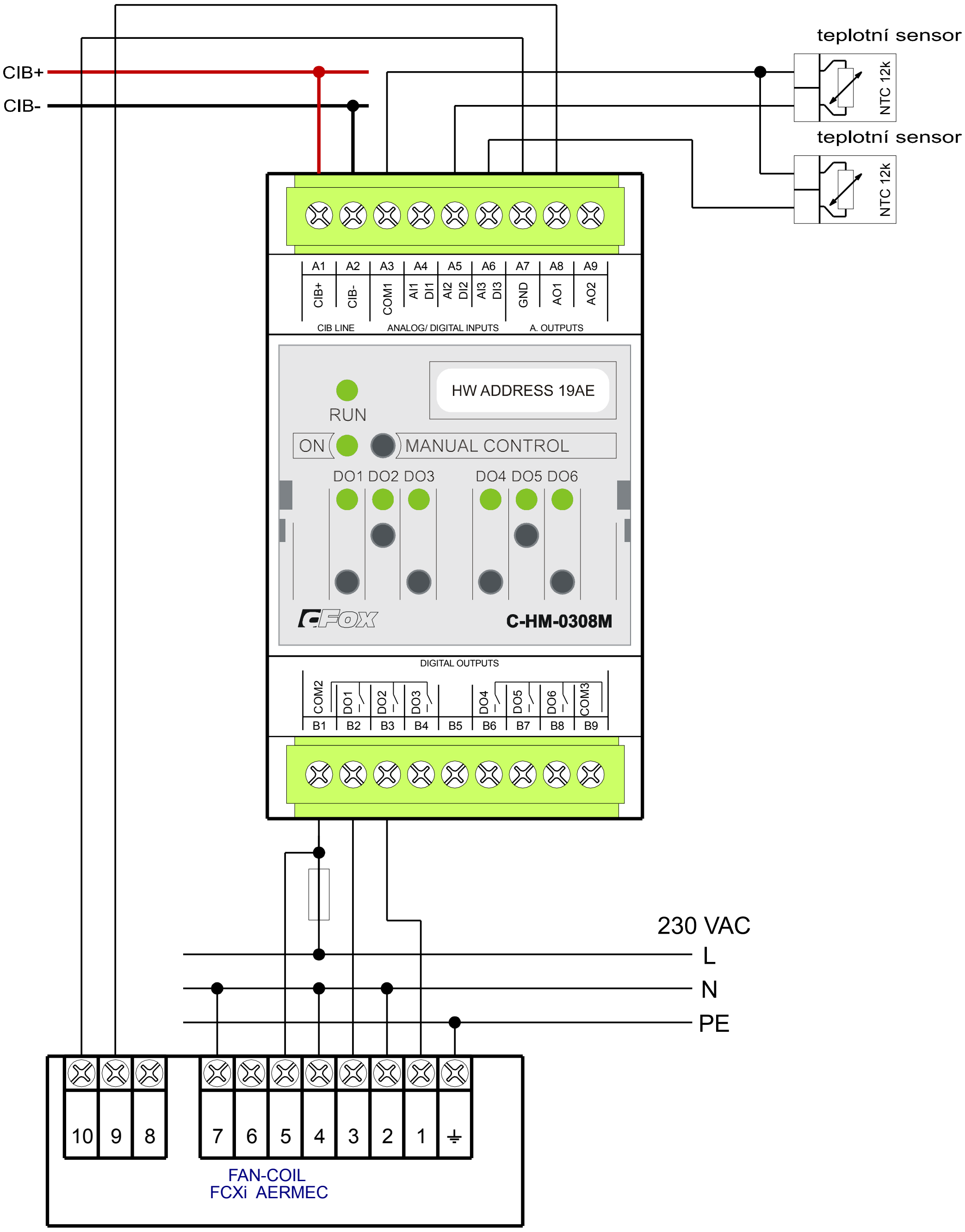


Fig. 4.6.1.1 An example of connecting the FCXI (AERMEC) fancoil unit

Notes:

1) In two-pipe fan-coil connection of FCXI unit we only control the valve drive on the terminals 3 and 4, in four-pipe connections on terminals 3-4 the heating valve drive is connected, on terminals 1-2 the cooling is connected; the drives are powered by 230VAC.

4.7 The boiler – control and regulation of the central heating sources

The boiler (gas, automatic pellet, automatic coal, etc.) can be controlled by any Foxtrot system relay output. It is recommended to limit the boiler's own "intelligence" - the equitherm curve, etc., and design the way of controlling the boiler together with the designer of the heating directly in the Foxtrot system; this provides an option to do the setting, make changes, monitor the behavior of the whole system in Foxtrot, including all remote control tools, monitoring and service.
It is possible to control the heat pumps in a similar way, as they are not themselves capable of intelligent communication with the control system of the house. You can use the input of the room thermostat, which controls the operation of the heat pump.

The boilers equipped with the **OpenTherm** interface can be controlled via the UC-1204 module. For an example of basic wiring and connection to the Thermona boiler fitted with the IU05 interface module, including the principles of connection,see the following chapters.

The heat pumps fitted with a communication interface can usually be also connected via this interface to the Foxtrot basic module. The heat pumps controlled by the Foxtrot system (included in the pump delivery) can be connected to the intelligent house control system via the Ethernet and also used for a better control and transfer of parameters - e.g. the setting of the pump can be included in the website of the house control and the overall design can be dealt with as a whole. The communication itself (data transfer between the pump control system and the Foxtrot system for smart home) must be designed in cooperation with the supplier or manufacturer of the heat pump.
Some heat pumps only allow basic control using several signals (ON/OFF, heating/cooling ...). Every specific connection has to be dealt with together with the heat pump supplier, or in accordance with the documentation issued by the manufacturer. For an example of possible connection of a heat pump, see Chapter 4.7.1.

Heat pumps and the heating systems controlled by the Foxtrot system:
ACOND
AC HEATING
CTC (regulator Regulus IR-12)
NEOTA
NUKLEON
PZP Komplet

4.7.1 Connecting the CARRIER 30AWH__H heat pump

The basic connection of the 30AWH__H heat pump can be controlled by binary signals. The heat pump is equipped with a compressor with the inverter technology, which provides both heating and cooling and is produced in several performance versions. For detailed information on the assembly and electrical connection, see the heat pump instruction manual.

The following figure shows an example of possible connection to the C-HM-0308M module (heat pump control) and measuring the heat pump current by the ED11.M electricity meter.

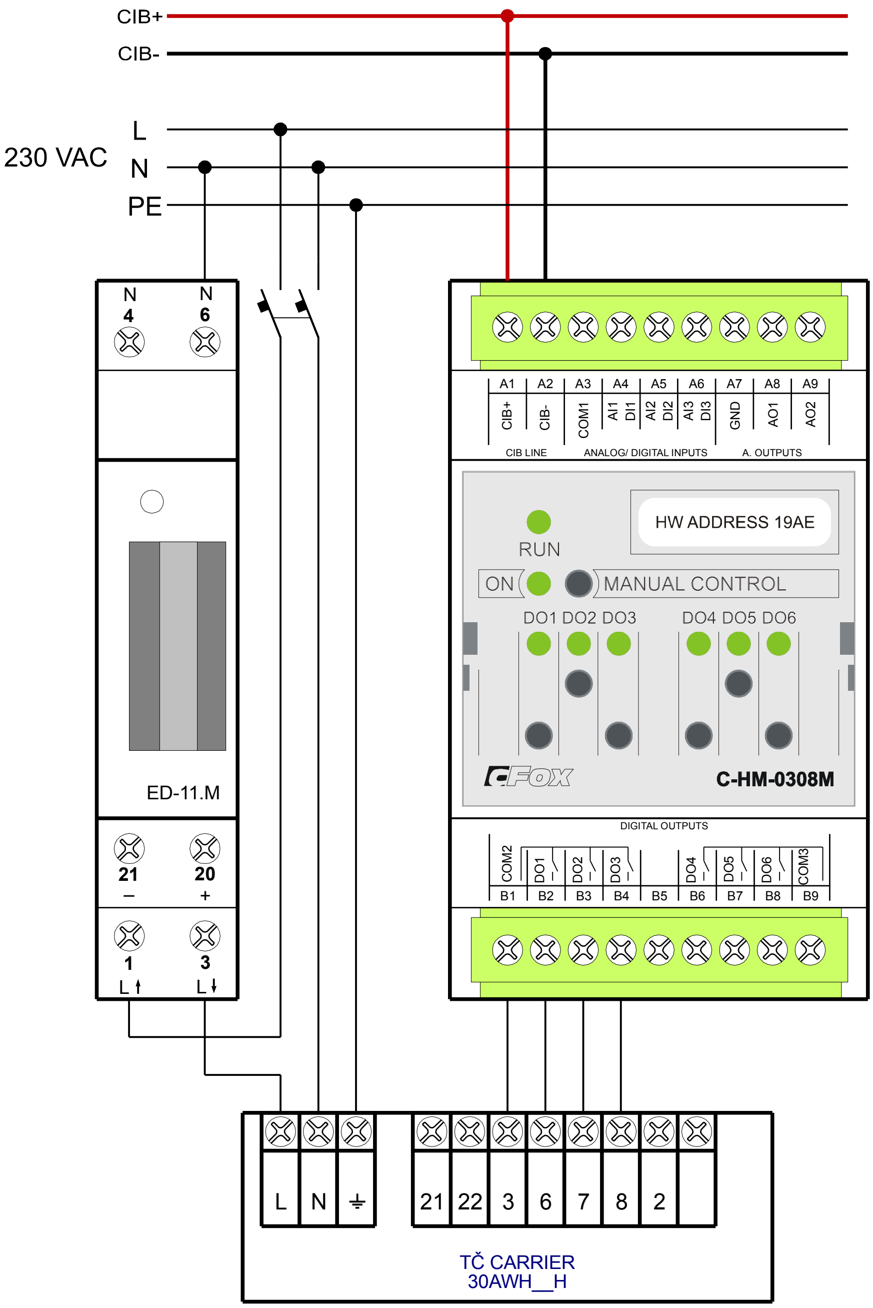


Fig. 4.7.1.1 An example of the 30AWH_H heat pump connection to the C-HM-0308M module

Notes:

1) The binary input of the heat pump must be controlled by contacts with at least 25mA 12V switching current.
2) Terminals of the heat pump: 3: Off/ON, 6: cooling/heating, 7:Normal/Economic

3) The value of the 230V power supply input protection depends on the type of the heat pump – see the heat pump documentation.

4.8 The air conditioning units control

4.8.1 Connecting the SAMSUNG air conditioning units

In order to connect the air conditioning units SAMSUNG (the DVM, CAC, FJM series), you should use the communication interface MIM-B04A, MIM-B13A/B mounted in the outdoor units of air conditioning equipment, which you should connect to the communication channel CH2 (CH3, CH4) of the Foxtrot basic module. Up to 16 outdoor units with a total of 200 connected indoor air conditioning units can be connected to one communication interface (RS485). The communication converters must be properly addressed and connected (see the Fig.); no other configuration is needed. The necessary condition is a proper connection of indoor and outdoor air conditioning units according to the manufacturer's specifications.
In order to operate the units, there is an FB library available. The Foxtrot system features allow monitoring the units (indoor unit errors, filter status, temperature, fan speed, mode, keypad lock in the local thermostat, plasma filter, etc.) and controlling the units (the fan speed, the operation mode, the required temperature, the active switching of the thermostat, the thermostat keys lock, the plasma, etc.).

Converters and corresponding outdoor units can be used for the connection:

MIM-B04A (Support of maximum 48 internal units):	DVM Mini DVM (R22) CAC
MIM-B13A/B13B (Support of maximum 64 internal units):	DVM PLUS II/III DVM PLUS II/III HR FJM Super FJM Mini DVM (R410A)

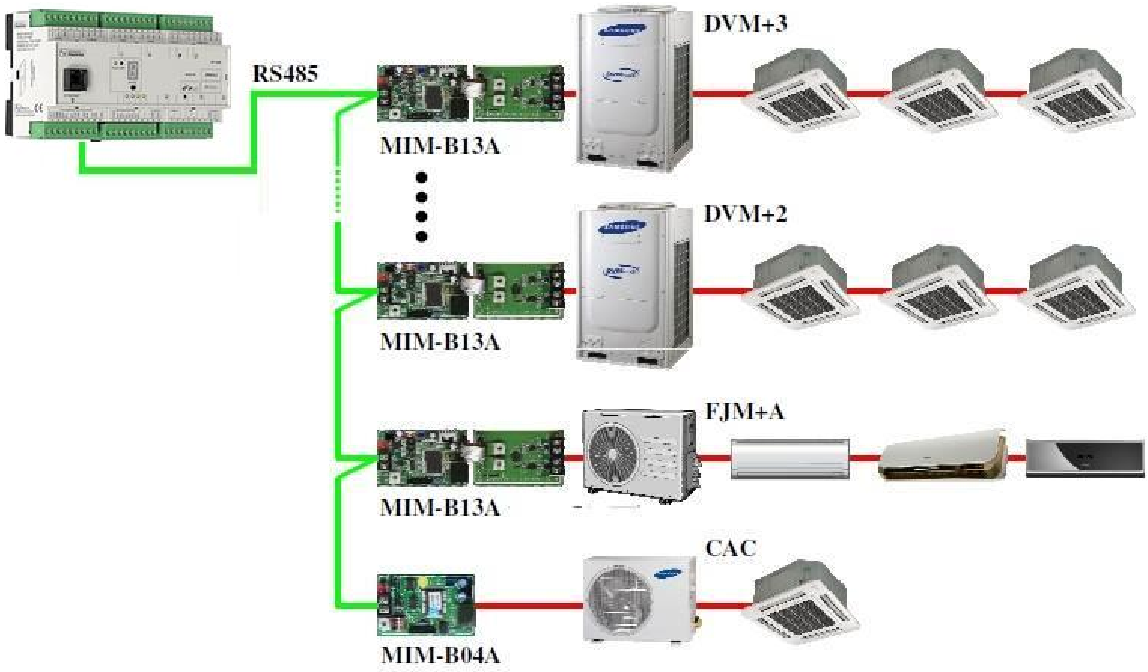


Fig. 4.8.1.1 An overview diagram of the SAMSUNG units connection to the FOXTROT system

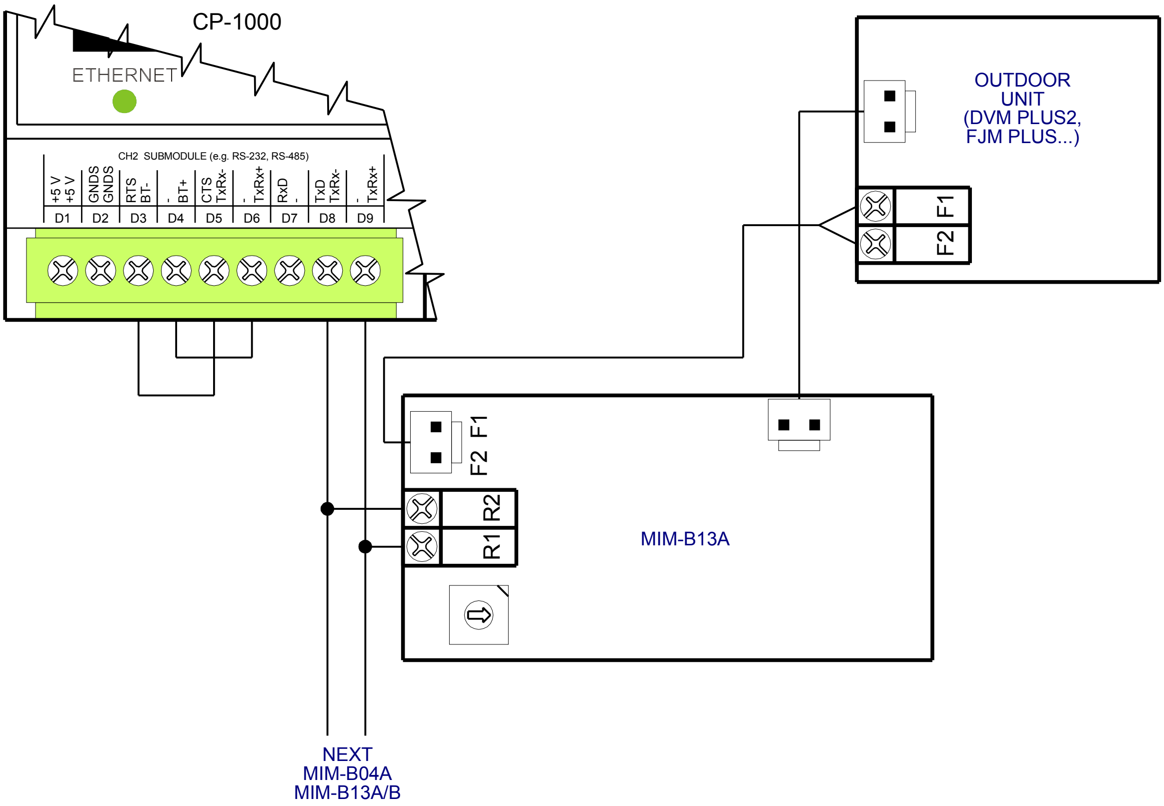


Fig. 4.8.1.2 An example of connecting the MIM-B13A (SAMSUNG) communication interface to the CP-1000

Notes:

1) The CH2 communication interface of the CP-1000 basic module in the example is fitted with the MR-0114 submodule; for more information see the documentation [4].
2) The RS485 interface connecting cable between the CP-1000 and the outdoor units of SAMSUNG interface modules is a standard RS485 cable, a shielded twisted pair, with 0.35mm minimum diameter.
3) The maximum length of the cable is about 1,000 m; it is necessary to observe the installation rules for the RS485 cable.
4) A maximum number of outdoor units (with MIM-B04A, MIM-B13A/B interface) is 16.
5) Detailed information on connection of the indoor and outdoor units and their installation is listed in the company materials on SAMSUNG air conditioning units.

4.8.2 Connecting the LG air conditioning units

In order to connect the LG air conditioning units (the Multi V, Multi M, Multi F, Single A, RAC, eco V series ...) the PI485 communication interface can be used (with variants such as the PMNFP14A0, PMNFP14A1, PHNFP14A0 and PSNFP14A0, then LGAP protocol) mounted in outdoor or indoor units of air conditioning equipment, which should be connected to the CH2 communication channel (CH3, CH4) of the Foxtrot basic module. Up to 256 indoor units (16 groups of 16 indoor units) can be connected to one communication interface (RS485). The communication converters must be properly addressed and connected (see the Fig.); no other configuration is needed. The necessary condition is a proper connection of air conditioning units according to the manufacturer's specifications.
In order to operate the units, there is an FB library available. The Foxtrot system features allow monitoring the units (indoor unit errors, filter status, temperature, fan speed, mode, keypad lock in the local thermostat, plasma filter, etc.) and controlling the units (the fan speed, the operation mode, the required temperature, the active switching of the thermostat, the thermostat keys lock, the plasma, etc.).

The following units can be used for the connection:

The Multi V	Multi V Plus, Multi V Super, Multi V Sync, Multi V Water series
The Multi & Single	Multi M/MDX, Multi F/FDX, Single A series
Units of bottled water	Products of bottled water RAC
The ventilation units	eco V

Variants of communication modules:

PMNFP14A0	installation to the Multi V, Multi, Single A outdoor units A maximum of 16 indoor units can be connected to the outdoor unit
PMNFP14A1	installation in the Multi V outdoor units A maximum of 48 indoor units can be connected to the outdoor unit
PHNFP14A0	installation in indoor units Single (Duct, CVT) only 1 indoor unit on the interface module
PSNFP14A0	installation in the indoor units Single (RAC, PAC, CST) only 1 indoor unit on the interface module

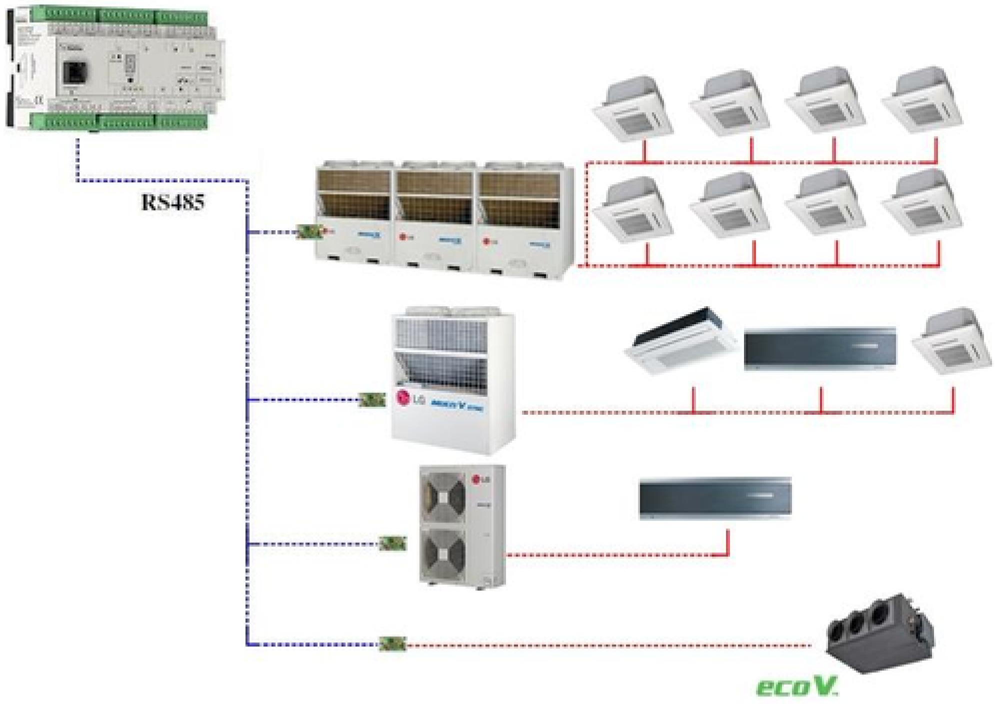


Fig. 4.8.2.1 An overview diagram of the SAMSUNG units connection to the FOXTROT system

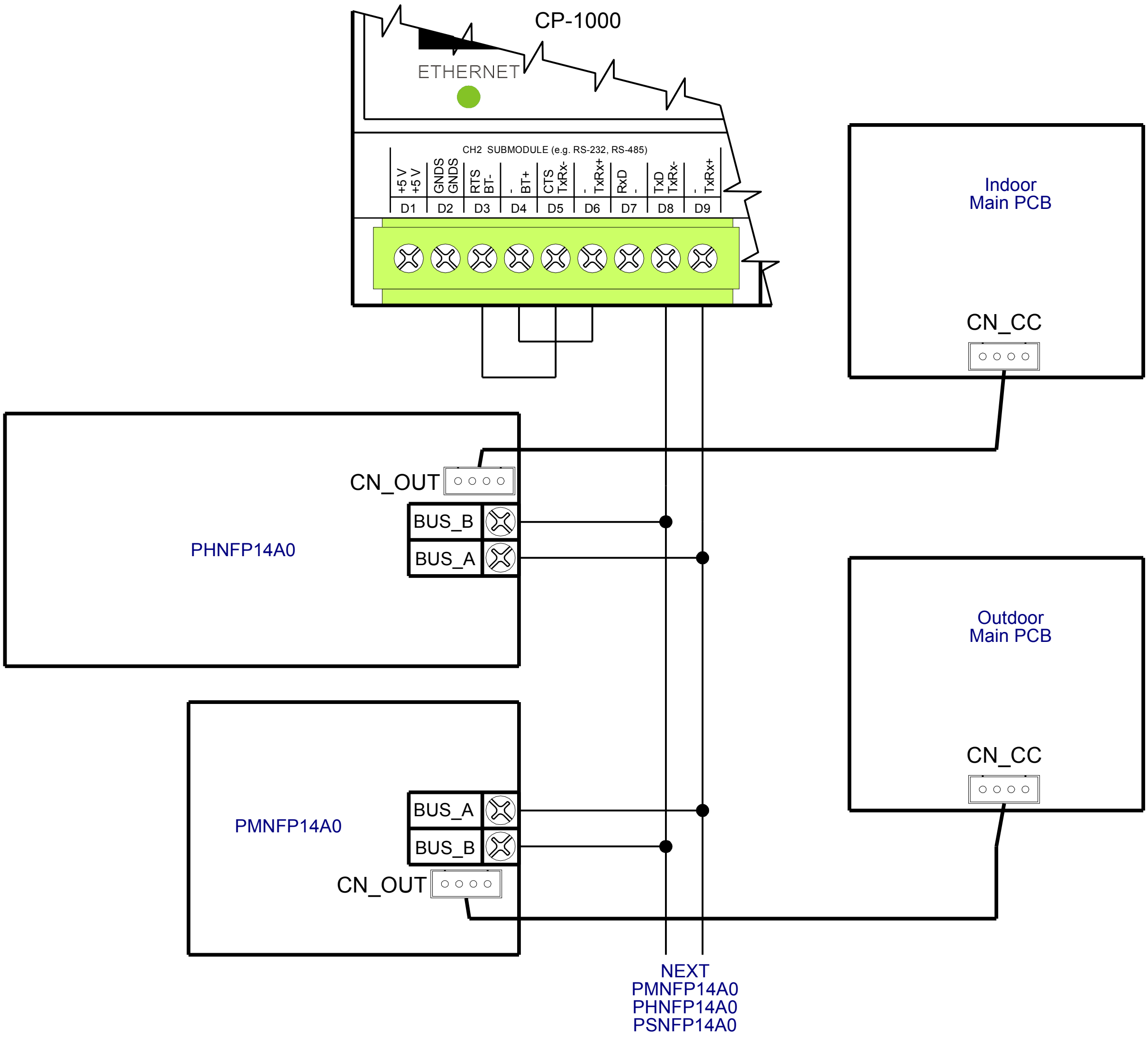


Fig. 4.8.2.2 An example of connecting the PI485 (LG) communication interface to the CP-1000

Notes:

1) The CH2 communication interface of the CP-1000 basic module in the example is fitted with the MR-0114 submodule; for more information see the documentation [4].
2) The RS485 interface connecting cable between the CP-1000 and the PI485 interface modules in LG units is a standard cable for RS485, a shielded twisted pair, with 0.35mm diameter.
3) The maximum length of the cable is about 1,000 m; it is necessary to observe the installation rules for the RS485 cable.
4) Detailed information on connection of the indoor and outdoor units and their installation is listed in the company materials on LG air conditioning units.

4.8.3 Connecting units via the COOLMASTER interface

TBD

4.9 Heating servo-drives and valves control

To control and regulate heating, cooling and similar systems, various types of valves are used: based on their function there are two-way, three-way and centre valves.
There are valves with only basic function ON/OFF or switching, or there are control valves, mixing and distribution valves.
To control them use the servo-drives, which can be categorized in accordance with the type of control (only ON/OFF or continuous control) into two-point, three-point, analog-controlled and other special variants (e.g. MP-bus controlled).

Two-way valves

A two-way valve is used for opening/closing individual heating branches, etc., or to regulate the flow in the respective branch. Accordingly, a suitable drive should be selected: a two-point or three-point, or analogue-controlled.

Three-way diverter valve

It is used e.g. for switching the heat sources (between the boiler, the heat pump or the solar system), or for switching heating circuits (central heating and heating water), etc.
Mixing function

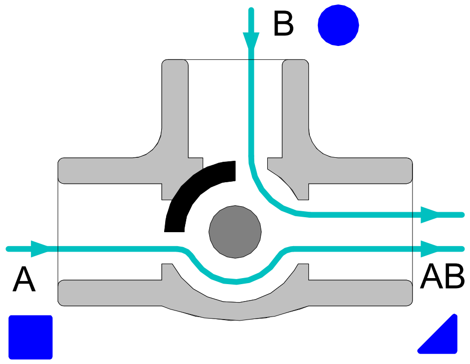
Mixing diverter valve

The mixing valves are used for mixing two fluids of different temperatures in such a ratio, that the required temperature is reached at the valve outlet. They are divided into three-way diverter valves and centre valves.
The three-way diverter valves mix water from two inlets into one outlet; by mixing they actually reduce or increase the flow in each inlet. These valves are typically used for mixing the heating water in the heating circuits (the underfloor or the wall heating, radiators), or for mixing the return branch to solid fuel boilers to prevent the low- temperature corrosion.

Basic principles of the mixing three-way valve:

The fluid inlets are usually marked with letters A and B.
The common outlet is marked by letters AB.

By moving the black segment (see the figure) the flow smoothly changes from both inlets A and B to the outlet. Usually the control range is 90° from one end (inlet A is open, B is closed) to the second (inlet A is closed, B is open).



In the diagrams the inlets are marked by a full triangle, and the outlets by a blank triangle.

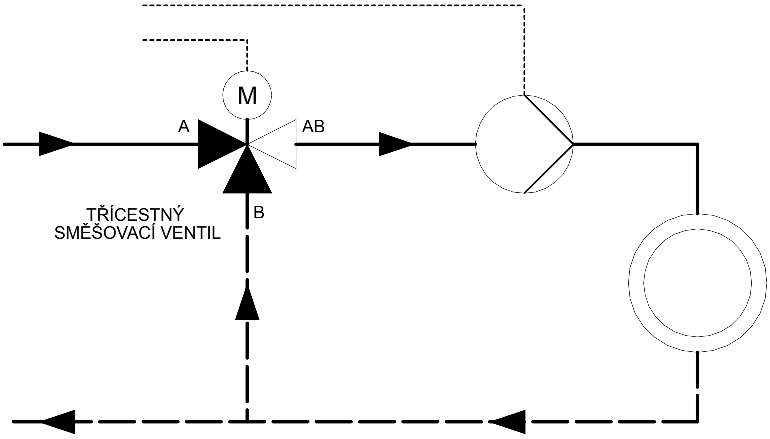
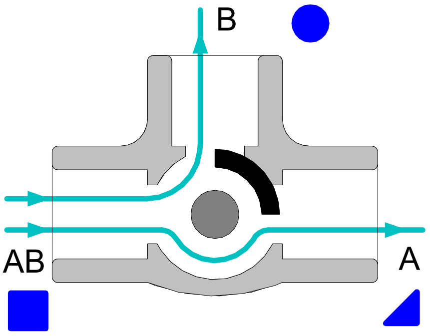


Fig. 4.9.1 Mixing heating circuit with a diverter valve

Wherever it is necessary to ensure a constant unhindered flow also at the inlet to the mixing valve, it is necessary to use the **centre valve**, which provides mixing to the desired temperature, while maintaining the flow on both ends of the valve. A typical example is the mixing of water behind a gas boiler, it which the flow of heating water must be maintained, or mixing the return branch to the solid fuel boilers.

Distributing valve

The distribution function of the valve is similar to mixing.
Basically the direction of the flow is reversed.



Two-point control

In the case of On/Off control (in the two-way and three-way diverter valves) you can use the two-point or three-point controlled drives.

A standard method is the two-point control, where the drive is controlled (switched) into the active position by one output. The valve moves to the other end (idle) position after opening the output either by a pull-off spring, or by an actuator powered by permanently connected voltage - see Chapter 4.10.1 Two-point controlled VZK zone ball valve. When the two-point-controlled valve is in the idle position, it can be either open or closed, depending on the model.

Three-point control

The mixing valves (the three-way mixing valve, the centre valve, the distribution valve) must be controlled by a drive, which allows setting any working position between the two extreme positions of the valve.

One of the methods is the so-called three-point control, when the drive is controlled via two outputs; there are three states: opening - idle - closing.

The same control method is sometimes also used for two-way control valves, see Chapter 4.10.2 Three-point controlled DANFOSS AMV 20 drive.

The three-point control is identical with standard Venetian blinds motors, and the same principles apply, see Chapter 7.1 Control of Venetian blinds and roller blinds, which contains further information and requirements for relay outputs, etc.

Analogue control

Drives controlled by 0 to 10V analogue voltage are also used for continuous valve control. This control allows you to comfortably and conveniently set the exact position of the valve as required by the regulation. The drives are powered either by 230VAC voltage - then the analogue control in the actuator is terminated individually, or it is powered by standard 24VAC power supply, and then there is usually one common terminal for the power supply voltage terminal and for the 0 to 10V analogue input; this should be taken into account when designing the connection. The drive on the heating radiators is powered and controlled in the same way, see Chapter 4.1.4 Proportional drive controlled by 0÷10V signal (Alpha AA 5004).

The bus-type of control, the MP-bus

Proportional control of servo-valves drives and flap drives is also enabled by drives with the MP-Bus interface supplied by Belimo.

For detailed information, see Chapter 2.8.7 UC-1203, module for connecting MP-Bus drives.

4.9.1 Two-point controlled VZK zone ball valve

The zone valve is used to control the flow into individual zones of hydraulic distribution system (e.g. heating, cooling or solar systems, water distribution, etc.). There are two-way or three-way valves. A two-way valve allows only closing or opening of individual hydraulic circuits; a three-way valve directs the flow from one common inlet to one of the two outlets, depending on whether it is open or closed. The zone valves are further divided in accordance with their use, maximum and closing pressure, temperatures and types of fluids, types of electrical drives and security features.

The zone valves are usually designed with a two-point control, allowing only an ON/OFF function (a two-way valve) or switching (a three-way valve).

The following figure shows an example of electrical connection of the VZK 2xx - 230 - 1P – 001 zone valve produced by Regulus. It is controlled by the C-IR-0203M module together with the Wilo Yonos circulation pump .

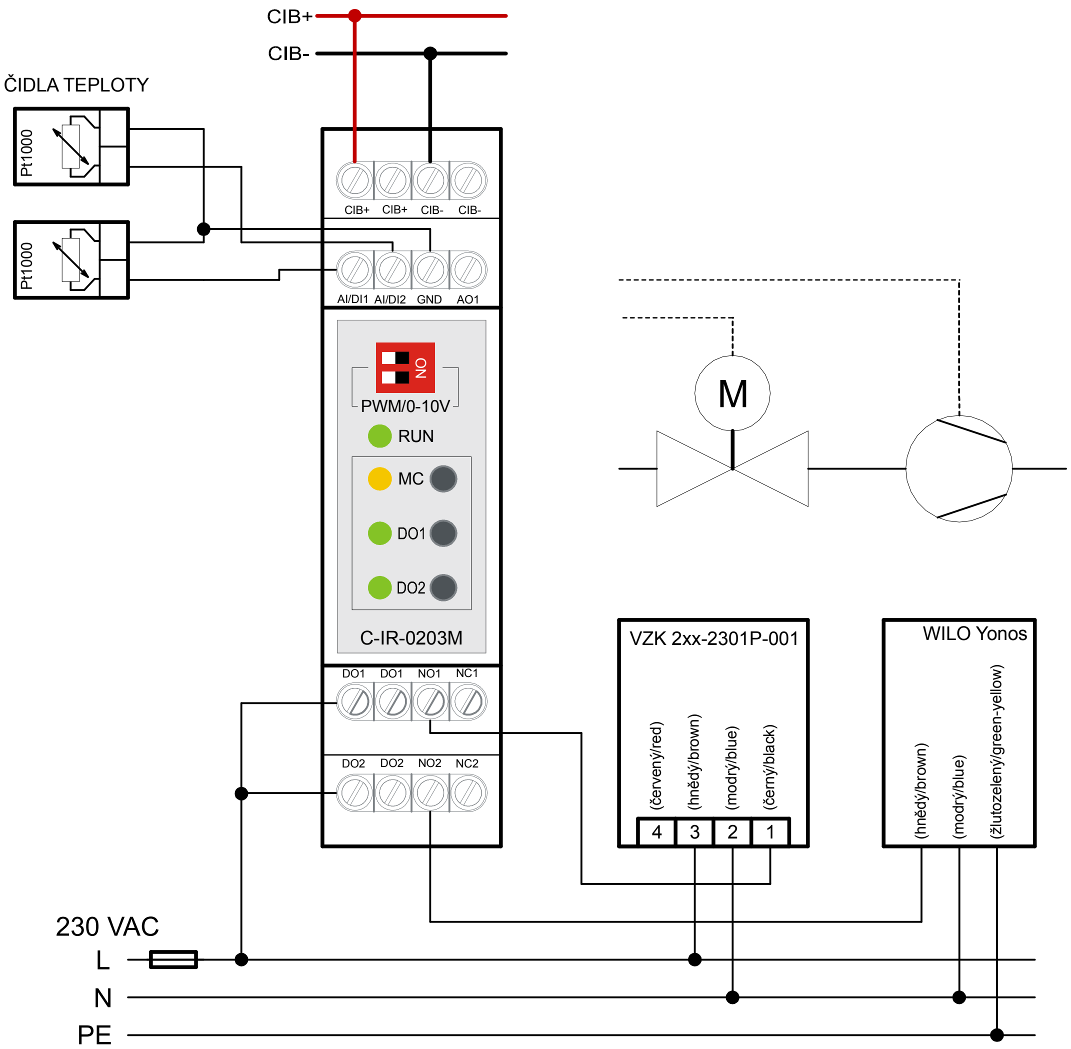


Fig. 4.9.1.1 An example of connecting a two-point controlled VZK valve

Notes:

1. The VZK valve has a stand-by consumption about 3VA; when the motor is running, it is approximately 7VA.

4.9.2 The three-point controlled DANFOSS AMV 20 drive

An example of a three-point controlled regulation valve is shown in the following figures.

The example uses a three-point controlled DANFOSS AMV 20, a drive with the 230VAC supply voltage, power consumption 2VA.

The actuator is controlled by a standard three-point control **closing**-**idle**-**opening**, which is used e.g. also for shutter drives and its electrical connection is identical. Two independent switching contacts can be used for electric control, or a specially connected output with two relays and mutually blocked switching of both outputs (see Chapter 7.1.4 Control of asynchronous motors C-OR-0008M for blinds and awnings). You must always make sure that both outputs are not switched on simultaneously.

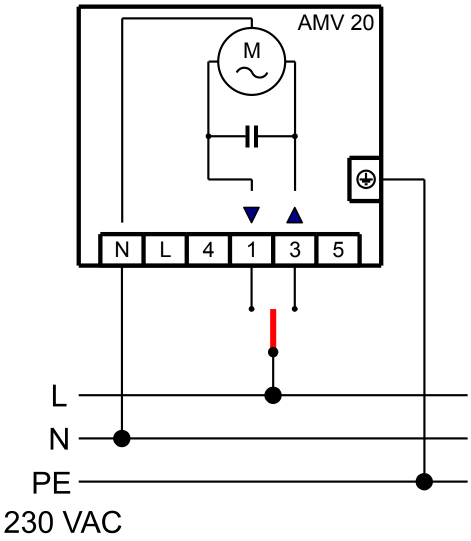


Fig. 4.9.2.1 Basic principles of (connecting) three-point drive control

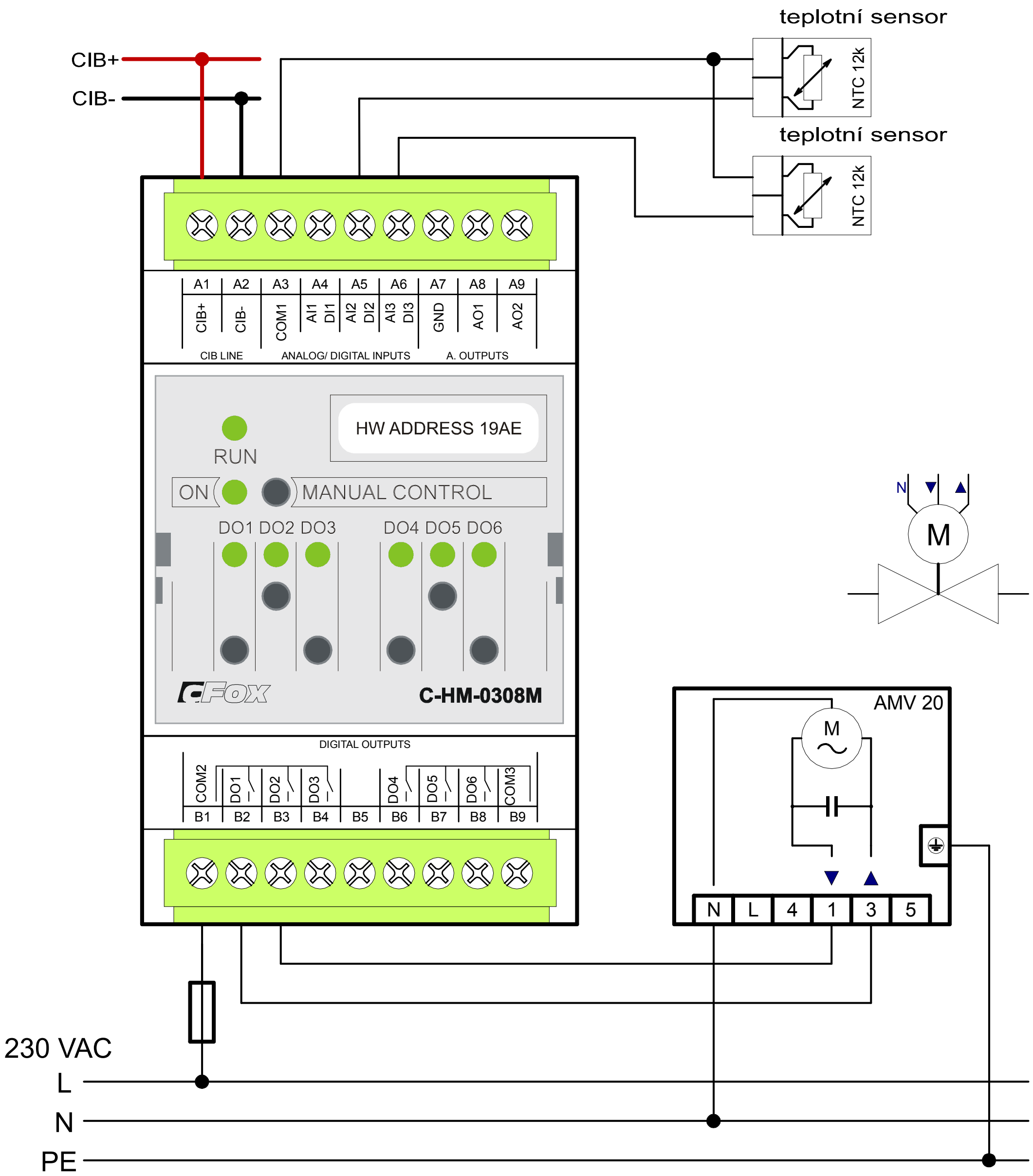


Fig. 4.9.2.2 An example of connecting a three-point controlled AMV 20 drive

4.10 Controlling circulation pumps with EC motors

The newly introduced circulation pumps with EC motors (energy-saving) bring new features from the viewpoint of control - both simple switching and an option of speed control. We are preparing a number of solutions and examples of controlling the speed and correct switching of these pumps.

TBD

4.11 Ventilation and recuperation units

The ventilation and recuperation units are supplied with their own devices, which are, however, often very cumbersome to adjust and cannot be integrated in the building control system. Therefore, it is better to implement the control of the recuperative or air ventilation units directly by the Foxtrot system, which is fitted with a number of input-output modules suitable for this purpose. Gradually the library of function blocks is expanding, and they are ready for regulation of ventilation and recuperation units, fan coil units, etc. The advantage of this solution is in the flexibility of hardware, because the ventilation control itself can be combined with other technologies - both in software control, and hardware configuration of the control system.

Possible variants of the peripheral modules according to technology:

Fans:

discreet speed control of 230V motor revolutions	relay modules, e.g. C-HM-0308M
Continuous regulation of 230V asynchronous motors, built-in version	C-FC-0230X
Continuous regulation of 24VDC EC motors, a built-in version	C-FC-0024X
Continuous regulation of 24VDC EC motors , 0÷10V control	E.g. C-HM-0308M
Continuous regulation of motors with a frequency changer, 0÷10V control	E.g. C-HM-0308M

Sensors:

Temperature sensors – the type of sensors according to the selected module	E.g. C-HM-0308M
Condensation sensors	C-HM-xxxxM
Indoor CO_2 sensors	C-AQ-0001R

Servo-drives:

Servo-drive with 3-point control, 230V or 24V	relay modules, e.g. C-HM-0308M
Servo-drive with 0÷10 V analogue control	AOUT, e.g. C-HM-03308M
Damper actuator, 1-point control	relay modules, e.g. C-HM-0308M
Servo-drive with the MP-Bus protocol	UC-1203

Further it is possible to control electrical heating (16A relay outputs, e.g. the C-OR-0008M),
to scan inputs from defective sensors (filter, etc.), from remote control (manual control e.g. from the bathroom, etc. ...).

4.11.1 Fan speed control, heat recovery units

The figure shows an example of controlling heat recovery units with two fans with EC motors, an actuator and a valve, up to three temperature sensors, and all connected to the C-HM-0308 module.

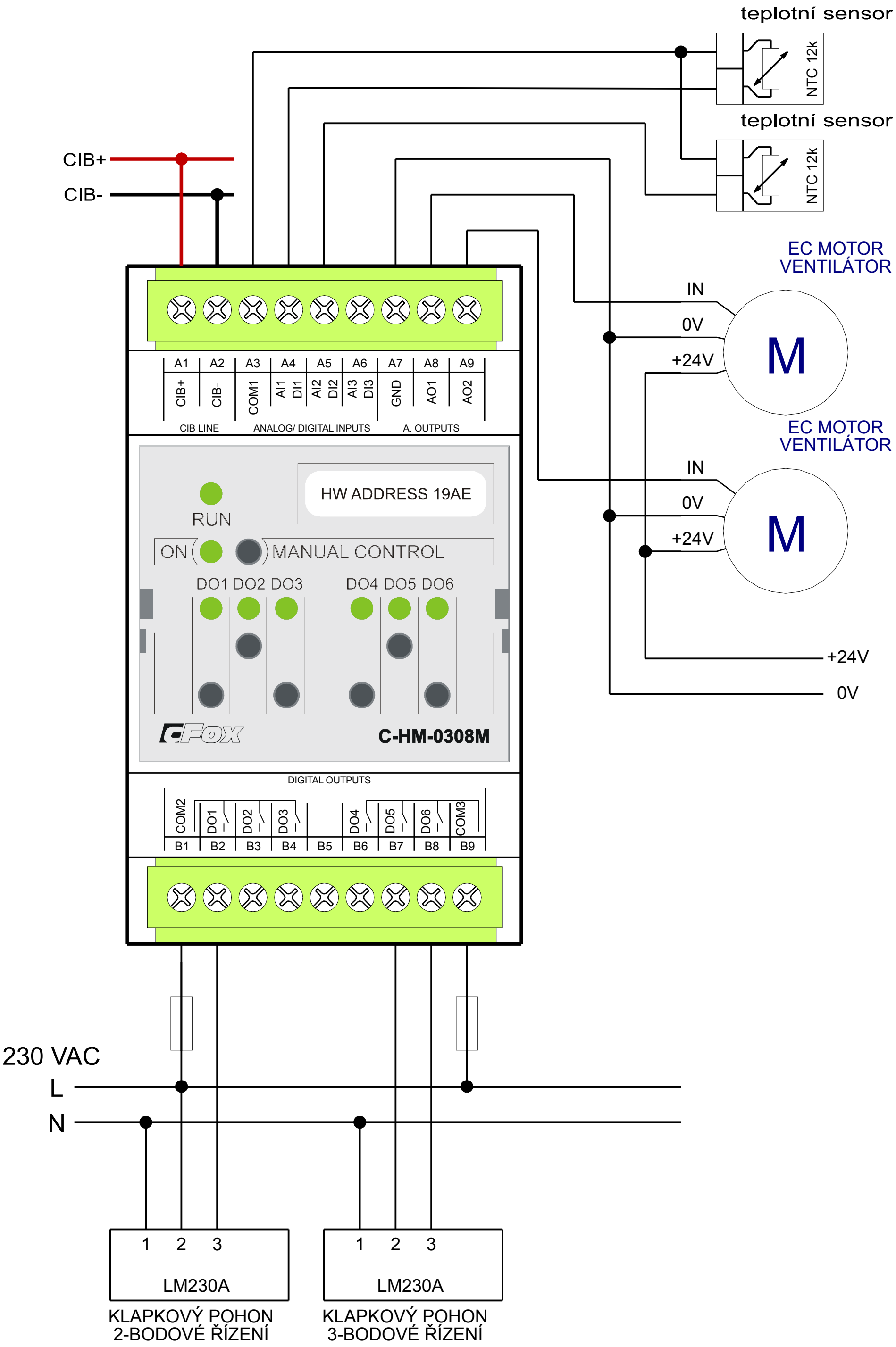


Fig. 4.11.1.1 An example of connecting a heat recuperative ventilation unit with EC motors

4.11.2 The inVENTer decentralized heat recuperation ventilation unit

The C-VT-0102B module is intended for powering and controlling up to two independent inVENTer ventilation units. The module is powered from the CIB at maximum power of both fans, its consumption is up to 5W - i.e. the CIB is loaded like with about 5 standard CIB modules.
The module is fitted with an input for an external temperature sensor (indoor temperature, outdoor temperature, etc.).
The InVENTer units are connected directly to the output module wires; the order of the outer terminals (outputs A1 and A2, or B1 and B2) does not matter, only the direction of the fan rotation is reversed, which must be counted with during regulation.

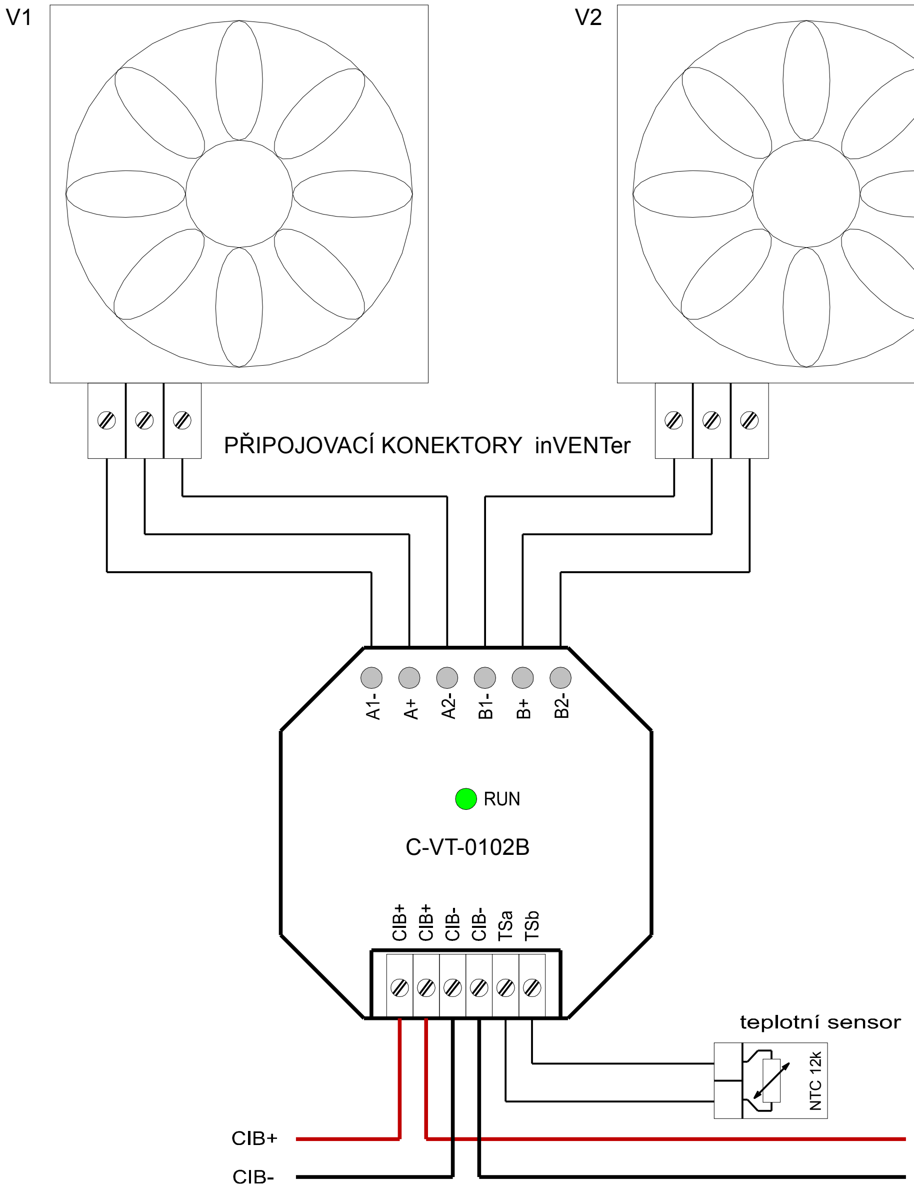


Fig. 4.11.2.1 An example of connecting the C-VT-0102B module with two INVENTER units

1. Temperature sensor (input TSa, TSb) - you can use: NTC 12k, NTC thermistors with maximum resistance 160k.
2. The inVENTer units fans are connected directly in the module outputs, maximum length of supply power wires - 15m.
3. The C-VT-0102B module has a maximum power consumption 5W (with two fans and maximum speed).

5 PVPS, H-PVPS, water heating

The table of contents of the chapter

The following chapters describe some selected basic concepts of standard (PVPS) and hybrid (H-PVPS) photovoltaic systems, their key components from the management and integration perspective, and examples of connection of individual parts of the system.

The following examples assume 1ph version and power of up to 4 kW (max. 16A max. per phase, in total maximum 10kW in 3ph PVPS) for own consumption with minimizing overflow into the network (the so-called micro-source in accordance with the Decree no.16/2016, and the Act no.458/2000 Coll.). It also includes protection and monitoring functions of the system in accordance with the PPDS (operating rules for the electricity distribution systems), Annex no. 4.

5.1 The basic variants of the PVPS and H-PVPS design

5.1.1 PVPS (grid-tie, on-grid)

The most common design of PVPS includes the PV panels themselves, and a power inverter, whose output is directly connected to the mains in the supply point (SP). This solution does not allow the island mode - the inverters used always need for their operation the mains voltage.

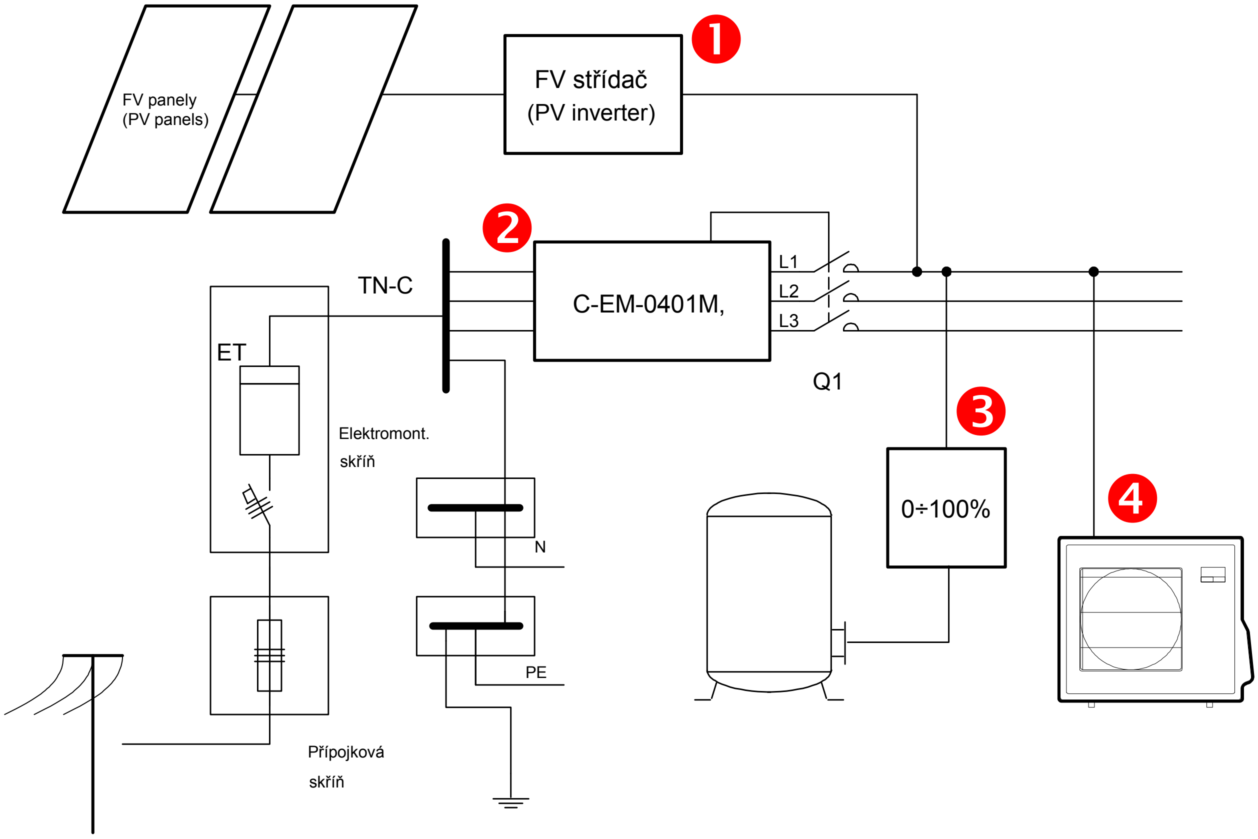


Fig. Basic overview diagram of 1ph grid-tie PVPS

Basic components for controlling PVPS

❶ An inverter, e.g. Sunny Boy 2.5 controlled by the Foxtrot system (communication interface)
❷ 3ph fast four-quadrant electricity meter with the function of protective disconnection in CIB
❸ Continuous power control into resistive loads (phase, amplitude)
❹ Continuous power input control of the heat pump or air conditioning compressor

5.1.2 Hybrid system, DC coupling of PV

Basic design of HFVE using a hybrid inverter and connected PV panels with DC/DC coupling via a charger (an MPPT tracker) to a backup battery. The L1 phase is connected to the hybrid inverter input, and the L1´ inverter output is connected to the power distribution in the supply point. This solution enables the island mode, when the L1´ phase is backed up, based on the inverter output power. In standard operation, the bypass function allows passing significantly higher power through the inverter than its inherent power, and the entire power consumption of the house can be connected to phase L1.In the event of a power failure it is necessary to reduce the consumption according to the maximum output of the inverter - which is one of the tasks of the control system.

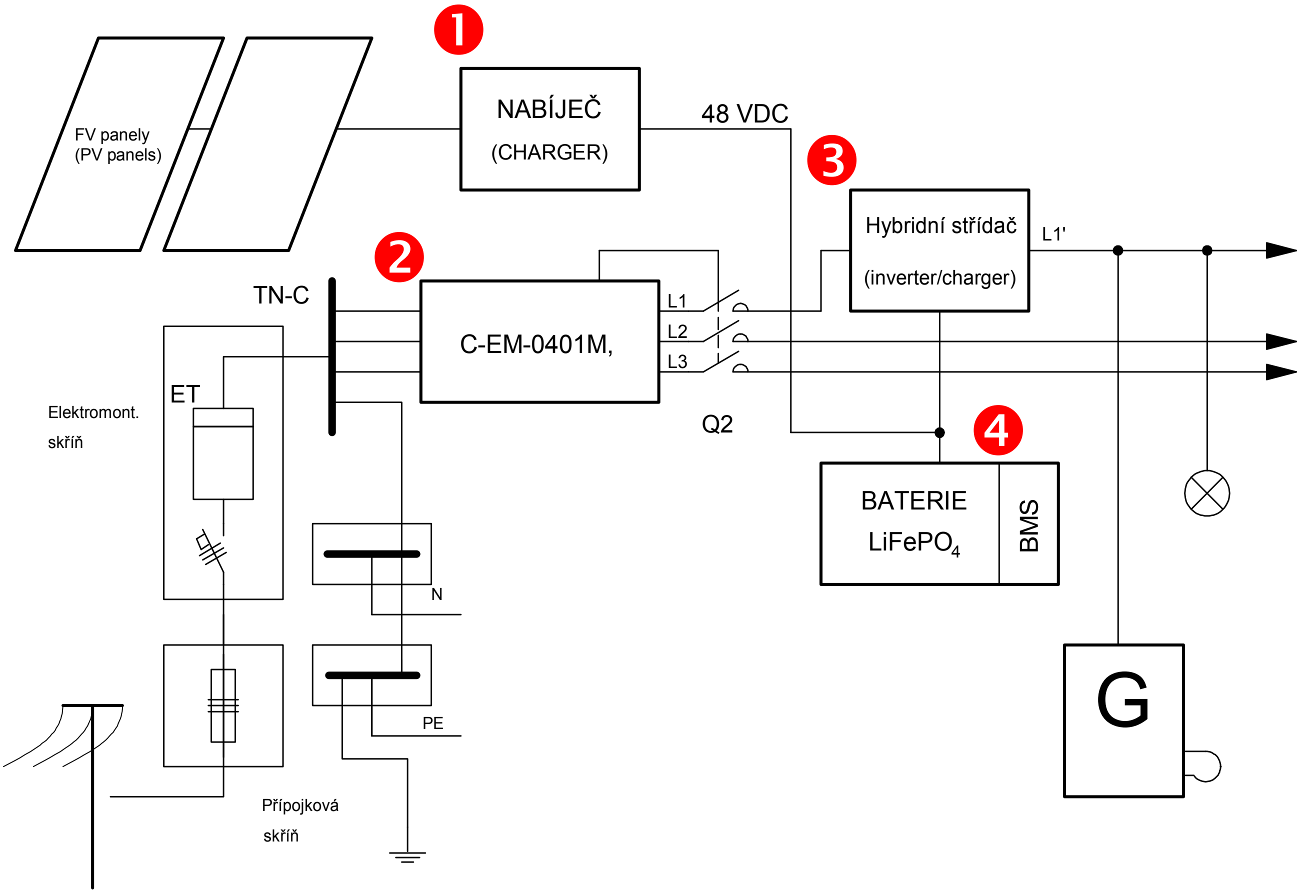


Fig. A basic overview diagram of a typical configuration of 1ph HFVE with DC coupling of PV panels

Basic components for controlling PVPS:

❶ DC/DC charger controlled by the Foxtrot system (communication interface)
❷ 3ph fast four-quadrant electricity meter with the function of protective disconnection in CIB
An ❸ Inverter, e.g. Studer Xtender XTM 2600-48 controlled by the Foxtrot system (the communication interface)
❹ A battery storage site, LiFePO₄ battery, e.g. 48VDC, 100 Ah including BMS (battery management system)

5.1.3 Hybrid system, AC coupling of PV

Basic design of HPVPS using a hybrid inverter and connected PV panels with AC coupling via a standard power inverter - also suitable for existing PVPS. The L1 phase is connected to the hybrid inverter input, and the L1´ inverter output is connected to the power distribution in the supply point. This solution enables the island mode, when the L1´ phase is backed up, based on the inverter output power. In standard operation, the bypass function allows passing significantly higher power through the inverter than its inherent power, and the entire power consumption of the house can be connected to phase L1.In the event of a power failure it is necessary to reduce the consumption according to the maximum output of the inverter - which is one of the tasks of the control system.The hybrid inverter will ensure even in the island mode the network for the function of the network inverter, and at the same time allows charging the connected batteries from the power surplus.

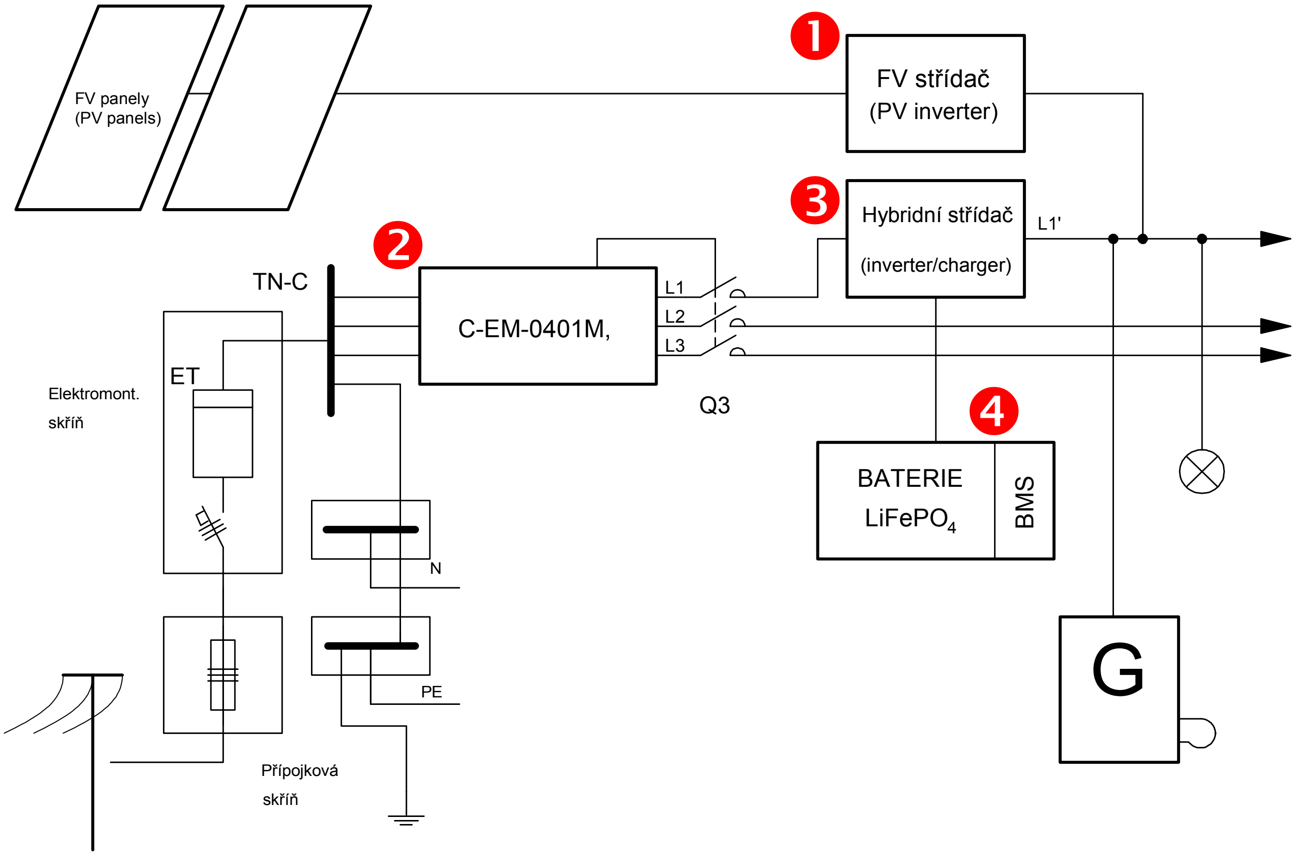


Fig. A basic overview diagram of a typical configuration of 1ph HFVE with AC coupling of PV panels

Basic components for controlling PVPS:

❶ An inverter, e.g. Sunny Boy 2.5 controlled by the Foxtrot system (communication interface)
❷ 3ph fast four-quadrant electricity meter with the function of protective disconnection in CIB
An ❸ Inverter, e.g. Studer Xtender XTM 2600-48 controlled by the Foxtrot system (the communication interface)
❹ A battery storage site, LiFePO₄ battery, e.g. 48VDC, 100 Ah including BMS (battery management system)

5.1.4 Hybrid system with a charger and an inverter

A hybrid connection with the attached PV panels via a DC/DC charger on the battery as well as the DC/AC inverter also connected to the battery. Phase L1´ is terminated in the part of the wiring without a backup, while the L1´ inverter output is connected to electrical appliances with a backup.This solution enables the island mode, when the L1´ phase is backed up, based on the inverter output power. In normal operation the L1' phase is connected to the L1 phase using a bridging relay❺, which makes it possible to cover the whole power consumption of the house. At the same time the inverter can be controlled to make sure that most power from the PV panels is consumed in the house (with limited power of the inverter).In the event of a power failure, it is necessary to reduce the consumption according to the maximum output of the inverter, which is one of the tasks of the control system. This solution does not allow the charging of batteries from the grid.

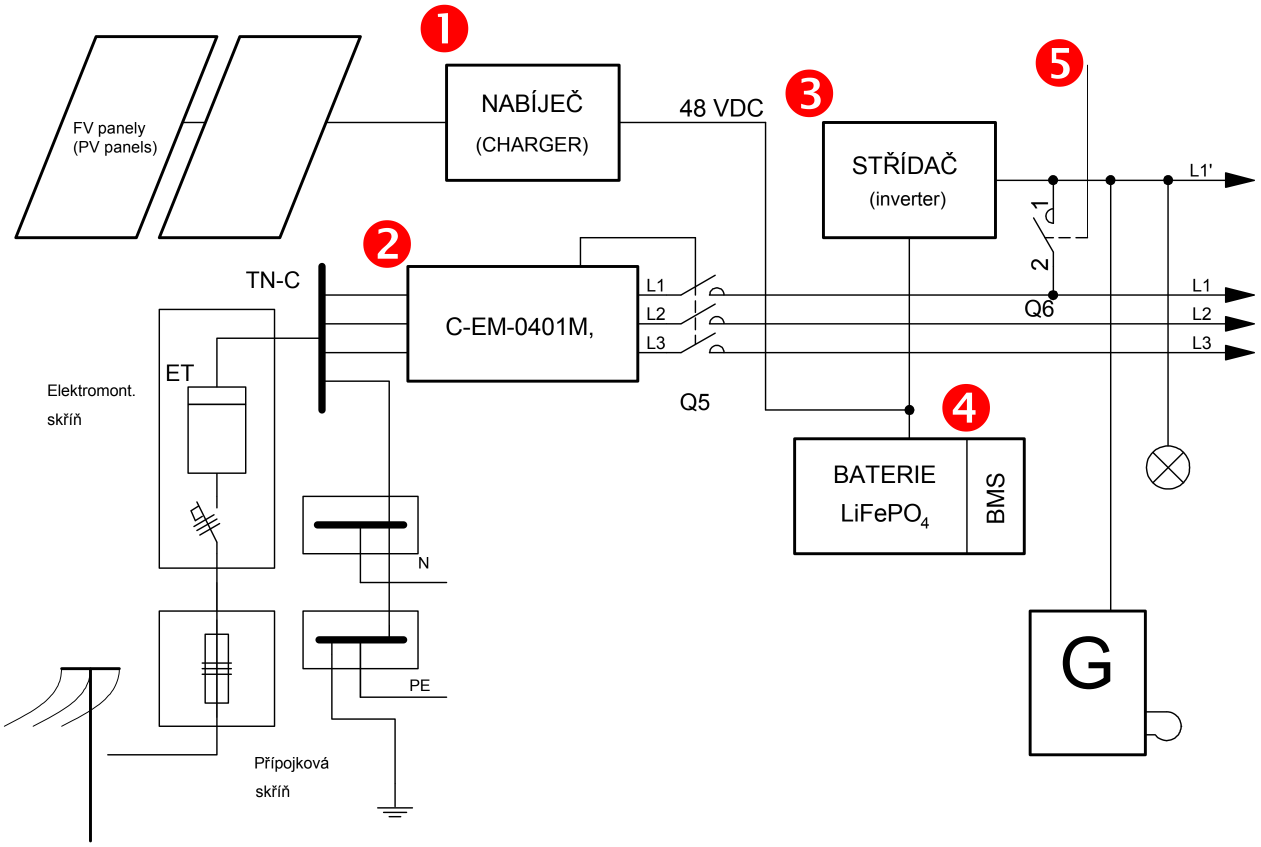


Fig. A basic overview diagram of a typical configuration of 1ph HFVE with a charger and an inverter.

Basic components for controlling PVPS:

❶ A charger, e.g. VONSCH Foto cachreg DC 48 controlled by the Foxtrot system (communication interface)
❷ 3ph fast four-quadrant electricity meter with the function of protective disconnection in CIB
❸ An inverter, e.g. VONSCH foto control 1ph 230/48 DC controlled by Foxtrot system (communication interface)
❹ A battery storage site, LiFePO$_4$ battery, e.g. 48VDC, 100 Ah including BMS (battery management system)
❺ A bridging relay controlled together with the charger and the inverter.

5.2 Basic components of PVPS and H-PVPS

Battery

Energy storage for storing the surplus from the PVPS production and to provide power during a blackout, etc. is provided by a stationary battery.

Battery capacity requirements for this purpose are based on several factors:

The required backup time during a power grid failure.An example of calculation of the appropriate capacity based on the required backup time and the estimate of power consumption of appliances being backed up is presented in the following chapter.

Appropriate capacity with respect to the power of the PV panels. For efficient utilization of energy from PV panels it is necessary to properly dimension the battery capacity. One of the cited possible values is 1.75 kWh in the battery corresponds to 1kWp of the PV panels power.

Another very important factor is the price of the battery, as well as its lifetime and the number of cycles - this is the key technology of the battery itself.

Technology

Considering the lifetime, the number of cycles and operation safety, the $LiFePO_4$ technology has very good results. All other information, diagrams and examples in the text further on that involve batteries are based on the $LiFePO_4$ technology. These batteries reach the lifetime of up to 20 years, from 5,000 to 8000 cycles (depending on the depth of discharge, the speed of charging and discharging). Reaching the quoted number of cycles does not mean that the battery is destroyed - only its capacity decreases to e.g. 80%. They can operate at temperatures below zero (they can be placed in a garage or other unheated areas), they do not require special storage from the safety perspective (they can even be placed in living areas). On the other hand, they are very sensitive to being overcharged or completely discharged, so BMS (battery management system) is vital for their effective operation. See below.

BMS

A battery made up of cells based on $LiFePO_4$ technology requires for its reliable operation (that includes monitoring and balancing each cell) the so-called BMS (battery management system). BMS monitors maximum and minimum voltage and maximum temperature in each cell, thus ensuring that the cell is not destroyed due to its overcharging or total discharging.

MPPT charger

Energy from photovoltaic panels can be fully utilized by the application of a charger with the MPPT function (Maximum Power Point Tracking).A charger with this feature includes a DC/DC converter, which maintains maximum power that

PV panels are able to supply for charging the connected battery (or for further use in the system).The same function is also integrated in conventional and hybrid inverters.

A standard inverter (common PVPS without a battery)

Conventional installations without a battery utilize standard power inverters, which convert the input DC voltage from the connected PV modules into AC 230VAC voltage. They are equipped with the MPPT function (including an MPP tracker), lower power (from 1.5kW to 3kW) usually have the option to connect a string of PV panels, bigger inverters (3 to 5kW) can be connected to two strings.

The power of a standard inverter indicates the maximum number of PV panels that can be connected to its input. Due to legislation and current installations in family houses, the power of inverters ranges from about 2 kW to 5 kW in a single-phase. There is a wide range of inverters available on the market for higher power in three-phase versions, but the following examples will focus on single-phase installations with the above-mentioned power.

The power consumption of the inverter itself is an important parameter both for island systems (where it can significantly reduce the amount of usable energy from batteries), and also for hybrid systems, because even here it represents an undesirable energy loss. Smaller inverters (up to about 4kW) should optimally have their own consumption max. 40W, larger inverters (over 5 kW) then up to 80W.

The maximum efficiency of inverters is about 90 ÷ 98%. The so-called European efficiency definition is even more accurate, as it reflects better the character of sunshine; the best inverters reach up to 97%.

PV panels

According to technology, there is a choice among monocrystalline, polycrystalline and amorphous panels. Compared with the other types, the amorphous panels have an advantage of smaller impact of partial shading of any panel in the string (by a chimney, trees, poles, etc.), but their efficiency is smaller and, as a result, they are more expensive.

The monocrystalline panels have a better efficiency if they are precisely positioned to face the sun and in direct sunlight, while the polycrystalline ones work better even when their position is not ideal and it is cloudy. There is not a significant difference between them in standard stationary applications on the rooftops.

An example of a PV panel:

The Axitec AC-250P polycrystalline panel, the parameters at 1,000W/m2, temperature 25°C:

Nominal power 250Wp

Nomimal output voltage 31.45V

Nominal current 7.98A

Efficiency 15.37 %

Placement of the panels.

The optimum tilt for the best year-round performance is the 35° angle facing south. The tilt of up to 45° provides a slightly lower performance in single-digits of percent.

If using two strings, it may be advantageous to locate one string facing SW and the other facing SE; the distribution of power throughout the day will be more uniform.

Decreasing the efficiency due to heating of the panel. The normal value of the temperature coefficient of the panel is 0.47% / °C, so in summer its performance may fall by more than 10%, while in winter it increases (the performance parameters are typically given by the manufacturer at the temperature of 25 °C).

5.3 Calculations and parameters for the design of the PVPS and H-PVPS

5.3.1 An example of power gains of a 3kWp PVPS

The following example shows anticipated profits from PV panels in the case of the optimum installation. The table shows the daily and monthly performance of the PVPS and the values give you a more accurate idea of how the given assembly can be utilized.

The rated power of a 3.0 kW PV system (conventional polycrystalline PV panels)

Basic parameters of the selected PVPS

Installation	CZ
azimuth	°0
panel tilt	35°
estimated total system losses (inverter, wiring,etc.)	10%
The annual sum of global radiation	1,260 kWh/m^2
Average annual production of electricity from the system	3010 kWh

The estimated annual balance of the PVPS

Month	Daily production in[kWh]	Monthly production in[kWh]
January	2.38	73.7
February	4,65	130
March	9.09	282
April	12.40	372
May	12.40	384
June	12.0	377
July	12.0	387
August	11.0	363
September	9.40	282
October	6.52	202
November	2.98	89.
December	2.07	64.
Average annual value	8.24	251
Total annual production		3010

5.3.2 A model estimate of the minimum consumption of the house during a power outage

The table below shows a possible method of calculation of the design of a battery storage with the requirement of at least minimum backup of the required part of the house wiring for a required time.
In order to design the system you need first the required battery capacity in kWh, and second, the maximum instantaneous power of the system (inverter), so that reliable operation of the backup can be ensured.
Individual appliances, their power consumption and run time are usually estimated, so it is appropriate to count with a margin.

Electrical appliance	Power consumption during operation	Running time estimate within 24 hours	Consumption estimate within 24 hours
Fridge	100W	8	0.8kWh
Router Wifi, AP internet	15W	24	0.4kWh
Gas boiler (during the heating season)	140W	12	1.7kWh
Desktop PC	150W	1	0.2kWh
Radio	20W	6	0.1kWh
LED TV	45W	2	0.1kWh
Lighting (in summer)	120W	3	0.4kWh
Lighting (in winter)	120W	7	0.8kWh
electronic security system, cameras	50W	24	1.2kWh
Control system	50W	24	1.2kWh
Immediate consumption (in summer)	550W		
Immediate consumption (in winter)	690W		
In total (in summer)			4.3kWh
In total (in winter)			6.4kWh

You can see from the table that in summer - when no backup of the heating system is considered, heating water and cooling is not planned - in the above-stated example the calculated capacity of the battery is 4.3 kWh; if you assume discharging it to about 20% of its capacity, then a 5kWh battery would suit for this purpose.
Typical values for a continuous power of the inverter around 2,000 VA would suit for this purpose without any problems.

5.4 Connecting inverters and chargers

The following chapter gives examples of connection of some inverters, hybrid inverters and control units to the Foxtrot system via direct communication interface.
Another option is to integrate the Solar Monitor module, which is described in the section below.

5.4.1 Connecting the STUDER XTM hybrid inverter

The hybrid inverter Studer Xtender XTM Series is a typical representative of hybrid inverters. It is made in a number of variants according to the required output power and the voltage of the connected battery. A typical example is the XTM 2600-48, which has a continuous output power 2,000VA, nominal voltage of the battery 48V and an inverter with a high flow current at 50A (from input to output).
The inverter is connected to the Foxtrot system via the RS-232 interface using the Xcom-232i communication module, which is connected with the inverter via the Com.Bus interface (equivalent to the CAN bus). Multiple inverters can be connected to the communication module, so it is possible to implement e.g. a three-phase assembly, inverters arranged in parallel, etc.

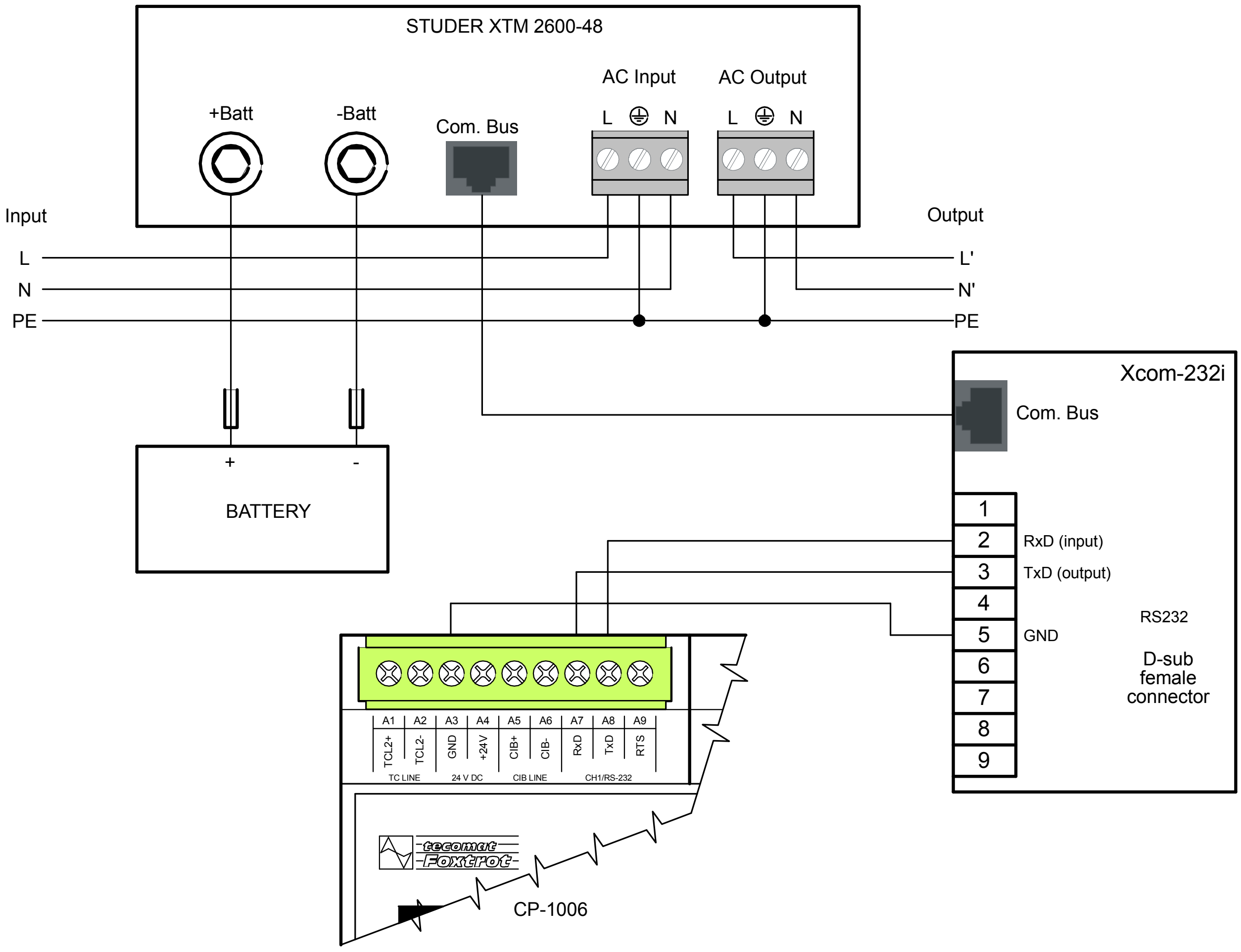


Fig. The basic connection of the Studer XTM inverter to the Foxtrot system

Notes:

1. In the Foxtrot system you can use any communication channel with the RS-232 interface, with max. cable length 15m, with a recommended cable RS-232.
2. The cable of the Com.Bus interface can be up to 300m long.

5.4.2 Connecting the charger and the VONSCH inverter for hybrid connection

If you want to implement a hybrid connection of the charger from PV panels to the batteries and the inverter with the 230VAC output, there is available the PHOTO CHARGER DC 48 with the FOTO CONTROL 1ph 230/48 DC inverter made by VONSCH.The charger has a continuous output of 3,000W to 48V batteries with the U_{MPPT} range from 200 to 550V_{DC}, and the inverter has a continuous output power 2,000VA and 48V nominal battery voltage.
Both modules are connected to the Foxtrot system via the RS-485 interface. Multiple inverters can be connected to the communication module, so it is possible to implement e.g. a three-phase assembly, inverters arranged in parallel, etc.
The diagram below shows the wiring of the communication part of the modules; there is not a complete connection of the assembly with respect to synchronization with the network, etc.

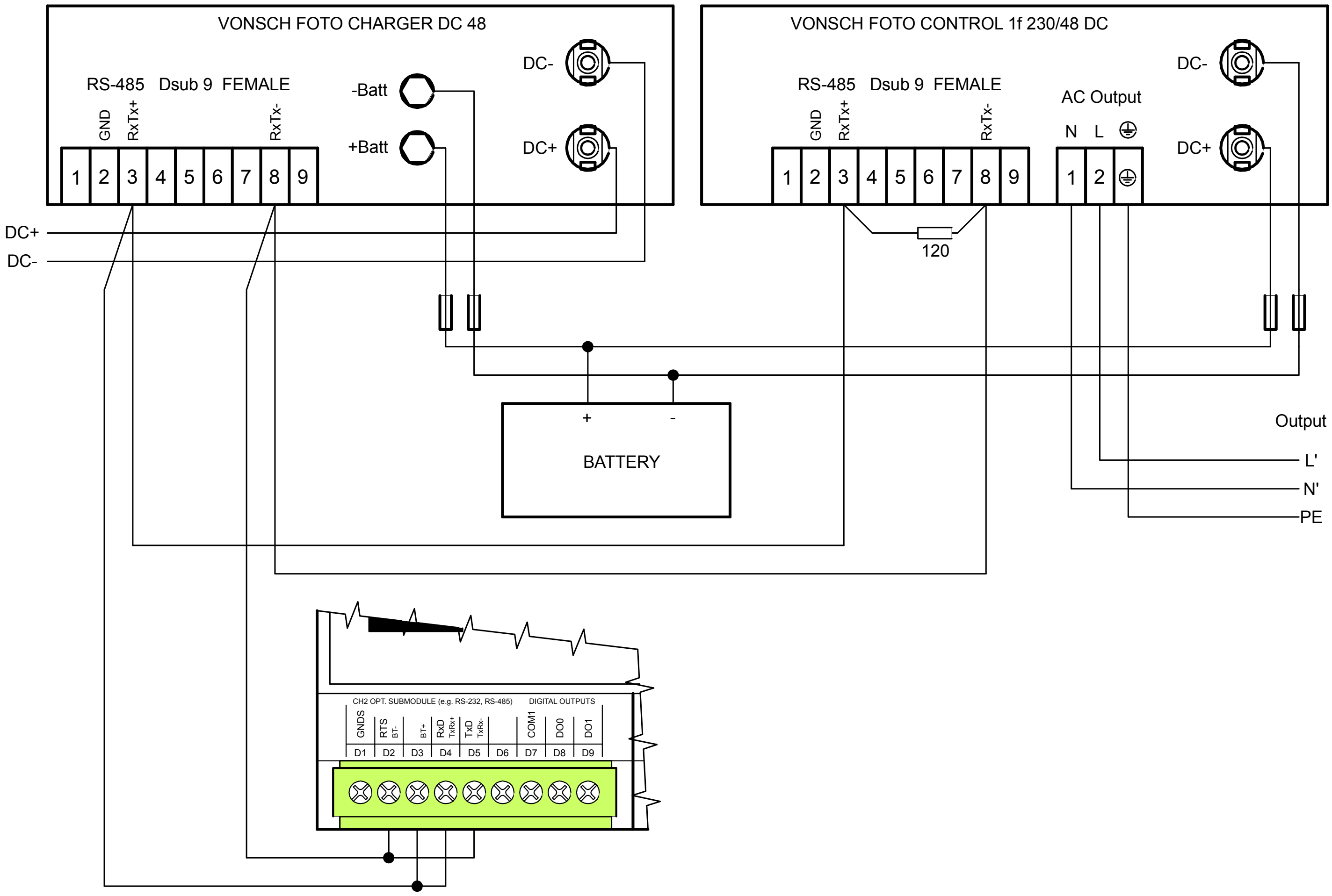


Fig. The basic connection of the VONSCH inverter and charger to the Foxtrot system

Notes:

1. In the Foxtrot system you can use any communication channel with the RS-485 interface, with max. cable length 1,000m, with a recommended cable RS-485.

5.4.3 Monitoring and controlling PVPS inverters, Solar Monitor

The Solar Monitor system, a product of a Czech company Solar Monitor Ltd. (www.solarmonitor.cz) is designed to supervise, to continuously monitor the inverters, to read errors, and to read operational data. In cooperation with the control system it offers complete control of active and reactive power in accordance with the applicable legislation. In order to integrate the Solar Monitor, the Foxtrot system features a library FB SolarMonitorLib.

The SM2-MU in the Solar Monitor Basic version is designed to connect one inverter, and it is suitable for rooftop applications on family houses, and for similar smaller installations.

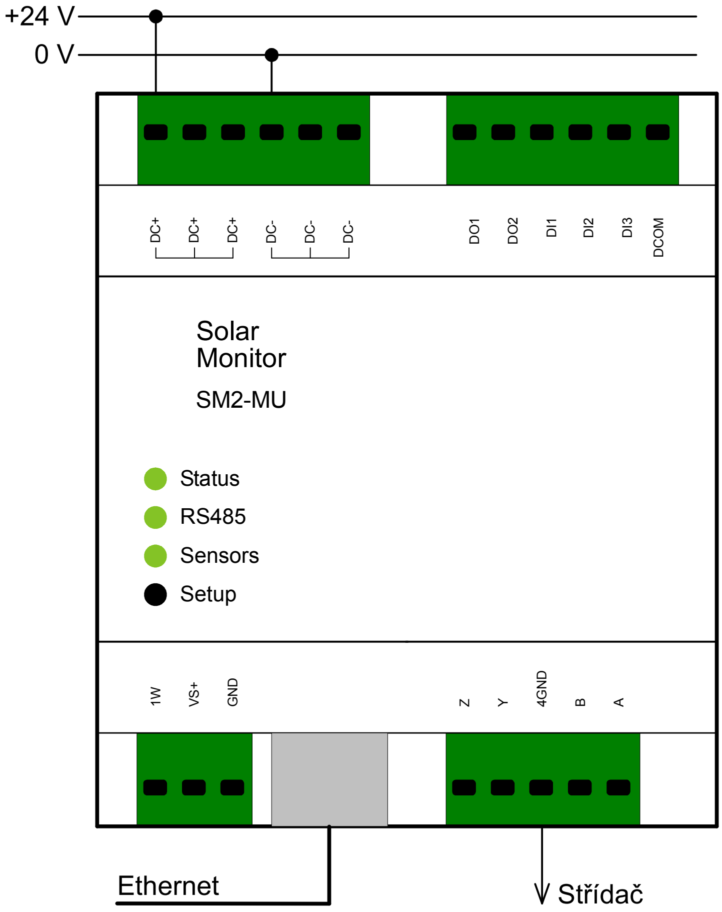


Fig. The basic connection of the SM2-MU (Solar Monitor) module

Basic parameters of the Solar Monitor module

Ethernet	RJ45 (100BASE-T)-100Mbit/s
Interface for connecting the inverter	2 x RS485 or 1 x RS422 (software selectable)
Supply voltage	9 ÷ 35VDC
Power consumption	max. 3W
Dimensions	71.6 x 89.7 x 62.2mm
Operating temperature	0 ÷ +70°C
Terminal block	0.5 mm² - 1.5 mm²

5.5 BMS, connecting the batteries to the system

5.5.1 The **C-BM-0202M module for charging and protection** control of **LiFePO$_4$ batteries**

The C-BM-0202M module together with balancing mini-modules B-BM-0201X placed on individual battery cells enables the BMS function (battery management system) of LiFePO$_4$ batteries in the CIB version of the periphery module.

The C-BM-0202M module is equipped with an inputfor measuring the battery current using the Hall sensor,, with a terminal block for connecting its own mini-modules monitoring and balancing individual cells of B-BM-0201X and two relay outputs designed for an emergency disconnection of the battery and charger independently of the control system.

TheB-BM-0201X sensor of the cell is mounted directly onto the battery cell, the module measures the temperature and the cell voltage, communicates with the C-BM-0202M module via special busi and also controls the resistance load for balancing the cell during charging or discharging.
The B-BM-B-0201X and B-BM-0201X models are designed for Winston batteries with the capacity from 90Ah to 200Ah (information on different capacity or another manufacturer of batteries are available on request).

The balancing control itself and protection of each cell is controlled by a function in the Foxtrot system application programme. There is also available detailed archive of data that makes it possible to monitor the quality of individual battery cells.

A balancing module for the Winston B-BM-0201X batteries

Basic parameters of the B-BM-0201X module

Supply voltage	2.3 ÷ 4V
Measuring temperature range:	-40 ÷ 125 °C
Temperature measurement error	±1°C
The voltage measurement range	2.3 ÷ 4V
The voltage measurement error	±1 %
Balancing power	5W
Idle consumption	17mA
Compensating current at U_{bat} = 4 V	1.25A
Galvanic isolation of the communication	Yes
Assembly	An M8 screw hole
The maximum number of links in the chain	16

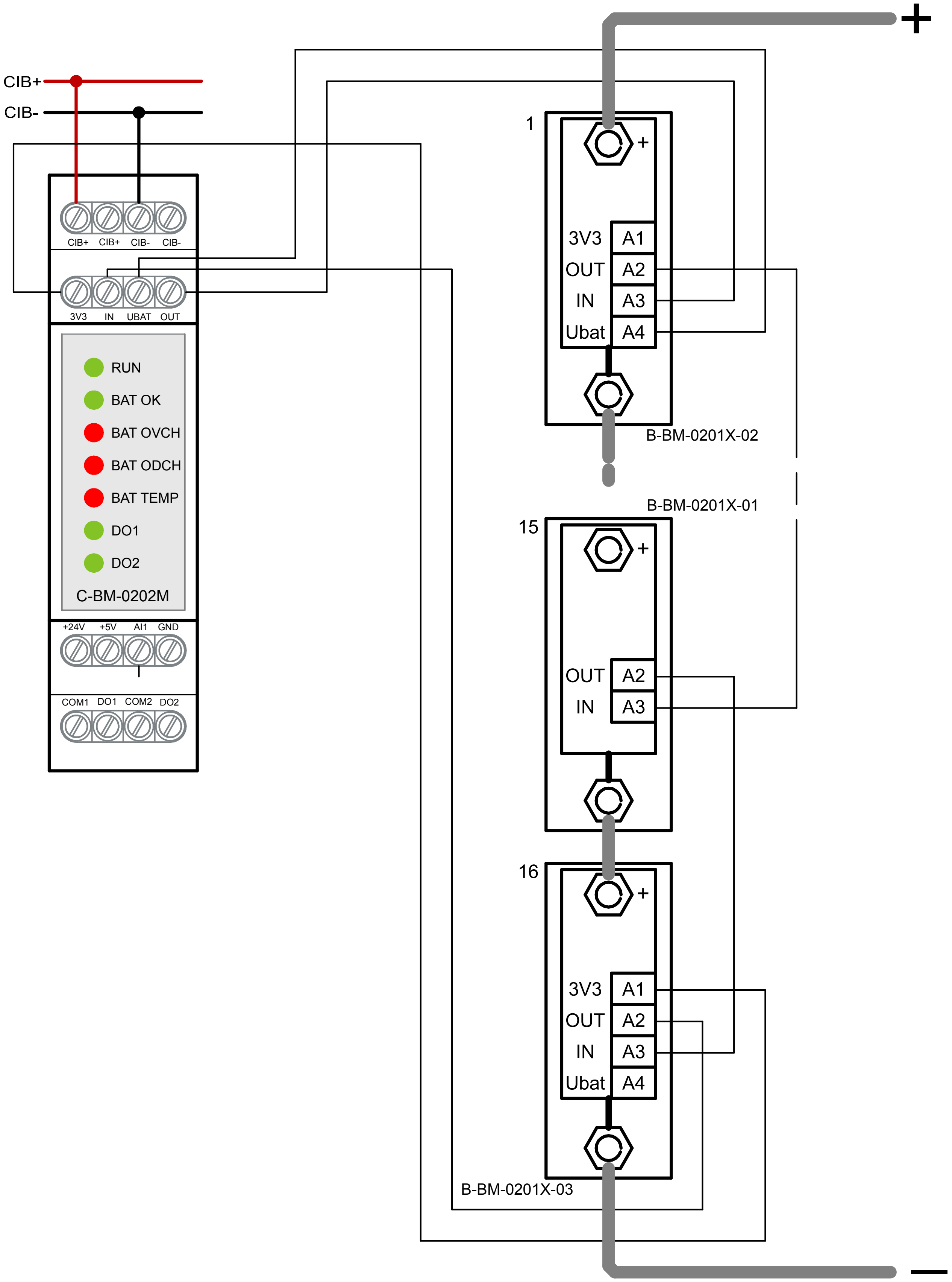


Fig.5.5.1 1 An example of connecting the C-BM-0202M and the B-BM-0201X-01 modules with Winston batteries.

Notes:

1. Interconnection of the communication line among individual modules is done using a wire with a solid core, or a stranded wire fitted with ferrules at both ends, with 0.5 ÷ 1.5 mm^2 cross-section (you should always connect the OUT terminal of one module to the IN terminal of the next module).
2. The maximum length of the bus connecting all B-BM-0201x modules with C-BM-0202M modules is about 3m.
3. The outside modules are connected with 2 wires (see the previous point) to the C-BM-0202M module.
4. If the communication among the modules is working properly, the red LED indicator on each module constantly lights. If communication is lost, the LED indicator on the modules flashes with one-second intervals.

The B-BM-0201X modules are normally supplied in sets of 16 pieces for batteries with a nominal voltage of 48V.
The first battery cell (shown in the Figure with number 1) is fitted with the B-BM-0201X-02 module, the last cell (no. 6) should be fitted with a module with the designation B-BM-0201X-03 and 14 other cells should be fitted with modules with the designation B-BM-0201X-01 (they have only two terminals in the terminal block). The modules should be interconnected by one insulated wire as shown in the example, and the first and the last module should be connected to the C-BM-0202M module.
The mini-modules are attached onto the cells as shown in the following figure.

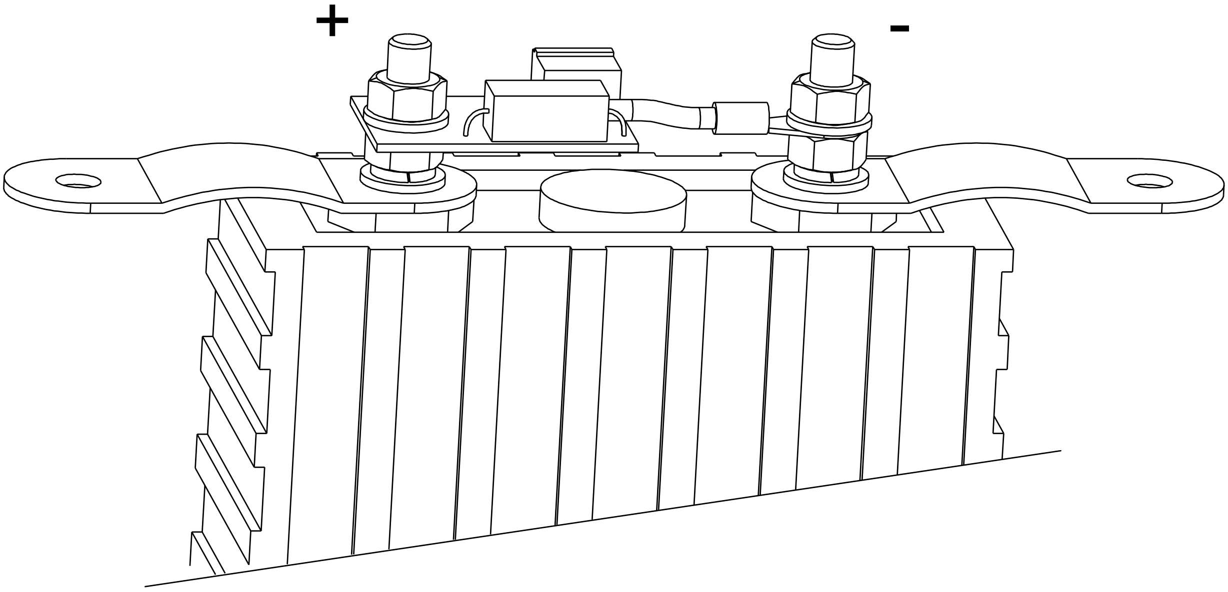


Fig. 5.5.1**.2 An example of mounting the B-BM-0201X module onto the Winston cell**

5.6 Controlling of internal consumption from the PVPS production

Efficient operation of PVPS or H-PVPS in standard installations (rooftop installations on houses) require the best possible immediate use of the electricity produced.

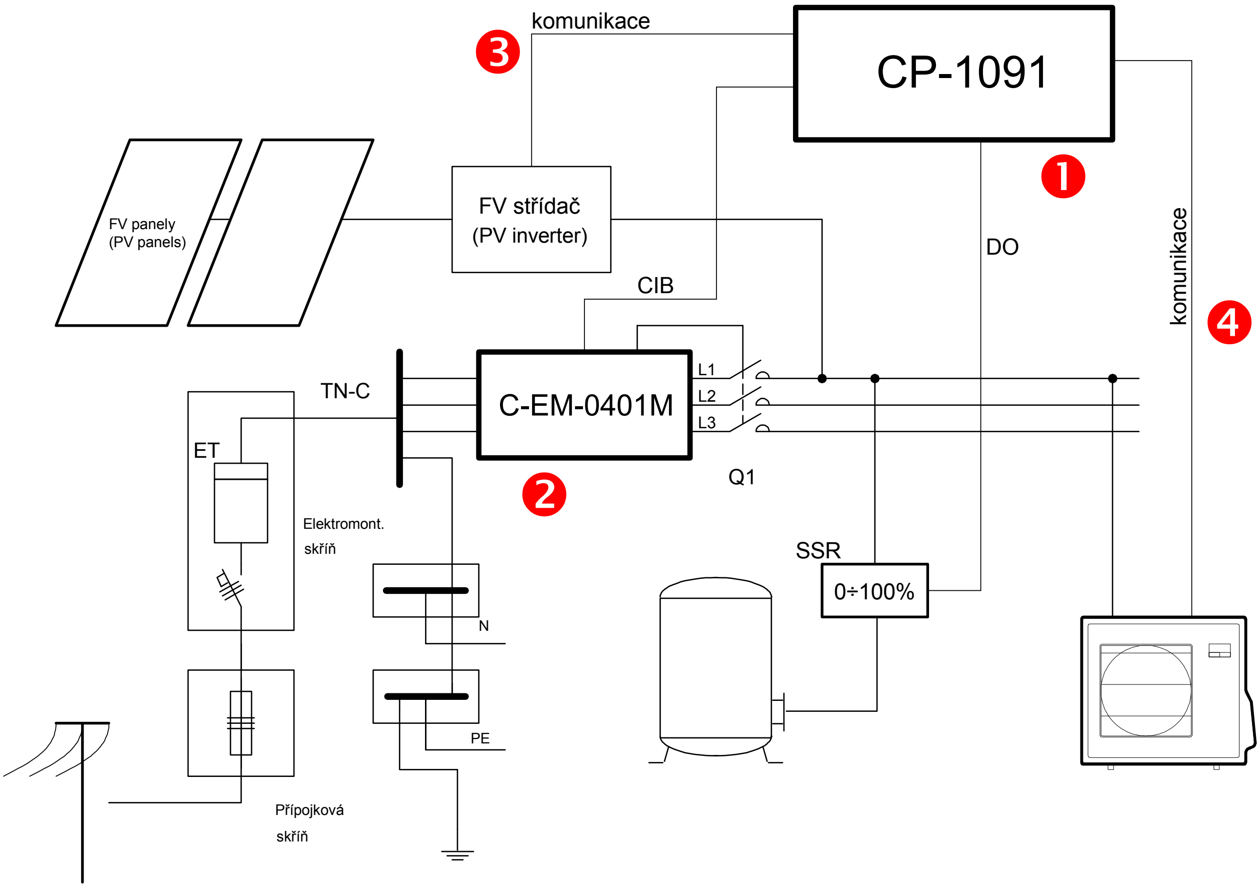
The simplest, but often limited from the energy point of view, is using the energy produced for heating utility water. The second option is to heat the water in the heating system (e.g. controlling a part of performance of bivalent source of the heat pump). Effective control requires fast regulation of the heating power, in this case by controlling the power of resistive loads. Other examples deal with controlling the load in the range of 1 to 2 kW. The best option, which is also the most expensive one, is the amplitude performance control; another possibility is the phase control of the power, and the simplest - but in terms of an impact on the network, the worst option - is using the elements of solid-state relays (SSR) switching at zero crossing.All these variants are listed in the following chapters.

The following example shows a connection, which even in a simple assembly provides a tool for quality control of the utilization of energy produced by the PPL and similar sources. It provides fast control according to the current power consumption of the supply point for single-phase and three-phase assemblies (basic control cycle is 200ms), with high-precision measurement of energy; the system also enables controlling with respect to the active and reactive component.

5.6.1 Connecting the CP-1091 for effective control of electricity produced by PVPS and H-PVPS

The basic variant of Foxtrot for these applications is the new module CP-1091, which is fitted with up to nine outputs for direct continuous control of electric heating, and 3 outputs for switching loads; it is possible to connect up to 6 S0 outputs from electricity meters, pulses from water and gas meters and other similar signals. The module can directly measure temperature from up to 6 connected sensors.
It is fitted with the CIB bus, which is used for connecting the C-EM-0401M fast electricity meters and other modules - such as the solar radiation sensor C-IT-0200-SI. The TLC2 master bus is also available for further extensions. At the same time, the module is fitted with the RS-485 interface for connecting e.g. an FVE inverter, and it can also be equipped with up to 3 additional serial channels - e.g. for controlling a heat pump or an air conditioner.

In order to control power consumption in grid-tie PV systems, you can use in a number of installations the CP-1091 basic module (1) with an attached fast electricity meter (2), which directly controls the power semi-conductor relays switching electric water heating (see the Fig. below). Effective control can further be aided by direct communication with the PVPS inverter (3), and also with a heat pump or air conditioning system, if available (4). The CP-1091 module can also switch a variety of other appliances, irrigation system pumps, etc., via other outputs, and it can meeter and monitor other media (water meters, etc.). This assembly will allow you to implement a number of installations of grid-tie PVPS both for smaller applications, such as family houses, small businesses, and also for larger network installations with several three-phase heaters and 3-phase PVPS.
If you add e.g. the C-EV-0302M module, the resulting assembly can moreover efficiently and effectively charge one or several electric vehicles. In this way a number of additional modules can be added, and the related controlled and monitored technologies.



Basic diagram of the Foxtrot system for controlling electricity produced by grid-tie PVPS.

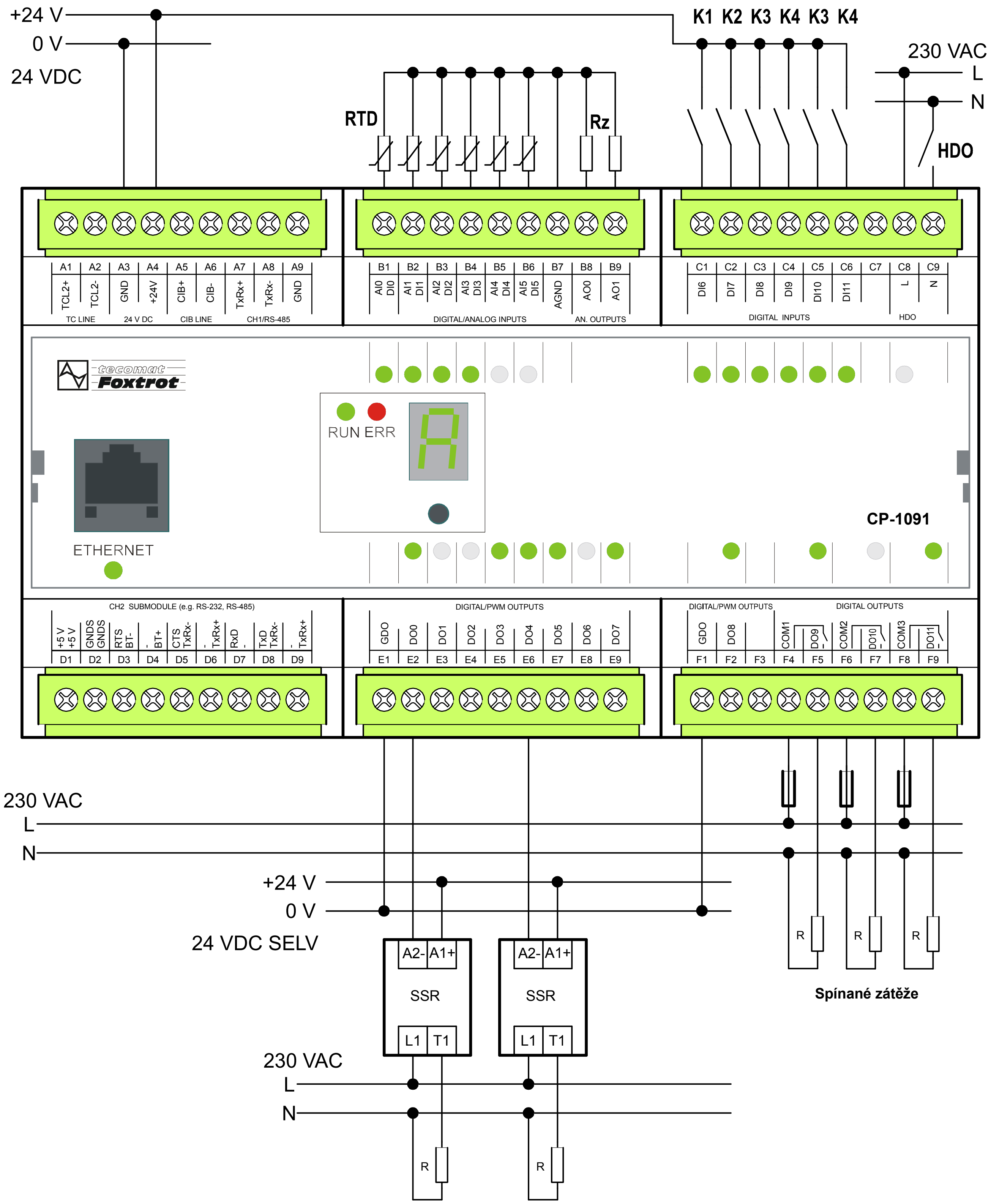


Fig. 5.6.1.1 A basic example of wiring the CP-1091 module and externích SSR relays

Notes:

1. Identical wiring of the outputs (SSR relay) applies to DO0 to DO8 (only DO0 and DO4 is shown in the example for the sake of clarity).

5.6.2 Continuous power control of electric heating, phase control of resistive loads

The phase power control into resistive loads up to 1,000W (it can be extended up to 2,000W) can utilize a standard peripheral module from the C-DM-0402M-RLC system designed primarily to dim bulbs; for a wiring example and further information, see Chapter: 6.8.2 Dimming incandescent bulbs with rated input up to 2 kW

5.6.3 Continuous power control of electric heating, amplitude control of resistive loads

The SRVS 10/230AC electronic continuous power control unit can be used for continuous power control into resistive loads, which makes it possible to control resistive loads up to the maximum output current of 10A. The output voltage of the control unit has a continuous sinusoidal shape with a variable amplitude.

Exact examples of wiring and further information is being prepared.

5.6.4 Continuous power control of electric heating of water, the SSR module

Continuous power control into resistive loads, e.g. heating cartridges in hot water storage tanks, can utilize the SSR modules; e.g. the RGS1A23D25 module is suitable for outputs of up to about 3kW module. It is controlled by PWM output of the system - in the example the C-IR-0203M module is used. The module allows switching of 2 heating coils and the third can be continuously controlled by the PWM output (this results in continuous control within the range of 0 to 3 kW for three 1kW spirals) and at the same time it enables measuring of up to two temperatures - e.g. the temperature in the accumulation tank needed for optimal temperature control of hot water.

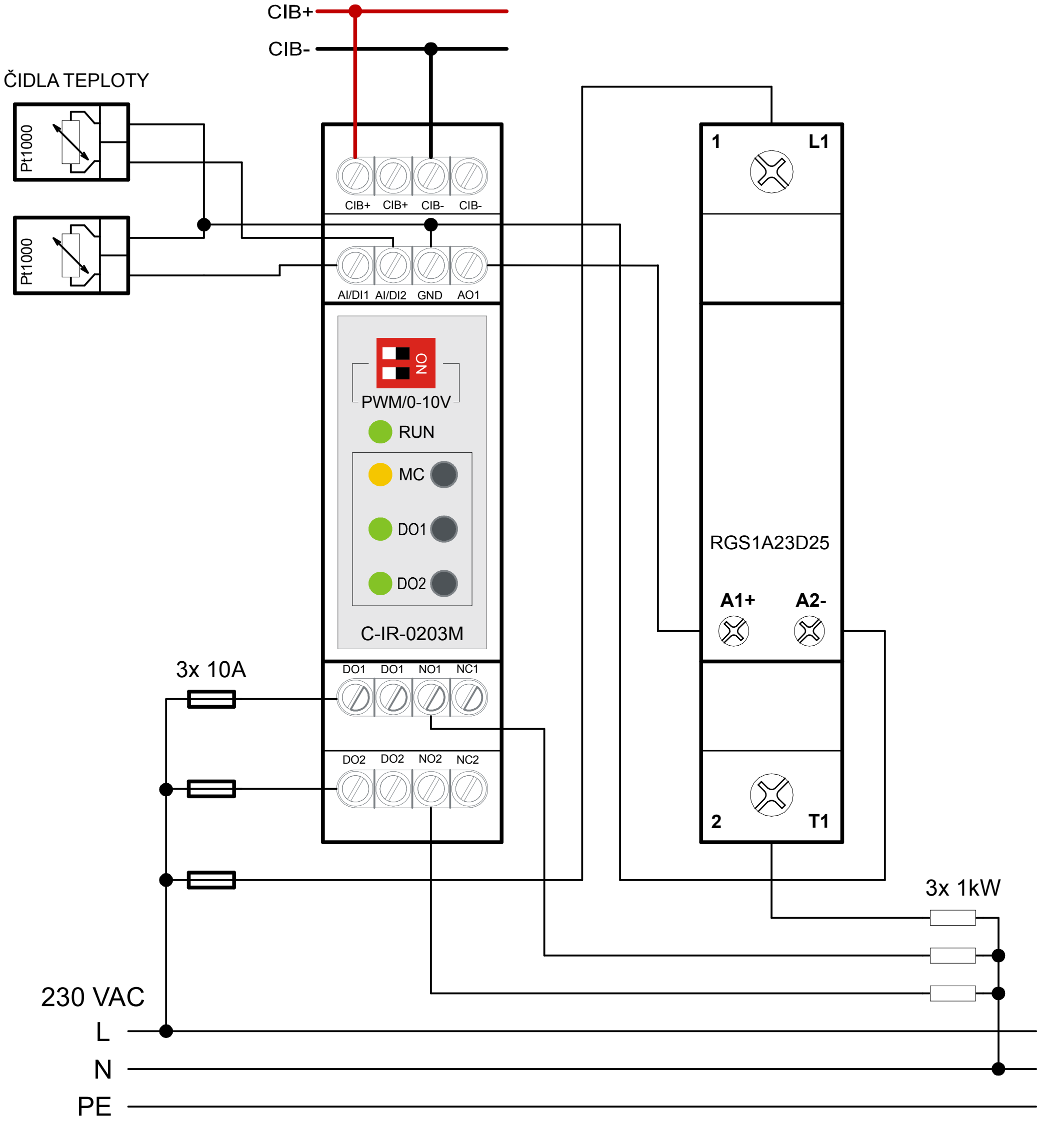


Fig. An example of continuous control of resistive loads (electric heating of water)

Notes:

1. The SSR module switches and disconnects at zero, which is positive for minimizing interference, but it impairs a possibility of continuous control, and also increases the risk of rapid voltage changes (the so-called flicker) caused by a long period of PWM, which can cause negative visual perception.
2. More precise power control into resistive loads (max. 1kW, or 2kW) makes it possible to use also the C-DM-0402M-RLC module.
3. Before installing the SSR modules, it is necessary to take into account their own considerable heat loss, which can limit the maximum switching capacity (according to the module manufacturer´s data).
4. The example shows a connection, in which the 0 ÷ 3kW load is continuously controlled on one

phase.

5.7 Heating water

Heating water is one of the very important parts of family houses and other buildings technologies from the point of view of energy consumption. Many solutions and types of equipment are used for its heating.

When water is heated by the solar system (solar thermal collectors), the Foxtrot system direct control can be advantageously applied; in addition to monitoring the functions (smart phones, tablets, etc.), remote monitoring, etc., it also facilitates measuring the gained heat energy and an intelligent link to other systems of heating or preheating water. E.g. when a solar system for preheating water is being installed, it is appropriate to control the related electric water heater to avoid e.g. unnecessary heating of water by electricity when the consumption is small, or when the water in the solar system tank is hot, etc.

Another possibility of reducing energy consumption is smart control of a standard electric storage water heater, for which there will be available support (hardware and software) in the Foxtrot system. Manufacturers of heaters gradually introduce on the market (in accordance with European legislation) the so-called smart boilers, which we would also like to incorporate in the control system, mainly with the optimum usage of other systems of heating or preheating water in mind (e.g. preheating by the heat pump).

Water heating control (charging accumulation tanks) is also important in installations that include solar panels. Here is recommended the option of continuous power control of the heating bodies. An example of this solution is presented in Chapter 5.6 Control of PVPS internal consumption.

5.7.1 Solar water heating

Solar thermal systems for heating water can be easily controlled directly by the Foxtrot system. No autonomous regulation is necessary; you can use directly the temperature sensors (collector, tank) connected to the analogue inputs of the Foxtrot system; the circulation pump is controlled directly by Foxtrot, and valves can also be controlled.

Selecting and connecting temperature sensors described in Chapter 10. During the selection you must take into account the thermal requirements on the collector temperature sensor and the correct placement of the temperature sensor in accordance with the specifications of collector manufacturers. For measuring the temperature in the storage tank, it is possible to use a common design of cable sensors, or sensors with a stem (as a standard, the tanks are equipped with immersion sleeves).

The circulation pump can be switched either by a standard relay output, or semiconductor outputs DO1 and DO2 can be utilized, which are equipped with the Foxtrot basic modules CP-10x6 and 10x8-CP; they allow a certain extent of control of the circulation pumps speed - see figure below.

For the control itself you can use the FB in Mosaic environment, or in the case of a specific installation (several tanks, heating, etc.) the application can be programmed as needed. The system can also be supplemented by measuring the gained heat.

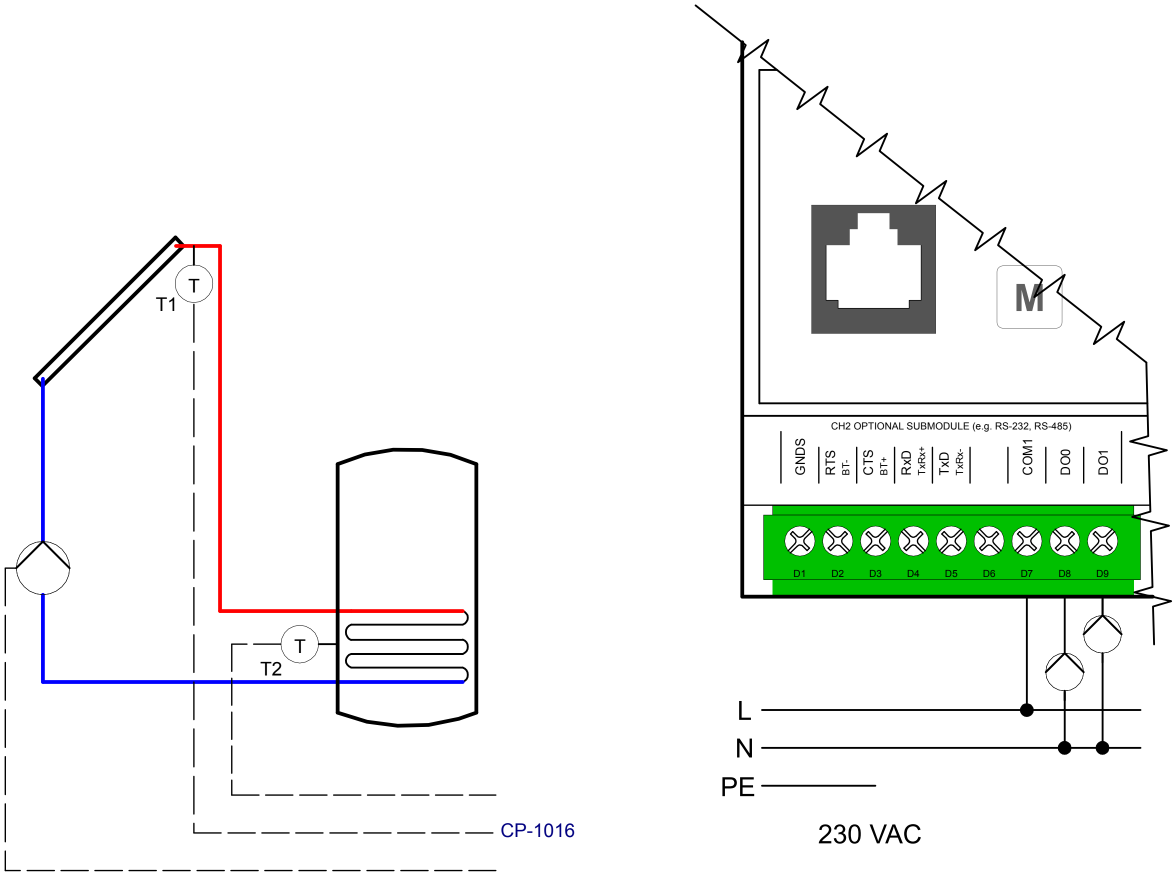


Fig. 5.7.1.1 An example of connecting the circulation pump to the CP-1016 basic module.

Notes:

1) The figure indicates the connection of up to two pumps with an asynchronous motor with a possibility of speed control (max. pump power consumption is about 140W.
2) The temperature sensors shown in the diagram should be connected to the CP-1016 module analogue inputs, or to any CFox module with suitable inputs for temperature measurement.

5.8 Charging control of electric vehicles

Charging electric vehicles
If you want to use an electric car as a business or private vehicle for frequent short trips - which is probably the most effective use today - you usually need to charge it directly at home, in the company, at the office, and for this purpose it is convenient to charge it with alternating current from the grid - from the owner’s supply point. This allows you to charge the vehicle continuously overnight, using the energy from the installed PPP, etc., but in order to charge the vehicle effectively, the process must be coordinated with other power consumption. The main circuit breaker must not be overloaded, the PVPS power should be optimally used and the electric vehicle should be charged as soon as possible.
www.wině.cgí
The need to control charging is even more evident when several electric vehicles have to be charged simultaneously, with a possibility of prioritizing, etc.

The Foxtrot system supplemented by the C-EV-0302M module can control the charging of one or several electric cars, depending on current operation of other electrical appliances, production of PVPS, the contracted consumption curve, and the like. The system monitors by the C-EM-0401M fast sub-meter the current power consumption in each phase and according to a pre-set maximum value, or according to instantaneous surplus of the PVPS production, possibly other requirements, controls via the C-EV-0302M module instantaneous charging current of the connected electric vehicle. The system has also information about the electric vehicle that is connected and it can monitor the supplied power and thus provide basic information about the charging status of the vehicle. At the same time it evaluates possible fault conditions, it can terminate or suspend charging at any time, etc.
All data can be stored, displayed locally or remotely, so there is always available an overview concerning the state of charging, even a possibility of intervention (e.g. to control charging when multiple vehicles are connected) for selected users.

The IEC 61851-1 standard distinguishes 4 modes of charging electric vehicles (EV):

1) AC charging, using a standard socket, typically 230V, it can also be 3x400V; it is significantly limited by a maximum current (max.16A, but usually only 8-10 A), a cable with no communication. Simple, but with limited power and without a possibility of controlling the charging.

AC charging, using a standard 230V socket or 3x400V, maximum 32A, the cable is fitted with a control of maximum charging current via the Control Pilot signal. It makes it possible for you to manually adjust the maximum power of charging, but it cannot be controlled according to the load of the supply point.

3) AC charging, 230V or 3 x 400V, max. 32A, a special charging device connected to the grid comprises charge control circuits and protection circuits; it is fitted with a special socket and a cable with a termination designed for the connection to an electric vehicle. This concept allows a smooth control of charging according to the loading of the supply point, including reverse diagnostic of the connection and the charging of the vehicle; **this is the variant that the examples are based on.**

4) DC charging, using a special DC charger with high power (the “CHADEMO” DC charger with the power up to 62.5kW, is used e.g. by Nissan Leaf).It requires a special costly charger, sufficient power of the grid, and it is suitable rather for fast public charging station.

The IEC 61851-1 standard distinguishes 3 modes of connecting electric vehicles for charging:

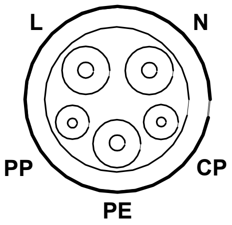
A) A connection with a cable, which is firmly terminated on the side of the electric vehicle and on the other end it is terminated with a plug that is put into a standard socket, or into the socket of charging equipment.

B) A connection with a cable, which is terminated at both ends with a connector (a plug, a socket).

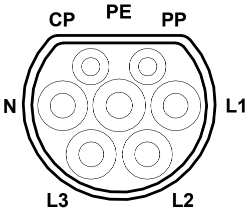
C) A connection with a cable that is firmly installed on the side of the charging device, and on the side of the car it is terminated in a plug. **The following examples deal with this option**.

Electric vehicles are fitted with several types of sockets, which differ with their charging power and voltage; they can be simply divided like this (the figure shows the termination from the front - from the "side of the car"):

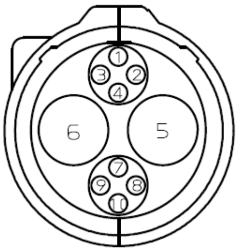
Type 1 (in accordance with SAE J1772 and IEC 62196-2) is a single-phase socket with additional contacts PP and CP. Maximum current is 32A, 230VAC. It is used by e.g. Nissan Leaf. Designated for charging from a standard grid with a possibility of utilizing the charging device that controls maximum current drawn by the EV.



Type 2 (in accordance with IEC 62196-2) is a three-phase socket with additional contacts PP and CP. Maximum current is 63A (in single-phase applications up to 70A), max. 500VAC. Designated for charging from a standard grid with a possibility of utilizing the charging device that controls maximum current drawn by the EV.



DC charging (CHADEMO, DC Combo…). For DC fast charging when using special charging stations.



The PP and CP signals (in accordance with the IEC 61851-1 standard) serve both to inform the electric vehicle that it is connected to the charging device (the PP signal) and it also allows you to control the charging current (the CP signal) - i.e. you can control the charging current of the vehicle based on the instantaneous available power given by the number of other appliances switched on at the supply point, so as to achieve the fastest possible charging while staying within the limits of the circuit-breaker as to the maximum current drawn. Charging can also be controlled based on the immediate power output of the local PVPS (minimizing the costs), etc.

5.8.1 Controlling 1ph charging of an electric vehicle by the EV-C-0302M module

The following example shows a basic wiring of the charging station for alternating current from the 230V grid, in a single-phase design using the C-EV-0302M module.
The example shows the Type 1 single-phase charging connector (in accordance with SAE J1772 and IEC 62196-2), which is used e.g. by the vehicle Nissan Leaf.
I dentical connection of CP and PP signals and the power supply control is also valid for other types of connectors for AC charging (eg. the 3-phase Type 2, etc.).
The module for charging control utilizes the CP (Control Pilot) signals and PP (Proximity function) signals in accordance with the EN 61851-1 standard. The module controls the mains voltage presence by the DO2 relay output; it switches a power contactor that connects the mains voltage to the charging cable.

This example shows a full connection, which can be implemented in various mechanical ways according to the location (inside or outside the building), and based on other requirements.

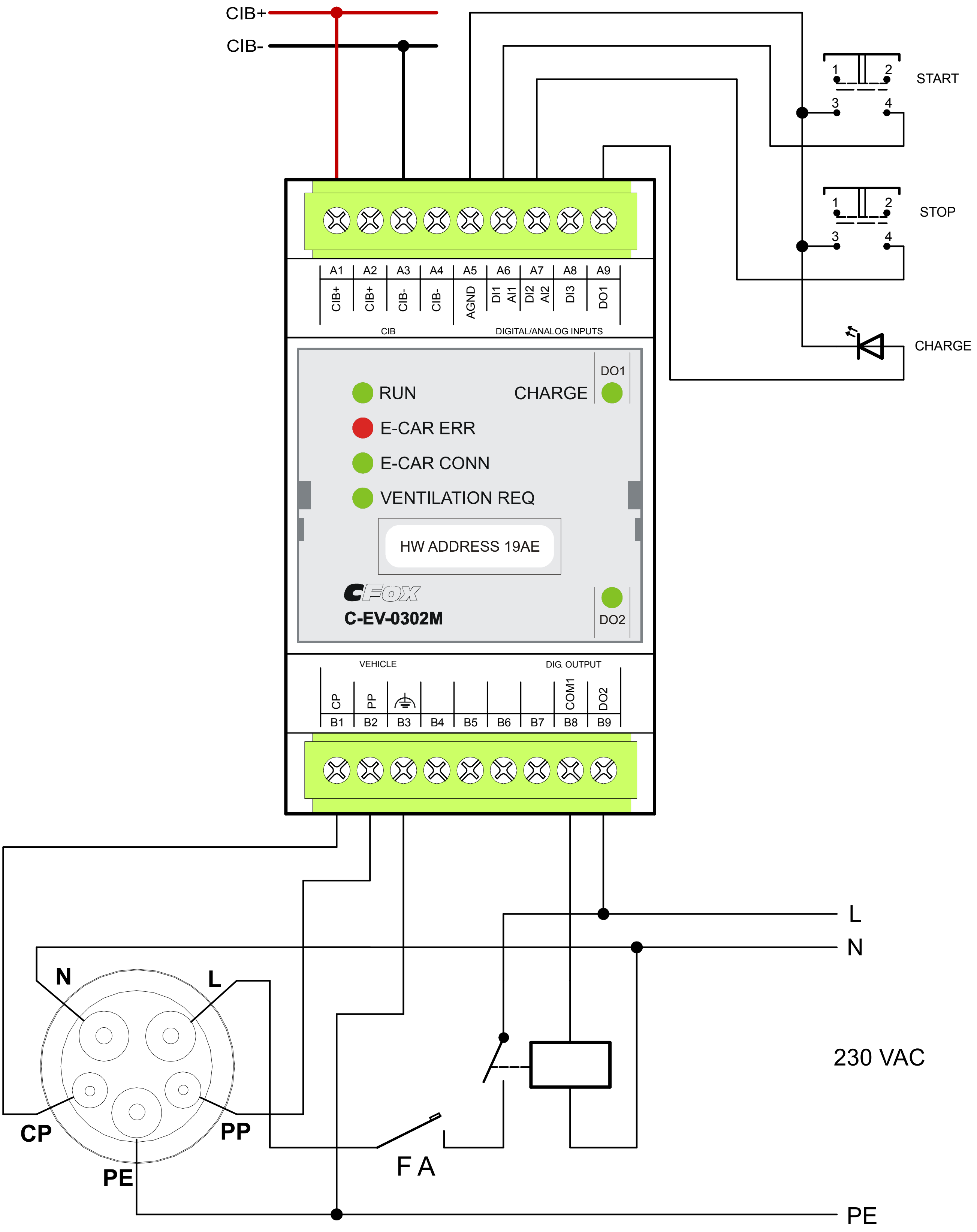


Fig. 5.8.1.1 A basic example of connecting the C-EV-0302M module.

Notes:

1. The DO1 output is only for charging indication using a LED, the output current max. 20 mA Lighting, socket circuits.

6 Lighting, socket circuits

The table of contents of the chapter

6.1 Basic information, concepts, classification of sources

6.1.1 Classification of sources

LED strips and LEDs powered by small voltage (typically 12VDC, 24VDC), they can be dimmed.
Switching sources for LED strips see Chapter 6.2. Switching LED lighting, bulbs, fluorescent lamps, etc.
Dimming LED strips see Chapter 6.3. Dimming LED, controlled by 12V, 24V voltage

LED power supply by rated current (typically 350, 500, 700, 1000 mA).
Dimmable by controllable current source, see the C-DM-0006M-ILED module.
Switching sources for current-actuated LEDs, see Chapter 6.2. Switching LED lighting, light bulbs, fluorescent lights, etc.
Dimming by current-excited LED, see Chapter 6.4. Dimming LED supplied from power source

A compact LED source (incorrectly a LED bulb).
A replacement of incandescent bulbs, standard threads according to bulbs, 230VAC power supply, only explicitly defined types can be dimmed, see Chapter 6.5.Dimming compact fluorescent lights (CFL) and LED bulbs.

Tube LED source (incorrectly a LED bulb).
A substitute for tubular fluorescent lamps, 230VAC power supply, usually cannot be dimmed.

Incandescent bulbs
Optical radiation is formed by heating a solid matter to a high temperature. An advantage is simple installation and maintenance, a disadvantage is low luminous efficacy (a 25W incandescent bulb has a luminous efficiency about 9lm/W) and a short average life (about 1,000 hours).
They are easily dimmed, see Chapter 6.8. Dimming – bulbs, 12V sources (halogen lamps, etc.)

Halogen bulbs
The bulb of halogen light is filled with a standard mixture of nitrogen and argon, krypton, or xenon. Additionally, the filling comprises halogenide compounds. Halogen bulbs have a better performance than ordinary incandescent bulbs. They are designed for 230V mains voltage, or as miniature and special types for low voltage (typically 12V). They have a higher efficiency than incandescent bulbs, but they are more expensive and have very little resistance to surge as well as short lifetime.
They are easily dimmed, see Chapter 6.8. Dimming – bulbs, 12V sources (halogen lamps, etc.)

Fluorescent lamps (low pressure discharge lamps) are a popular source of light. In fluorescent lamps about 21% of the supplied energy is converted into light. Their lifetime is from 8 to 12,000 hours.
For dimming, dimmable electronic ballasts controlled by 0 (1) ÷10 V signal, see Chapter 6.7.Dimming – fluorescent lamps, or by DALI interface – see Chapter 6.6. Dimming – DALI.

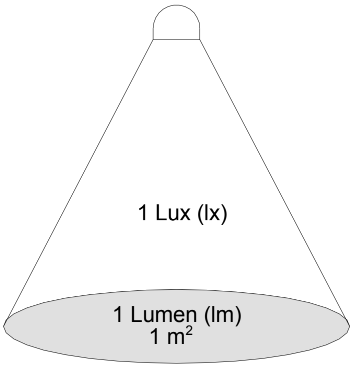
Compact fluorescent lamps are light sources, which combine the characteristics of fluorescent lamps and the appearance of bulbs. Compact fluorescent lamps fall into a group of low-pressure mercury discharge sources and they are designed as fluorescent tubes with electronic ballast and a socket. Their luminous efficacy ranges from 50 to 100lm/W.
Only explicitly defined types can be dimmed, see Chapter 6.5. Dimming compact fluorescent lights (CFL) and LED bulbs.

High-pressure discharge lamps (mercury discharge lamps, sodium, gas mixture, with very high pressure, xenon lamps).
They are usually used for street lighting and similar purposes.
High-pressure discharge lamps usually cannot be dimmed.

For dimming various sources, mainly in more complex control situations, there is a solution available with DMX and DALI

6.1.2 Basic concepts

Luminous flux (lm) indicates the amount of light energy (the total quantity of radiation), which is emitted by a light source with regard to the sensitivity of the human eye (it characterizes the light output of the source).



Illuminance (lx) – expresses the ratio between the luminous flux and the illuminated area.
1 lx illuminance occurs when a luminous flux of 1 lm is evenly distributed over an area of 1m^2.

Luminous intensity (cd) – expresses a luminous flux emitted in certain direction expressed by a solid angle (the rate of luminous flux emitted into a solid angle).

Brightness (cd/m^2) - brightness of the light source or of an illuminated area is crucial for the perception of brightness of light.

Luminous efficacy (lm/W) is a measure of how effectively the light source alters the supplied electrical energy into visible light (also specific output of the light source).

The type of source	power consumption [W]	Luminous efficacy [lm/W]	Luminous flux [lm]
Incandescent bulb	75	12,5	940
Halogen bulb	70	17	1190
Compact fluorescent light	20	58	1160
Linear fluorescent lamp	14	97	1358
Metal-halide lamp	35	100	3500
LED strip (standard), 1m	13	70	910
LED CREE, current actuated chip	11	118	1300

The colour of light (colour temperature, chromatic adaptation) characterizes the colour of light, which is indicated in kelvins (K) and expresses the temperature of a black body, whose light produces the same colour impression. This information is important especially in LED sources and fluorescent lamps.

Colour temperatures:

2,800 K	Incandescent bulb
< 3,300K	Warm white
3,300 ÷ 5,000 K	Cool white
> 5,000K	Cool white/daylight
5,500 K	Photographic flash and discharge lamps
6,000 K	Clear midday light
10,000 K	Cloudy sky, blue sky with no sun

Colour rendering index (R_a, more often CRI) – an evaluation of fidelity of colour perception resulting from lighting from a specific light source, compared with the colour perception in sunlight. The CRI value can be from 0 (colours are not discernible) up to a 100 (natural, perfect colours). The specified value for interiors where people have permanent residence is at least 80.

6.1.3 LED – basic information

LED diode can consist of a combination of several colours, but usually it is formed by a chip producing blue light by luminiscent material, and a part of this light is transformed so that the resulting colour is white. The resulting quality of colour rendition (CRI) is usually inversely proportional to the efficacy. E.g. LED with a specific light output of 80 lm/W have a very good colour rendering index (CRI) of 85%, while with CRI at e.g. 70%, the light output can be up to 130 lm/W.

Powerful LED chips (today chips with power in W units are common) must be cooled. Part of the energy is converted into heat, but unlike in incandescent lamps, it is not emitted and must be dissipated. Since the recommended temperature for LEDs is about 80 °C (the recommended surface temperature of the radiator is about 55 °C), it is necessary to mount the powerful LEDs onto relatively massive coolers (which does not seem to correspond with the acclaimed excellent efficiency, but it is just necessary to realize the different working temperatures and the method of heat dissipation).

LED sources – selection and comparison:

Performance – in standard interiors (as replacement for fluorescent lamps or incandescent bulbs), LED sources are already quite sufficient and their luminous flux is able to perform well in interior lighting.

Efficiency – this is where LED outperforms almost all sources in comparable colour rendition (e.g. metal-halide lamps have a better efficiency, but they are not used indoors).

The colour of light – LED also wins here, as virtually any colour can be mixed, and it can be maintained even when the conditions change (dimming, etc.).

The colour rendering index – this is where conventional sources win - the incandescent bulbs. Today, however, LED already reach CRI 80 or more, so it can be easily used for general interior illumination; there are even LEDs with up to 90 CRI, which at the cost of lower efficiency and higher costs may already replace incandescent bulbs in special applications (lighting in galleries, etc ...).

Lifetime – here LED also wins. The lifetime of LED sources is estimated at 50,000, sometimes even close to 100,000 hours. Another advantage is arbitrary switching frequency and instant availability of full power.

6.2 Switching LED lighting, incandescent bulbs, fluorescent lamps, etc.

Switching light circuits, or various types of 230VAC light sources has its own specifics, which have been recently significantly changing.

With the advent of energy-saving sources also increases the proportion of switching power supply sources for energy-saving light sources, which generally have the character of a capacitive load.
This means that at the moment of switching (the so-called **cold start**) they consume for a very short time (from dozens μup to ms) much higher current than in standard operation. Therefore, it is not recommended to use any relay output modules with relays that are not specifically designed for high switching (inrush) currents to control the switched sources.

Standard relay contacts cannot be used for switching lights or light sources. We strongly recommend not to use in any case standard relay contacts, including relays with 16A current, for switching 230V lighting. ALWAYS use relay outputs that are designated for switching capacitive loads - see the description and overview below.

A correct selection of relay modules must be taken into account already in the specification and designing stage, as additional "strengthening" of undersized relay contacts is almost impossible (different serial impedances are problematic, with regard to the variability of the used sources and their physical properties).

It is also necessary to carefully avoid any attempts of using weaker relay contacts (common relays) and deal with the surges by external installation relays or contactors on a DIN rail. Majority of installation relays used in this way (typically in the socket on a DIN rail) have worse parameters (inrush current) than the relays of the modules listed below. Similarly the installation contactors do not have such high short-term currents and thus from the perspective of their own contact it is a worse solution than using modules fitted with a relay with 800 A inrush contacts.

E.g. - thecommonly used source MW LPV-35-12 (35W, 12VDC) for **LED strips** can in the instant of being connected to 230V mains consume up to 60A (the so-called cold start, as defined in the manufacturer's data sheet) and it cannot be switched by a relay output with a standard contact, but only by relay outputs that are specifically recommended for these loads - i.e. modules:

C-OR-0011M-800	11 relay outputs with an inrush current of up to 800A
C-LC-0202B	2 relay outputs with an inrush current of up to 80A
C-OR-0008M	8 relay outputs with an inrush current of up to 80A
C-OR-0202B	2 relay output with an inrush current of up to 80A
C-HM-1113M	1 relay output with an inrush current of up to 800A
C-HM-1121M	3 relay outputs with an inrush current of up to 800A
C-IR-0203S	1 relay output with an inrush current of up to 80A
R-OR-0001B	1 relay outputs with an inrush current of up to 800A

The **RFox** variants (e.g. R-OR-0008) are also available for most of the modules, as their parameters are functionally identical and their usage and connection correspond to those of the **CFox** version.

LED lights are sources, which also often have the character of a capacitive load.
E.g. after the LED light EMOS A70 LED PREMIUM 16W (similarly also A 80 LED PREMIUM 20W) is switched on, the inrush current can reach up to 25A for a short time (about 100μs), so it is not possible to use

conventional relay outputs for these LED lights (also relay contacts with maximum current e.g. 20A cannot often be used for LED lights); in this case, stronger contacts with switching current at least 80A must be used, in the best case 800 A (e.g. the C-OR-0011M module).
Four pieces of these LED lights switched by one output take in peak more than 70A – so there must be used a relay output with an inrush current of 800A.

After the LED light OSRAM PARATHOM CLASSIC A 40 ADVANCED 6W is switched, it takes the inrush current of up to 130A, but only for about µs, so in this case it is also necessary to use a relay with a stronger contact.
E.g. when 16 of these lights in one installation were switched on, the peak current reached over 400A; in this case, maximum current is already limited by the total impedance of the distribution system.

For switching **standard incandescent bulbs** any Foxtrot system relay outputs can be used. E.g. the relay outputs of the C-HM-0308M module are equipped with relays with a 5A contact the permanent switching current is 3A. Therefore, lights up to 600W can be switched by each output. However, it is better to also use modules with more powerful relays due to the potential current surge resulting from a broken filament, and mainly the possibility of exchanging the bulb for a source with a capacitive load.

Inductive transformers for 12V halogen lights can be switched by 5A relay contacts 5A; for **electronic transformers** it is strongly recommended to use 16A outputs.

Fluorescent lamps (both standard and compact) should be switched by 16A outputs.

It is also necessary to take into account the number of loads connected in parallel to one relay output. E.g. in some electronic ballasts and power supplies, the surge current reaches up to 40A, so they can be easily switched by the C-OR-0008M module, but should there be simultaneously switched several of these ballasts, then relays with higher switching currents must be used, e.g. the C-OR-0011M-800 module.

In some cases, providing release of upstream short-circuit breakers should be considered, and the light sources should be divided into several groups, which are switched sequentially.

6.2.1 Switching 230 VAC light sources, the C-OR-0011M-800 module

The most universal module for switching light circuits is C-OR-001M-800. This module is fitted with 11 relay outputs with a 16A switching contact, which is equipped with a tungsten pre-contact with maximum switching current of 800A for 200μs. Each contact has independent termination, allowing free distribution into groups of fused lighting circuits. The outputs can also be used to control socket circuits and basically any additional loads, for which the relay contacts parameters are suitable.

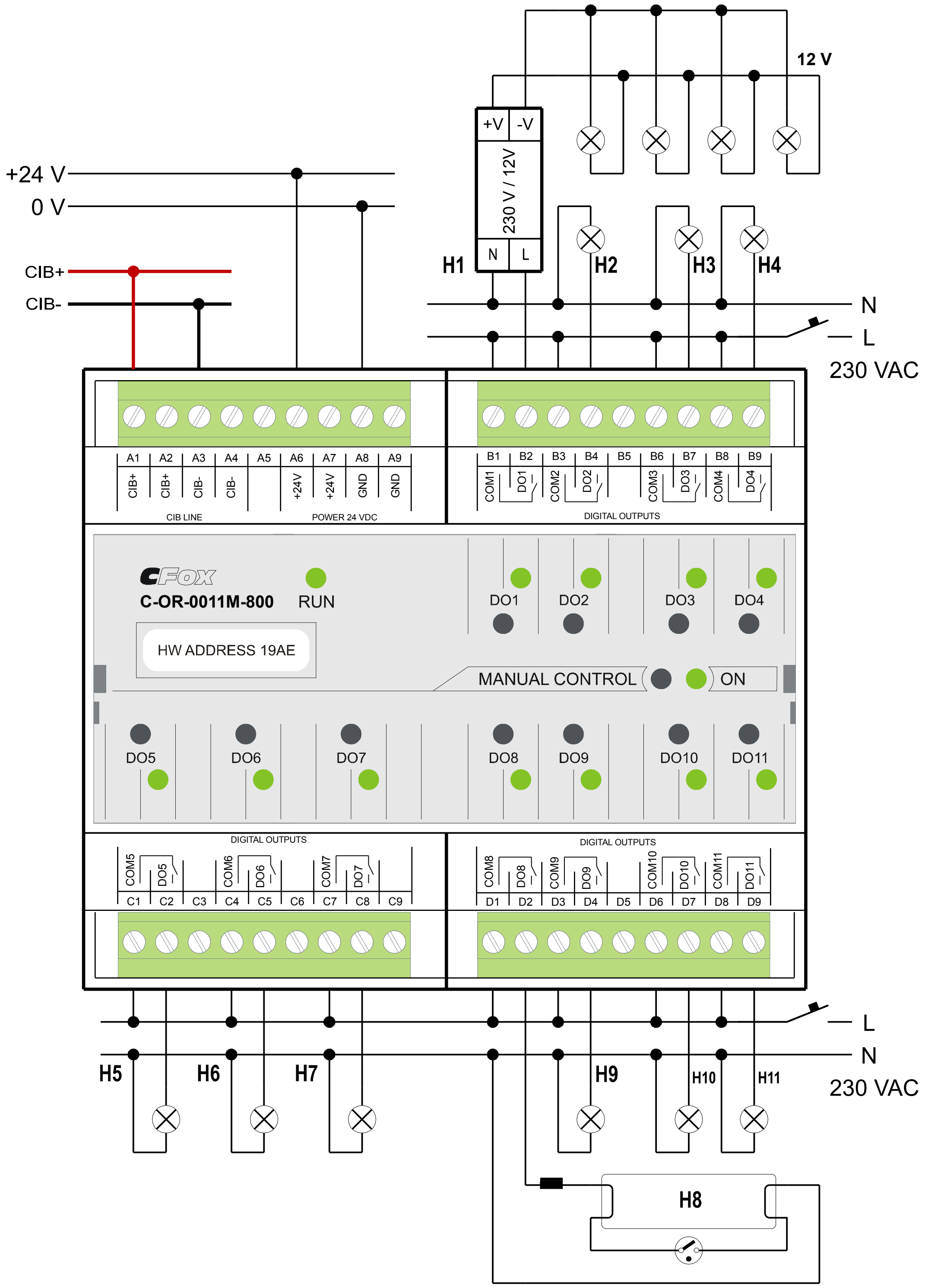


Fig. 6.2.1.1 An example of the connection for switching the light sources by the module C-OR-001M-800

6.2.2 Switching 230VAC light sources, the C-LC-0202B module

For controlling 230VAClights there is a specialized module C-LC-0202B, designed to control two lights and placed in a flush box near the light sources.
The module is fitted with two inputs, which are designed for the connection of the push-button light control.
During a communication failure, an autonomous function of the module is provided - the DO1, DO2 outputs (lights) are controlled by DI1 and DI2 buttons.

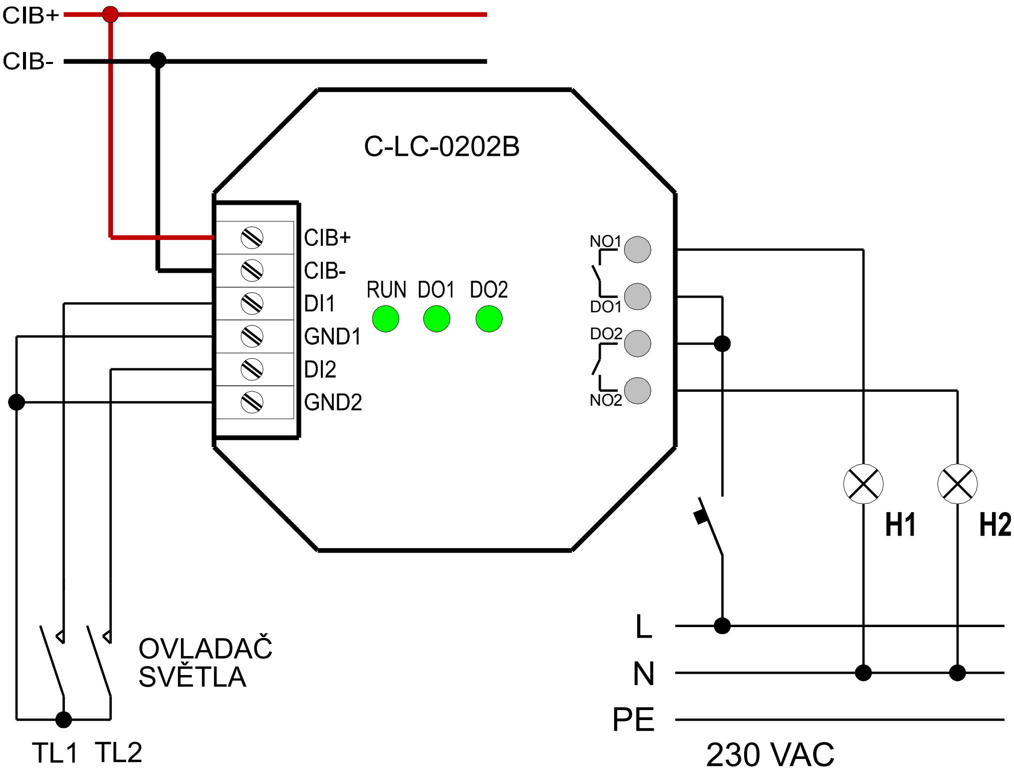


Fig. 6.2.2.1 A wiring example of switching the light sources by the module C-LC-0202B

Notes:

1. The relay contacts have an inrush current of up to 80A, so they can easily manage the accompanying effects of switching and opening contacts.
2. Two inputs, DI1 and DI2, are designed for direct connection of the lights control buttons; in the case of the deep flush box (e.g. KOPOS CPR or CPR 68 68/L), or a box with a lateral space (e.g. KUH 1 or KUH 1/L), the C-LC-0202B module can be installed directly under the button control.
3. In the case of communication failure, the DI1 a DI2 inputs automatically control the outputs using single buttons (the DO1 output is closed by the first push of the DI1, and the next push will open it. The DO2 output is controlled by the DI2 analogically).

6.2.3 Switching external switched power supply for LED sources (voltage and current).

The following example illustrates the switching of light sources with a capacitive load character - the commonly used sources MW LPV-35-12 (35W, 12VDC). When connected to the 230V power network, these sources can briefly consume up to 60A (the so-called cold start, according to the manufacturer's catalogue sheet). Therefore we recommend e.g. the C-OR-0008M module for their switching:

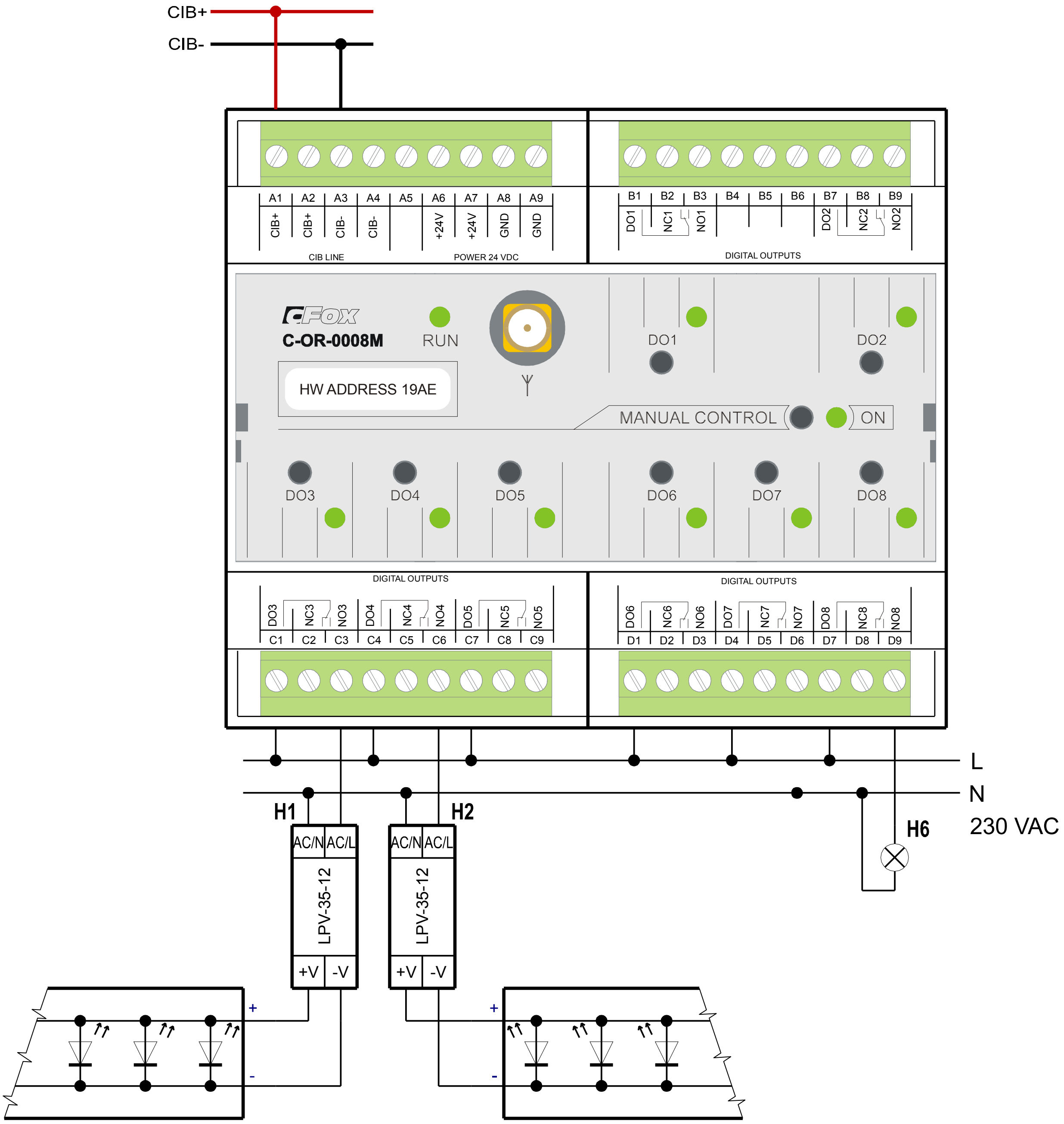


Fig. 6.2.3.1 An example of switching the switched sources for LED by the C-OR-0008M module

6.2.4 Switching a common source with independent control of several LED strips

If you want to use a more powerful 230VAC/12VDC supply for powering several LEDs (e.g. strips) and separate switching of individual strips is also required as well as switching off the entire source (to avoid permanent power consumption when the lighting is switched off), it is recommended to use the C-HM-1113M (or C-HM-1121M) modules: to switch the source, the 16A output can be used (DO11, this output is designated for switching current of up to 800 A), and to switch the individual LED strips, the 5A relay outputs can be used - see the Figure:

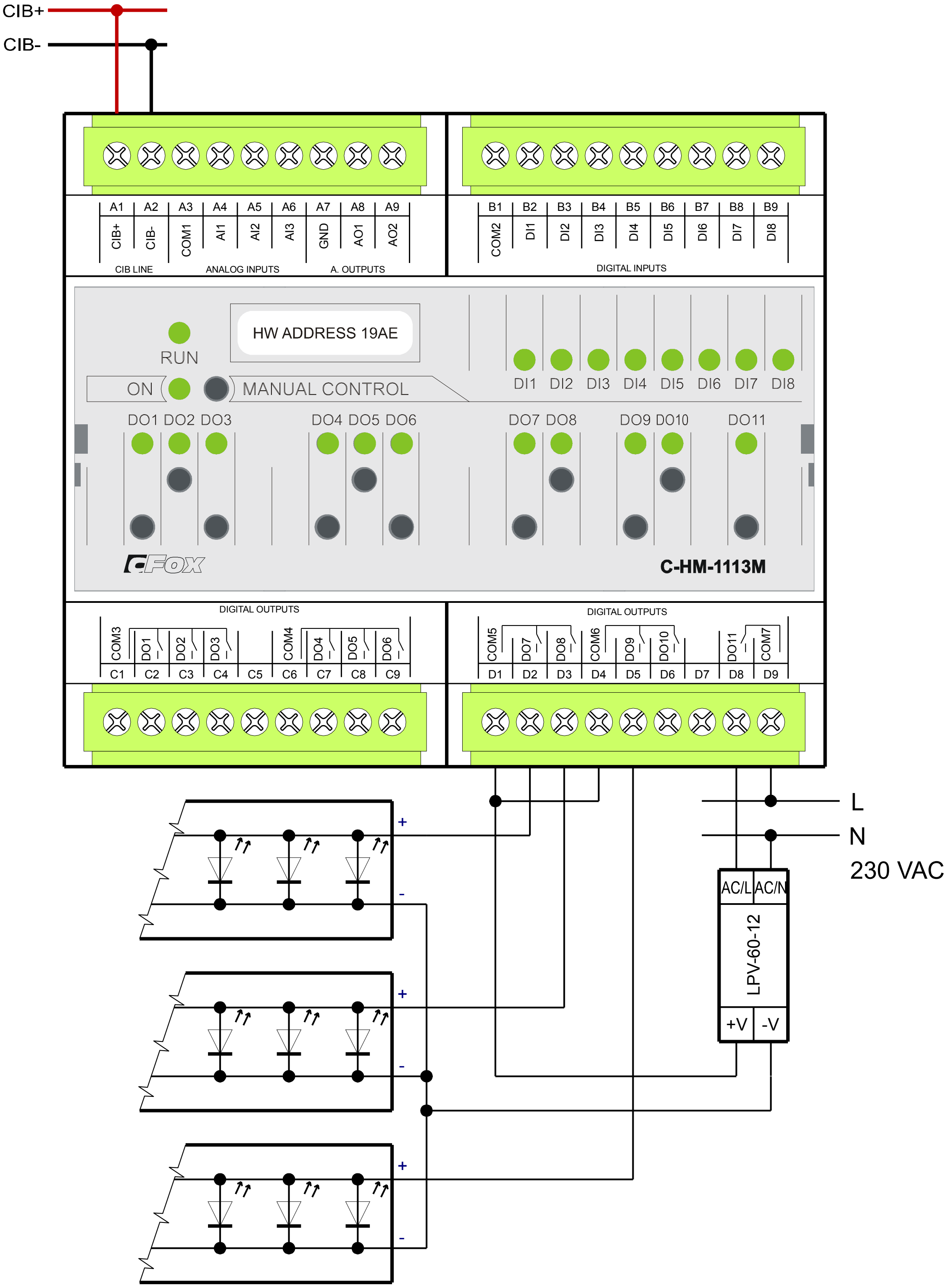


Fig. 6.2.4.2 An example of switching LED strips powered by a switched power supply module C-HM-1113M

6.2.5 Switching the lighting – 230VAC incandescent bulbs , 12VDC incandescent bulbs

The diagram shows the wiring of the C-OR-0008M module, which switches various types of loads - from incandescent bulbs, fluorescent tubes to the 12V source for halogen lamps. The C-OR-0011-800 module can be used in a similar manner - its parameters are even more advantageous for switching light circuits.

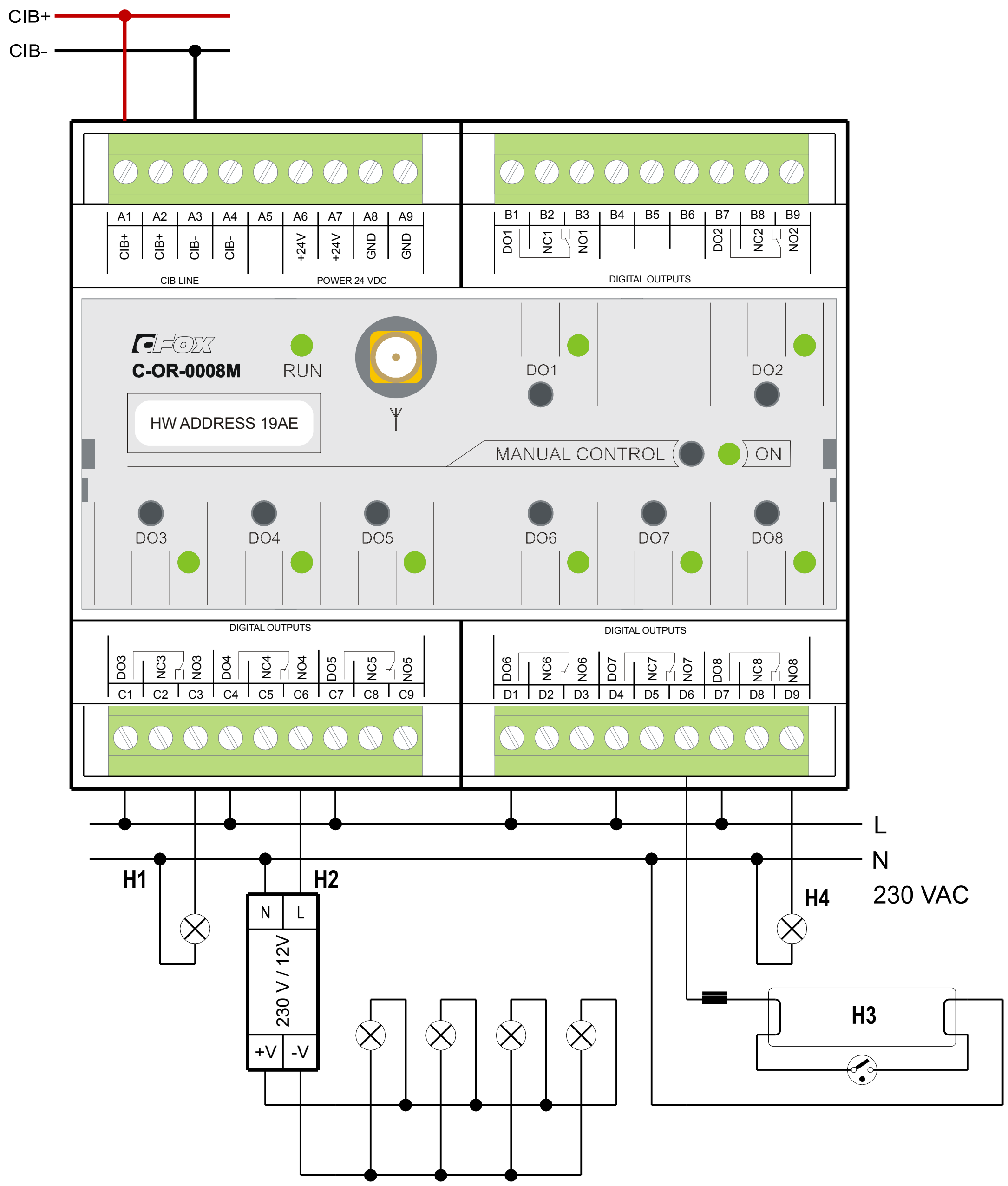


Fig. 6.2.5.1 An example of switching incandescent bulbs and fluorescent lamps by the C-OR-0008M

6.3 LED dimming, 12V, 24V voltage control

Voltage controlled LEDs are known as commonly used LED strips.
The most common are LED strips with 12VDC nominal voltage, either monochrome or two-colour, or RGB with a common terminal + (i.e. anodes of diodes coupled on a strip).
Slightly less common are LED strips with 24 VDC nominal voltage.

For these LED strips there is a dimming module C-DM-0006M-ULED. The module can dim and power LED strips with 12 ÷ 24VDC nominal voltage, 6 independent channels in total, with a maximum voltage per channel of 4A under the equal load of all the outputs of one module. Each output can be loaded with max. 6A, but the total current of all outputs in one module must not exceed 24A!

⚠ The C-DM-0006M-ULED module cannot be used for dimming RGB strips with a common negative terminal!

⚠ The C-DM-0006M-ULED module cannot be used for dimming current-actuated LED strips!

⚠ The C-DM-0006M-ULED module is not fitted with short-circuit protection of outputs !

The defined characteristics of LED strips include - in addition to the nominal voltage - the wattage per unit of length -
e.g. the power LED strip 60/NW 2200 CREE has the wattage of 36 W/m;
with a nominal voltage of 12V, which corresponds to a maximum consumption of 3 A/m.
It means that with maximum current of 4A, about 1.33cm LED strip can be dimmed via one output of the C-DM-0006M-ULED or a 2m long LED strip can be dimmed with a maximum current of 6A.

When powering LED strips over longer distance, it is also necessary to allow for voltage drops in the supply cables. It is recommended to calculate losses and accordingly select the corresponding diameter of the connection cables. For an example of powering of the power strip see Chapter An example of connecting the power LED strip over a long distance to C-DM-0006M-ULED.

Despite their energy efficiency, the LED strips get warm during the operation , especially the power LED strips; therefore they require thorough heat dissipation, and it is always necessary to take into account the LED strip manufacturer's requirements for adequate cooling - the cooling profiles, etc.

6.3.1 Dimming RGB, monochrome and two-colour LED strips

For continuous brightness control of LED strips with 12V or 24V DC nominal voltage there is the C-DM-0006M-ULED module.Maximum current in one output is 4A, maximum current in the common powering terminal (terminals A6, A7) is 24A.

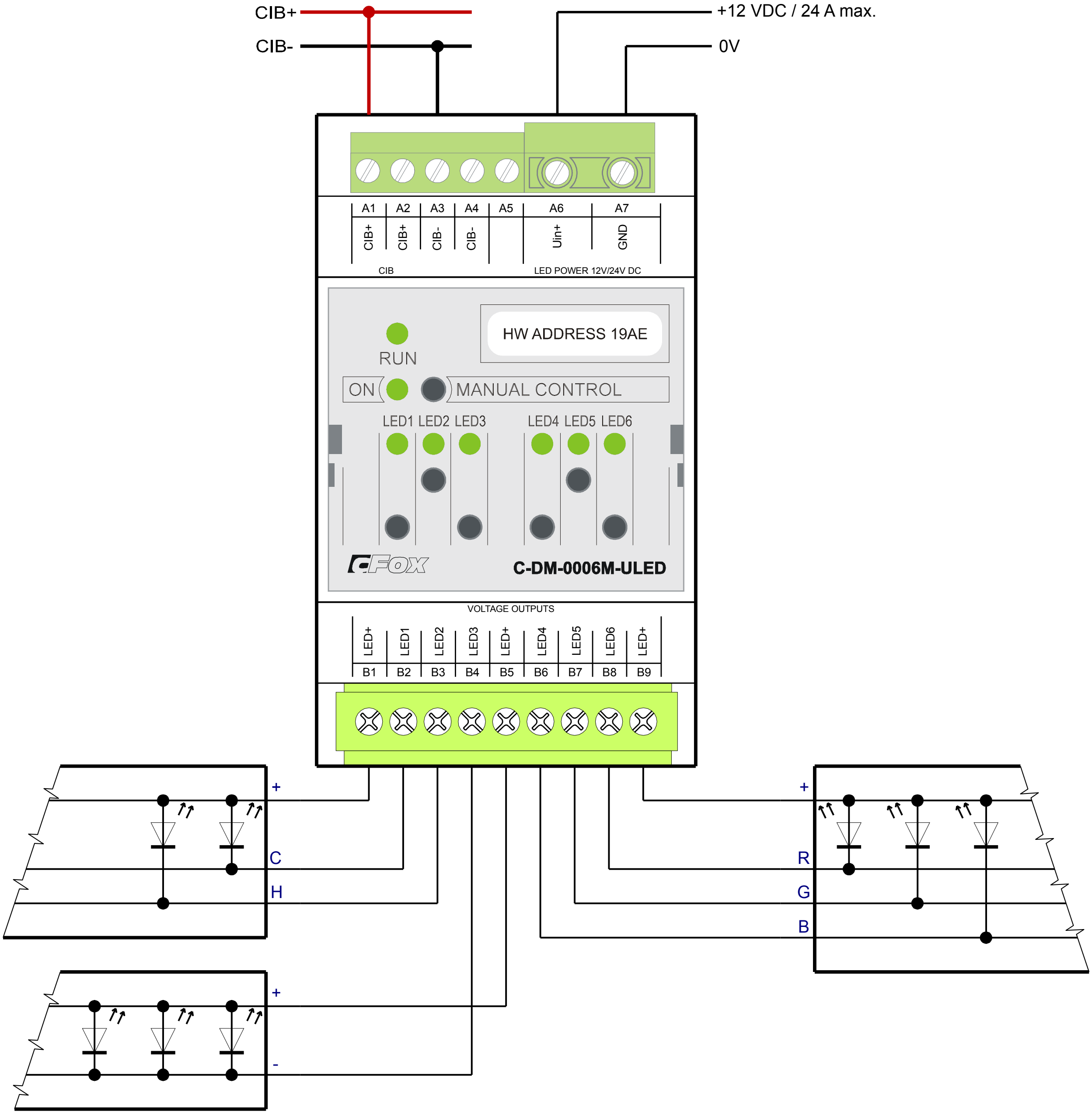


Fig. 6.3.1.1 An example of wiring the C-DM-0006M-ULED dimmer, dimming LED strips

Notes:

1) Maximum current in each output (from LED1 up to LED6) is 4A.
2) The current in each output terminal (LED+: terminals B1, B5, B9)) is 16A - that means that all LED strips can´t be connected to one common terminal (e.g. B1).
3) Each module must be powered from an independent 12V or max. 24V/24A power supply.
4) The negative CIB terminal is galvanically connected with the negative terminal of the source for LED (A7).

5) The C-DM-0006M-ULED module is not fitted with short-circuit protection of outputs !

6.3.2 An example of wiring a power LED strip over a longer distance to C-DM-0006M-ULED

The C-DM-0006M-ULED module is designed for a DIN rail mounting. Likewise, the power supply for the LEDs (e.g. DR-60-12) is designed to be installed in the distribution cabinet, which means that in most cases the controlled voltage must be lead from the dimmer outlets over a longer distance.
If the voltage is 12V, the losses in the cables are much higher and they should be taken into account. If the power supply allows fine tuning of the output voltage, the voltage of the source can be increased, which at least partially eliminates the losses in the cables. However, care must be taken not to overload some LED strips by increased voltage, if LED strips with different output or length of cables are supplied simultaneously.

The following diagram shows the results of a specific measurement of LED strip connection to the LED1 channel of the C-DM-0006M-ULED module, which is supplied by the DR-60-12 source. The strip is connected by a 30m cable.

The LED strip used: 1m of 60/NW 2200 CREE strip, parameters: 12V, 36 W/m, 2200 lm/m
The source used:DR-60-12, the output of the source is set at 13.42V
Cable: 2x1.5 CYKY, 30m length
The dimming module: C-DM-0006M-ULED

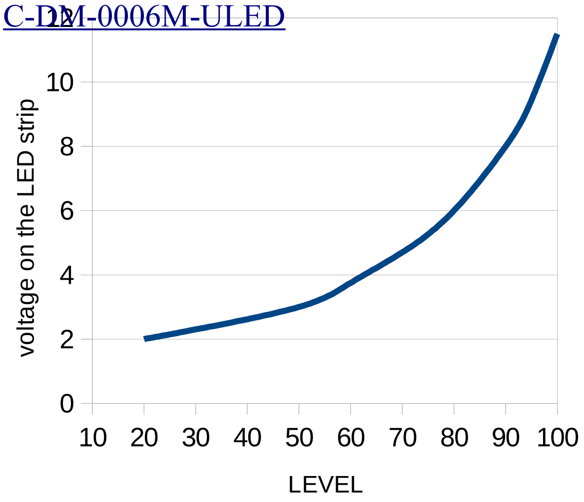


Fig. 6.3.2.1 Measured voltage curve in a LED strip

The resistance of standard CYKY cables:
CYKY 1.5 resistance 12.5 Ω/km (info: PRAKAB)
CYKY 2.5 resistance 7.5Ω/km
CYKY 4 resistance 4.7Ω/km

Total resistance of the CYKY 1.5 cable for 30 meters: 0.75Ω (0.0125Ω/m x 30 x 2)

The voltage on the source output 13.42V (it roughly corresponds to the voltage on the LED1 output).
The the LED strip voltage (maximum) 11.5V

13.4V – 11.5V = 1.92V, from which follows the current of 2.56A and the power consumption of the LED strip is 295W.

The measured values prove that even the power LED strip can be powered and dimmed over a longer distance without any problems. In order to reach the voltage of 12V in the LED strip, you could use a source with an option of setting even higher voltage, or use a cable with a larger diameter (e.g. CYKY 2.5), but due to the fact that the closer the voltage in the LED is to the maximum, the more the efficiency decreases, and as the difference is relatively small, the specified example is applicable without any problems.

The diagram also illustrates the so-called "logarithmic characteristics" of the dimmer, which is normally implemented in the C-DM-0006M-ULED module.

6.3.3 Dimming LED point reflector sources (MR16)

The dimmer C-DM-0006M-ULED can also dim low voltage dimmable reflector sources, e.g. LED SUPERSTAR MR16 12V advanced.
These LED sources are connected in the same way as LED strips and similar sources. However, some sources cannot be connected in parallel to one output, which means that only one LED source can always be connected to one module output, which also applies to the LED used in the following example.
The LED SUPERSTAR MR16 12V advanced 35 24° ADV 5W/830 GU5.3 used in the example manufactured by OSRAM) can dim from about 5% to 100%.

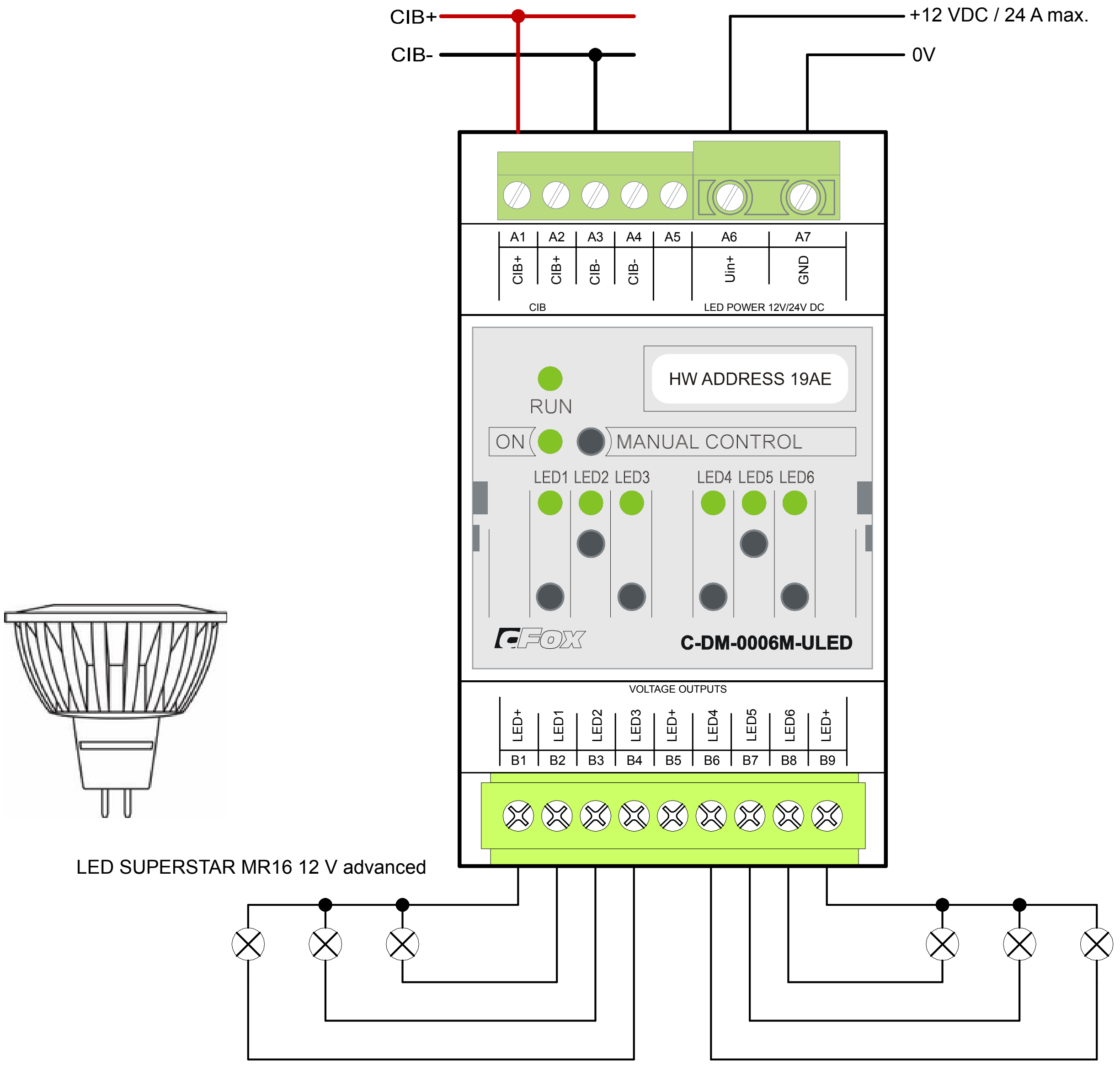


Fig. 6.3.3.1 An example of wiring the dimmer C-DM-0006M-ULED, dimming of spot LED lights.

Notes:

1. N.B.: only one LED source mentioned in the example can be connected to one output of the module (if several LED sources are connected in parallel, they flicker and do not behave correctly). If several LED sources should be used, their parallel connection to one module output must first be tested.
2. The C-DM-0006M-ULED module is not fitted with short-circuit protection of outputs !

6.3.4 Dimming LED strips by controlled 230V power supply, e.g. LPF produced by Mean Well

Dimmable power sources, such as the LPF series produced by Mean Well, can also be used for dimming and powering LED strips (12V or 24V rated voltage) and dimming LEDs powered by nominal current (LED current strips, LED chips).
These resources are controlled by analogue signal 0 to 10Vm, and either any analogue Foxtrot system output can be used, or a specialized module C-DM-0002L-10V, which is equipped with programmable control in time (ramp), similarly to other C-DM series modules.

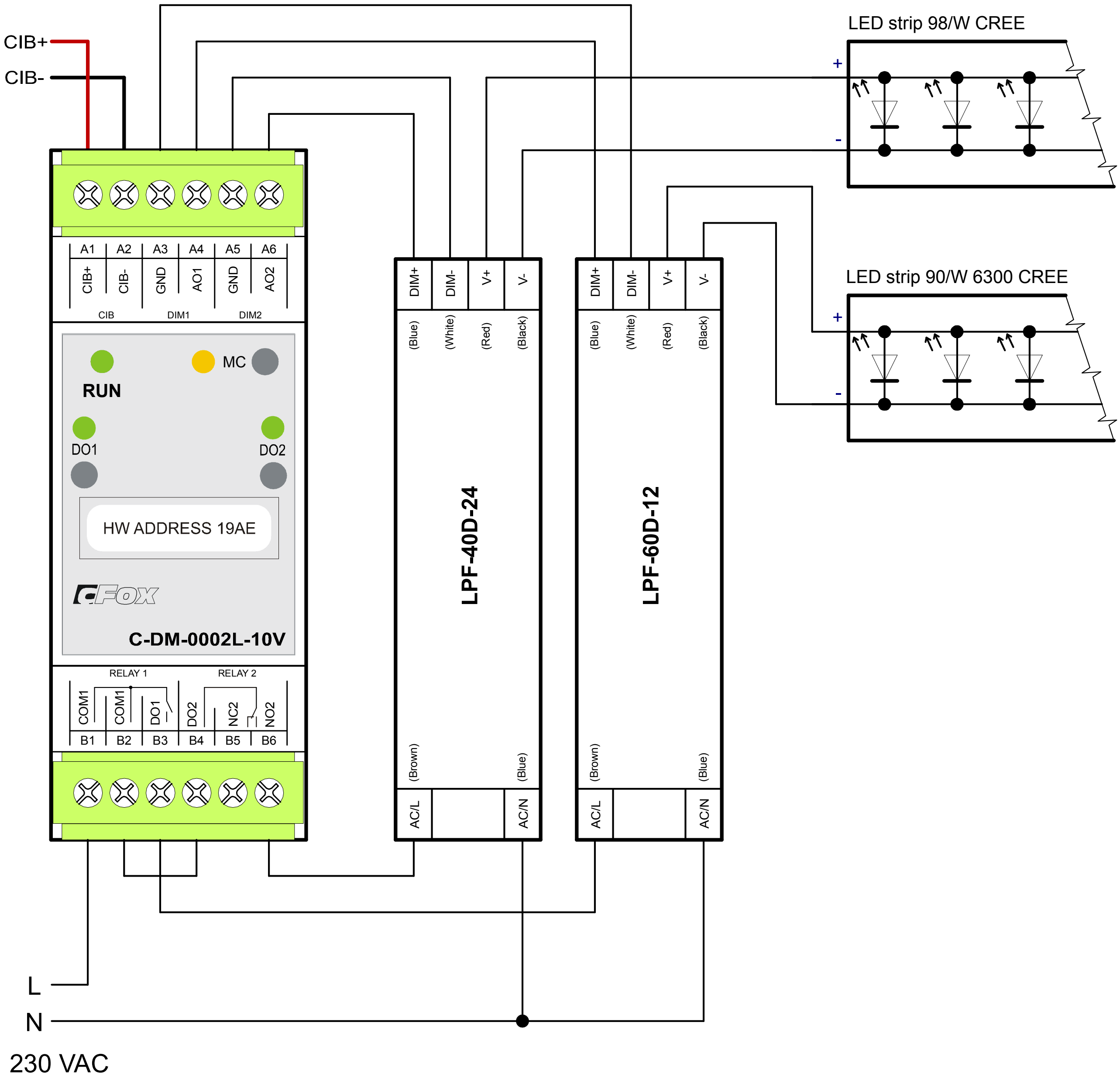


Fig. 6.3.4.1 An example of using the C-DM-0002L-10V module to control the LPF sources

Notes:

1. The text below gives you basic information concerning dimming of the LPF series sources and the LED strips used:

LPF-40D-24
Dimmable switched power supply designated primarily for powering LED sources both with nominal voltage (standard LED strips) and with rated current (power LED chips and modules),
controllable constant current within the output voltage range from 14.4 ÷ 24VDC
Inrush current after switching (cold start) is max. 50A for max. 210 µs. µs.
If the setting of characteristics in the C-DM module is linear, then from 10% up the value of the required brightness corresponds to the value of the output current:

The required value	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %
Output current	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %

Below the 10% value the output level is zero, i.e. the light source is switched off.

LPF-60D-12
Dimmable switched power supply designated primarily for powering LED sources both with nominal voltage (standard LED strips) and with rated current (power LED chips and modules),
controllable constant current within the output voltage range from 7.2 ÷ 12VDC
Inrush current after switching (cold start) is max. 55A for max. 270 µs. µs.
If the setting of characteristics in the C-DM module is linear, then from 10% up the value of the required brightness corresponds to the value of the output current:

The required value	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %
Output current	10 %	20 %	30 %	40 %	50 %	60 %	70 %	80 %	90 %	100 %

Below the 10% value the output level is zero, i.e. the light source is switched off.

Led strip 98/W CURRENT CREE, an example of use:
CRI > 80
the length of the strip 1,143mm (it must correspond to the maximum supply current)
luminous flux 3,900lm
power input of the LED strip 33W
maximum current in the given connection 1.67A (using the LPF-40D-24 source)

This strip is one of the types that are designed to be supplied from a power source.They do not have resistors in series at LEDs, so they reach the highest efficiency from these sources. They cannot be connected in parallel in various lengths like standard voltage tapes; their length is limited by the maximum current - the design of a particular strip, and it must be addressed in the design stage (the strip cannot be shortened as needed).
These strips are supplied from sources of constant current, or from a source of voltage that can be operated in the "constant current" mode - e.g. the sources used in this example.

Led strip 90/W 6300 CREE,
CRI > 80
luminous flux 6300lm
power input of the LED strip 79W
length of the strip 1,056mm
maximum current in the given connection x A (using the LPF-60D-12 source)

The strip used in the example is one of very powerful voltage LED strips. It is controlled by the voltage source as a standard.

6.4 Dimming LEDs powered from a current source

LEDs powered by nominal current are actually the manufactured LED chips (components), which provide the highest luminous efficacy and the best of them already surpass the efficiency of almost any other sources used in the interior (> 110lm/W). Even their colour rendering and colour temperature can today fully replace the incandescent bulbs and other sources.

An example of a LED chip:
The power chip CREE XML on Al plate for fastening on the cooler, with max. power consumption 10 W (max. current 3A), the luminous flux 1,000lm (at 700mA the luminous flux is 200 ÷ 300lm),
CRI up to 80.

LED power supplies, for which you can use dimmers with rated current, e.g. C-DM-0006M-ILED), are used more and more frequently.
Large portion of LED lights (e.g. large-area LED panels, ceiling and wall lights) include power LEDs connected to a system, which is powered by the so-called driver, which is usually a cheap source of nominal current with the primary (input) part for 230VAC. The output parameters are usually given on the sources - e.g. the rated current at 1A, the output voltage at 30-45V.
This resource should be disconnected and replaced with an appropriate dimmable source or a dimmer - see the connection example in Chapter 6.4.3. Dimming LED ceiling panels with 1A current, the C-DM-0006M-ILED module.

6.4.1 Dimming LEDs with a nominal current of 150, 350, 500 or 700 mA

For smooth brightness control of current-powered LED sources with nominal supply current of 150mA, 350mA, 500mA or 700mA, there is available the C-DM-0006M-ILED module. Each output can be set individually and independently. The supply voltage for LED coming from an external power supply connected to A7, A8 terminals is within the range of 4.5 to 48V DC (the same applies to all LED supplied and controlled by a module).

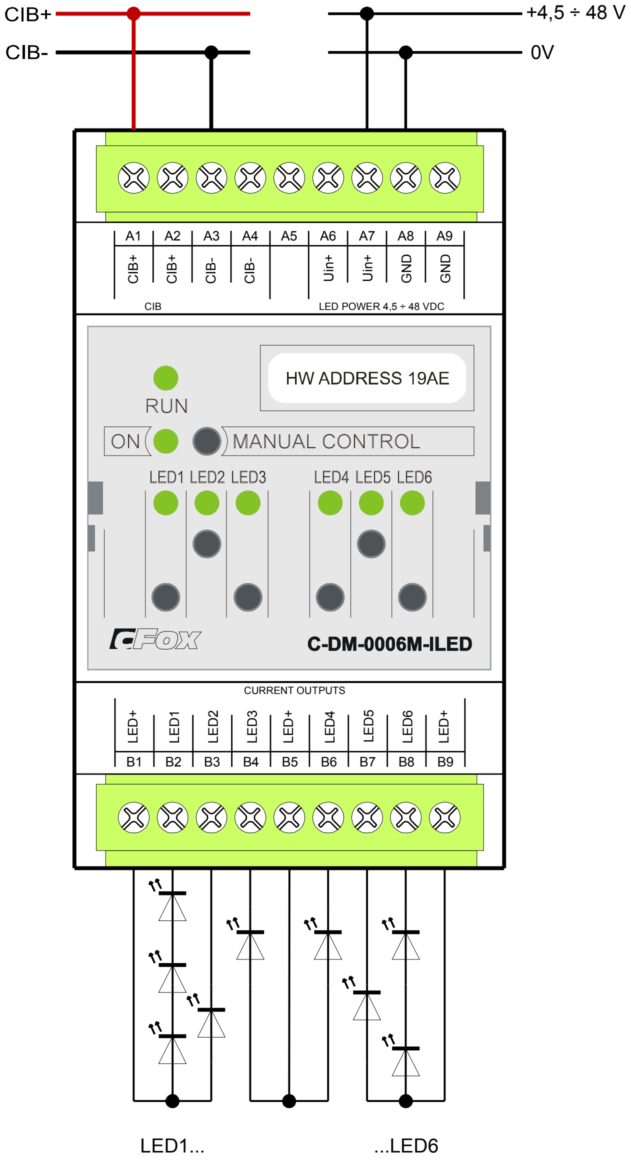


Fig. 6.4.1.1 An example of wiring the dimmer C-DM-0006M-ILED, dimming of current-controlled LEDs

Notes:

1) Maximum current from each output (LED1 up to LED6) can be set from the values of 150mA, 350mA, 500mA or 700mA. The output current in each output can always be controlled in the range for 0 up to a maximum current.
2) The supply voltage for LEDs is connected to twin terminals Uin+ and GND. The output voltage of the power supply must be in the range from 45 V to 48 V.
3) More current-powered LEDs can be connected in series with respect to the supply voltage (maximum 48V – depending on the power supply used).
4) The negative CIB terminal is galvanically connected with the negative terminal of the power supply

for LED (A8). It is recommended to power the C-DM-0006M-ILED modules from a single source only if they are located in close proximity (with very short power supply cables).

6.4.2 An example of dimming the CREE power LED chips by the C-DM-0006M-ILED module

When designing the dimming of power chips or current-actuated power LED strips (they are being used more thanks to their higher efficiency, compared with voltage LED strips), it is necessary to correctly dimension the power supply for the LEDs.

The requirements for the LED power supply:
The C-DM-0006M-ILED dimmer enables powering from the 4.5 ÷ 48 VDC power supply, with a maximum current consumption of 4.2 A. It is advisable to select a slightly higher nominal voltage of the power supply (e.g. by 5 V) than the sum of maximum voltages in the chips of each channel connected in series. It is also recommended to have similar numbers of LEDs wired in series in each channel of the dimmer (e.g. if there is one chip connected to the LED1 output and 5 chips connected to the LED2 output with a voltage drop about 3.5V/chip, the dimmer must be powered by about 24VDC power supply, which means that in the case of LED1 there will be a very high power dissipation in the module (as this channel only needs about 8V power supply).

The following description presents an example of connection of specific LED chips on the C-DM-0006M-ILED module, which is powered by the DR-60-12 power supply.

The LED chip used:	CREE XT-E R4/6300K, max. UF = 3,4 V, IF = 1,5 A, 231 lm/700 mA
The source used:	DR-60-12
Cable:	the wire cross-section is 0.5 mm^2, the length is about 5 ÷ 15m
The dimming module:	C-DM-0006M-ILED

LED chips:
The dimmed LED chips in the example are the CREE XT-E, soldered to aluminum PCB TR20-1M (manufactured by TRON); there are always two PCBs mounted on one cooler and located in the ceiling. The XT-E chip comes in many variants, according to the desired colours of light; max. chip power consumption is 5 W, when excited by current of 1.5 A, the selected type reaches the luminous flux of 401 lm. When excited by 700 mA current, the luminous flux reaches 231 lm (it is clear that with the increasing current, the efficiency of the chips decreases).

Selecting a suitable power supply:
If wiring 2 chips in series, you can count with a 2 x 3.4V maximum voltage for power supply; we used a 12V supply to have a sufficient margin. With the maximum current in all channels, the module takes from the supply 4.2A, which requires at least a 50 W supply. In this case, it is beneficial to use the DR-60-12 power supply.

Switching the LED power supply (DR-60-12).
n order to prevent the power supply DR-60-12 from being constantly connected to the network and needlessly consume current, its input is switched by a 230VAC relay output; in this case the DO1 input of the C-IR-0203M module is used.
The inrush current (so-called "cold start") of the power supply DR-60-12 stated by the manufacturer is up to 36A, so it should be switched (just like a vast majority of similar power supplies for LEDs) by a relay with an appropriate contact, most often with the so-called "inrush technology". The C-IR-0203M module is equipped with a relay with an inrush current of up to 80A. Therefore it is suitable for this purpose.

The measured results:
In this connection, the maximum measured consumption of one chip was typically 2.2 W.

Before a test, 10 chips were placed in a suspended ceiling in a room, i.e. 5 pieces of coolers and each with two LEDs, with total power of 22 W; next to them were placed two 60 W incandescent bulbs, in total a 120 W, in all cases just the sources with no covers.
Then, illuminance was measured at floor level, always in the place with the highest intensity.

The illuminance at floor level by 120 W incandescent bulbs was in total 69 lx.
The illuminance at floor level by 22 W LED chips was in total 132 lx.

In this case, the approximate efficiency of LED illumination was about 10 times higher than that of incandescent lamps. What contributes to the positive result of LEDs is their lighting characteristics aiming directly down and the angle exceeding 120°, compared with omni-directional bulbs.
The following diagram shows another measurement - the dependence of illuminance on the value entered in the C-DM-0006M-ILED dimmer, where you see again the so-called "logarithmic" characteristics of the dimmer reflecting the perception of light intensity by the human eye.

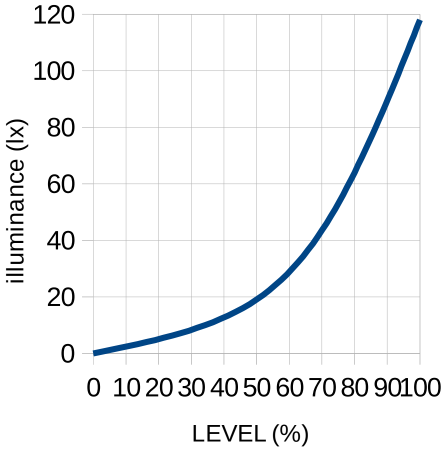


Fig. 6.4.2.1 The measured dependence of the light intensity on the required value

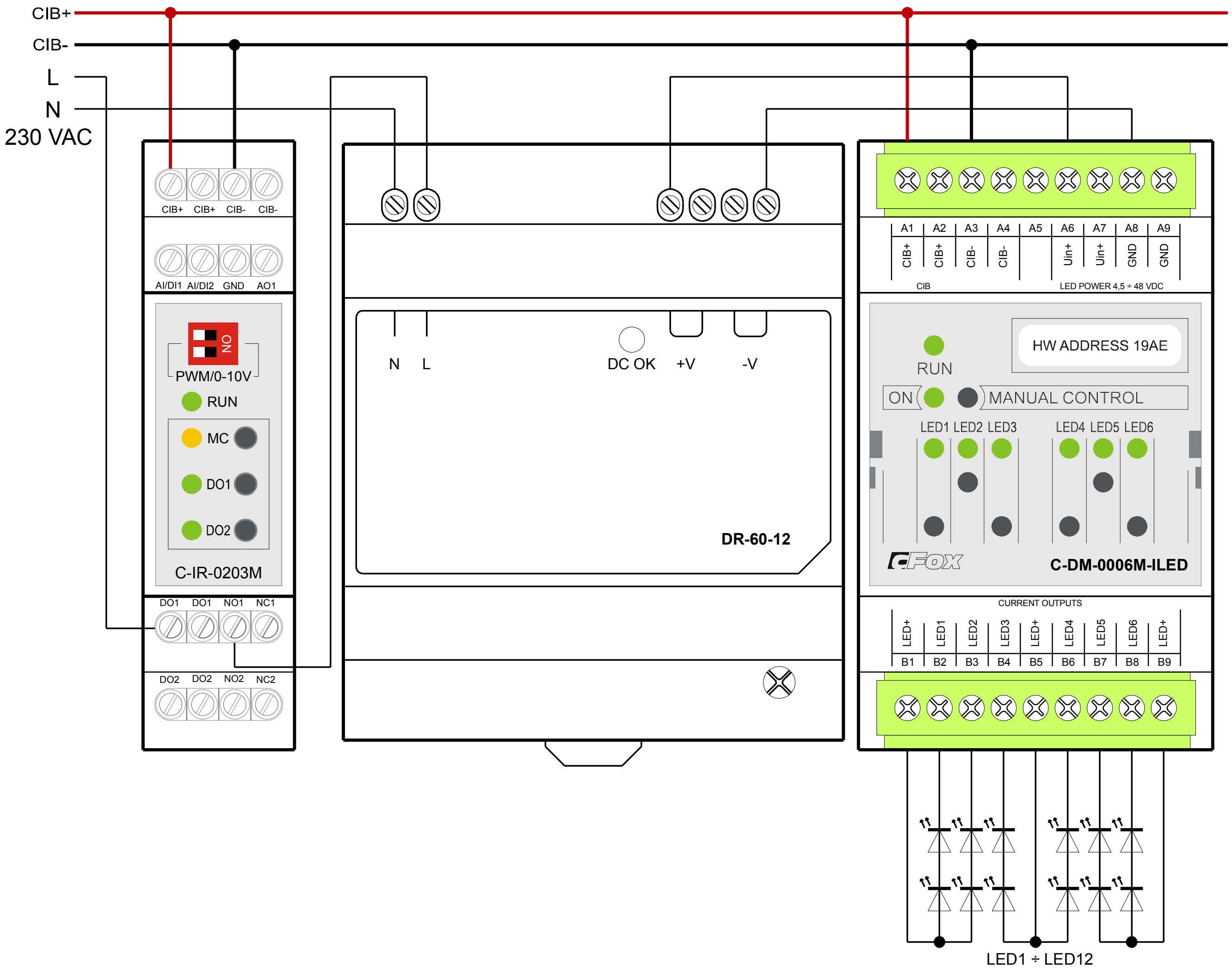


Fig. 6.4.2.2 An example of controlling 12 LED CREE chipsbythe C-DM-0006M-ILED dimmer, including the power supply control

Notes:

1. The LED chips layout in the module outputs in the example is optimal - on each channel there are two pieces wired in series.

6.4.3 Dimming LED ceiling panels with 1A current, the C-DM-0006M-ILED module.

Some light sources with a single 230V source (the driver) are fitted with LEDs in wiring suitable for direct dimming - i.e. instead of the source, which is a part of the light, it is possible to connect the LEDs (the LED circuits of the light) directly to a suitable dimmer.
E.g. the LED panel HLP59545WW is fitted with LEDs with wiring designed for 1A DC rated current power supply (the required power supply voltage range for the panel is 36 ÷ 42V).Instead of the 230VAC source with this output, which is a standard part of the package with the light, connect the panel connected directly to the output of the C-DM-0006M-ILED dimmer (further referred to as C-DM).
The C-DM module is fitted with outputs with a maximum current 700mA, but the LED1 and LED3 outputs (analogically the LED2 a LED4) can be connected in parallel, and with their 500mA configuration you get the total current of 1A; when you supply the C-DM module from a 48VDC source, you get the right power to control two LED panels with one C-DM module. In the application SW both coupled channels must be controlled in the same way (the same required value).

The second option of dimming a light similar the LED panel used in the example is to use controlled sources, which are controlled by the analogue system output; see the example in Chapter 6.3.4. Dimming LED strips by controlled 230V sources, e.g. by LPF sources manufactured by Mean Well.

Comments to the next Fig6.4.3.2:

1. The LED panel HLP 59545 is connected directly to the output of the C-DM-0006M-ILED module (don´t use the source that is included in the product package!)
2. Outputs of the C-DM-0006M-ILED module can be connected in parallel only like this:output 1 with output 3, output 2 with output 4. This gives you a common dimming output with max. current at 1.4A (the configuration of the module output is 700mA) or 1A (outputs are set at 500mA).
3. The DRP-480-48 switching power supply provides them at its 48VDC output with a 10A maximum current - i.e. this configuration is capable of powering even twice as large assembly than the one shown in the example.
4. The source DRP-480-48 must be switched (its power supply is 230VAC) by a relay contact designed for capacitive loads (max. current in the so-called cold start is 40A).
5. It is necessary to provide adequate ventilation of the source, because when its temperature exceeds the ambient temperature, the maximum available power drops - see the diagram in Fig.6.4.3 .1 t is valid for a standard position of the assembly on a DIN rail).
6. Powering several C- DM-0006M-ILED modules from one source (see an example in Fig6.4.3. 2) is possible, but the modules have to be close to one another and the wires between ULED and CIB modules must be as short as possible.

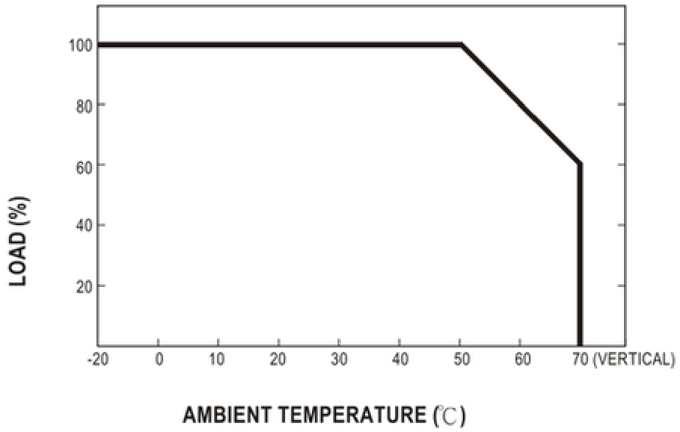


Fig.6.4.3.1 The DRP-480-48 power supply loading characteristics

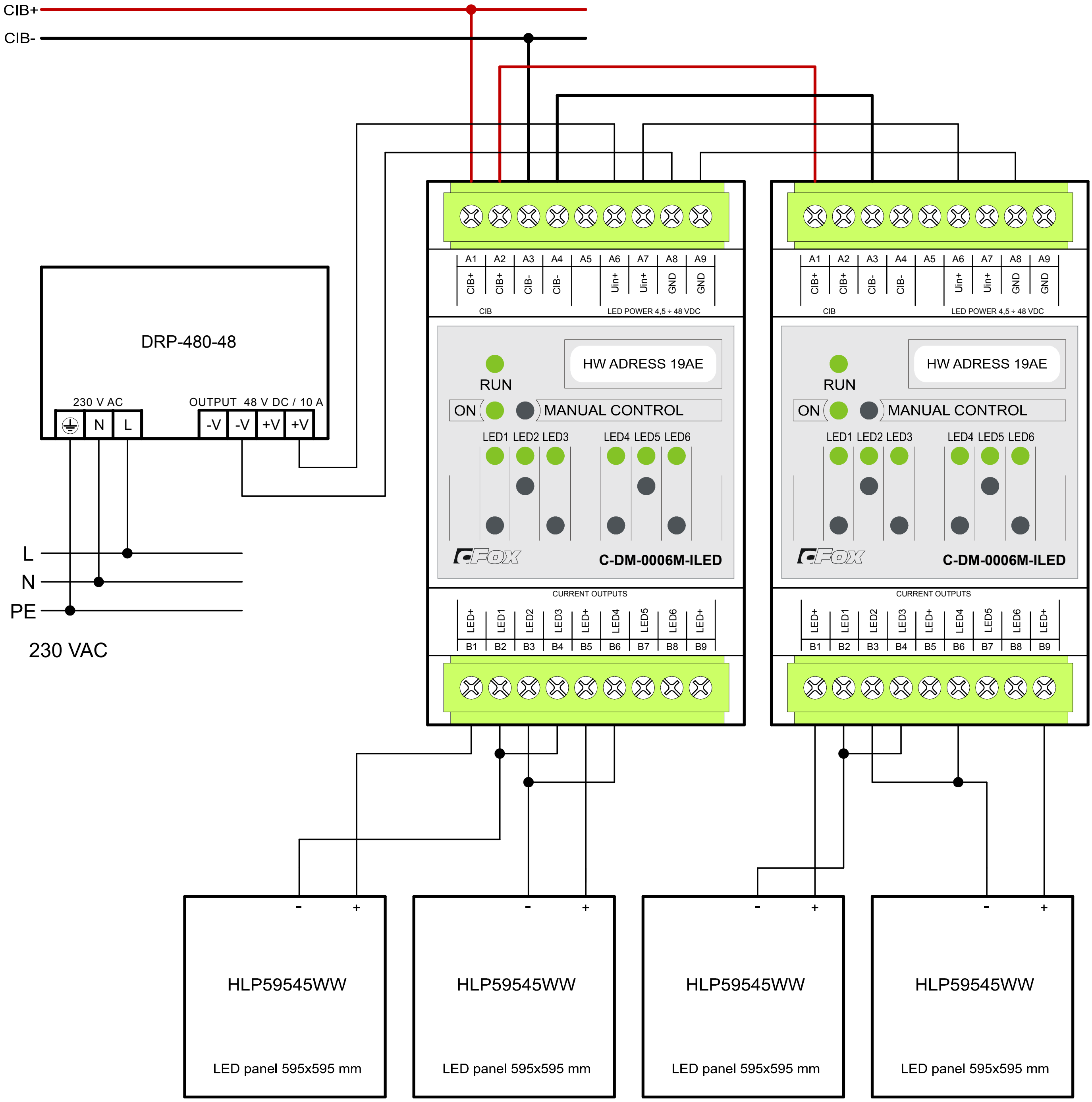
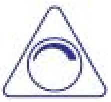


Fig. 6.4.3.2 An example of controlling a LED panel with 1A nominal current by the C-DM-0600M-ILED module

6.5 Dimming compact fluorescent lamps (CFL) and LED bulbs

Compact fluorescent lamps (further CFL) and LED bulbs (further LED), which are designed by the manufacturer for dimming, so they have the word "Dimmable" or an appropriate symbol on the cover, such as:



are dimmed by the C-DM-0402M-RLC dimming module.

The C-DM-0402M-RLC module in this application (CFL and LED bulbs) should be set on RL loads (resistive and inductive load). With RC setting (capacitive and resistive) load, the CFLs and LEDs behave abnormally, they flicker, etc.

The wiring example is identical with the examples illustrating dimming bulbs, see Chapter 6.8.1. Dimming incandescent bulbs with rated input up to 500W.

Compact fluorescent lamps and LED bulbs cannot be dimmed from 0%. All of these sources require some energy for their own function, so it only makes sense to control them from about 20 to 45% of the set brightness values. If a lower value is set, the source behaves abnormally, it flickers, increases uncontrollably its brightness, etc. Therefore there must be set the so-called ignition limit for each channel of the dimmer (the MINIMUM variable in the software configuration of the module), which defines the minimum brightness value that can be set. If a lower value is set (the LEVEL variable), the dimmer is not switched on, and if a higher value is set, it immediately starts from the set level MINIMUM (the RAMP variable), which means there is no delay in switching on the source. The minimum brightness value differs in each type of CFL or LED; it also depends on the operating temperature and on the fact whether the light is switched from zero, or if the brightness decreases to zero.

The measured values of samples of certain types are specified in the following Chapter 6.5.1. Tested CFL and LED bulbs, the measured parameters. The table shows that e.g. that it only makes sense to dim compact fluorescent lamps (CFL) in the range of 30 ÷ 70% (the LEVEL value), and other information.

6.5.1 Tested CFL and LED bulbs, the measured parameters

To verify their proper functionality, we have tested (and still are testing) various CFL and LED bulbs. The wiring of the tested sources is identical with that in dimming incandescent bulbs, see Chapter 6.8.1. Dimming incandescent bulbs with rated input up to 500W.

The measured values of selected samples of some types of CFL and LED bulbs are listed in the following table.

The table also lists the measured values of PCD dimmable switching power supplies made by MEAN WELL, whose characteristics are similar, but by their nature they represent a capacitive load, which means that the RC type of load must be set.

A table with the measurement results of the CFL and LED bulbs samples tested:

Type	**Marking**	**Input [W]**	**Luminous flux [lm]**	**Light on threshold [%]**	**Upper limit [%]**	**The type of load**
CFL	Philips Tornado 1% Dimmable	15	900	30	70	RL
CFL	Philips Tornado T3 Dimmable	20	1200	30	70	RL
CFL	Philips Softone 20W WW E27	20	1150	45	70	RL
CFL	Philips Master, PL-Electronic Dimmable	20	1200	30	70	RL
CFL	Osram Dulux intelligent dimmable classic A	16	880	45	70	RL
CFL	Sparsam (IKEA)	15	820	30	70	RL
CFL	Megaman 3U218d dimmerable	18	1008	35	90	RL
						RL
LED	Philips Master LEDluster clear	4	250	20	70	RL
LED	Philips Master LEDspot PAR 20	7	-	20	70	RL
LED	Megaman LG0911dv2 dimmable LED classic	11	620	40	90	RL
LED	LEDON LED LAMP	6	400	40	80	RL
LED	Osram PARATHOM CLASSIC A 40 ADVANCED	6	470	30	90	RL
LED	Osram PARATHOM CLASSIC B 25 ADVANCED	3,8	250	25	90	RL
LED	MEAN WELL PCD-16-1050B + LED chips SOC20-1M	-	-	20	80	RC
LED	MEAN WELL PCD-25-700B + LED chips SOC20-1M	-	-	20	50	RC

Type the source type – compact fluorescent light (CFL), LED bulb or a source for LED (Mean Well)
Marking the name of product
Input nominal input of the source according to the manufacturer's specification
Luminous flux maximum luminous flux according to the manufacturer's specification
Light on threshold the level at which the tested sample starts to emit light when being switched on (i.e. from a switched-off state)
Below this level, the light flickers, or the source does not emit light.
The switching off limit the level when the tested sample is completely switched off (i.e. from the switched on state) is about 10 to 15% lower in comparison with the ignition level (temperature dependent) – it is not stated in the table.
Upper limit above this level, the human eye can no longer distinguish any increase in brightness.
The type of load setting the dimmer (setting the type of load).

The table shows that, for example compact fluorescent lamps (CFL) can be dimmed in the range of 30 ÷ 70% (the LEVEL variable). These values are not always the same, they differ depending on the type, but also a particular piece, as well as the operating temperature. The regulation should also be adapted to these parameters - it is often less than half of the whole 0 ÷ 100% range that is made use of.

6.6 Dimming – DALI and DSI interface

The DALI protocol is designed for connecting lighting devices in accordance with the specification NEMA Standards Publication 243-2004 Digital Addressable Lighting Interface (DALI) Control Devices Protocol PART 1-2004 a PART 2-2004.
The communication of the DALI bus runs in series via a special synchronous protocol in two wires.
Up to 64 "slave" ballasts for lights can be connected to the bus.
The participants are addressed using the so-called short addresses in the range of 0...63, or group addresses 0..15 (the library for distinguishing group addresses uses numbers in the range of 100...115), or by accessing "broadcast addressing" (global address 255), which means to all "slave" devices simultaneously.
To control DALI ballasts, there are two modules:
For up to 12 ballasts there is the small built-in module C-DL-0012S,
for larger installations with up to 64 ballasts, the C-DL-0064M module.

The DSI protocol was designed by TRIDONIC in 1991 to control lighting ballasts. It was basically a predecessor of DALI interface.
The protocol uses a single value of lighting, which is passed by the bus to all the connected ballasts. It means that all the converters connected to one DSI interface are controlled together, and they have the same level of brightness. The communication receives no feedback on the state of the ballasts, and the number of ballasts on one DSI interface is not strictly limited.

For detailed information on programming and operating the modules C-DL-0012S and C-DL-0064M see the documentation of TXV 003 66.01.

6.6.1 Controlling DALI ballasts, the C-DL-0012M module

To control lighting devices with DALI protocol (typically ballasts for fluorescent lights, etc.) there is the CIB - DALI protocol converter, the C-DL-0012S module. It is designed to connect devices with DALI protocol in accordance with the specification: NEMA Standards Publication 243-2004 Digital Addressable Lighting Interface (DALI) Control Devices Protocol PART 2-2004.
Signals from CIB buses and DALI are led by strip wires distinguished by different colours. The module is supplied from the CIB bus, and the module does not provide galvanic isolation of buses.
The C-DL-0012S module makes it possible to control independently 12 DALI elements on the bus.

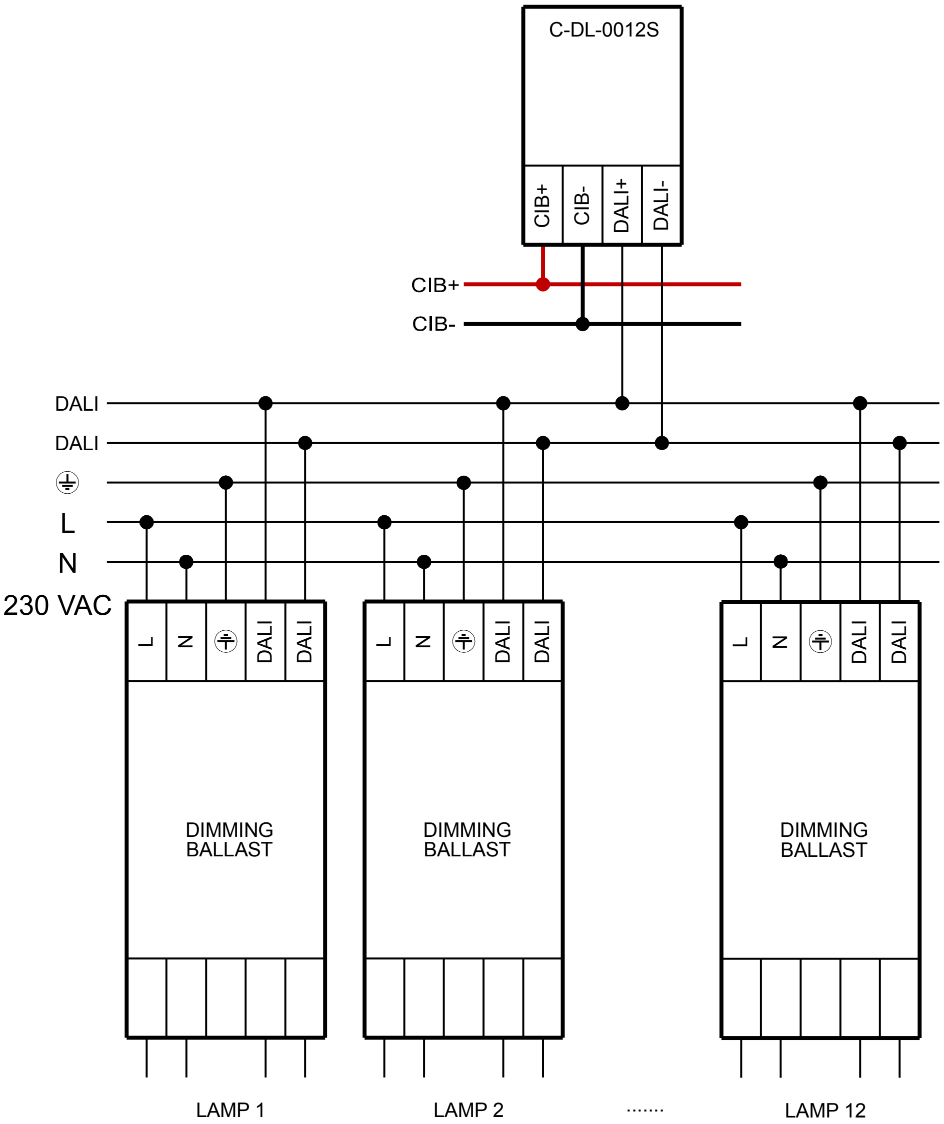


Fig. 6.6.1.1 An example of wiring C-DL-0012S, controlling the sources with a DALI bus

Notes:

1) The type of cable used for the DALI bus is 5 x 1.5mm^2, a standard cable for electricity installation (the cable contains both DALI bus and 230VAC wires), maximum total cable length is 300m, possible topologies include linear, tree or star.
2) The DALI bus is not polarized (both signal wires DALI can be swapped in SLAVE elements), the bus is not terminated by element. The DALI bus is galvanically isolated from the supply voltage of 230V (it meets the SELV).

6.6.2 DALI ballast control, module C-DL-0064M

The C-DL-0064M module is a protocol converter CIB – DALI. It is intended for the connection of lighting devices with the DALI protocol according to the specification: NEMA Standards Publication 243-2004 Digital Addressable Lighting Interface (DALI) Control Devices Protocol PART 2-2004.
The signals of CIB and DALI buses are brought to screw terminals. The module power supply is from an external 24VDC off the CIB. The module provides galvanic isolation of the DALI bus from other circuits. Software control must be supported by function blocks from the DaliLib.mlb library.

The number of ballasts	Maximum 64
Galvanic isolation of DALI from CIB	Yes
Supply voltage (Terminals A3, A4)	24VDC -15% +25%
Internal protection	Yes
Typical consumption	30 mA
Maximum consumption from a 24V power supply (fully loaded DALI)	320 mA

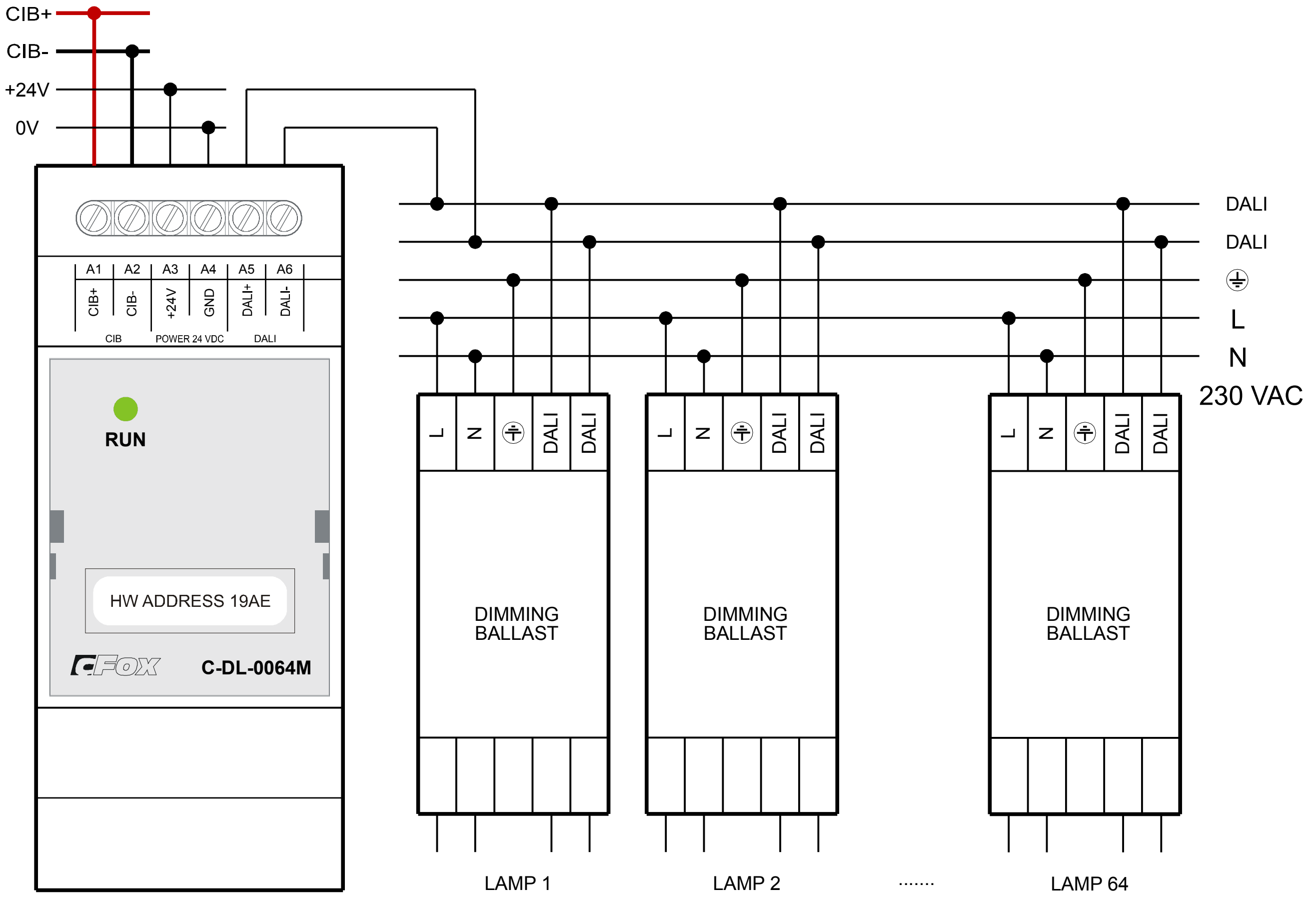


Fig. 6.6.2.1 An example of wiring the C-DL-0064M, the control of sources with a DALI bus

Notes:

see the previous chapter

6.6.3 The DSI ballasts control, module C-DL-0064M

The C-DL-0064M module can be set in the mode of the protocol converter CIB – DSI. It is designed to connect lighting devices with DSI protocol of Tridonic company.
The signals of CIB and DALI buses are brought to screw terminals. The module power supply is from an external 24VDC off the CIB.

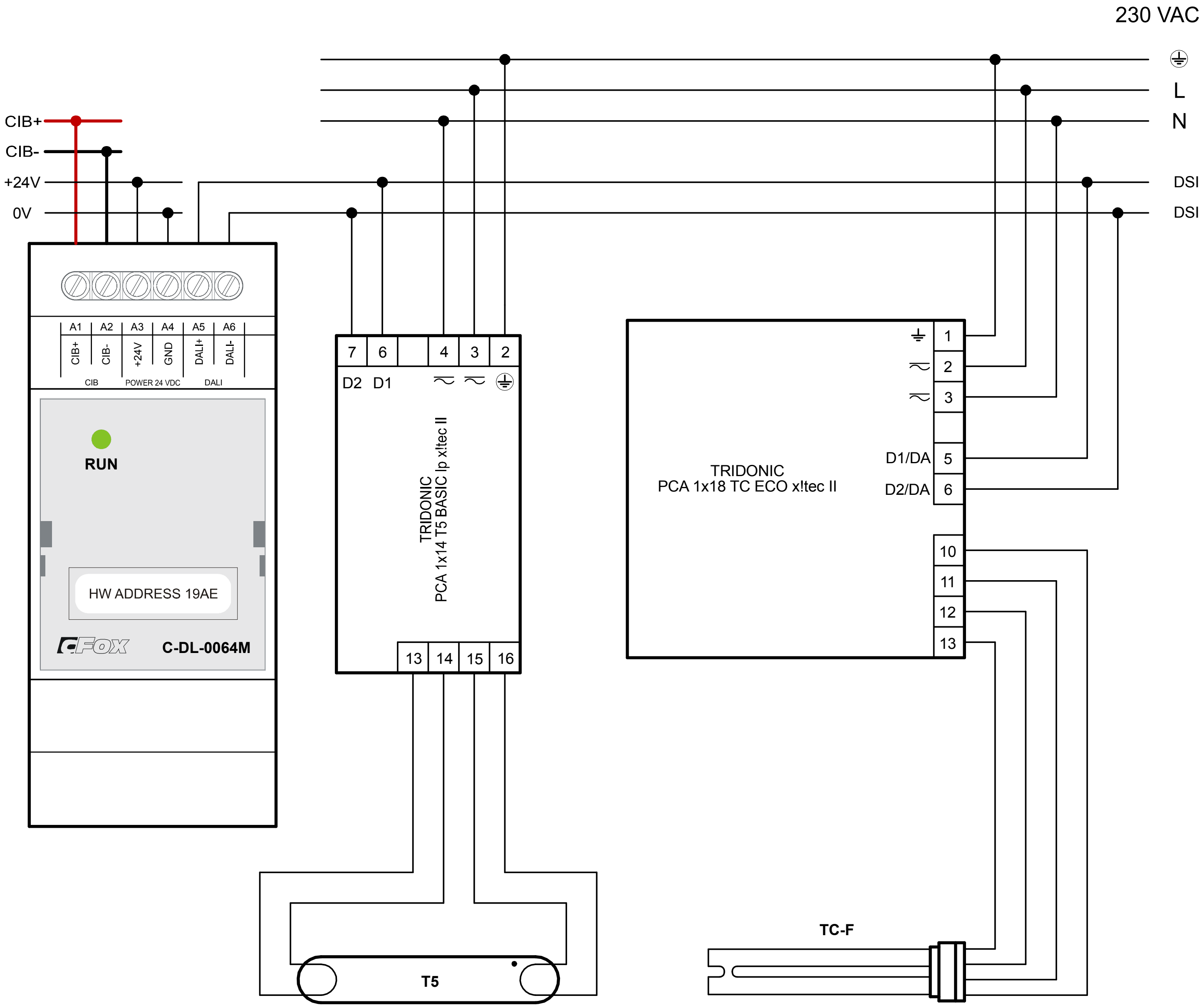


Fig. 6.6.3.1 An example of wiring the C-DL-0064M, the control of sources with a DSI bus

6.6.4 Switching power supply to the DSI, DALI, etc. ballasts

Electronic ballasts, whether they are controlled by a 0 to 10 V signal or by a DALI or DSI interface, have very often a significant capacitive load, and at the moment of switching the supply voltage, they draw for a short period multiple times higher current.

E.g.:

- some OSRAM ballasts draw up to 10 times higher current than the standard rated current,
- the Helvar ballast EL1/2x18-42TCS can take during the first 192 µs (the so-called cold start) the current up to 40A.

These maximum current values also dependent on the length and cross section of the wires.
When several ballasts are being switched simultaneously, what must be taken into account is both the maximum through the switching relay contact, and also upstream fusing (to avoid the release of the upstream circuit breaker).

The Tridonic ballast PCA 1x14 T5 BASIC Ip x! Tec II draws up to 19.6 A for 147 µs, with the 2.5mm2 cross-section of the supply cable (yet the rated ballast current is only 0.08A!). The manufacturer provides a tabular chart with the maximum number of ballasts that can be connected simultaneously without tripping the circuit breaker; this is listed for each specific type of ballast, the cable cross-section and the front-end circuit breaker (characteristics and rated current).

Therefore, it is always necessary - when choosing a suitable connection (the type of relays, the number of simultaneously switching ballasts) - to take into account the parameters provided by the manufacturer.

We recommend using a relay contact with minimum switching current of 80A for switching a single ballast, such as the C-OR-0008M or C-LC-0202B (it can be stated that a relay with inrush switching current below 40A is of very little use for switching ballasts); when switching several ballasts simultaneously it is necessary to use a relay with a higher switching current: we recommend using modules fitted with relays with switching current of 800A - e.g. the C-OR-0011M.

If there are more than 4 simultaneously switching ballasts, it is necessary to thoroughly examine the maximum switching currents of the ballasts and the type of circuit breaker used in order to make sure that the front-end protection is reliable; sometimes it is necessary to divide the ballasts on several relay contacts and the SW should handle the consecutive switching (in large premises, such as industrial halls, etc., this method of control is acceptable).

6.7 Dimming – fluorescent lamps with a 0 ÷ 10 V ballast

Dimmable electronic ballasts for fluorescent lamps often use the analogue signal 0 to 10V, or 1 ÷ 10V to controlling dimming.
Any **analogue output** of the Foxtrot system can be used for brightness control.

Some ballasts do not completely switch off the fluorescent lamp, even if the voltage is 0; it is necessary to turn off the ballast power supply to switch the lamp off. This also reduces the unnecessary permanent power consumption of the ballast.

Selection of the relay output of the system for switching the ballast power supply needs to be addressed with regard to the maximum ballast switching current (the cold start); in some ballasts this value reaches 40A (for detailed description see Chapter 6.6.4.Switching power supply to ballasts DSI, DALI, etc).

If several ballasts are controlled simultaneously, maximum current in the analogue output must be observed (typically 10mA - see the respective module data), but what must mainly be observed is the maximum switching current of the relay output. When switching a higher number of ballasts (in industrial halls, etc.), they must be divided into several groups and multiple relay outputs must be used.
It is also necessary to take into account **the front-end protection,** to avoid its tripping. When ballasts are divided among a number of relay outputs, it is recommended to arrange their consecutive switching and thus decrease the current surge on the upstream protection.

6.7.1 HELVAR ballast control by C-IR-0203S module

To control the HELVAR electronic ballasts (and similar types of other manufacturers) designed to dim fluorescent lamps controllable by analogue voltage 0 ÷ 10V or 1 ÷ 10V, it is possible to use e.g. the C-IR-0203S module, which is fitted with a relay output to switch off the ballast power supply (complete switching off, cutting a permanent consumption) and an analogue output for the brightness control itself, which can be fitted directly in the lighting fitting or in the flush box.

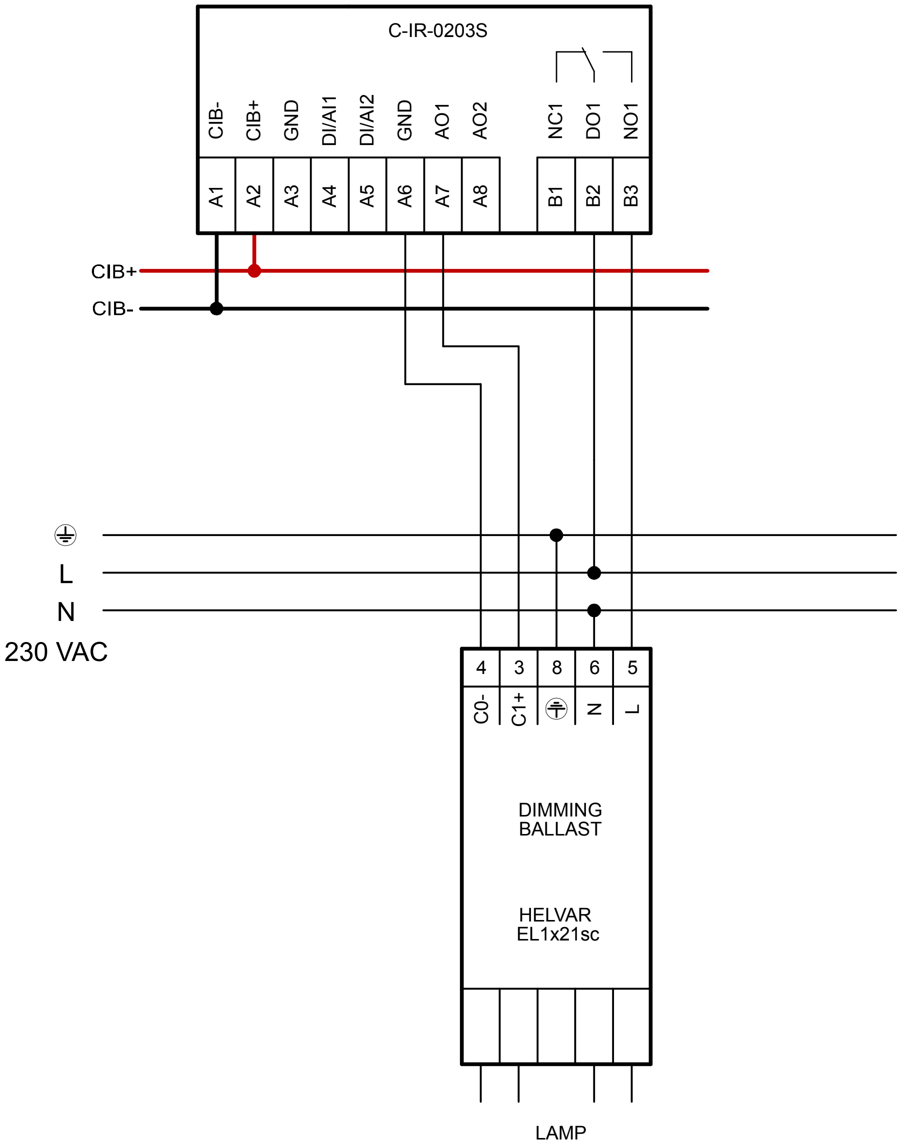


Fig. 6.7.1.1 A wiring example – dimming fluorescent lights ballasts 1÷10V by the C-IR-0203S module

Notes:

1. The module is equipped with a relay with a maximum inrush current of 80A; in the case of simultaneous control of multiple ballasts it is necessary to keep the total current below this value when the power supply is on.

6.7.2 0 ÷ 10 V ballast control by C-IR-0202S module

For controlling the electronic ballasts of fluorescent lights controllable by analogue voltage 0 ÷ 10V or 1 ÷ 10 V e.g. the C-IR-0202S module can be used, which is equipped with a relay output for switching off the ballast power supply (i.e. complete switching off and cutting off permanent consumption) and an analogue output for brightness control itself. This can be fitted directly in the light or in the flush box. Other modules with analogue outputs can also be used for control (e.g. the C-HM modules, which are also fitted with relay outputs for disconnecting power supply in a DIN rail version).

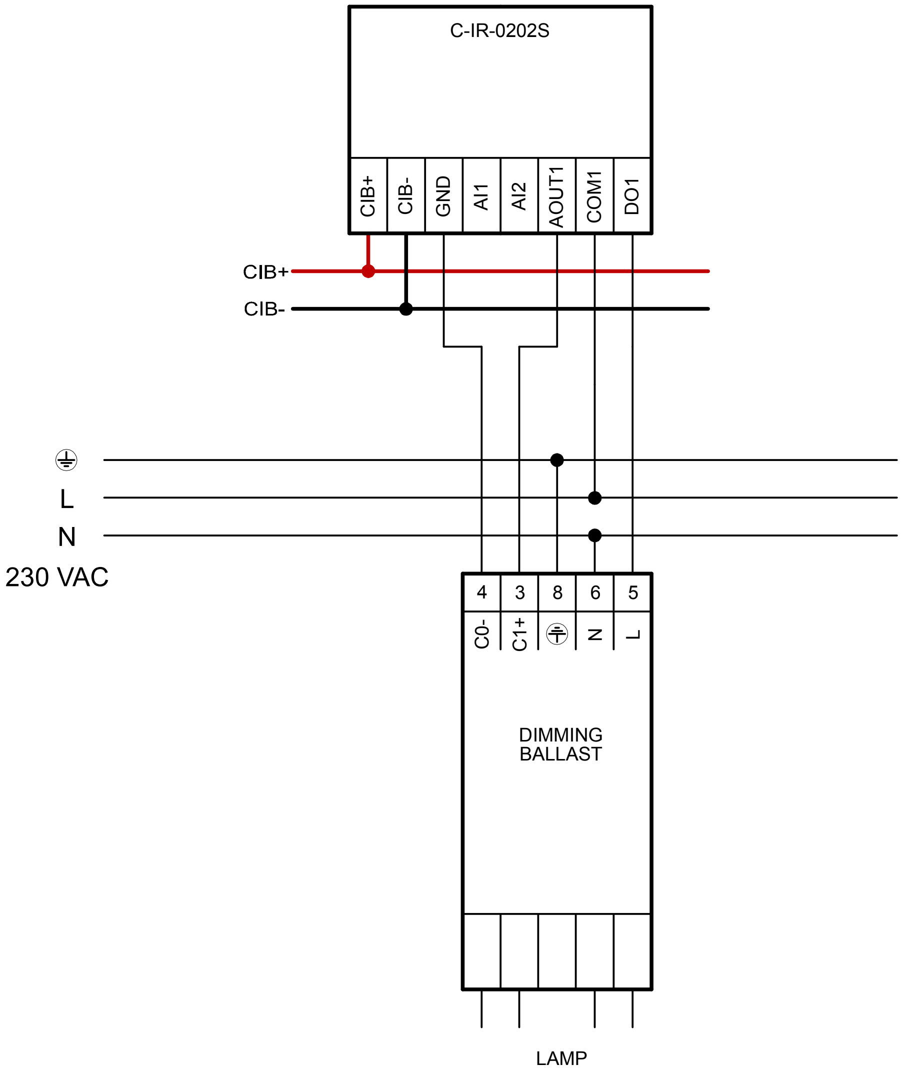


Fig. 6.7.2.1 A wiring example – dimming fluorescent lights ballasts 1÷10V by the C-IR-0202S module

Notes:

1. It should always be verified whether the ballast doesn´t draw more power than 5A when the power supply is switched on (maximum current in the module relay contact); if it does, another module must be used, e.g. the C-IR-0203 S (fitted with a relay with an 80 A inrush current).

6.8 Dimming – incandescent bulbs, LED lights, CFL, 12 V sources

For dimming incandescent bulbs, 230V fluorescent lights, 230V LED lights, compact fluorescent lights (CFL), electronic and inductive transformers for 12V sources (halogen lamps) there is available the dimming module C-DM-0402M-RLC in the version on a DIN rail.

The C-DM-0402M-RLC module facilitates switching and dimming by RLC load (resistance, inductive and capacitive load) and dimmable compact LED sources and compact fluorescent lamps.

It is not permitted in this module to simultaneously connect inductive and capacitive loads in one output. It is also necessary to protect the L units input by a fuse with F characteristics, which must be rated according to the connected load.

The C-DM-0402M-RLC module has 2 dimmable channels.
Each channel can be loaded by a incandescent bulb or several bulbs connected in parallel (this only applies to resistive loads - incandescent bulbs) with a maximum input of 500W - see Chapter Dimming sources with the output up to 500W.

Incandescent bulbs can be dimmed to their full output of 500VA. For higher outputs up to 2kW, as many as four channels can be connected in parallel; for wiring examples and further information see Chapter Dimming sources with the output up to 2kW.

LED lights can be dimmed up to a total input of 250VA, dimming multiple LED bulbs wired in parallel is possible up to 16 pieces; technical characteristics provided by the manufacturer must also be taken into account (such as limiting the number of LED lights that can be dimmed simultaneously).

Compact fluorescent lamps (CFL) can be dimmed up to their total input of 250VA.

Inductive transformers can be used up to the 250VA input, provided the minimum permanent load of the transformer is 80% of its nominal load.

The stated inputs are valid for **the 230VAC network**. If the dimmer is used in the 110VAC (50 ot 60 Hz) network, all inputs and outputs are only half!

The C-DM-0402M-RLC dimmer also has four universal inputs, which can be used for local control or for connecting e.g. temperature sensors (Ni1000, Pt1000). For more information on characteristics, principles of usage and wiring the dimmer C-DM-0402M-RLC see Chapter 14.1.16.

6.8.1 Dimming incandescent bulbs with the power input up to 500W

Connecting the output and input circuits of the C-DM-0402M-RLC dimmer for loads up to 500W is demonstrated in the following figure.

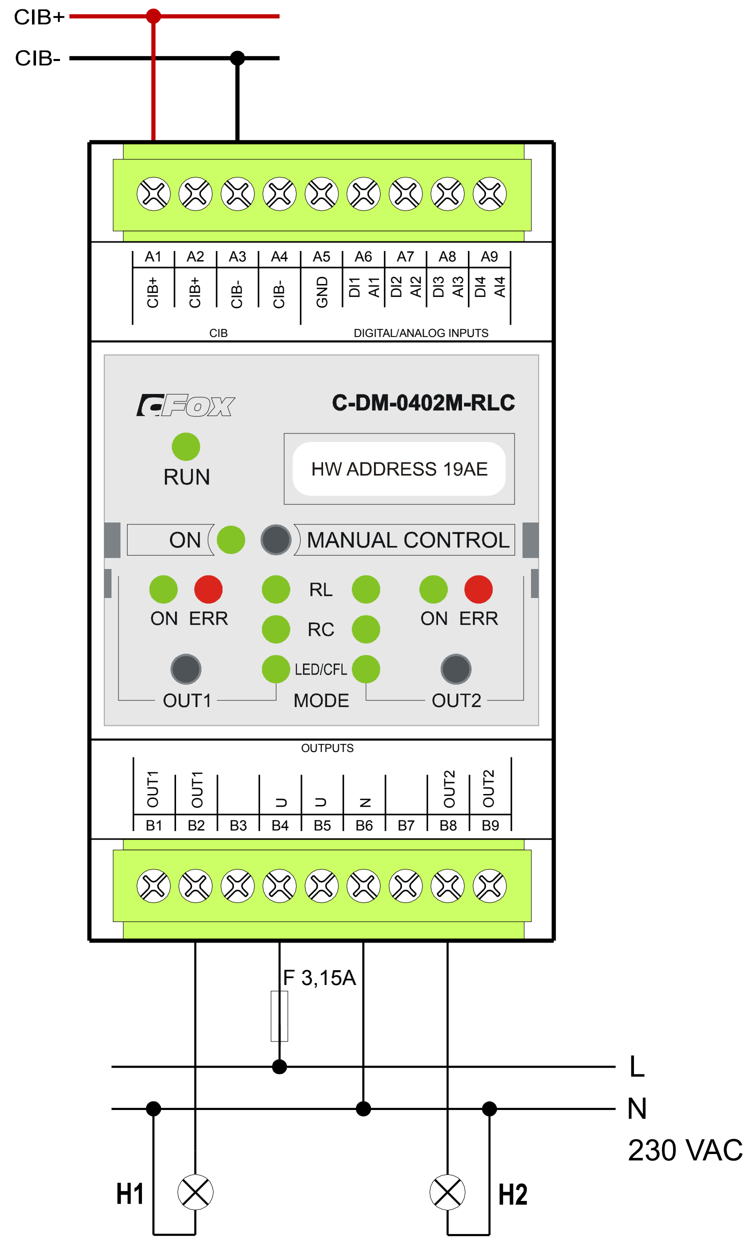


Fig. 6.8.1.1 An example of wiring the C-DM-0402M-RLC

Notes:

1. The inputs from AI/DI1 to AI/DI 4 are configurable as analogue (direct connection of temperature sensors Pt1000, Ni1000, NTC 12k, KTY81-121 resistance up to 160k), or as simple binary inputs (potential free contact connection).
2. In the same way compact fluorescent lamps (CFL) and LED lights are wired and dimmed.

6.8.2 Dimming incandescent bulbs with wattage up to 2kW

For dimming loads exceeding 500W there is available a parallel connection of dimmer outputs (only resistive load).
In the case of parallel connection of 2 channels, you get the total dimming power of 1kW,
when 4 channels are connected (two C-DM-0402M-RLC modules), you can get up to 2kW.
In order to operate correctly, both modules (connected by their output to reach the power of 2kW) must be on the same CIB branch, and they must be configured and controlled identically (identical data must be sent to both channels of both modules).

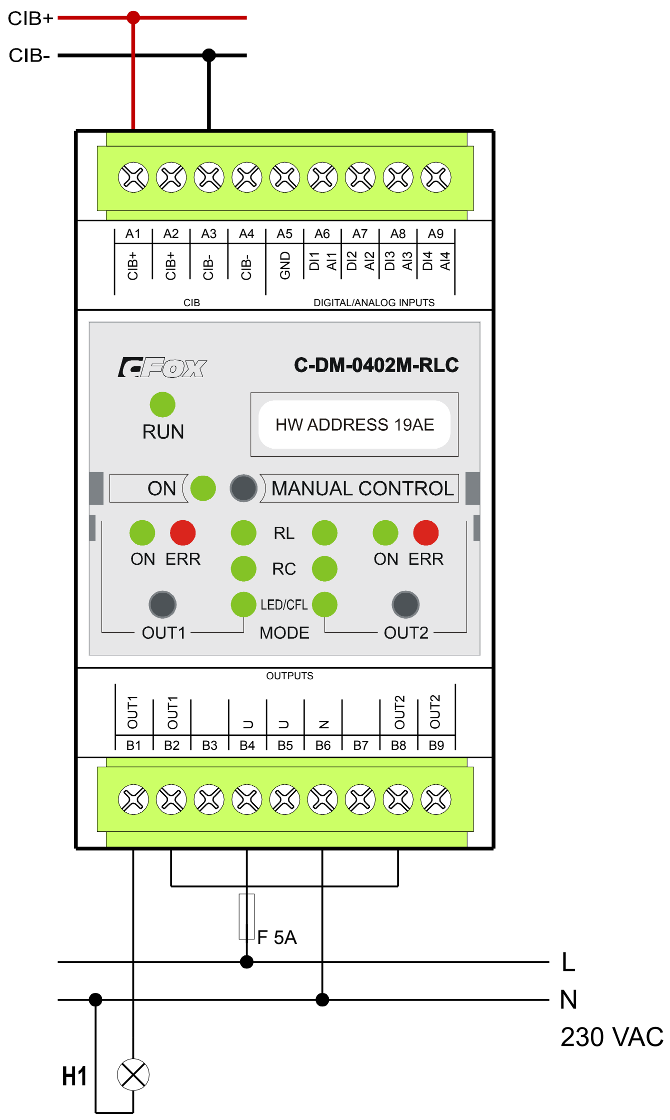


Fig. 6.8.2.1 Wiring the C-DM-0402M-RLC dimmer for loads up to 1kW

Notes:

1. To reach the dimming power of 1kW (load H1 in the example), any four channels of dimmers on the same CIB branch can be combined according to the example, i.e. always two channels of one module (see the figure), or four channels of two different modules (e.g. due to the power distribution and the resulting warming).
2. B1 and B2 terminals are internally interconnected; similarly also B4 with B5 and B8 with B9.
3. The N terminal is necessary for the internal circuits of the module; it is not loaded with a dimmed output, so it can be connected by a wire with smaller cross-section – e.g. 0.75mm^2

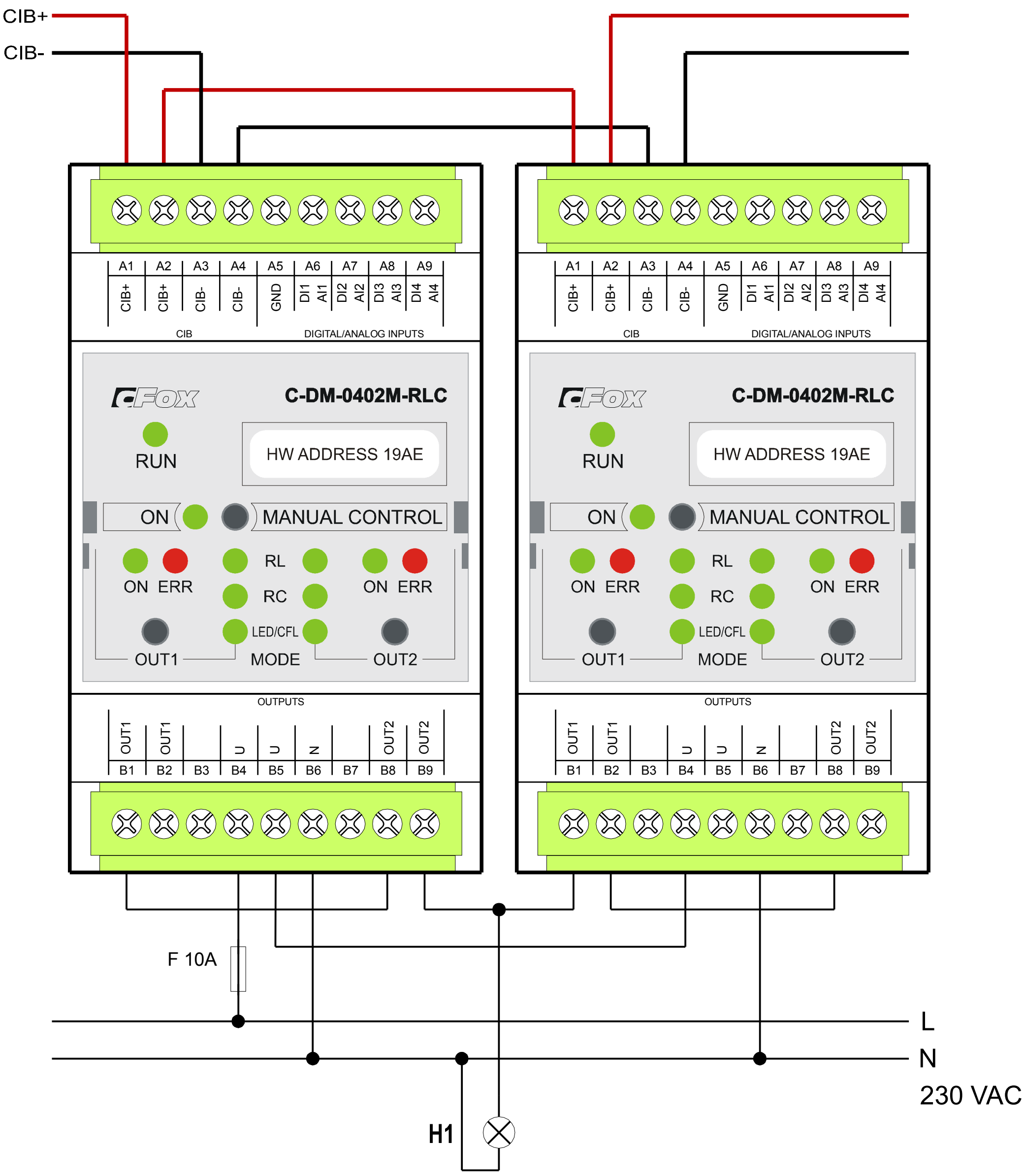


Fig. 6.8.2.1 Wiring the C-DM-0402M-RLC dimmer for loads up to 2 kW

Notes:

1. To reach the dimming power of 2kW (load H1 in the example), any four channels of dimmers on the same CIB branch can be combined according to the example, i.e. always two channels of two modules (see the figure), or four channels of four different modules (e.g. due to the power distribution and the resulting warming), and the like.
2. Terminals B1 and B2 are internally connected, similarly also B4 with B5 and B8 with B9.
3. With regard to the load of the terminals it is preferable not to transfer the overall power by the internal circuits of the modules, but to connect the outputs as shown in the figure (B9 outputs of the left module are connected with the B1 output of the right module and the H1 load).
4. The N terminal is necessary for the internal circuits of the module; it is not loaded with a dimmed output, so it can be connected by a wire with smaller cross-section – e.g. 0.75mm^2

5. To reach the power up to 1.5kW you can analogically connect 3 dimmer channels.

6.8.3 Dimming – low voltage sources with inductive and electronic transformers

To dim low voltage incandescent bulbs powered by inductive or electronic transformers, the dimming module C-DM-0402M-RLC on DIN rail can be used. It enables switching and dimming the RLC loads (resistive, inductive and capacitive loads) and dimmable compact LED sourses and compact fluorescent lamps.

Please note: It is not permitted in this module to simultaneously connect inductive and capacitive loads in one output. It is also necessary to protect the L units input by a fuse with F characteristics, which must be rated according to the connected load.

The C-DM-0402M-RLC dimmer has also 4 universal inputs , which can be used for local control or for connecting e.g. the temperature sensors (Ni1000, Pt1000). The connection of the output and input circuits of the dimmer C-DM-0402M-RLC is shown in the figure below.

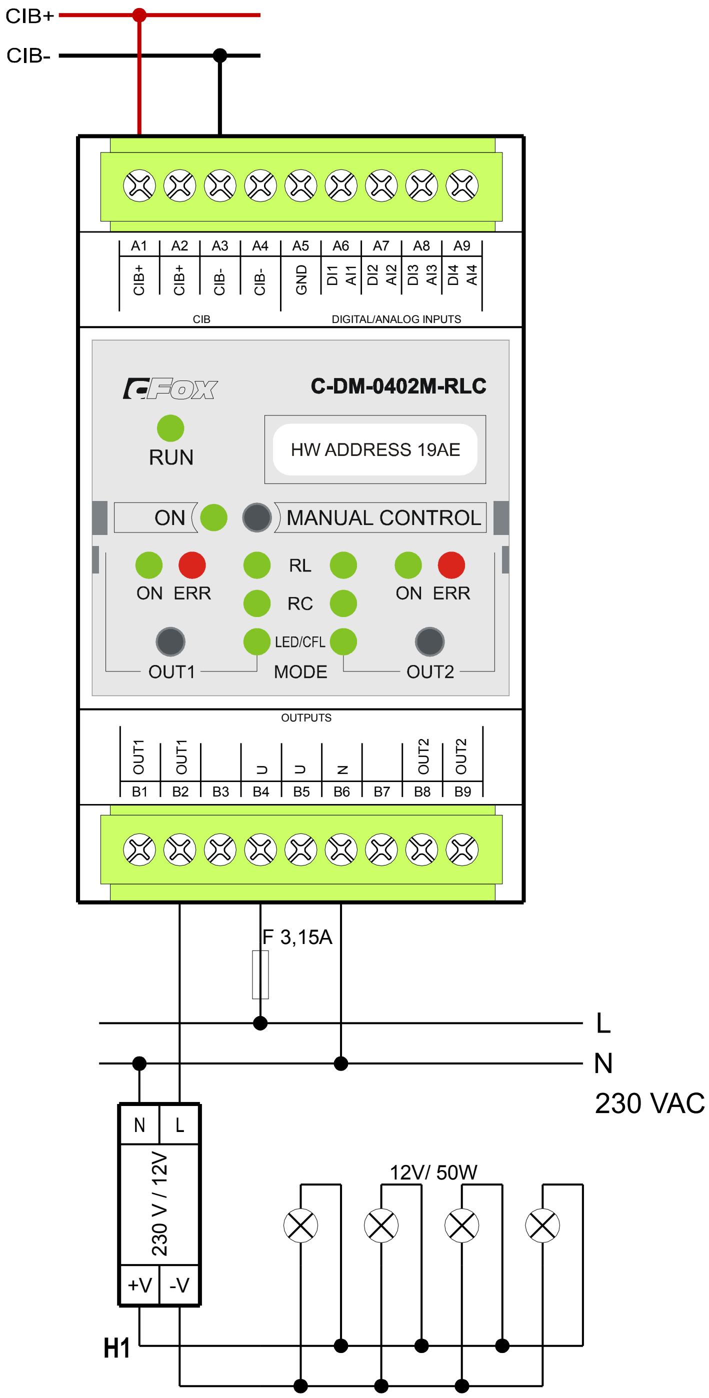


Fig. 6.8.3.1 An example of wiring the C-DM-0402M-RLC module

6.9 Dimming – the DMX control

The DMX512 is a serial protocol for the control of lighting technology such as dimmers and other special effects via a digital interface. The protocol has been maintained since 1998 by the organization ESTA (Entertainment Services and Technology Association). The multipoint wiring topology creates a bus with a single control station (master) and several controlled devices. The bus uses the RS485 interface and is typically implemented by a 120 Ω two-wire connection, and the slave stations create the so-called daisy chain, and a terminating resistor is connected to the last station.
The DMX512/1998 standard specifies that the connector must be the 5-pin XLR with female connectors used on transmitting ports and male connectors on receiving ports. However, the generally used connector is a 3-pin XLR.

The electrical requirements for the connection of the DMX bus are identical with the RS485 bus:

1. Strictly linear wiring without branching; if necessary, branching into a star can be resolved using active components (a hub).
2. The line must have impedance termination at both ends. E.g. on the side of the master module you can use the bus terminator, which is available on the MR-01xx submodule (see the example in Fig. 6.96.9. 1 for the MR-0106 submodule) and which is activated by soldering pads on the sub-module (for the description, see the TXV 101 15 submodule documentation); the other end of the bus (the last DMX controlled device) should be terminated with about 120 Ω resistor.
3. The bus must be lead in a shielded cable (see the recommended cables for RS485) with a twisted pair (data lines); the shielding must be connected to pin 1 of the connector. . The shielding must not be connected to the metal cover of the connector!
4. Due to a real possibility of causing interference (the power lighting control, etc.), the installation must be implemented correctly and all recommendations should be observed.

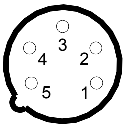
A master of DMX bus can be implemented only in the Foxtrot basic module, using the MR-0105, MR-0106 or MR-0115 submodules.

It works only on communication channels CH3 or/and CH4, which have the RS485 interface, because only these channels allow broadcasting at the 250kBd rate.
Regarding the lighting control, the Mosaic environment provides support in the form of function blocks.

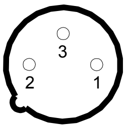
In accordance with the standard, the connector shielding must be implemented on no. 1 pin (in 5-pin connector); it must not be connected to the metal connector cover.

DMX Connector:

Pin	Signal	Wire (colour)
1	Earth (0 V)	Shielding
2	Data -	Black (1. pair)
3	Data +	White (1. pair)
4	Data2 -	Green (2. pair)
5	Data2 +	Red (2. pair)



5-Pin XLR plug



3-Pin XLR plug

6.9.1 The control of DMX devices, connection to the CH4 interface of the CP-1000 module

The following example illustrates the connection of DMX bus to the communication interface CH4 of the basic module CP-1000. As many as 512 devices on the DMX bus can be controlled in this way using the Foxtrot system user programme. The Mosaic programming environment offers support for easy application.

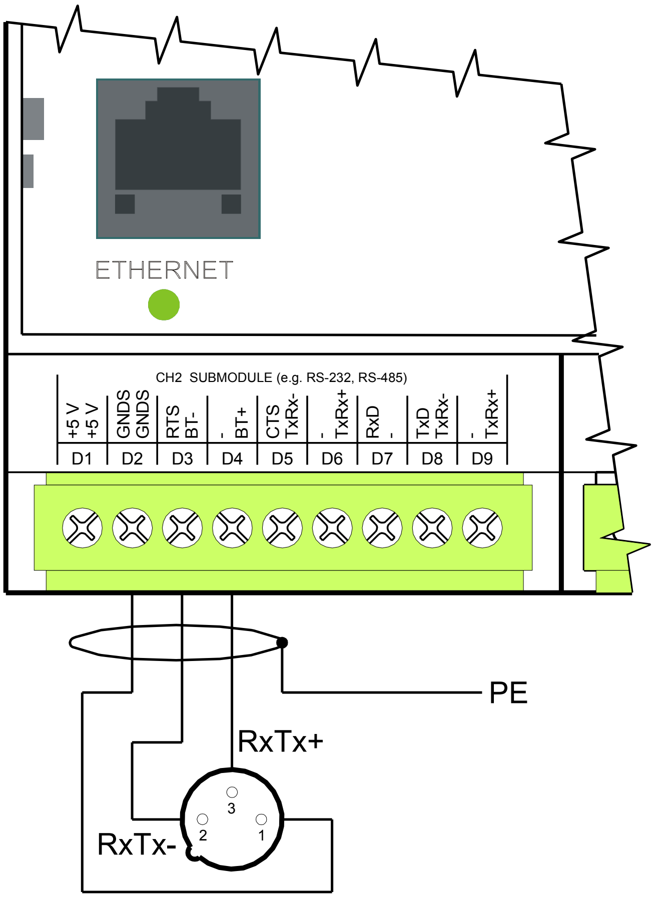


Fig. 6.9.1.1 An example of wiring a DMX connector to the CH4 CP-1000 (the MR-0106 or MR-0115 submodule)

Notes:

1) The cable shielding must be connected at one point only to the protective earth (PE); for detailed information regarding the correct installation of cables, see Chapter Cable installation and routing.
2) The cables for DMX distribution are consistent with the cables for the RS-485 interface; for recommended types, see Chapter Recommended cables for the RS-485 communication.

6.10 Controlling socket circuits and sockets

Sockets and single-phase socket circuits are usually protected by a 16A circuit breaker and they can be controlled (switched) by the Foxtrot system 16A relay outputs.

Depending on the requirement for the placement of the switching element, the following devices can be used:

- the relay outputs located in the control panel (typically modules C-OR-0008M, C-OR-0011M-800, 16A outputs of the C-HM-1121Mmodule and their RFox variants), see Chapter 6.10.1
- located in the flush box C-OR-0202B a R-OR-0001B, see Chapter 6.10.2
- freely usable plug adapter R-OR-0001W, see Chapter 6.10.3

As for switching 3ph sockets, usually with a higher rated current (32 A, etc.), it is necessary to use an external contactor rated for the relevant current and switched by a relay output of the system. The contactor should be treated (by its controlled coil) as an inductive load, i.e. to use interference suppression elements as described in Chapter 13.7.

6.10.1 Controlling socket circuits, the C-OR-0011M-800 module.

The most common way of controlling the socket circuits is by relay outputs directly from the control panel. Standard socket circuits protected by 16A circuit breakers can be controlled e.g. by the C-OR-0011M-800. The module is equipped with a relay with high quality contacts and an inrush current of up to 800A, which allows switching all types of devices powered from the sockets that correspond to 16A protection.

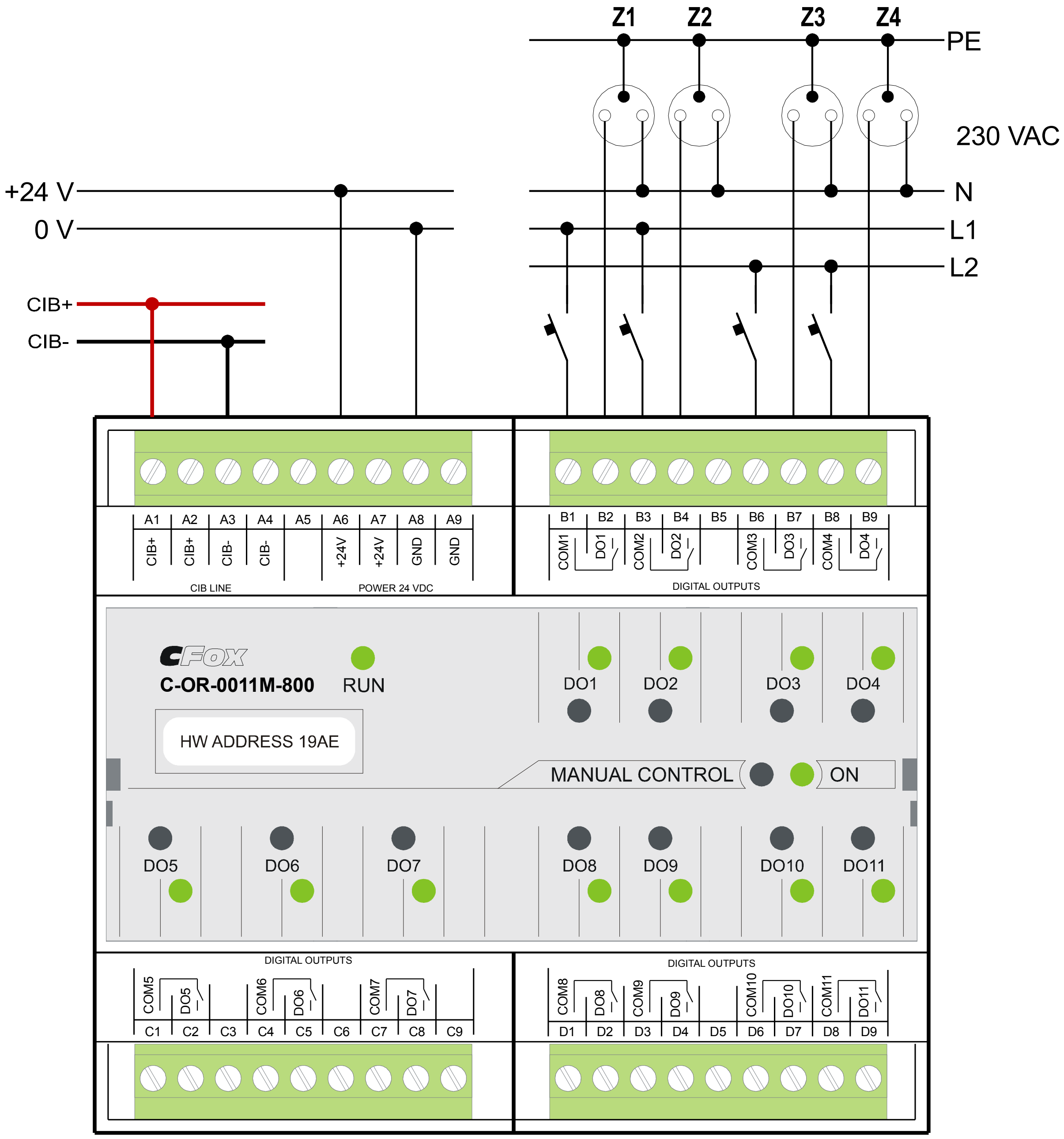


Fig. 6.10.1.1 An example of wiring the C-OR-0011M-800 module for controlling sockets

Notes:

1. Between the DO1 and DO2 outputs there is only working isolation (see the description of the module C-OR-0011M-800 in Chapter 14. Accessories), so they must be powered from the same phase (L1); between the DO2 and DO3 outputs there is isolation that meets the safe separation of circuits and therefore the DO3 and DO4 outputs can be powered from a different phase (L2).
2. The terminals used are rated for currents up to 16A, the same as the contact of the relays used.

6.10.2 Controlling the socket circuits, the R-OR-0001B module

If there is a requirement to control sockets directly where they are installed, or if already installed sockets need subsequently to be controlled, it is recommended to use the wirelessly communicating R-OR-0001B module, which should be fitted in a flush box next to the switched socket or under it.

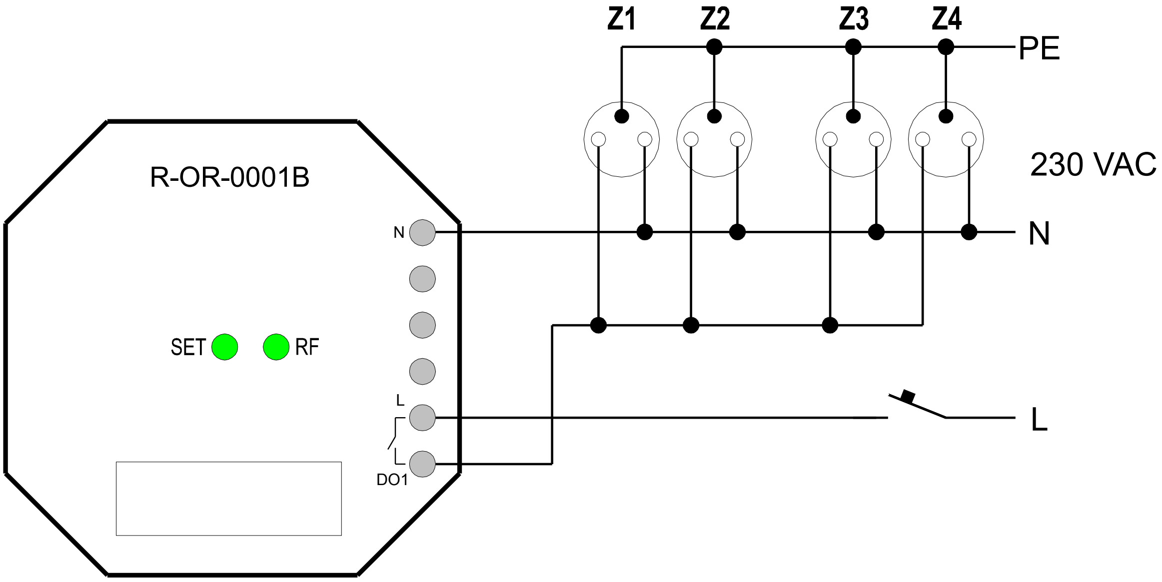


Fig. 6.10.2.1 An example of wiring the R-OR-0001B module for controlling sockets

Notes:

1. The module is designed for assembly in the flush box - a deep box under the socket, or in an independent standard box KU68, etc.
2. The contact of the relays used is 16A for continuous current, an inrush current up to 800A.
3. For detailed technical information on the module, see Chapter 14.

6.10.3 Controlled sockets – the R-OR-0001W socket adapter

In order to control appliances powered from standard 230VAC sockets, the R-OR-0001W adapter can be used.

The adapter should be installed in a standard wall socket and it is fitted with another socket, which is controlled by RF communications according to the Foxtrot system user programme. From the viewpoint of its function, it is a standard relay control system output.

7 Window blinds, shades, windows, doors

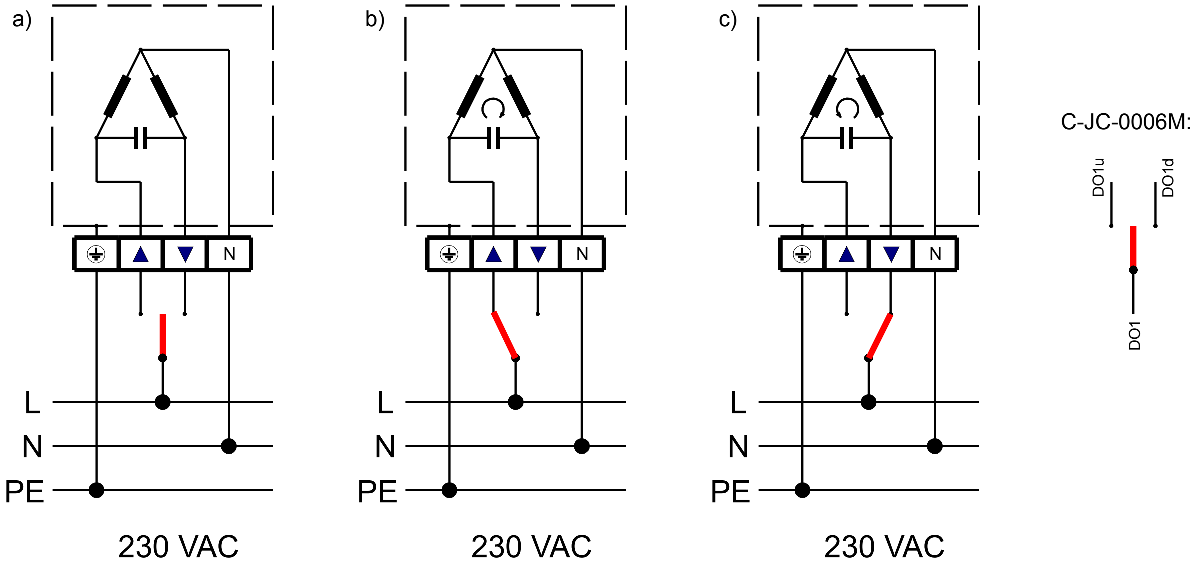
The table of contents of the chapter

This chapter describes the characteristics, identifies possible problems and gives examples of connections for the control of:
- exterior and interior venetian blinds
- roller blinds
- awnings and similar shading technology devices

- the control of the actuators and entrance doors locks
- garage doors
- outside fence gates

7.1 The control of venetian blinds and roller blinds

The motors for drives of blinds, awnings and similar devices are typically **AC asynchronous motors** with reverse switching of power supply coil (directly and via the capacitor), with a typical power consumption from 60 to 150VA. The three-point controlled actuators used for the control of e.g. heating systems have motors with identical design. They are controlled in the same way and they can also be connected in the same way as the asynchronous motors for blinds.
The following figure shows the principle of control of the rotation direction in 1ph asynchronous motor for blinds:



a) The motor is inactive, both outputs (e.g. the DO1u and DO1d outputs in the C-JC-0006M module) are open.

b) The motor is turning up, the DO1u output is switched to the phase of the 230VAC supply wire.

c) The motor is turning down, the DO1d output is switched to the phase of the 230 VAC supply wire.

Switching can be carried out by any Foxtrot system relay outputs, but in order to rule out switching both outputs (directions) at the same time, it is preferable to use relays where switching contacts are connected with an interlocking switch (see the Chapter Control of asynchronnous motors for external venetian blinds and awnings).

It is absolutely necessary to eliminate in these drives a simultaneous connection of input terminals for both directions - it is very likely to damage the motor.

Only one motor can be connected to one relay output of the system, unless it is specifically permitted by the manufacturer of the blinds (their drives).

The control logic itself (end positions, running time, turning blinds) must be dealt with in the application program according to specific motors and their controlled shading elements, e.g. via the ready-to-use function blocks in the Mosaic environment.

It is always necessary to ensure that there is no simultaneous switching of both outputs (up and down), and if the direction of movement is rapidly switched (e.g. from the way up to the way down), at least 300 ms pause must be guaranteed (as specified by the motor manufacturer) to avoid damaging both the motor and the complete relay system output.

For interior venetian blinds and roller blinds are also used smaller **DC motors** (12VDC or 24VDC), in which the direction of rotation is reversed by changing the polarity of the supply voltage (see. Chapter Control of asynchronous motors for blinds and awnings).

In outdoor awnings it is advisable to deal with automatic closing in relation to the wind speed, for whichthe T114 anemometer can be used, as well as the GIOM3000 weather station or similar sensors. It is also possible to use information from the rain gauge and other sensors in the Foxtrot system.

The venetian blinds can also be controlled with regard to the speed of wind, like awnings, and information from glass break detectors can also be used for their control (e.g. if glass is broken during a hailstorm, the venetian blinds are closed to mitigate possible damage in the house interior, in spite of the risk of the blinds being damaged).

Both outdoor and indoor illumination intensity sensors can also be used for the control of blinds in order to maintain the desired level of interior illumination.

7.1.1 Control of asynchronous motors for blinds and awnings, the C-JC-0006M

In order to control the 230VAC motors reversed by switching the coil (like in the 3-position actuators for valves and dampers), there is a specialized module C-JC-0006M equipped with 6 outputs for controlling blinds. In this module, blocking simultaneous switching of both outputs is done both mechanically (via an internal arrangement of relay outputs) and by the programme (provided by the module firmware).

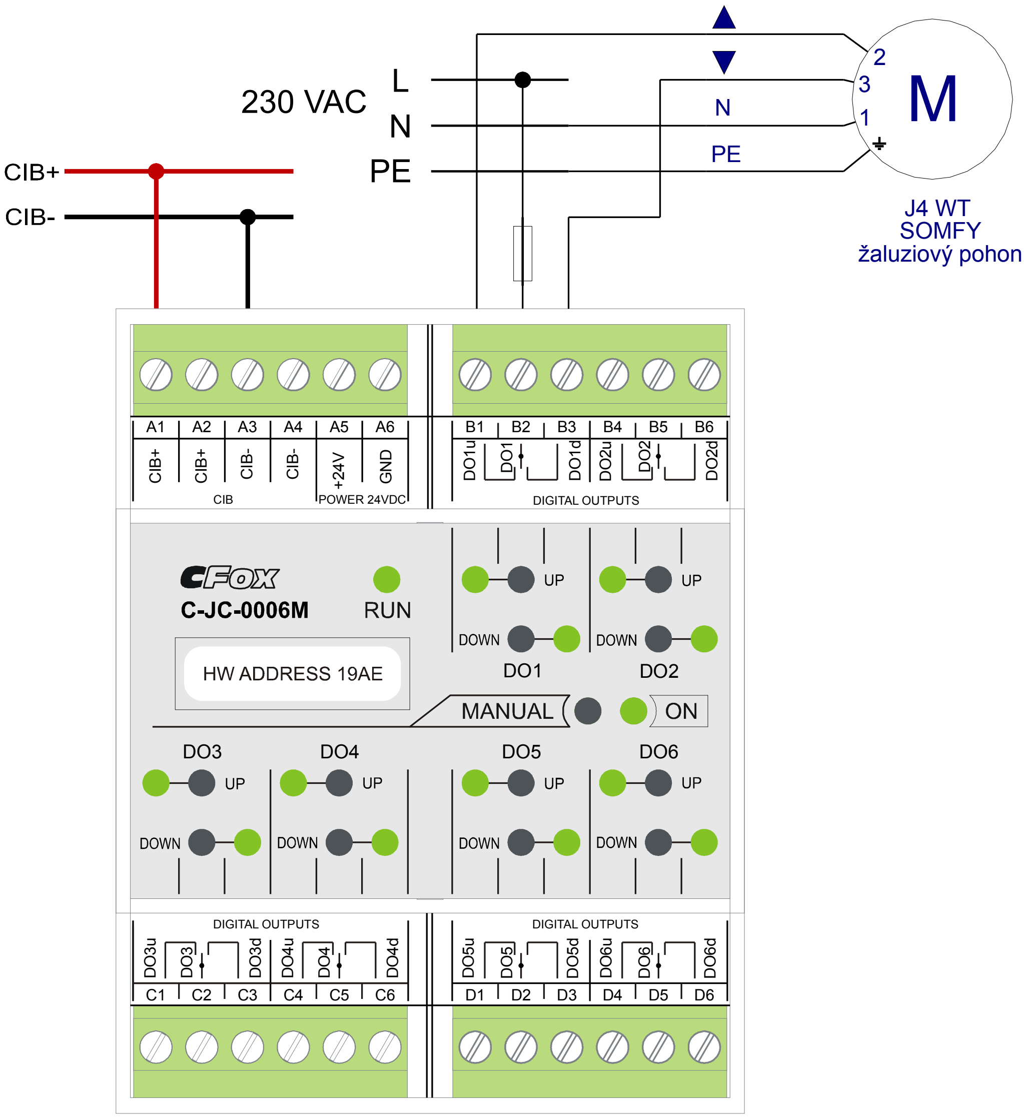


Fig. 7.1.1.1 An example of wiring the blinds motor control by the C-JC-0006M

Notes:

1) The relay outputs with interlocking of switching both outputs; when DO1u is switched, the motor goes up, when DO1d is switched, it goes down.
2) The relay contacts can have a maximum current of 5A.
3) Considering the power of motors for shading elements actuation, the 0.8 ÷ 1.5mm^2 cross section of the power and control cables is sufficient.
4) On the front panel of the module there are buttons, which allow manual control of blinds in case of communication failure, or even during a normal system operation (if the configuration enables this).
5) Parallel connection of multiple motors is only possible if it is expressly permitted by the manufacturer; in the case of the J4 WT motors, the manufacturer permits parallel connection of max. 3 drives on one relay control output of the system.

7.1.2 Control of asynchronous motors for blinds and awnings, the C-JC-0201M

In order to control the 230VAC motors reversed by switching the coil (like in the 3-position actuators for valves and dampers), there is the specialized module C-JC-0201B designed for the control of one blind and located in the flush box close to the shading element, or directly inside the body of the blind. In this module, blocking simultaneous switching of both outputs is done both mechanically (via an internal arrangement of relay outputs) and by the programme (provided by the module firmware).

The module is equipped with two inputs, which are designated for the connection of a push-button control of the blinds. If there is a communication failure, there is an autonomous function of module, which controls the outputs (blinds) via push-buttons.

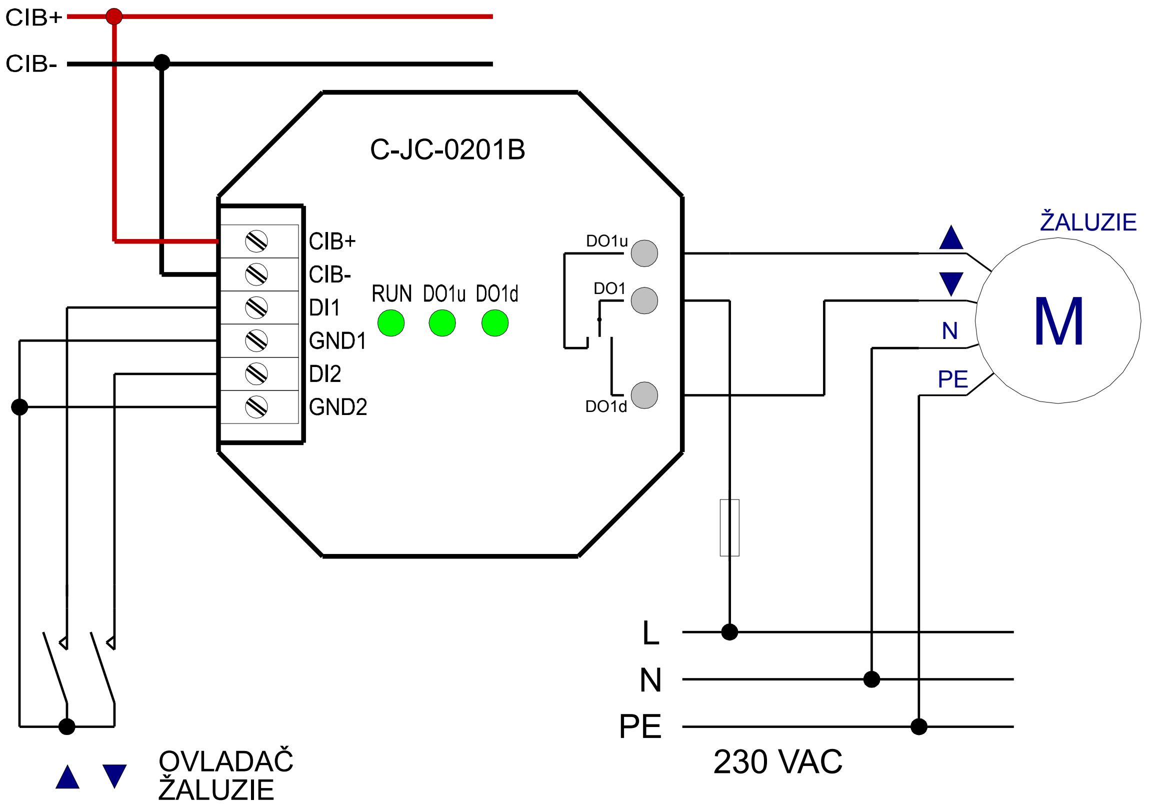


Fig. 7.1.2.1 An example of wiring the blinds motor control by the C-JC-0201B module

Notes:

1) The relay output is designed with mutual mechanical locking of switching both outputs simultaneously; when DO1u is switched, the motor goes up, when DO1d is switched, it goes down.
2) The relay contacts have an inrush current of up to 16A, so they can easily manage the accompanying events of switching and opening contacts.
3) Considering the power of motors for shading elements actuation, the 1.5mm^2 cross section of the power and control cables is sufficient.
4) Two inputs - DI1 and DI2 - are designed for direct connection of push-buttons of the blinds control unit; if the deep flush box is used (e.g. KOPOS CPR or CPR 68 68/L), or a box with a lateral space (e.g. KUH 1 or KUH 1/L), the C-JC-0201B module can be mounted directly under the push-button actuator.
5) In the case of a communication failure, the module automatically controls the outputs in accordance with the status of the DI1 a DI2 inputs (when the DI1 is pushed, the DI1u output is switched; when the DI2 is pushed, the DO1d output is switched); simultaneous switching is blocked.

7.1.3 Control of asynchronous motors for blinds and awnings, the C-JC-0202B

To control the 230VAC motors with reverse switching of power supply coil (similarly to the 3-position drives for valves and dampers), we recommend to use relay outputs that can block simultaneous switching of both outputs (which usually causes damage to the motor drive).

Wiring the control by a by the module located directly in the construction or close to the shielding element in the flush box..

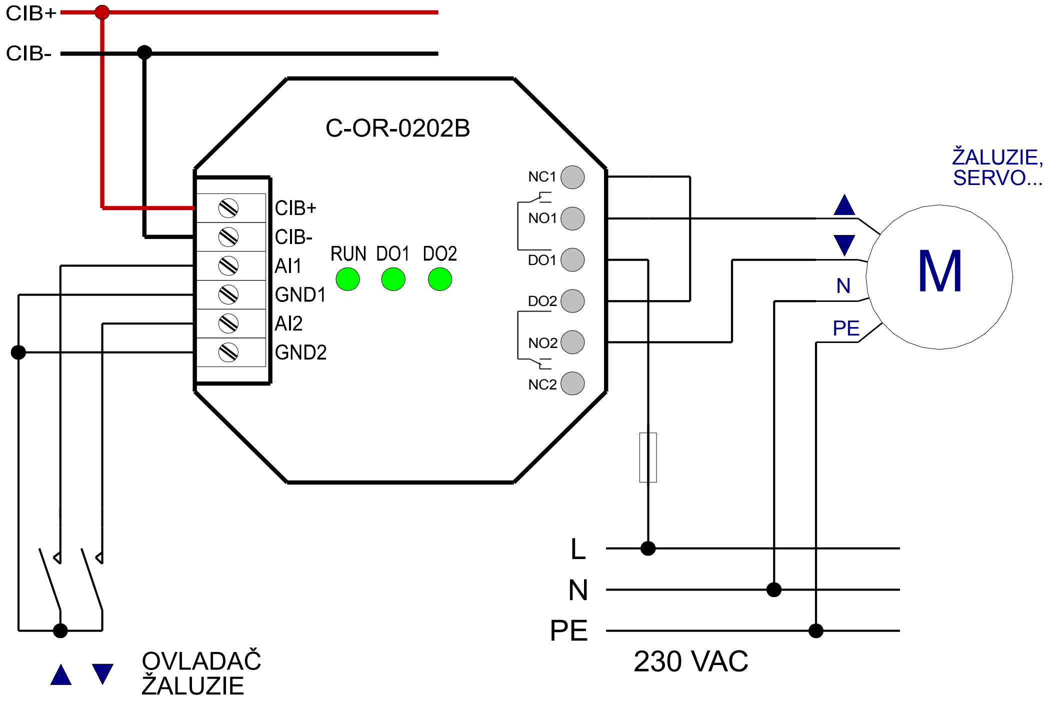


Fig. 7.1.3.1 An example of wiring the blinds motor control by the C-OR-0202B module

Notes:

1) Relay outputs with interlocking of switching both outputs; when DO1u is switched, the motor goes up, when DO1d is switched, it goes down; if both outputs are switched simultaneously, the motor goes up.
2) The relay contacts have an inrush current of up to 80A, so they have no problem managing the switching phenomena during switching and opening contacts.
3) Considering the power of motors for shading elements actuation, the 1.5mm^2 cross section of the power and control cables is sufficient.
4) Two universal inputs (AI1 and AI2) can be used for a direct connection of buttons of blinds control units; in the case of a deep flush box (e.g. KOPOS CPR 68 or CPR 68/L), or a box with a lateral space (eg. KUH 1 or KUH 1/L), the C-OR-0202B module can be installed directly under the push-button control unit.

7.1.4 Control of asynchronous motors for blinds and awnings, C-OR-0008M

To control the 230VAC motors with reverse switching of power supply coil (similarly to the 3-position drives for valves and dampers), we recommend to use relay outputs that can block simultaneous switching of both outputs (which usually causes damage to the motor drive).

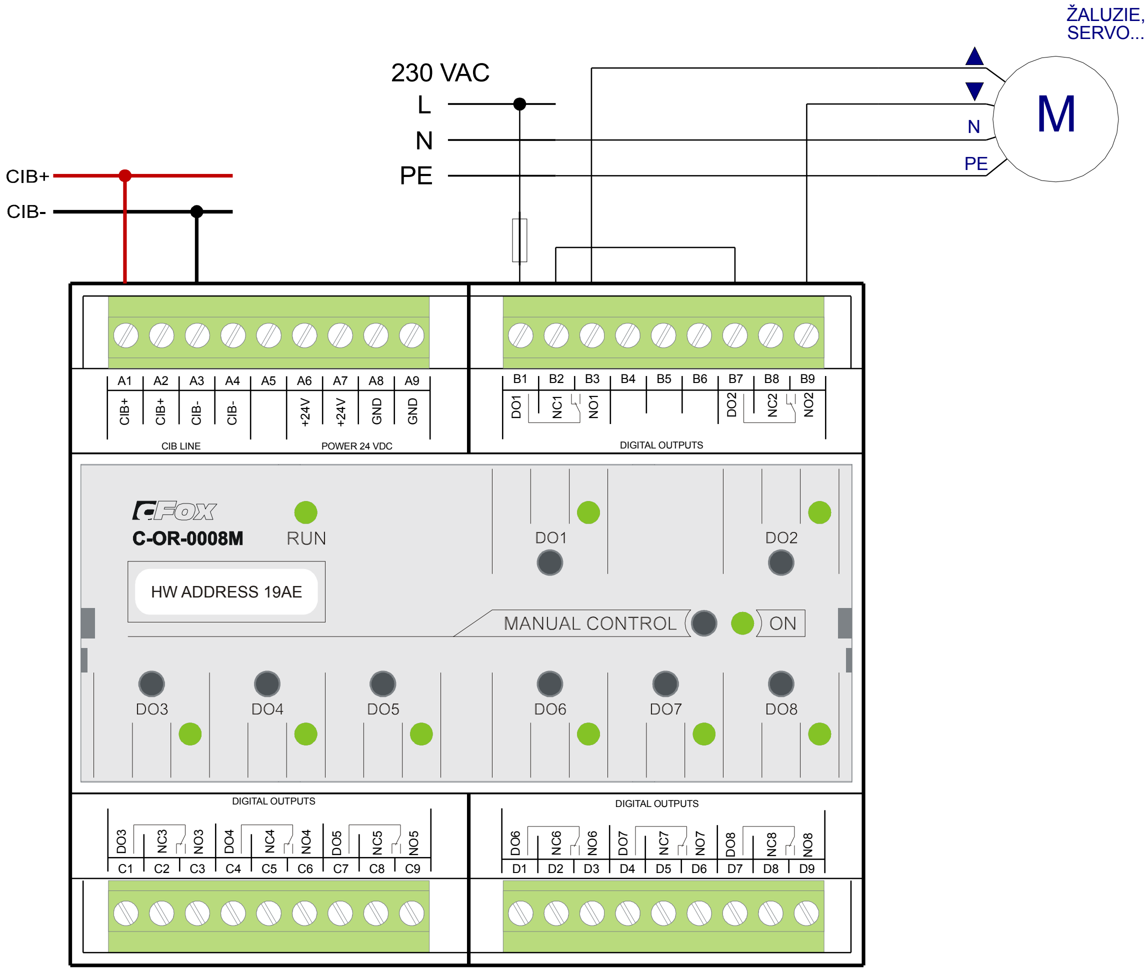


Fig. 7.1.4.1 An example of wiring the blinds motor control by the C-OR-0008M module

Notes:

1) Relay outputs with interlocking switching of both outputs; after switching DO1, the motor goes up, when DO2 is switched, the motor goes down; if both outputs are switched on by mistake, the motor remains inactive.
2) The relay contacts have an inrush current of up to 80A, so they have no problem managing the switching phenomena during switchning and opening contacts.
3) Considering the power of motors for shading elements actuation, the 1.5mm2 cross section of the power and control cables is sufficient.

7.1.5 Control of the SOMFY blinds, the RS485 RTS communication converter

To control the SOMFY RTS roller and venetian blinds motors, you can use the communication transducer RS-485 RTS connected to the RS-485 communication interface of the Foxtrot system.
One RTS module can wirelessly control up to 16 motors by means of the Animeo RTS motor controller modules, which control conventional roller and venetian blinds motors (e.g. 24VDC reversed motors).

Fig. 7.1.5.1 An example of connecting the SOMFY blinds by the RS-485 interface

Notes:

1) The RTS RS485 module is connected by a standard cable for the RS-485 interface, see the description of the interface.
2) One bus can control up to 16 RTS modules, and each RTS module can control several motors.
3) There is standard RS-485 communication with 4,800 Bd data transfer rate; the description of communication is available on request.

7.1.6 Control of SONESSE 30 RS485 drives manufactured by SOMFY

The Sonesse 30 RS485 tubular drives can be controlled via their direct communication with the RS-485 interface. The drive can be connected to any communication channel of the Foxtrot system with the RS-485 interface, without the need for any additional converter or control module. The function block of the system makes it possible to control the position of the motor (commands to open, close and stop it), reverse reading of the engine status (reaching the end position).

The motor on the side intended to be mounted on the house construction has three connectors. The 4-pin connector is designated for the initial setup (the end position, etc. ...).The 3-pin connector has a terminated communication interface RS-485, and 24VDC supply voltage is connected to the 2-pin connector.

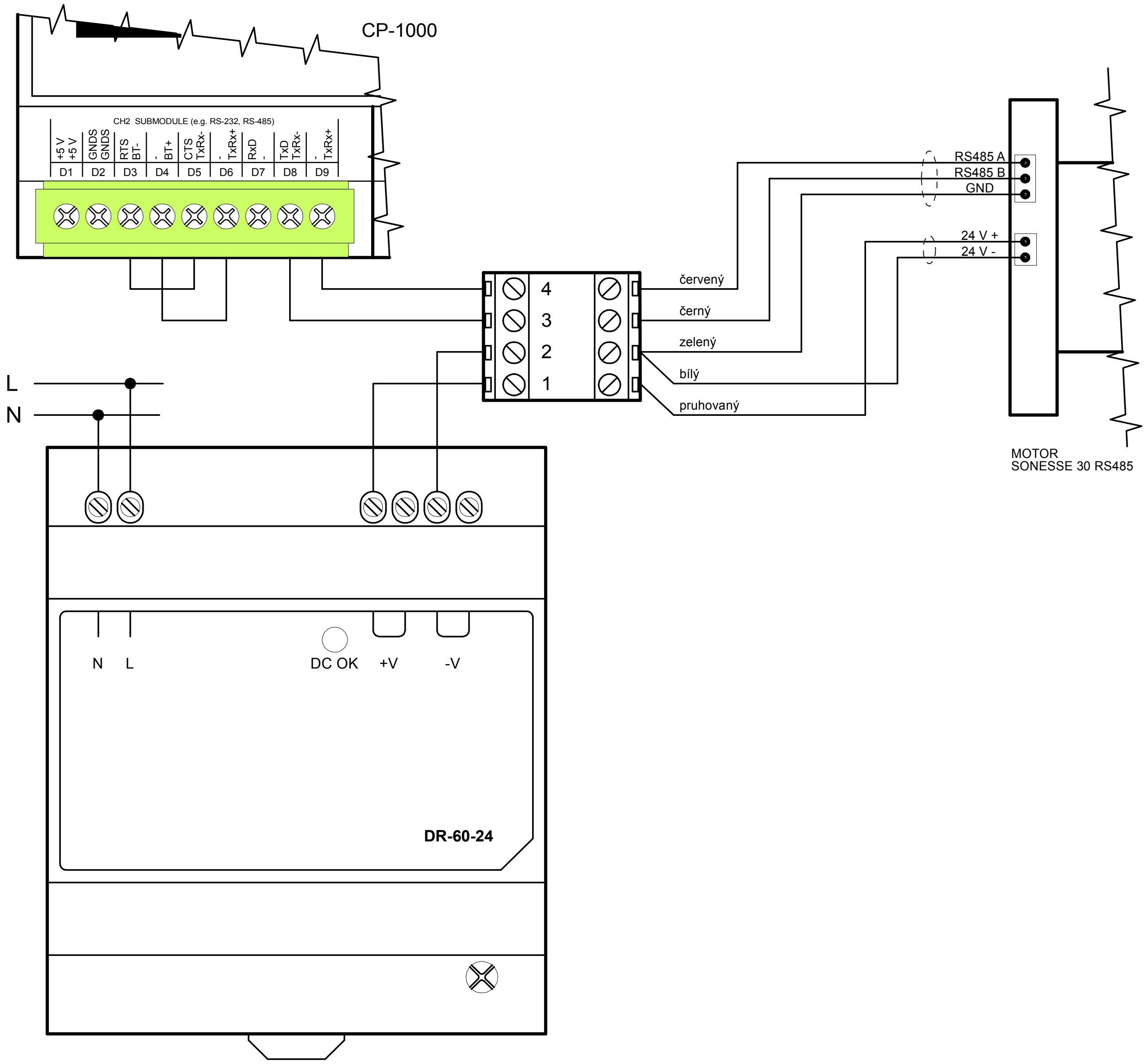


Fig. 7.1.6.1 An example of connecting the SONESSE 30 RS485 motor to CH2 interface of the CP-1000 module

Notes:

1. Cables with the RS-485 interface and power supply are part of the motor; the example shows the wiring to the interface connector recommended by the motor manufacturer.

7.1.7 Control of ILT motors manufactured by Somfy

The ILT drives by SOMFY can be controlled via direct communication with the control module RS485 4ILT INTERFACE with the RS-485 interface, which can control up to 4 motors with ILT interfaces.The unit can be connected to any communication channel of the Foxtrot system with the RS-485 interface. The function block of the system makes it possible to control the position of the motor, reverse reading of the engine status and reaching the end position.

The motor (maximum 4) is connected to the control unit via a special cable with the RJ9 connector, the control unit is fitted with a plug terminated with the RS-485 interface for connection to the control system.

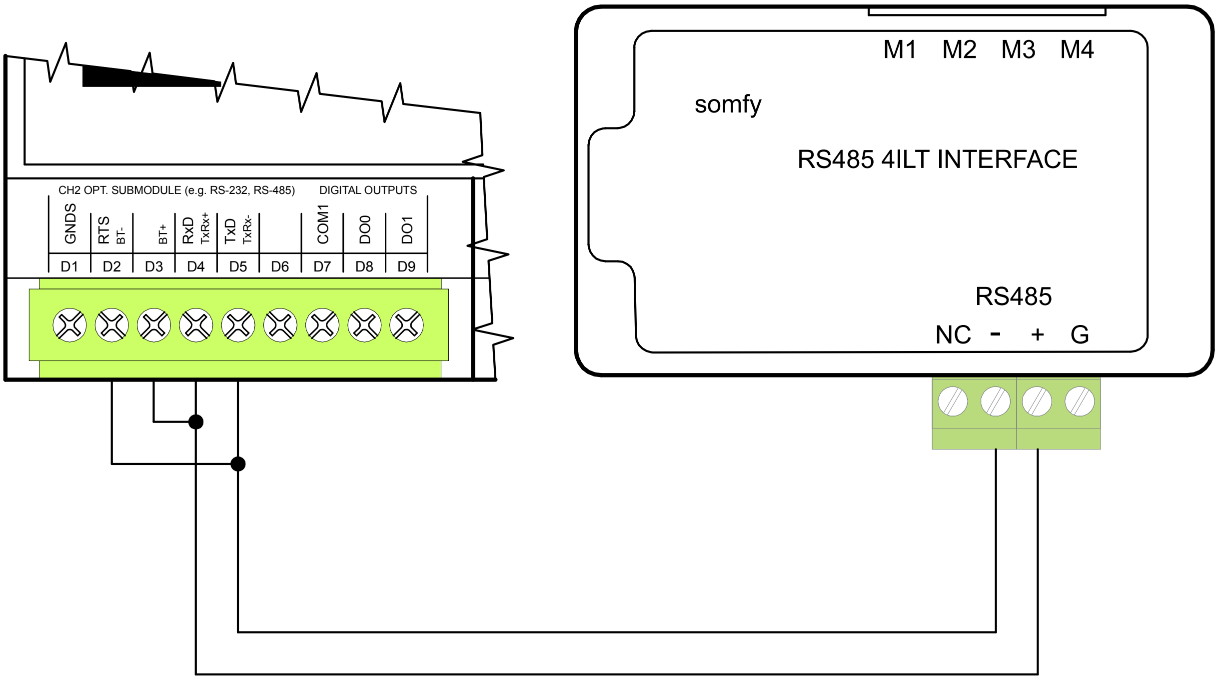


Fig. 7.1.7.1 An example of connecting the RS485 4ILT to the CH2 CP-1006

7.1.8 Control of direct current motors for roller blinds

In order to control DC motors reversed by switching the polarity of supply voltage (motors for interior blinds, and such like), we recommend to use relay outputs with a switching contact, such as the C-OR-0202B.

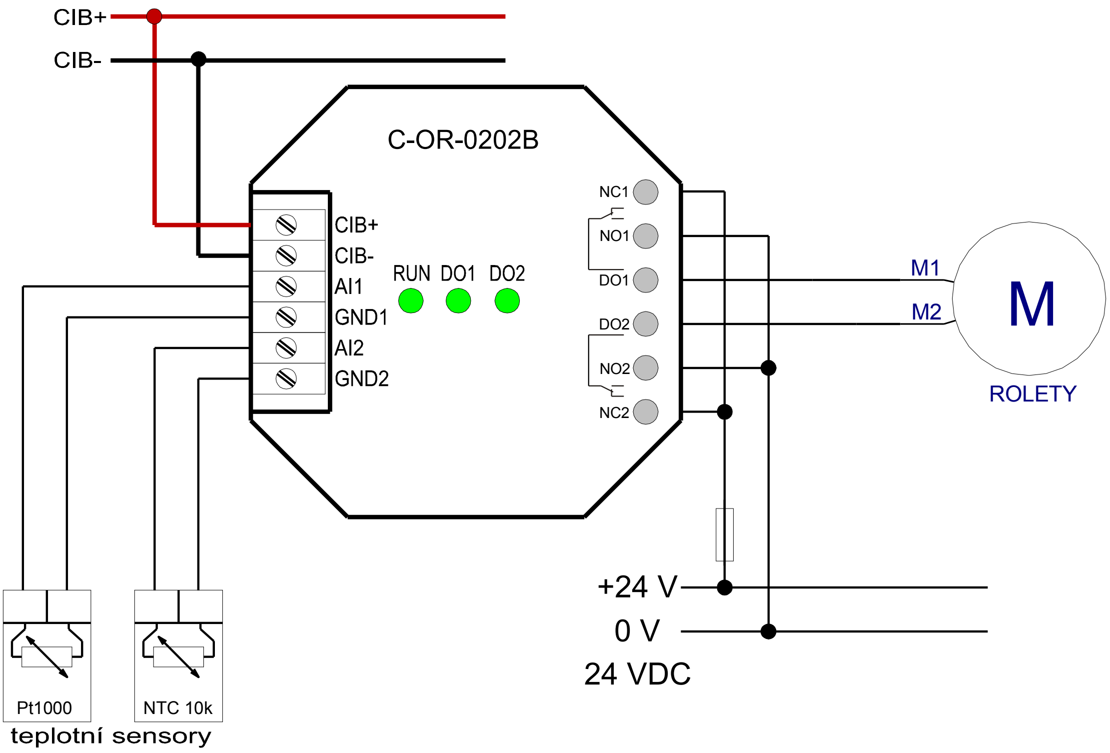


Fig. 7.1.8.1 An example of wiring the control of DC motor for roller blinds by the C-OR-0202B module

Notes:

1) The power supply for motors and the necessary protection should be mounted in accordance with the specifications of the particular motor manufacturer.
2) The external temperature sensor can be used for measuring the temperature in the room, or the input can be used for connecting a potential-free contact (a window contact, a push button, and such like).
3) E.g. the Somfy LT 28 actuator connected in this way requires the supply voltage in the range of 20 to 27VDC.
4) The relay outputs of the C-OR-0008 module can also be connected in the same way, if it is required to fit the switching elements in the switchboard panel.

7.1.9 Connecting the LUTRON system blinds

The LUTRON system blinds can be integrated as part of the installation of the LUTRON system - the control of lighting and blinds, which is supplied as a complete system that is integrated in the Foxtrot system house control.

Further information and solutions are provided by the KD Elektronika company.

7.2 Gates and doors control

The control of doors and gates can be designed similarly to LineaMatic sliding gate connection; the remote control can be designed with the help of RFox control unit, or with a separate remote control, whose contact outputs are connected to the CFox peripheral module for the actuator control (like the push-buttons). To secure the gate, you can use a door opening detector specially designed for these applications.

7.2.1 Connecting the LineaMatic sliding gate

For controlling the LineaMatic sliding gate, an actuator produced by Hörmann can be used. The actuator basic control uses two signals - full opening or partial opening of the gate (about 1.5m) for the passage of people.

To control the gate it is recommended to use the C-OR-0202B module located at the gate. The module inputs can be used e.g. for the local control buttons, or for connecting the RF receiver outputs (if you want to use a remote control produced by a different manufacturer).

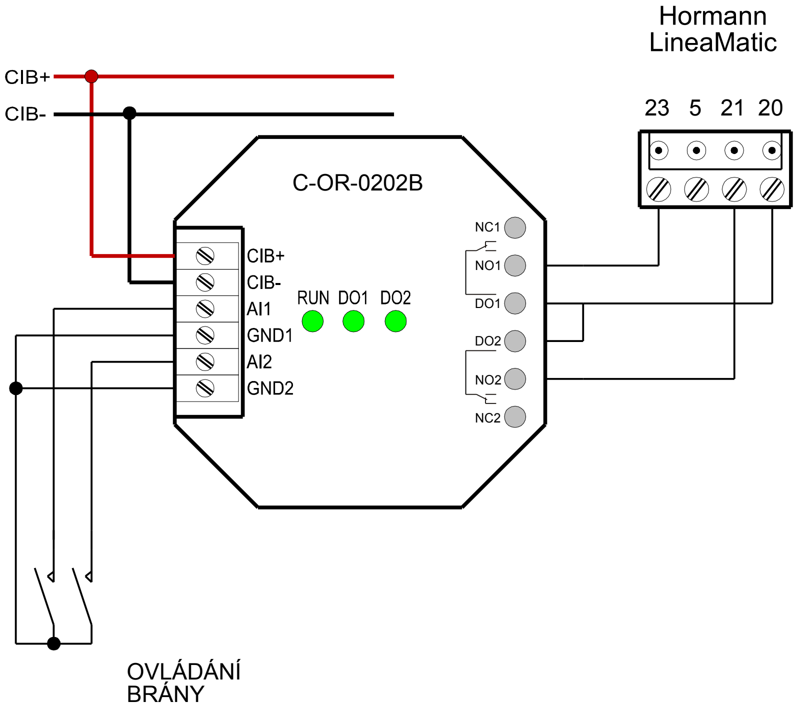


Fig. 7.2.1.1 An example of connecting the LineaMatic drive to the C-OR-0202B module

Notes:

1) The terminal block signals ("ext. Funk") Lineamatic:
   20 – GND,
   5 – 24VDC output (maximum 500mA),
   23 – a partial opening of the gate
   21 – impulse control (opening -stop-closing -stop).
2) A maximum distance of the relay module from the gate drive (the length of the cable) id 10m.

7.2.2 Connecting the cylindrical insert with the integrated reader APERIO C100

In order to integrate the wireless APERIO C100 cylinders or E100 escutcheons manufactured by Assa Abloy, there should be used the C-WG-0503S module with the Wiegand protocol.
The Wiegand communication HUB should be connected to the C-WG-0503S module; it provides wireless communication with its own APERIO C100 cylinder or with the APERIO E100 escutcheons, which provide locking the door and its user control via the RFID cards.

Basic features of APERIO C100:
The function of the outside knob:
- It is electronically controlled, in idle state it rotates freely.

The function of the inside knob:
- It is not electronically controlled, when it rotates, the cam in the cylinder is always engaged.

If panic lock is used, it also controls the latch.

Applications:
- For full and frame doors with a narrow frame profile, for glass and other atypical designs.
- A suitable solution for extending the existing access control systems or for applications with restrictions in installations of standard cable technologies.
- The cylinder can be easily configured for standard RFID technologies.

Benefits:
- On-line communication.
- It is compatible with all DIN mortice locks, suitable for locks on glass door wings and walls.
- Battery-powered, simple replacement.
- A possibility of monitoring access.
- Easy and quick to install.

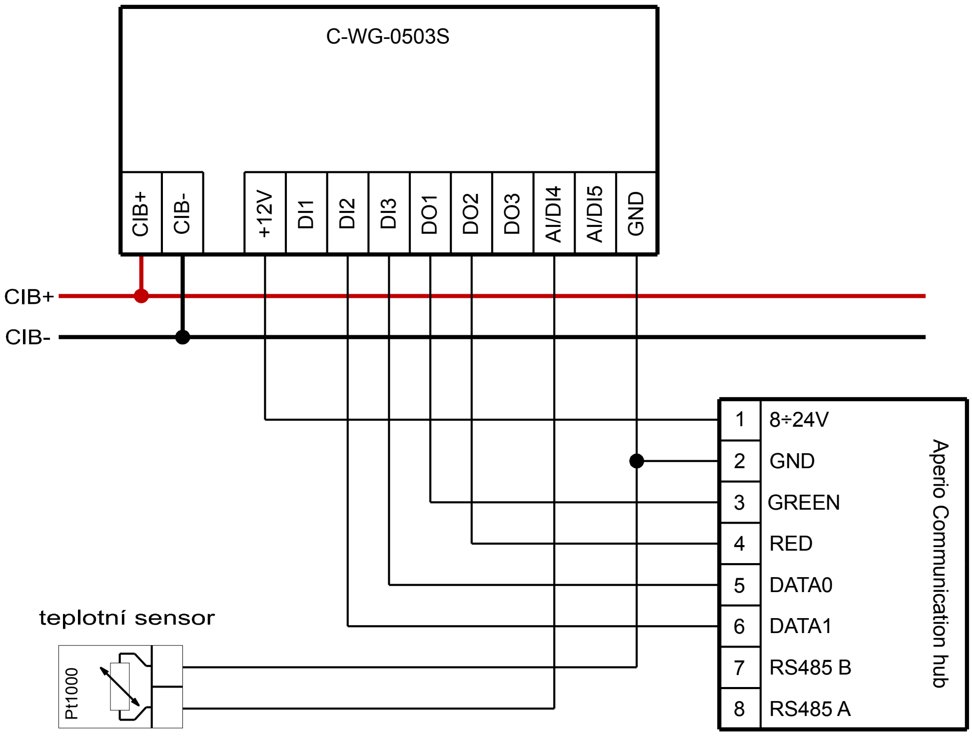


Fig. 7.2.2.1 An example of connecting the Aperio hub to the C-WG-0503S module

Notes:

1. The hub connector is located in the centre of the module rear wall (a standard removable connector).
2. The module is mounted with two screws on the flush box with a 60 mm hole spacing.
3. The GREEN entry activation allows opening the door, the RED entry activation denies access.

The APERIO C100 technical specification:

Dimensions	Basic dimension is 30/30 mm (other sizes increase by 5mm)
The dimension of the knob	42 x 36.4 mm (LxO)
Modularity	All electronics is mounted in the outside knob, with respect to an easy battery exchange.
LED information on the status	red / green / orange
Battery	Lithium CR2
Battery lifetime	minimum 40,000 cycles
Wireless communication	IEEE 802.15.4 (2.4 GHz)
Providing wireless communication	AES 128 Bit
Operating distance between the HUB / cylinder	up to 5m
RFID technology	Mifare, DesFire, iCLASS, 125 kHz and others
The range of operating temperatures	0 ÷ 60°C
Ingress protection	IP30
Surface finish of the knob	Black, with rubber coating
Off-line entry authorization	10 card holders

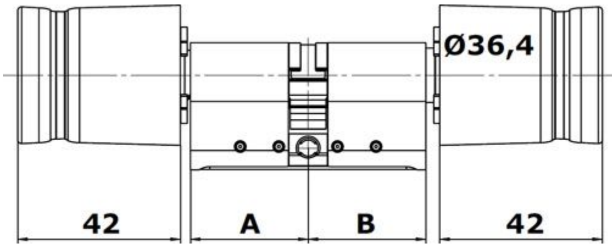


Fig. 7.2.2.2 Basic dimensions of the Aperio C100 cylinder

Aperio communication HUB Wiegand:
It provides a wireless connection with the APERIO E100 (C100 etc.) escutcheons on the door and interconnection via the Wiegand interface with the control system.The module is fitted with an integrated antenna and LED indicators on the front panel. On the rear side there is the connector and the controls for setting the parameters. The module is fitted with two screws on the standard flush box.

LED for visualization of the HUB status	red / green / orange
Dimensions	82 mm x 82mm x 13mm
Power supply	9 ÷ 30VDC
Consumption	80mA with 12VDC, 40mA with 24VDC
Protection	IP30
Operating temperature	0 ÷ 60°C
Humidity	< 85% without condensation
Radio	IEE 802.15.4 (2.4 GHz)
Radio communication encoding	AES 128 Bit
The distance between the Hub and the lock	Recommended maximum distance of 5m (on the same side of the wall).

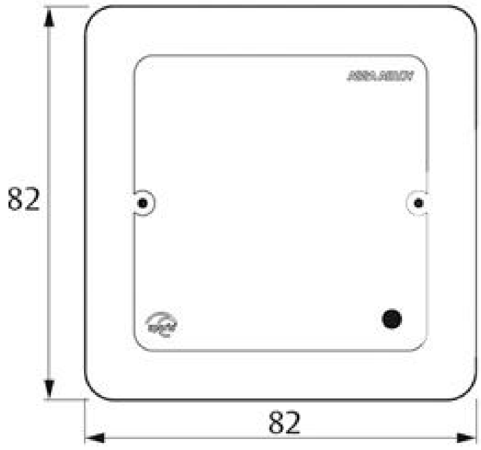


Fig. 7.2.2.3 Basic dimensions of the Aperio hub module

7.3 Control of windows and roof windows

7.3.1 Control of Velux roof windows

In order to integrate the Velux roof windows control system, it is possible to use e.g. the KLF 050 module, which communicates wirelessly with the window electronics (VELUX Integra) and it is controlled by the Foxtrot system via standard relay outputs with identical connection as that of the blinds. Any two switching relay contacts of the system can be used, or the specialized blinds outputs.

The module is designed for installation into a standard flush box; its dimensions are 49 x 47 x 28mm and it is powered by 230VAC.

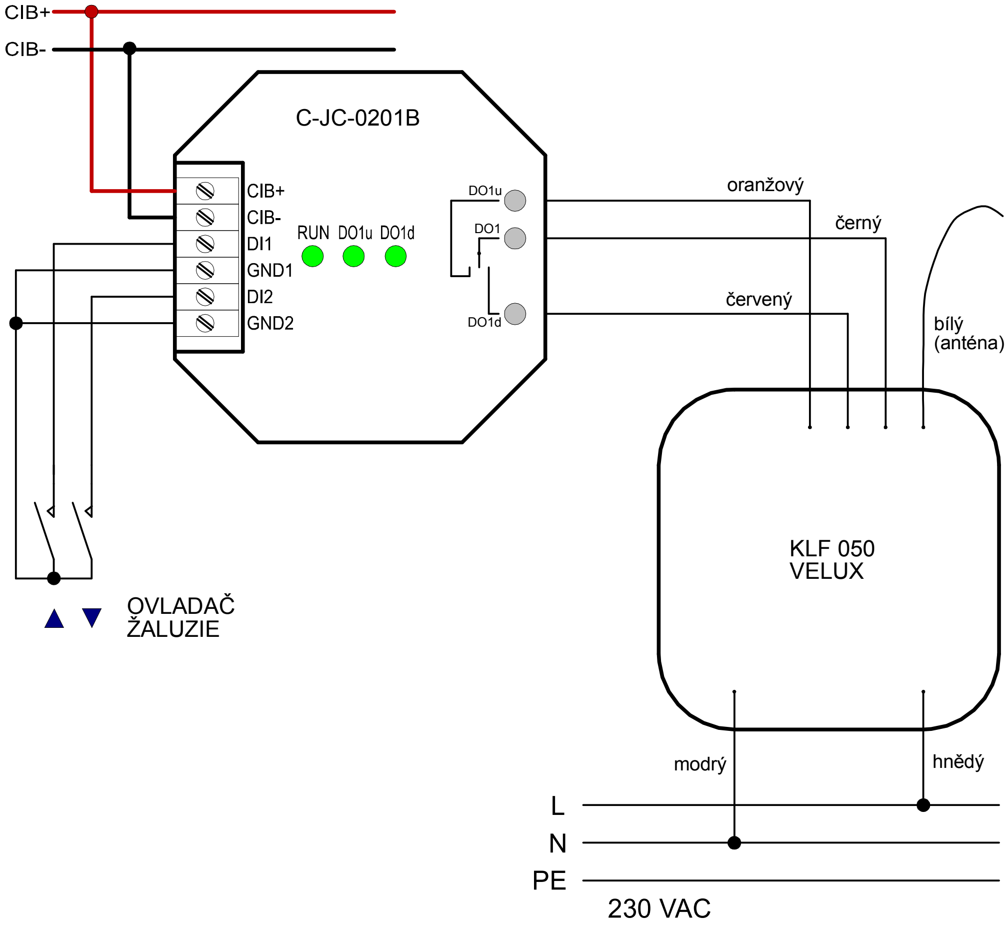


Fig. 7.3.1.1 Connecting the Velux KLF 050 module to the C-JC-0201B blinds module

Notes:

1. In this connection, the "up" position (switched DO1u) opens the window, the "down" position (DO1d is switched on) closes it.
2. The signal range (the distance between the module and the control electronics of the window) given by the manufacturer is about 300m in an open area and about 30m indoors. This has to be counted with when the module is being installed and when it´s being connected with the Foxtrot module.

7.3.2 Control of ROTO roof windows

In order to integrate the ROTO roof windows control system, it is possible to use the RotoTronic E and RotoTronic EF units, which control the motors of the window. The unit should be connected to the Foxtrot system via standard relay outputs with identical connection as that of the blinds. Any switching relay contacts of the system can be used, or the specialized blinds outputs.
The following example shows the connection to the C-JC-0006M module; if the standard cable supplied with the ROTO unit is used, the example also lists the colours of the wires in the cable.

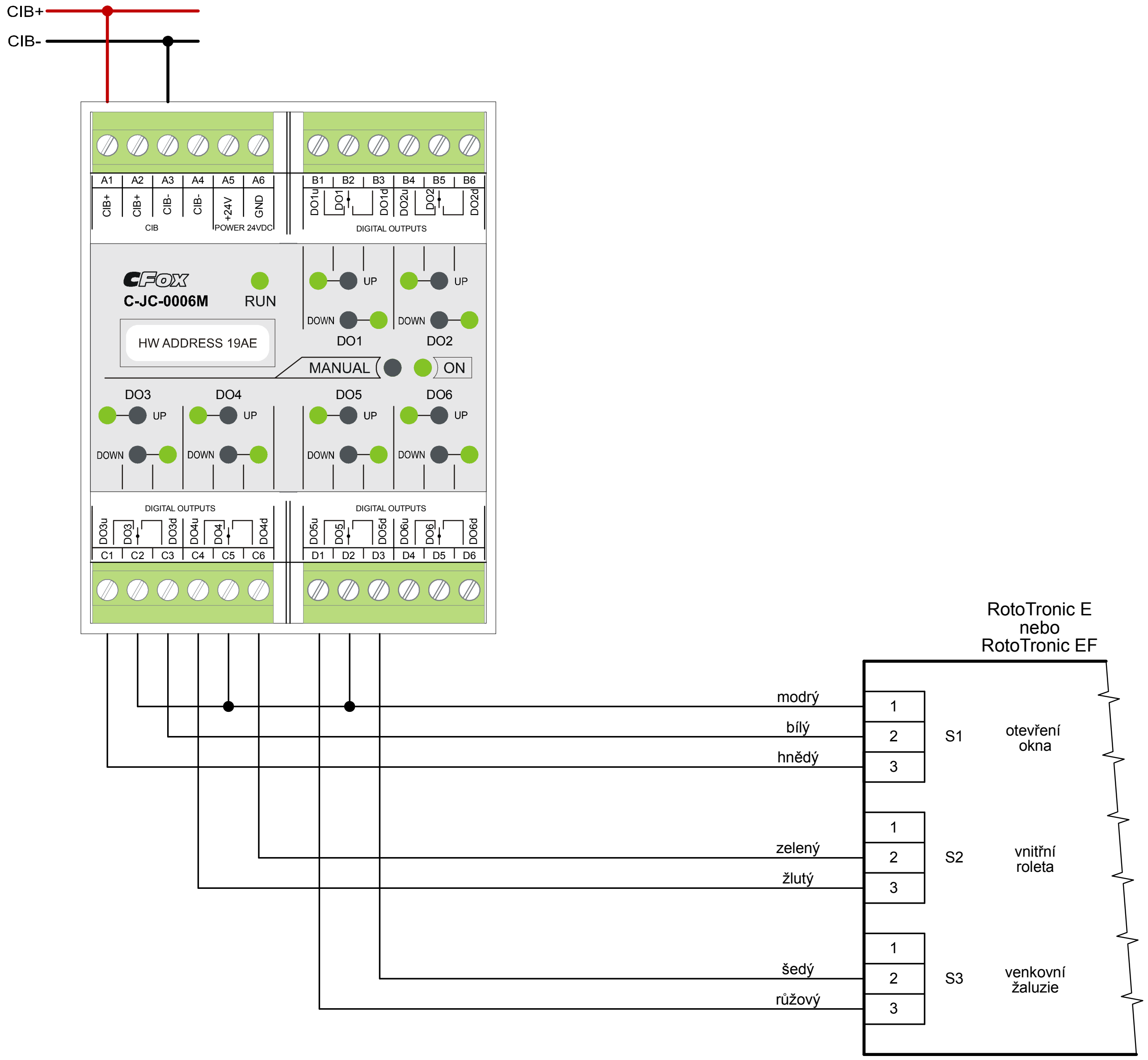


Fig.7.3.2.1 The connection of the RotoTronic E (EF) module to the C-JC-0006M blinds module.

Notes:

1. There is available a 10 m long connecting cable for the ROTO control unit, which corresponds to the JY(St)Y 5x2x0.6 type.

7.3.3 The control of Schüco windows

In order to integrate the control system for skylights, side-hung windows, windows that open to the outside and horizontal pivot windows Schüco TipTronic, you can use the signals of control electronics (BUS-A and BUS-B) for direct control of each window by the Foxtrot system.

Any relay outputs of the system can be used for the control; it is appropriate to use two separate, mutually independent outputs - see the example with the C-OR-0202B module.

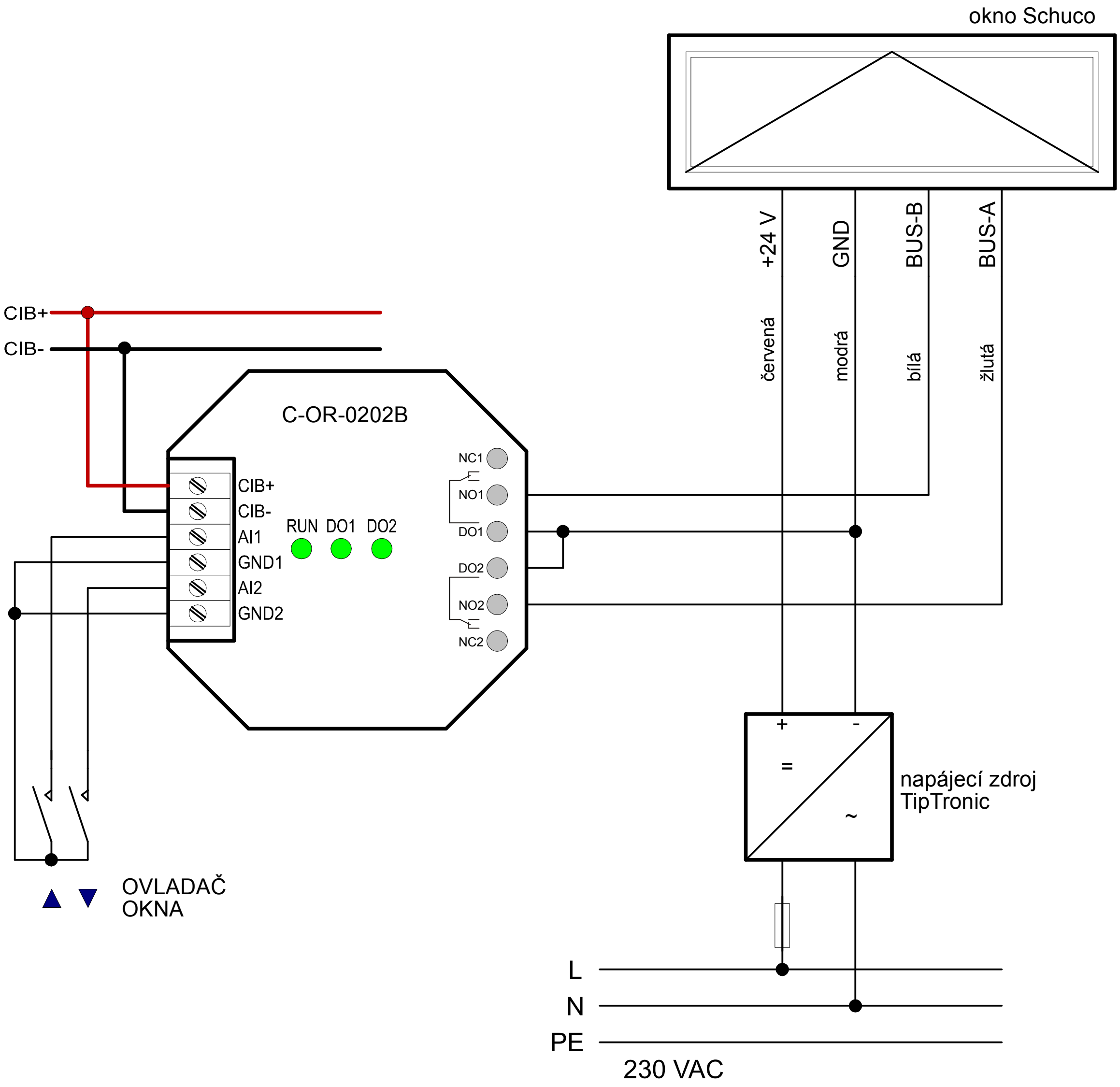


Fig.7.3.3.1 Connecting a Schüco TipTronic window to the C-OR-0202B module

Notes:

1. The total length of the cable between the Foxtrot module and the window should not exceed 30m.
2. The cable must not lead alongside other cables, especially power cables.
3. It is recommended to use separate relay outputs for the control, so that all control functions enabled by the system can be used (even simultaneous switching on both outputs represents a specific function).
4. The DO1 output opens the window, the DO2 output closes it.

8 Security and fire alarm detectors, access control

The table of contents of the chapter

Electronic security systems, especially in relation to family houses, can be designed by integrating detectors (motion detectors, window and door sensors, glass break detectors, etc ...) and control units (RFID readers, keyboards) directly into the Foxtrot system, where the alarm function is executed by the application program in the system. The implementation is easy if you use the FB prepared for the Mosaic environment, or the prepared ESS in the FoxTool environment.
All data (the detectors status, armed or disarmed status of each zone) is also available for other control functions in the house (the control of lighting, heating, ventilation, disconnecting the plugs, etc.).

Should you require a certified ESS (for insurance purposes, ARC, etc.), you can use the intrusion detection systems on the market equipped with a communication interface, which can be connected to the Foxtrot system (e.g. Tecnoalarm, Galaxy, DSC, Paradox, and others). Then the electronic security system can be integrated in the house control and the basic information that the security system contains can be used e.g. for the lighting control (presence simulation), heating (attenuation), switching off socket circuits, etc., similarly to a direct solution of electronic security offered by the Foxtrot system. It is only necessary to take into account the limitations in data transmission, especially in the disarmed status (e.g. a delay in the evaluation of motion from the detector for lighting control). However, this depends on the specific solution of the particular electronic security control panel and its communication with the Foxtrot system.

Fire alarm systems in large buildings are always designed as autonomous (as required by law). In family houses a fire detector is required on each floor; flats must have one fire detector. Connecting the fire detectors to the Foxtrot system is specified in Chapter 8.3.

Access control (for arming/disarming the ESS, opening doors, the access system, etc.) can be dealt with via a series of keyboards and proximity card readers; the connection of some types is described in the following chapters. Further processing (the evaluation of validity of card codes, etc.) is already executed by the Foxtrot system, for which there are again prepared FBs for easier implementation.

8.1 Motion detectors (PIR sensors), ESS

The ESS detectors (PIR, glass break detectors, and such like) generally available on the market are equipped with relay or contact outputs (ALARM, TAMPER ...) suitable for a connection to the CFox or RFox binary inputs.
The connection (and evaluation) to the system can be done in several basic ways (processed with the help of some support materials [7]):

NC contacts
This type of connection is mostly used for fire detectors, where there is probably no danger of sabotaging the loop. This type of simple connection is also common for ESS detectors in household alarm systems. Basically it is O.K, even though a malfunction of a detector (or the whole group of detectors) cannot be ruled out if a short circuit occurs in the cables or in the terminal block. Therefore it is advisable to use rather balanced loops.

A single balanced loop
It is mostly used where there are a number of detectors in one loop. The contacts are connected in series. The connection is simple and transparent. The disadvantage is precisely that there are many detectors in series and thus the place of activation cannot be accurately identified. The contacts (ALARM and TAMPER) are always NC (normally connected), which means that the switched contact represents the idle status. For more detailed information see Chapter 13.8.3. Single balanced inputs – voltage levels, evaluation.

A double balanced loop
Each detector mostly transmits two information items: activation (motion, opening the door, ...) and disruption of the cover – a sabotage. By using two resistance values, the idle state and the activation of the detector are transmitted. The idle state is determined by the basic value of resistance, and doubling this value results in activation. A short circuit or disconnecting the loop is considered as a sabotage of the loop or opening the cover of the detector. The resistance values have a tolerance range of about 10% to avoid wrong evaluation due to resistance fluctuations caused e.g. by temperature changes.
The contacts (ALARM and TAMPER) are always NC (normally connected), which means that the switched on contact represents the idle status.
For detailed information see Chapter 13.8.4. Double balanced inputs – voltage levels, evaluation.

Subsequent chapters describe specific modules suitable for connecting alarm detectors as well as recommended types of detectors for each area of security, including examples of connection and basic technical information.

8.1.1 Connecting PIR detectors with double-balanced loop to the C-IB-1800M module

The C-IB-1800M module is suitable for installations where the customer prefers the star configuration of ECC detectors connection - i.e. a cable leads from each detector to the control panel for the power supply and evaluation of the detector status. This module can also be used for the connection of push buttons (lighting control, etc.); the AI/DI1 to AI/DI4 can also be used for measuring temperature or processing pulse inputs from electricity meters, flowmeters, etc. ...
The module allows direct powering of detectors from its 12 VDC output. Due to a higher power input, the module can be powered either from the CIB, or directly from the 27 VDC supply (voltage with a battery backup).
For more information on powering, maximum power inputs, etc., see the chapter describing the C-IB-1800M module.

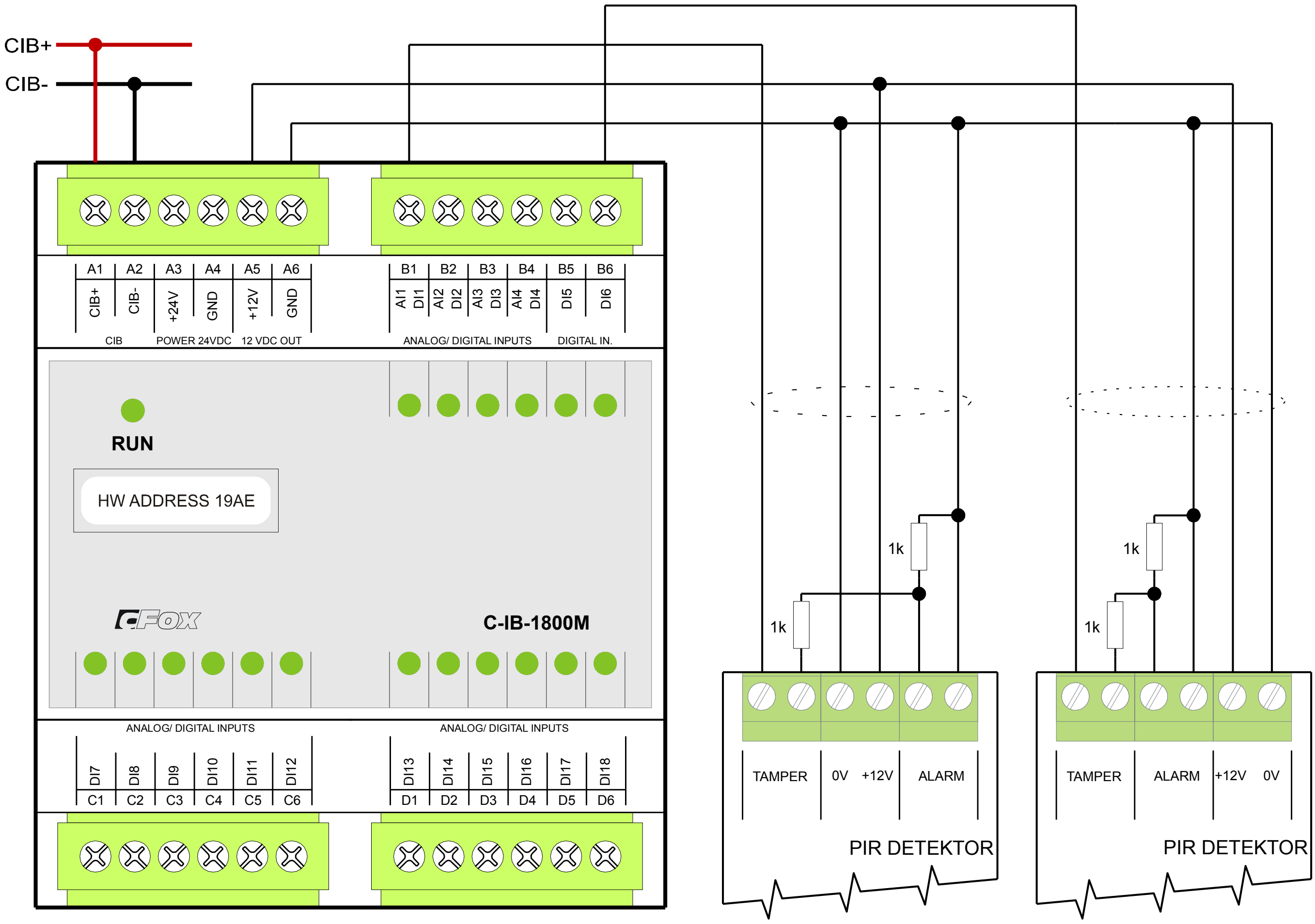


Fig. 8.1.1.1 An example of connecting the ESS detectors to the C-IB-1800M module.

Notes:

1. Up to 18 double balanced detectors can be connected to the module; the module also provides 12V power supply for the connected detectors. A maximum current from the 12V supply is given by the module supply mode - for details see the description of the C-IB-1800M.
2. Detectors can also be powered from a different source, e.g. the 12V supply from the PS-2-60/27 module; it is necessary to ensure that the 12V level is backed up during a power failure.

8.1.2 Connecting a PIR detector with a double-balanced loop to C-IT-0200S module

If you want to connect a detector to the CFox module located in the flush box (e.g. directly under the detector), a variety of modules with double balanced inputs is available, such as the C-IT-0200S module. Here you have to provide a 12V power supply for the detectors, unlike with the C-WG-0503S module, which itself provides both 12VDC and processing of two balanced loops, and can also be connected to a maximum of three contacts (push buttons, a fire detector, etc.). For examples of the connection of this module see the following chapters.

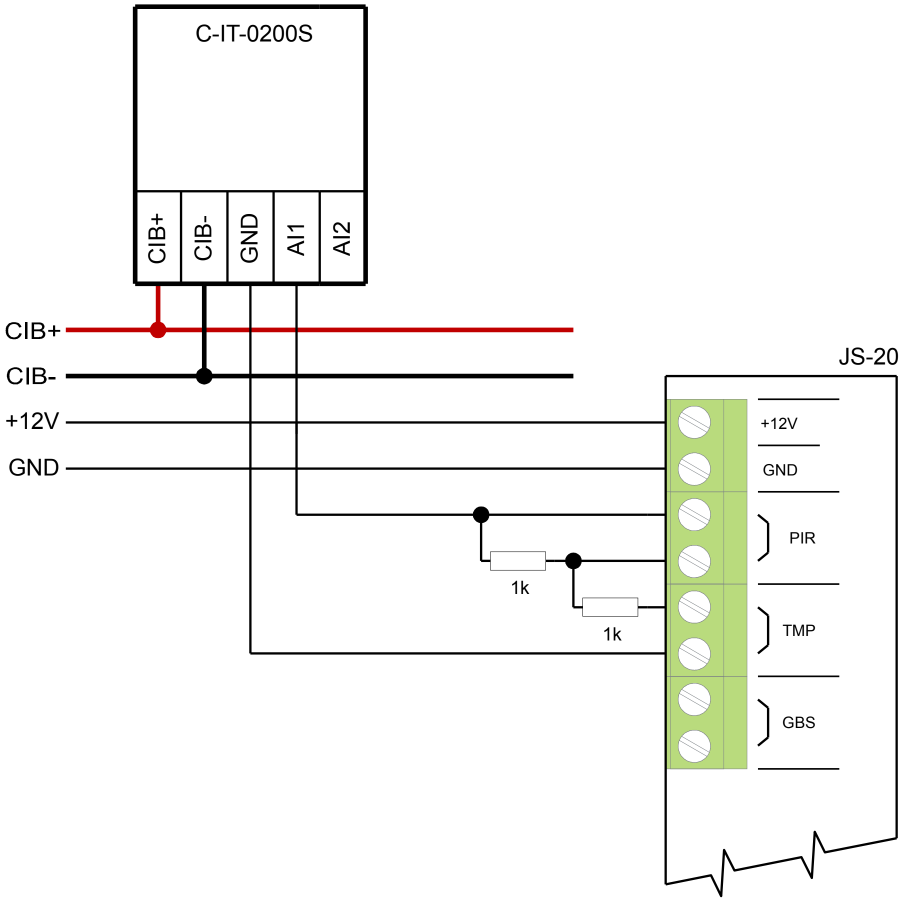


Fig. 8.1.2.1 An example of connecting an ESS sensor (in this case it is JS-20) scanned by the C-IT-0200S module

8.1.3 Connecting interior motion detectors (PIR) to the C-WG-0503S module.

The usage of interior motion detectors varies according to the type of protected areas, access of animals in the armed status, the size of the areas, etc. There are a number of manufacturers and types of detectors on the market. Possible recommended basic variants of detectors are listed in the following chapters, including examples of connection and basic technical information; the list includes the Elite detectors, the TEXECOM manufacturer, and the distributor ATISgroup.
The Elite-QD detector is a standard PIR sensor, for ordinary living spaces,
the Elite-PW has increased resistance to pets up to 40kg; it is equipped with precision mirror technology, and
the Elite-DT, combining microwave and PIR technology, is highly resistant to false alarms and is designed for garages, boiler rooms and similar spaces.

Table8.1.3.1: Basic parameters of the Elite interior motion detectors

Type	Elite QD	Elite PW	Elite DT
Order number	031 30300	031 30700	034 30100
The principle of detection	infrared passive QUAD sensor, 42 detection zones	mirror technology, 24 detection zones	dual MW (9.35GHz) + PIR, 42 detection zones
Coverage	15 x 15m	15 x 15m	15 x 15m
Detection angle	90°	90°	90°
Sensitivity adjustment	1 to 3 pulses (adjustable)	1 to 3 pulses (adjustable)	1 to 2 pulses (adjustable)
Alarm output	NC, max. 50mA	NC, max. 50mA	NC, max. 50mA
Sabotage contact	NC, max. 50mA	NC, max. 50mA	NC, max. 50mA
LED indication	Yes, 3x LED	Yes, 3x LED	Yes, 3x LED
Temperature comensation	yes	yes	yes
Supply voltage	9 - 16V=	9 - 16V=	9 - 16V=
Consumption	11mA	11mA	11mA
Operating temperature	-35 to + 60°C	-35 to + 60°C	-35 to + 55°C
Operating humidity	max. 95%	max. 95%	max. 95%
Assembly, the height	on the wall, typically. 1.5 – 3.0m	on the wall, typically. 1.5 – 1.8m	on the wall, typically. 1.5 – 3.0m
Dimensions	112.3 x 63 x 40mm	112.3 x 63 x 40mm	112.3 x 63 x 40mm
The weight	150g	170g	180g

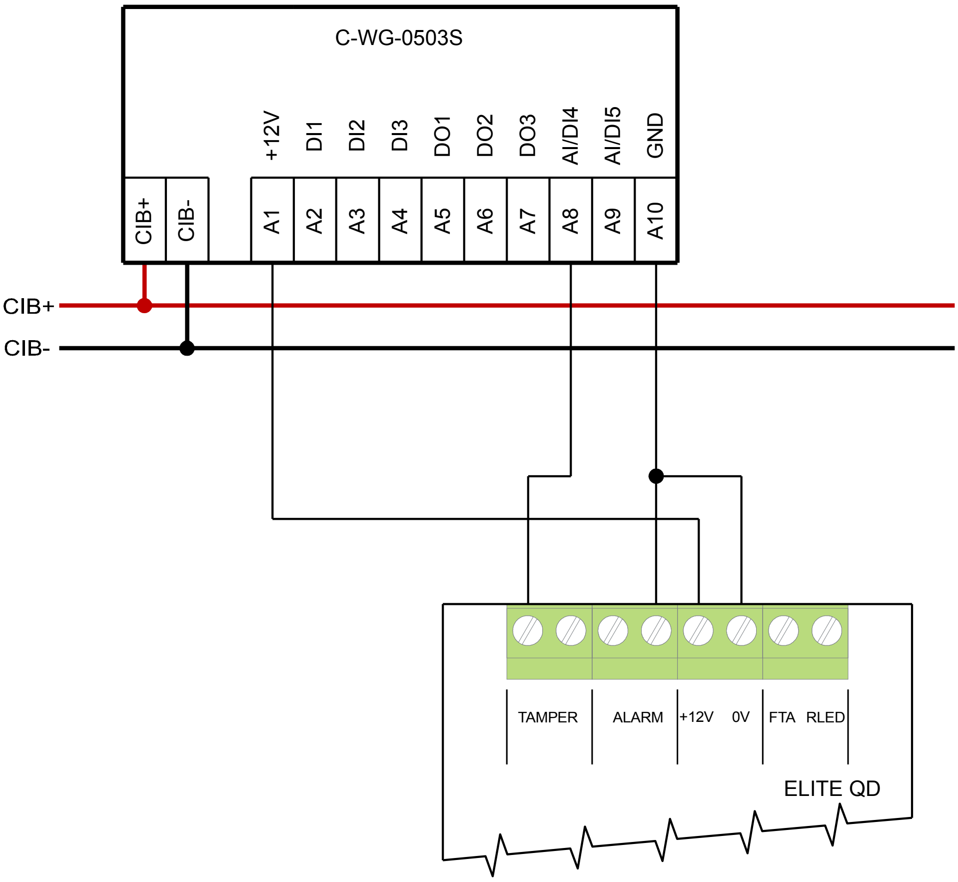


Fig. 8.1.3.1 An example of connecting the Elite QD motion detector to the C-WG-0503S module

Notes:

1) The connection assumes the use of double balanced loop; both the JP3 and JP4 jumpers in the detector must be set to 1k resistance.
2) Correct installation of the detector is specified in the product operating instructions.
3) The detector´s power consumption from the 12V supply is typically 11mA.
4) A cable with the wire diameter of at least 0.3mm can be used for the connection, e.g. the SYKFY cable; its length can be up to dozens of meters.

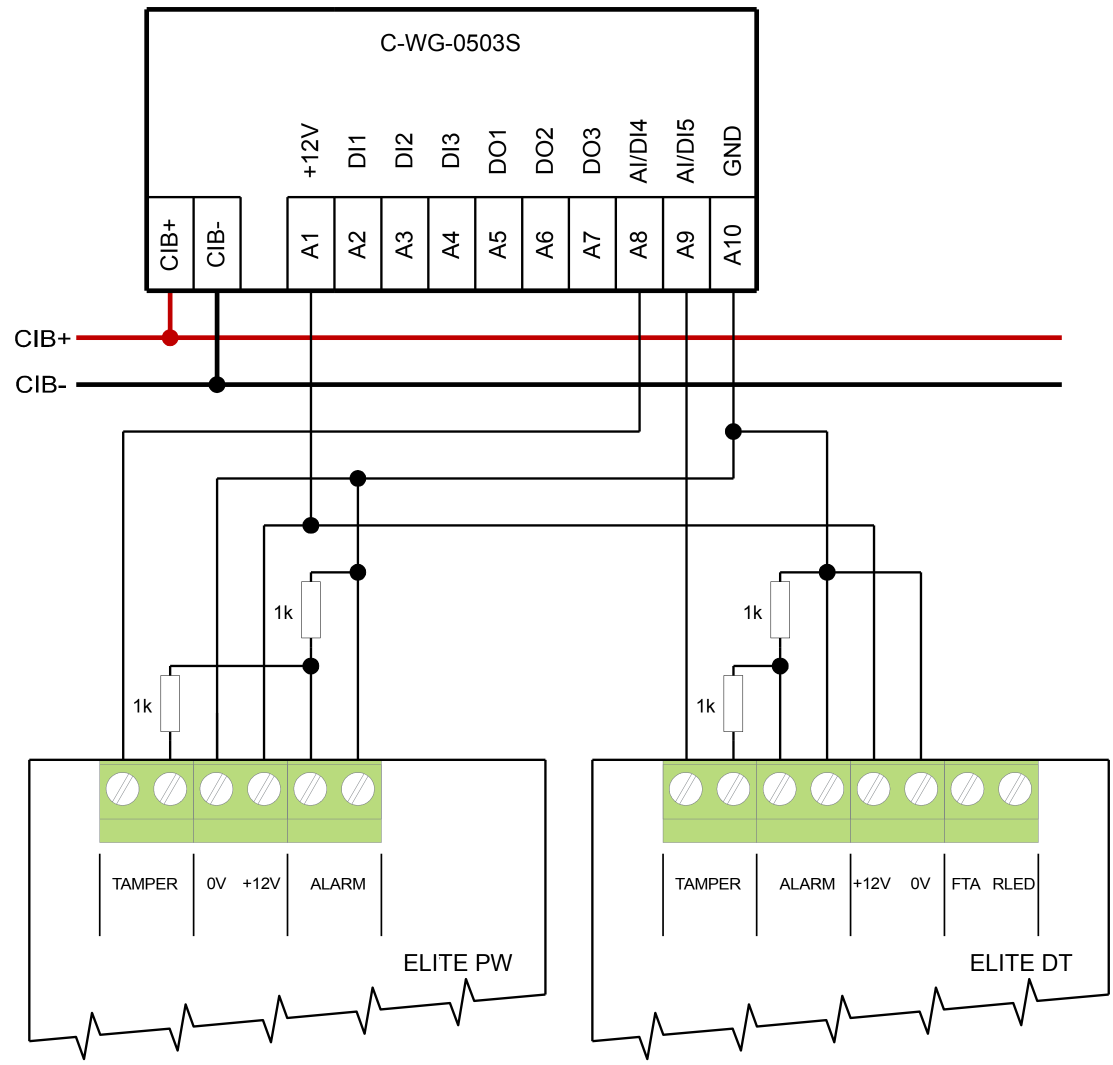


Fig. 8.1.3.2 An example of wiring the Elite PW and DT motion detectors to the C-WG-0503S module

Notes:

1) The example shows the connection of the detectors loop as double balanced; the ALARM and TAMPER outputs in the detectors must be correctly connected with 1K resistors (see the general description of double balancing in Chap. 8.1.1).
2) Correct installation of the detectors is specified in the product operating instructions.
3) Each detector's power consumption from the 12V supply is typically 11mA.
4) A cable with the wire diameter of at least 0.3mm can be used for the connection, e.g. the SYKFY cable; its length can be up to dozens of meters.

8.1.4 Connecting exterior motion detectors (PIR) to the C-WG-0503S module.

We recommend the basic variants of the Elite detectors, the TEXECOM and Tecnoalarm manufacturers and the ATISgroup distributor for outdoor applications of motion detectors (the perimeter protection).
The Elite-EXT-TD-B detector is a PIR scanner with two sensors; the range and sensitivity are adjustable, it has the day/night modes, supplied in white or black version.
The outdoor dual Elite Orbit DT detector is a combined PIR + MW detector with a large range, in an elegant design for wall mounting.
Trired is an outdoor triple PIR detector manufactured by Tecnoalarm, with the curtain characteristics, anti-masking protection and anti-opening and anti-detachment tamper. It features an adjustable detection of masking and range for each beam.

Table8.1.4.1: The basic parameters of the Elite and TRIRED outdoor motion detectors

Type	External TD	Elite Orbit DT	TRIRED
Order number	031 32000 (white) 031 32001 (black)	031 32101	031 74600
The principle of detection	mirro technology, two PIR sensors	digital technology PIR+MW	Tripple PIR detector
range	Adjustable 2, 5, 8, 12 m	Adjustable 10, 20, 30 m	30m
Detection angle	90°	90°	
Rotating optics	180°	180°	
Sensitivity adjustment	2 to 4 pulses (adjustable)	1 to 2 pulses (adjustable)	
Alarm output	NC, max. 100mA	2x, NO and NC, max. 50mA	NC, max. 50mA
Sabotage contact	NC, max. 100mA	NC	NC, max. 50mA
LED indication	yes	yes	
Temperature comensation	yes	yes	
Supply voltage	9 ÷ 16VDC	9 ÷ 15VDC	10.5 ÷ 14.5VDC
Consumption	28mA	15mA	27mA
Operating temperature	-35 to + 55°C	-20 to + 60°C	-25 to + 65°C
Operating humidity	max. 95%	max. 95%	max. 95%
Assembly, the height	on the wall, typically 1.0 ÷ 1.4m	on the wall, typically. 1.5 ÷ 6m	on the wall, typically. 1.35 ÷ 2.2m
Dimensions	250 x 86.5 x 87mm	141 x 165.5 x 109mm	82 x 400 x 260mm
The casing colour	White or black	silver	White
The weight	500g	300g	1.3kg
Protection	IP65	IP55	IP55

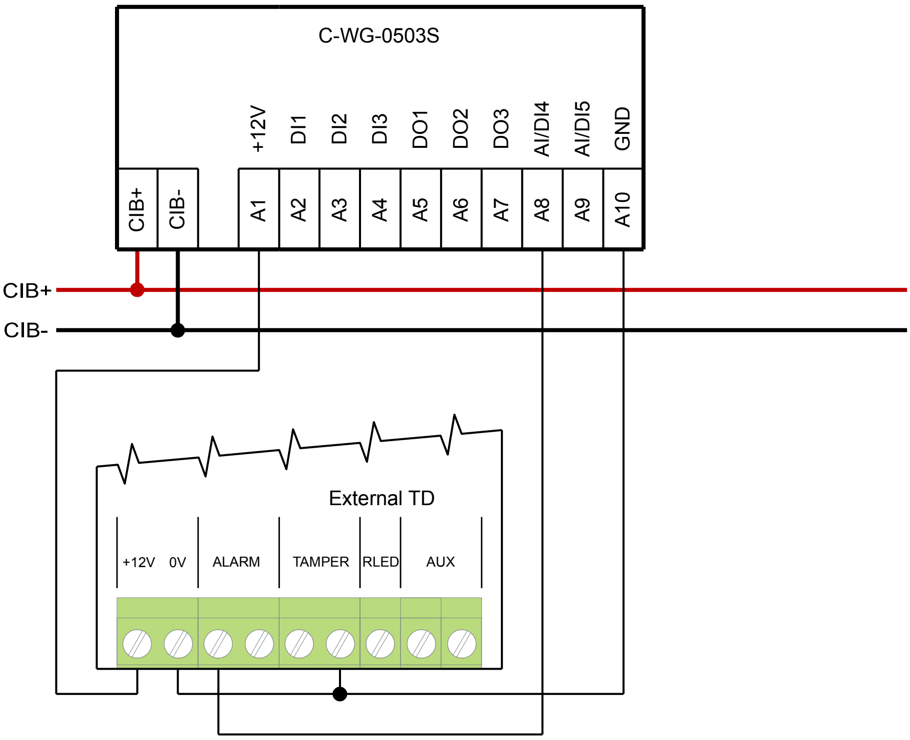


Fig. 8.1.4.1 An example of connecting the External TD motion detector to the C-WG-0503S module

Notes:

1) The connection assumes the use of double balanced loop; both the JP7 and JP6 jumpers in the detector must be set to 1k resistance. (see the general description of double balancing in Chap.8.1.1).
2) Correct installation of the detectors is specified in the product operating instructions.
3) A cable with the wire diameter of at least 0.3mm can be used for the connection, e.g. the SYKFY cable; its length can be up to dozens of meters.

The Elite Orbit DT and Trired detectors are connected in the same way as e.g. the interior detectors; using double balancing, the external 1k resistors should be connected to the ALARM and TAMPER outputs.

8.2 Glass break detectors

8.2.1 Connecting the IMPAQ Glass Break detector to the C-WG-0503S module.

The IMPAQ Glass Break detector can be used for the detection of breaking glass; it is manufactured by the TEXECOM and distributed by the ATISgroup. It is a digital acoustic glass break detector with digital sound processing, designed for sheet, laminated, hardened, tempered, wired glass with a thickness from 2.4 to 6.4mm.

The sensor analyzes four different frequency ranges (frequency, amplitude, time sequence), which ensures high resistance to false alarms.

The false alarm immunity is enhanced by using the Flex technology, which represents an analysis of low frequencies caused by bending the glass sheet at the beginning of the destruction. An alarm is only triggered when an evaluated bending is immediately followed by the sound of shattering glass. This eliminates false alarms, e.g. when a glass object is broken in the interion (such as a glass).

Exact information on the assembly, correct setting and the parameters is stated in the product operating instructions..

Table8.2.1.1: The basic parameters of the Impaq Glass Break detctor

Type	Impaq Glass Break
The principle of detection	An acoustic detector of bending and breaking glass
Sensor:	Electret microphon
range	9m
Detection	170°
Alarm output	NC, 50mA
Sabotage contact	NC, 50mA
LED indication	yes
Supply voltage	9 ÷ 16VDC
Consumption	11mA
Types of glass	sheet, laminated, hardened, tempered, wired, thickness 2.4 - 6.4mm
Minimum glass dimensionms	300 x 300mm
Sensitivity adjustment	yes, continuous
Alarm memory	yes
Colour	White
Operating temperature	-10 ÷ +55°C
Assembly	On the wall, corner or ceiling
Dimensions (vxšxh)	87 x 62 x 26mm
The weight	60 g
A picture of the detector	

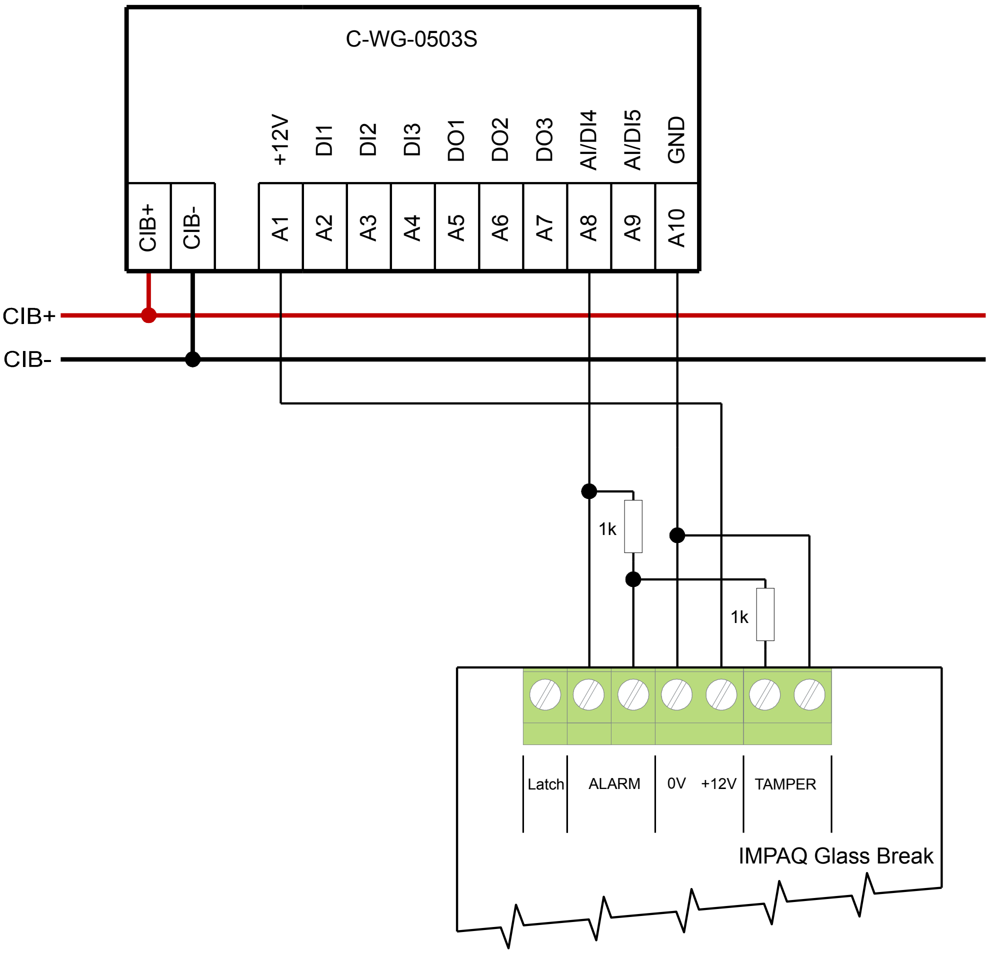


Fig. 8.2.1.1 An example of connecting the IMPAQ Glass Break detector to the C-WG-0503S module

Notes:

1) The example shows the connection of the detectors loop as double balanced; the ALARM and TAMPER outputs in the detectors must be correctly connected with 1K resistors (see the general description of double balancing in Chap. 8.1.1).
2) Correct installation of the detector is specified in the product operating instructions.
3) The detector's power consumption from the 12V supply is typically 11mA.
4) A cable with the wire diameter of at least 0.3mm can be used for the connection, e.g. the SYKFY cable; its length can be up to dozens of meters.

8.3 Fire detectors, fire alarm systems

8.3.1 Connecting the EXODUS fire detectors to the C-WG-0503S module

Fire detectors from the EXODUS series, manufactured by TEXECOM, can be used for monitoring areas as a part of fire prevention. The detectors are available in four designs, depending on the type of protected area. All variants have the same mounting base with the terminal block, the same size and design. The detectors are approved for protection in family houses and buildings intended for housing.

Selection of a suitable detector depends on the type of space:

rooms, offices (dust free environment)	EXODUS OH/4W
kitchens, garages, boiler rooms	EXODUS RR/4W
boiler rooms, operations up to 50 °C	EXODUS FT64/4W
boiler rooms, operations up to 80 °C	EXODUS FT90/4W

The **EXODUS OH/4W** is a detector with optical detection of smoke and thermo-differential detection of rising temperature;
it detects dense smoke (smoldering fire) or little smoke and a temperature rise from fast flaming fires; it is suitable for fast detection of a normal fire; the resistance to false alarms is higher compared with only optical or ionization detectors, which are not suitable for smoky, dusty and steamy environment (a kitchen, bars, bathrooms).

The **EXODUS RR/4W** works on the principle of thermo-differential detection of temperature rise (rapid increase in temperature), or triggers an alarm when the temperature exceeds 58°C; it is suitable for fast fire detection in smoky or dusty environment, e.g. in bars, attics, and in spaces where the temperature does not exceed 38°C; it is not suitable for environments where the temperature changes rapidly, such as bathrooms or kitchens.

The **EXODUS FT64/4W** works on the principle of fixed temperature heat detectors, and it triggers alarm when the temperature reaches 64°C; it is suitable for fire detection in a smoky environment, or where temperature changes rapidly, e.g. bathrooms, kitchens and other areas where temperatures exceed 44°C; it is not suitable for rapid detection of slow burning or smoldering fires or for operating temperatures above 44°C.

The **EXODUS FT90/4W** operates on the principle of thermo-maximum detection of temperatures above 90°C; the detector is suitable for environments with temperatures up to 70°C, e.g. boiler rooms, but it is not suitable for rapid detection of slow burning or smoldering fires.

Table8.3.1.1: The basic parameters of the EXODUS fire detectors

Type	EXODUS OH/4W	EXODUS RR/4W	EXODUS FT64/4W	EXODUS FT90/4W
The principle of detection	Dual, optical for smoke and a change of temperature	Detection of temperature rise	Detection of maximum temperature above 64°C	Detection of maximum temperature above 90°C
Alarm output	NC, max. 50mA			
Supply voltage	9 ÷ 16VDC			
Consumption	15mA			
Colour	White			
Colour differentiation	blue	green	orange	red
Operating temperature	-10 ÷ +55°C	-10 ÷ +55°C	-10 ÷ +55°C	-10 ÷ +80°C

Assembly	on the ceiling (identical mounting base for all variants)
Dimensions	diameter 107mm, height 55mm
The weight	200g

Fig. 8.3.1.1 A picture of the EXODUS detector (the coloured ring determines the exact type).

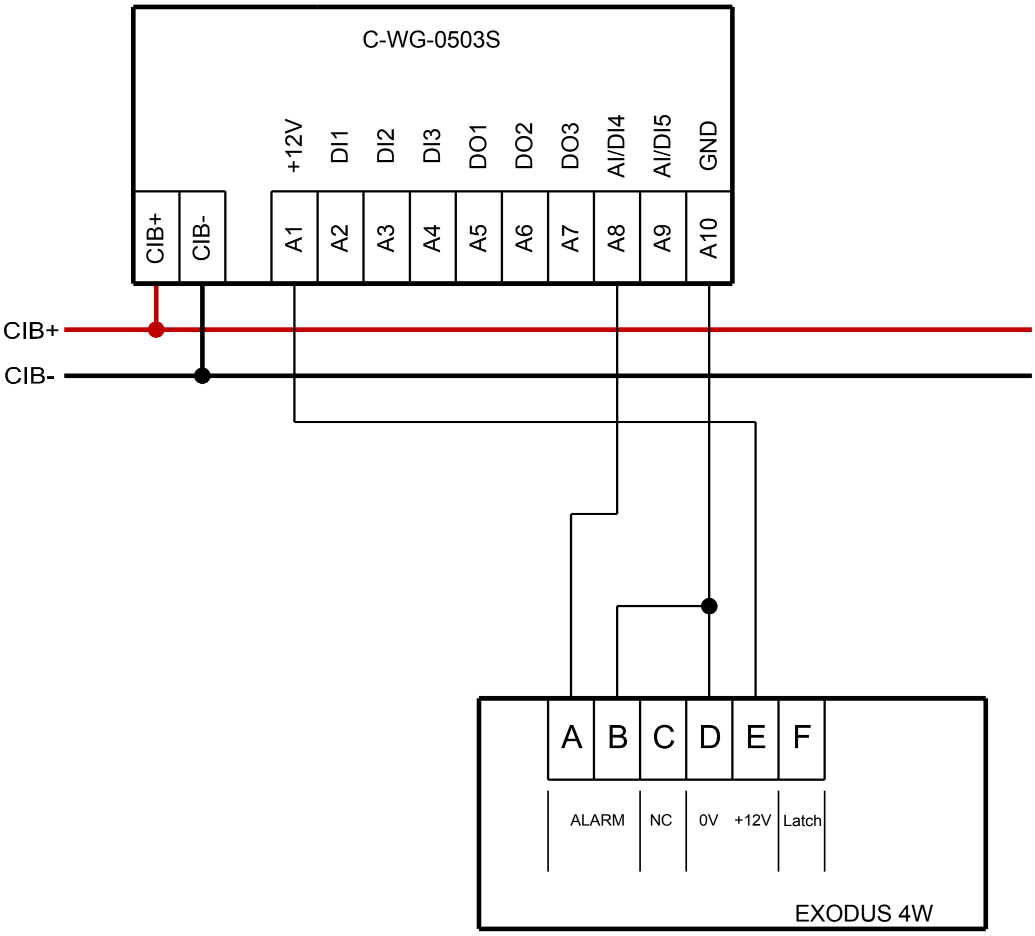


Fig. 8.3.1.2 An example of connecting the EXODUS 4W detector to the C-WG-0503S module

Notes:

1) The example is applicable to all variants of the EXODUS detectors (they have the same mounting base with the terminal block).
2) Terminals A to F are arranged in a circle around the perimeter of the detector.
3) Correct installation of the detector is specified in the product operating instructions.
4) The NC terminal is not used.
5) A cable with the wire diameter of at least 0.3mm can be used for the connection, e.g. the SYKFY cable; its length can be up to dozens of meters.

8.4 The opening detectors

There are a number of devices available for monitoring of the opening of doors, which differ primarily in their mechanical design and the purpose. Some recommended types are described below.

When installing the detectors (magnetic contacts), you must follow a few guidelines:

- The protected windows and doors must have an exacttly defined position when they are closed (e.g. their position must not be changed by wind, which could to a disconnection of the contact and a false alarm).
- A maximum stated gap (for the switched - idle state) is considered in ideal conditions; any metallic ferromagnetic material in the vicinity of the contact reduces the range (e.g. metal door frames decrease the maximum gap by more than half).
- The contact must be set as exactly as possible to achieve the best possible functionality.
- The part of the contact with the terminal is always installed on the fixed part of the windows or doors (the frame).
- The connection of a 2-wire or a 4-wire contact is illustrated in the following example.

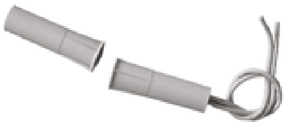
Monitoring of the opening of e.g. massive garage gate is provided by the MM-106 gate contact manufactured by ARITECH. It is a massive aluminium contact with a 30cm long terminated armoured cable.

The DC-101 contact manufactured by ARITECH is suitable for monitoring standard windows and doors; the housing is white or brown, tho contact is surface mounted with two screws.

The TAP-10 contact is designed for flush mounting; it is available in white (the WH version) or brown (the BR version) plastic housing, and it should be flush-mounted into a bored hole.

Table8.4.1: The Basic parameters of opening detectors

Type	MM-106	DC-101 (DC-101-B)	TAP-10
Maximum gap	50mm	15mm	25mm
Mounting	2 screws	2 screws	the hole with an 11mm diameter
Connection	A cable with 4 wires , 30cm, armoured	A cable with 4 wires, 2.5m long	2 separate wires, 40cm long
Contact	NC	NC	NC
The contact operating voltage	1 ÷ 50 DC	Max. 100V/0.5A	
Colour	aluminium	White (brown)	white (WH), brown (BR)
Dimensions	175 x 50 x 15mm	50 x 9 x 9mm	11 x 32mm

A picture of the contact			

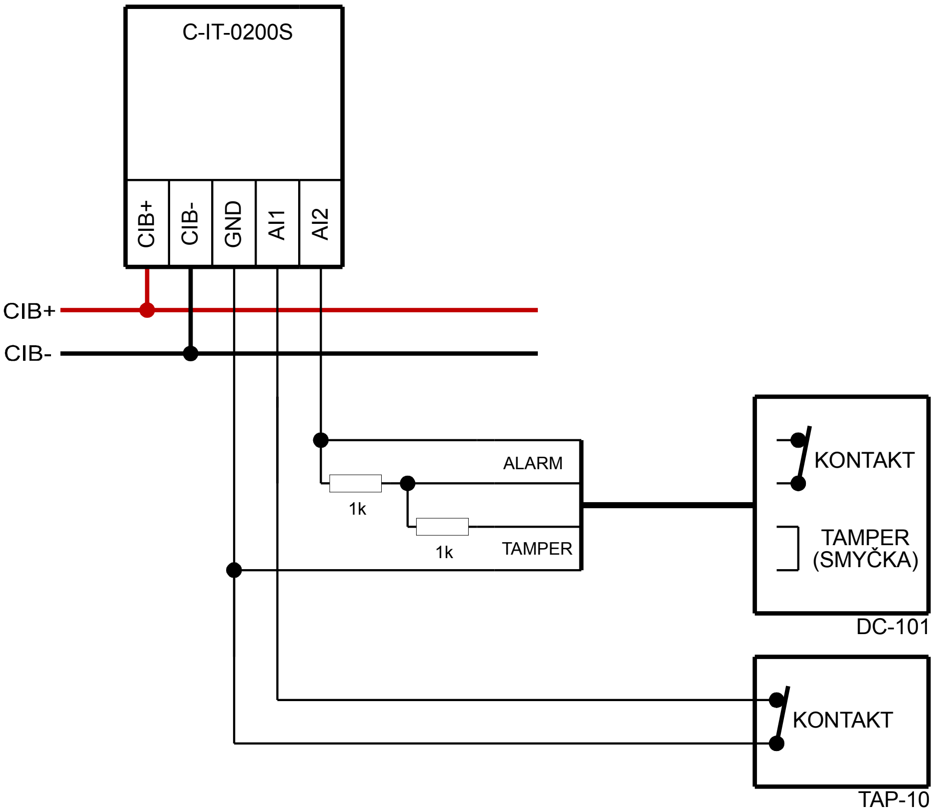


Fig. 8.4.1 An example of connecting 2 and 4-wire contacts to the C-IT-0200S module

Notes:

1) The example shows the wiring of the contact and the tamper loops in the DC-101 as double-balanced; the contact wires and the tamper loop wires in the cable must be connected correctly with the 1k resistors (see the general description of double ballancing in Chap.8.1.1).
2) The lower magnetic contact represents a simple connection of an NC contact to the C-IT-0200S module.
3) Correct installation of the detector is specified in the product operating instructions.
4) A cable with the wire diameter of at least 0.3mm can be used for the connection, e.g. the SYKFY

cable; its length can be up to dozens of meters.

8.5 Sirény

Sirens serve as an acoustic signal of alarms. The outdoor sirens, which should notify people of the alarm, and the internal sirens, which should mainly make the intruder's stay inside the building unpleasant.

8.5.1 Connecting an indoor siren

Indoor sirens are usually connected with two wires; after being connected to a 12V power supply, they generate a very strong signal (over 110 dB). The siren is usually mounted on the ceiling, in a less accessible place.

The following example shows the connection of the SA-913 T internal siren to the CP-1000 basic module with a standard power supply with a backup - the PS2-60/27 power supply and 2 x 12V batteries.

The siren is triggered by the DO1 relay output; any relay output of the CFox and RFox modules can be used; however, you should ensure that the module switching the power supply to the siren has also a backup battery, i.e. it should be functional even during a power failure.

The TAMPER (the sabotage contact of the siren housing) in the example is connected as a standard NC contact to the DI1 input. If you want to evaluate the loop as balanced (here it is single balanced), you should use a different DI system input, which supports balanced inputs (e.g. the C-IB-1800M module input), or you can also use the input to CP 1000, which should be measured as AI; a 1kΩ resistor should be connected in series to the loop, and the loop resistance should be measured and the measurement will be processed in the user programme.

On the next page:
Fig. 8.5.1.1 An example of connecting an internal siren SA-913T to the CP-1000 powered by the PS2-60/27 power supply

8.5.2 Connecting an outdoor siren

The outdoor siren is usually connected to a permanent power supply, which provides charging the built-in battery. In addition to its own acoustic transducer and battery, the siren is also usually equipped with a blinker and control electronics.
The siren is activated either by disconnecting the supply voltage (sabotage), or by activation input (alarm). It is also usually equipped with a tamper contact (a sabotage contact), whose state is either transmitted to the system, or its activation (opening the cover) triggers the siren (a sabotage again).

The outdoor siren should be installed on the facade of the house to such a height that it cannot be easily reached, which reduces the risk of its being disabled. It is recommended to cover it against direct rain (under the roof) and find a protected place from falling snow and ice, which should be clearly visible from the neighbourhood; it could deter potential intruders.

Depending on the type of siren, its electronics contains activation inputs either for + or –. These options should be consulted in the user manual for each particular siren and use the corresponding output in the control panel to activate the siren.

8.6 Connecting the ESS control panels to the Foxtrot system

The installations with an ESS separate control panel (due to certification, special technical requirements, etc.) can integrate the control panel in the control system of the house, i.e. the basic module of the Foxtrot system can be connected to the to ESS control panel via a communication interface.

8.6.1 Connecting the Tecnoalarm control panels

There is an easy solution for convenient integration of ESS control panels into the Foxtrot system; it allows a rapid integration into the user program even without any knowledge of the control panel and communication with it. The solution rests on a module built in the ESS control panel, which should be connected via the RS232 interface to the basic Foxtrot module, and the program service will be provided by a standard function block, which secures all communication with the control panel; all data is transmitted in a fixed data structure, independent of any specific control panel.

The transmitted data is divided into several groups:

1) The status of the loops (sensors) - information on the current status of up to 512 connected sensors (the data is also active in the disarmed state, and it can be used, e.g. for the control of heating or lighting).
2) The status of subsystems; a subsystem is a group of sensors (e.g. "a garage").
3) System statuses - the status of the control panel and other information.

Only one instruction can be entered in the control panel, which is "arm" - a possibility of remotely arming the house if the residents have left and failed to do it.

The first control panel that can be connected in this way is the Tecnoalarm **TP16-256**, distributed by ATISgroup; it is a security control panel:

- it has 16 to 256 independently programmable loops and 32 subsystems,
- 1 tamper loop, 32 guarding programmes,
- an integrated voice module, 201 user codes, 64 electronic keys, 32 timers, 8 time windows, a relay output for the sirens (indoor and outdoor),
- a space for a 17Ah battery, a metal casing, an anti-opening and anti-detachment tamper, an integrated telephone and voice communicator, a memory of 3,000 events, the RDV and RSC functions.

8.6.2 Connecting the Paradox control panels

The Paradox control panels can be integrated into the house control system via the APR-PRT3 module connected to the RS232 interface of the basic Foxtrot module.
The control panel provides information on the status of individual loops, the subsystems statuses, it can be armed and disarmed from the Foxtrot system, including arming or disarming the subsystems, etc.
The control panel is equipped with a standard Dsub 9 pin connector with a terminated RS232 interface, and it should be connected to the basic Foxtrot module like a standard RS232 device.

The communication between the Foxtrot PLC and the Paradox security systems uses the ASCII protocol, which is implemented in the APR-PRT3 Printer Module.

This module is an accessory to connecting the following Paradox control panels:

The type of control panel	Version
Digiplex EVO48 control panel	All versions
Digiplex EVO96 control panel	All versions
Digiplex EVO192 control panel	All versions
DGP-848 control panel	V4.11 and higher
DGP-NE96 control panel	V1.60 and higher

The models differ in the number of zones and the number of subsystems (areas) of the control panel. The data structure for data exchange with the Paradox control panel is designed for a maximum number of 192 zones and 8 subsystems. This corresponds with the largest model - Digiplex EVO192.

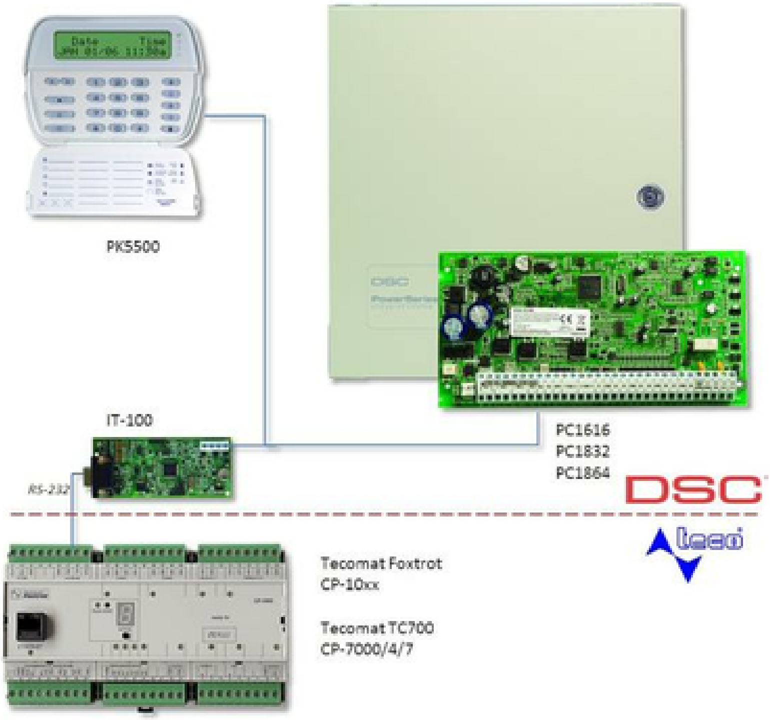
8.6.3 Connecting the DSC control panels

The DSC Power Series control panels can be connected to the Foxtrot basic module via the IT-100 communication module. The Mosaic programming environment offers a function block for communication with the DSC control panels Power Series PC1616, PC1832 and PC1864.

The Foxtrot basic module periodically inquires into the control panel status and reads all data.
What is available for the user is the status of all zones, all blocks (subsystems), the status of LEDs on the control panel and the status of the control panel itself.

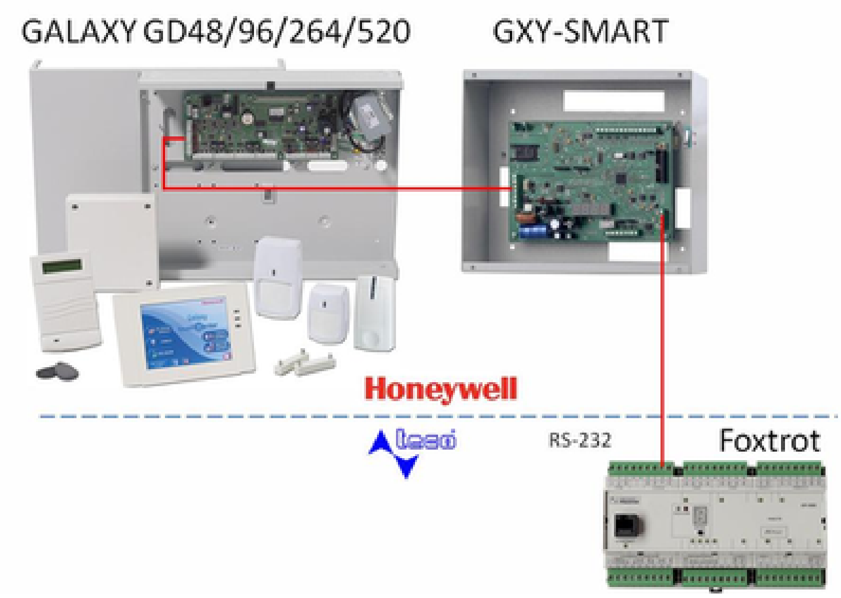
Communication takes place via the serial channel, using the RS-232 interface.
The default setting of the DSC control panel is 9,600 baud, 8 bit data, without parity, 1 stop bit.

The control panel is equipped with a standard Dsub 9 pin connector with the RS232 terminated interface; it should be connected to the Foxtrot basic module as a standard RS232 device (only the RxD, TxD and GND signals are used, the wiring is a standard crossover "null modem"). For more information on using the Foxtrot serial communication channels see the documentation [4].



8.6.4 Connecting the Galaxy control panels

The Mosaic programming SW offers a function block for the integration of the security control panlels Galaxy Dimension GD-48, GD-96, GD-264, GD-520, including some older control panels in the Galaxy and Galaxy G3 series (the exact list of control panels is listed in the TXV 003 74 documentation). The Tecomat systems are interconnected with the Galaxy control panels via the GXY-SMART communication module. This module serves for the integration of the control panels Galaxy Classic, Galaxy G3 and Galaxy GD with third-party devices. The communication utilizes the RS-232 interface, with the communication rate of 115,200 Baud.



On the Foxtrot PLC side, the CH1 serial channel is used for communication (it is equipped with the RS-232 interface); one of the CH2, CH3 or CH4 can also be used, provided they are fitted with the RS-232 interface module. On the GXY-Smart module, the CN3 terminal block is used, with the signals of the RS-232 RX, TX and GND interfaces. The wiring is done with a crossover cable (the RX signal GXY-Smart should be connected with the TX signal on the Foxtrot serial channel, the TX signal GXY-Smart should be connected with the RX signal on the Foxtrot serial channel and the GND signals should be connected).

The principle of connection consists in continual monitoring of the statuses of all detectors and subsystems (groups) connected to the GALAXY control panel, their tamper contacts, failures and alarms generated by the control panel.

Supported commands and functions:

MONITORING

- the status of detectors in the zones (closed, open)
- the status of alarms in the zones (idle, alarm)
- the status of tampers in the zones (ok, tamper)
- the status of failures in the zones (ok, trouble)
- the status of the groups (closed, open, partially activated, ready for activation, idle, alarm, reset required)

CONTROL AND SETTING

- switching off a group
- instant full switching on a group
- a partial switching on a grou
- reset of a group alarm
- cancellation of switching on a group
- active switching on a group

The detector statuses can be utilized in the Foxtrot system for any additional logic in an intelligent installation. E.g. it is possible to control lighting, heating and air conditioning based on the data from motion sensors or window contacts, both in the disarmed and the partially armed mode. This data can also be utilized for additional functions of the security system - such as generating an alarm text message, an e-mail message, and such like.

8.6.5 Connecting the JABLOTRON 100 system

The JABLOTRON 100 alarm system (JA-JA-101K and 106K control panels) can be integrated via the JA-121T module - a universal bus interface RS-485 of the JABLOTRON 100th system.

The module should be connected to the Foxtrot system via the RS-485 serial interface to the communication channel, e.g. the CH2 channel of the CP-1000 basic module (see the example below) or to an external communication module SC-1101.
The JA-121T module also requires an external supply voltage of 12 V DC, which can be provided either by an external source, e.g. the DR-15-12 (see the example below), or you can utilize the of 12 V DC output level of the PS2-27/60 power supply.

The JA-121T module is mounted on the JABLOTRON 100 bus, which is designed for connecting various parts of the system - detectors, keypads, sirens, etc. It is a four-wire bus with free topology; precise principles of installation, including the connection of the JA-121T module, are described in the JABLOTRON documentation.
The JA-121T module is suppled in an uncovered DPS, and it can be mounted in a flush box.

The basic parameters of the JA-121T module

TBD

The JA-101K control panel is an essential element of the JABLOTRON 100 security system.
It offers flexible setting and facilitates protection of small business spaces, larger houses, offices and firms.
The desired setting and the size of the system is programmed using the F-link software.
The JA-101K control panel offers:

– up to 50 wireless or bus zones
– up to 50 user codes
– up to 6 sections

JA-106K is an extended version of the JABLOTRON 100 system control panel.
It offers flexible setting and provides intelligent protection of larger houses, offices and firms. It also offers a flexible solution for protection of residential complexes, office buildings and firms that need a system with many sections. The desired setting and the size of the system are programmed via the F-link software.
The JA-106K control panel offers:

– up to 120 wireless or bus zones
– up to 300 user codes
– up to 15 sections

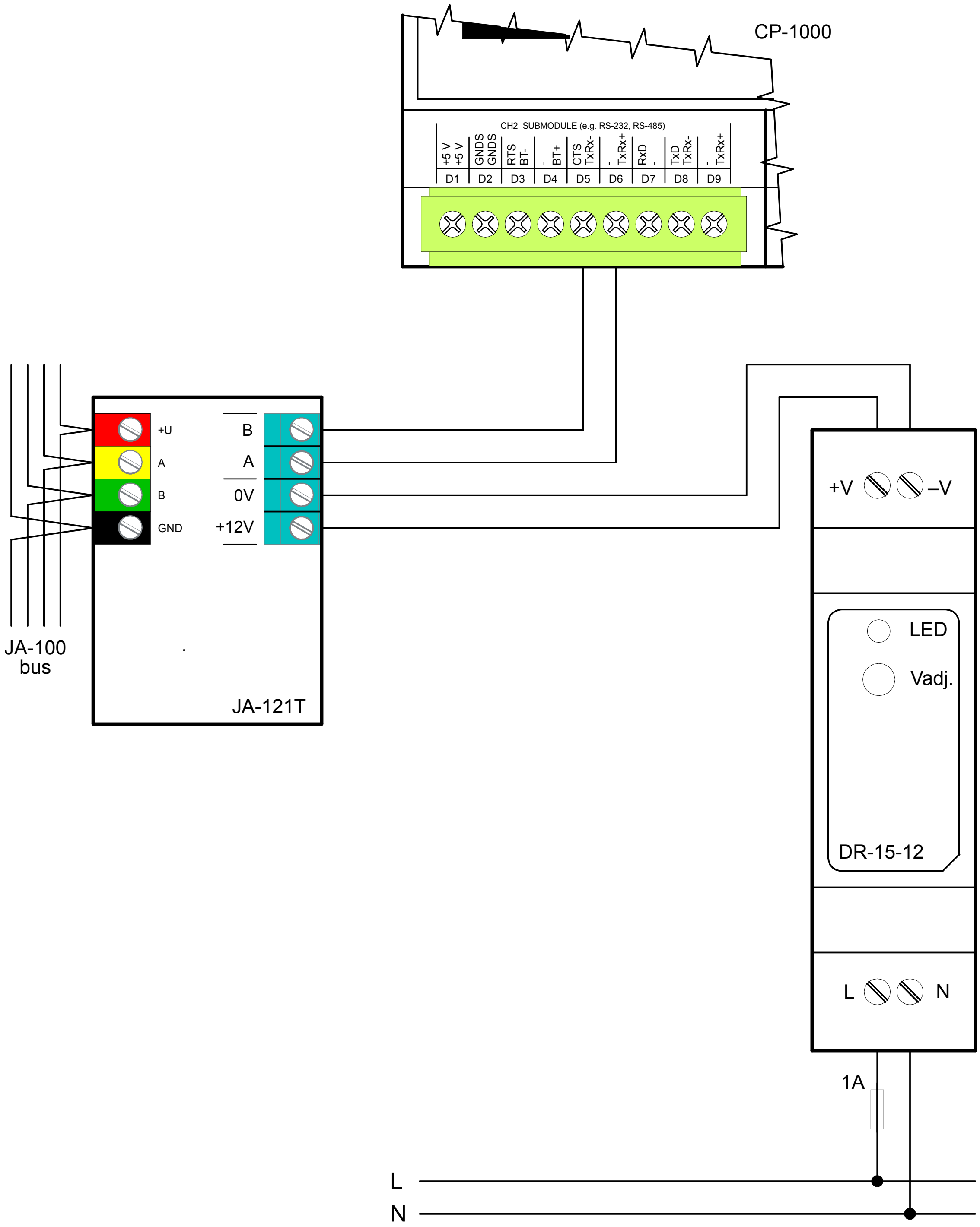


Fig. 8.6.5.1 An example of connecting the JA-121T module to the CP-1000 basic module.

8.7 Contact-free identification, RFID sensors

There are several systems and standards that are used for contact-free identification using cards and identifiers. The the most widely-used types include the 125 kHz Unique and MIFARE, MIFARE DESFire.

The Unique EM4100/EM4102 is the most widely used type in the Czech Republic for standard applications; it is R/O (read only), it is not re-writable, with 125KHz operating frequency.

The Mifare is a system for cards in accordance with ISO14443A, it works on 13.56MHz frequency, it is both R/W (read/write), and it is used for access and security systems. In recent years it has been gradually replaced by the MIFARE DESFire standard, which mainly offers a higher security.

Mifare DESFire je standard s vysokou bezpečností založenou na The Mifare DESFire is a high security standard based on the rithm 3DES (Triple DES) encrypting algo, used e.g. for electronic cards and wallets (Czech Railways, OpenCard), in accordance with ISO14443A; it works on 13.56 MHz frequency, the R/W.

The Wiegand interface
The RFID readers (contact-free scanning of cards and similar identifiers) are usually equipped with the Wiegand interface with the protocol types Wiegand 26, Wiegand 34 or Wiegand 42 bits. The data transmission takes place over two data wires Data0 (or Data L) and Data1 (or Data H) with a common signal GND. The data wires have the idle level log. H, if communication takes place, the corresponding wire goes to the level log. L. The voltage level is 5V.
A reader with the Wiegand interface can be connected up to the distance of 150m with a shielded cable with a miniumum 0.35 mm^2 cross section.
Sensors with the Wiegand protocol can be connected to the C-WG-0503S module or to the MX-0301 submodule.

8.7.1 Connecting the AXR-100/110 sensor to the C-WG-0503S module

Contact-free reading of cards and similar identifiers in accordance with the standards such as Unique 125 kHz and Mifare, DESFire Mifare 13.56 MHz can be facilitated by the AXR-100/110 sensors (manufactured by EFG CZ s.r.o), which should be connected to the C-WG-0503S module.
The module provides powering the sensor, communication between the Wiegand and the sensor, and control LEDs and the buzzer.
The sensor is suitable for the door; it can be installed on the door frame. Detailed technical information on the sensor can be found at the end of this chapter.

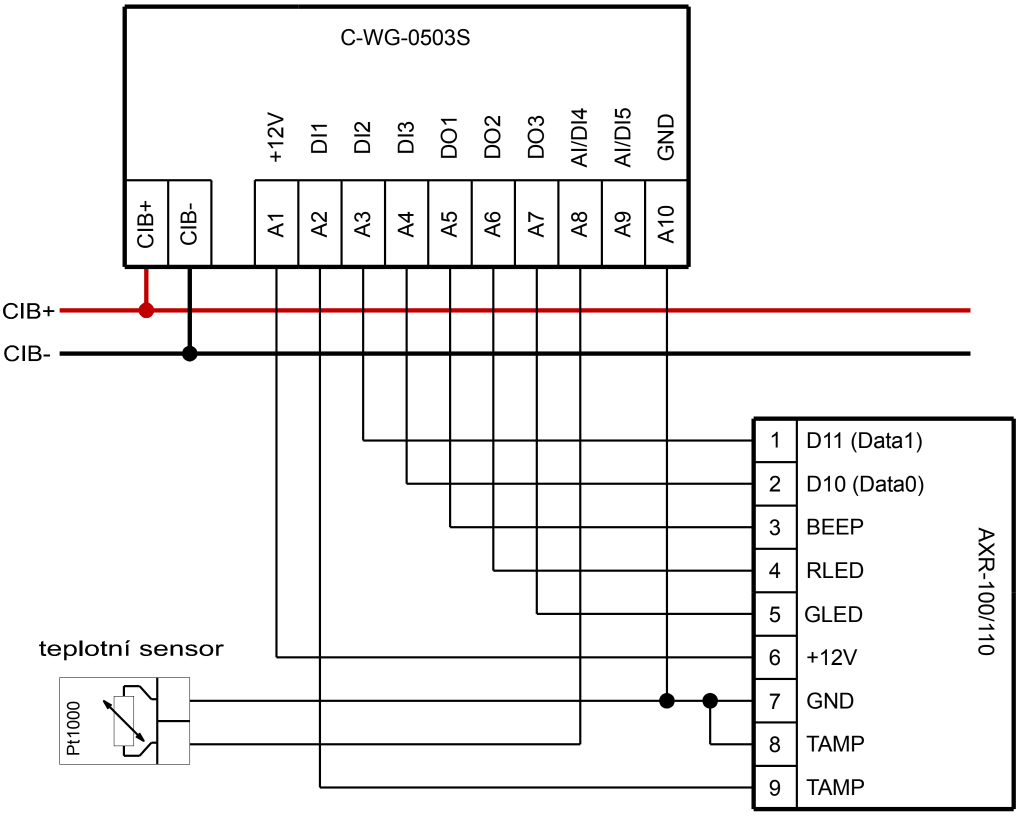


Fig. 8.7.1.1 An example of connecting the AXR-100/110 sensor to the C-WG-0503S module

Notes:

1) The cable for connecting the sensor can be as long as dozens of meters (the Wiegand interface allows the length of up to 150m); preferably the cable should be shielded with the minimum cross section of 0.35mm^2
2) The consumption of the AXR-100 sensor from the supply voltage is specified at 112 mA, but this is impulse consumption; the average current level approximately 50 mA and it meets the specifications of the C-WG-0503S module (maximum consumptiuon from the 12V output is 60mA).
3) The free inputs AI/DI4 and AI/DI5 can be utilized e.g. for connecting the temperature sensors (measuring the temperature in the room, etc.).

The properties and parameters of the AXR-100 and AXR-110 sensors.

The AXR-100/110 sensor is designed for contact-free reading (RFID) identifiers in accordance with the type of technology used: the Unique/HS (AXR-100) or the Mifare (AXR-110). The coloured LED on the front side of the sensor informs about the reading of the identifier, together with an audible signal (a buzzer controlled by connecting the terminal 3 (BEEP) with the clamp (7) GND). The LED indicates 3 statuses:

1) Blue - idle operation state.
2) Green - access allowed (controlled by connecting terminal 5 (GLED) with terminal (7) GND).
3) Red - No Entry (controlled by connecting terminal 4 (RLED) with terminal (7) GND).

Table8.7.1.1: Basic parameters of the AXR-100/AXR-110 sensor

Technical parameters	AXR-100	AXR-110
Nominal supply voltage	12VDC	
Maximum current consumption	112mA 1)	75mA 1)
The Wiegand interface	26/42 bits (3/5 Byte)	Wiegand 42 bits (5 Byte)
Reading distance – ISO card	max. 10.5cm 2) 3)	max. 7cm 2) 3)
Reading distance - the Tearshape pendant	max. 5cm 2) 3)	max. 3.5cm 2) 3)
Reading distance - the Keyfob pendant	max. 7cm 2) 3)	max. 3.5cm 2) 3)
The RFID frequency range	125kHz	13.56Mhz
The type of sensor	just for reading (read only)	
The supported types of identifiers	EM4100 EM4102 Q5	ISO 14443A Mifare4) ISO 14443A DESFire4)
Acoustic signal	buzzer	
Optical indication	LED (blue, green, red)	
Terminal block	A screw connector	
Screw	M2, thew material is CB4FF+Zn	
Terminal	Cu Zn40 Pb2+Ni	
Contact	CuSn7+Ni	
Tightening torque for the terminal screws	0.4Nm	
Maximum cross-section of the connected wire	6mm^2	
The sensor dimensions (width x height x depth)	42 x 120 x 40mm	
The dimensions of the housing (width x height x depth)	45 x 124 x 41mm	
The range of operating temperatures	-20 to +50 °C	
Protection	IP 54 5)	

1) The median value of the pulse current is less than 60mA, so it can be directly supplied by a 12V output in the C-WG-0503S module.
2) This measurement is for the identifiers supplied with the sensor. Other types of ID may have a different reading distance.
3) It has been measured on a non-metallic surface. Metallic surface can decrease the reading distance.
4) Only for reading of a unique serial card number.
5) The declared protection is valid only if the proper installation procedure has been followed.

Colour variations of the housing (optional accessories):

H-100/B	housing of the AXR-100 sensor, black
H-100/W	housing of the AXR-100 sensor, white
H-100/G	housing of the AXR-100 sensor, grey
H-100/T	housing of the AXR-100 sensor, titanium
H-100/R	housing of the AXR-100 sensor, red

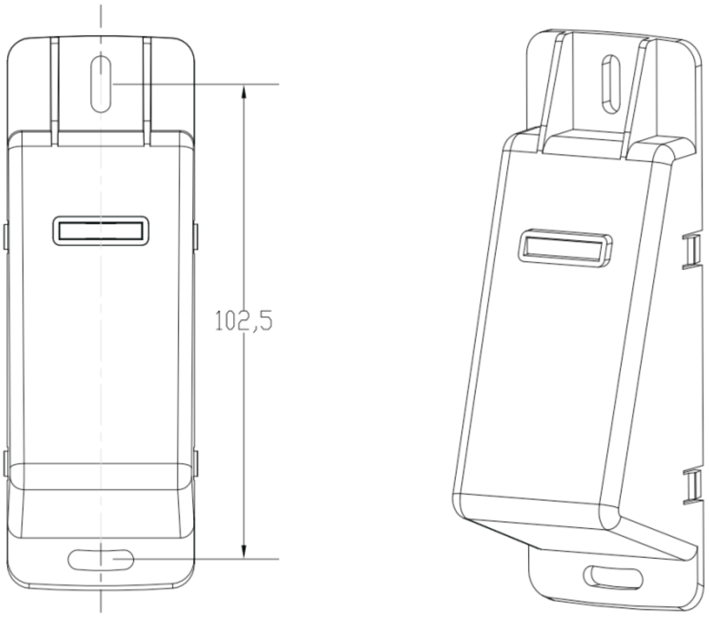


Fig. 8.7.1.2 The mounting dimensions of the AXR-100/110 sensor (a view without the top cover)

Notes:

1) The recommended mounting height is 120cm from the floor to the bottom edge of the sensor.
2) There is room in the rear part of the sensor for the connector and the cable.
3) The coloured top cover (see the variants in the text above) can be fixed by its snapping onto the sensor.

Table8.7.1.2: A description of terminals and signals of the AXR-100/AXR-110 sensor connector.

Connector PIN	Function	Description
1	D11(D21)	The data wire Data 1 Wiegand interface
2	D10(D20)	The data wire Data 0 Wiegand interface
3	BEEP	Buzzer (inside pull-up on +5V, switching at zero)
4	RLED	Red LED (inside pull-up on +5V, switching at zero)
5	GLED	Green LED (inside pull-up on +5V, switching at zero)
6	+12V	positive pole of the supply voltage
7	GND	the ground of the supply voltage
8	TAMPER	Protective loop, inside the sensor connected to pin No. 9
9	TAMPER	Protective loop, inside the sensor connected to pin No. 8

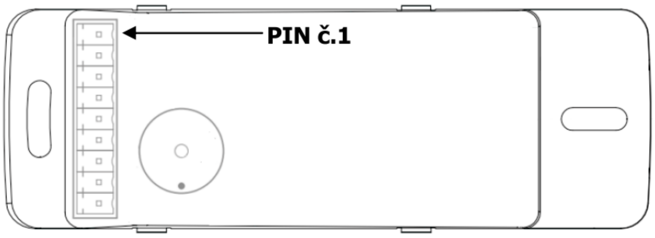


Fig8.7.1.3 Placement of the connector on the rear side of the AXR-100/110 module (a rear view)

8.7.2 Connecting the SSA-R1000/1001 sensor to the C-WG-0503S module

An example of connection of card readers SSA-R1000/R1100 (Samsung Format, 125 kHz) and SSA-R1001/R1101 (MIFARE, 13,56 MHz), produced by SAMSUNG, to the C-WG-0503S module is described in this chapter.

The C-WG-0503S module provides communication of Wiegand with the sensor and control of LEDs and the buzzer. Due to a high consumption, the sensor power supply must be provided by an external 12VDC source (the 12 VDC output of the C-WG-0503S module cannot be used in this case).

Detailed technical information on the sensor can be found at the end of this chapter.

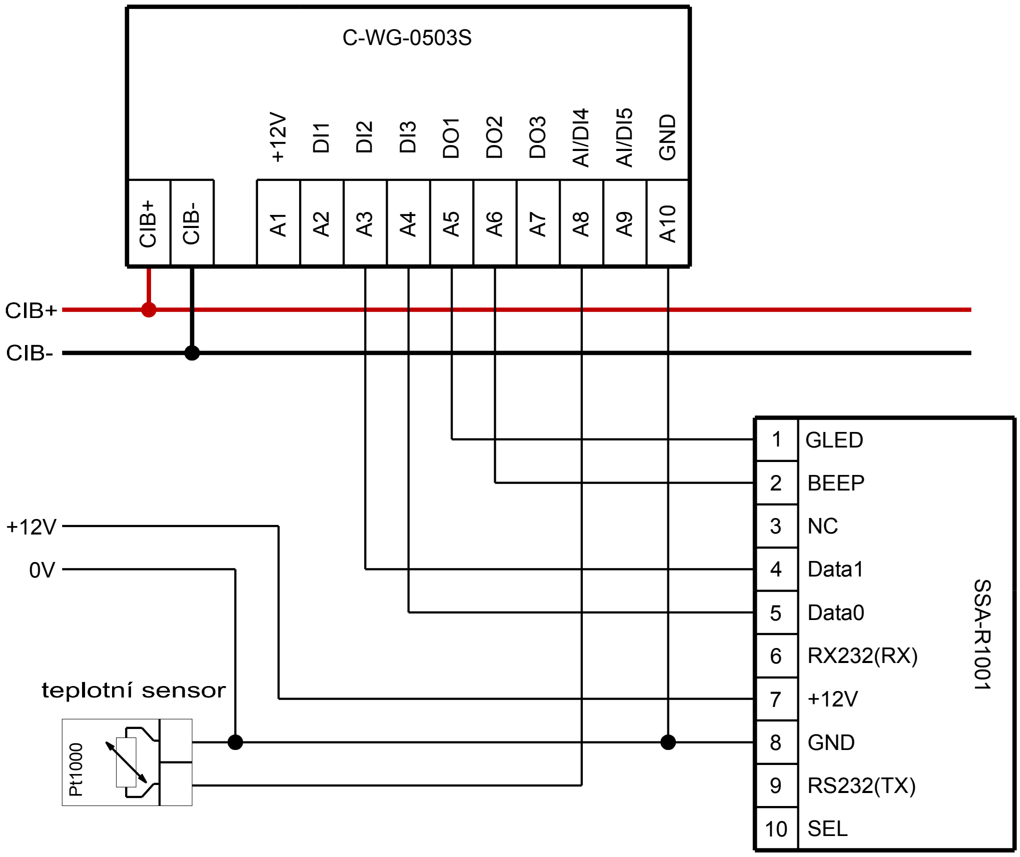


Fig. 8.7.2.1 An example of connecting the SSA-R1000/R1001 sensor to the C-WG-0503S module

Notes:

4) The cable for connecting the sensor can be as long as dozens of meters (the Wiegand interface allows the length of up to 150m); the communication and control require a shielded cable with the minimum cross section of 0.35mm^2, the power supply only requires an unshielded cable with the minimum cross section of 0.75mm^2.
5) The consumption of the SSA-R1000 sensor from the supply voltage is specified at 120 mA, which does not meet the specifications of the C-WG-0503S module (a maximum consumption from the 12V output is 60mA), so the sensor must be powered from an external source.
6) The free inputs AI/DI4 and AI/DI5 can be utilized e.g. for connecting the temperature sensors (measuring the temperature in the room, etc.).

The properties and parameters of the SSA-R1000/R1100 and SSA-R1001/R1101 sensors

The SSA-R1000/1001/R1100/R1101 sensor is designed for contact-free reading (RFID) identifiers according to the type of Samsung 125 kHz Format (SSA-R1000 SSA-R1100) or MIFARE (SSA-1001, SSA-R1101) technology used. The sensor is equipped with red and green LED indicators and a buzzer.

The sensor is designated both for indoor and outdoor use, it is equipped with a compact housing and the

interior electronics is embedded for maximum durability.
The sensor is mounted on the wall with two screws (approx. M3, or 3.5mm wood screws), vertically above one another with the spacing of 8.38cm; in the middle between the mounting holes there is a fixed connecting cable.
The cable is terminated with free coloured wires moulded (see tab.8.7.2.2) in a connector.

Table8.7.2.1: The basic parameters of the SSA-R1000/R1100 and SSA-R1001/R1101 sensors

Technical parameters	SSA-R1000	SSA-R1100	SSA-R1001	SSA-R1101
Nominal supply voltage	12VDC			
Maximum current consumption	120mA 1)		80mA 1)	
Interface	26 bits Wiegand		34 bits Wiegand	
Reading distance – ISO card	max. 10cm 2)		max. 10cm 2)	
The RFID frequency range	125kHz		13.56Mhz	
The supported types of identifiers	PSK 125kHz, Samsung Format		ISO 14443A Mifare 3)	
The type of sensor	just for reading (read only)			
Acoustic signal	buzzer			
Optical indication	LED (green, red)			
Terminating signals	Cable, the length about 40cm, the diameter of the insulation is 6mm			
The cable termination	Connector			
Dimensions of the housing (width x height x depth) mm	47 x 122 x 26	75.3 x 109 x 31	47 x 122 x 26	75.3 x 109 x 31
The range of operating temperatures	-30 to +50 °C			
Housing – colour, material	Silver with a black stripe, polycarbonate			
Protection	IP 65			

1) The current consumption exceeds the 12V output of the C-WG-0503S module, so the sensor must be powered from an external source (e.g. from the 12V output level of the PS2-60/27 power supply, or from the DR-15-12 supply).
2) The distance is only valid for cards and identifiers supplied by the sensor manufacturer.
3) Only for reading of a unique serial card number.

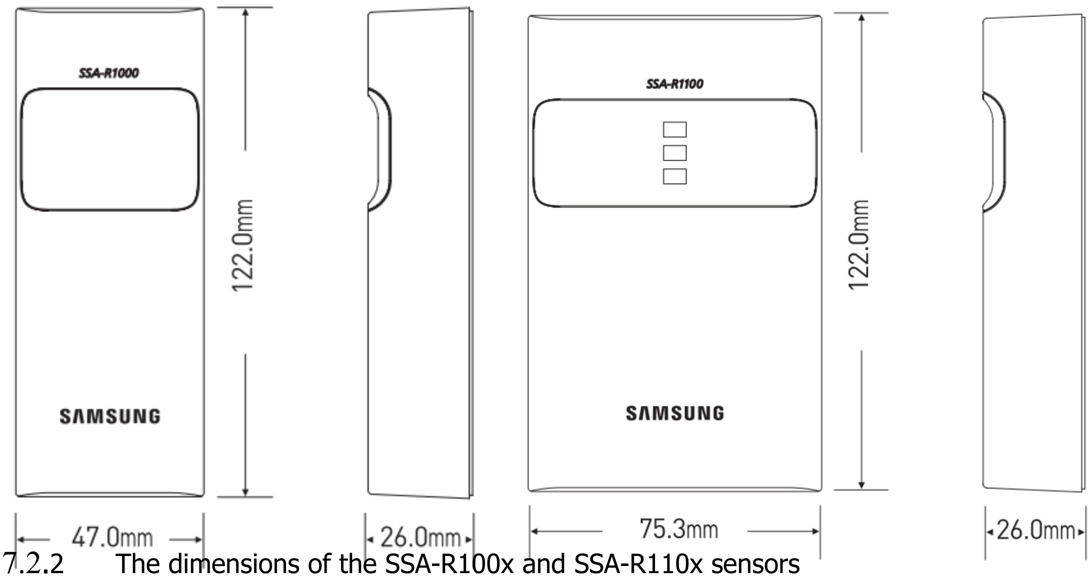


Fig. 8.7.2.2 The dimensions of the SSA-R100x and SSA-R110x sensors

Table8.7.2.2: A description of the terminals and signals of the SSA-R1000/R1100 and SSA-R1001/R1101 sensors connectors

Connector PIN	The colour of the wire	Function	Description
1	yellow	GLED	green LED (it is activated by connecting the signal to GND)
2	blue	BEEP	buzzer (it is activated by connecting the signal to GND)
3	orange	NC	not used

4	White	data1	data wire, Data 1 Wiegand interface
5	green	data0	data wire, Data 0 Wiegand interface
6	brown	RS232(RX)	RS232 (not used)
7	red	+12V	positive pole of the supply voltage
8	black	GND	the ground of the supply voltage
9	violet	RS232(TX)	RS232 (not used)
10	grey	SEL	34/26 bit Wiegand selection (26 bit – by connecting to GND)

8.7.3 Connecting the OP10, OP30 and OP45 sensors to the C-WG-0503S module

Contact-free reading cards and similar identifiers in accordance with the standard 125 kHz can be also facilitated by the sensors OP10, OP30I, OP45 and other Honeywell products, which should be connected to the C-WG-0503S module.
The module provides powering the sensor, communication between the Wiegand and the sensor, and control LEDs and the buzzer.
Detailed technical information on the sensor can be found at the end of this chapter.
Design:
OP10 a miniature design..
OP30 a narrow design for mounting next to the door frames.
OP45 a square design for mounting on a flush box.
The OP40 and OP90 should be connected in the same way.

Table8.7.3.2: A description of signals of the OPxx sensor connectors

Wire	Signal
red	+12V
black	GND
white	data1
green	data0
brown	LED
violet	TAMPER

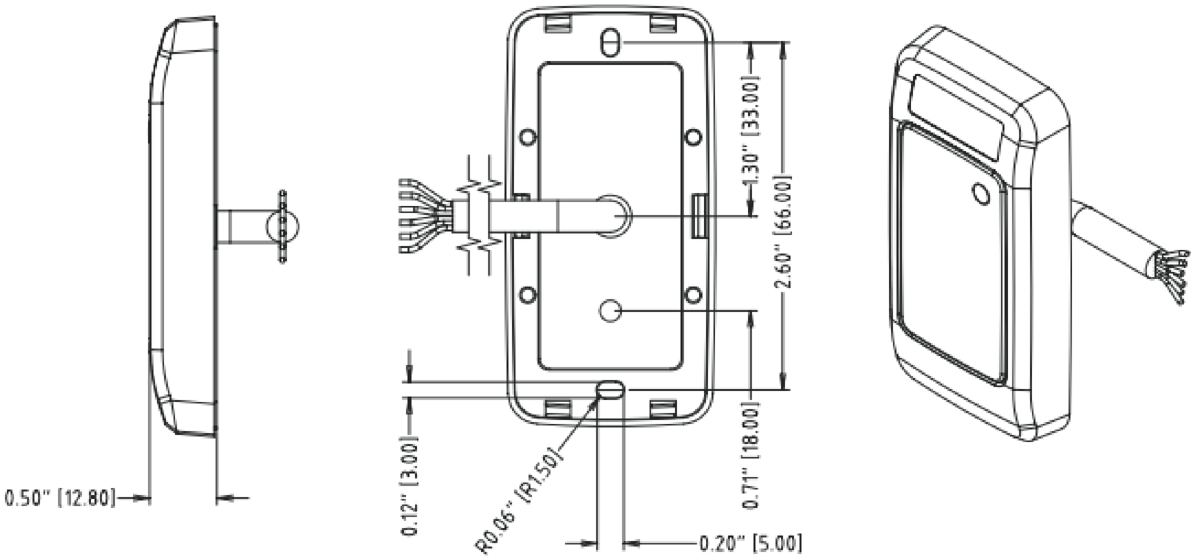


Fig. 8.7.3.1 The dimensions for mounting of the OP10 sensor (information in inches and mm)

The properties and parameters of the OP10, OP30 and OP45 sensors
The OPxx sensors are designed for contact-free reading (RFID) of 125 kHz identifiers.
The sensor is equipped with a two-colour LED indication and a buzzer.
The sensor is designed both for indoor and outdoor installation.
The sensor is mounted on the wall with two screws (approx. M3, or 3.5mm wood screws); the layout of the mounting holes is indicated in Fig. 8.7.3.1; in the middle between the mounting holes in the rear wall there is a fixed connecting cable.
The cable is terminated with free coloured wires, see table8.7.3.1.

Table8.7.3.1: The basic parameters of the OPxx sensors

The type of reader	**OP10**	**OP30**	**OP45**
Technology	HID, contact-free		
Working frequency	125kHz		
Supply voltage	5 - 16 Vss		
Consumption	35mA		
The output format	Wiegand		
Maximum reading range	5cm	9cm	9cm
LED diode	2-coloured		
buzzer	yes		
The casing colour	black+grey+beige (supplied)		
Protection	IP 65		
Operating temperature	-31 - 63°C		
Relative humidity	0 - 90 %		
Usage outdoors	yes		
Dimensions - the height	80mm	145mm	89 mm
Dimensions - the width	40mm	43mm	89 mm
Dimensions - the depth	13mm	20mm	15mm
Compatible card (an example)	ProxCard II, ISOProx II		
Compatible pendant (an example)	ProxKey II		
Compatible sticker TAG (an example)	MicroProx Tag		

8.7.4 The RFID CFox card reader in the interior design, the C-WG-0503R-design

Regarding contact-free identification, such as opening doors, identification of workers in the workplace, etc., we can offer a RFID reader C-WG-0503R-design, which is available in various designs, e.g. ABB Time, Logus, Unica, Gira, Niko, Legrand and others. Please send us a query if you require a design which is not quoted in the price list.

The module consists of two parts connected with a cable.
The first part (the RFID module) is the mechanical component of the specific design, with a fitted RFID reader (an antenna), two LED indicators, an optional temperature sensor (fitted option agreement), and buzzer. Both LEDs and the temperature sensor are visible on the face of the mechanical part.
The RFID sensor is compatible with the EM4100 (125 kHz) standard.

The second part (the WG-C-0503S) represents the module electronics in the built-in design; in addition to the interconnection with the first part, it has a terminated CIB bus with one or two analogue inputs available (depending on whether the temperature sensor in the first part is fitted).

Both modules are supplied connected with about 100mm long free wires, assuming an installation in a standard flush box. If it is requested that the RFID reader and the module electronics should be separated (e.g. for safety reasons, with the RFID module in front of the door, and the electronics and the CIB being inside behind the door), the supplied wires can be longer. An illustration of how to connect both parts as well as additional is presented information, see Fig. 8.7.4.2.

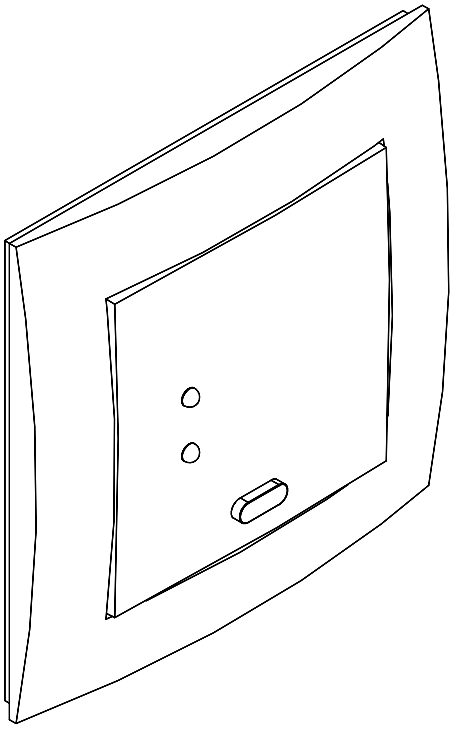


Fig. 8.7.4.1 A view of the C-WG-0503R-design module, the Logus design
Notes

1. The module in the figure is also fitted with a temperature sensor.

C-WG-0503R-design

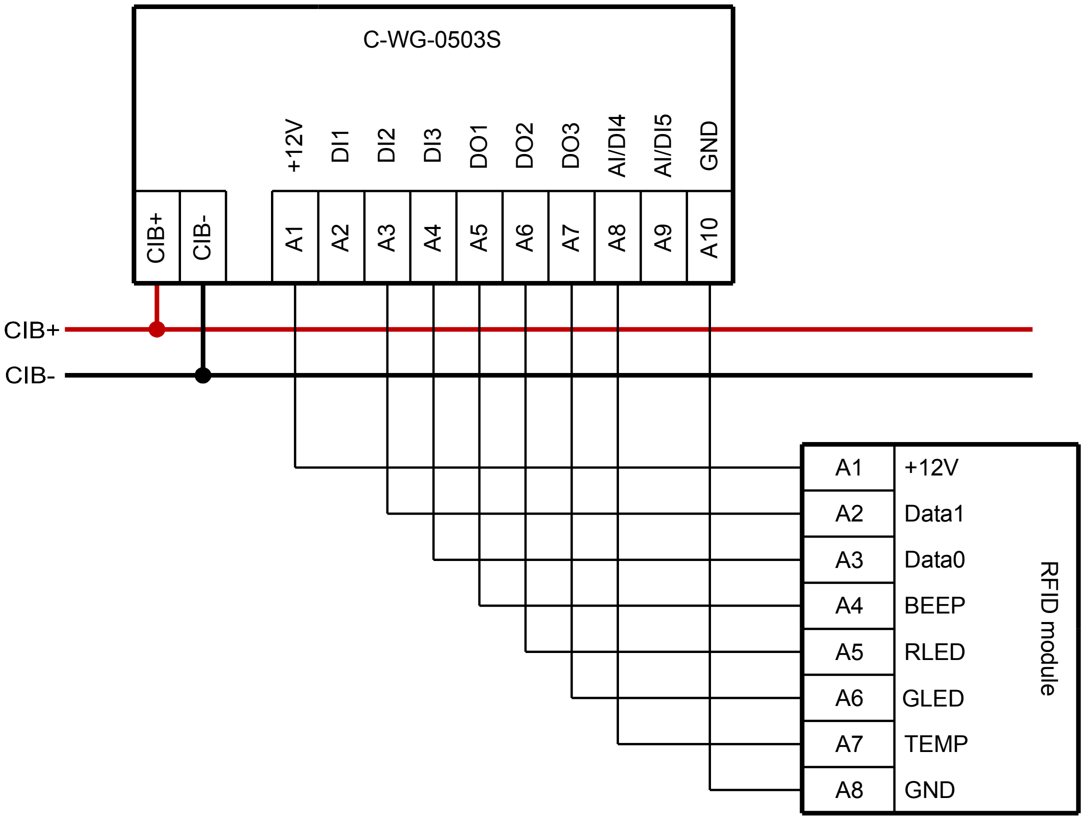


Fig. 8.7.4.2 Connecting both parts of the C-WG-0503R-design module.

Notes:

1. By default, both parts are connected with separate wires (the length about 100mm). The connection can be extended up to about 1m; the diameter of wires in the cable should be at least 0.5mm.
2. The free inputs AI/DI5 and AI/DI4 (if the RFID module is not fitted with an internal temperature sensor, the AI/DI4 is also available) can be used e.g. for connecting temperature sensors or a PIR detector, etc. The detectors can be powered from the +12V output of the C-WG-0503S module; a maximum of 25mA is available (a maximum consumption of the powered detectors).
3. The reading range is up to 8cm (typically 4 ÷ 6cm) and depends on the mechanical construction of the sensor and the type of scanned identifier.

8.7.5 The RFID card reader for a customized embedded design

The RFID reader of C-WG-0503R identifiers is also available for customer-designed mechanical placement of the scanning part.

The RFID reader can be ordered without the mechanical part; in this case, the reader will be supplied as a board fitted with a sensor with an antenna and other components (a LED, a buzzer, terminal blocks) and then it can be mounted into various types of mechanical applications.

The RFID reader is identical with the version described in Chapter 8.6.4, including the interconnection of both parts, with only the mechanical part of the specific design missing (typically the plug).

It is important to ensure that the sensor is not influenced by a proximity of electrically conductive objects (a metal cover, etc.).
Maximum care should also be taken during the handling and installation to avoid damaging the module electronics.

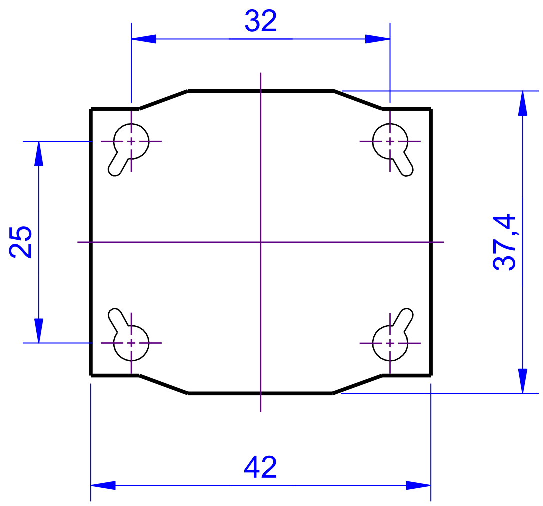


Fig. 8.7.5.1 The dimensions and placement of the holes for mounting the scanning part of the RFID module

Notes:

1. By default, both parts of the module (the RFID scanning part and the embedded C-WG-0503S part) are interconnected with separate approx. 100mm long wires. The connection can be extended up to approx. 1m; the diameter of wires in the cable should be at least 0.5mm.
2. The free inputs AI/DI5 and AI/DI4 can be used e.g. for connecting temperature sensors or a PIR detector, etc. The detectors can be powered from the +12V output of the C-WG-0503S module; a maximum of 25mA is available (a maximum consumption of the powered detectors).
3. There should be minimum of electrically conductive objects in close proximity to the sensor with the antenna (the black cube), as they could have a negative impact on the range of the antenna. Every customized design and its impact on the range should be tested.
4. The module should be mounted with the antenna (the black cube) facing the scanned identifier; the terminal should be located on the rear side of the board.
5. The reading range is up to 12cm and depends on the mechanical construction of the sensor and the type of scanned identifier.

8.8 The keypad, access control

8.8.1 Connecting the SSA-R2000V keypad to the C-WG-0503S module

The access control via a keypad with a proximity card (or similar identifiers) reader is best arranged by utilizing the SAMSUNG-produced SSA-R2000V keypad, which should be connected to the C-WG-0503S module. The sensor is equipped with a numeric proximity keypad and a proximity card reader in two variants: the SSA-R2000V (Samsung Format, 125kHz) and the SSA-R2001V (MIFARE, 13.56 MHz).
The C-WG-0503S module provides Wiegand communication with the sensor and control of LEDs and the buzzer. Due to the consumption reaching 230mA, the keypad must be powered from an external 12VDC supply (the 12VDC output of the C-WG-0503S module cannot be used for this keypad).
For detailed technical information on the keypad, see the end of this chapter.

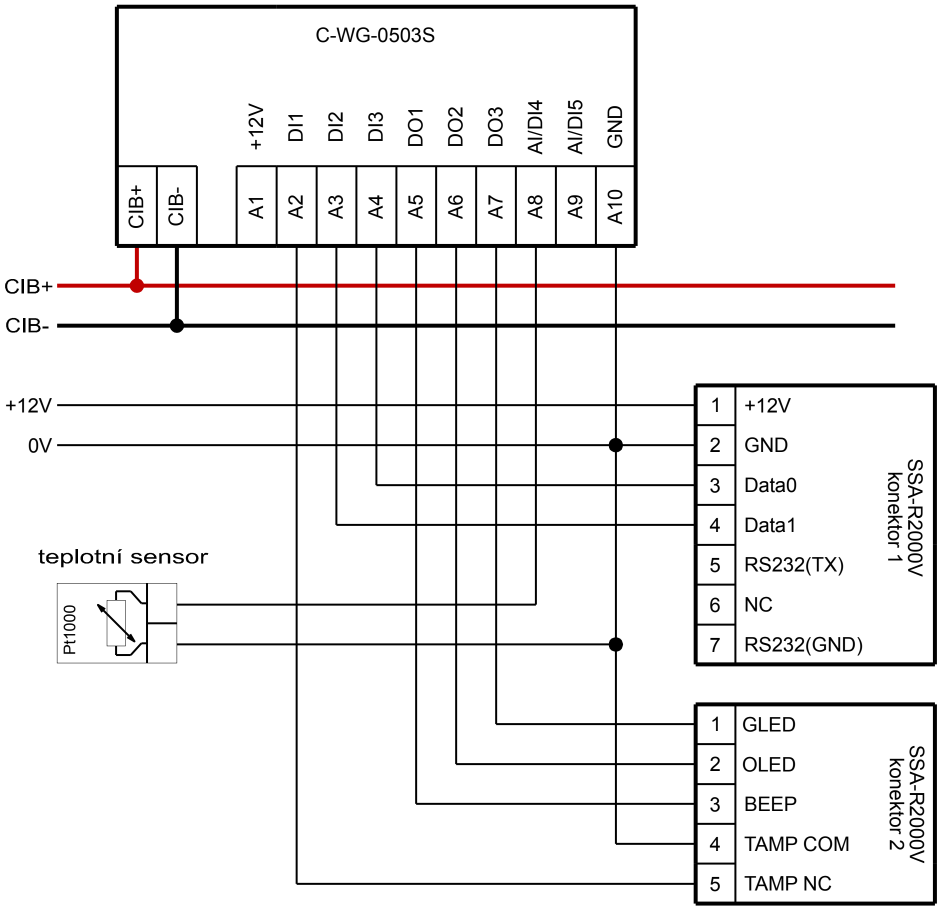


Fig. 8.8.1.1 An example of connecting the SSA-R2000V sensor to the C-WG-0503S module.

Notes:

7) The cable for connecting the sensor can be as dozens of meters long (the Wiegand interface allows the length of up to 150m); the communication and control require a shielded cable with the minimum cross section of 0.35mm^2, the power supply only requires an unshielded cable with the minimum cross section of 0.75mm^2.
8) The consumption of the SSA-R2000V sensor from the supply voltage is specified at 230 mA, which does not meet the specifications of the C-WG-0503S module (a maximum consumption from the 12V output is 60mA), so the sensor must be powered from an external source.

9) The free inputs AI/DI4 and AI/DI5 can be utilized e.g. for connecting the temperature sensors (measuring the temperature in the room, etc.).

The properties and parameters of the SSA-R2000V sensors

The SSA-R2000V sensor is designed for reading proximity (RFID) identifiers according to the type of technology used - the Samsung 125kHz Format (SSA-R2000V) or the MIFARE (SSA-R2001V); it is also used for entering the PIN code via the touch keypad. The sensor is equipped with a red, orange and green LED indication and a buzzer.

The sensor is designed for both indoor and outdoor use, it is in a vandal-resistant version, with a contact-free keypad in a compact housing; the interior electronics is embedded for a maximum durability. The module is equipped with a tamper contact against unauthorised manipulation.

The sensor is mounted on the wall with two screws (approx. M3, or 3.5mm wood screws); the layout of the mounting holes is indicated in Fig. 8.8.1.3; in the middle between the mounting holes in the rear wall there is a fixed connecting cable. The tamper contact is located in the top part, approximately between the mounting holes.

The cable is terminated with free coloured wires moulded into two connectors (see tab8.8.1le.2).

Table8.8.1.1: The basic parameters of the SSA-R2000V and SSA-R2001V sensors

Technical parameters	SSA-R2000V	SSA-R2001V
Nominal supply voltage	12VDC	
Maximum current consumption	230mA ¹⁾	150mA ¹⁾
The interface RFID sensor	26 bits Wiegand	34 bits Wiegand
The keypad coding	8bit code	8bit code
Reading distance – ISO card	max. 10cm ²⁾	max. 10cm ²⁾
The RFID frequency range	125kHz	13.56Mhz
The supported types of identifiers	PSK 125kHz, Samsung Format	ISO 14443A Mifare ³⁾
The type of sensor	just for reading (read only)	
Acoustic signal	buzzer	
Optical indication	LED (green, orange, red)	
The keypad	contact-free, numeric keys, ESC, ENT	
Terminating signals	cable, approx. 100cm long, a 6.5mm insulation diameter	
The cable termination	2x connector	
The dimensions of the housing (width x height x depth)	87 x 109 x 25mm	
The range of operating temperatures	-30 to +50 °C	
Housing – colour, material	a silver frame with a black keypad, polycarbonate and aluminium	
Protection	IP 68	

1) The current consumption exceeds the 12V output of the C-WG-0503S module, so the sensor must be powered from an external source (e.g. from the 12V output level of the PS2-60/27 power supply, or from the DR-15-12 supply).
2) The distance is only valid for cards and identifiers supplied by the sensor manufacturer.
3) Only for reading of a unique serial card number.

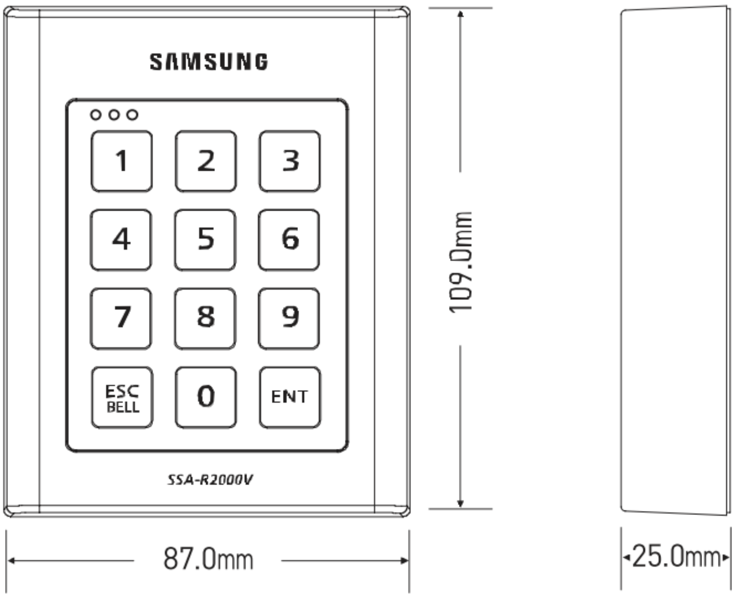


Fig. 8.8.1.2 The dimensions of the SSA-R2000V sensor

Table8.8.1.2: A description of the terminals and signals from the SSA-R2000V sensor

Connector PIN		The colour of the wire	Function	Description
Connector 1	1	red	+12V	positive pole of the supply voltage
	2	black	GND	the ground of the supply voltage
	3	green	data0	data wire, Data 0 Wiegand interface
	4	White	data1	data wire, Data 1 Wiegand interface
	5	violet	RS232(TX)	RS232 transmitter (not used)
	6	brown	NC	not used
	7	orange	RS232 (GND)	RS232 GND
Connector 2	1	yellow	GLED	green LED (it is activated by connecting the signal to GND)
	2	grey	OLED	orange LED (it is activated by connecting the signal to GND)
	3	blue	BEEP	buzzer (it is activated by connecting the signal to GND)
	4	pink	TAMP COM	the tamper common terminal
	5	light yellow	TAMP NC	the tamper NC contact output

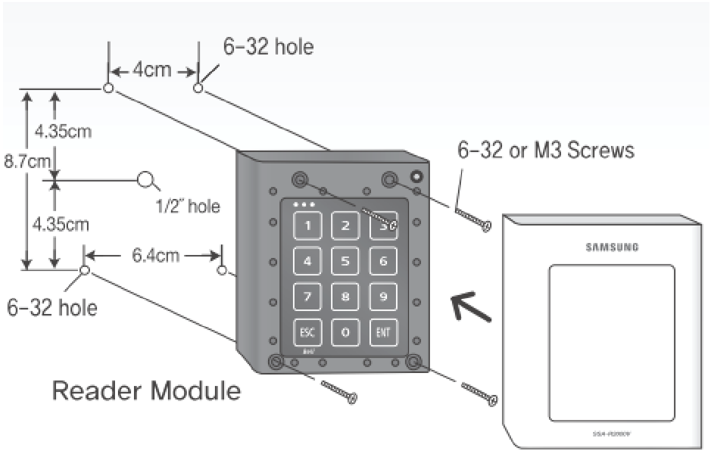


Fig. 8.8.1.3	A drawing of mounting the SSA-R2000V sensor on the wall

8.8.2 Connecting the ACM08E keypad to the C-WG-0503S module

The access control via a keypad with a proximity reader of cards or similar identifiers can utilize the ACM08E sensor with a keypad connected to the C-WG-0503S module. The sensor is equipped with a numeric contact keypad and a proximity card reader in accordance with the EM 125kHz standard.
The C-WG-0503S module provides Wiegand communication with the sensor and control of LEDs and the buzzer. For detailed technical information on the keypad, see the end of this chapter. The module is equipped with a green, red and yellow LED. The green LED shines permanently (it is not controlled), the red shines in an idle position, and after the card is scanned, the red light is for a moment replaced by a yellow light and the buzzer beeps. When the LED external input is activated, the red LED also goes off and the yellow LED lights up. The precise LED control status should always be checked on each particular piece (the LED manufacturer has made some colour changes).

Table8.8.2.2: A description of interconnection of the ACM08E sensor outputs and the C-WG-0503S module outputs.

The ACM08E sensor			The C-WG-0503S module termination		
Wire	**Signal**	-	**Wire**	**Signal**	**Terminal**
red	+12V	-	red	+12V	A1
black	GND	-	blue	GND	A10
white	data1 Wiegand	-	brown	data1 Wiegand	A3
green	data0 Wiegand	-	yellow	data0 Wiegand	A4
blue	LED	-	grey	DO2	A6
yellow	buzzer	-	violet	DO1	A5

Notes:

1) The table shows the interconnection of wiring of both modules. N.B.: In the ACM08E module it is necessary to verify, whether the colours of signals in the legend on the rear side of the keypad module correspond with this table, as the manufacturer has made some changes to the colour marking and different colours of the wires therefore cannot be ruled out).
2) The cable for connecting the keypad can be extended to dozens of meters (the manufacturer allows the length up to 150m); the communication and control require a shielded cable with the minimum cross section of 0.35 mm^2 , and the power supply only requires an unshielded cable with a recommended cross section of $0.75mm^2$
3) The indicated consumption of the ACM08E sensor from the supply voltage is 70mA, which still allows the use of the 12VDC power supply output of the C-WG-0503S module (a maximum consumption from the 12V output is normally 60mA).
4) The free inputs AI/DI4 and AI/DI5 can be utilized e.g. for connecting the temperature sensors (measuring the temperature in the room, etc.).

The properties and parameters of the ACM08E sensor

The ACM08E sensor is designed for contact-free (RFID) reading of identifiers of the EM 125 kHz type as a standard, and for entering PIN codes via a touch keypad.

The sensor is equipped with a red, yellow and green LED indicators and a buzzer.

The sensor is designed for indoor and sheltered outdoor installation (the manufacturer does not specify the level of protection) with a contact keypad; the internal electronics is embedded for maximum durability.

The sensor is mounted on the wall with two screws (approx. M3, or 3.5mm wood screws); the layout of the mounting holes is indicated in Fig. 8.8.2.3; in the middle between the mounting holes in the rear wall there is a fixed connecting cable.

The cable is terminated with free coloured wires, see table8.8.2.2.

Table8.8.2.1: The basic parameters of the ACM08E sensor

Technology	Proximity reader RFID, a keypad
Working frequency	125kHz
Supply voltage	5 - 16 Vss
Consumption	max. 70mA [1)]
The output format	Wiegand 26 bit
Reading range	2 ÷ 15cm
LED diode	2-coloured
buzzer	yes
The casing colour	black
Operating temperature	-25 ÷ 75°C
Relative humidity	10 ÷ 90%
Dimensions - the height	108mm
Dimensions - the width	88mm
Dimensions - the depth	32mm

1) The current consumption allows the use of the 12V output of the C-WG-0503S module for powering the sensor, or the sensor can be powered from an external source (e.g. from the 12V output level of the PS2-60/27 supply, or from the DR-15-12 power supply).

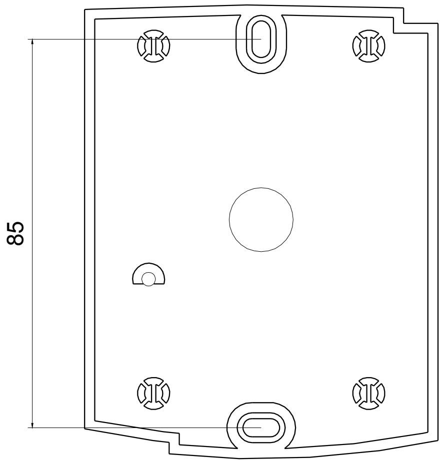


Fig. 8.8.2.2 The front view and the drawing of the ACM08E sensor mounting

8.9 The communication with the user and the ARC

In order to effectively respond to any alarm, such as the activation of electronic security system, fire detector, sabotage, etc. (similarly also the activation of flood detectors or power outage), there must be available a method of communication with the user or with a contracted security guard service.
For this purpose there are SMS text notification modems for the communication with the user, or with the Alarm receiving centre (ARC); for more information see Chapter 9.5 SMS Communication.
The communication to the ARC is described in the following text:

8.9.1 Communication interface towards the Alarm receiving centre (ARC)

We are preparing a Foxtrot system communication interface to the ARC for those users, who would like to use the Foxtrot system also in the function of the ESS control panel and require a permanent connection with the Alarm receiving centre (ARC).

TBD

8.10 Emergency lighting in the house

Emergency lighting, escape routes lighting and anti-panic lighting are defined by the appropriate standards, depending on the type of premises and the nature of its use.

Emergency lighting is used in case of a failure of standard lighting; it must remain fully functional even during a power outage. Its power supply is provided by independent sources, either separate (each emergency light is fitted with a battery that guarantees the required lighting time), or central, where the emergency power is distributed from a central source to individual lights.
In accordance with the Decree no.246/2001 Coll. establishing fire safety conditions and state fire surveillance (the Fire Prevention Decree), the emergency lighting represents a fire safety equipment.

Alternative lighting is a type of emergency lighting, which makes it possible to continue in normal activities without substantial changes.

Anti-panic lighting (in public spaces) should prevent panic and enable people to safely move towards escape routes. It is defined by hygiene requirements, so e.g. even an office space with an area of over 60m^2 must have anti-panic lighting (a condition for the approval). The lighting is defined by the illuminance value > 0.5lx at the floor level; this does not apply to a 0.5 meter-wide perimeter of the room. The minimum duration of lighting is 1 hour

Emergency escape lighting must allow the users to safely escape from the premises by providing proper lighting and marking the direction of escape.

In **dwelling houses** and houses for individual leisure time activities there is no obligation to install emergency lighting, but with regard to safety of the inhabitants and more comfortable arrival to the house during a power outage (disarming the alarm, movement in the entrance area, etc.), it is recommended to consider installation of at least basic emergency lighting when planning smart control of your house.

The following examples do not deal with emergency lighting in the light of the relevant standards (public buildings, meeting places for people, manufacturing facilities, etc.), but only with the automatically controlled lighting during a power failure, or possibly according to the level of outdoor lighting and the presence of people.

It is advantageous to use the distribution from the CIB bus and the bus modules for the basic emergency lighting, as it provides both the 12V voltage supply, and control of the emergency lights.

An independent power supply (typically 12VDC) can also be used; it should be distributed to the locations of the emergency lights. It is controlled by standard relay outputs of the control system.

It is advantageous to use the LED lighting for emergency purposes, either as independent lights, e.g. in suspended ceilings, or the emergency lights can be fitted in standard lights as an additional source, e.g. a short LED strip powered from the 12V output of CFox modules (e.g. the C-WG-0503S) - see the following example.

8.10.1 Emergency lighting – a LED strip with the C-WG-0503S module

Easy implementation of emergency lighting can be done using the C-WG-0503S module, which provides a 12VDC power supply and controls (via the binary output) the LED strip, which can be fitted in a conventional lighting fixture.
For example a 5-cm ordinary 12V, 4.8 W/m LED strip provides sufficient lighting for hallways or similar rooms, although the power consumption is no more than 0.24W, i.e. it only draws a 20mA current and can be directly switched e.g. by the DO1 output of the C-WG -0503S module (the binary module outputs can switch a maximum current of 30mA). If the LED strip is placed on the ceiling, the light intensity at the floor-level is approximately 1lx. The advantage of this solution is its energy efficiency, as using the relay output for switching the lighting can be avoided; just the actual switching of the relay from the CIB, or batteries, consumes 0.2 ÷ 0,4 W.
The example also shows the connection of PIR detectors OPTEX RXC-ST to the C-WG-0503S module.

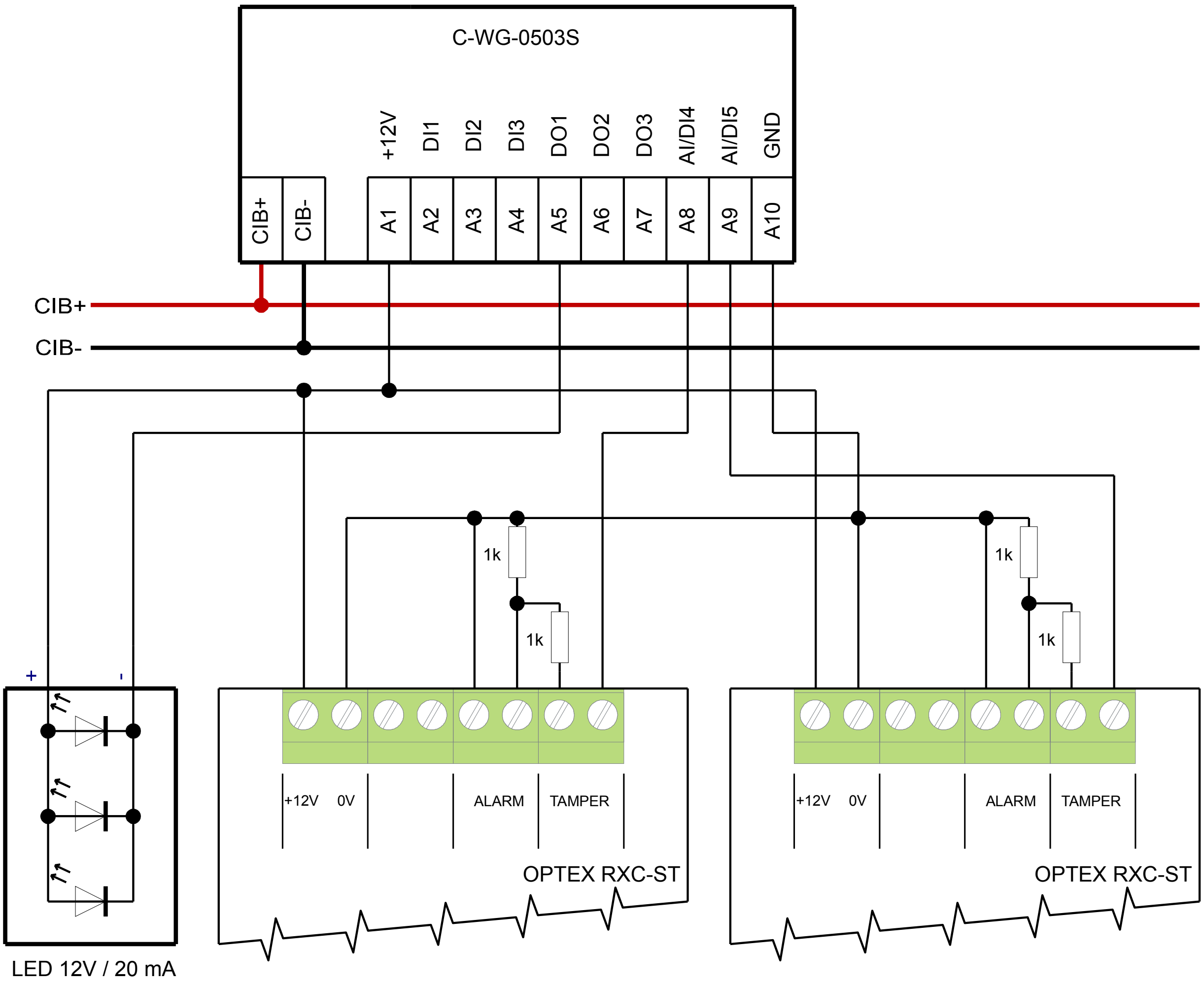


Fig. 8.10.1.1 An example of connecting a LED strip to the C-WG-0503S module.

Notes:

1) The example shows the connection of the detectors loop as double balanced; the ALARM and TAMPER outputs in the detectors must be correctly connected with 1K resistors (see the general description of double balancing in Chapter 8.1.1).
2) Correct installation of the detectors is specified in the product operating instructions.
3) Each detector consumes from the 12V supply typically 8mA. The LED light source can consume a maximum of 30mA (limiting the DO1 output).

4) The detectors can be connected by a cable with the wires diameter of at least 0.3mm; the cable can be as long as dozens of meters, e.g. the SYKFY cable for connecting the LED light source can use any insulated wires with at least 0.5mm diameter and a length up to 30m.

9 The communication with the user, the multimedia

The table of contents of the chapter

The chapter contains information about drivers and controls, which allow the user to operate all functions of the system - i.e. to control the lights (how to switch on and off, or dim, and how to select the light scenes), to control the blinds, home devices (TV, multimedia, household appliances that can be reasonably controlled, etc.), to control the heating, cooling and ventilation systems and other technologies, depending on each specific installation.

9.1 Control push-buttons on the wall (control of lighting, blinds, etc.)

Control units on the wall (a replacement of conventional switches) can be designed or integrated into the system in several ways, depending on the comfort, options, price and assortment.

The first one is a controller as the **bus element** of the Foxtrot system. In this case the best use of the element is on the wall (several short-stroke push-buttons, an integrated temperature sensor, connection of additional temperature sensors, LED indication, etc.), but at the same time, the range is limited to directly supported designs, such as **Logus** from Efapel, **Time** from ABB and the whole series of controllers produced by **OBZOR** (Decente, Elegant and Variant).
Besides the modules (control units) on the CIB bus (Time, Logus, Obzor designs), wireless control units designed by ABB Time can also be used, such as the R-WS-0200R-Time and R-WS-0400R-Time modules, which have - in terms of functionality - identical characteristics as the CFox modules C-WS-0400R-Time.

Another option is to use **short-stroke push-buttons** produced and supplied by the manufacturers of the electric installation elements, such as GIRA, JUNG, EATON and others. These buttons can be connected to the binary inputs of the system, either directly in the flush box under the appropriate control unit, or with a cable in the control panel on the inputs of modules on a DIN rail. However, the limitation is the availability and the assortment of control units on the market.

The third option is to use **common buttons** without a detent (for the blinds, for the bell, etc.). With no possibility of signalling and usually only one or two buttons for the control unit, such buttons have only one advantage: they are available in nearly every design. The buttons should also be connected to the binary inputs of the system - like in the previous paragraph.

The fourth option is to **integrate the control units** with the communication of other manufacturers - we can offer solutions for the KNX controllers.

9.1.1 Controllers on the CIB bus, the Logus design

You can control the lighting, blinds, ventilation and similar applications using the control unit C-WS-0200R-Logus with one fingerboard (2 buttons - one at the top and one below), or the C-WS-0400R-Logus with two fingerboards (4 buttons - each fingerboard has a button at the top and below). Both types of drivers are equipped with an internal temperature sensor, and up to two external temperature sensors can be connected to them (a room temperature sensor - the Pt1000 sensor itself in an adjacent frame of Logus design, the S-TS-01R, and the second sensor e.g. for measuring the floor temperature).
The module is fitted with LED indicators. For each flap there is available a red and green LED; their control can be custom-made to suit the customer's requirements.

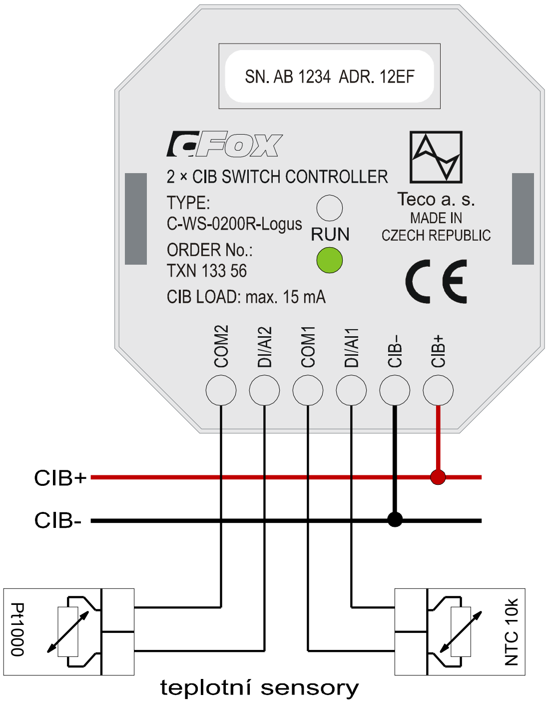


Fig. 9.1.1.1 An example of connecting the C-WS-0200R-Logus and the C-WS-0400R-Logus controllers

Notes:

1) The temperature sensors may be the Pt1000, NI1000, NTC 12k or other NTC with the resistance of up to 100k, the length of the connection cable can reach dozens of meters - a typical application is for a floor sensor; the recommended cables include e.g. the SYKFY or similar, with at least 1x2 0.5mm wires.
2) The module is designed as a standard installation element to be mounted on the flush box (KU68).
3) Connecting wires: Insulated wires with the cross-section of 0.75mm^2 with pressed-on sleeving approx.100mm long.

9.1.2 Controllers on the CIB for designs by ABB

In order to control the lighting, blinds, ventilation and similar applications, you can use the controller C-WS-0200R-ABB with one fingerboard (2 buttons - one at the top and one below), or the C-WS-0400R-ABB with two fingerboards (4 buttons - each fingerboard has a button at the top and below). The controllers are fitted with fingerboards and frames according to the specific ABB design; there are available Time, Neo, Levit, Tango and other designs (available on demand). Both types of controllers are equipped with an internal temperature sensor, and up to two external temperature sensors can be connected to them (a temperature sensor in the room - e.g. the Pt1000 sensor itself in the adjacent frame in the S-TS-01R selected design, and another sensor, e.g. the floor temperature).
The module is fitted with LED indicators. For each flap there is available a red and green LED; their control can be custom-made to suit the customer's requirements.

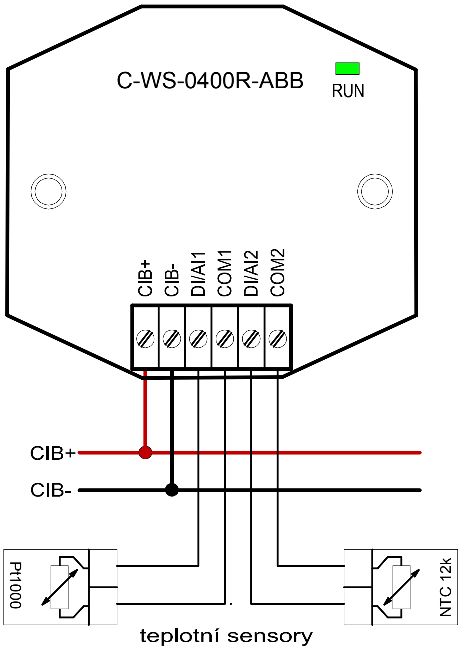


Fig. 9.1.2.1 An example of connecting the C-WS-0200R-ABB and C-WS-0400R-ABB controllers

Notes:

1. The temperature sensors may be the Pt1000, NI1000, NTC 12k or other NTC with the resistance of up to 100k, the length of the connection cable can reach dozens of meters - a typical application is for a floor sensor; the recommended cables include e.g. the SYKFY or similar, with at least 1x2 0.5mm wires.
2. The module is designed as a standard installation element to be mounted on the flush box (KU68).
3. The CIB and both universal inputs DI/AI1 and DI/AI2 are terminated on the terminal block in the rear part of the module.

9.1.3 Controllers on the CIB bus, the Decente, Elegant and Variant designs

In order to control the lighting, blinds, ventilation and similar applications, you can use the controller C-WS-0200R-Obzor with one fingerboard (2 buttons - one at the top and one below), or the C-WS-0400R-Obzor with two fingerboards (4 buttons - each fingerboard has a button at the top and below). The controllers are fitted with fingerboards and frames according to the specific design – Decente, Elegant or Variant. Both types of controllers are equipped with an internal temperature sensor, and up to two external temperature sensors can be connected to them (a temperature sensor in the room - e.g. the Pt1000 sensor itself in the adjacent frame in the S-TS-01R selected design, and another sensor, e.g. the floor temperature).
The module is fitted with LED indicators. For each flap there is available a red and green LED; their control can be custom-made to suit the customers´ requirements.

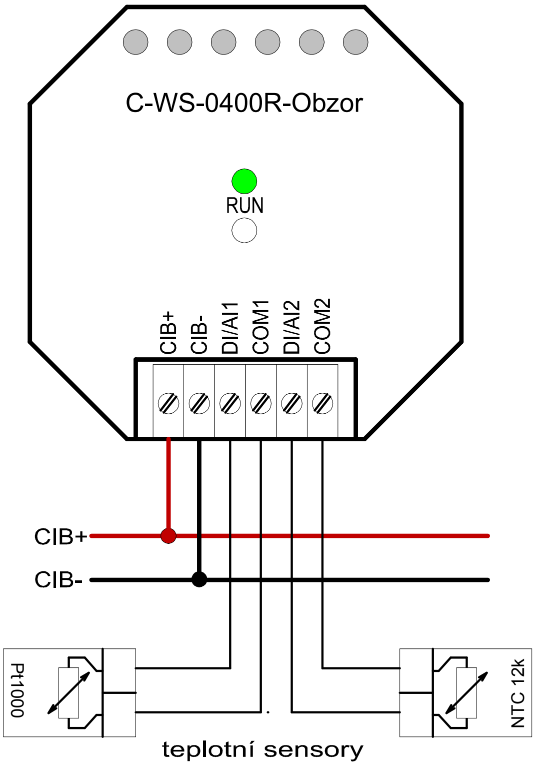


Fig. 9.1.3.1 An example of connecting the controllers C-WS-0200R-Obzor and the C-WS-0400R-Obzor

Notes:

1. The temperature sensors may be the Pt1000, NI1000, NTC 12k or other NTC with the resistance of up to 100k, the length of the connection cable can reach dozens of meters - a typical application is for a floor sensor; the recommended cables include e.g. the SYKFY or similar, with at least 1x2 0.5mm wires.
2. The module is designed as a standard installation element to be mounted on the flush box (KU68).
3. The CIB bus and both universal inputs DI/AI1 and DI/AI2 are terminated on the terminal block in the rear part of the module.

9.1.4 Controllers on the CIB bus, the iGlass design

To control the lighting, blinds, ventilation and similar applications, the controller C-WS-0x00R-iGlass can be utilized. It is available in several versions according to the number of keys (1-6 buttons, a circular controller, a display) and the mechanical design (the size of the glass cover is 80 x 80mm or 80 x 120mm). The controllers are equipped with capacitive buttons and a glass face. Up to two external temperature sensors can be connected to the controllers (e.g. a room temperature sensor - the Pt1000 sensor itself in an adjacent frame, and another sensor e.g. for measuring the floor temperature).
The C-WS-0x00R-iGlass module is equipped with a LED backlight and it can respond to an approaching hand. For detailed technical information, and overview of available variants of controllers,dimensions and other data, see Chapter 14.

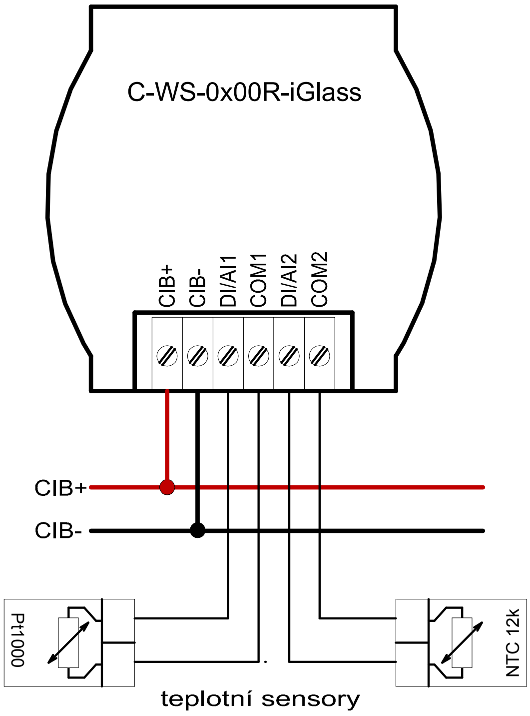


Fig. 9.1.4.1 An example of connecting the C-WS-0x00R-iGlass controllers

Notes:

1. The temperature sensors may be the Pt1000, NI1000, NTC 12k or other NTC with the resistance of up to 100k, the length of the connection cable can reach dozens of meters - a typical application is for a floor sensor; the recommended cables include e.g. the SYKFY or similar, with at least 1x2 0.5mm wires.
2. The module is designed as a standard installation element to be mounted on the flush box (KU68).
3. The CIB bus and both universal inputs DI/AI1 and DI/AI2 are terminated on the terminal block in the rear part of the module.

9.1.5 The wireless controllers RFox, the ABB Time design

In order to control the lighting, blinds, ventilation and similar applications, you can use the wireless controller R-WS-0200R with one fingerboard (2 buttons - one at the top and one below), or the R-WS-0400R with two fingerboards (4 buttons - each fingerboard has a button at the top and below); it is supplied as a standard RFox peripheral module. Both types of controllers are manufactured in ABB Time design; they are powered by a lithium battery CR2032 placed under the fingerboard (fingerboards). The design of the module is flat, which allows mounting on flat surfaces (gluing on glass), on the flush box or a wall, or even placing it loose.

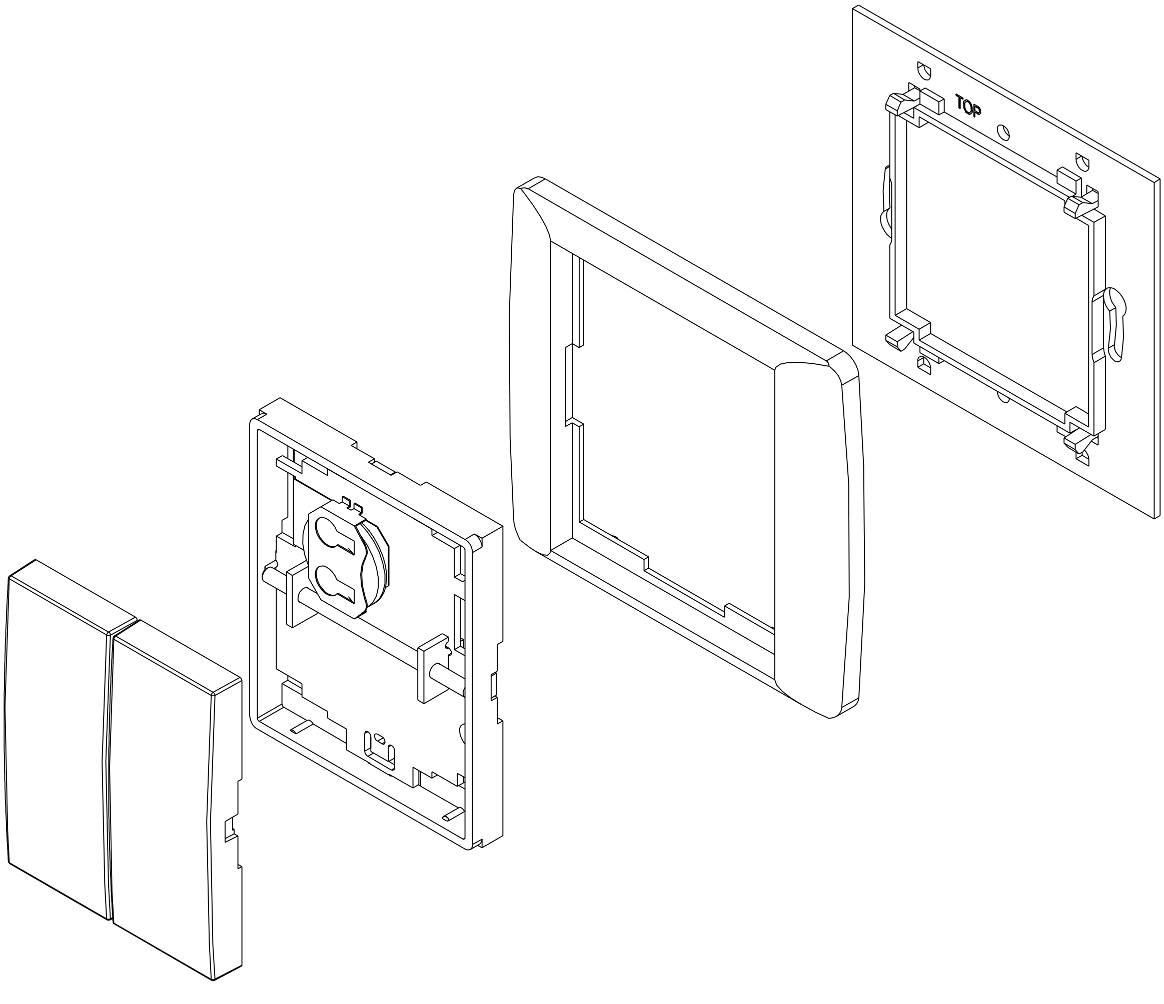


Fig. 9.1.5.1 The design of the R-WS-0200R and the R-WS-0400R controllers

Notes:

1) The module consists of the fingerboards, electronics in the interjacent frame, a standard frame (the figure shows the ABB Element) and the supporting part (in the figure left to right).
2) The battery is in the upper left corner; it was disconnected in the factory with an insulating tape, which should be pulled out at the back when you are bonding the module to the system.
3) The supporting part has a flat rear wall, which can be glued or screwed onto flat surfaces (the holes have a standard 60mm spacing).

9.1.6 The short-stroke push-buttons S-WS-0004R-Merten, connection to the C-IT-0504S

The S-WS-0400R-Merten is a controller with a short-stroke control, with LED indication and a temperature sensor. The controller should be connected to a device that allows reading binary inputs, controlling LEDs via binary outputs and measuring the temperature (the NTC 12k sensor is fitted under the fingerboard of the module); e.g. the CFox module C-IT-0504S may be used.
The S-WS-0400R-Merten can also be connected to different inputs and outputs while maintaining the polarity of the inputs and outputs. The C-IT-0908S-PNP module may also be used, but approx. 3k3 resistors must be included in series with the binary outputs of the C-IT-0908S module (to comply with a maximum 3mA current on the C-IT-0908S module output).
The LED outputs can also be switched by other analogue outputs, which supply 5mA current at the voltage of 10V.

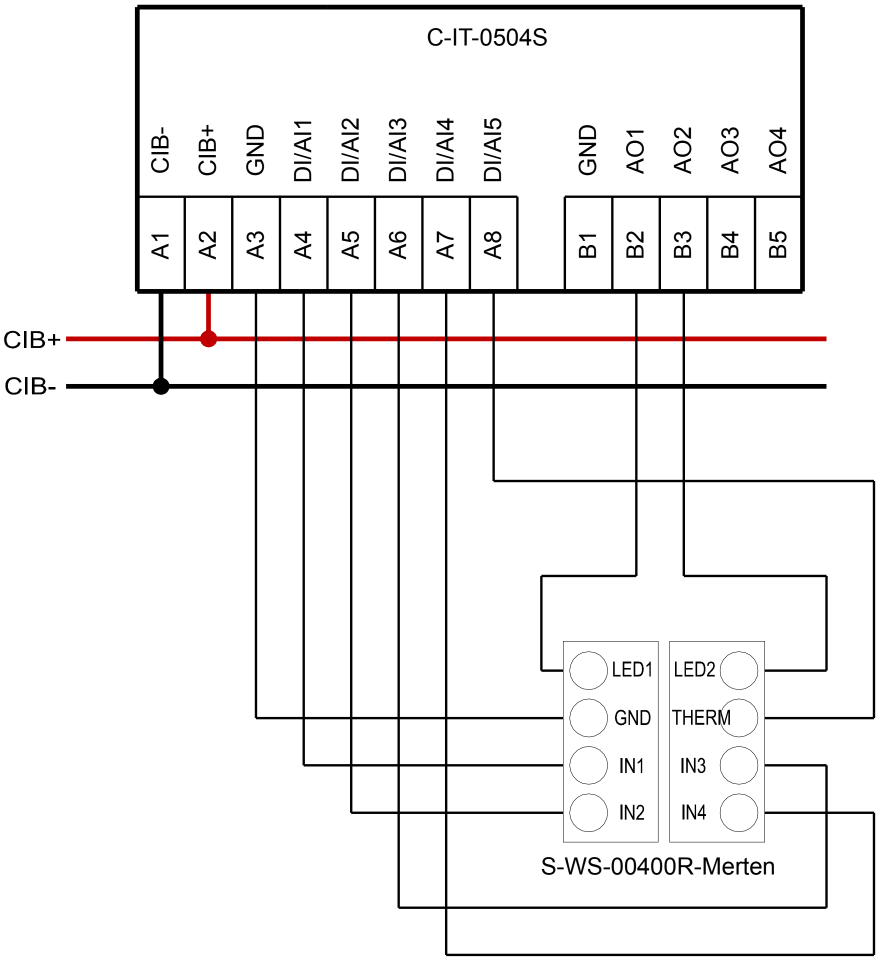


Fig. 9.1.6.1 An example of connecting the S-WS-0400R-Merten controller to the C-IT-0504S module

Notes:

1) The module consists of fingerboards, the basic part with the buttons, LEDs, a temperature sensor, a terminal block and the supporting parts for mounting on a flush box, which will be completed with a standard Merten frame.
2) The layout of signals on the terminal block is shown in the example of wiring; the placement of the terminal block on the rear side of the module is shown in the following figure.

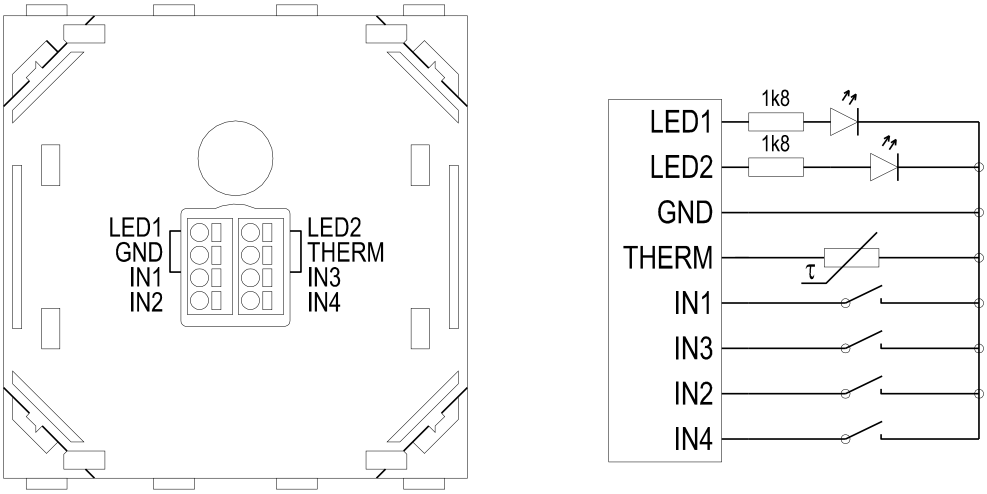


Fig. 9.1.6.2 The placement of the terminals on the rear side of the S-WS-0400R-Merten module

9.1.7 Wall push-buttons scanned by the input module C-IT-0200S

If you wish to scan the controllers (push-buttons) in other designs, you can select from the standard range of selected manufacturers push-buttons without adjustment and mount them onto the CIB module with digital inputs.
It is advantageous to use the C-IT-0200S module for controllers with one or two push-buttons, as it can be placed directly into the flush box under the controller.

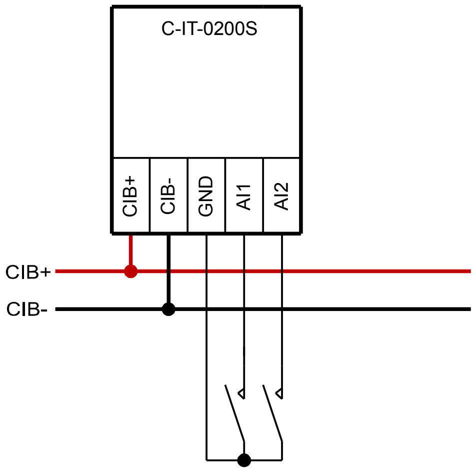


Fig. 9.1.7.1 An example of connecting two push-buttons scanned by the C-IT-0200S module

Notes:

1) All the module outlets (the CIB and the inputs) are terminated in an insulated wire approx. 100mm long, terminated in a sleeve; they should be installed directly in the terminals of the wall push-button controller.

9.1.8 Wall push-buttons scanned by the input module C-IT-0504S

The built-in C-IT-0504S module can be used in a similar way as the C-IT-0200S; it can scan e.g. 4 push-buttons of the controller, measure the interior temperature, and it can also control up to 4 LEDs, if the controller is equipped with them.
The module is equipped with 5 inputs, which can be configured (together for 4 inputs and the fifth separately) as analogue (connecting the temperature sensors, such as the Pt1000), or binary (connecting the push buttons, balanced inputs). It is also equipped with 4 analogue outputs 0 ÷ 10V, max. 3mA per output (for powering the LEDs of the controllers, for lighting and heating control).

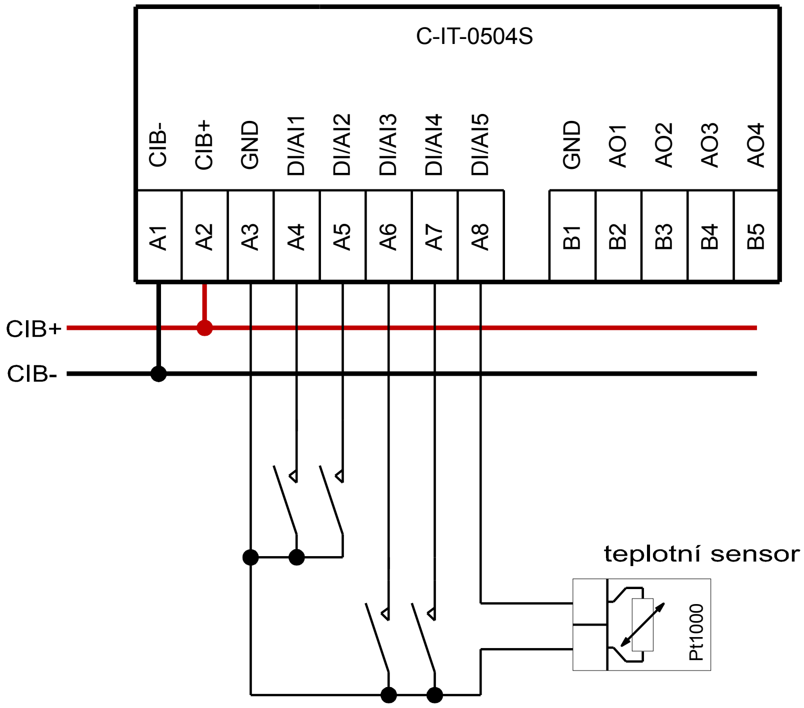


Fig. 9.1.8.1 An example of connecting the push-buttons and the temperature scanned by the module C-IT-0504S

Notes:

1) The example illustrates a possible module configuration as 4 + 1 (4 contact inputs, the fifth is analogue - the reversed combination is also possible, or all inputs can be binary or analogue).
2) The analogue outputs can be utilized e.g. for controlling the lighting ballasts, etc.

9.1.9 The GIRA 2001 xx controller scanned by the C-IT-0504S input module

The GIRA 2001 push-button controller is equipped with two short-stroke push-buttons (with a 24V AC/DC nominal power supply) and two LEDs (24VDC, 1mA power supply). It can be connected to the embedded C-IT-0504S module, which should be placed in the flush-box under the controller, and the result is a complete controller on the CIB bus. There are also 3 more inputs available, e.g. for measuring the room temperature (in an adjacent frame by the Pt1000 temperature sensor – see Chap. 10.1.4) and the floor temperature. Similarly the GIRA 2003 controller with six push-buttons can be connected to the C-IT-09008S module. A similar example is presented in the following chapter (the Jung controller).

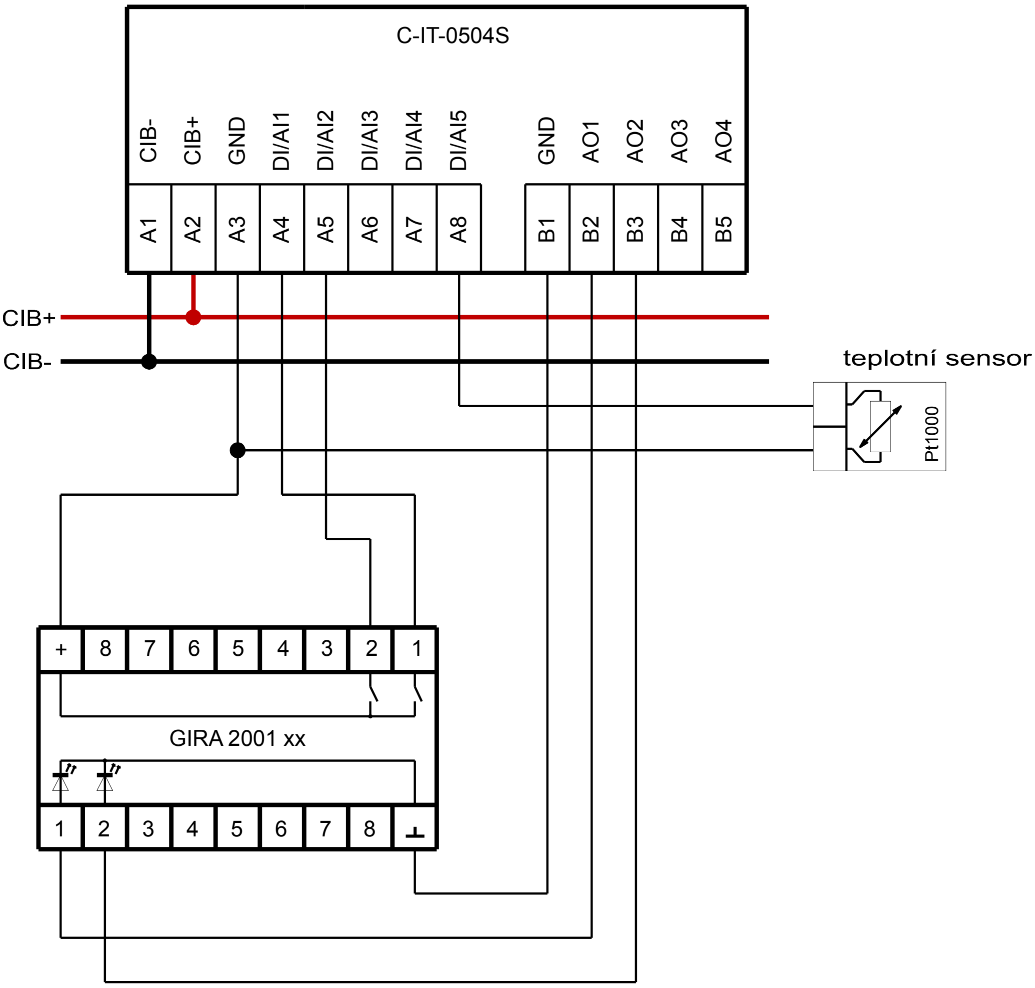


Fig. 9.1.9.1 An example of connecting the GIRA 2001 controller and the temperature sensor to the C-IT-0504S module.

Notes:

1) The analogue outputs of the C-IT-0504S module have a max. of 10V, 3mA on the output, so the LEDs on the controller excited by these outputs shine without any problems. The analogue outputs need to be controlled as binary - i.e. they work with the values of 0% and 100%.
2) The C-IT-0504S module is terminated with about 100mm long wire, which should be connected directly into the GIRA controller connector (the colours of the wires and other details are given in the Chapter on the C-IT-0504S).

9.1.10 The JUNG 3248TSM controller scanned by the C-IT-0908S input module

The JUNG 3248TSM push-button controller is equipped with eight short-stroke push-buttons (with nominal 24V AC/DC power supply), and eight LEDs (24VDC, 1mA power supply). It can be connected to the embedded module C-IT-0908S (the PNP version - order No. TXN 133 52), which should be placed in the flush-box under the controller, which makes it a complete controller on the CIB bus. There is also another input available, e.g. for measuring the room temperature (in the adjacent frame by a separate temperature sensor Pt1000 - see the S-TS-01R temperature sensor).
The outputs DO1 to DO8 are intended only for the excitation of LEDs by approx. 3mA current.

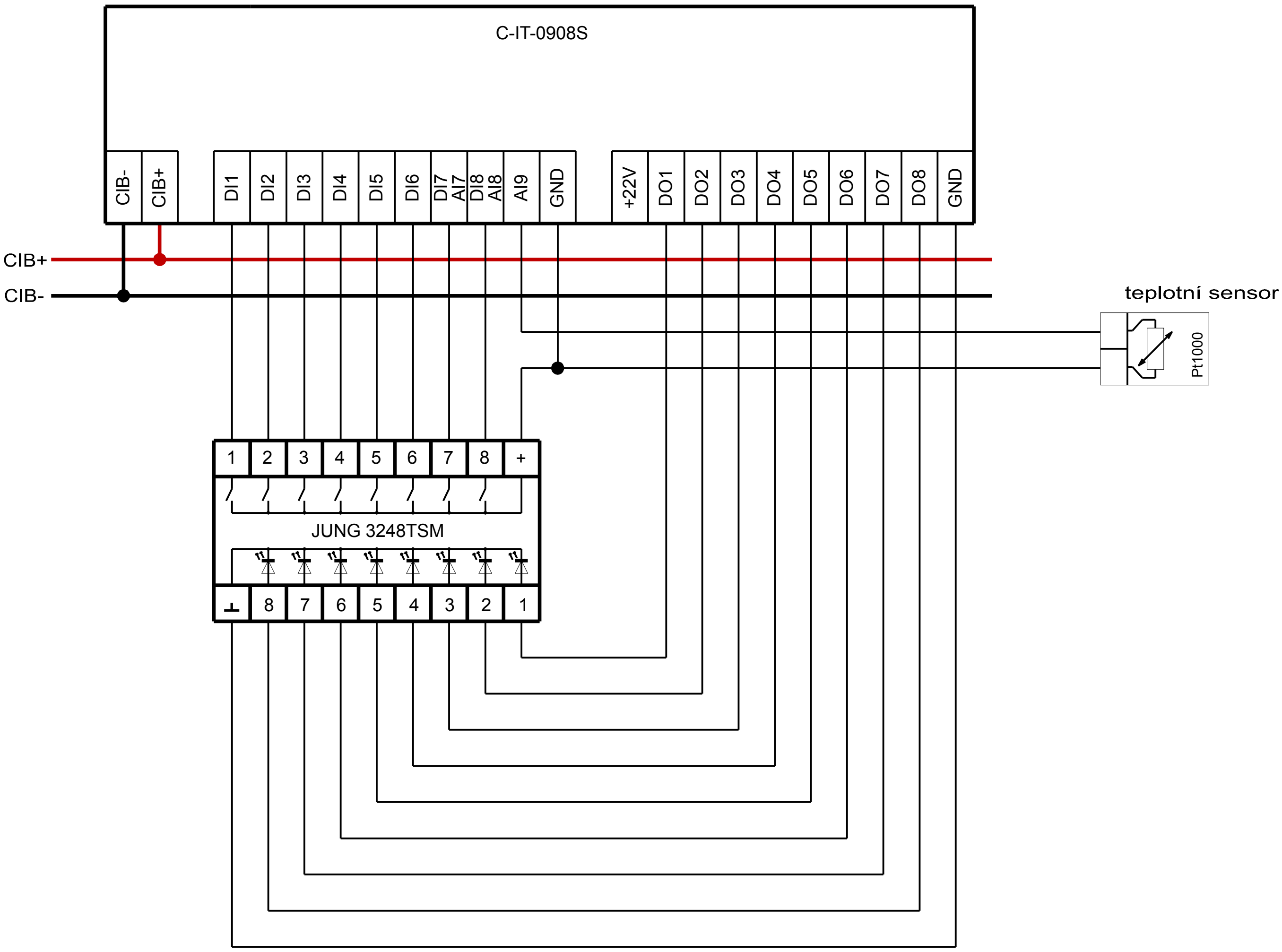


Fig. 9.1.10.1 An example of connecting the JUNG 3248TSM controller and the temperature sensors to the C-IT-0908S module.

Notes:

1. The outputs and inputs of the C-IT-0908S module are terminated on separate coloured wires, which should be inserted directly in their respective terminals (the screw-less terminal block) on the rear side of the Jung controller (the GIRA 2001 and GIRA 2003 controllers should be connected analogically).
2. The C-IT-0908S module is supplied in two variants; you have to use the version with the PNP outputs, order No. TXN 133 52 (with no suffixes).

9.1.11 The push-buttons scanned by the C-IB-1800M module in the control panel

Installations with assumed placement of the control system modules in the control panel require the C-IB-1800 module. It should be placed in the main control panel (together with the basic module) or in subordinate distribution boards (in order to optimize the number of cables in the house).
This module can also be used for connecting the ESS detectors, and the AI/DI1 to AI/DI4 inputs can also be used for measuring temperature, or processing pulse inputs from electricity meters, flowmeters, etc. For more information about powering, maximum power consumption, etc., see the Chapter describing the C-IB-1800M module.

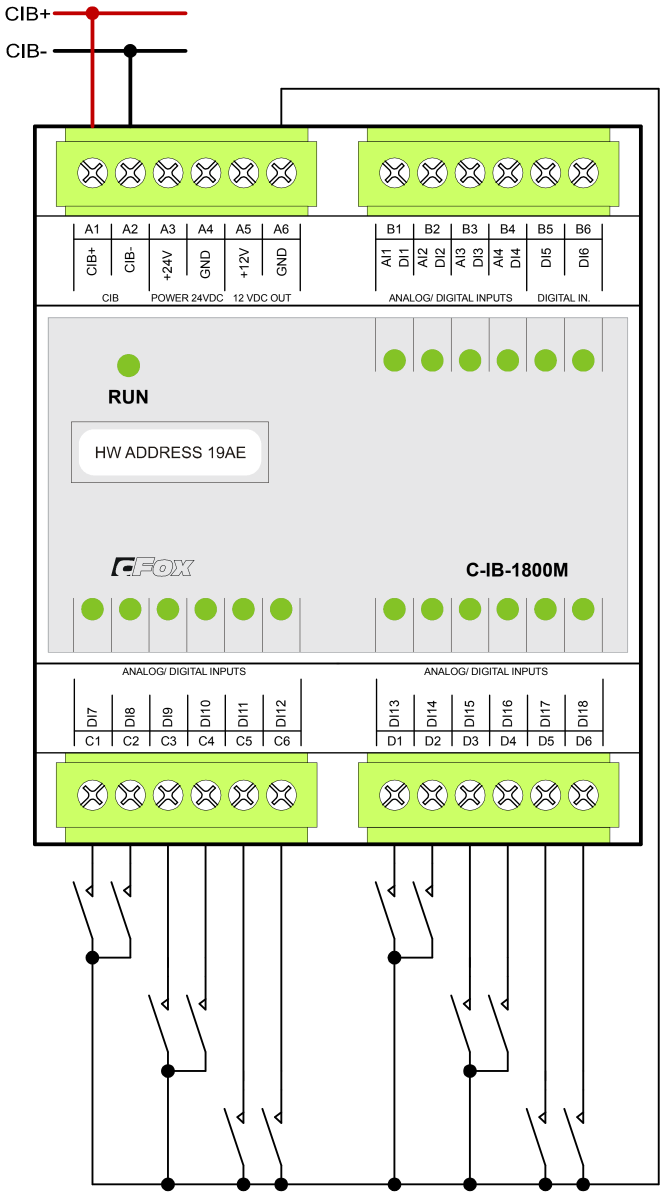


Fig. 9.1.11.1 An example of connecting the push-buttons scanned by the C-IB-1800M module.

Notes:

1) The cable for push-button controllers, e.g. SYKFY, JY (St) Y, etc., with the length of up to approx. 30m.
2) If there are several controllers in one place, you can use for all of them a common multicore cable. The temperature sensor connection can also lead in a common cable (e.g. if there is a multiple frame on the wall with a push-button control and a temperature sensor, all these signals can lead via a common cable to the control panel); in this case, a shielded cable should always be used.
3) If the cables are long or run in parallel with LV distribution, shielded cables are recommended, as

they reduce the risk of false switching due to interference.

9.1.12 The push-buttons scanned by the C-IB-1113M module in the control panel

If you wish to scan the controllers (push-buttons) in other designs, you can select from the standard range of selected manufacturers push-buttons without adjustment and mount them onto the CIB module with digital inputs.

Installations with assumed placement of the control system modules in the control panel can also use the C-HM-1113M and the C-HM-1121M modules. They should be placed in the main control panel (together with the basic module) or in subordinate distribution boards (in order to optimize the number of cables in the house).

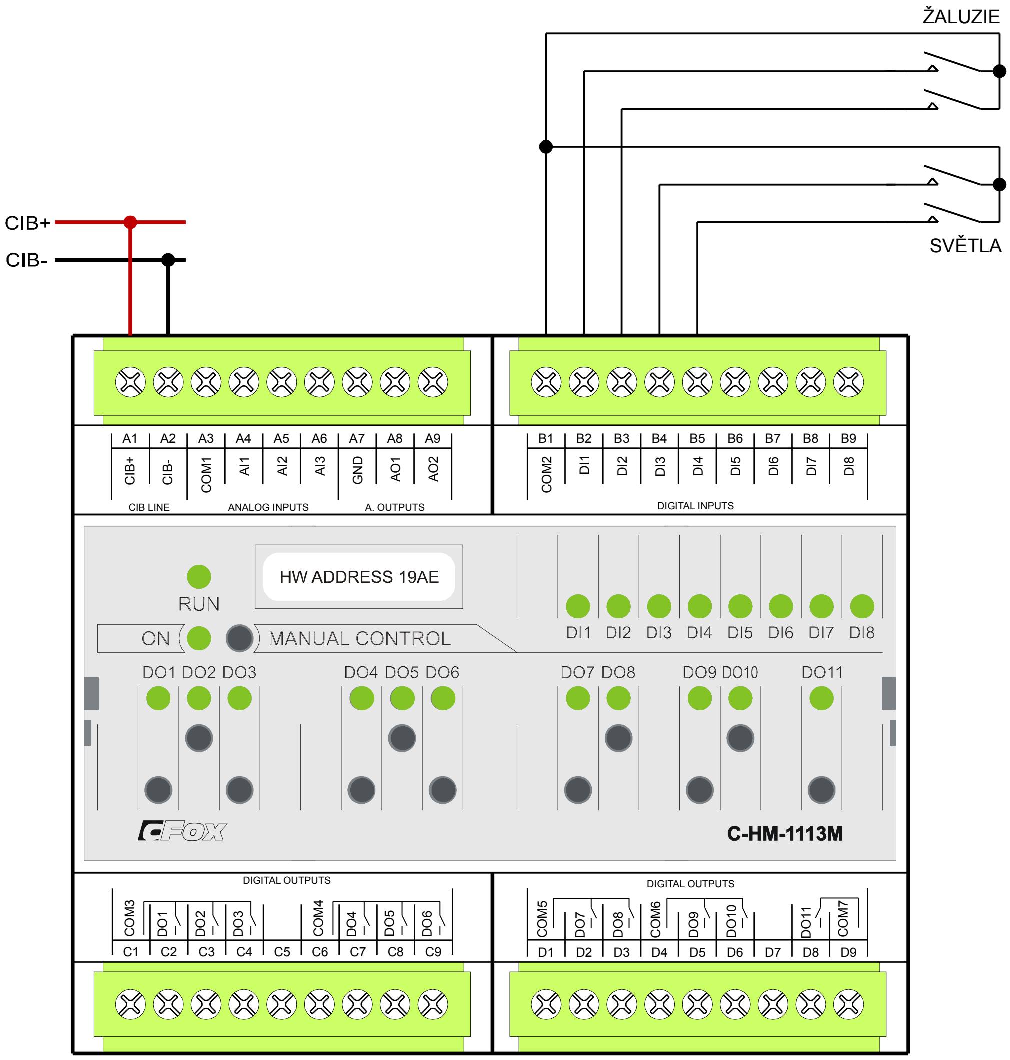


Fig. 9.1.12.1 An example of connecting the push-buttons scanned by the C-HM-1113M module.

Notes:

4) The cable for push-button controllers, e.g. SYKFY, JY (St) Y, etc., with the length of up to approx. 30m.
5) If there are several controllers in one place, you can use for all of them a common multicore cable. The temperature sensor connection can also lead in a common cable (e.g. if there is a multiple frame on the wall with a push-button control and a temperature sensor, all these signals can lead via a common cable to the control panel); in this case, a shielded cable should always be used.
6) If the cables are long or run in parallel with LV distribution, shielded cables are recommended, as they reduce the risk of false switching due to interference.

9.1.13 A rotary controller on the CIB, the C-RS-0200R

The C-RS-0200R-Logus is a rotary interior controller with the function of one button with a connection to the CIB. At the same time it is fitted with two universal inputs terminated in the terminal block on the rear side of the module, e.g. for interconnection of the floor temperature sensors, auxiliary push-buttons (S-WS-0200R) etc.

For detailed information concerning the use of the module, its assembly and design variants, including information on the assembly of the whole controller, see the description of the module C-RS-0200R in Chapter 14.

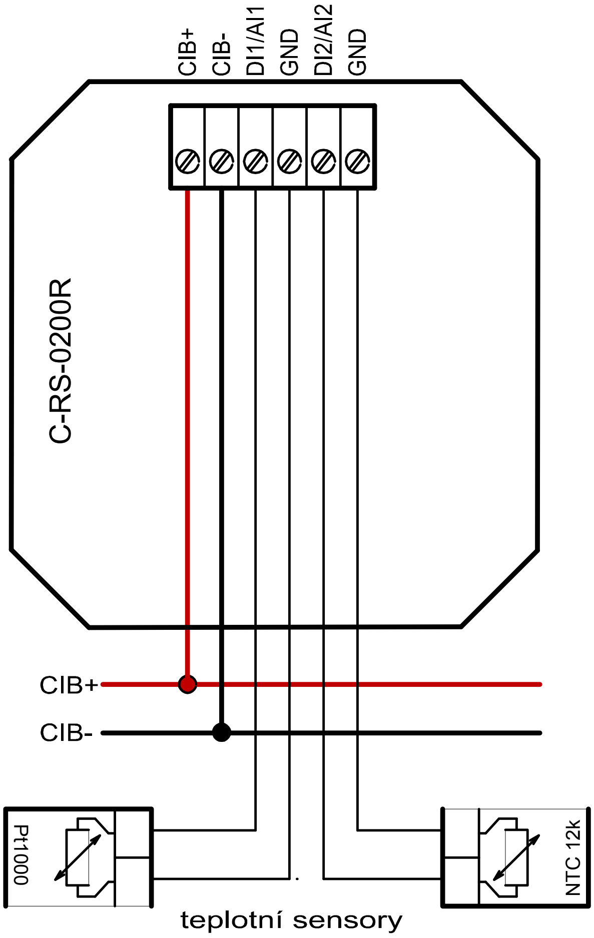


Fig. 9.1.13.1 An example
of connecting the rotary controller C-RS-0200R

9.2 The heating displays and controls on the wall

9.2.1 The C-RC-0002R-design heating control module

A number of designs can use the wall-mounted version of the module with a display. The module is always executed with respect to the particular electrical installation design, comprising a display (with the temperature display), push-buttons (temperature correction and change of mode), LEDs and internal temperature sensor, as well as outputs for the connection of an external temperature sensor (e.g. the floor temperature).

The module consists of two parts. The internal part contains the sensor electronics and is terminated with 4 wires (the CIB and the external temperature sensor) and a connector, where the cable from the other part is inserted. The second part represents a wall-mounted design feature with an installed display, push-buttons, a LED and a temperature sensor terminated on a 70mm cable with a connector. The second temperature sensor (NTC 12k or NTC up to 100k) is e.g. for measuring the floor temperature.

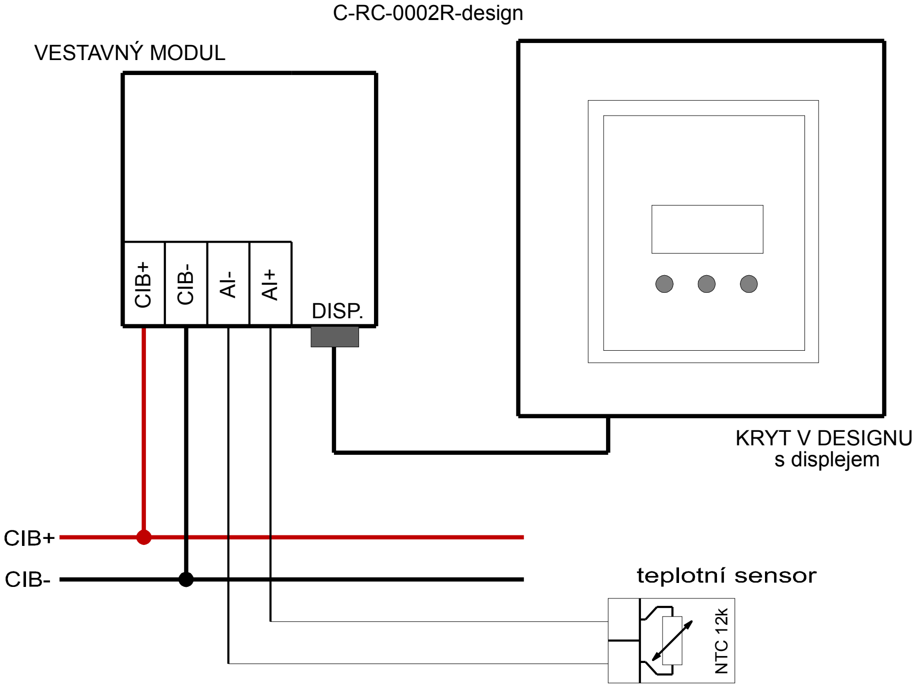


Fig. 9.2.1.1 An example of connecting the C-RC-0002R-design control module, including the external temperature sensor.

Notes:

1) The external temperature sensor must be an NTC 12k or other NTC with the resistance of up to 100k; the connection cable can be up to dozens of meters long. A typical use is for a floor sensor, the recommended cables include e.g. the SYKFY or similar cables, with at least 1x2 wires with 0.5mm diameter.
2) The module is designed as a small embedded module in a flush-box (KU68); it is terminated with four 10cm wires (the CIB bus and an external temperature sensor) and a connector, in which the cable from the top part of the module is inserted (i.e. the design cover with the display, push-buttons, a LED and the temperature sensor).

9.2.2 **The C-RC-0003R-design** heating control module

A number of designs can use the wall-mounted version of the module with a small graphic display. The module is always executed with respect to the particular electrical installation design, comprising a display (with the display of two measured values and several symbols), push-buttons (for temperature correction and a change of mode), and an internal temperature and relative humidity (RH) sensor, as well as outputs for the connection of an external temperature sensor, such as the floor temperature.

The module consists of two parts. The internal part contains the sensor electronics and is terminated with a 4-pole terminal block with terminated CIB, an external temperature sensor and a connector, where the cable from the other part is inserted.
The second part represents a wall-mounted design feature (e.g. Logus - see the figure at the end of this chapter) with its own display, push-buttons and a temperature and RH sensors terminated on a 70mm cable with a connector. The second temperature sensor (Pt1000, Ni1000, N TC 12 k or NTC up to 1)60k is e.g. for measuring the floor temperature.

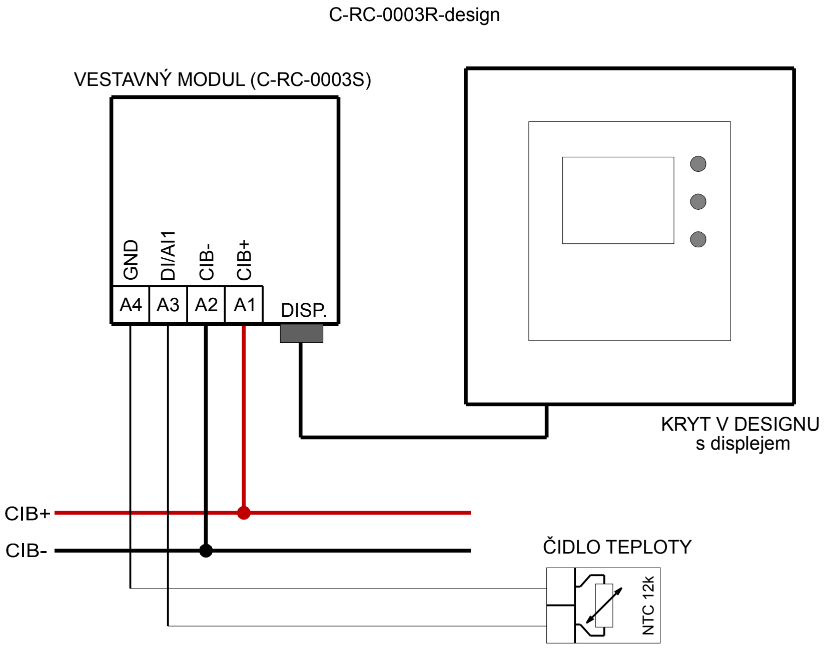


Fig. 9.2.2.1 An example of connecting the C-RC-0003R-design control module, including the external temperature sensor

Notes:

1. The external temperature sensor must be the Pt1000, Ni1000, KTY81-121, NTC 12k or some other NTC with the resistance of up to 160k, the connection cable can be up to dozens of meters long. A typical use is for a floor sensor, the recommended cables include e.g. the SYKFY or similar cables, with at least 1x2 wires with 0.5mm diameter.
2. The module should be installed in a standard flush box (KU68)
3. Some design variants (e.g. UNICA) have displays without a backlight – a specific design and its characteristics have to be consulted with the Teco a. s. commercial department.

An example of display in the Efapel Logus design

9.2.3 The RCM2-1, CFox heating, air conditioning and lighting control module

A comfortable, yet very simple and transparent control of heating with the temperature correction, changing the heating mode, manual fan speed control (stepped or smooth), outdoor temperature display and the time is provided by the RCM2-1 module.

The module is equipped with an internal temperature sensor and allows the connection of the NTC 12k external temperature sensor.

It should be flush-mounted with 2 or 4 screws into a 60mm-diameter box, or on the wall. The module has an alphanumeric display with special symbols. A view of the display with all the symbols is available at the end of this manual, in the Chapter on the RCM2-1.

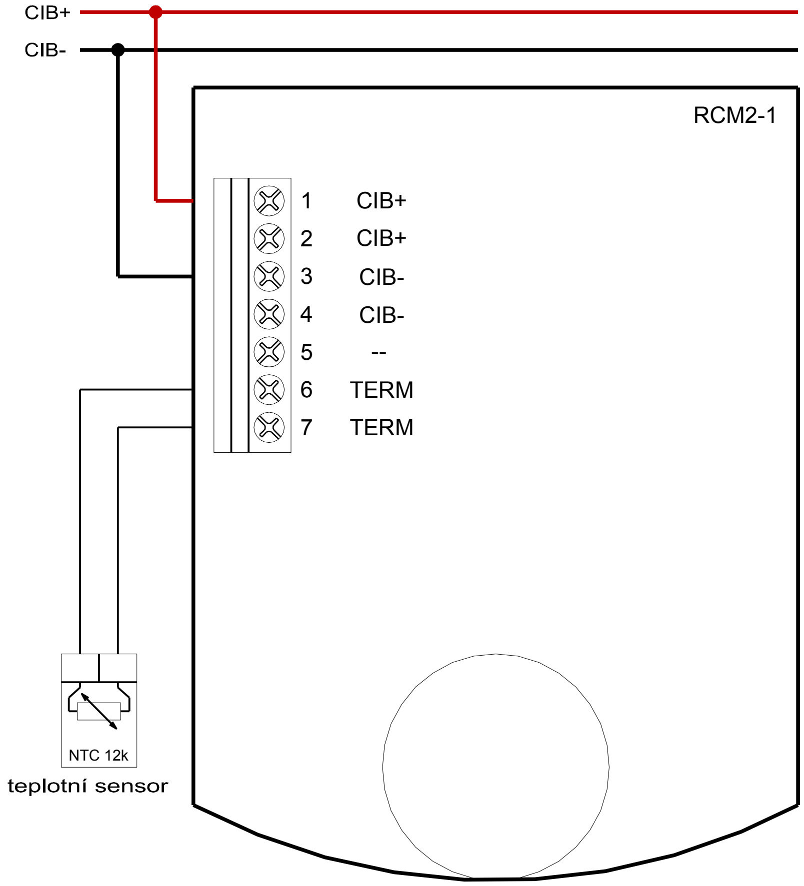


Fig. 9.2.3.1 An example of connecting the RCM2-1 control module, including the temperature sensor

9.2.4 The R-RC-0001R, CFox heating, air conditioning and lighting control module

A comfortable, yet very simple and transparent control of heating with the temperature correction, changing the heating mode,a manual fan speed control (stepped or smooth), outdoor temperature display and the time is provided by the wireless version of the R-RC-0001R module.
The module is equipped with an internal temperature sensor and allows the connection of the NTC 12k external temperature sensor (e.g. for measuring the floor temperature control).
It should be flush-mounted with 2 or 4 screws into a 60mm-diameter box, or on the wall.
The module is equipped with an LCD displaying values such as temperature, time, humidity, RPM, heating, cooling, etc., and a number of graphic icons used in the fields of heating, ventilation, air conditioning. The display and the basic functional capabilities are identical with the RCM2-1 module.
The module is powered by an internally located $LiSOCl_2$ AA 3.6V battery ER14505M.

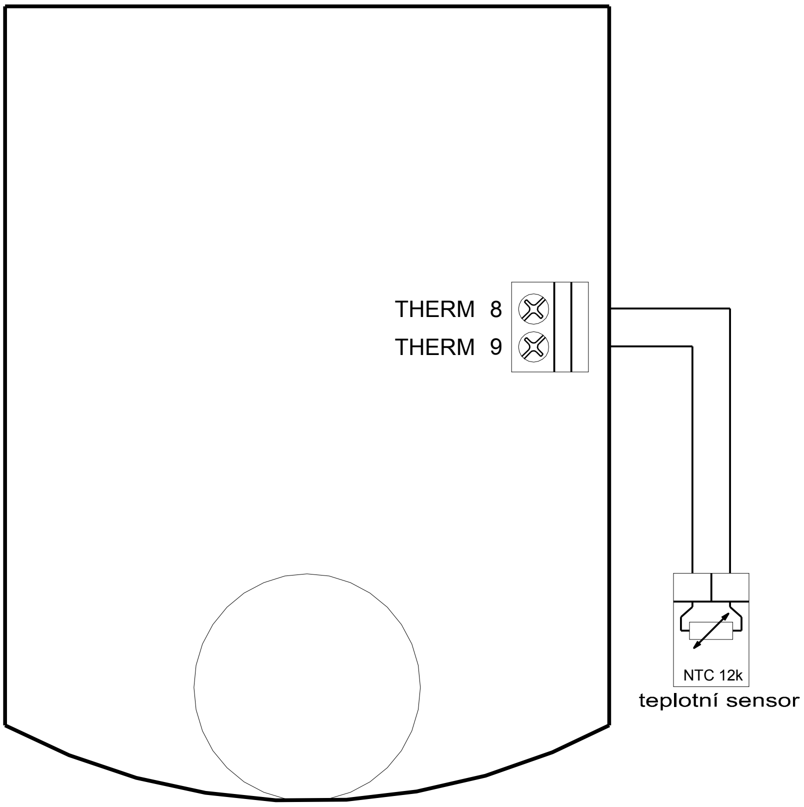


Fig. 9.2.4.1 An example of connecting the R-RC-0001R control module, including the temperature sensor

Notes:

1) The external sensor is connected with a cable, which is a part of the sensor; you can also use any two-core cable with at least 0.3mm diameter and up to 20m length of the wire.

9.2.5 The C-RC-0005R

Hotels, boarding houses and similar facilities can use the C-RC-0005R hotel controller. The module is equipped with several capacitive push-buttons (see the Fig.) and an OLED display. The buttons allow you to easily and intuitively change the required room temperature, the ventilation or air conditioning parameters, as well as allow local setting of alarms and "Do not disturb" and well as "Clean up the room" notices on the external side of the door (provided the facility allows this).
It will be possible to supply the module with customized glass, variable basic colour of the module, inscriptions, logos, etc.
The module measures the room temperature and humidity, and is also equipped with two inputs AI/DI1 and AI/DI2 for connecting additional temperature sensors, window contacts, etc.
The module is placed in a plastic box with a glass front surface, which is pushed onto the bracket bolted to the rectangular installation box (a standard flush-mounted installation box or a hollow-wall box); for details on the C-RC-0005R module see in Chapter 14.

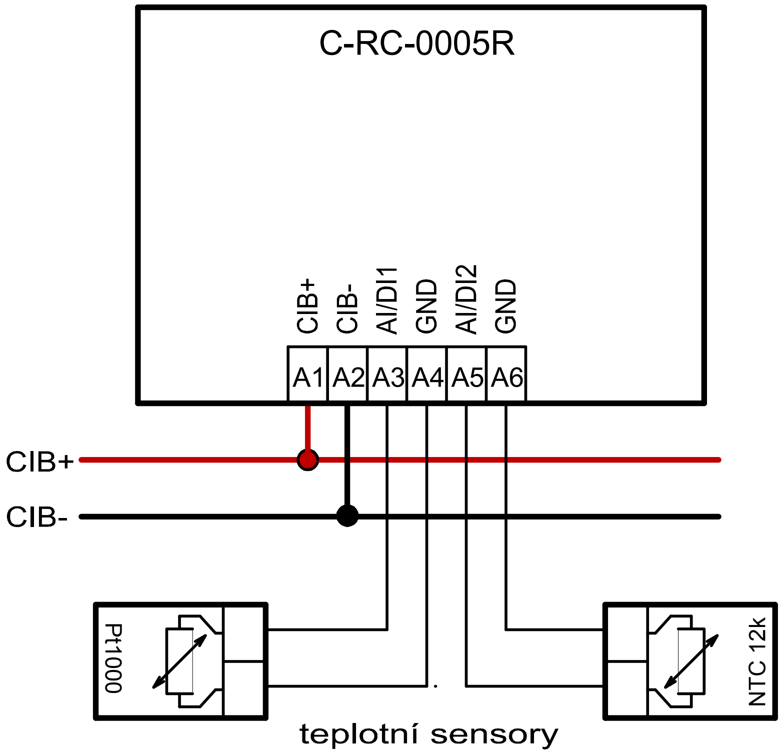


Fig. 9.2.5.1 A basic example of connecting the C-IR-0005R module.

9.2.6 The C-RC-0011R

The C-RC-0011R interior controller with an LCD display and 5 touch buttons is designed primarily for local control of heating, cooling and ventilation systems for office buildings, like remote control for heating systems, etc. The display is equipped with a number of symbols (for a detailed description of the C-RC -0011R module see in Chapter 4), which allow you to comfortably see and easily change the basic parameters of the heating system.The module is also ready for changing the weekly time schedule, which is available in the form of a function block in the Mosaic environment, and it is compatible with the Foxtrot website and can be controlled from the application iFoxtrot, SCADA in the Reliance environment.
The control unit has five touch buttons on the display that control the functions. The module is designed as a standard peripheral on the CIB bus.
The module is further equipped with an internal temperature and humidity sensor of the interior and it is fitted with an analogue AI1 input that allows the connection of e.g. a floor temperature sensor, or an outdoor temperature sensor.

Gradually, the module will be extended with a variant which will be equipped with multiple inputs and outputs so that you can both display and set the values, and also directly control e.g. the induction unit in the room, the fan coil or other source of heat/cold. It will also be complemented with a battery-powered RF module variant.

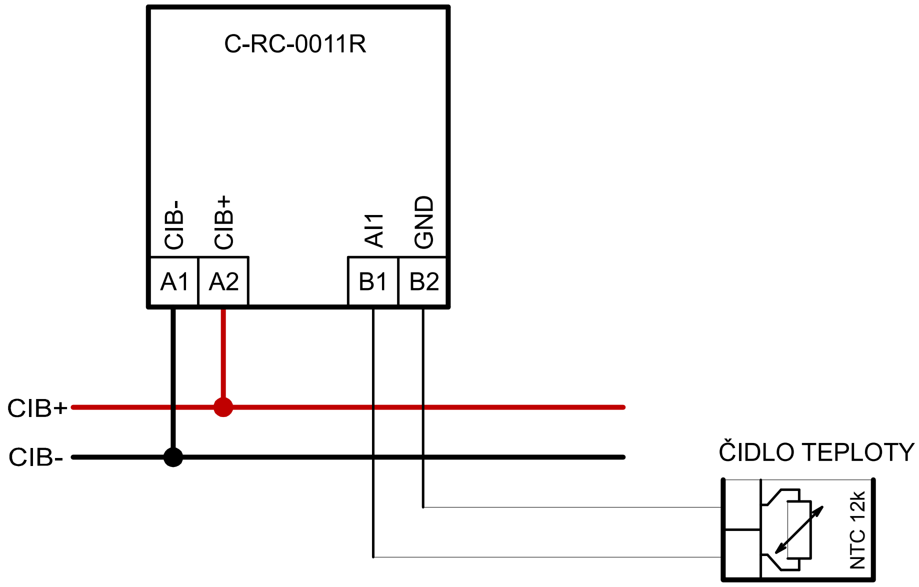


Fig. 9.2.6.1 A basic example of connecting the C-RC-0011R module.

9.3 Infrared (IR) control

The C-RI-0401R module is recommended for control via an IR remote controller (receiving IR code), or for transmitting the IR codes (IR transmission). It consists of the internal part (the electronics, the CIB connection) available separately as the C-RI-0401S, and the design part, which is implemented in accordance with the required design with a wall-mounted module with built-in IR transmitter and receiver, with the lighting and the temperature sensor, supplied under the order number TXN 133 47 (for the exact form of the order number and other information, see the product catalogue, and possibly contact the commercial department of the Teco a.s. company).
The module also allows custom-made implementation of the visible part (in accordance with the electrical installation design). Some items, e.g. the lighting sensor, or the IR section, can be omitted. Special designs based on the customer's requirements, such as integrating the IR transmitter inside the device, can also be implemented.
The module also allows remote placement of the IR transmitter and receiver (e.g. in different rooms or on different walls of the same room). In this case the module is supplied in the version C-RI-0401S with an independent IR receiver and transmitter (the electronic components), which the customer must install and connect.

9.3.1 An IR transmitter and receiver to be mounted on the wall: the C-RI-0401R-design

The C-RI-0401R-design module contains a receiver and a transmitter of IR signal. They are intended for scanning and generating signals from the controllers used for controlling various types of devices, such as air conditioning units. The captured IR signal from the controller can be saved in the module, and then reproduced again.

The module is also by default equipped with a standard lighting and interior temperature sensor. The following figure shows the mechanical design - the cover with sensors and built-in electronics, the standard frame and its lower part, which is mounted on a common installation box; the frame with electronics is clipped on, with the cable that goes through it to the second part of the module - the part with the bus (it is available separately, such as the C-RI-0401S).

The module is available in several designs; those based on the customer's special requirements are on demand.

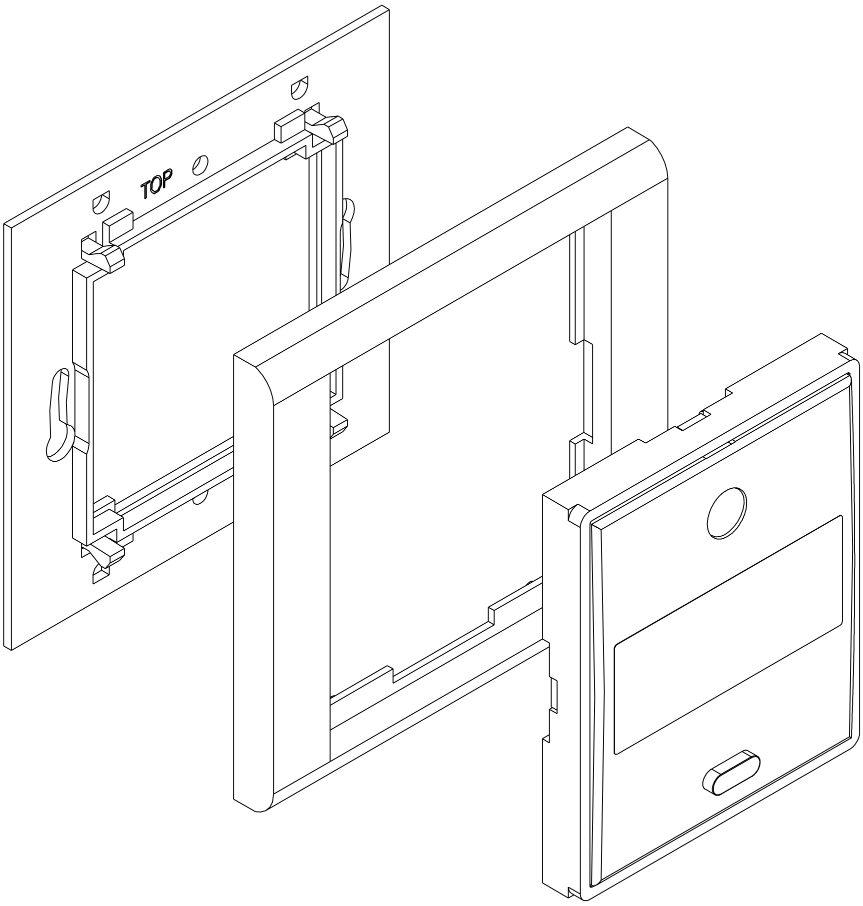


Fig. 9.3.1.1 The assembly of the design part of the C-RI-0401R-Time module

9.4 Integration of multimedia systems

9.4.1 The connection of the AV Control4 system with the Foxtrot system.

There is an integration module Control4 available to expand the Foxtrot system to enable it to distribute music and video throughout the house and control entertainment and consumer electronics. By interlinking both systems you have a comprehensive tool for the control and management of the house, starting with the heating, lighting, shading and security up to the entire multimedia system, while controlling a variety of other technologies.

The integration module must be connected to the same local area network (LAN) together with the Foxtrot basic module and the control unit of the Control4 system. The HW configuration of peripheral modules is exported from the FoxTool environment (or Mosaic) to the CIB bus, and the file is saved in the Integration Module. At that moment, the Control4 displays a list of CIB elements (push-buttons, relays, temperatures) that you can work with - press the buttons and play films and music, switch the air conditioning and ventilation on and off, visualize the modes, control the relays on CIB from the TV, panels, smart phones, etc.

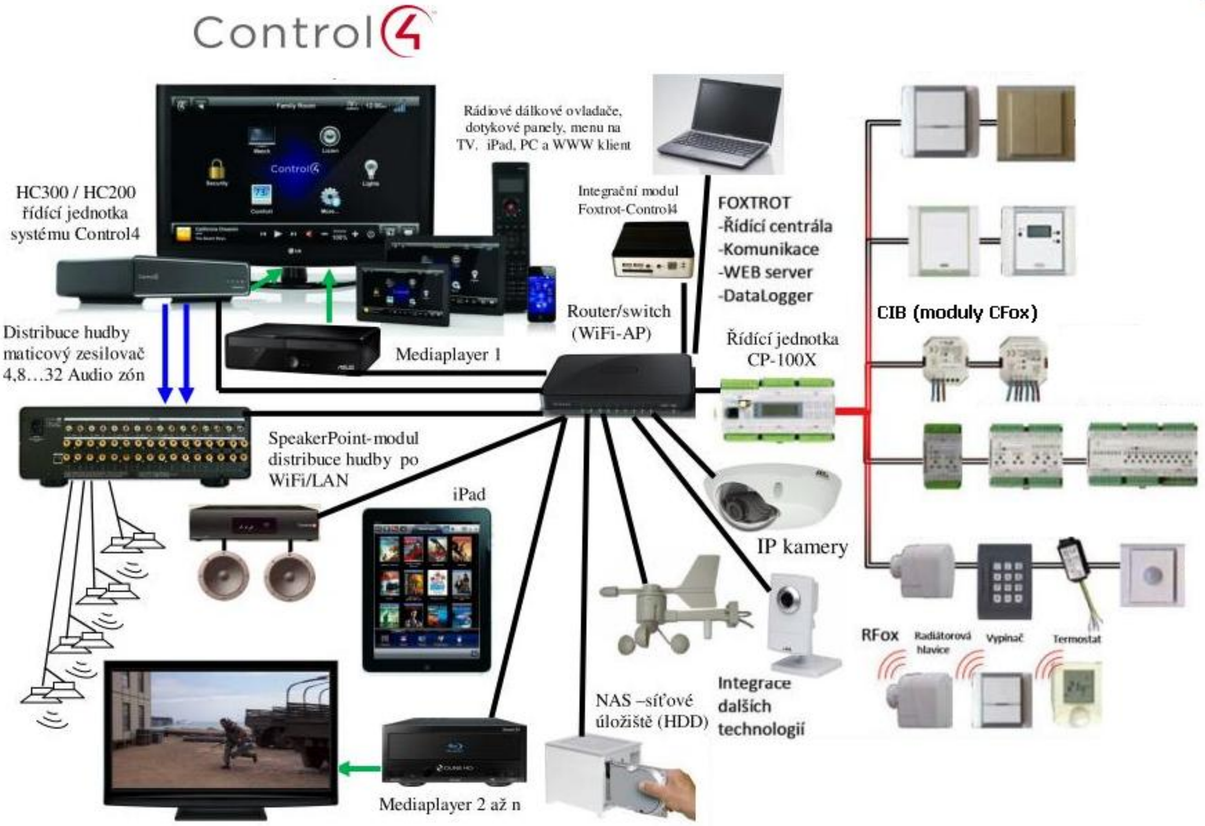


Fig. 9.4.1.1 An example illustrating the interconnection of the Control4 and Foxtrot systems

Notes:

1) Linking of the Control4 and the Foxtrot system is provided by the Integration module connected to the same LAN, together with the Foxtrot basic module and the control unit of Control4. Therefore there is no special requirement for hardware connection on the Foxtrot side. The issue is dealt with by a standard connection to the LAN network (10/100 Mbit Ethernet connection - see examples in the documentation [4]).
2) Detailed information on the installation of the Control4 system, including integration with the Foxtrot system, and support will be provided by the Yatun company, the supplier of the Control4 system.

9.4.2 Linking the Bang&Olufsen AV system with the Foxtrot system.

There is support available for linking the Bang & Olufsen AV system with the Foxtrot system. The linking is implemented via the RS232 serial line with the MasterLink Gateway unit of the B&O system.
The system can be operated directly from the Foxtrot website, and Foxtrot is also able to receive commands from the B&O system. The specific implementation is then the result of a specific project and the scope of what the end customer wishes to control directly from the B&O system controllers.
The Master Link Gateway is a module designed for comprehensive integration between the B&O audiovisual products and the products of manufacturers of the control systems. The module is designed for installation in a 19 "rack, or for placing loosely on a flat surface.
For basic parameters of the module and the wiring, see the following table and figure.

Table9.4.2.1: The basic parameters of the Master Link Gateway (MLGW) module, the B&O system

Dimensions (the module itself)	35.5 x 4.5 x 15cm
Dimensions (including the rack brackets)	48.3 x 4.5 x 15cm
The weight	1.63kg
Supply voltage	100 ÷ 230VAC
Consumption	typically 2.5W
Operating temperature	-10 ÷ 50°C
The Master Link interface	the Bang&Olufsen system
The RS232 interface	a standard connector Dsub 9, plug

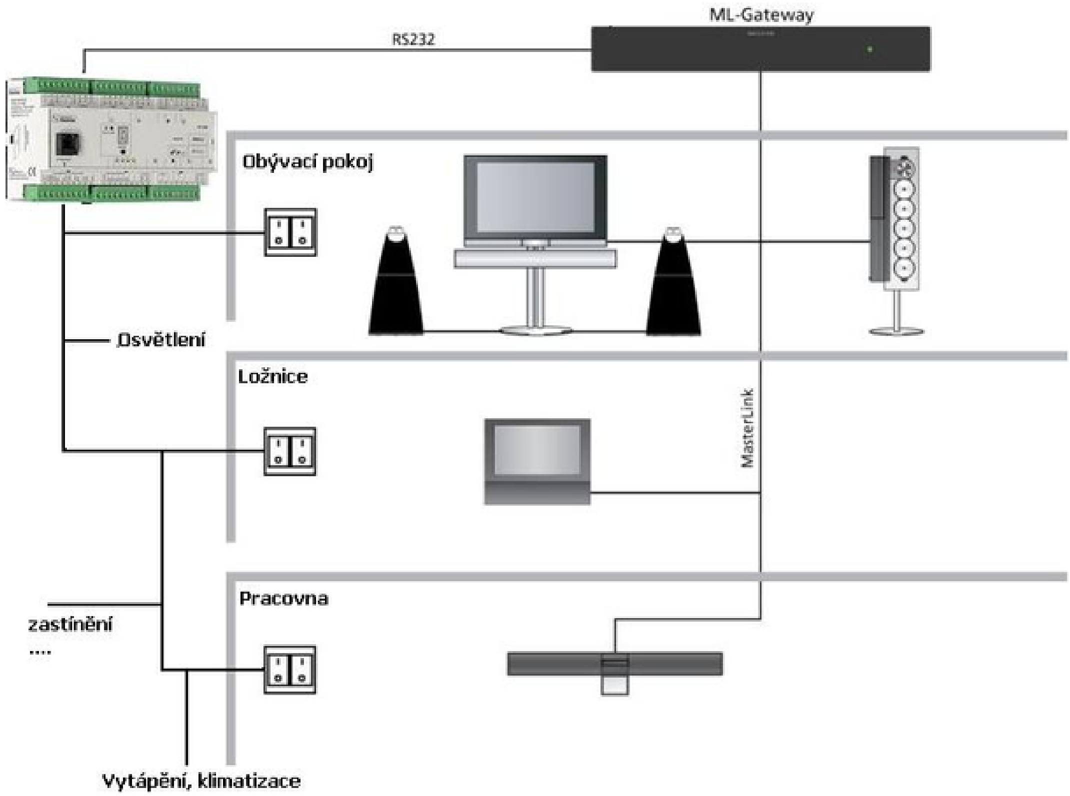


Fig. 9.4.2.1 An illustrative example of linking the Bang&Olufsen system with the Foxtrot system

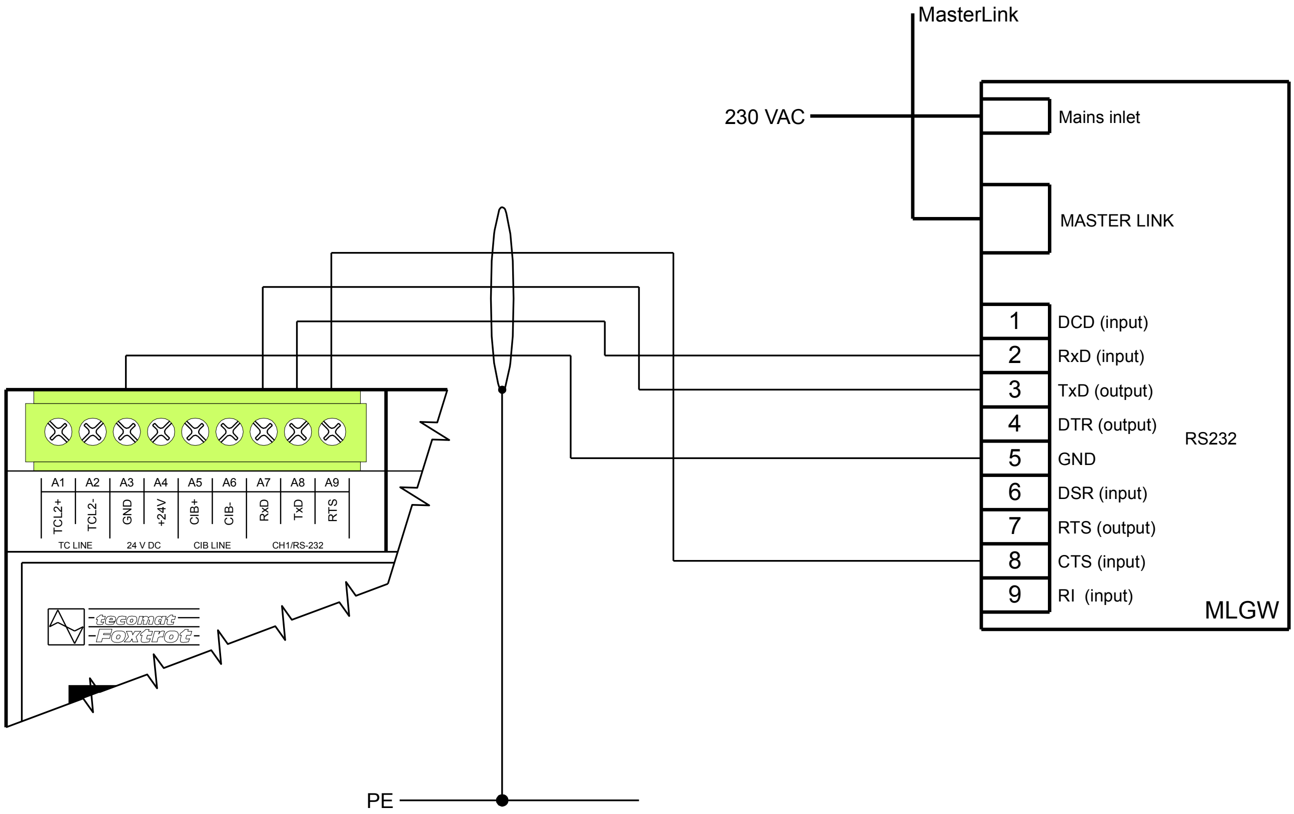


Fig. 9.4.2.2 An example of wiring the MLGW module with the CH1 (RS232) of the Foxtrot basic module

Notes:

1) The RS232 communication line should be connected with a shielded cable, a maximum length of 10m; the MLGW module manufacturer recommends 2-5 meters.
2) The RS232 interface is terminated on the MLGW module in a standard Dsub 9-pin plug connector.
3) Setting the communication parameters must be consistent with the setting of the MLGW module; the exact procedure and other conditions of the installation must be dealt with the B&O system supplier.

9.5 SMS communication

The SSM modems connected to the communication interface of the Foxtrot basic module will provide communication between the Foxtrot system and the user, e.g. by sending alarm information (ESS - intruders, fire hazards, power failure, flooding the boiler room, etc.), or sending status information. On the other hand, the modems are also capable of controlling the system by text messages: the users can turn on the heating before arriving home, activate the ESS system remotely after leaving home (if they have forgotten to do so), etc.
The **UC-1205** is supplied by default.
However, modems manufactured by other companies can also be used for text communication, e.g. the INSYS modems. When using modems that are compatible with conventionally-supported modems, users can take advantage of support for processing SMS text messages and communicating the Foxtrot system with the modem, which is available in the Mosaic environment and the Foxtrot systems. If users wish to use modems with incompatible communication, the operation software must be provided by the Foxtrot system application programme.

GSM modems are usually fitted with a connector (typically SMA) for connecting an external antenna. Antennas are available in many versions, which differ in size, gain, mounting possibilities, placement and design.. Basic types of antennas supplied are listed in Chapter 9.5.3. Aerials for SMS modem and RFox master RF-1131.

9.5.1 SMS communication, connecting the UC-1205 modem to the Foxtrot basic module

The SMS modem UC-1205 is placed in a 1M box (the size of a single-phase circuit breaker), so it can be fitted next to the basic module in a common plastic distribution cabinet, or, if it is stand-alone, it can be put in a conventional plastic box designed for e.g. secondary protection (1M, 3M boxes).
On the front part, the modem is fitted with a pull-out drawer for standard SIM cards (pressing a button beneath the SIM will eject the drawer) and a standard SMA connector for antenna connection.

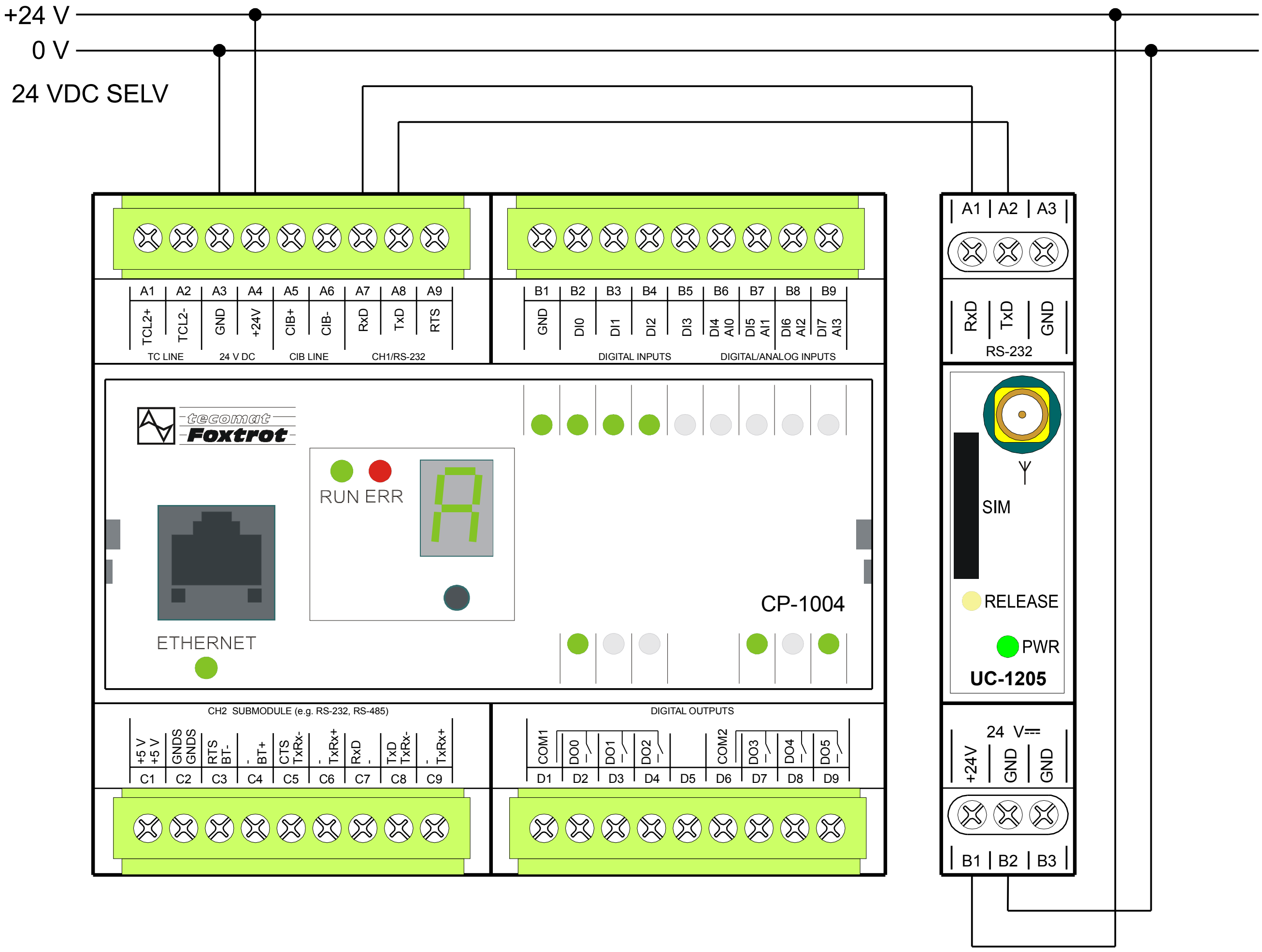


Fig. .1 An example of connecting the SMS modem UC-1205 to the Foxtrot 9.5.1basic module CP-1004

Notes:

1) The UC-1205 SMS modem is in terms of communication a standard modem device, so the RxD terminal of the modem is an output and should be connected to the RxD terminal of the Foxtrot basic module communication interface.
   Similarly, the modem TxD terminal should be connected with the TxD terminal of the Foxtrot basic module. At the same time it is necessary to connect the modem and Foxtrot module GND signals.
2) The modem is usually powered from the same source as the Foxtrot system, but it can also be powered from a separate 24 VDC source.
3) The modem connection cable can be extended up to approx. 15 meters (for a better mobile network signal); a shielded cable with minimum cross section of 0.15mm ^{2} must be used.

9.5.2 SMS communication, connecting the INSYS GSM small modem to the Foxtrot basic module

The following example illustrates the wiring of the INSYS GSM small modem to the CH1 interface of the Foxtrot basic module.

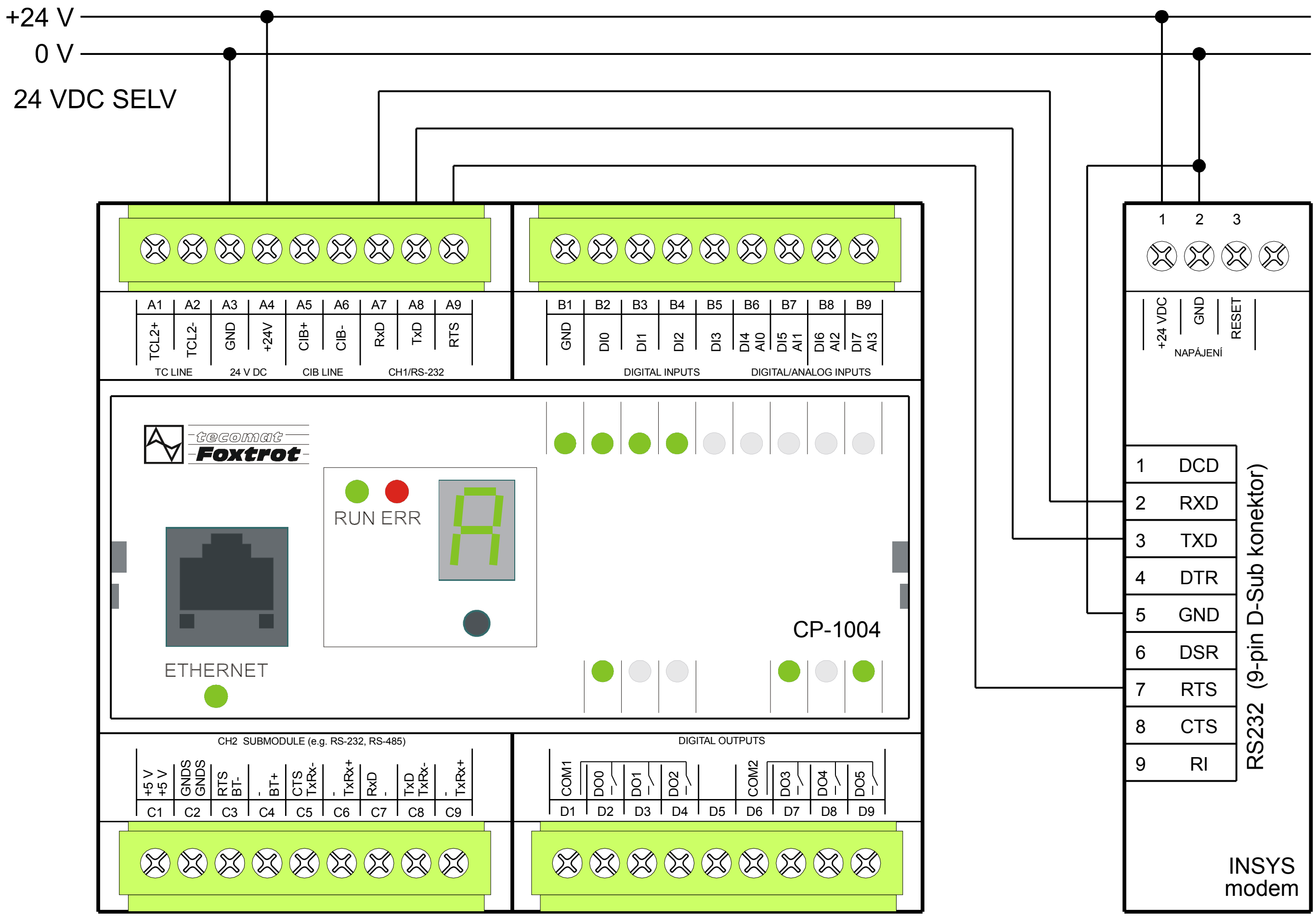


Fig. 9.5.2.1 An example of connecting the SMS modem INSYS to the Foxtrot basic module CP-1004

Notes:

1) The conditions for connecting the RS232 interface are the same as those in the UC-1205 modem example.

9.5.3 The antennas for the SMS modem and the RFox master RF-1131

The AN-06 antenna

A short antenna with a joint - its orientation can be adjusted. The antenna is terminated with an SMA connector and it can be used for RFox modules (the RF-1131 master, peripheral modules such as the HM-R-1121, R-OR-0008, etc.), or for the UC-1205 GSM modem.

The basic technical parameters:

Frequency range	868 ÷ 916MHz
Polarization	vertical
Gain	2.15dBi
Impedance	50Ω
The method of attachment	screw-on, with adjustable angle
Connector	SMA(m)
The weight	9g
Dimensions	85/65mm x 10mm

Fig. 9.5.3.1 The AN-06 antenna

The AO-AGSM-MG5S antenna

This vertical whip type of antenna with a magnet in its base can be attached to any metal surface. The antenna is equipped with approx. 3-meter cable terminated with an SMA connector; it can be used for the RFox modules (the RF-1131 master, peripheral modules such as HM-R-1121, R-OR-0008, etc.), or the UC-1205 GSM modem.

The basic technical parameters:

Frequency range	900/1,800MHz
Radiation pattern	H-360º, V-30º
Polarization	vertical
Gain	5dB
VSWR	< 1.8 : 1
Impedance	50Ω
The method of attachment	magnetic
Connector	SMA(m)
Cable	RG174/U, the length 3m
Operating temperature	-30 ÷ +90°C
Storage temperature	-40 ÷ +95°C
The weight	74g
Dimensions	Ø 3.5mm x 282mm

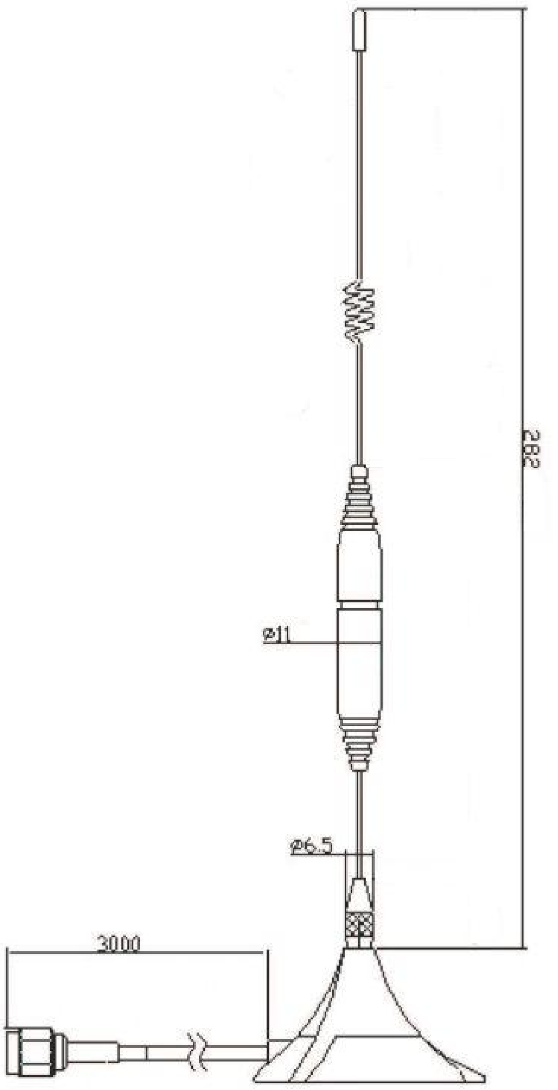


Fig. 9.5.3.2 The antenna AO-AGSM-MG5S

9.6 Communication with other systems

9.6.1 The KNX system integration (e.g. by using the KNX controllers)

The Foxtrot systems can be linked with the KNX installations via the KNX IP BAOS 772 module.
This module allows both the exchange of data between the TECOMAT PLC and the KNX elements network, and the KNX network configuration by the ETS4 software. The KNX IP BAOS 772 module is connected to the KNX bus, and from the perspective of
the KNX installation it represents a complete KNX device. The KNX IP BAOS 772 module is connected with the basic Foxtrot module via the LAN network (the Ethernet interface) - i.e. both modules (Foxtrot and KNX IP BAOS 772) should be connected to a common network, like the weather stations, IP cameras, programming PC. This covers all the necessary HW interconnection, and no additional HW is needed.

The KNX IP BAOS 772 module is fully configurable in the KNX network using ETS4 software; up to 1,000 objects can be loaded (Group Objects) and linked to the group addresses in the KNX network.
Information about these objects is provided by the integrated server JSON (JavaScript Object Notation). The Foxtrot basic module processes this information and saves the values in variables in the system memory.
The data is exchanged over the LAN network, and both the Foxtrot basic module and the KNX IP BAOS 772 module publish new values of the objects only when there is a change. This means that communication is not blocked up with cyclical reading or writing; on the contrary, if nothing is happening, the systems only maintain the connection and the transmission channel is free and ready to pass the necessary information when a change occurs in any object monitored by the Foxtrot or KNX network.

9.7 Voice communication and control

9.7.1 The C-VO-0001B voice output module

We are in the process of designing the C-VO-0001B module for the implementation of the control system voice commands; the module will be capable of generating up to 128 messages or sounds.
Voice commands and messages are prepared on a PC and saved on a microSD card, which should be inserted in the slot on the side of the module. The module is a standard CFox peripheral module; what is controlled from the system is the volume and other settings (fadeout), and there are selected messages to be played. They can even be combined into a chain to generate various other messages. The volume can be adjusted (to a maximum) by the potentiometer directly on the module. The quality of the audio output is suitable for a variety of voice messages, gongs, etc., max. 12 bit/37kHz, the amplifier is class D, filterless. Various built-in speakers and other devices can be connected with the module.

The number of messages	128
Audio output	loudspeaker 8Ω, max.7W

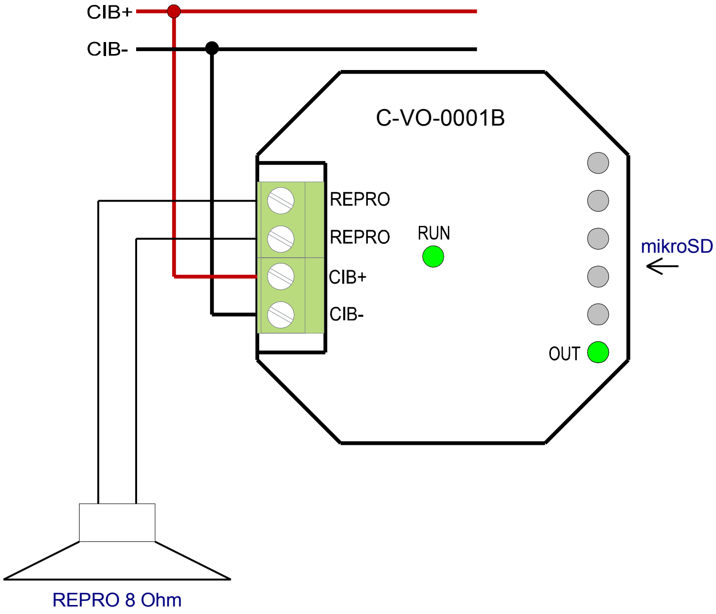


Fig. 9.7.1.1 An example of wiring of the C-VO-0001B voice module

Suitable speakers that can be connected to the module should have an 8Ω impedance (or higher). The recommended speakers are:.

The ceiling speakers, e.g. the CM608, with an 8Ω impedance. Although these speakers have quite a high power, they function relatively well with the module, with sufficient volume and quality; even music can be played on them (various jingles, etc.).

A speaker to be fitted in a flush box 2"- 32Ω and a matching cap for the Logus design.

The 8200-0-0012 speaker for flush mounting with a corresponding interjacent frame and the top frame of the selected design is recommended for ABB frames, such as Levit, Neo, Time, Element, Future linear, Solo, Solo carat, or the exclusive Alpha.

Small speakers (in the designs) cannot provide a high quality sound, so they are particularly suitable for playing various messages, instructions, sound signals, etc.

9.8 Control by motion sensors

Lighting in some spaces can be controlled by the PIR detectors, which switch lights on an off depending on the activity of people, the level of outdoor lighting and other conditions.
This solution is mainly suitable for the lighting of communication lines in the house (e.g. children do not need to look for switches at night), or automatic control of lighting in selected rooms.

PIR intrusion detectors can evaluate the movement of people, either by connecting the detectors directly to the Foxtrot system (which provides the function of the ESS control panel), or indirectly by reading the information from the PIR detectors of a separate ESS control panel connected to the Foxtrot system by a communication interface.

It is necessary to count with a slower response of the PIR intrusion detectors to a motion detection (a change in the setting of the detector, e.g using a jumper, etc., can to some extent help to eliminate false alarms), and also the location of the PIR intrusion detector in accordance with the security of the building may not always be consistent with the requirements for e.g. lighting control (the detector is located to primarily intercept an intruder entering e.g. through the window, while the lighting control system needs to capture the person entering through the door, etc.).

In some cases it is better to use the PIR detectors to control the lighting directly - either they need to be positioned to optimally respond to the movement of people inside the house, or in locations where the security system is not installed.
There is a CFox module we have designed specifically for these applications, the C-RQ-0400R-PIR, which is supplied in a number of designs according to the customers´ wishes - see the example below,
or you can connect suitable PIR detectors to the DI inputs of the Foxtrot system. Either conventional intrusion detectors can be used, or special PIR control detectors - e.g. the Vantage FL-MS MINI mentioned in the example below, which have the optimum position in the room in terms of controlling the lighting.

9.8.1 **Controlling lights by a CFox C-RQ-0600R-PIR** detector.

Lighting of rooms can also be controlled using a PIR detector implemented in the design of the electrical installation elements of the C-RQ-0600R-PIR. The module can further be fitted with a temperature sensor (on request), and another temperature sensor (e.g. the floor temperature sensor) or a binary input signal can be connected. It it is requested by the customer, the temperature sensor can be replaced with a combined temperature and relative humidity sensor.

The PIR sensor is designed as a spherical cap with 24mm in diameter. It is usually mounted in the centre of the selected cover, with the temperature sensor below.
The PIR sensor has a range of about 5-7 meters, the detection angle is about 60° - the closer to the sensor, the greater is the angle, and with the distance it decreases.
It is usually placed at the same height as standard controls (switches) - e.g. 130cm.
When the sensor is mounted on the ceiling that is 240cm high, the coverage is approx. circular and its diameter on the ground is about 5m.

The sensor must be positioned in accordance with the principles applicable for the location of PIR detectors; it is intended only for indoor spaces and great temperature changes can have a negative impact on the function of the sensor.
The sensor needs about 60 seconds for stabilizing after being switched on, and in this time there should be no movement in its field of view.

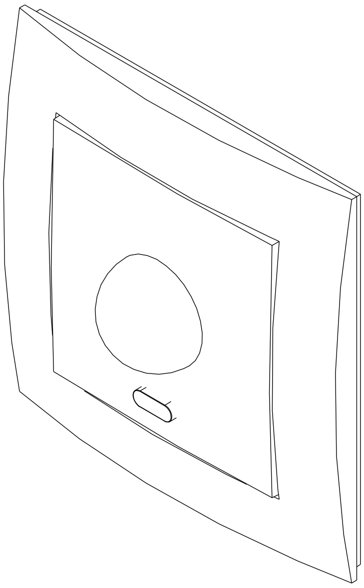


Fig. 9.8.1.1 The C-RQ-0600R-PIR module

Notes:
1. The module in the figure is fitted with a PIR detector and a temperature sensor.

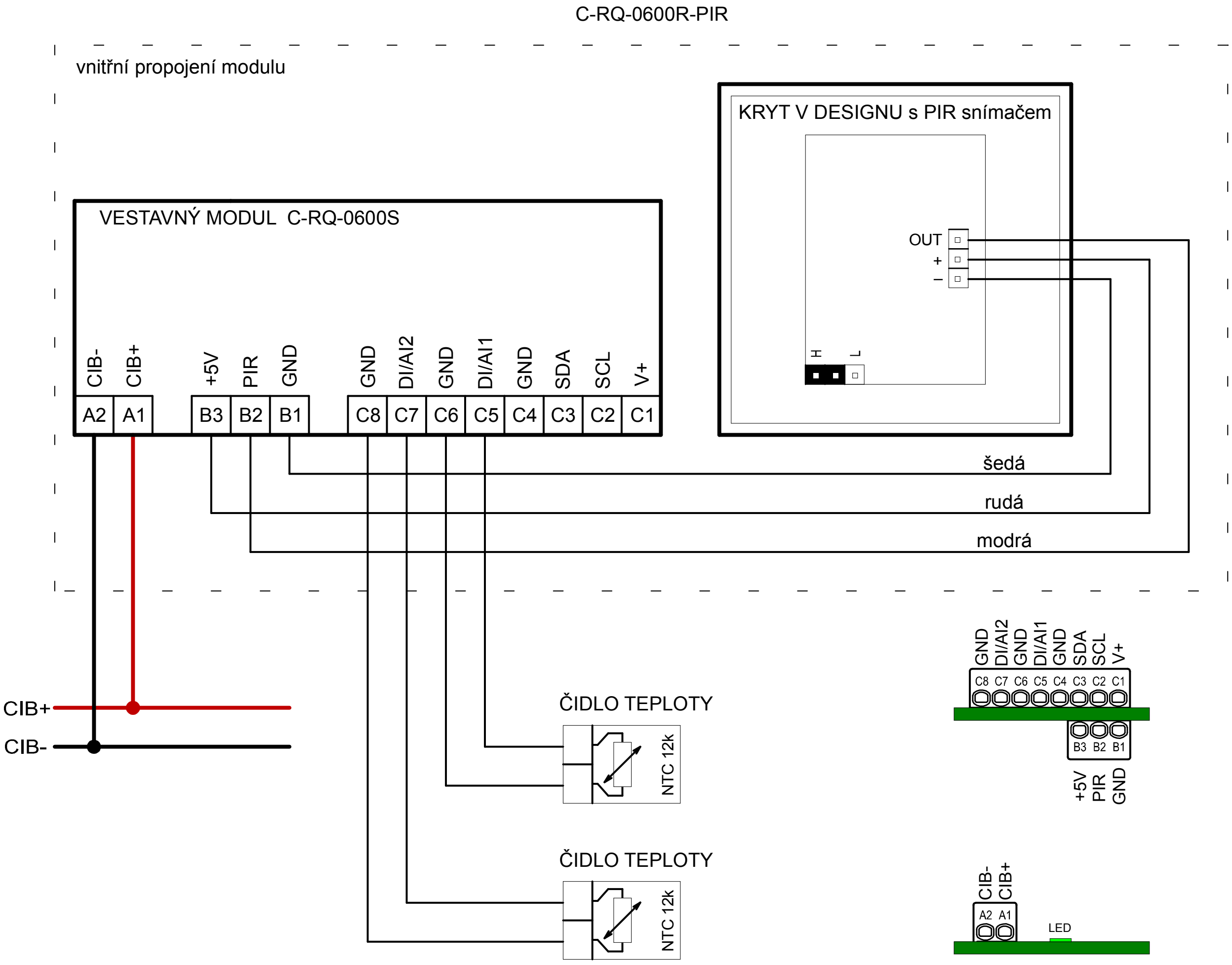


Fig. 9.8.1.2 Connecting the module C-RQ-0600R-PIR including the interior wiring

Notes:

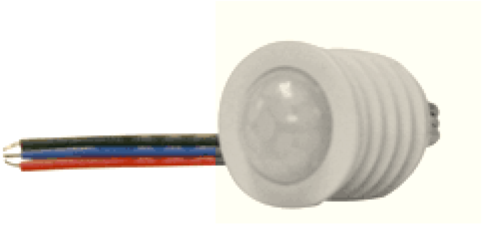
1. The C-RQ-0600R-PIR module consists of two parts, which are supplied already connected – see the figure.
2. The terminals at both ends of the C-RQ-0600S module are shown in the bottom right corner of the picture.

9.8.2 Controlling lights using the PIR detector Vantage FL-MS

A miniature PIR motion sensor Vantage FL-MS MINI 360° can be used to control the lighting indoors. The sensor is very small, with a detection range of 360°, and it is typically installed on the ceiling of the room.

The PIR sensor Vantage has a TTL open collector output, so it can be easily connected to the inputs switched against signal ground, e.g. the DI1 to DI5 on the C-WG-0503S.
The PIR detectors usually use NC outputs, but always with a relatively long switching time (from 500ms to a few seconds), so it is possible to connect them without any problems to the DI inputs DI of the CFox and RFox modules.

Supply voltage	12VDC
Consumption	4.8mA
Output	TTL open connector
Detection range	6.4m when the sensor is 2.4m high
Assembly height	1.8 ÷ 3m
Operating temperature	-20 ÷ +50 °C
External diameter of the detector	Ø 21mm
Mounting hole	Ø19mm
The detector height	25mm



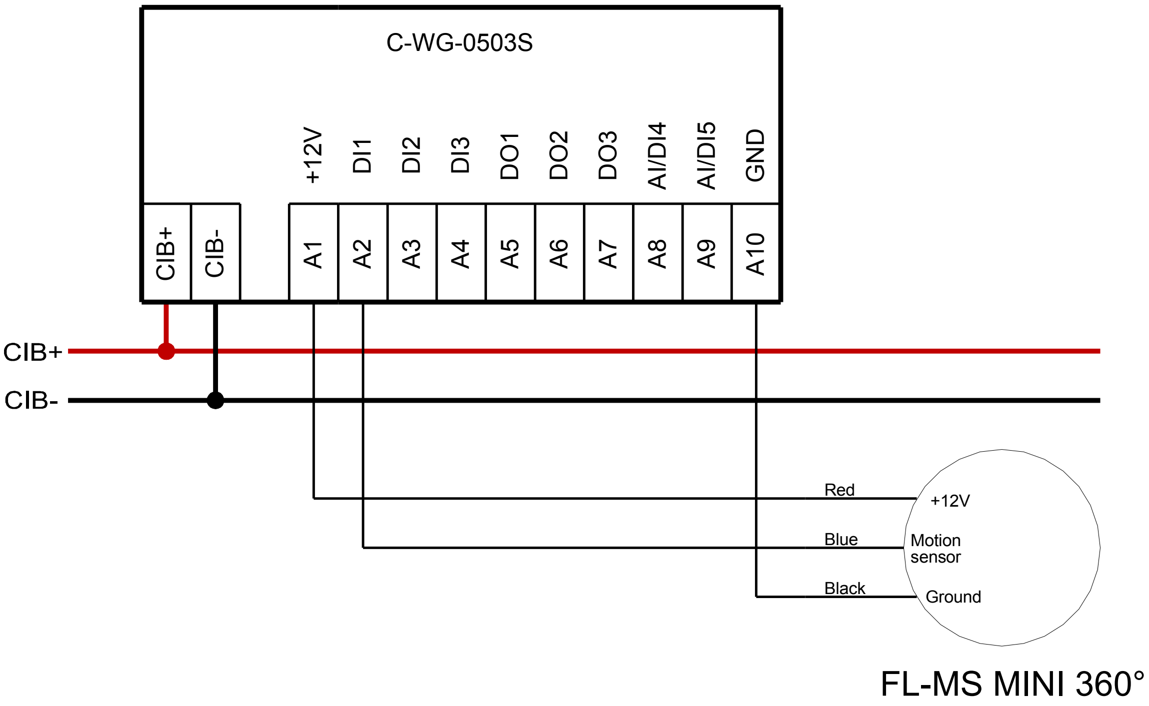


Fig. 9.8.2.1 Connecting the PIR detector FL-MS MINI to the C-WG-0503S module

Notes:

1. The detector cable length can be extended up to several meters, a min. diameter of wires in the cable is approx. 0.5mm.

2. If other PIR detectors are used, the DI input parameters must be observed (the min. and max. voltage or resistance).

9.9 Energy control for hotel rooms, etc.

9.9.1 Energy saver in the hotel room (the card holder) VingCard

When using the card system Assa Abloy (even offline, without a direct link to the control system), it is possible to use the wall-mounted module VingCard Energy Control Unit as a card holder to control energy.The module contains an RFID reader, which can recognize the right card and energizes two relay outputs, which connect the electrical circuits in the room in a standard installation. In the case of intelligent control the module activates the system input, which consequently activates the appropriate systems in the room.

The module is powered from the 230VAC grid, it is fitted with two relay outputs. The first output (RELAY 1) switches the 230V phase directly on the output terminal. The second output is potential free, but the mechanical design does not secure safe isolation of the contact from the 230V power supply, which means that it must not be connected directly to the common DI of the Foxtrot system.Direct connection is possible only to the 230V inputs (only in some basic modules). A conversion relay must be used, which secures safe isolation of the module circuit from the DI of the Foxtrot system.

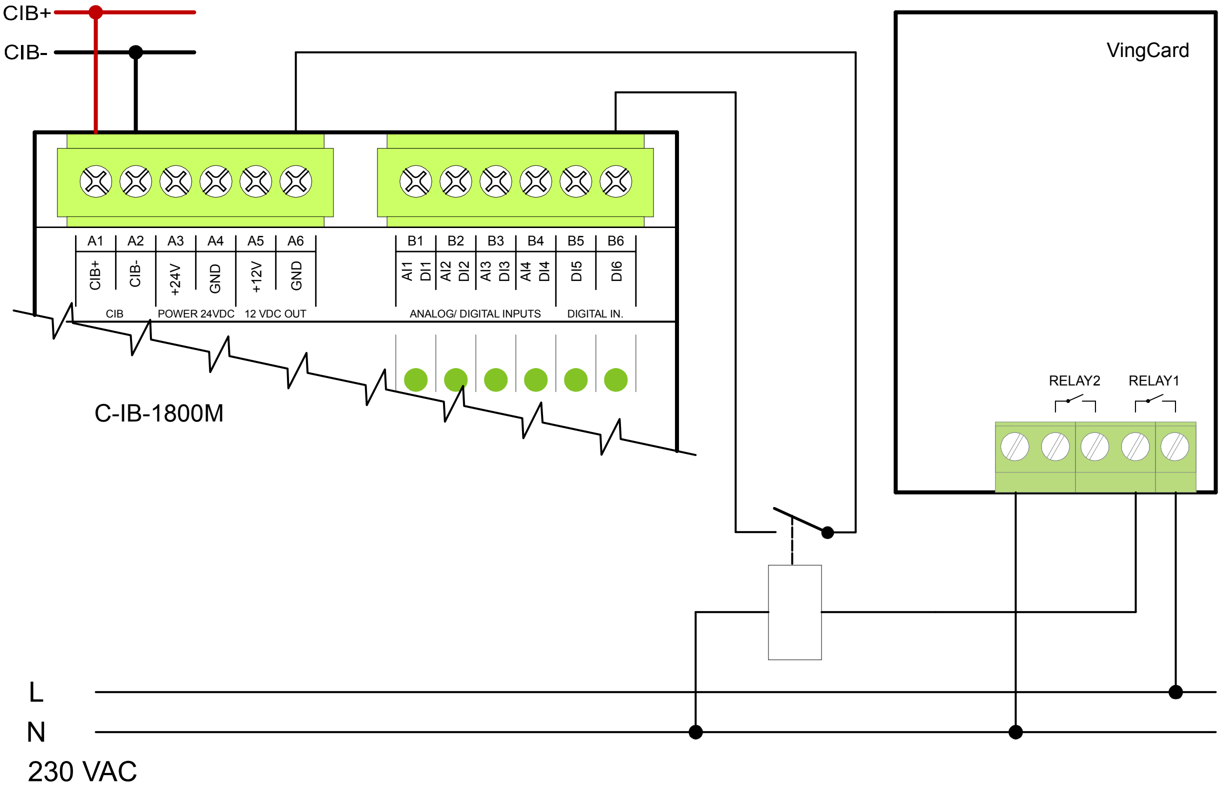


Fig. An example of connecting the VingCard Energy Control Unit to the Foxtrot system inputs

Notes:

1. Use any relay with a coil for 230VAC, insulated contact/coil min. 3000VAC and the smallest possible allowed current in the contact (relays with the minimum current 100 mA are not suitable for this purpose).
2. Scanning the RFID card holder state can be done by any DI of the Foxtrot system.
3. The 230VAC inputs (e.g. the CP-1000) can be used directly, without a conversion relay, the 230V input of the CP-1000 module can be connected directly instead of the relay coil.

10 Measuring temperature

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Temperature (outdoor, indoor, of technical devices, etc.) can be measured by a wide range of CFox and RFox modules, or by separate temperature sensors connected to the analogue inputs of CFox, RFox and Foxtrot modules. Table 10.1 gives a brief overview of the most widely used temperature measurements and the recommended sensors; table 10.2 shows the ranges of analogue inputs of individual CFox and RFox modules.

Basic types of temperature sensors (a brief overview):

The **Pt1000** – a platinum resistance temperature sensor with the R_0 = 1,000Ω basic resistance at 0 °C. There are also produced sensors with a different resistance at 0 °C: the Pt100 (R_0 = 100 Ω), Pt500 and others.
The quality of the platinum sensor is high, is features long-term temperature stability, a disadvantage is somewhat lower sensitivity (lower Tk) and a higher price.
Tk = 3,850 is the standard **temperature coefficient of resistance** in platinum sensors.
There is also used the so-called "American version" with Tk = 3910.
The parameters are defined by the EN 60751 standard: Industrial platinum resistance thermometers and platinum temperature sensors.
Tolerance classes for platinum resistance thermometers and platinum temperature sensors:

The tolerance class	B	A
Basic tolerance range	± 0.3 + 0.005. l t l °C	± 0.15 + 0.002. l t l °C
The temperature range	-200 ÷ +850 °C	-200 ÷ +650 °C

The most common class for standard applications is class B.

The temperature coefficient of resistance defines the relation between the resistance and the temperature. It is defined in several ways, e.g. the coefficient of Pt1000 sensors, the European implementation:
The temperature coefficient of resistance α = 3.85 x 10–3[$°C^{-1}$],
or Tk = 3,850 ppm/ °C (correctly 3851, after a refinement of the value in the A2 appendix of the ČSN EN 60751 standard),
or W_{100} = 1.385 (the ratio of resistance R_{100} at 100 °C and resistance R_0 at 0 °C).

Ni1000 – Ni1000 - a nickel resistance temperature sensor with the basic resistance at 0 °C R_0=1000 Ω. A standard resistance sensor, in comparison with Pt sensors it has a smaller temperature measuring range, good stability, is very popular in measurement and control applications.
By default, nickel sensors are supplied with the temperature coefficient of resistance at Tk = 6,180 (W_{100} = 1.618) or Tk = 5,000 (W_{100} = 1.500).

The tolerance class	B
Basic tolerance range	± 0.4 + 0.007. l t l °C
The temperature range	-50 ÷ +250 °C

NTC 12k – thermistors with a negative temperature coefficient of resistance. Inexpensive sensors, with a smaller temperature range and worse precision. They have a very nonlinear characteristic.
NTC 12k – a sensor with a 12k resistance at 25 °C. There are produced a number of NTC sensors with various resistance values at 25 °C: 5k, 10k, 15k, and others.

Maximum tolerance of resistance at 25 °C, R_{25}	typically ± 3%
The temperature range	- 45 ÷ + 125 °C

KTY 81-121 – a silicon temperature sensor with a positive temperature coefficient. A cheap resistance sensor with lower accuracy (the basic error is about ± 2° C at ambient temperature).

Nominal resistance R_{25}	980 ÷ 1000Ω
The temperature range	- 55 ÷ + 150 °C

TC – a thermocouple, a thermoelectric temperature sensor.
Thermocouples are mainly used for measuring very high temperatures, up to 2,300 °C; the sensors have poorer stability over time and very low sensitivity. .
Thermoelectric sensors are based on the Seebeck effect (converting thermal energy into electricity). A thermocouple consists of two wires of different metals with a conductive connection at each end. If the temperature t_m of the measuring junction differs from the temperature of the t_0 reference junction, small thermoelectric voltage occurs (only several dozens of mV). The reference junction should be constant at the temperature of t_0 in order for the sensor to work properly. Alternatively, the impact of the thermoelectric voltage of this junction should be compensated (using the so-called cold junction compensation, CJC). In order to connect the sensor with the system analogue input, compensation or thermocouple wiring is required.
Thermocouple wiring is made of the same material as the thermocouple itself. That is the reason why there are also types J, K, ...Owing to this, no new thermocouples occur in other joints (e.g.on the terminals between the thermocouple and the subsequent cable). If we used an ordinary wire, the combination of the two different materials would result in creating another thermocouple, which would generate voltage in relation to the temperature of this joint. This voltage would be added to the voltage of the thermocouple itself, rendering the measured values worthless.
Compensation wiring is a cheaper substitution of thermocouple cables. The material is not identical with that of the thermocouple, and the compensation wiring maintains the same parameters as thermocouple cables, but only up to 200 °C (rarely to 260 °C).
The specific type of thermocouple and the mechanical design of the sensor must be addressed with respect to each specific application. This text has been compiled with the help of information [6], where you will also find a specific selection of thermocouple sensors.

Basic properties of thermocouples (the selection according to the module C-IT-0200I):

Type	Range	Usage
B	250 to 1,820 °C	Suitable for extremely high temperatures
J	-200 to 1,200 °C	Suitable for oxidation, reducing, inert atmosphere and vacuum.
K	-200 to 1,370 °C	Suitable for oxidation, reduction and inert atmosphere, not suitable for vacuum.
N	-200 to 1,300 °C	Suitable for frequent and great variations in temperature; it does not respond to the neutron flux (suitable for the nuclear industry).
R	-50 to 1,760 °C	Suitable in high temperatures, resistance against corrosion and oxidation.
S	-50 to 1,760 °C	-the same-
T	-200 to 350 °C	The most suitable sensor for measuring low temperature, it can be used in vacuum, oxidizing and reducing atmosphere.

A summary table of the relation between the resistance of sensors and the temperature

Type of sensor	**Pt1000**	**Ni1000**	**Ni1000**	**NTC 12k**	**KTY 81-121**
Tk	3850	6180	5000	-	-
°C	Ω	Ω	Ω	kΩ	Ω
-20	921,6	893	913,5	98,93	677
-10	960,9	945,8	956,2	58,88	740
0	1000	1000	1000	36,13	807
10	1039	1055,5	1044,8	22,8	877
20	1077,9	1112,4	1090,7	14,77	951
25	1097,3	1141,3	1114	12	990
30	1116,7	1170,6	1137,6	9,8	1029
50	1194	1291,1	1235	4,6	1196
100	1385,1	1617,8	1500	0,95	1679
150	1573,3	1986,6	1799,3	-	2189
250	1941	2896,4	-	-	-

Table 10.1: Classification of temperature sensors according to the measuring technology

Measuring	Module on CIB	Independent sensor	RFox module	Note:
Interior temperature	C-IT-0200R-design TXN 133 20	S-TS01R-design	-	The wall-mounted sensor, on customer's request
	C-IT-0200R-Time TXN 133 19.01	S-TS01R-ABB TXN 134 01.01	R-IT-0100R-Time	The wall-mounted sensor, the ABB Time design
	C-IT-0200R-ABB TXN 133 19.xx	S-TS01R-ABB1) TXN 134 01.xx	-	ABB design sensor (except for the Time), it must be specified
Outdoor temperature	C-IT-0100H-P TXN 133 16.11	P11PA		Sensor on the facade
The floor temperature		SK8NTC12k-2PS-xx		Sensor for underfloor heating regulation
Temperature of the solar heating circuit medium		SK2PA-2SS-xx		The cable temperature sensor mounted on a pipe in the circuit
Water temperature in the tank		SK8NTC12k-2SN-xx		The cable sensor inserted in the tank immersion sleeve
Water temperature in the piping	C-IT-0100H-P TXN 133 16.12	P15PA		Contact sensor, heating water and utility water, solar systems
	C-IT-0100H-P TXN 133 16.12	P13PA-xx	R-IT-0100H-A	Sensor with an immersion sleeve (installed inside a pipe)
Air temperature in the duct	C-IT-0100H-P TXN 133 16.0x	P12PA-xx		An internal pipe sensor, HVAC regulation, the length of the stem must be specified
Water temperature in the swimming pool	C-IT-0100H-P TXN 133 16.0x	P12PA-xx		A sensor in the immersion sleeve in the piping, the length of the stem must be specified
Boiler flue gas temperature	C-IT-0200I, TXN 133 09 + thermocouple sensor			Thermocouple sensor measured by the C-IT-0200I module

Notes:

1) For the ABB Tango design, a different variant of the sensor order no. should be used: TXN 134 02.01 (the standard version in white).

For an overview of modules and types of connectable temperature (and other analogue values) sensors, see the following table:

ROZSAH MODUL	Pt1000	Ni1000	NTC 12k	NTC 5 ÷ 15k	KTY 81-121	0 ÷ 20 (4 ÷ 20) mA	0 ÷ 10V	0 ÷ 2V	0 ÷ 1V	Termočlánky	kondenzace	interní čidlo	Odpor 0÷ 160 kΩ	Odpor 0÷ 450 kΩ	Odpor 0÷600 kΩ	Odpor 0÷6 MΩ	DI, kontakt	Vstup S0	vyvážené vstupy	-100 mV ÷ 100mV	-1V ÷ 1V	-2V ÷ 2V	čidlo rosení SHS
C-IT-0200R			1									1											
C-IT-0200S	2	2	2	2	2								2				2		2				
C-IR-0202S	2	2	2	2	2								2				2		2				
C-IT-0504S	5	5	5	5	5								5				5		5				
C-IT-0908S	3	3	3	3								3	3				8		8				
C-RC-0002R			1	1								1	1										
RCM2-1			1									1											
C-IT-0200I	2	2	2	2	2	2	2			2		1	2							2	2	2	
C-IT-0100H												1											
C-HM-0308M	3	3	3		3						3				3	3							
C-HM-1113M	3	3	3		3						3				3	3							
C-HM-1121M	3	3	3		3						3				3	3							
C-HC-0201F-E	1	1	1	1	1							1	1										
C-WS-0200R			2	2									2										
C-WS-0400R			2	2									2										
C-FC-0024X			3	3									3				3						
C-VT-0102B			2	2									2										
C-AM-0400M	4	4	4	4	4	4	4	4	4				4				4	4					
C-AM-0600I	5	5	5	5	5	5	5	5	5		1		5	1			5	4					1
C-RI-0401	2	2	2	2	2							0/1	2				2						
C-OR-0202B	2	2	2	2	2								2				2		2				
C-WG-0503S	2	2	2	2	2								2				3		2				
R-IT-0100R												1											
R-IT-0100H-A												1											
R-RC-0001R			1									1											
R-HC-0201F			1									1											

Table 10.2: An overview of the CFox and RFox modules for measuring temperature and analogue values (voltage, current, etc.)

The number in the table box shows, how many inputs of the selected module enable measuring the sensor or the signal in the appropriate column.

10.1 Measuring the interior temperature

The interior temperature is usually measured by a temperature sensor mounted on the wall of the room. The highest quality of the measurements is achieved if you comply with several principles:

Placement of the temperature sensor.

Temperature sensor should be mounted about 130 ÷ 150 cm high, always on the wall, which is not affected by other sources of heat or cold.

It is not desirable:: - to put the sensor on an external wall with no thermal insulation
- to put the sensor too close to the door and other places with variable draft
- to put it close to air-conditioning vents
- to put it above the sources of heat (the fridge, TV, a light source)
- to install it in a place where cold air flows - openings in the ceiling, draft

to put it in unsealed pipes with cables to the sensors, etc.,
- to locate it in the corner or some other place with limited natural air circulation of the air in the room.

In large rooms it is not recommended to locate the sensors too far from the "point" sources of heat (panel radiators, etc.), because even though the temperature will be regulated accurately at the location of the sensor, it can fluctuate by several degrees Centigrade near the heat source. Then the temperature fluctuation depends on typical places where the residents spend most time and on its distance from the heat sources and from the sensors. .

Selecting the sensor.

The spatial room temperature can be measured in several ways. It depends on the requirement of the design of the measuring element itself, on the fact if you simultaneously measure the floor temperature, whether you prefer the bus elements distributed around the house (CFox, RFox) or direct temperature sensors connected with cables to the analogue input of modules in the control panel. The spatial temperature is measured simultaneously by the heating controllers and temperature sensors, which can be connected to the CFox wall-mounted controllers (“switches”).

Measurement accuracy.

The sensors measuring the interior temperature usually achieve a resolution of 0.1 to 0.3 °C, the measurement accuracy (excluding the sensor location) is about ± 0.3 ÷ 0.6 °C; some sensors (e.g. the NTC) measure with a larger absolute error, which could be corrected by a programme (offset of the measured temperature in the module configuration, etc.).

Due to the potential effect of the sensor placement (which cannot always be influenced) on its accuracy, it is appropriate in some cases to add a service temperature correction, which should be done after the system has been installed and all temperatures stabilized with the help of an external thermometer. Some combined modules (a backlit display with a temperature sensor, etc.) also influence the measured temperature to a certain extent due to their own electronics heat dissipation. Therefore, the system should be stabilized before reprogramming the measured temperature.

The temperature measurement and control of its accuracy must always be done when the system is stabilized - after being turned on, the heating must function for at least one hour; the room must be in a stabilized state (warm, with minimum movement of people). A greater movement of people has a significant impact on the temperature and the relative humidity changes in the room; this should be taken into account when conducting an inspection of the accuracy or a software compensation of the sensor.

10.1.1 The CFox temperature sensor design according to the electrical installation, the C-IT-0200R-design

A number of designs can use wall-mounted temperature sensors. The module is always manufactured in the respective electrical design and it includes an internal temperature sensor and terminals for connecting an external temperature sensor (e.g. floor temperature).

The sensor consists of two parts. The internal part contains the sensor electronics and is terminated with 4 wires (the CIB and the external temperature sensor) and a connector, where the cable from the other part is inserted. The second part represents the wall-mounted design feature itself with an installed temperature sensor terminated on a 70mm cable with a connector. The second temperature sensor (NTC 12 k or NTC up to 100k) is e.g. for measuring the floor temperature.

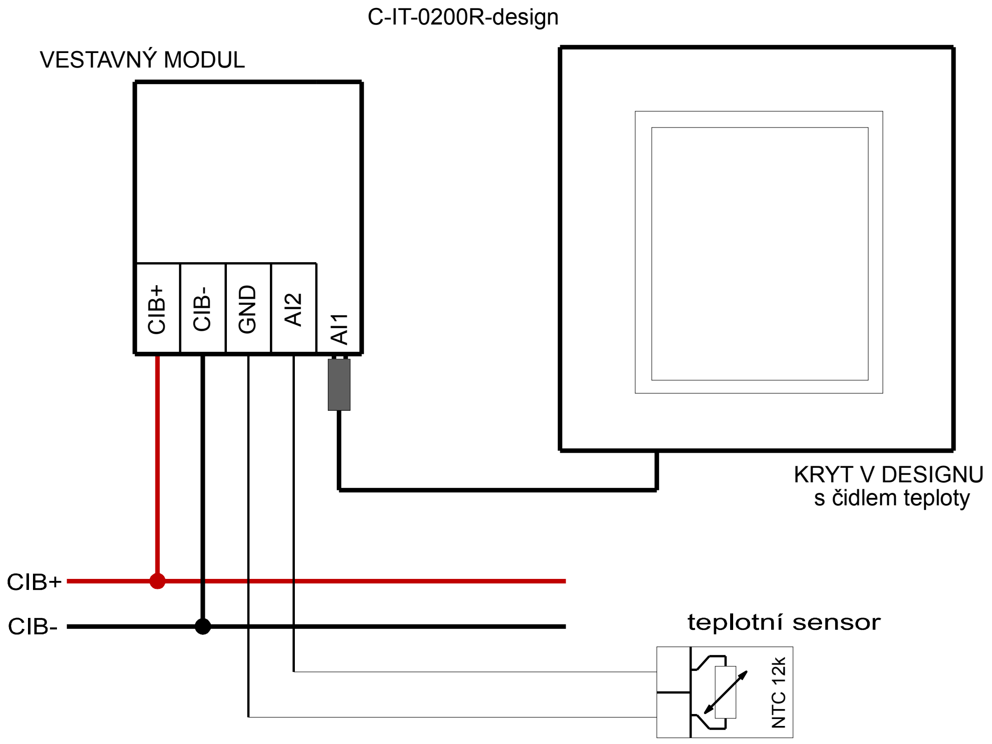


Fig. 10.1.1.1 A wiring example – the floor and interior temperature measurement, the C-IT-0200R-design, TXN 133 20

Notes:

1) The external temperature sensor must be an NTC 12k or other NTC with the resistance of up to 100k; the connection cable can be up to dozens of meters long. A typical use is for a floor sensor, the recommended cables include e.g. the SYKFY or similar cables, with at least 1x2 wires with 0.5mm diameter.
2) The module is designed as a small embedded module in a flush-box (KU68); it is terminated with four 10cm wires (the CIB bus and an external temperature sensor) and a small connector, in which the temperature sensor cable from the top part of the module (the design cover with the temperature sensor) should be inserted.
3) The temperature sensor is usually placed in the front surface of the cover and is visible from the outside (a small oval metal housing), which guarantees that the sensor actually measures the temperature in the room, with the minimum effect of the heat dissipated by the internal electronics and the temperature of the wall.

10.1.2 The CFox temperature sensor in the ABB, C-IT-0200R-Time design

The version for ABB designs, e.g. the sensor C-IT-0200R-Time, order number TXN 133 19.01, Time white-white. The price list includes variants of ABB designs and custom-made colour finishing of the covers.

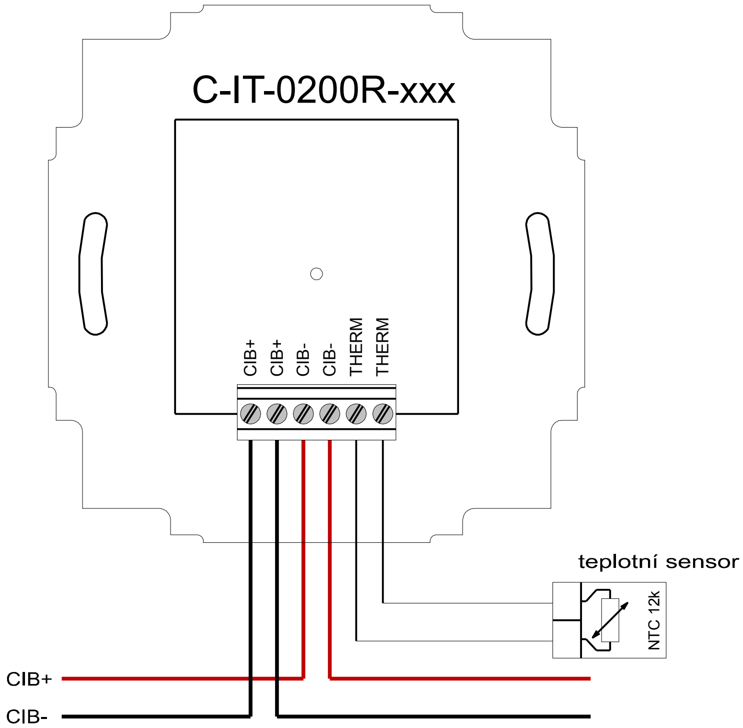


Fig. 10.1.2.2 A wiring example – the floor and interior temperature measurement, the C-IT-0200R-ABB, TXN 133 19

Notes:

1) The external temperature sensor must be an NTC 12k, the connection cable can be up to dozens of meters long. A typical use is for a floor sensor, the recommended cables include e.g. the SYKFY or similar cables, with at least 1x2 wires with 0.5mm diameter.
2) The module is designed as a plug in ABB design, the terminal block is located on the rear part of the module, which is screwed on the installation box (KU68), the depth of the module is approx. 13mm.

10.1.3 The RFox temperature sensor, the ABB Time design

Interior temperature can be measured with the R-IT-0100R-Time wireless temperature sensor. The thermometer module is manufactured in the ABB Time design, it is powered by the CR2032 lithium battery located underneath the fingerboard (cover). The design of the module is flat, which allows mounting on flat surfaces (gluing on glass), on the flush box or a wall, or even placing it loose.

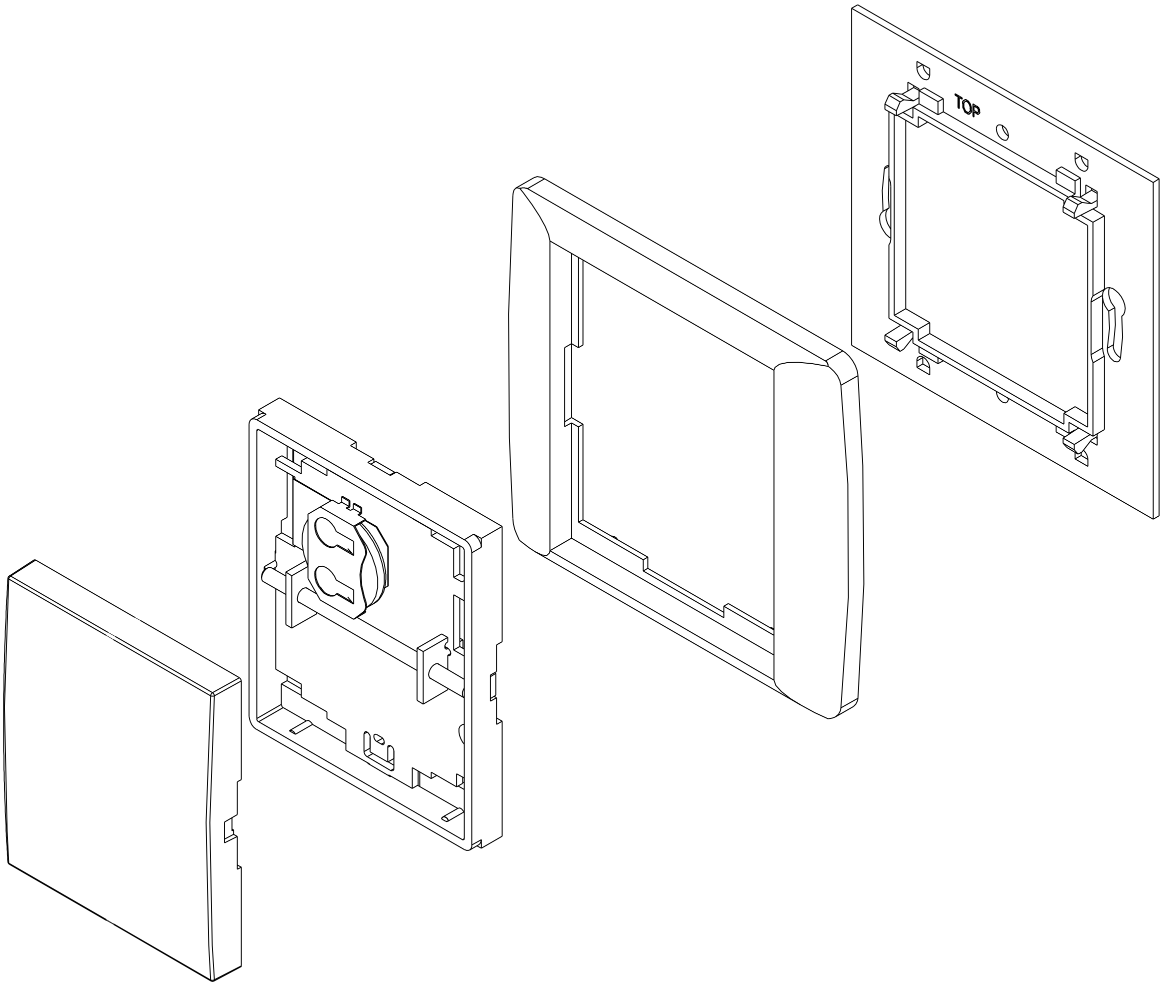


Fig. 10.1.3.1 The R-IT-0100R-Time module design

Notes:

1) The module consists of the fingerboard (the cover), electronics in the interjacent frame, a standard frame (the figure shows the ABB Element) and the supporting part (in the figure left to right).
2) The only purpose of the buttons below the fingerboard is bonding. Pressing the button during the operation immediately wakes the module up, the temperature is measured, communicated and the module goes to the sleep mode again; even during debugging the application, it allows you e.g. to measure the temperature and test communication as needed.
3) The battery is in the upper left corner; it was disconnected in the factory with an insulating tape, which should be pulled out at the back when you are bonding the module to the system.
4) The supporting part has a flat rear wall, which can be glued or screwed onto flat surfaces (the holes have a standard 60mm spacing).

10.1.4 The separate temperature sensor S-TS-01R, connected to the AI of the system

The interior temperature can be measured with the S-TS-01R stand-alone temperature sensor (e.g. the NTC 12k) designed according to the customer's requirements. The sensor is available in ABB Time design under the order number TXN 134 01.01 (basic white). Other generally available design options (e.g. ABB, Legrand, Unica) are included in the price list, versions for other designs are custom-made. The sensor is equipped with an NTC 12k element terminated on the rear side (the direction inside the installation box).

We can also deliver a custom-made sensor equipped with the Pt1000 sensor (on request, with a different order designation).

We can supply temperature sensors for other designs as well, but check with us the availability of a specific type of design.

The sensor can be connected to any analogue input with an appropriate measurement range (NTC 12k). E.g. it can be connected to the C-WS-0x00R controller as an indoor temperature sensor (and put into a twin frame together with the controller) - see the figure below.

The temperature sensor can also be connected to any input of the system with an appropriate range, e.g. the AI1 to AI4 inputs of the C-IB-1800M module, the AI1 to AI3 inputs of the modules C-HM-0308M, C (R) -HM-1113M and C (R) -HM-1121M.

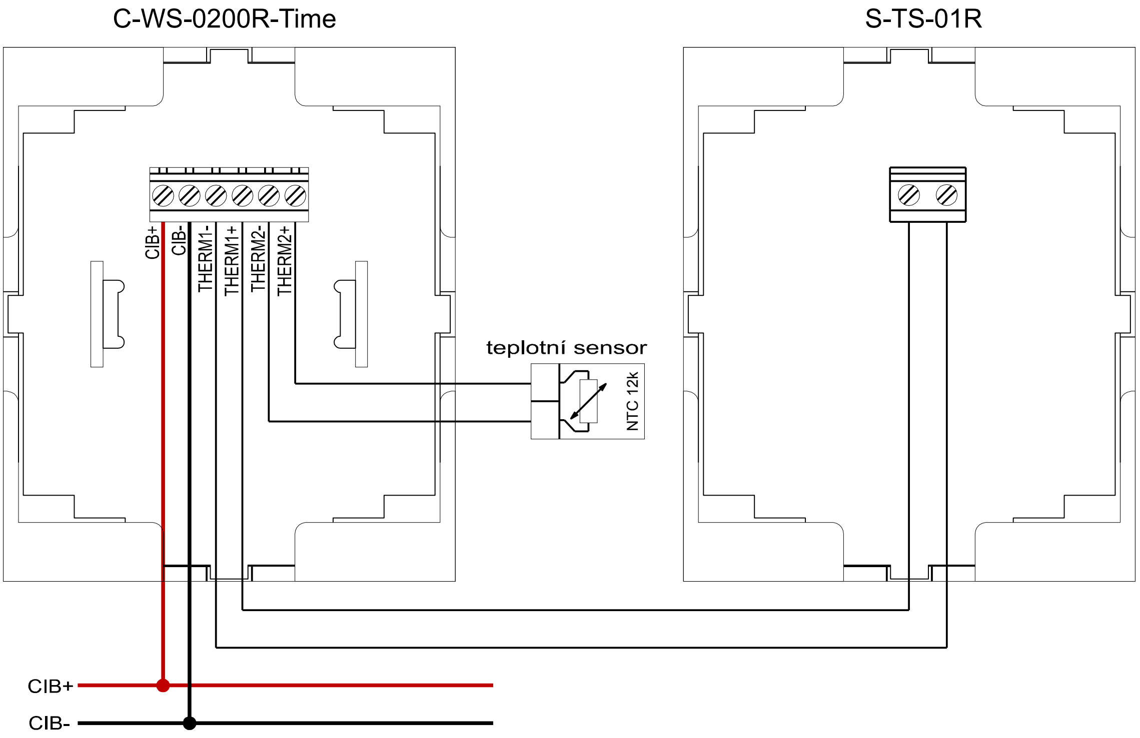


Fig. 10.1.4.1 An example of connecting the S-TS-01R sensor to the C-WS-0200R-Time module

Notes:

1) The length of the connecting cable to the S-TS-01R sensor can be up to dozens of meters; the cable used can be e.g. the SYKFY or similar, with at least 1x2 shielded wires with 0.5mm diameter.
2) The sensor is designed as a dummy plate (the ABB design in this case), the terminal block is located on the rear part of the module, which is screwed on the flush box (KU68), the depth of the sensor is approx. 13mm.

10.2 Measuring outdoor temperature

10.2.1 The outdoor temperature sensor CFox, C-IT-0100H-P

The outdoor temperature sensor on the CIB bus, the C-IT-P-0100, order number TXN 133 16.11, is designed for mounting on the wall. The module is placed in a box with extra protection, with a cable gland. The dimensions and other details are provided in the information on the P11PA sensor. The TXP 300 01 side wall mount has to be ordered for this module (see the next chapter).

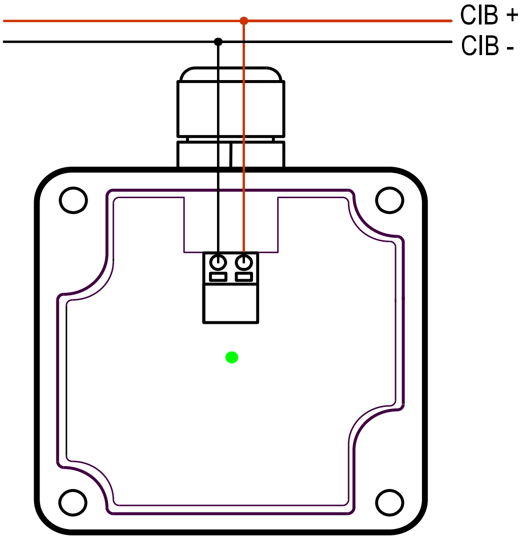
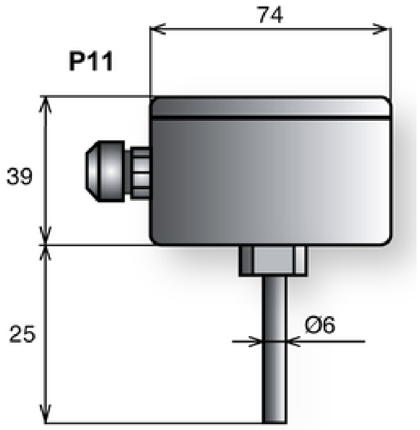


Fig. 10.2.1.1 An example of wiring the C-IT-0100H-P sensor

10.2.2 The outdoor temperature sensors Pt1000, P11PA

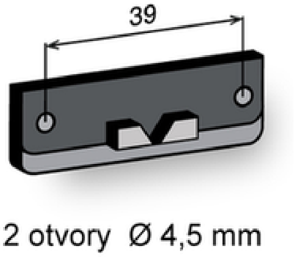
Outdoor temperature can be measured by a scanner fitted with the Pt1000 sensor, which should be connected to the system analogue input. The sensor housing is made of plastic, the metal measuring stem is made of stainless steel, grade DIN 1.4301. A part of the sensor is a plastic side wall mount used for fixing the sensor on the wall.

Measurement range	-30 ÷ 80ºC
Accuracy class	B in accordance with IEC 751
Stem	stainless, DIN 1.4301, Ø = 6mm, the length 25mm
Isolation resistance	> 100MΩ at 25ºC (500VDC)
Level of protection	IP 65 (ČSN EN 60529)
Relative humidity	< 95%
Gland	PG9, the cable diameter 4 ÷ 8mm



Terminal block	the wire cross-section 0.35 ÷ 2.5mm²

The plastic side wall mount TXP 300 01 - the dimensions for wall mounting (for the P11PA sensor it is included in the delivery, for the C-IT-0100h-P sensor, order number 133 16.11 TXN it must be ordered separately.



10.3 Measuring the temperature of the floor, temperature sensors with a cable gland

10.3.1 Measuring the temperature of the floor, the NTC or Pt1000, Ni1000 cable sensors

In order to measure the floor temperature (to regulate water and electrical floor heating systems), you can use a cable temperature sensor connected to the system analogue inputs, e.g. to the analogue input of the temperature sensor or the wall-mounted heating controller.
The temperature sensor should be placed in a protective plastic tube of sufficient diameter (about 10mm), which must be embedded and flush-mounted in its base; it is placed at least 0.5m from the edge of the floor, not too close to the heating element (see the relevant assembly instructions of the underfloor heating systems).

For an example of connection see e.g. the CFox wall-mounted temperature sensor C-IT-0200R-design.

The cable temperature sensor can be used for contact temperature measurements of liquid, solid or gaseous substances, e.g. the **solar heating circuits**, the **water temperature in the storage tank**, etc. In addition to measuring the floor temperature, it is used for measuring the temperature in the tanks of heating systems, and it can also be used for measuring the temperature in the piping, by thoroughly attaching the sensor to the pipe and carefully insulating it. Its main component is the temperature sensor itself, which is placed in a metal casing and its terminals are connected to the power cord. The temperature range in the table applies for the sensor itself and for the power cable. If the cable is equipped with shielding, this shielding is not connected with the case or with any other wire of the sensor.

The standard scanners are equipped with 12k NTC sensors in the version up to 80 °C and up to 125 °C, also with the Pt1000 (3850 ppm) and Ni 1000 (6180 ppm) sensors. The standard lengths are listed in the price list, and other variants of cable sensors or different cable lengths are custom-made on request. The following table specifies the basic electrical and mechanical parameters of commercially available sensors:

Order number	**SK8NTC12k-2PS-xx**	**SK8NTC12k-2SN-xx**	**SK2PA-2SS-xx**	**SK8S-2PS-xx**
Temperature sensor	NTC 12k	NTC 12k	Pt1000	Ni1000/6180ppm
The temperature range	-30 ÷ +80 °C	-50 ÷ +125 °C	-40 ÷ +200 °C	-30 ÷ +80 °C
An example of usage	floor sensor	water temperature in the tank	Solar hot water system	floor sensor
The power cable	0.34mm^2	0.5mm^2	0.22mm^2	0.34mm^2
The wire insulation	PVC	silicon	silicon	PVC
Cable	LiYCY 3x0,34 mm^2	MC-ECS 3x0.5mm^2	MCBE-AFEP 2x0.22mm^2	LiYCY 3x0.34mm^2
Shielding	yes	NO	yes	yes
Insulation of the lining	PVC	silicon	silicon	PVC
Casing	galvanized brass	galvanized brass	stainless DIN 1.4301	galvanized brass
	Ø = 6.8mm	Ø = 6.8mm	Ø = 6mm	Ø = 6.8mm
	length 25mm	length 25mm	length 60mm	length 25mm

xx – the length of the cable in meters (for standard supplied lengths see the price list)

10.4 Measuring temperature – technology

The temperature in the house technology (the heating source, the solar system, the swimming pool technology, etc.) can be measured in several ways.

A suitable sensor is selected according to the following features:

- The medium measured and the mechanical mounting: air temperature (in the air duct) can be measured by sensors with a stem, water in the piping of a smaller diameter (central heating) is measured by contact sensors, for larger diameters the suitable sensors are those with an immersion sleeve.
- The temperature ranges: we mostly measure temperature of water or air, so common types of sensors suffice, only flue gas measurement requires higher temperature ranges.
- The connection: sensors with the CIB interface (a CFox peripheral module), or separate sensors fitted only with a scanning element (Pt1000, Ni1000, NTC), which are connected to the analogue input of the system.

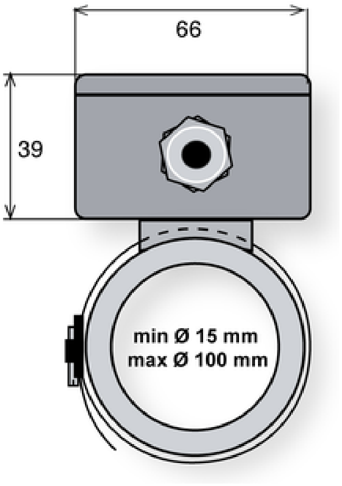
Standard temperature measuring equipment fitted with sensors such as Pt1000, Ni1000, NTC and others can be used; they should be connected to the analogue inputs of CFox or RFox modules, or directly in the Foxtrot basic modules (e.g. the CP-1006 and CP-1008). The range of standard sensors can be found in the price list, and an overview of CFox modules suitable for measuring temperatures is listed in Table 10.1.

Using directly the sensors on the CIB bus is another option.
The C-IT-0100H-P variants: with the stem in the piping, with the immersion sleeve, the contact version on the piping and the outdoor version.
The C-IT-A-0100H-A variants: with the stem in the piping, with the immersion sleeve, and for a greater range of temperatures.
The R-IT-0100H-A battery temperature sensor, the design with the immersion sleeve, with the stem, etc.

10.4.1 Measuring the temperature of water in the piping, the CFox C-IT-0100H-P contact sensor

The temperature of water in the heating system (e.g. the output water from the heating source, the temperature of water in the solar system, etc.) is measured by contact temperature sensors; the available CFox module is the C-IT-0100H-P, the Order No. is TXN 133 16.12. The module is designed to measure the surface temperature of piping. It is placed in a plastic head with a terminal block for the connection of the CIB bus. The module includes a metal holder with a fastening tape
for the piping. The modules are used in a standard environment, where they are not exposed to aggressive chemicals.
The wiring example is identical with that of the C-IT-0100H-P outdoor sensor.

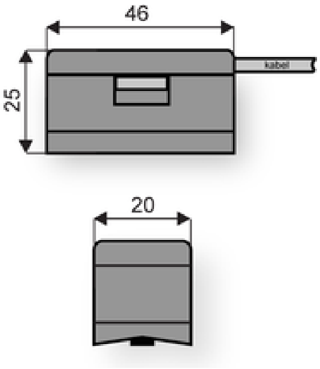
Measurement range	-30 ÷ +120ºC
Isolation resistance	> 100MΩ at 25ºC (500VDC)
Level of protection	IP 65 (ČSN EN 60529)
Relative humidity	< 95%
Ambient temperature	-25 ÷ +80ºC
Gland	PG9, the cable diameter 4 ÷ 8mm
Terminal block	maximum 1mm^2 wires on the terminal



10.4.2 Measuring the temperature of water in the piping, the Pt1000, P15PA contact sensors

The temperature of water in the heating system (e.g. the output water of the heating source, the temperature of water in the solar system, etc.) is measured by contact temperature sensors; there is available a contact sensor fitted with the Pt1000, P15PA, which should be connected to the analogue inputs of the system. The sensor is designed to measure the surface temperature of piping and it is placed in a plastic head with a terminal block. The module includes a metal holder with a fastening tape for the piping. The sensors are used in a standard environment, where they are not exposed to aggressive chemicals. The sensor is supplied with a silicone 2m-long cable.

Measurement range	-30 ÷ +120ºC
Accuracy class	B in accordance with IEC 751
Isolation resistance	> 100MΩ at 25ºC (500VDC)
Level of protection	IP 65 (ČSN EN 60529)



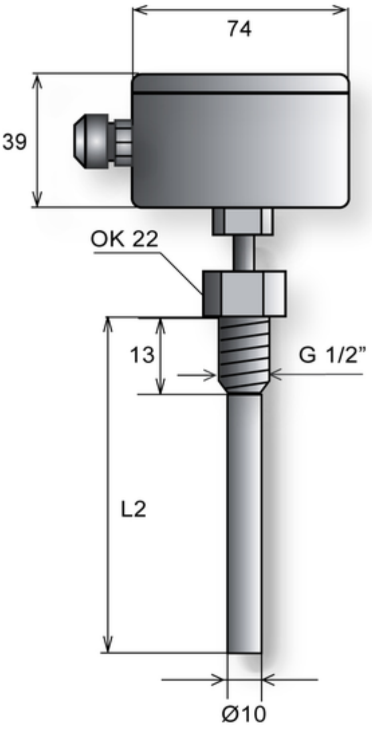
Relative humidity	< 95%
Ambient temperature	-25 ÷ +80ºC
Gland	PG9, the cable diameter 4 ÷ 8mm
Cable	2m length

10.4.3 Measuring the temperature of water in the piping, the CFox, C-IT-0100H-P sensor with an immersion sleeve

The temperature of liquid flowing in the piping is measured by a temperature sensor with a stem in a stainless steel sleeve fitted in the piping; there is available the CFox module C-IT-0100H-P, the Order No. is TXN 133 16.0x (x - the stem length), and it is necessary to additionally order the appropriate immersion sleeve TXP 300 1x (x - the sleeve length). The module is placed in a plastic head with a terminal block for the connection of the CIB bus; the metal measuring stem is made of stainless steel, grade DIN 1.4301, the stainless steel sleeve is equipped with a G1/2" screw thread. The standard version of the module is designed for a maximum temperature of 150ºC. The modules are used in a standard environment, where they are not exposed to aggressive chemicals.

The wiring example is identical with that of the C-IT-0100H-P outdoor sensor.

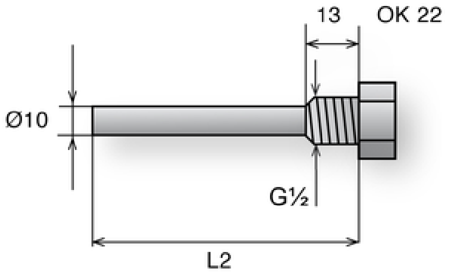
Measurement range	-30 ÷ +150ºC
Accuracy class	B in accordance with IEC 751
Isolation resistance	> 100MΩ at 25ºC (500VDC)
Level of protection	IP 65 (ČSN EN 60529)
Relative humidity	< 95%
Ambient temperature	-25 ÷ +80ºC
Stem	stainless, DIN 1.4301, Ø = 6mm, the length of the immersion pocket L2: see the table
Head	made of polycarbonate, grey dimensions: 74 x 66 x 39mm
Gland	PG9, the cable diameter 4 ÷ 8mm
Terminal block	maximum 1mm^2 wires on the terminal



L2 (mm)	Order number	Order number
	The C-IT-0100H-P **module**	**The immersion sleeve**
100	TXN 133 16.01	TXP 300 11
160	TXN 133 16.02	TXP 300 12
220	TXN 133 16.03	TXP 300 13
280	TXN 133 16.04	TXP 300 14
340	TXN 133 16.05	TXP 300 15

Immersion sleeve, basic parameters:

Lengths: L2 (mm)	100,160,220,280,340
Screw thread	G½ and M20x1.5
Material	DIN 1.4301
Maximum pressure	4 MPa



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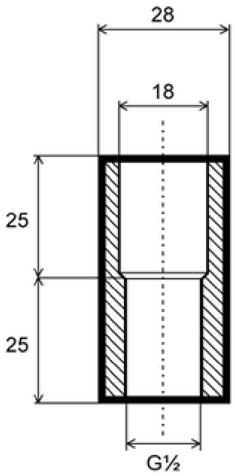

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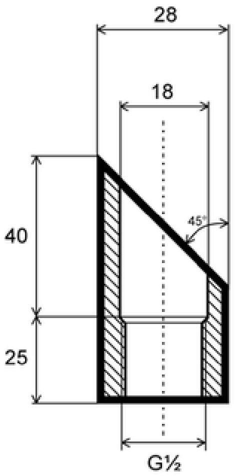


Dimensions of the immersion sleeve a welding flange for the sleeve

10.4.4 Measuring the temperature of water in the piping, the CFox, C-IT-0100H-P sensor with an immersion sleeve

The temperature of liquid flowing in the piping is measured by a temperature sensor with a stem in a stainless steel sleeve fitted in the piping; there is available the CFox module C-IT-0100H-A, the Order No. is TXN 133 17.0x (x - the stem length), and it is necessary to additionally order the appropriate immersion sleeve TXP 300 1x (x - the sleeve length). The module is placed in an aluminium head with a terminal block for the connection of the CIB bus; the metal measuring stem is made of stainless steel, grade DIN 1.4301, the stainless steel sleeve is equipped with a G1/2" screw thread. The standard version of the module is designed for a maximum temperature of 250 ºC. The modules can also be used in the thermally and chemically more demanding environments, with a maximum ambient temperature (the operating temperature of the head itself) at max. 80 °C.

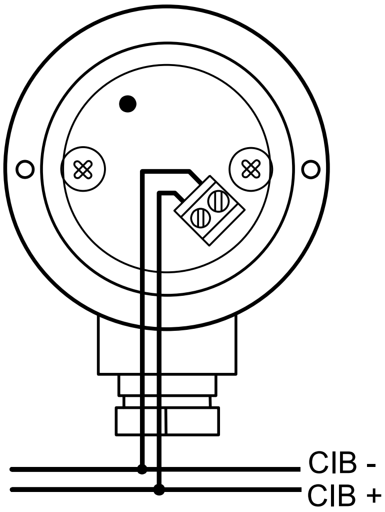
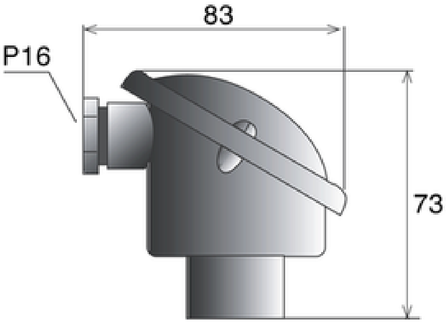


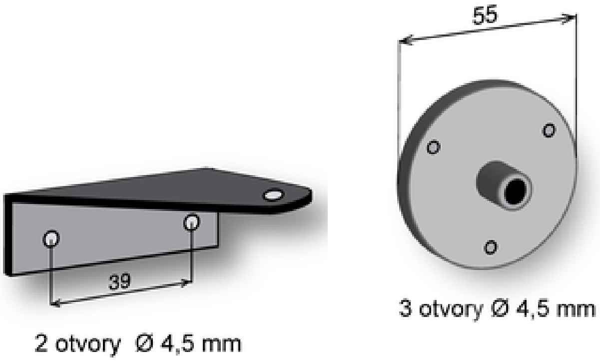
Fig. 10.4.4.1 An example of wiring the C-IT-0100H-P sensor

Measurement range	-30 ÷ +250ºC
Accuracy class	B in accordance with IEC 751
Level of protection	IP 54 (ČSN EN 60529)
Relative humidity	< 84%
Ambient temperature	-25 ÷ +80ºC
Stem	stainless, DIN 1.4301, Ø = 6mm, the sleeve length L2: see the table
Head	material Al, dimensions: 74 x 66 x 39mm
Gland	the cable diameter 5 ÷ 7mm



Terminal block	maximum 1mm^2 wires on the terminal

L2 (mm)	Order number	Order number
	The C-IT-0100H-A module	Immersion sleeve
100	TXN 133 17.01	TXP 300 11
160	TXN 133 17.02	TXP 300 12
220	TXN 133 17.03	TXP 300 13
280	TXN 133 17.04	TXP 300 14
340	TXN 133 17.05	TXP 300 15

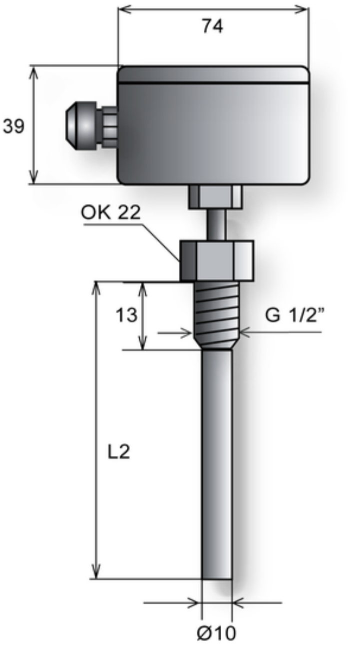


The side and the central holders of the C-IT-A-0100H-A sensor stem

10.4.5 Measuring water temperature in piping, the Pt1000, P13PA sensor with an immersion sleeve

The temperature of liquid flowing in the piping is measured by a temperature sensor with a stem in a stainless steel sleeve fitted in the piping; there is available a contact sensor fitted with the Pt1000, P13PA-x sensor (x - the sleeve length), which should be connected to the analogue inputs of the system. The terminal block is placed in a plastic head with a terminal block, the metal measuring stem is made of stainless steel, class DIN 1.4301. The delivery of the sensor includes the stainless steel sleeve with a G1/2" screw thread. The standard version of the module is designed for a maximum temperature of 150ºC, the stem is about 20mm longer than the sleeve. The sensors with the stems extended by 60mm can also be used for temperatures up to 250ºC (see the table with the order numbers, the "Design up to 250ºC"). The sensors are used in a standard environment, where they are not exposed to aggressive chemicals.

Measurement range	-30 ÷ +150 ºC (the extended design -30 ÷ +250ºC)
Accuracy class	B in accordance with IEC 751
Isolation resistance	> 100MΩ at 25ºC (500VDC)
Level of protection	IP 65 (ČSN EN 60529)
Relative humidity	< 95%
Ambient temperature	-30 ÷ +80ºC
Stem	stainless, DIN 1.4301, Ø = 6mm, the length of the immersion pocket L2: see the table
Head	made of polycarbonate, grey dimensions: 74 x 66 x 39mm



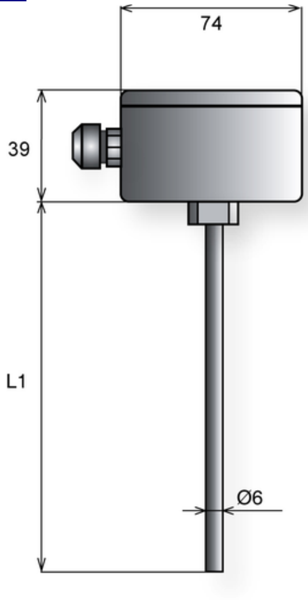
Gland	PG9, the cable diameter 4 ÷ 8mm
Terminal block	the wire cross-section 0.35 ÷ 2.5mm²

L2 (mm)	Order number	Order number
	The design up to 150 °C	The design up to 250 °C
100	P13PA150-100	P13PA250-100
160	P13PA150-160	P13PA250-160
220	P13PA150-220	P13PA250-220
280	P13PA150-280	P13PA250-280
340	P13PA150-340	P13PA250-340

10.4.6 Measuring air temperature in the air ducts, the CFox, C-IT-0100H-P sensor with a stem

The temperature of flowing air and other gaseous media, e.g. in air ducts and ventilation systems, is measured by temperature sensors with stems mounted in the duct;there is available the CFox C-IT-P-0100H-P module, order number TXN 133 16.0x (x - the stem length). The module is placed in a plastic head with a terminal block for the connection of the CIB bus; the metal measuring stem is made of stainless steel, class DIN 1.4301. The module includes a central plastic holder used for mounting the module on the wall of the air duct. The modules are used in a standard environment, where they are not exposed to aggressive chemicals. The central TXP 300 03 holder needed for mounting the module must be ordered separately. The wiring example is identical with that of the C-IT-0100H-P outdoor sensor.

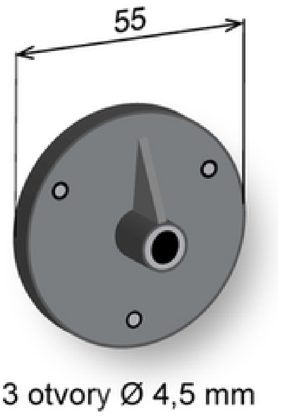
Measurement range	-30 ÷ +250ºC
Isolation resistance	> 100MΩ at 25ºC (500VDC)
Level of protection	IP 65 (ČSN EN 60529)
Relative humidity	< 95%
Ambient temperature	-25 ÷ +80ºC
Stem	stainless, DIN 1.4301, Ø = 6mm, the stem length L1: see the table
Head	polycarbonate, dimensions: 74 x 66 x 39mm
Gland	PG9, the cable diameter 4 ÷ 8mm
Terminal block	maximum 1mm^2 wires on the terminal



The stem lengths:

L1 (mm)	Order number
120	TXN 133 16.01
180	TXN 133 16.02
240	TXN 133 16.03
300	TXN 133 16.04
360	TXN 133 16.05

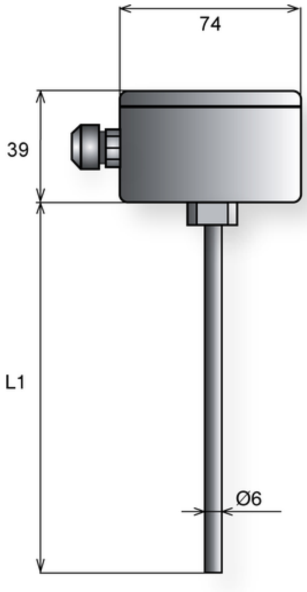
The central holder TXP 300 03 of the C-IT-0100H-P sensor



10.4.7 Measuring air temperature in HVAC air ducts, the Pt1000, P12PA sensor with a stem

The temperature of flowing air and other gaseous media, e.g. in air ducts and ventilation systems, is measured by temperature sensors with stems mounted in the duct; there is available a contact sensor fitted with the sensors Pt1000, P12PA-length, which should be connected to the analogue inputs of the system. The sensor is placed in a plastic head with a terminal block, the metal measuring stem is made of stainless steel, class DIN 1.4301. The sensor includes a central plastic holder (see the TXP 300 03 holder) used for mounting the sensor on the wall of the air duct. The sensors are used in a standard environment, where they are not exposed to aggressive chemicals.

Measurement range	-30 ÷ +250ºC
Accuracy class	B in accordance with IEC 751
Isolation resistance	> 100MΩ at 25ºC (500VDC)
Level of protection	IP 65 (ČSN EN 60529)
Relative humidity	< 95%
Ambient temperature	-30 ÷ +80ºC
Stem	stainless, DIN 1.4301, Ø = 6mm, the stem length L1: see the table
Head	made of polycarbonate, grey dimensions: 74 x 66 x 39mm
Gland	PG9, the cable diameter 4 ÷ 8mm
Terminal block	the wire cross-section 0.35 ÷ 2.5mm²



L1 (mm)	Order number
120	P12PA-120
180	P12PA-180
240	P12PA-240
300	P12PA-300
360	P12PA-360

10.4.8 Measuring high temperatures up to 1,100°C, TC, C-IT-0200

Flue gas temperature in boilers and in other applications in the high temperature measurement field can be measured by temperature sensors fitted with thermocouple probes.
Thermocouples can be measured by the C-IT-0200I module (see the example below),
or you can use the analogue input module IT-1602 (a peripheral Foxtrot system module on TCL2 bus),
or if less precision is needed (e.g. flue gas temperature in the boiler), you can use the analogue inputs of the basic module CP-10x8; for more information see the documentation [4].

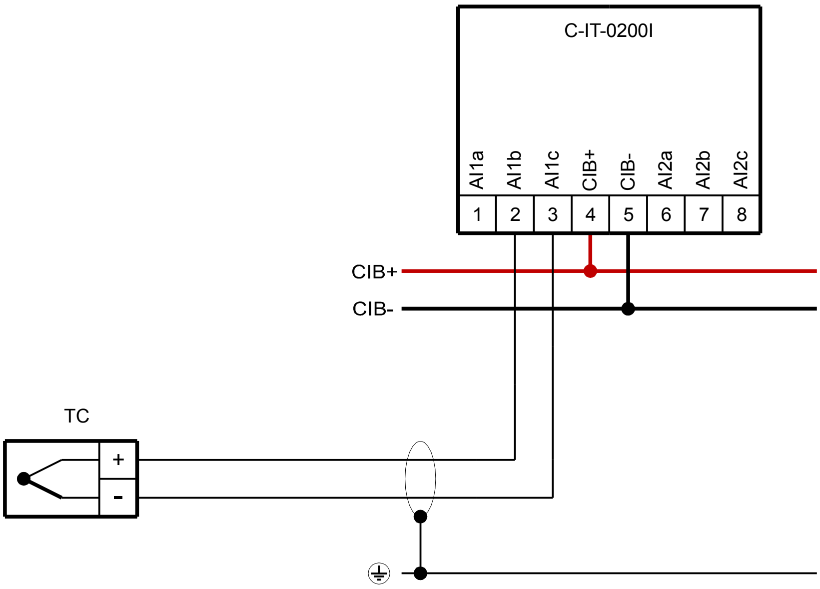


Fig. 10.4.8.1 An example of connecting the C-IT-0200I module, the connection by a thermocouple temperature sensor

Notes:

1) The thermocouple sensor should be connected directly to the C-IT-0200I module terminals via the compensation wiring. The thermocouple cold junction compensation is addressed by using an internal temperature sensor. .

10.5 Measuring radiant heat

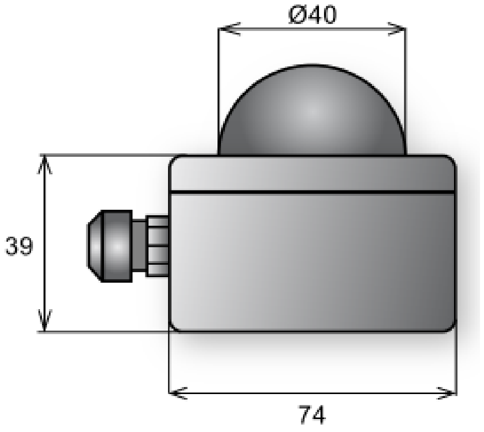
Regarding the regulation of radiant heat sources (infrared electric heaters, gas heaters, etc.), it is possible to use a temperature sensor with a simple design, which is mainly sensitive to the radiation component of the heat sources.

10.5.1 Measuring radiant heat in large halls (industrial heating)

The P30PA resistance sensors of radiant heat are designed to detect and measure the radiant component of heat in larger rooms and halls with a dry environment. The sensors capture the efficient radiant heat component in the monitored space. Good measurement results are only achieved thanks to using black hemispherical sensors. The sensor head is made of plastic material (polycarbonate); it has a terminal block inside for connecting sensors to the system analogue input; the standard analogue inputs used for the measurement should have the range suitable for the Pt1000 (RTD) sensor.

Basic parameters

Resistance at 0 °C	1000Ω
Temperature coefficient	3850 ppm/ °C
Precision class	B according to DIN 43760
The recommended measuring current	0.1mA
Maximum measuring current	1mA
The operating temperature range	-30 ÷ 80 °C
The range of the storage temperatures	-30 ÷ 80 °C
Relative humidity	< 90% without condensation
Protection	IP65
The cross-section of the connecting wires	Maximum 1.5mm^2
Gland /Ø cable	PG9 / 4 ÷ 8mm



Notes:

1. The sensor must be placed is such a way, that the hemispherical surface faces the source of radiant heat, around the place where you want to maintain the desired temperature.
2. The sensor can be connected to any analogue system input that enables measuring the Pt1000 sensor. The electrical connection of temperature sensors is shown in the examples of connection of a number of peripheral modules, such as connecting the Pt1000 sensor to the AI1 and AI2 inputs of the C-IR-0203M module.

10.6 Connecting 1-wire sensors

Easy integration of special-purpose circuits manufactured by Dallas, which communicate over 1-Wire bus, can be done using the TUDS-40 MOD unit, supplied by Firvena; it processes independently communication from the DALLAS sensors on its two data 1-Wire lines, and then sends the information forward to the Foxtrot system via a standard communication interface RS -485 with MODBUS RTU protocol. There is available a library for the Mosaic environment, which makes easy installation possible as well as the operation of the connected sensors. For detailed information on how to use the unit, how to configure it, and support for the Foxtrot system and information on the peripheries, see the website www.modbusto1wire.cz.

On each of the 1-Wire lines it can serve up to 20 sensors (in total 40).
For simple and easy reading/deleting of the addresses of temperature sensors, the unit is equipped with a two-digit LED display and control buttons. Programming the sensors can also be done by a PC with the RS-485 converter.
The LED indicators on the front panel indicate feeding of the device and the presence of a temperature sensor for each line separately.

1-Wire bus is easy to install. . It is recommended to use shielded twisted pair (FTP) type Cat 5e, Cat 6 or Cat 7 for cabling. The sensors can best be connected via terminal boards that include line balancing circuits (the line is then resistant to interference) and disconnecting jumper for easy programming of the sensors to the transmitter.

Reliable operation of the TUDS-40-MOD device will be secured by using recommended temperature sensors, which have been tested by the manufacturer; they contain a connectable terminal with electrical circuits, which provides protection and balance of the line. The DALLAS temperature sensor has a code set by the manufacturer, on whose basis it communicates with the TUDS-40- MOD unit.

Basic parameters of the TUDS-40 MOD module

Supply voltage	24V AC/DC ±10%
internal combustion of the device	2W
indication	yes, LED display
Interface to the system	RS-485
protocol	MODBUS RTU, slave, supported functions 03
communication speed	optional 9.6 kBd, 19.2 kBd, 38.4 kBd, 76.8 kBd
address	0 ÷ 247
parity	No
stopbit	2 (the device responds even to one stopbit)
Galvanic isolation of power supply from	yes
iCommunication to the sensors	type 1-Wire (DALLAS)
the number of sensors on one bus	20
the number of buses (lines)	2
Galvanic isolation of power supply from	yes
indication of the buses state (lines)	yes, LED display

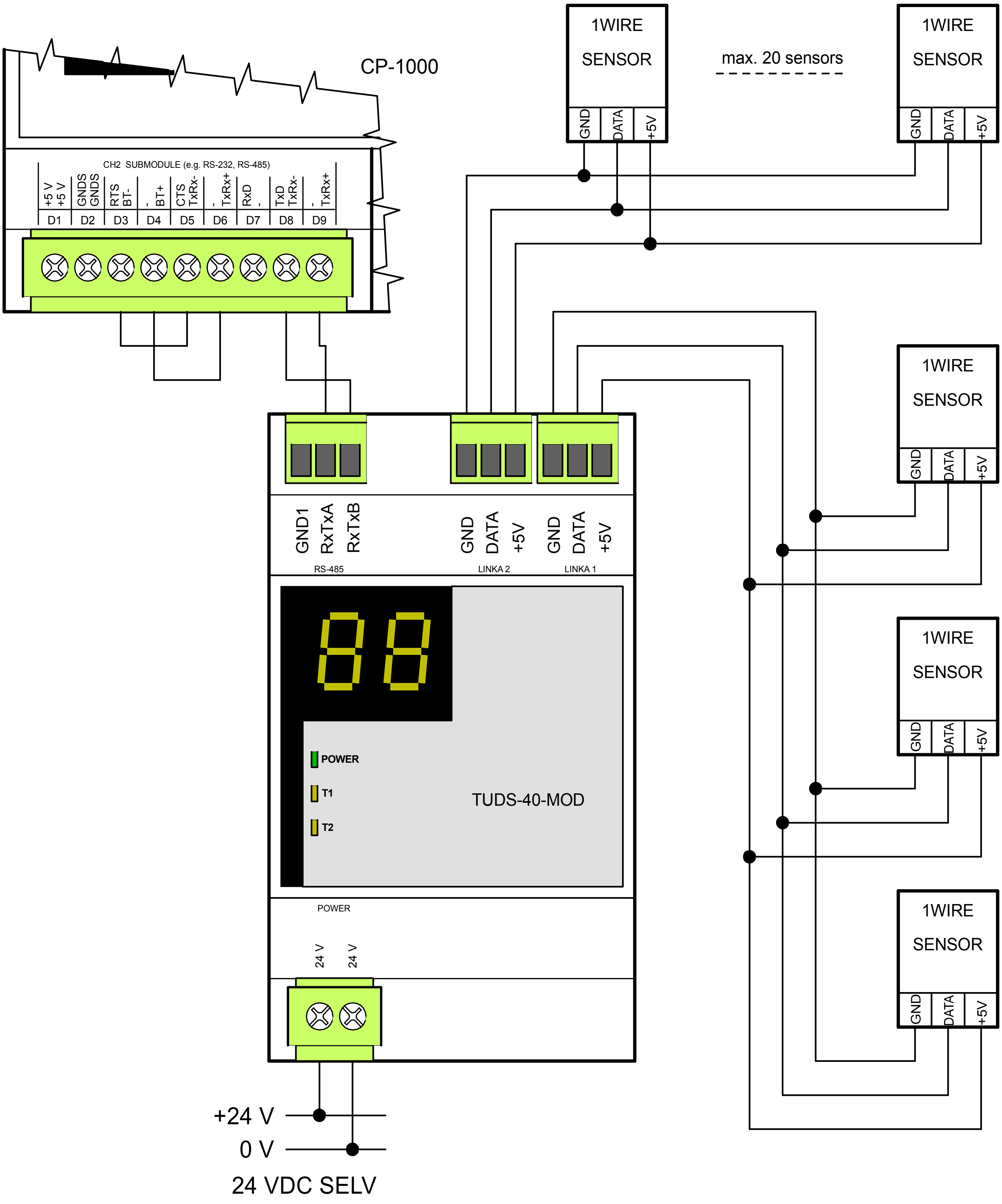


Fig. 10.6.1 The basic example of connecting theTUDS-40 MOD unit

Notes:

1. Each 1-Wire bus (Line 1, Line 2) can only have 20 sensors connected to it; the wiring must be a strict line without any branches (the branches in the diagram only illustrate the interconnection).
2. Maximum length of each line is around 300m
3. recommended cable - shielded FTP
4. The polarity of the 24VDC supply voltage is arbitrary, the module can also be powered from a 24VAC source.

11 Metering energies and non-electrical phenomena

The table of contents of the chapter

11.1 Metering electrical energy

Electrical energy or the grid current is metered for various reasons:

- consumption of various technologies (heat pumps, heating water, etc.)
- monitoring maximum power (not to exceed max. current of the circuit breaker)
- regulation of the PVPS internal consumption

In the following examples we consider secondary measurement (not for billing). The electricity meter at the entrance to the building (a property of the distribution companies) is equipped with a communication interface, but it is sealed and we do not consider using it.

Metering the consumption of 1ph devices (the heat pump compressor) and calculating the instantaneous current (for visual information and easier control according to the current - load isolating, etc.); it is recommended to use a 1ph electricity meter with a pulse output 9901M, or ED11.M.

In **metering the consumption of 1ph devices**, you can also use the ED 110 electricity meter with an optical interface; the values (power, voltage, current) are read by the TXN 149 01 optical head; the electricity meter is a two-tariff device, so the power is read separately for each tariff. The pulse output S0 can also be used in the ED 110 electricity meter.

In **metering the generation and consumption of 1ph electrical energy** (photovoltaic power plants, the wind power station for the owner's own consumption, etc.), you can use the ED 110 electricity meter with an optical interface, and the values (the power of consumption and supplies for two tariffs, voltage, current), are read by the TXN 149 01 optical head.

Metering the consumption of 3ph devices (in the household) and calculating the instantaneous current (for visual information and easier control according to the current - load isolating, etc.) can utilize the 9901M 1ph electricity meter for each phase separately; a disadvantage is the need for three pulse inputs, and an advantage is the availability of information about each phase and a good price.

Metering the consumption of 3ph devices can also be done by the three-phase electricity meter with an S0 pulse output, the ED 310 type (for currents up to 63A with direct measurement, for higher currents there is the 310I ED variant with indirect measurement); only one pulse input is needed, but there is no separate information about the consumption of each phase; or the optical interface can be used, and the values (power, voltage, current) are read by the TXN 149 01 optical head; the electricity meter is usually at least for two tariffs (the ED 310 can manage up to four tariiffs), so the power for each tariff can be read separately. The RS485 communication interface or the M-bus can also be used for communication.

Metering the generation and consumption of 3ph power (PVPS, wind power for the user's own consumption, etc.) can be done by the ED 310 three-phase electricity meter with direct measurement (for currents up to 63A), or the ED 310I with indirect measurement (for higher currents); an optical interface is used, and the values (power consumption and generation, the voltage, the current), are read by the TXN 149 01 optical head; the electricity meter ED 310 is for up to four tariffs, so the power for each tariff can be read separately. Alternatively, the RS485 interface or the M-bus can be used for communication.

Detailed measurement of 3ph network can be done by the SMM33 module, which is designed to measure and monitor line and phase voltages, currents, active and reactive power, the power factor, THD voltages and currents and frequencies in single-phase and three-phase low voltage networks.

Metering the supply and consumption of DC electrical energy (MVE, PVPS) can be done by the DC meter VMU-E, which allows measuring voltages up to 400 VDC and currents up to 1,000 ADC. The electricity meter is connected to the RS485 interface of the Foxtrot basic module via the VMU-X communication module.

11.1.1 Metering the consumption of 1ph network, the 9901M and ED11.M electricity meter, measuring the S0 pulses

Metering the consumed energy (e.g. by the monitoring of the heat pump consumption) can be done by electricity meters with the S0 output; we deliver the 9901M electricity meter, and the ED11.M meter can also be used for some applications. The primary function of the C-AM-0600I modules is to connect the S0 electricity meters with a pulse output, in accordance with IEC 62053 it is class A (for more information on the S0, see the end of this chapter). The electricity meters that comply with the class B can be connected e.g. directly to the CP-1008 inputs.
The SW function block enables you to get the total energy consumed and the calculated instantaneous power and current (assuming a constant 230VAC voltage).

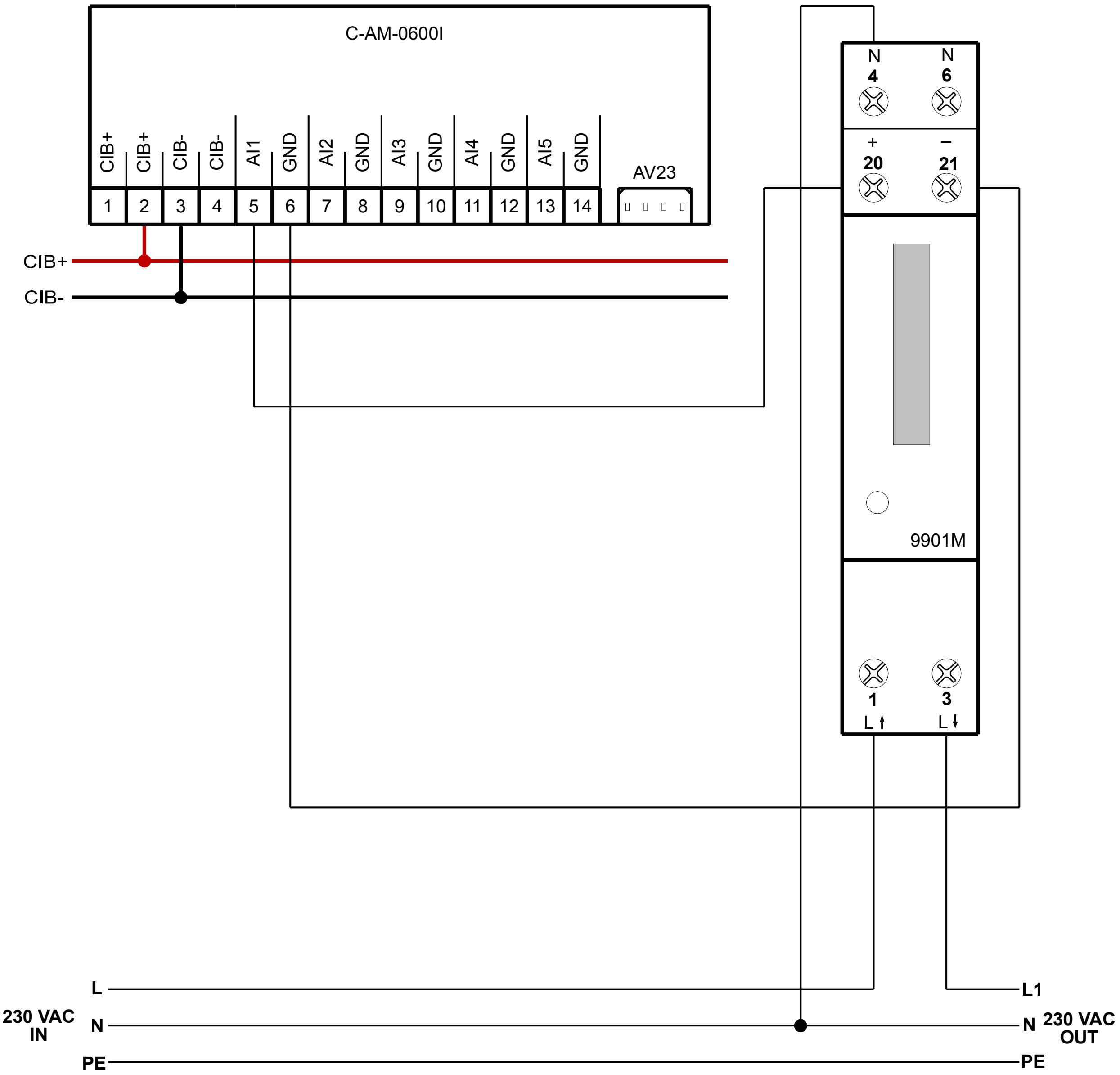


Fig. 11.1.1.1 An example of wiring the 9901M electricity meter to the C-AM-0600I module

Notes:

1) The grid voltage input is connected to terminal 1, the output (with measured consumption) to terminal 3. The outside wire N is connected to terminal 4 or 6 (the terminals are connected internally), or the N wire can be lead through the meter ("V" connection).
2) For detailed parameters of 9901M, see the following text and the table.
3) In order to connect the electricity meter S0 output, a standard cable can be used, min. 2x 0.5mm, e.g. the SYKFY 2x2x0.5, with a maximum cable length 100m.

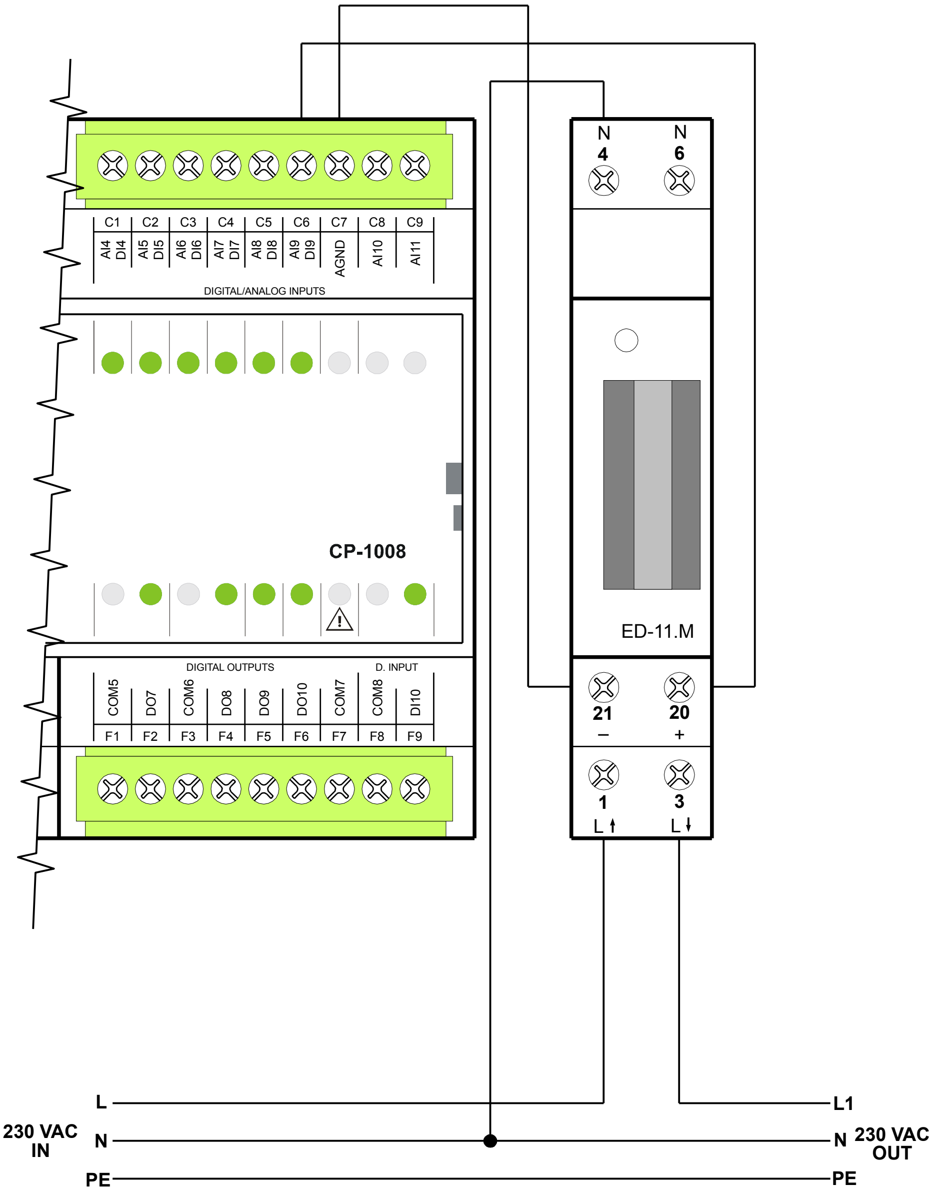


Fig. 11.1.1.2 An example of connection the ED11.M electricity meter to the CP-1008 basic module

Notes:

4) The grid voltage input is connected to terminal 1, the output (with measured consumption) to terminal 3. The outside wire N is connected to terminal 4 or 6 (the terminals are connected internally), or the N wire can be lead through the meter ("V" connection).
5) For detailed parameters of ED11.M, see the following text and the table.
6) In order to connect the electricity meter S0 output, a standard cable can be used, min. 2x 0.5mm, e.g. the SYKFY 2x2x0.5, with a maximum cable length 100m.

The properties and parameters of the 9901M electricity meter

The 9901M electricity meter is an electronic meter for monitoring the power consumption in the area of small-scale customers; its size is similar to a circuit-breaker module.
It is a single-phase static single-tariff electricity meter for active energy in the accuracy class 1, which is designed for direct connection. It is designed for sub-metering of consumption up to 45A without official verification. The mechanical counter displays the measured values in the kWh units with 5 whole and one decimal digit (a total of 6 digits).
The 9901M electricity meter measures in the range from 25mA inrush current up to 45 A.
The electricity meter is equipped with an S0 interface in accordance with IEC 61393/DIN 43864. The circuit is galvanically isolated and transmits impulses with frequency that corresponds with the power consumed.
The design allows an easy installation on a DIN rail.

Basic parameters of the 9901M electricity meter

Connection		direct two-wire
Internal consumption		maximum 0.4W
The range of the measured current		25mA ÷ 45A
Nominal voltage U_n		230VAC ±30%
Pulse output:		
	The number of pulses	1,000imp./1kWh
	Nominal supply voltage	12 ÷20VDC
Operating temperature range		-20 ÷ 50 °C
Maximum cross-section of the connected wire		$6mm^2$
The terminal bolt head		4.5mm combined groove
The torque of screw terminals		2 ÷ 5Nm
The module dimensions (width x height x depth)		18 x 90 x 58mm (1M)

The properties and parameters of the ED11.M electricity meter

The ED11.M electricity meter is an electronic meter for monitoring the consumption of electric power supplied to retail customers; the size is similar to a circuit breaker.
It is a single-phase static single-tariff electricity meter for active energy in the accuracy class 1, in accordance with the ČSN EN 61036 standard, it is designed for direct connection. It is designed for sub-metering of consumption up to 25A without a possibility of official verification. The mechanical counter displays the measured values in the kWh units with 5 whole and one decimal digit (a total of 6 digits).
The ED11.M electricity meter measures in the range from a 20mA inrush current up to 25A, with a sufficient margin in accordance with the standards.
The electricity meter is equipped with an S0 interface in accordance with IEC 61393/DIN 43864. The circuit is galvanically isolated by an optocoupler, to whose output a transistor with an open collector is connected; it emits pulses with a frequency that corresponds to the energy consumed.
The design allows an easy installation on a DIN rail.

Basic parameters of the ED11.M electricity meter

Connection	direct two-wire
Internal consumption	maximum 0.5VA
The range of the measured current	20mA ÷ 25A
Nominal voltage U_n	230VAC

The operating voltage range		0.85 U_n ÷ 1.1 U_n
Pulse output:		
	The number of pulses	1600imp./1kWh
	Nominal supply voltage	18 ÷27VDC
Operating temperature range		-20 ÷ 55 °C
Maximum cross-section of the connected wire - a string		4mm^2
Maximum cross-section of the connected wire - a wire		4mm^2
Minimum cross-section of the connected wire		1mm^2
The terminal bolt head		4.7mm combined groove
The torque of screw terminals		0.5Nm
The module dimensions (width x height x depth)		18 x 88 x 58mm (1M)

The S0 pulse output

In accordance with the IEC 61393/DIN 43 864 standard, the electricity meter output signal provides the information about consumption; one pulse corresponds to a certain amount of active electrical energy measured by the meter. Most electricity meters generate from 500 to 10,000 pulses/1kWh (this value is entered into the function block in the programming environment).

The output in electricity meters is usually designed with a semiconductor switching element (the passive output), the output is measured by the system input powered typically by 24VDC voltage; some outputs can be supplied with as little as 8VDC, a maximum voltage is about 20 ÷ 30VDC (a maximum current is usually no more than 30mA).
N.B.: Some electricity meters meet the specifications for S0, class A (e.g. the 9901M) and they can be connected e.g. to the C-AM-0600I module; these meters can also be connected to standard binary 24V inputs (e.g. the IB-1301 peripheral module), but some electricity meters have a limited range of voltage and current in the S0 output switched-on mode - such as the ED11.M electricity meter. These electricity meters can be connected directly to the binary inputs of the basic modules CP-1008 and CP-1006 (see the example above), but they cannot be connected to the inputs with the 24V (IB-1301), or the S0 inputs in Class A (C-AM-0600I).

The S0 output terminals in the electricity meters are usually numbered 20 and 21.

The polarity of the output must be observed, and some electricity meters have on the terminal 20 the negative pole, some have the positive pole (see e.g. the ED11.M meter).

11.1.2 Connecting an electricity meter via the TXN 149 01 optical head

The TXN 149 01 optical interface probe (also called an optical head) is designed to read data and to communicate with the electricity meter, the ripple control receiver and other devices. The probe converts optical signals into signals of the serial interface RS-232 (RxD and TxD). Its main purpose is to facilitate communication with electricity meters, ripple control receivers or other devices equipped with an optical interface in accordance with the EN 62056-21 standard. The probe contains a galvanically isolated optoelectronic transmitter and receiver.

The probe contains a built-in toroidal magnet, which facilitates its removable attachment on the surface of any device, and also allows its centring in the place of the optical interface. It is to be connected to the serial interface of the Foxtrot basic module via a cable terminated with separate wires.

The probe of the optical interface is to be connected to the screw terminals of the RS-232 interface of the Tecomat Foxtrot basic module. For more information about the Foxtrot communication channels, see the documentation [4].

Signals on the wires of the TXN 149 01 probe:

The colour of the wire	Signal
green	RxD
red	TxD
white	+24V
blue	GND

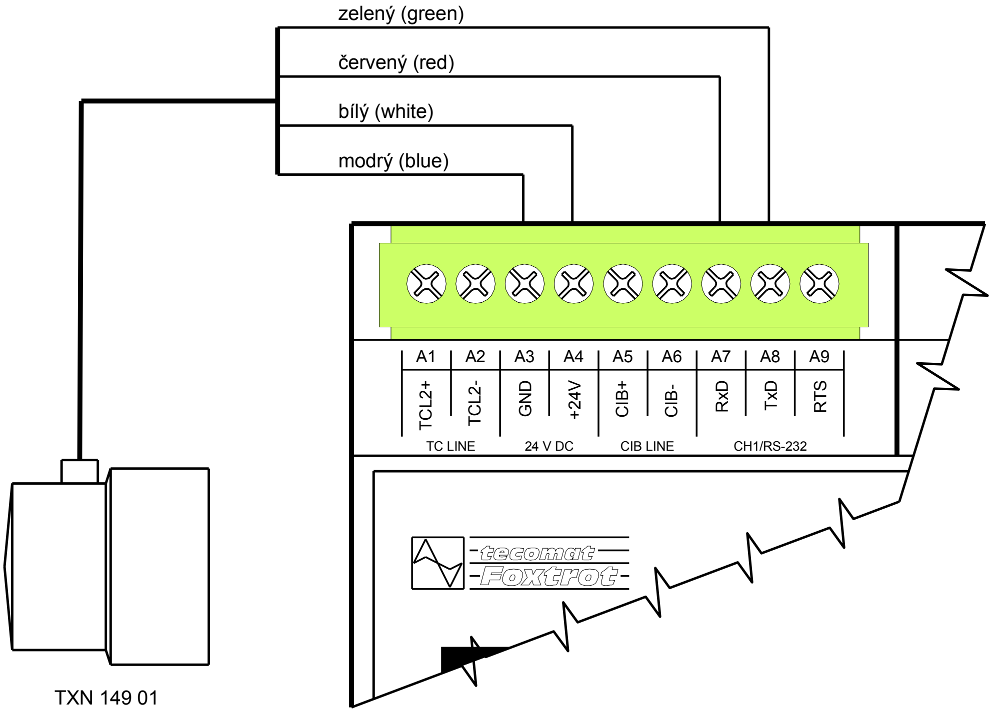


Fig. 11.1.2.1 An example of connection of the TXN 149 01 probe to the CP-10x6 (or CP-10x4, 10x5, 10x8)

Notes:

1) The connection cable length is about 140cm, the colour-coded pins are terminated with sleeves.
2) The probe requires a 24VDC supply voltage, -15% + 25%, the power input about 0.15W.
3) Orientation of the toroidal magnet on the probe: the north should be on the side of the device to be connected.

4) The probe height is 32mm

11.1.3 Metering the generation and consumption of 1ph network, the ED 110 electricity meter

For measuring the consumed energy (e.g. monitoring the consumption of the heat pump) or for sub-metering of generation (supply) and consumption of 1ph electrical energy, we recommend the ED 110 electricity meter (order number ED 110.D0.14E302) with direct measurement up to 32A.

All data (for detailed information about the electricity meter, see further in this chapter) can be read from the meter by using the TXN 149 01 optical probe.

Metering only the consumed energy (e.g. by the monitoring of the heat pump consumption) can be done via the S0 output. Connecting the electricity meter with the S0 pulse output is primarily done by the C-AM-0600I modules. The SW function block enables you to obtain the total consumed energy and calculated instantaneous power input and current (assuming a 230VAC constant voltage).

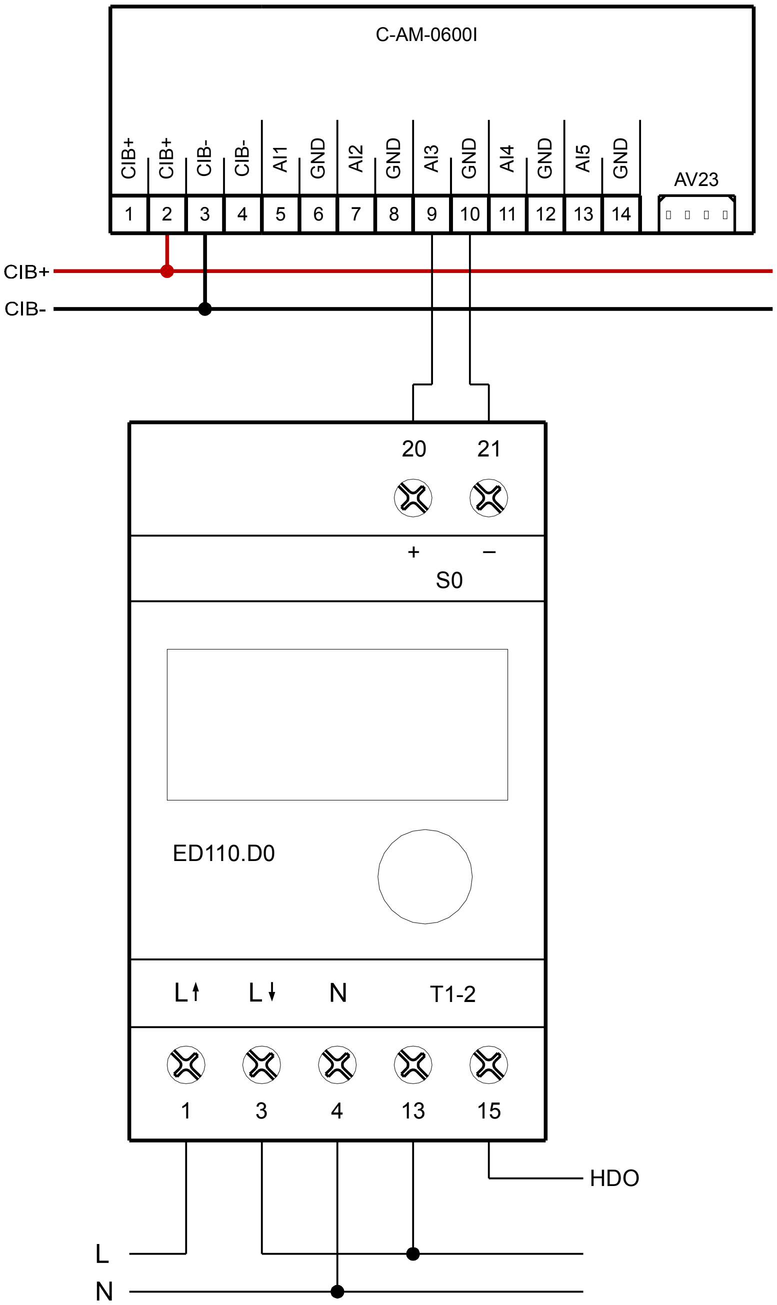


Fig. 11.1.3.1 An example of connecting the C-AM-0600I module and the ED 110.D0 electricity meter

The properties and parameters of the electricity meter ED 110

The ED 110.D0 electricity meter is a single-phase static double-tariff electricity meter for active energy in the class A or B in accordance with the ČSN EN 50470-1 and 50470-3 standards, designed for direct connection. It does not have a galvanically isolated voltage and current circuit. The measuring system allows measurements even in the presence of DC and harmonic elements in the measured circuit (the voltage and current) over the measurement range of the meter. The negative effects of DC components are eliminated in each measuring period. The electricity meter measures and saves these basic values (and if necessary, displays them on the screen):

- The consumption and supply for each of the two tariffs (i.e. 4 energy registers).
- The reading time in each register of consumption and supply (i.e. 4 time registers).
- Total sums registers for the total consumption time and total supply time.
- Maximum current and maximum power.
- Operating time, the number of network outages, time after resetting the maximum current and power.
- Instantaneous effective voltage.
- Instantaneous effective current
- Instantaneous power
- cos φ

Electricity meters have an optional optical infrared communication interface, in accordance with the ČSN EN 62056-21 standard.

Basic parameters of the electricity meter ED 110

Connection		direct two-wire
Own consumption (voltage circuits incl. power supply)		maximum 0.7W, maximum 8VA cap.
The current circuit internal consumption		maximum 0.05VA
Inrush current Ist		less than 15mA
Minimum current Imin		200mA
Reference current Iref		5A
Maximum current Imax		continuous 32A
Maximum range of the measured current		15mA ÷ 40A
Nominal voltage U_n		230VAC
The operating voltage range		$0.75\ U_n \div 1.15\ U_n$
Pulse output S0		class A acc. to ČSN EN 62053-31
	The number of pulses	programmable from 0.15 to 10,000 imp./1kWh
	Nominal supply voltage	24VDC
	Maximum supply voltage	30 VDC
Operating temperature range		-25 ÷ 55°C
Maximum cross-section of the connected wire - a string		$4mm^2$
Maximum cross-section of the connected wire - a wire		$4mm^2$
Minimum cross-section of the connected wire		$1mm^2$
The terminal bolt head		4.7mm combined groove
The torque of screw terminals		0.5Nm
The module dimensions (width x height x depth)		53 x 90 x 58mm (3M)

11.1.4 Metering the generation and consumption of 3ph network, the ED 310.DR electricity meter, the RS485 interface

We recommend the ED 310.DR (order number ED 310.DR.14E304-00) with direct measurement up to 60A for the measurement of secondary generation (supply) and consumption of 3ph electrical energy.
The electricity meter can measure: the consumption and supply of active energy in kWh for the rates T1 to T4, RMS current, RMS voltage, instantaneous power, maximum current, maximum power, the power factor, the number of outages of voltage and information on the statuses: the active tariff (in which the electricity meter reads the consumption or supply) and the actual direction of the current (consumption/supply). All data can be read from the electricity meter using the TXN 149 01 optical probe, or the RS485 communication line.
The following figure (on the next page) shows the connection of electricity meter ED 310.DR to the CH2 communication channel of the Foxtrot basic module. The next part of the chapter contains detailed information on the actual electricity meter.

Notes (referring to the figure):

1) The RS485 communication interface is terminated on two RJ-45 connectors. Both RJ-45 connectors are equal (internally connected). The description of the connector signals is shown in the table.
2) The RS485 interface is galvanically isolated from other parts of the meter (4kV/50Hz/60s) and it is therefore necessary to supply the communication part from an external source. The power is also terminated on the RJ-45 connector; the supply polarity is irrelevant. N.B.: The interface power supply is electrically connected with the RS485 communication interface, so a separate power supply (24VDC) must be used, or a galvanically isolated interface on the side of the Foxtrot system.
3) The wiring in the figure (with no bus termination on the meter side) can only utilize a cable between the Foxtrot CH2 and the meter, which is no longer than 2 meters (ideally less than 1m). A standard patch cable (preferably shielded FTP, also unshielded UTP) can be used for the connection; one end of the cable should be inserted into the connector of the electricity meter, the second should be nipped off and the wires should be connected as illustrated (see the table for the description of the connector and colours of the wires in standard UTP/FTP cables).
4) If you need a longer cable, then (on the side of the meter - if there are several, it should be the last one) a 120Ω resistor must be connected between the signals Rx/TX+ and Rx/Tx-, as close as possible to the meter. The resistor can be connected e.g. to the nipped-off end of the UTP cable and inserted in the other connector on the electricity meter.
5) The figure shows the termination of the S0 output (terminals 11 and 12).
6) The selection of tariff - (there are up to four tariffs) - is controlled by the terminal 1 and 2 against terminal 3.

The layout of RS485 interface signals on the RJ-45 connectors.

Pin of the RJ-45 connector	Signal	The colours of wires in a standard UTP patch cable (acc. to T568B)
1	The power supply input (e.g. +24V - the supply polarity is irrelevant); the power supply of the RS485 interface circuits, the pins are internally connected.	**white/orange**
2		**orange**
3		**white/green**
4	Rx/Tx +	**blue**
5	Rx/Tx -	**white/blue**
6	The power supply input (e.g. 0V - the supply polarity is irrelevant); the	**green**
7		**white/brown**

8	power supply of the RS485 interface circuits, the pins are internally	**brown**
Shielding	When the FTP cable is used, the braid should be connected to the PE terminal PE in the control panel.	

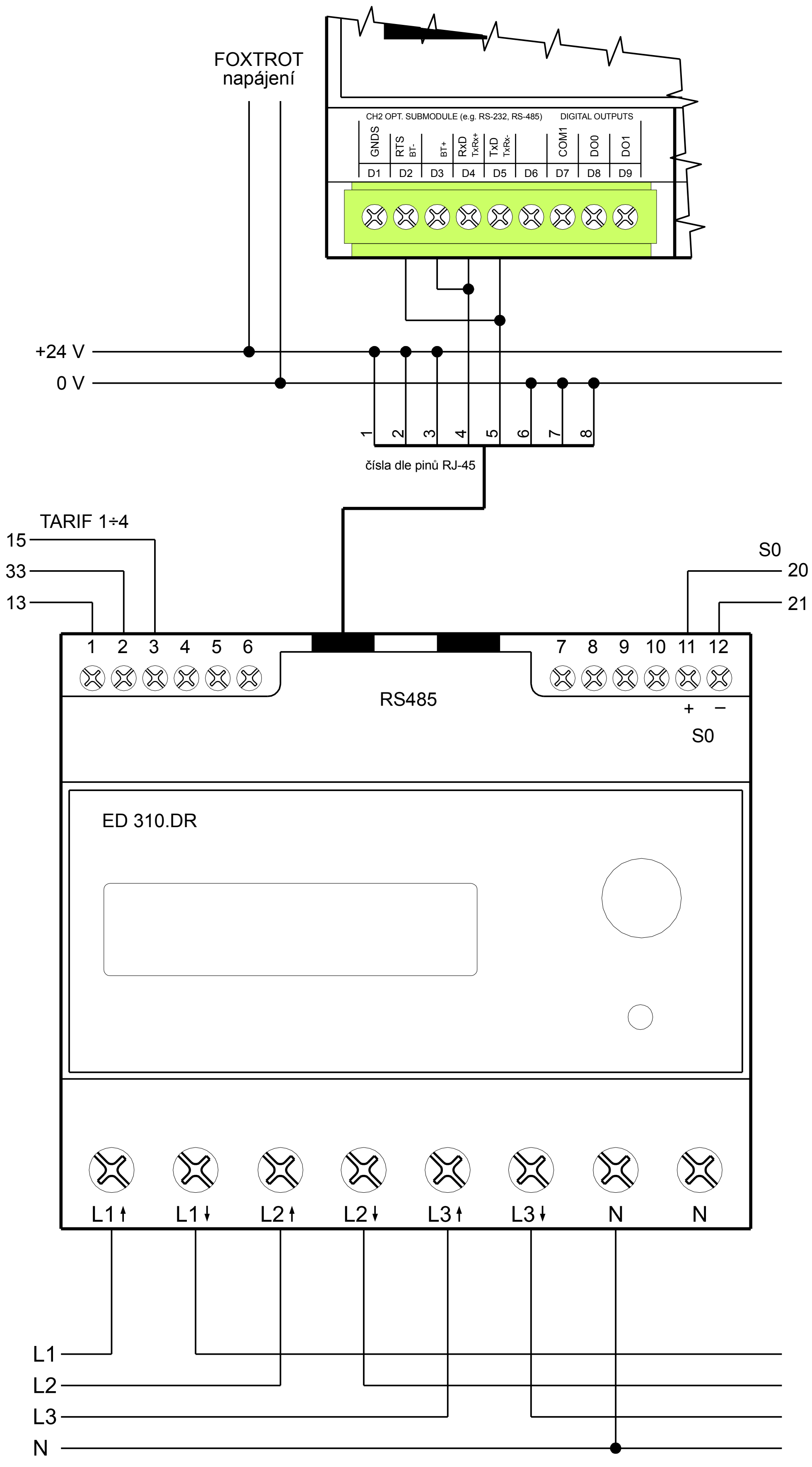


Fig. 11.1.4.1 An example of connecting the ED 310 k CH2 CP-10x6 (10x8) electricity meter

The properties and parameters of the electricity meter ED 310.DR

The ED 310 electricity meter is a three-phase static four-tariff meter of active energy, class A or B in accordance with the EN 50470-1 and 50470-3 standard, which is designed for direct (ED 310) and indirect (ED 310) connection.

The electricity meter measures and saves these basic values (and if necessary, displays them on the screen):

- The consumption and supply for each of the four tariffs (i.e. 8 energy registers).
- The reading time of consumption and supply for each register (i.e. 8 time registers).
- Total sums registers for the total consumption time and total supply time.
- Maximum current and maximum power.
- Operating time, the number of network outages, time after resetting the maximum current and power.
- Instantaneous effective voltage.
- Instantaneous effective current
- Instantaneous active power

The ED 310 electricity meters measure in the range from the inrush current up to 63A (ED 310.I to 7.5A) with a sufficient margin in accordance with the standard (the DC component and harmonics).

The ED 310 electricity meters are equipped with up to three external inputs for switching up to 4 tariffs. Switching tariffs is done by alternating voltage applied between the tariff meter terminals. Indication of the active tariff is displayed.

The electricity meter is equipped with the RS 485 interface. The interface is electrically isolated from the other parts of the meter (4kV/50Hz/60sec), and it is therefore necessary to power the communication part by an external source.

When the RS 485 bus is active, the meter optical interface is automatically disconnected.

Basic parameters of the electricity meter ED 310.DR

Connection		direct four-wire
Own consumption (voltage circuits incl. power supply)		maximum 0.7W, maximum 8VA cap.
The current circuit internal consumption		maximum 001VA
Inrush current I_{st}		less than 15mA
Minimum current I_{min}		200mA
Reference current I_{ref}		5 or 10A
Maximum current I_{max}		according to requirements from 40A up to 60 A
Maximum range of the measured current		15mA ÷ 63A
Nominal voltage U_n		230VAC
The operating voltage range		$0.75\ U_n \div 1.15\ U_n$
Pulse output S0		class A acc. to ČSN EN 62053-31
	The number of pulses	programmable from 0.15 to 10,000 imp./1kWh
	Nominal supply voltage	24VDC
	Maximum supply voltage	30 VDC
	Maximum current	15mA
The RS485 interface		galvanically isolated from the electricity meter and from the 230V grid
	The range of the interface supply voltage	12 ÷ 24VDC or 12 ÷ 18VAC
	Maximum consumption from the power source of supply voltage	50 mA
Operating temperature range		-25 ÷ 55 °C
Maximum cross-section of the connected wire - a string		$25mm^2$
Maximum cross-section of the connected wire - a wire		$16mm^2$

Minimum cross-section of the connected wire	x mm^2
The terminal bolt head	M5, Phillips countersunk, size 2
The torque of screw terminals	2 ÷ 3Nm
The module dimensions (width x height x depth)	107 x 91 x 72mm (6M)

11.1.5 The SMM33 module for measuring and analysis of 3ph network

In order to provide a detailed analysis of a 3ph network (measuring and monitoring the line and phase voltages, currents, active and reactive power, the power factor, THD voltages and currents and frequencies in the low-voltage network, etc.), you can use the SMM33 module connected to the communication channel of the Foxtrot basic module. For more information about the Foxtrot communication channels, see the documentation [4].

The SMM33 module is equipped with inputs for connecting three voltage signals of nominal value of up to 3 x 230V_{ef} and three fully isolated current inputs up to 5A_{ef}.

Supply voltage of the device must be connected to the AUX V terminals via a disconnecting device (a switch - see the example of connection.

It must be located right by the device and it must be easily accessible by the operator. The disconnecting element must be marked as such. A circuit breaker with a nominal value of 1A can be used as a disconnecting device, but its function and status must be clearly marked (by symbols "0" and "I" in accordance with the ČSN EN 61010-1).

The measured voltage should be secured e.g. by a 1A thermal fuse. The measured voltage can be connected via measuring voltage transformers.

The current signals of measuring current transformers with a nominal value of 5A or 1A must be brought to the terminal couples I1k, I1l, I2k, I2l, I3k, I3l; however, their orientation must be observed (terminals k, l).

The RS 485 communication line should be connected to terminals A, B and the shielding to the GND terminal. The endpoints of the communication line must be fitted with terminating resistors.

Basic technical parameters of the SMM33 module

Supply voltage	85 ÷ 275VAC/45 ÷ 450Hz, 80 ÷ 350VDC
Power consumption	3VA/3W
The over-voltage class and the degree of pollution	III/2 - accoring to ČSN EN 61010-1
Connection	galvanically isolated, the polarity is irrelevant
The measured voltage	(U_{nom} = 400/230VAC) 4 ÷ 500VAC/2.3 ÷ 285VAC (phase-to-phase/phase)
Voltage measurement accuracy	± 0.5% from the value ± 0>1% from the range ± 1 digit
Input impedance	660 kΩ (Li – N)
Connection	star pattern
Permanent overload (acc. to IEC 258)	2 x (i.e. 1,000/570V)
Peak overload	4 x for 1 second (i.e. 2,000/1,140V)
Frequency	45 ÷ 65 Hz
Frequency measurement accuracy	± 0,02 %
Measured current	0.02 ÷ 7 AAC (I_{nom} = 5 AAC);
Current measurement accuracy	± 0.5% from the value ± 0>1% from the range ± 1 digit
Connection	galvanically isolated
Permanent overload (IEC 258)	14 AAC
peak overload	70 AAC for 1 second
Communication port	RS 485 galvanically isolated, the Modbus-RTU protocol
Active power (P_{nom} = 230*I_{NOM} W)	the range is limited by the range of measured voltage and current
Measurement accuracy of active power	±2% ±1 digit
Reactive power (Q_{nom} = 230* I_{NOM} VA)	the range is limited by the range of measured voltage and current
Measurement accuracy of reactive power	±2% ±1 digit
The power factor P.F. (accuracy)	0.00 ÷ 1.00 ±2%;

Cos φ (accuracy)	-1.00 ÷ +1.00 L, C ±2%
THD (accuracy)	up to 25. order, 0 ÷ 200%, (±2% ±1 digit, pro U, I > 10% U_{NOM} ,I_{NOM})
Operating temperature	-25 to 60 °C
Maximum wire cross-section for the terminal	$2.5mm^2$

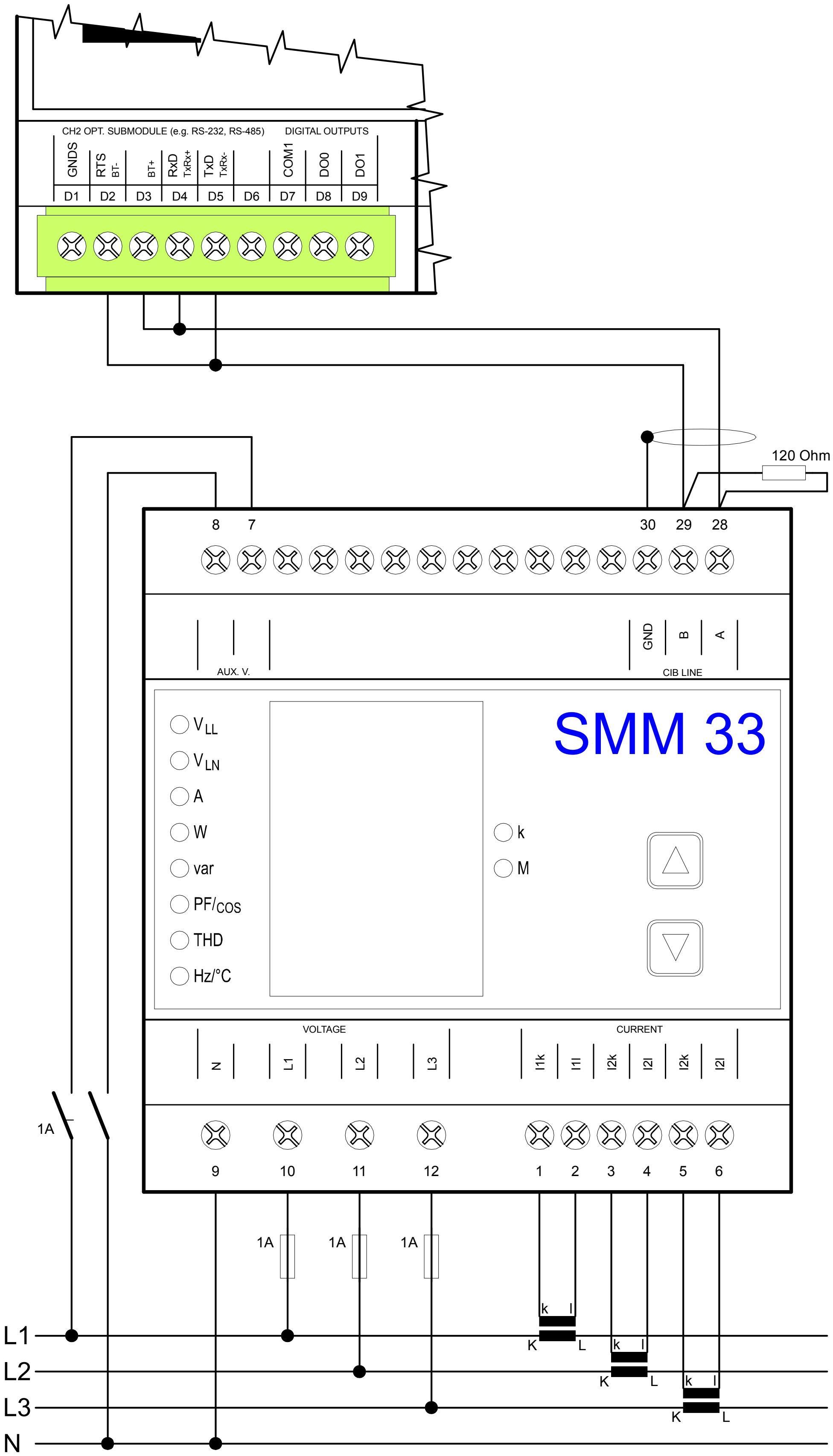


Fig. 11.1.5.1 An example of connecting the 3ph network analyzer SMM33 to CH2 CP-10x6 (10x8)

11.1.6 Metering DC voltage, current and power (PV power station etc.)

In applications with photovoltaic panels or a small wind turbine, it is sometimes necessary to meter a DC network - DC voltage, current and power. Measuring voltages up to 400 VDC and current up to 1,000 ADC is enabled by the VMU-E DC electricity meter. A basic example of the VMU-E electric meter connection with the VMU-X S1 supply and communication module with an external shunt, with a connection to the CH2 communication interface of the Foxtrot system is shown in the following figure.

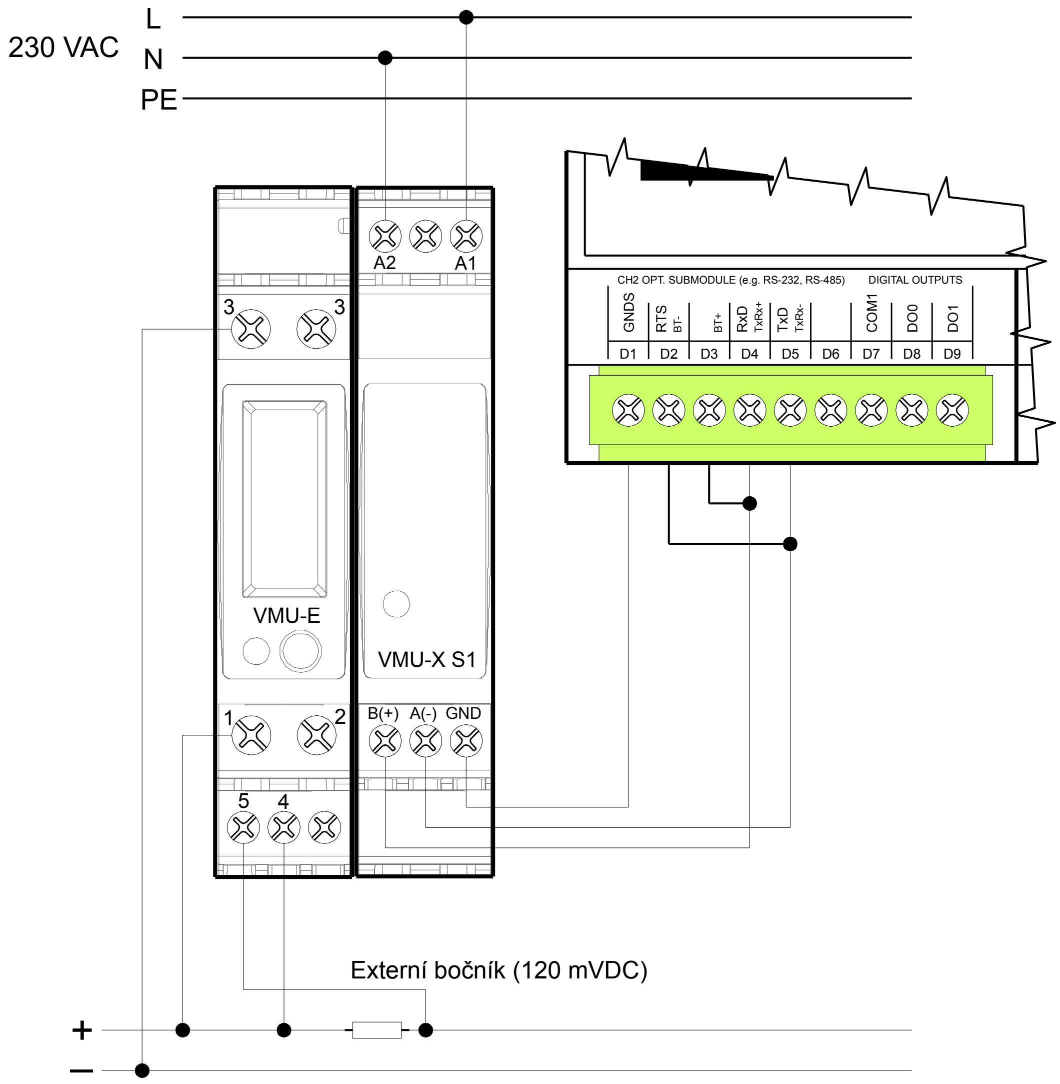


Fig. 11.1.6.1 An example of connecting the DC electricity meter VMU-E, VMU-X S1 to CH2 CP-10x6 (10x8)

Notes:

1) The VMU-X S1 module can be supplied from a 38 ÷ 265 VAC/VDC source, the power supply is galvanically isolated from other circuits, the power input is max. 1.5W/3VA.
2) Both modules are combined into one unit using a side connector; the width of each module is 1M, with a standard DIN rail housing.
3) Indirect current measurement, maximum 1,000A (the shunt is optional, depending on the current); direct measurement is also possible (with another diagram) up to 20ADC.
4) The RS-485 interface is galvanically isolated (4 kV isolation) from other circuits; if cable length does not exceed two meters, no termination is needed on the side of the meter, otherwise there should be fitted a standard approx. 120Ω terminating resistor; a standard cable for the RS-485 interface can be used.

The properties and parameters of the DC electricity meter, the VMU-E and VMU-X S1 assembly
The electricity meter is made of modules for mounting on a DIN rail; they are interconnected with a side connection into one unit. The set with the measuring module (E) and the power supply and communication module (X)
allows measuring DC values and the amount of energy transferred. The current measurement can done via terminals for direct measurement up to 20A, or by auxiliary terminals for an external shunt (with programmable range) for measurements up to 1,000A. The RS485 communication interface allows access to all variables: voltage, current, power and total energy, minimum and maximum voltage, current and power.
The LED on the VMU-E module indicates:

- flashing red indicates that the energy is being metered (adjustable, e.g. 1,000 pulses/kWh),
- a permanently lit red light indicates an alarm condition (the alarm indication has a higher priority than indication of ongoing communication or metered energy),
- flashing green indicates ongoing communication on the RS485 port (in the case of simultaneous metering energy and
- communication, the colours alternate).

Green colour of the LED diode on the VMU-X module indicates functional power supply.

Basic technical parameters of the set of modules VMU-E and VMU-X S1

Supply voltage	38 ÷ 265VAC or 38 ÷ 265VDC
Power consumption	3VA/1.5W
The category of installation	III (acc. to EN 60664)
The connection of powering of modules	galvanically isolated (4kV), polarity is irrelevant
The measured voltage	10 ÷ 400VDC
Voltage measurement accuracy	± 0.5% from the level ± 2 digit
Input impedance (measuring the voltage)	5 MΩ
Permanent overload	500VDC
peak overload	800VDC for 1 second
The metered current (direct metering)	0.05 ÷ 20ADC
Current measurement accuracy	± 0.5% from the level ± 2 digit
The input impedance (direct measurement)	0.006Ω
Permanent overload	20ADC
Peak overload	100ADC for 1 second
The measured voltage in the external shunt (indirect metering of the current)	0.1 ÷ 120mV DC
Measurement accuracy	± 0.5% from the level ± 2 digit
The input impedance (indirect measurement)	> 30kΩ
Permanent overload	10VDC
peak overload	20VDC for 1 second
Communication port	RS-485 galvanically isolated (4kV), the Modbus-RTU protocol
Operating temperature	-25 to 55 °C
Maximum cross-section of the connected conductor – wire, terminals: 1, 2	16mm^2
Maximum cross-section of the connected conductor - wire, terminals: 1, 2	10mm^2
Minimum cross-section of the connected conductor, terminals: 1, 2	2.5 mm^2

The torque of screw terminals	maximum 1.1Nm
Maximum cross-section of the connected conductor, terminals: 4, 5, A1, A2, B(+), A(-), GND	1.5mm^2
The torque of screw terminals	Maximum 0.8Nm

11.1.7 Metering the generation and consumption of electrical energy, 3ph fast metering, the PA 144 electricity meter

For fast and precise measurement of 3ph networks (measuring the phase voltages, currents, active and reactive power, the power factor, THD voltages, currents and frequencies in the low voltage networks, etc.) in the range of rated currents from 15A to 150A (depending on the configuration of the electricity meter you can use the PA144 meter connected to the communication channel of the Foxtrot basic module. For more information about the Foxtrot communication channels, see the documentation [4].

The supply voltage of the electricity meter must be connected to terminals X1 and X2 via a disconnecting device (a circuit breaker - see the following example of connection). A suitable disconnecting device is a circuit breaker with a nominal value of 1A.
The measured voltage should be secured e.g. by a 1A thermal fuse. The measured voltage can be connected via measuring voltage transformers.
The current signals from the current measuring transformers (the transformer selection is done according to the current range and the method of installation) should be connected to the terminal pairs l1, k1, l2, k2, l3, k3, l4, k4, but the correct position must be observed (the white wire to the k terminal; the connection of transformers is described in detail in the notes to the following wiring example).
The RS -485 communication line should be connected to terminals A, B and the shielding to the GND terminal. The endpoints of the communication line must be fitted with terminating resistors.

You can order the PA 144 electricity meter with other ranges of the maximum measured currents (from 5A to 600A), with two variants of current transformers (the ring-type and the split-core current transformers) as well as with the communication interface Ethernet (Modbus TCP protocol). Instead of the PA 144 electricity meter we can alternatively supply the **SMC 144 network analyzer**, which has identical electrical wiring, including variants of transformers, but it differs in additional features of network analysis, such as the quality analysis in accordance with the EN 50 160, e.g. power failures, micro-failures, decreases in power supply, etc.

Variants of electricity meters according to the current range and the type of instrument transformers are shown in the following tables (all four current inputs of the electricity meters have always identical transformers):

The design with the ring-type current transformers:

Maximum measured current	15A	35A	75A	150A
Order number	PA 144 U P015 N N N	PA 144 U P035 N N N	PA 144 U P075 N N N	PA 144 U P150 N N N
The type of measuring transformer	JP3W	JP5W		
Internal diameter of the hole for the measured wire	7mm	13mm		
External dimensions of the transformer	24 x 27 x 11mm	37 x 41 x 14mm		

The design with the split-core current transformers:

Maximum measured current	75A	150A
Order number	PA 144 U S075 N N N	PA 144 U S150 N N N
The type of measuring transformer	JC10F	JC16F
Internal diameter of the hole for the measured wire	10	16
External dimensions of the transformer	23 x 50 x 26mm	30 x 55 x 31mm

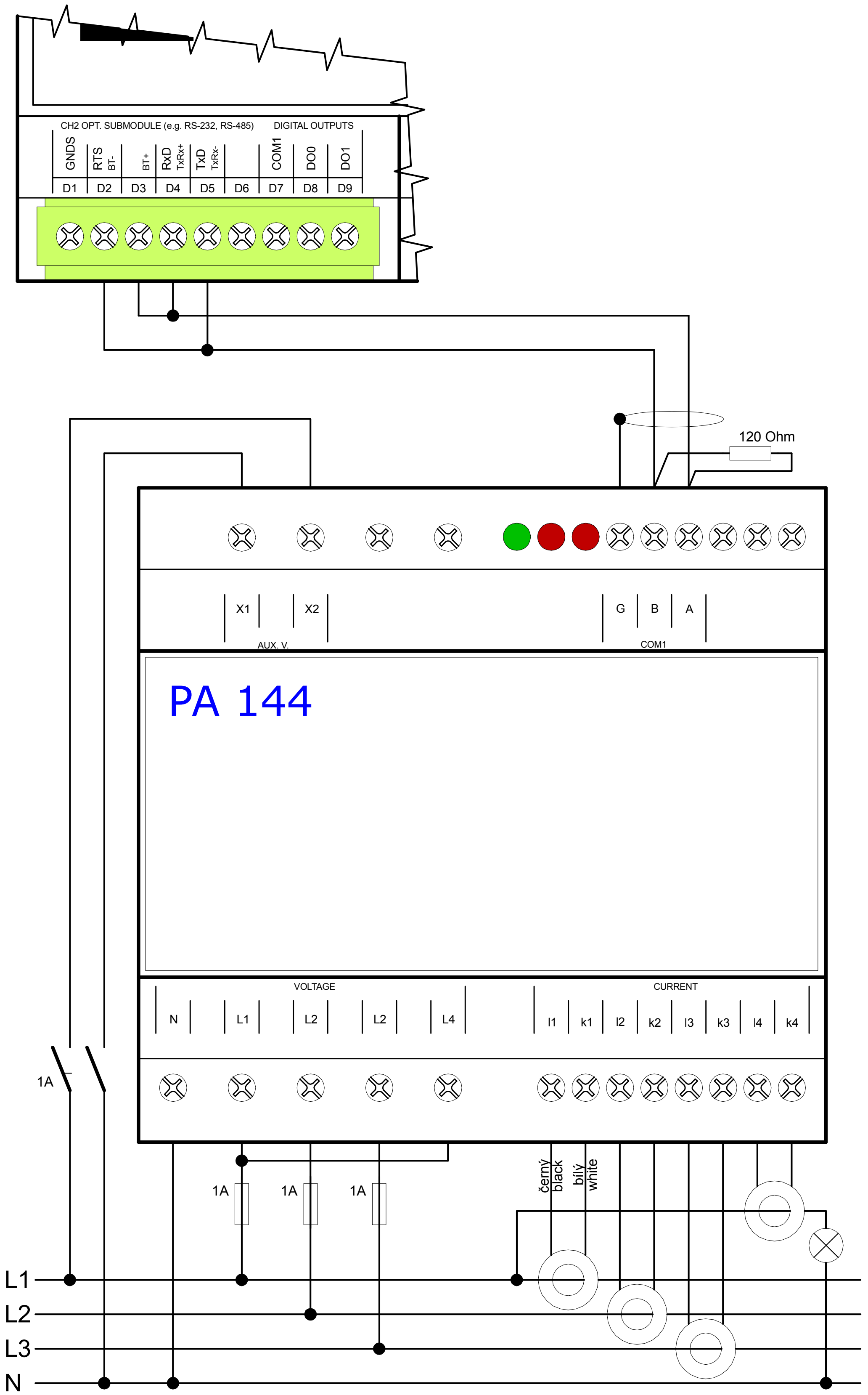


Fig. 11.1.7.1 An example of connecting metering 3ph network by the PA 144 device connected to the CH2 CP-10x6 (10x8)

Notes:

1. The A terminal of the communication line RS-485 should be connected to the TxRx+ terminal of the Foxtrot system communication interface (likewise the B terminal should be connected to the B TxRx- terminal). The communication interfaces at both ends should be correctly terminated - see the example.
2. The measuring voltage inputs should be connected via approx. 1A thermal fuses.
3. Current transformers should be connected with the correct polarity. The white wire goes to the k terminal, the black wire to l terminal of the corresponding input.
4. The wire to be measured should be put through the opening in the transformer in such a way, that the outlet on the yellow side faces the electrical appliances, and the black side (in the following picture it is "the side of the power supply") the wire is connected to the power supply of the installation (this is valid for standard wiring of metering the consumption of the installation).
5. Ring-type transformers are supplied with insulated stranded wires about 110mm long.

The design and orientation of the direction of the metered current for the ring-type transformers are indicated in the following Figure; the dimensions are given for the JP5W type.

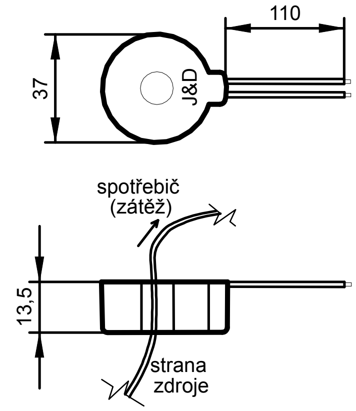


Fig. 11.1.7.2 The correct direction of running the cable through the ring-type transformer

The PA 144 electricity meter - basic characteristics.

The PA 144 is a four-quadrant electricity meter (kWh and KVArh), which also measures other current electric parameters (frequency, voltage and currents including the THD and harmonics, power and power factor, etc.). Data acquired in this way is transmitted via the communication line. If necessary, it can be extended to a full analyser and data-logger SMC 144.

- Four independent voltage inputs (terminals L1 to L4) measured against zero input (terminal N).
- Four ring-type (option P) or split (option S) current sensors with nominal current selectable from 5 to 600A.
- Power supply 75 - 510VAC (or the voltage 24-48VAC or 20-75VAC), terminals X1, X2
- 128 samples per period, voltage and current inputs are read continuously without delays, gaps and failures, the basic measurement interval is 200ms
- The calculation of harmonic voltages and currents up to the order of 63.
- Evaluation of all commonly measured single- and three-phase variables, such as power (active, reactive, apparent, distortion and fundamental active and reactive power), the power factor, harmonic and THD currents and voltages.

Basic technical parameters of the PA 144 electricity meter

Supply voltage	85 ÷ 275VAC/45 ÷ 450Hz, 80 ÷ 350VDC
Power consumption	7VA/3W
The over-voltage class and the degree of pollution	III/2 - according to ČSN EN 61010-1
Connection	galvanically isolated, the polarity is irrelevant
The measured voltage	(U_{nom} = 400/230VAC) 11 ÷ 520VAC / 6 ÷ 300VAC (phase-to-phase/phase)
Voltage measurement accuracy	±0.05% from the value ± 0.02%
Input impedance	2.7MΩ (Li – N)
Connection	star pattern
Permanent overload (acc. to IEC 258)	1,300V (UL-N)
Peak overload	1,950V (UL-N) for 1s
Frequency	50/60 Hz (42 ÷ 57/51 ÷ 70Hz)
Frequency measurement accuracy	±20mHz
Measured current	0.0025 ÷ 1.2× Inom A (according to configuration, Inom = Pxxx)
Current measurement accuracy	±0.0% from the value ± 0.02% from the range
Connection	indirect, via external transformers
Permanent overload (IEC 258)	2 × Inom
Peak overload	20 × Inom (for Inom < 35A), 10xInom (for Inom 35 ÷ 100A)
Communication port	RS 485 galvanically isolated, the Modbus-RTU protocol (optional Ethernet Modbus-TCP)
Active power (P_{nom} = 230*I_{NOM} W)	the range is limited by the range of measured voltage and current
Measurement accuracy of active power	±0.5% ±0.005% Pnom
Reactive power (Q_{nom} = 230* I_{NOM} VA)	the range is limited by the range of measured voltage and current
Measurement accuracy of reactive power	±0.5% ±0.005% Pnom
Metering energy	4 (6) quadrant, the range is limited by the range of the measured voltage and current
Accuracy of measuring active power	Class 1 according to EN 62053-21
Accuracy of measuring reactive power	Class 2 according to EN 62053-23
The power factor P.F. (accuracy)	±0,005

Cos φ (accuracy)	±0,005
THD (accuracy)	up to 50. order, 0 ÷ 20 %, ±0.5
Operating temperature	-25 ÷ 60 °C
Maximum wire cross-section for the terminal	2.5 mm^2

11.1.8 Metering 4x 1ph generation or consumption, the PA 144 electricity meter

The PA 144 electricity meter can also be used for fast and precise measurement of several single-phase electrical appliances, e.g. up to 4 single-phase appliances powered from the same (see the Fig. below) or different phases. For detailed information about the PA 144 electricity meter, its variants (the current range,etc.) and its wiring, see the previous chapter.

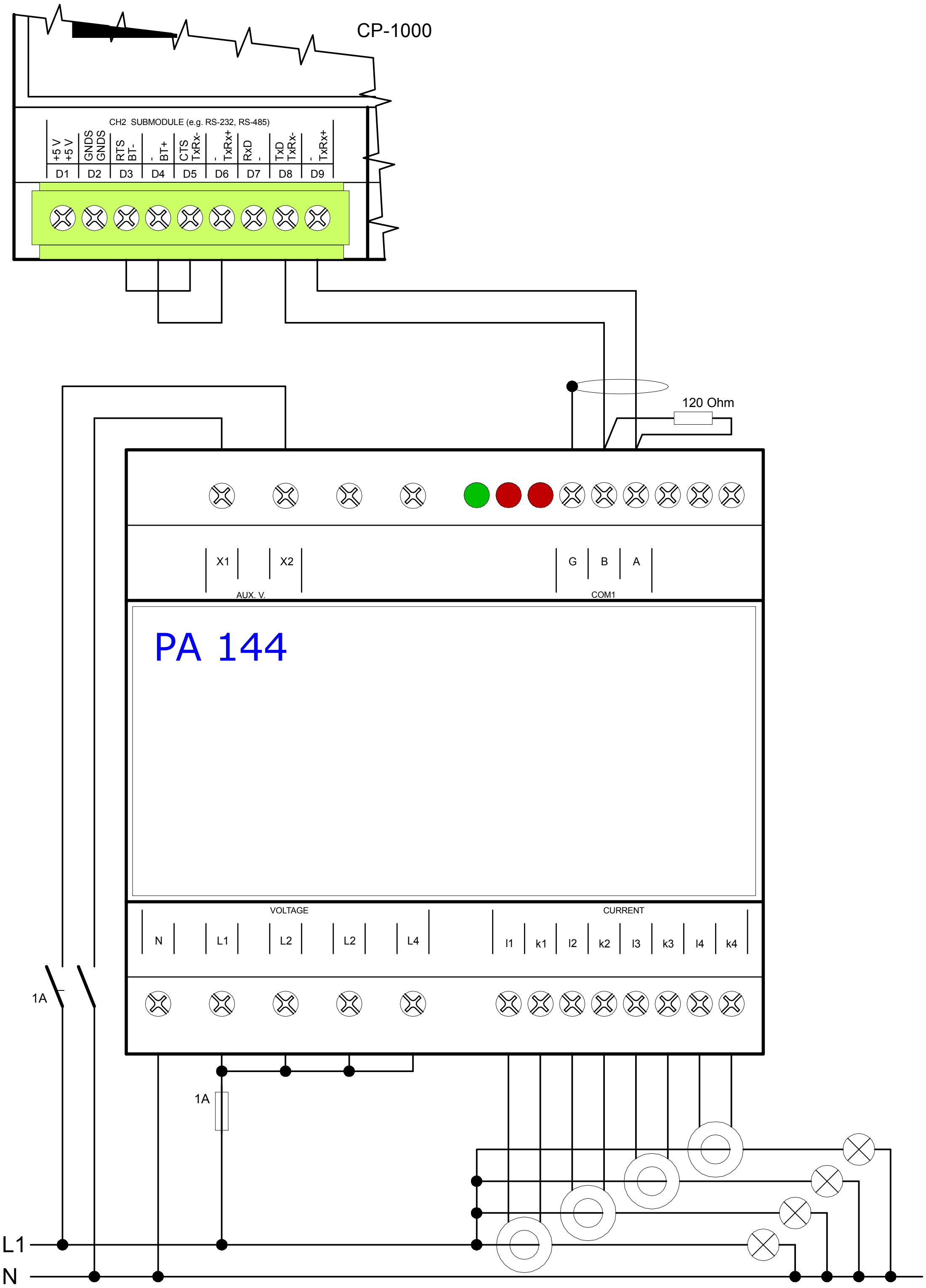


Fig. 11.1.8.1 An example of connecting 4x metering 1ph network via the electricity meter PA 144 connected to CH2 CP-1000

For notes on wiring, see the previous chapter.

11.1.9 Metering the generation and consumption of electrical energy, 3ph fast metering, the C-EM-0401M electricity meter

For fast and precise measurement of 3ph networks (measuring the phase voltages, currents, active and reactive power, the power factor, THD voltages, currents and frequencies in the low voltage networks, etc.) in the range of rated currents from 15A to 150A (depending on the configuration of the electricity meter) you can use the C-EM-0401M electricity meter on the CIB bus. The electricity meter is also equipped with voltage and frequency protection for controlling PVPS, H-PVPS and co-generation units.
You can also order the C-EM-0401M electricity meter with different ranges of maximum measured currents (from 5A to 600A),with two variants of current transformers (the ring-type and split-core).

Connection and measurement:
four voltage inputs (L_1, L_2, L_3, L_4) measured against zero input (N).
The measured voltage should be secured e.g. by a 1A thermal fuse.

Four inputs for metering the current designed for the connection of ring-type (option P) or split-core (option S) transformers with a rated current from 5A to 600A (I_1, I_2, I_3, I_4).
Current signals of the instrument current transformers (selecting transformers based on the current range and method of installation is shown in the following table) should be connected to the terminal couples l1, k1,l2, k2,l3, k3, l4, k4, but their proper orientation must be observed (the white wire goes to the k terminal - the connection of transformers is described in detail in the notes to the following example diagram).

Standard supply voltage of the electricity meter is 75 ÷ 510VAC or 80 ÷ 350VDC.
The supply voltage of the electricity meter must be connected to terminals X1 and X2 via a disconnecting device (a circuit breaker - see
the following example of connection). A suitable disconnecting device is a circuit breaker with a nominal value of 1A.
You can order an electricity meter with the supply voltage range 24 ÷ 48VAC or 20 ÷ 75VDC.

The electricity meter takes 128 samples per period, and the sampling is controlled by the measured frequency on L_1. The electricity meter measures and evaluates voltage and current signals continuously without interruption, the basic evaluation interval is 200ms.
In this interval it is possible to read from the electricity meter instantaneous values of active power (generation, consumption) for each phase.
Other variables can be read via query commands as needed.
In addition to voltage, currents and active power the electricity meter also provides:
reactive, apparent, distortion and fundamental active and reactive power, the power factor, harmonic and THD currents and voltages, the calculation of harmonic currents and voltages up to 63 harmonics.

Current inputs of the electricity meters should never be used for direct measurement of the current! Always use the device with the supplied instrument transformers.

Variants of electricity meters according to the current range and the type of instrument transformers are listed in the following tables (all four current inputs of the electricity meters have always identical transformers):

The design with the split-core current transformers:

Maximum measured current	15A	35A	75A	150A
Order number	C-EM-0401M-P015	C-EM-0401M-P035	C-EM-0401M-P075	C-EM-0401M-P150
The type of instrument transformer	JP3W	JP5W		
Internal diameter of the hole for the measured	7mm	13mm		

wire		
External dimensions of the transformer	24 x 27 x 11mm	37 x 41 x 14mm

The design with the split-core current transformers:

Maximum measured current	35 A	75A	150A
Order number	C-EM-0401M-S035	C-EM-0401M-S075	C-EM-0401M-S150
The type of measuring transformer	JC10F	JC10F	JC16F
Internal diameter of the hole for the measured wire	10	10	16
External dimensions of the transformer	23 x 50 x 26mm	23 x 50 x 26mm	30 x 55 x 31mm

The C-EM-0401M electricity meter is equipped with a DO1 output, which is controlled by a protective function implemented in the meter. The electricity meter carries out the functions of voltage and frequency protection; the scope of the monitored under-voltage, over-voltage, under-frequency and over-frequency, including the reaction times is to be set in the electricity meter parameters. Similarly, the time of the restoration is also set after the causes of activation of the protection have subsided.

…. more detailed data of the protection function will be added.

Basic technical parameters of the electricity meter C-EM-0401M

Supply voltage	85 ÷ 275VAC/45 ÷ 450Hz, 80 ÷ 350VDC
Power consumption	7 VA/3W
The over-voltage class and the degree of pollution	III/2 - according to ČSN EN 61010-1
Connection	galvanically isolated, the polarity is irrelevant
the measured voltage	(U_{NOM} = 400/230 VAC) 11 ÷ 520 VAC / 6 ÷ 300 VAC (phase-to-phase/phase)
Voltage measurement accuracy	±0.05% from the value ± 0.02%
Input impedance	2.7 MΩ (L_i – N)
Connection	star pattern
Permanent overload (acc. to IEC 258)	1,300V (U_L-N)
Peak overload	1,950V (U_L-N) for 1s
Frequency	50/60 Hz (42 ÷ 57/51 ÷ 70Hz)
Frequency measurement accuracy	±20mHz
Measured current	0.0025 ÷ 1.2× I_{NOM} A (according to configuration, I_{NOM} = Pxxx, Sxxx)
Current measurement accuracy	±0.05% from the value ± 0.02% from the range
Connection	indirect, via external transformers
Maximum wire diameter (the P version)	JP3W 6mm/JP5W 13mm/JP6W 19.3mm
Maximum wire diameter (the S version)	JC10F 10mm / JC16F 16mm JC24F 24mm
Permanent overload (IEC 258)	2 × I_{NOM}
Peak overload	20 × I_{NOM} (for I_{NOM} < 35 A), 10 x I_{NOM} (for I_{NOM} 35 ÷ 100A)
Active power (P_{NOM} = 230 x I_{NOM} W)	the range is limited by the range of measured voltage and current
Measurement accuracy of active power	±0.5% ±0,005% P_{NOM}
Reactive power (Q_{nom} = 230 x I_{NOM} VA)	the range is limited by the range of measured voltage and current
Measurement accuracy of reactive power	±0.5% ±0.005% P_{NOM}
Metering energy	4 (6) quadrant, the range is limited by the range of the measured voltage and current
Accuracy of measuring active power	Class 1 according to EN 62053-21
Accuracy of measuring reactive power	Class 2 according to EN 62053-23
The power factor P.F. (accuracy)	±0,005
Cos φ (accuracy)	±0,005
THD (accuracy)	up to 50. order, 0 ÷ 20 %, ±0.5
Operating temperature	-25 ÷ 60 °C
Maximum wire cross-section for the terminal	2.5 mm^2

Relay output D1	Electromechanical relay, without internal protection
Working voltage of the D1 output	Maximum 230VAC or 30VDC
Maximum switching current via the D1 output	3A
Dimensions	105 x 90 x 58mm
The weight	0.2kg

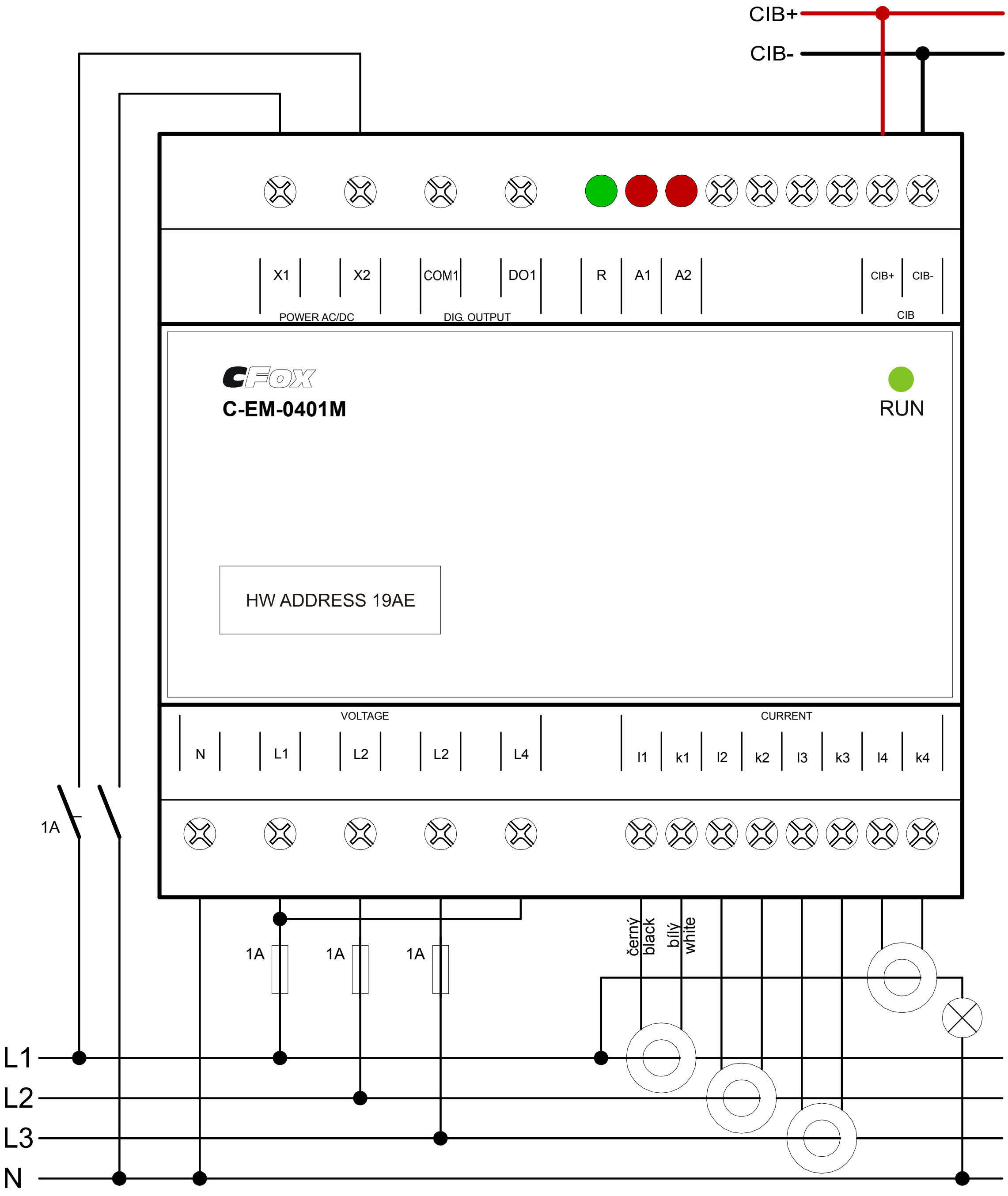


Fig. 11.1.9.1 An example of wiring the metering of 3ph network by the C-EM-0401M device

Notes:

1. The measuring voltage inputs should be connected via approx. 1A thermal fuses. All the measured voltages are connected to the internal resistors via a high impedance.
2. The current ring transformers should be connected with the correct polarity: the white wire should be connected to the terminal k, the black wire to the terminal l of the corresponding input.
3. The wire to be measured should be put through the opening in the transformer in such a way, that the outlet on the yellow side faces the electrical appliances, and the black side (in the following picture it is "the side of the power supply") the wire is connected to the power supply of the installation (this is valid for standard wiring of metering the consumption of the installation).
4. The ring-type transformers are supplied with insulated stranded wires about 110mm long.
5. The split-core current transformers are terminated with M3 screw terminals; they can be connected to the electricity meter by stranded insulated wires with the minimum diameter 0.5mm.
6. The wires between the transformers and the terminal block of the electricity meter should not exceed approx. 1m.
7. After the power supply is turned on, a 10-second starting sequence starts (it is indicated by rapid flashing of green LED diode R - the flashing interval is 400ms). After returning to a standard metering mode, the flashing slows down to 2-second intervals.

The design and orientation of the direction of the metered current for the ring-type transformers are indicated in the following Figure.

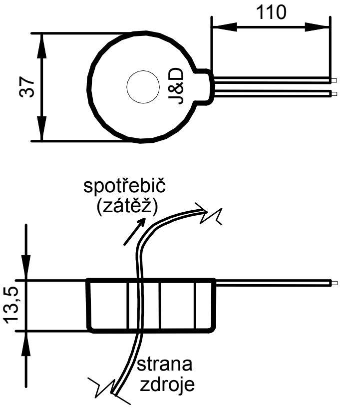


Fig. 11.1.9.2 The correct direction of running the cable through the ring-type transformer, the dimensions refer to the JP5W type

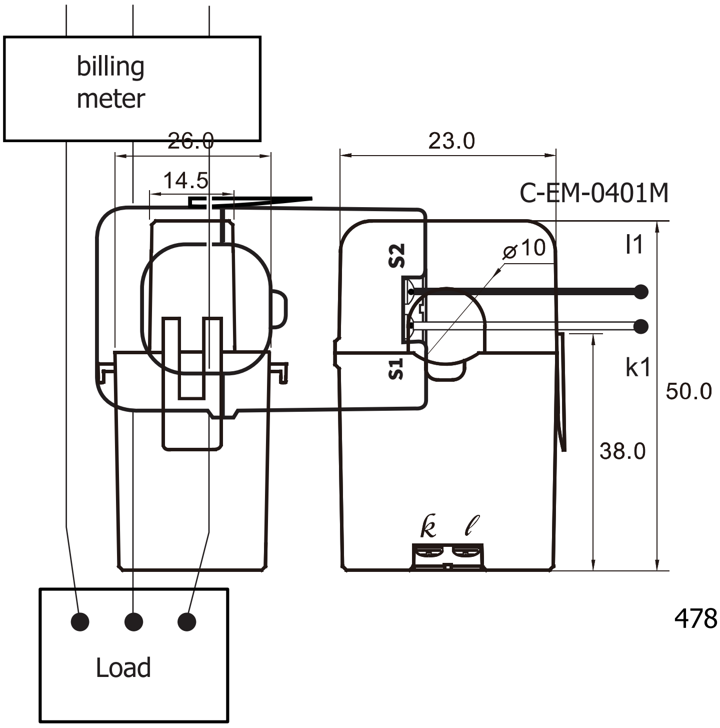


Fig. 11.1.9.3 The correct direction of running the cable through the split-core current transformer, the dimensions refer to the JC10F type

11.2 Heat and flow measurement

The **flow of water**, e.g. in the water heating system, cold and hot water in the house, monitoring of leaking water at a recreational facility, and such like, the speed flowmeters can be used; they are fitted with an output for scanning the instantaneous flow.
In velocity flowmeters, the flowing fluid acts on a set of blades on a rotor that spins. The revolutions of the rotor are transmitted to the counter, or they are scanned and electronically evaluated. Impurities in the liquid may cause damage to the flowmeter, so this type requires the installation of a fine filter to reduce the risk of a fault. A disadvantage of velocity flowmeters is their permanent operating pressure loss caused by the hydraulic resistance of the revolving part.

If you want to **meter the fluid flow in the primary circuit of the solar system**, you should use a flowmeter with a higher temperature resistance. The temperature sensors and flowmeters for metering in solar system circuits must be resistant to operating temperatures of at least 120 °C (the temperature sensor on the collector up to 180 °C).
A suitable flowmeter is the AV23 connected to the C-AM-0600I module, which can simultaneously measure the temperature of the medium.

Metering the water-supplied heat (the heat produced by the heat pump, the hot water for domestic appliances, etc.) can be done in combination of the flow measurement with two added temperature sensors (for the hot water outlet and the return flow) and the heat supplied is calculated (by the function block) in the application software. The temperature sensors can also be utilized for the control and monitoring of the system.

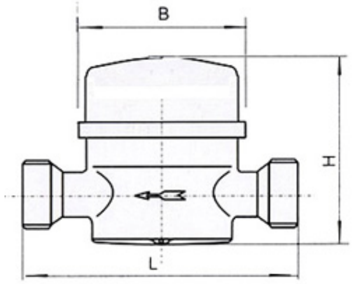
Metering the heat generated by the solar system can be done by the AV23 flowmeter, where a second temperature can be added, and the supplied or consumed heat is calculated (by the function block) in the application software. An advantage of this flowmeter is a greater range of temperatures and viscosity of the medium, which makes it suitable for the primary circuit of the solar system. Pressure losses in primary circuits of solar systems can fluctuate during the operation due to a considerable dependence of antifreeze mixtures viscosity on temperature; if the power of circulation pumps is fixed, the flow in the circuit can fluctuate up to 30%.

When selecting a flowmeter, you should also take into account the parameters of the distribution system, especially the required maximum flow of water. For more information about the guidelines for the distribution and control of water, see the Chapter Water - control.

11.2.1 Metering the flow of water in central heating and water for homes (cold and hot).

The flow of water (cold or hot water, monitoring the leakage, consumption) can be metered by a flowmeter (water meter), e.g. the TA-E/20 with a pulse output, which should be connected to the C-AM-0600I module impulse inputs, or to the binary dry inputs of the basic module CP-10x8 or 10x6-CP. The flowmeter (produced by Bonega) is a single-inlet blade household water-meter with internal slide control and dry-running counter, with a wheel for photometric readings, intended mainly for cold and hot drinking water. It can be installed in the water distribution system as a standard water meter, the working position is arbitrary. The basic data and dimensions are listed in the following table:

The order number		TA-E/20
Nominal clearance DN	mm	20
	inches	G 3/4"
Connecting the water meter (D)	inches	G 1"
Maximum (overloading) flow-rate Qs	l/min	83
Nominal flow-rate Qn	l/min	41
Minimum flow-rate Qmin	l/min	0,83
Real starting flow-rate	l/min	> 0.1
Maximum operating pressure	MPa	1,6
Impulse number	pulses/l	2
Installation length (L)	mm	130
Height (H)	mm	78
Width (B)	mm	75



The flowmeter is fitted with a sensor, which is included in the supply; it is terminated with an approx. 50cm cable outlet. The cable is terminated with two tinned outlets (with white and red insulation, polarity is arbitrary) and shielding. The shielding can be left unconnected, the terminals should be connected to a module input, e.g. the C-AM-0600I:

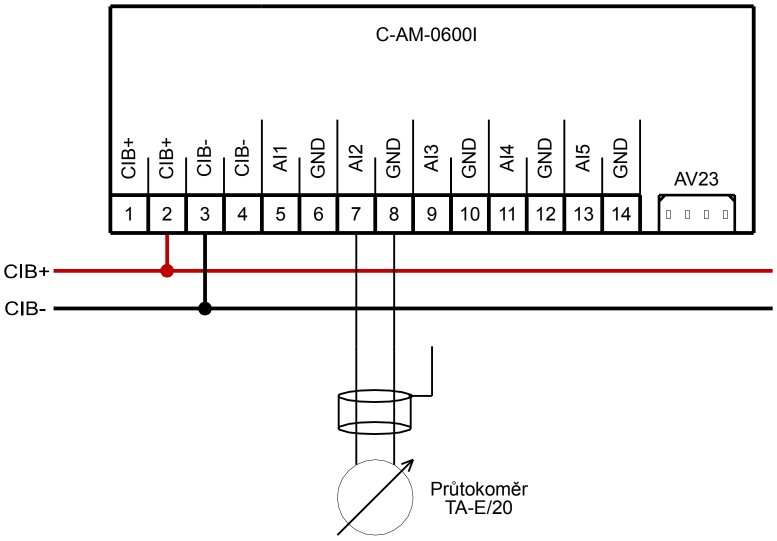


Fig. 11.2.1.1 An example of connecting the flowmeter TA-E/20 to the C-AM-0600I module

Notes:

1) The supply cable can be extended up to approx. 20m; preferably the cable should be shielded, e.g. the SYKFY 2x2x0.5 or JYSTY 1x2x 0.6.

2) If you connect the flowmeter supply cable directly to the C-AM-0600I module terminal, the shielding should not be connected. If the cable is extended, the shielding should be connected to the protective ground.

11.2.2 Heat measurement, produced and consumed heat in hot water distribution and central heating (e.g. HP)

The generated or consumed heat can be metered using a flowmeter, e.g. the TA-E/20 with the pulse output, which should be connected to the pulse inputs of modules C-AM-0600I, or to binary potential-free inputs of the basic modules CP-10x8 or CP-10x6. The hot water outlet and return flow temperature can be measured using two temperature sensors connected to the same modules, or to any modules with the range corresponding with the temperature sensor used. The actual calculation (of the instantaneous power, total energy delivered) is provided by the system via prepared function blocks.

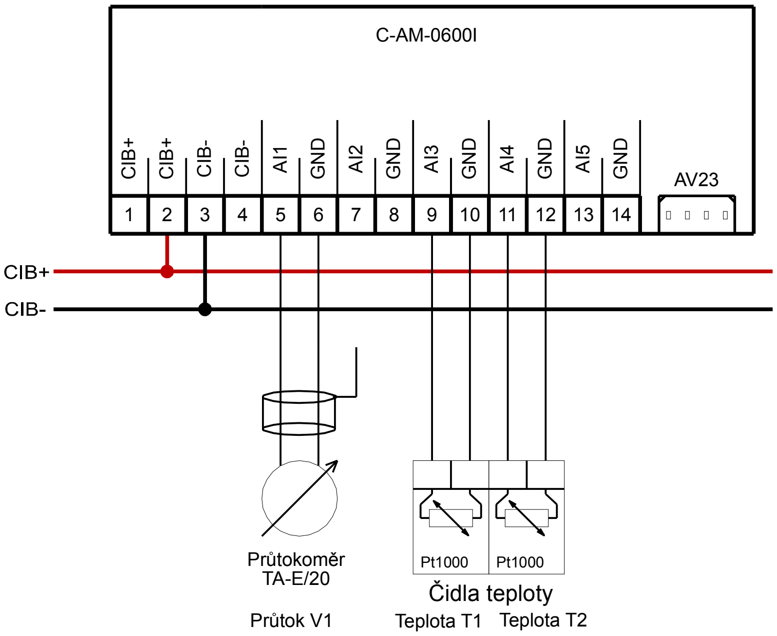


Fig. 11.2.2.1 An example of connecting the flowmeter TA-E/20 for metering heat to the C-AM-0600I module

Notes:

1) The supply cable can be extended up to approx. 20m; preferably the cable should be shielded, e.g. the SYKFY 2x2x0.5 or JYSTY 1x2x 0.6.
2) If you connect the flowmeter supply cable directly to the C-AM-0600I module terminal, the shielding should not be connected. If the cable is extended, the shielding should be connected to the protective ground.

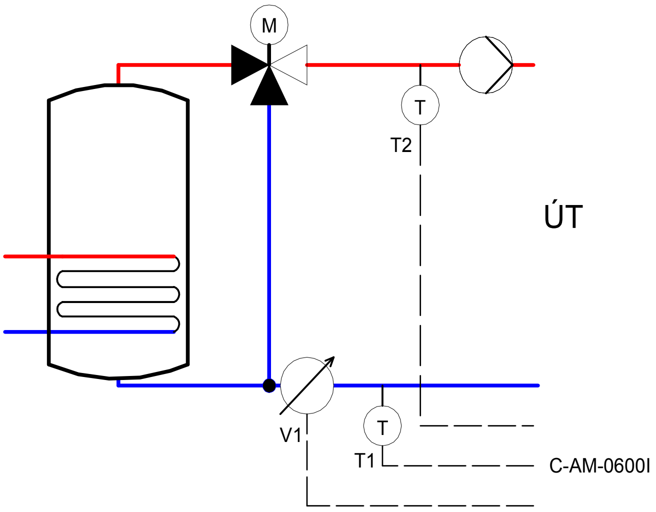


Fig. 11.2.2.2 An example of placement of the elements for metering heat consumed by the central heating

11.2.3 Metering the heat of the solar circuit (maximum medium temperature 120 °C)

Metering the flow and the supplied heat in drinking water distribution systems, in solar systems and heating systems using water and antifreeze liquids with maximum temperature of the media at 120 °C, and the flow range from 1 to 12 or 2 to 40l/min., can be done by the AV23 flowmeter. It is a flowmeter that uses the Grundfos VFS (Vortex Flow Sensor) module for measuring flow and temperature. This module is also used by other producers of flowmeters, which can also be used (for flow rates up to 200l/min).

The regulatory flowmeter AV23 is designed for a simultaneous measurement of flow and temperature of the medium. The flow measurement is based on the principle of vortex in the medium.

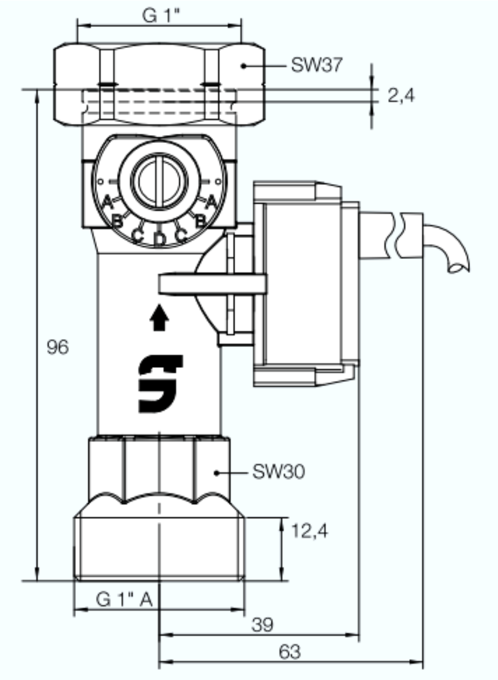
The fluids:

- mixtures of water with common anti-corrosion and anti-freeze additives (resistant against glycol)
- heating water
- drinking water
- cold and hot water

The flowmeter can be fitted into any location in the solar circuit (in conventional solar panels, maximum operating temperature of 120 °C is sufficient), but the best is the installation in the return piping (see Fig. 11.2.3.2). The operating position of the flowmeter is arbitrary.

During the installation, the 110cm length of the supply cable must be taken into account. The cable is terminated with a special connector for a direct connection to the C-AM-0600I module, and it isn't recommended to extend it.

The order number	**223.7702.000**	**223.7704.000**
The flow rate	1 – 12 (l/min)	2 – 40 (l/min)
Clearance	DN 20	DN 20
The screw fitting	G1" × G1" A	G1" × G1" A
Maximum operating temperature:	120 °C	
Measuring temperature range:	0 - 100 °C	
Maximum operating pressure :	8 bar	
The flow measurement accuracy	< 3% of the final value	1.5% of the final value
Medium viscosity:	≤ 4 mm²/s	
Screw thread	G (cylindrical) in accordance with ISO 228	
Material of the housing:	brass	
Material of the internal parts:	brass, stainless steel, plastic material	
Material of the reader::	PPS, PPA, PA	
Material of the sealing:	EPDM	
Connection	with gaskets 1"	
Protection:	IP44a	



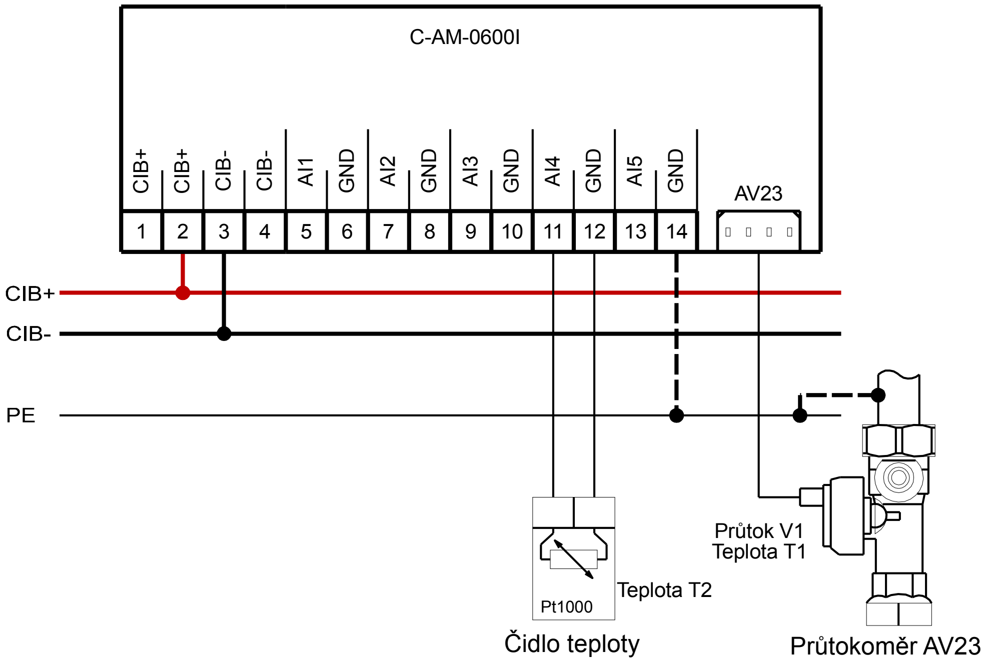


Fig. 11.2.3.1 An example of connecting the flowmeter/thermometer AV23 to the module C-AM-0600I

Notes:

1) The flowmeter is equipped with a 110 cm-long cable, which is terminated with a connector for connecting to the C-AM-0600I module.
2) The valve can be installed in a horizontal, inclined or vertical position. However, you must pay attention to the direction of the arrow indicating the flow of the medium.
3) The temperature sensor can be connected to any input of the module (AI1 to AI5), measuring the temperature T2 can be done by the temperature sensor connected to any module in the system.
4) N.B.: In order to secure the indicated measurement precision, the VFS module (the flow sensor) manufacturer recommends to ground the negative terminal of the flowmeter power supply (in the fig. it is the GND terminal of the C-AM-0600I module) and also to connect the pipe with the flowmeter to the PE terminal. Grounding is illustrated by the broken line in the figure. In terms of electrical safety, this will also change the grounding terminal CIB and the installation into PELV. Mind the ground loops - the system power supply, including the CIB bus, must not be grounded at any other point of the installation.

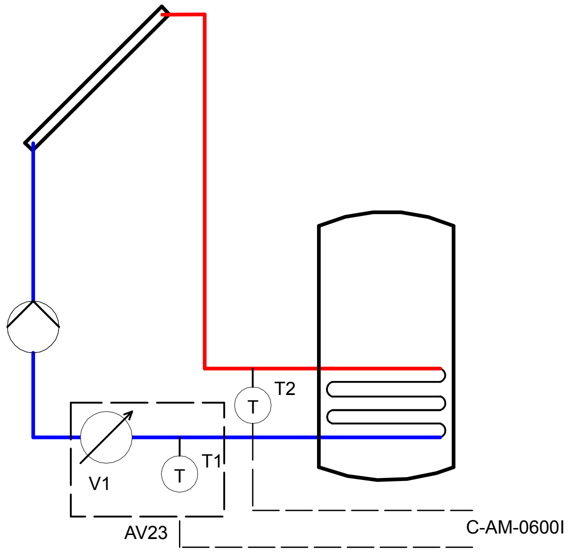


Fig.11.2.32 An example of placement of the elements for metering heat generated by the solar system

11.3 Measuring the quality of air, CO_2, RH, VOC, ...

On the CFox and RFox buses are available modules for measuring CO_2, smoke, volatile compounds (VOC) and RH (relative humidity). Modules from the C-AQ-0001R to C-AQ-0004R are designed to be mounted on the wall or in a flush box in the interior, and their dimensions and external connections (CIB buses) are identical.

General guidelines for the placement of sensors in the interior:

Suitable conditions

- In places that are the most significant in terms of indoor air quality.
- About 1 ÷ 2.5m high above the floor level.
- At least approx. 1m from the corner of the room.
- In places where the temperature varies in the range from approx. 10 to 40 °C.
- Close (but not too close) to the exhaust of air from the room.

Unsuitable conditions

- Close to the windows.
- Close to the front door.
- In areas with limited air circulation as the vestibule, niches, etc.
- In areas with rapid fluctuations in temperature.
- In areas with rapid fluctuations in humidity.
- In places where humidity in the air condensates.
- In places where people would breathe directly on the sensor.
- In places where you can find vapours of various chemicals, such as detergents, etc.
- In areas with a risk of the sensor being splashed with various liquids.

CO_2 - when you should use carbon dioxide sensors

A good indicator of indoor air quality is the concentration of carbon dioxide (CO_2), where the main source of air pollution are people. With increasing concentration of CO_2, the levels of other pollutants also increases, such as various bacteria, microorganisms, ammonia, volatile organic substances, and the like. It is therefore recommended to monitor the concentration of CO_2, and on the basis of the values measured to either control the ventilation system, or at least manually to ventilate the internal spaces.

Of course in premises equipped with a ventilation equipment it is recommended to use the CO_2 sensor for controlling the current power of the ventilation system.
In comparison with the ventilation systems controlled only on the time basis, the systems controlled by air quality sensors can meet the seemingly contradictory requirements: to minimize the power consumption and simultaneously increase and maintain good quality if air indoors.

The CO_2 sensors that measure mainly carbon dioxide content in the air do not detect common air pollution.In areas where other sources of air pollution can occur as well, it is recommended to use such air pollution sensors that are sensitive to various gases polluting the air. In these cases, it is insufficient to control the ventilation only based on the values of the CO_2 concentration.

Physical evaporation from the surface of skin also releases volatile organic compounds (VOCs), which are the bearer of odours as well. Two-thirds of these pollutants are comprised of acetone, butyric acid, ethanol and methanol. The rest are acetaldehyde, allyalcohol, acetic acid, amyl alcohol, dimethyl ketone and phenol. As the volume of CO_2 evaporated from human skin corresponds with that of other harmful substances, and as the concentration of CO_2 is easy to measure, the evaluation of indoor air is done via measuring the CO_2 content.This procedure is only applicable in rooms where smoking is not allowed, and where the main sources of emissions of harmful substances are human metabolism, building construction, materials and the equipment of the rooms.

The C-AQ-0001R sensor is designed to monitor the current concentration of CO_2. Ventilation control (preferably with heat recovery) by monitoring CO_2 concentration is very important for the rapidly growing market for low-energy and passive houses.The importance of timely resolution of moisture occurrence is also increasing. In this respect, the recuperation of humidity can be an answer - see the Chapter Ventilation.

A typical level of CO_2 in the atmosphere in the country is 350 ppm, while in towns it is 400 ppm, and in city centres it reaches 450 ppm.

Recommended values for indoor environment (living areas):
The recommended target is <800 ppm (high indoor air quality).
A recommended median value is <1000 ppm (medium to medium-low air quality).
A recommended maximum value is < 1400 ppm (low air quality).

SMOKE – when you should use smoke detectors

Carbon monoxide (CO) is a colourless and odourless toxic gas, which is created especially during incomplete combustion. Exposure to higher concentrations may be very dangerous, as carbon monoxide reduces the ability of blood to carry oxygen, which may cause undetected gradual poisoning. Symptoms at low concentrations are headaches, fatigue, nausea, etc.
These symptoms are often observed even at concentrations below 25ppm.
In most buildings, the concentration of carbon monoxide is below 5ppm.
Concentration above that level usually indicate the presence of products of incomplete combustion.
The sources of carbon monoxide are mostly smoking and operation of motor traffic.

When tobacco is burning, a whole range of toxic gases is generated, of which the most important from the toxicological point of view is carbon monoxide - CO. It is a colourless and odourless gas with a high ability to bind to haemoglobin (more than 200-times higher ability than that of oxygen) and it is highly toxic. It prevents the transfer of oxygen in the blood from the lungs to the body, which causes asphyxiation.

Another important toxic gas in terms of negative effects on humans is nitrogen dioxide - NO_2. It penetrates very easily from the lungs into the bloodstream, causing problems especially to children and sensitive individuals suffering e.g. from asthma. For them, a harmless concentration of nitrogen dioxide is believed to be ten times lower than for healthy individuals. Nitrogen dioxide irritates mucous membranes and causes burning eyes, breathing problems and headaches.
The SMOKE sensor, the C-AQ-0002R module, should be used for controlled ventilation in rooms frequented by smokers (restaurants and other areas with greater movement of people). It is also suitable for controlling ventilation in houses where smokers live.

VOC – when should you use sensors of volatile organic compounds.

There are many synthetic chemicals and even natural materials referred to as volatile organic compounds (VOC). In buildings there are many sources of these chemicals, such as plastics, furniture, construction materials, various chemical cleansers, polishes, cigarette smoke, and also cooking fumes, rotting substances of organic origin, and such like.
The VOC sensor, the C-AQ-0003R module, can be used e.g. for control of ventilation in kitchen operations, etc.

RH - relative humidity

Humidity actually means the quantity of water vapour contained in the air, and this quantity depends on the pressure and temperature.
Humidity of air indoors is usually expressed as the so-called relative humidity indicated as a percentage.

Absolute humidity of air is determined by the weight of water vapour per unit of air volume. The unit of absolute air humidity is one kg/m3.

Relative humidity is the ratio between the quantity of water vapour contained in the air, and the highest possible amount of vapour at a given temperature. It is expressed as a percentage. Relative humidity is calculated as the quotient of the absolute humidity of air to the highest possible absolute humidity of air at a given temperature.

The higher the air temperature, the more water vapour the air can hold, and conversely - when the air is cooling, the relative humidity increases without changing the absolute quantity of water in the air, and vice versa.

Humidity of air is one of the most important quality parameters of the internal environment, which has a significant impact on people's health.

High relative humidity has a number of unpleasant and dangerous effects, such as the occurrence of mould on the walls, especially in the areas of the so-called thermal bridges. These are areas where for some reason there is a lower thermal resistance of the masonry and therefore the temperature is lower as well, resulting in condensation of humidity in the air. Subsequently the plaster and masonry deteriorate, as well as furniture and other wooden structures, which leads to an impairment of the microclimate associated with health risks. This phenomenon occurs for example in older, badly insulated family homes or in buildings, where old windows have been replaced with new ones, which are considerably tighter, but these buildings do not have adequate ventilation.

The opposite situation occurs especially during the heating season, when the indoor humidity is too low.
Less than 40% relative humidity already causes drying of mucous membranes and the respiratory tract illnesses. This is caused by low outdoor air temperature, as the amount of water vapour it contains is too small. Ventilating the room by e.g. opening the window lets some cold outside air into the warm room, where its temperature increases and it results in a further reduction of the relative humidity. Heating up the air drawn in by the ventilation equipment, or by the heat recovery system, has the same effect. Due to the high efficiency of the heat recovery system, users often let it run continuously, even when it is not needed, e.g. when nobody is in the ventilated area. Heating the cold outside air results in a great decrease in relative humidity of the inlet air, and in addition, the inside air with a higher relative humidity is pushed out from the ventilated space. The effect is a decrease of the relative humidity of the internal air even below 30%.
This can be improved by making use of additional sources of moisture, such as house plants, aquariums, or using humidifiers.

The recommended relative humidity, which entails a feeling of well-being, naturally together with the temperature around 20 °C, is **about 50%**. Such environment has a positive effect on our mucous membranes, which are then more resistant to infections.

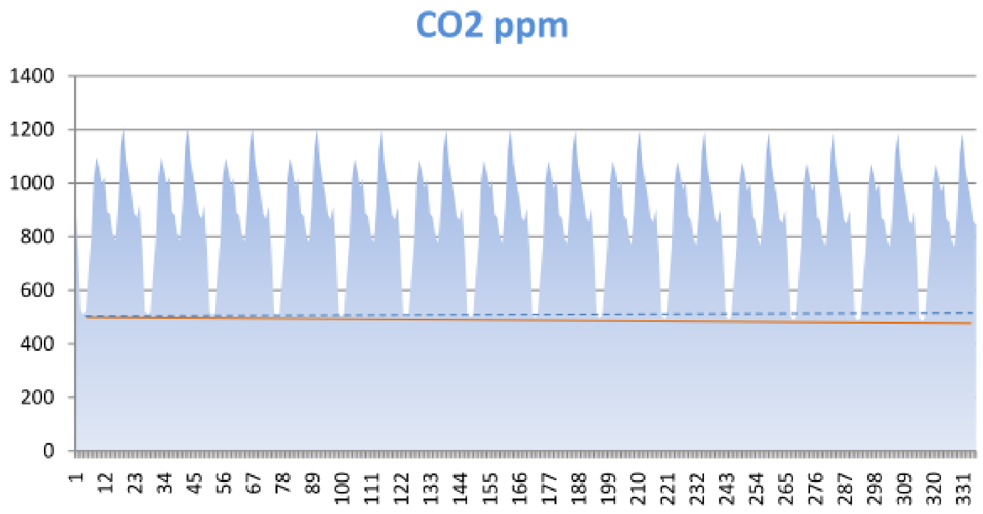
Relative humidity can be measured e.g. by the C-AQ-0004R module.

11.3.1 Measurement of CO_2, CFox module C-AQ-0001R

The C-AQ-0001R module is a spatial sensor of concentration of carbon dioxide (CO_2) in the air. The principle of CO_2 measurement is based on the dependence of infrared radiation attenuation on the concentration of CO_2 (non-dispersive infrared radiation absorption). The CO_2 concentration testifies to the quality of air in an area, so the module can be used e.g. for controlling ventilation in rooms and buildings. The device is intended for mounting on the wall or on the flush box.
The module contains two measurement inputs. The first one is connected to the CO_2 sensor. The temperature sensor is connected to the second input, which is only intended for servicing. The sensor measures the temperature inside the device and provides information about the operating conditions of the module. The sensor is capable of measuring the concentration in the air in the range of 0 ppm up to 5,000 ppm.

The module for the measurement of carbon dioxide has been calibrated by the manufacturer for the range of concentrations from 400 to 2,000 ppm of CO_2 in the air.

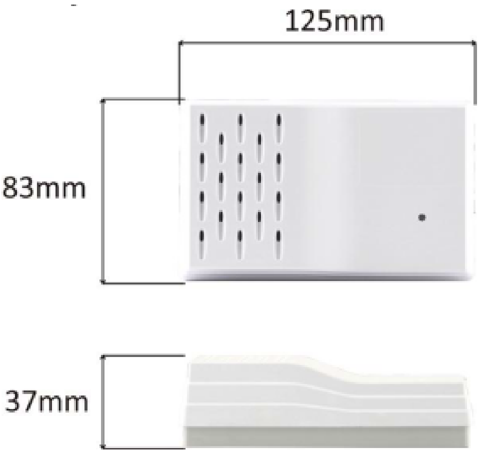
Auto-calibration feature of the C-AQ-0001R module
The C-AQ-0001R module is equipped with an auto-calibration function, which compensates for possible drifting of the CO_2 sensor due to the inevitable ageing of the infrared radiation source; this discrepancy is in the order of several ppm/month.
Thanks to this function it is not necessary to recalibrate the sensor during the operation; the sensor automatically maintains its accuracy over a period of many years (typical duration is 15 years).
In simple terms, the auto-calibration feature works as follows: the sensor internally monitors the concentration of CO_2 24 hours a day for a two-week period. The minimum concentrations are then statistically evaluated to find out, whether there has been a shift of the "zero" in the sensor, and if so, a slight correction is made of the internal sensor calibration values. For this feature to work properly, it is necessary to ventilate to a level of 400-500 ppm in the interval of 14 days. Of course the sensor can easily eliminate days when there was no decrease in the concentration of CO2 to the expected minimum and does not take them into account. The room must be periodically ventilated in order for the sensor to work properly, ideally when the interior space is not used for at least four hours a day.
What the sensor peforms is a light correction of the factory calibration values, based on the long-term trends in measured concentrations of CO_2 in points close to the outdoor environment, where it can be assumed that these values are constant over the long term.
This auto-calibration function can be disabled, however, then it is recommended to periodically recalibrate the sensor roughly once every three years. The following diagram illustrates the principle of the auto-calibration feature.

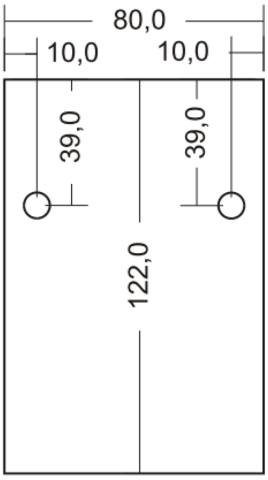


A long-term slight drift of the sensor.

A correction using the auto-calibration feature.

Fig. 11.3.1.1 An example of wiring of the air quality sensor C-AQ-000xR





11.3.2 Measurement of smoke, CFox module C-AQ-0003R

The C-AQ-0003R module is a spatial sensor sensitive to the gaseous pollutants in the air. The sensor exhibits a high sensitivity to low concentrations of gaseous pollutants, such as e.g. carbon monoxide and hydrogen, which are found in cigarette smoke. It is therefore suitable for the ventilation of areas contaminated with cigarette smoke. The sensor is also suitable for preliminary detection of alcohol vapours, leak detection of gases such as methane, propane-butane, natural gas, etc. Measuring the air pollution works on the semiconductor basis. The sensitive semiconductor element changes its conductivity in relation to the air pollution. This change in conductivity is further processed by embedded electronics. The sensor is sensitive to the substances contained in cigarette smoke, and it also exhibits sensitivity to other organic vapours, including various deodorants, fragrances, odours and such like. Furthermore, the sensor demonstrates certain sensitivity to relative humidity of air, and good long-term stability.

Some examples of detected sources of pollution: cigarette smoke, cooking fumes and also rotting materials of organic origin.
Applications:For controlling ventilation systems, ventilation control in restaurants, offices, business premises, locker rooms, smoking rooms, homes, flats, etc.

⚠ The sensor is not designed for safety indication, e.g. gas leakage or smoke detectors (as a replacement of fire detectors).

The connection of the sensor to the CIB bus, its mechanical dimensions and mounting data are identical with the C-AQ-0001R module.

11.3.3 Measurement of VOC (volatile organic compounds), CFox module C-AQ-0002R

The C-AQ-0002R module is a spatial sensor of gaseous air pollutants. The sensor exhibits a high sensitivity to low concentrations of air pollutants, such as e.g. ammonia, hydrogen sulphide, which are by-products of decomposition of organic waste material, or which are released from the materials used for the interiors of buildings. Therefore it is suitable for the ventilation of spaces polluted by gaseous substances of organic origin, cooking fumes, cigarette smoke, and such like. The sensor is also suitable for preliminary detection of alcohol vapours, leak detection of gases such as methane, propane-butane, natural gas, etc. Measuring the air pollution works on the semiconductor basis. The sensitive element changes its conductivity in relation to the air pollution. The sensor is not sensitive only to the above-mentioned compound, but it exhibits certain sensitivity to other organic vapours, including various deodorants, fragrances, perfumes, odours, and such like. Furthermore, the sensor demonstrates certain sensitivity to relative humidity of air, and good long-term stability.

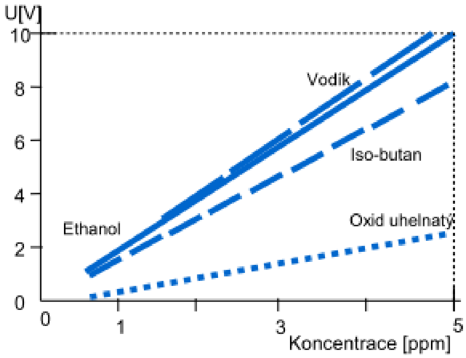
⚠ The sensor is not designed for safety indication, such as gas leakage or smoke detection.

Some examples of detected sources of pollution: Cooking fumes and rotting materials of organic origin. Substances released from furniture, carpets and other materials in buildings.

Applications:Ventilation control in restaurants, bistros, hotels, offices, kitchens, dressing rooms, households, etc.

The sensor is stabilized only after prolonged operation, when it has been continuously supplied voltage for at least 2 days; this is true for most electrochemical sensors. Electrochemical sensors are susceptible to moisture at low temperatures during transportation; they are distributed from the factory with a moisture absorber (silica gel).

Orientation dependence of output voltage on the concentration
(the range 0 - 5 ppm for ethanol)



Connecting the sensor to the CIB bus, mechanical dimensions and mounting data are identical with the C-AQ-0001R module.

11.3.4 Measuring relative humidity (RH) , CFox module C-AQ-0004R

The C-AQ-0004R module is a spatial sensor of relative air humidity. It is designed for indoor measurement, to control ventilation systems, air-conditioning and heat recovery units, for the measurement and control of relative humidity in industry, in warehouses, and the like.

The module measures relative humidity in the range from 0 to 100%, the operating temperature range from 0 to 50 °C.

Connecting the sensor to the CIB bus, mechanical dimensions and mounting data are identical with the C-AQ-0001R module.

11.3.5 Measuring relative humidity (RH) and temperature , CFox module C-RQ-0600R-RHT

The C-RQ-0600R-RHT module is designed to measure relative humidity and temperature of air in the interior. It is designed to control ventilation systems, air-conditioning and heat recovery units.

The module measures relative humidity in the range from 0 to 100%, the operating temperature range from 0 to 50 °C.

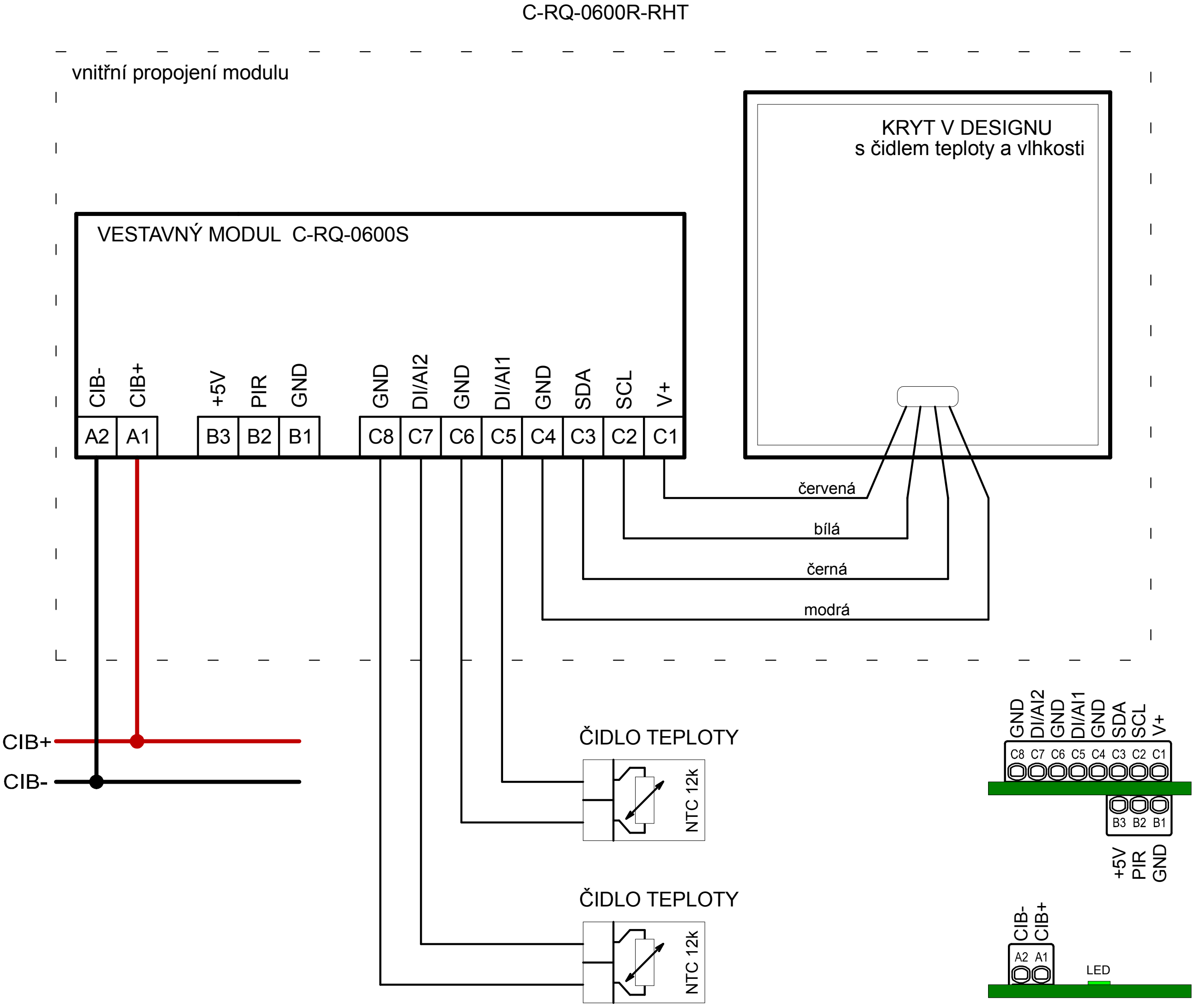


Fig. 11.3.5.1 An example of wiring the C-RQ-0600R-RHT module and the layout of the terminals in the mechanism of the module

Notes:

1. The right part of the figure shows the layout of terminals on the front side of the module.

11.3.6 Measuring outdoor relative humidity and temperature , CFox module C-RQ-0400I

Measurement of outdoor humidity and temperature can be done by the C-RQ-0400I sensor.
The module is also equipped with two universal inputs allowing connection of e.g. an additional temperature sensor, a button (for digital input), etc.
More detailed properties of the combined temperature and humidity sensor and the whole module are listed in the chapter describing the C-RQ-0400I module.

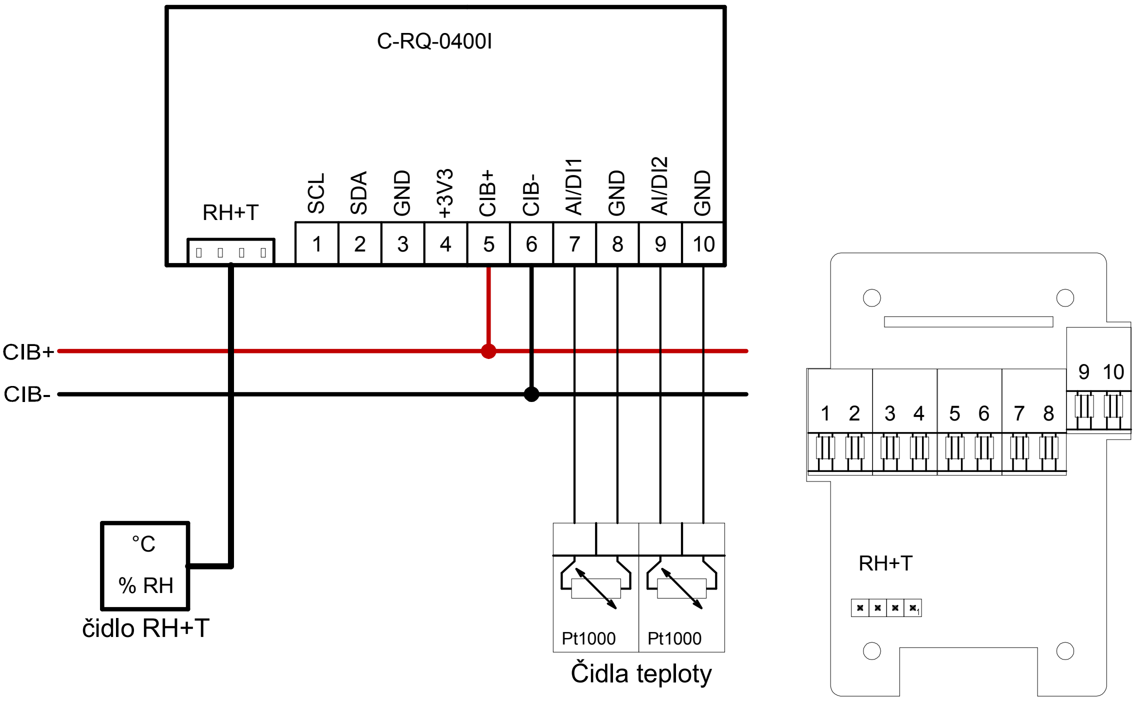


Fig. 11.3.6.1 An example of wiring the C-RQ-0400I module and the layout of the terminals in the mechanism of the module

Notes:

1. The combined temperature and humidity sensor is terminated by a cable, connected to the connector in the left bottom corner of the module.

11.3.7 Measurement of outdoor relative humidity and temperature with a detached sensor

Measuring humidity in the environment with the risk of flowing water, condensation, etc., can be done by the C-RQ-0400I-xx sensor (xx - the cable length in dm), with the sensor mounted on the cable of the given length (max. 2m). The sensor can be placed in an environment with condensing moisture, dripping water, etc.

More detailed properties of the combined temperature and humidity sensor are listed in the chapter describing the C-RQ-0400I module.

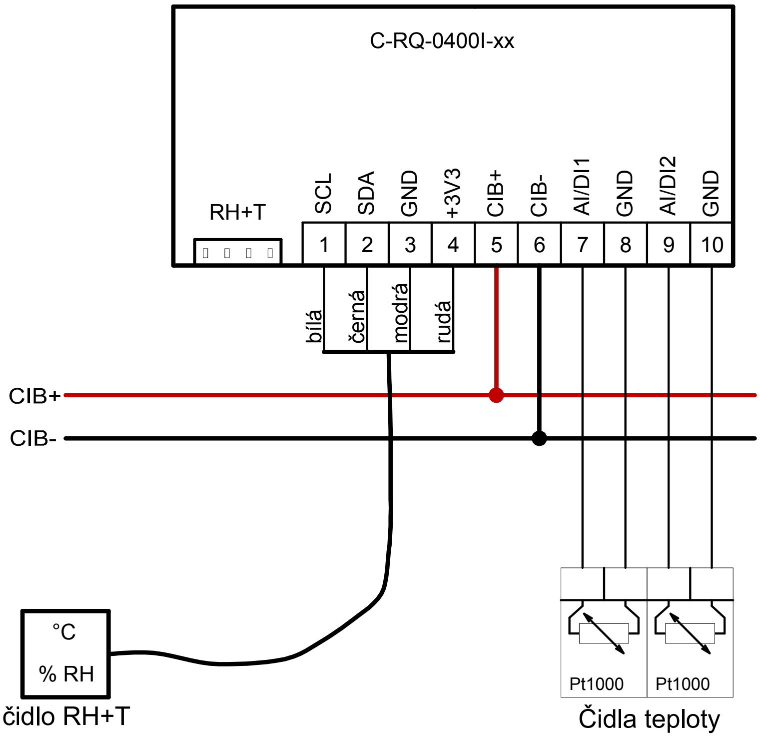


Fig. 11.3.7.1 An example of connecting the C-RQ-0400I-xx module

Notes:

1. The combined temperature and humidity sensor is terminated in the module by a cable, which is connected to the module terminal block; the wire colour coding is shown in the diagram.

11.3.8 Measuring relative humidity and temperature in HVAC ducts

Measuring relative humidity and temperature of air in non-aggressive environment in air conditioning ducts, ventilations ducts, etc., can be done by the C-RQ-0400H-P sensor.
More detailed properties of the combined temperature and humidity sensor are listed in the chapter describing the C-RQ-0400H-P module.

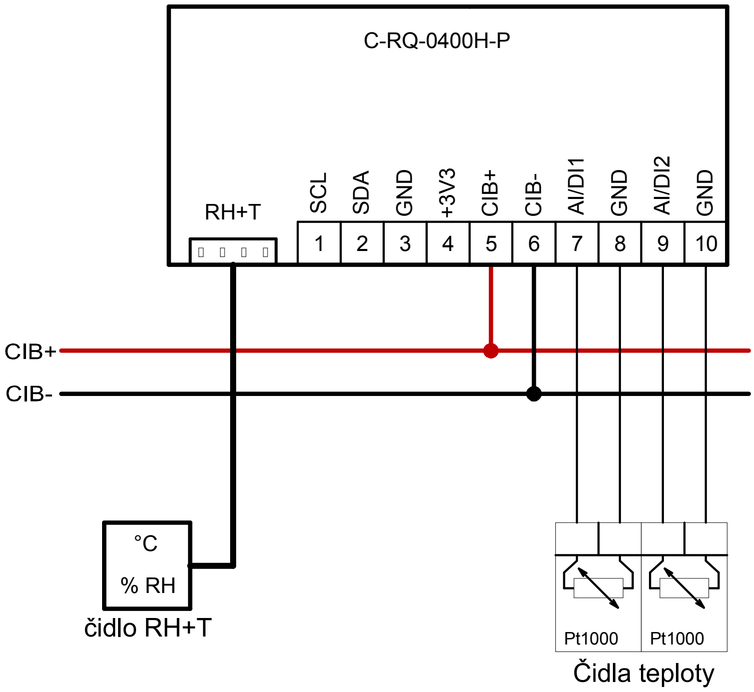


Fig. 11.3.8.1 An example of wiring the C-RQ-0400H-Pmodule and the layout of the terminals in the mechanism of the module

Notes:

1. The combined temperature and humidity sensor is terminated by a cable, connected to the connector in the left bottom corner of the module.

11.3.9 RH and temperature measurement for HVAC applications, the sensor with a 4÷20mA output

For measuring temperature and humidity in e.g. ventilation units, in agriculture, etc. Combined sensors with analogue output can be used, typically with a 4 to 20mA current loop. For an example of wiring the kHCPA converter of temperature and humidity (produced by Sensorika) see the fig. below.

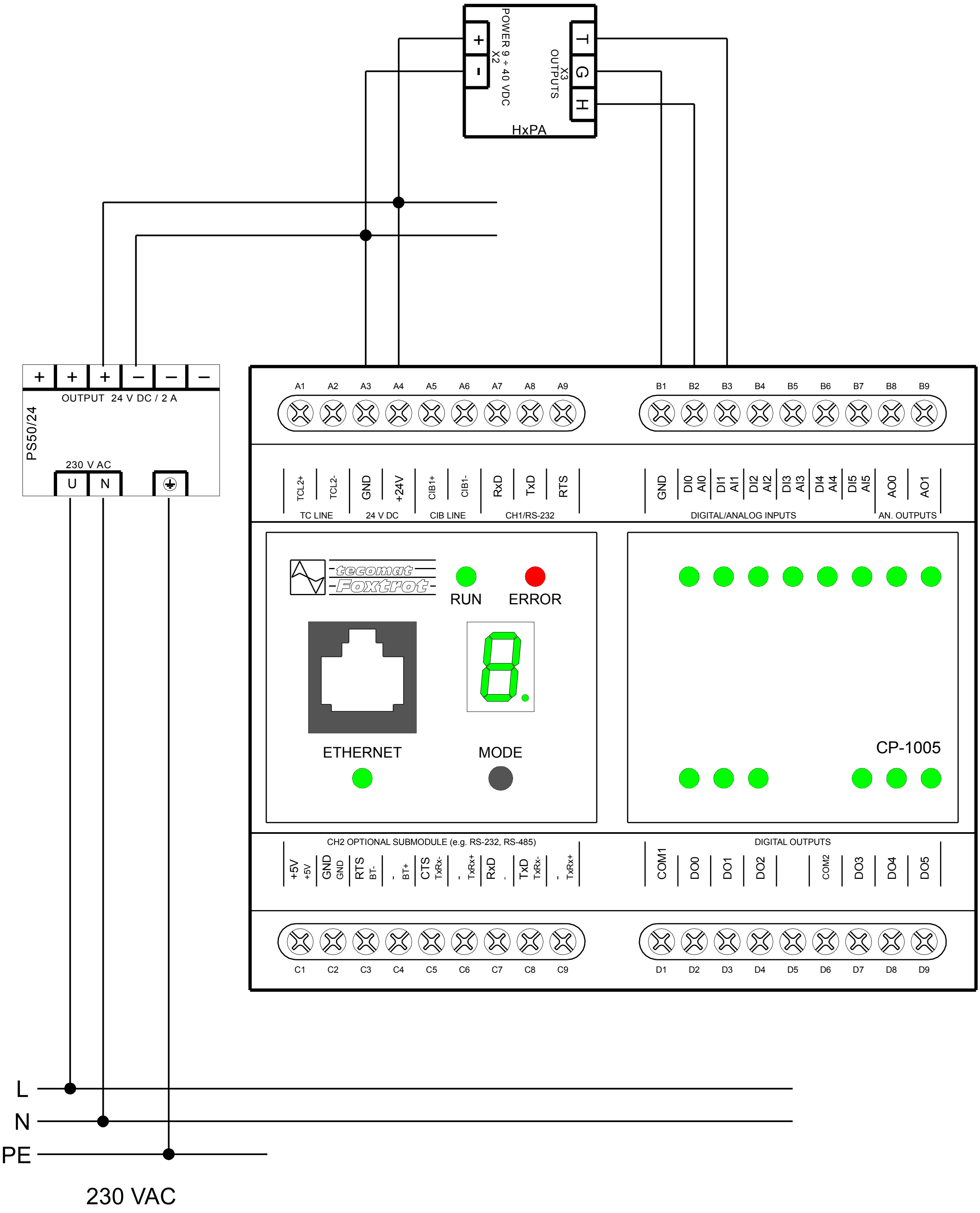


Fig. 11.3.9.1 An example of wiring the kHCPA converter to the CP-1005 module

Notes:

1) The converter is equipped with active current outputs with a common minus terminal.

11.4 Measurements of dewing (condensation of air humidity)

In order to prevent condensation on piping, cooling ceilings, walls of equipment, etc., there are special resistive dewing probes used (Chap.11.4.1). By modifying the properties of a sensitive polymer layer they allow measuring high humidity. For this purpose, there are also conductive probes, which have two insulated electrodes on the mount, and the resistance between the two electrodes is measured (Chap.11.4.2).

The resistive probe with the polymer layer (Chap.11.4.1) can only be connected to the AI5 input of the C-AM-0600I module.

The probe with the isolated electrodes (Chap.11.4.3) can be attached to the AI5 input of the C-AM-0600I module, or to the inputs AI1 to AI3 of the modules C-HM-0308M, HM-C-1113M and C-HM-1121M.

In order for the dew sensor to function properly, it must have the same temperature as the surface that is to be protected against condensation, and access of air from the room must be provided. The sensor should be placed in the coldest point of the monitored ceiling or device; in water-cooled ceilings, the sensor should be installed on the cooling water supply pipes. The contact surfaces between the sensor and its seating can be coated with some thermally conductive paste. The exact procedure of placing the sensor in capillary ceiling cooling system must be resolved as per the ceiling cooling system manufacturer's instructions.

Pollution and aggressive chemicals affect the measurement accuracy and shorten the life of the sensor.

Dew point

What is usually specified is the temperature of the dew point. It is the temperature to which it would be necessary to cool the air (at a constant pressure), so that the water vapour contained in it becomes the so-called saturated steam. When the temperature is further reduced, the saturated steam is transformed into liquid and dew is formed.

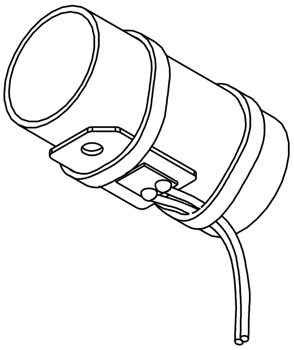
11.4.1 Measuring dewing (protection against dewing on cooling ceilings, etc.)

Dewing can be prevented using a special SHS sensor with the resistance characteristic and sensitivity to high air humidity. Typical applications include cooling ceilings, control panel cabinets and similar devices, where dewing e.g. on the walls must be prevented.

The sensor can withstand short periods of up to 100% humidity, but it must not be exposed to continuous condensation.

The sensor should be fixed with an adjustable strap on the feed pipe (the coldest part of the system), or it can be screwed onto the monitored surface. The contact surfaces between the sensor and its seating can best be coated with some thermally conductive paste. The sensor should be protected against damage and getting dirty (by colouring, etc.).
There must be a small hole in the plaster under the sensor, so that air could penetrate from the room to the sensor. Only then the sensor can correctly measure the humidity of air in the place where the system pipe is located.

The range of relative humidity (RH)	0 to 100%
The range of temperatures	0 to 60 °C
Dimensions (the metal base of the sensor)	20 x 12x 0.6mm
Mounting hole	Ø 3.2mm
Impedance at RH < 75%	< 20kΩ
Impedance at RH < 93%	< 100kΩ
Impedance at RH > 97%	> 150kΩ
The reaction time due to the humidity changes from 75 to 99.9%	around 60s



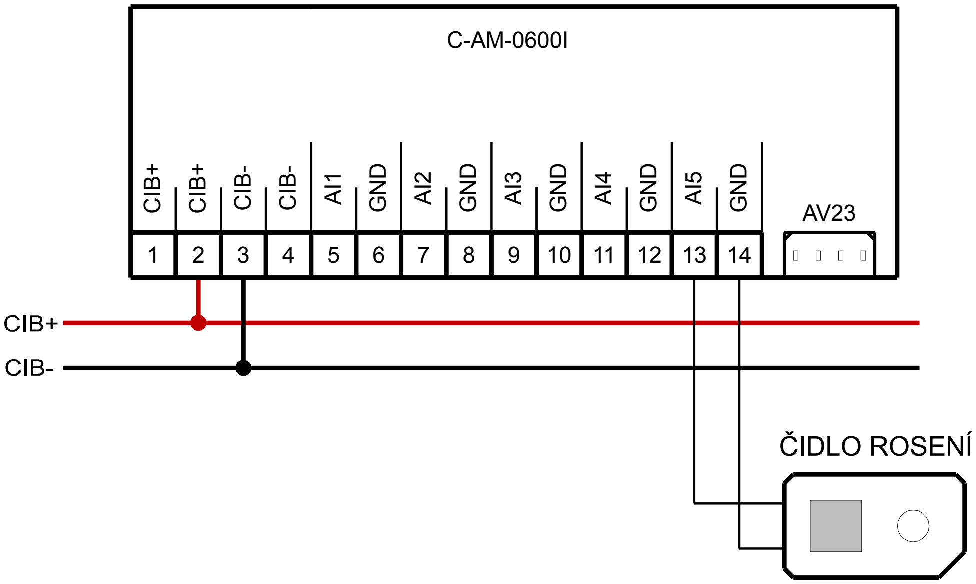


Fig. 11.4.1.1 An example of wiring the SHS dew sensor to the C-AM-0600I module

Notes:

1) The SHS sensor can only be connected to the AI5 input.
2) The supply cable can be extended up to approx. 30 m. You should use a shielded cable, e.g. the SYKFY 2x2x0.5, or J-Y(St)Y 1x2x0.6.
3) When the sensor is being mounted, care should be taken to maintain quality conductive connection with the monitored surface, and to avoid damaging the active surface of the sensor.

11.4.2 Measuring the dewing of a higher number of cooling ceilings, etc.

A solution for a high number of measuring points with the peripheral Foxtrot module IT-1604. If it is necessary to monitor the dewing of ceilings in several rooms, the IT-1604 module can be used (with some added external resistors), to which up to 8 SHS sensors can be connected.

The connection of the sensors including the required 39k and 270k resistors is illustrated in the following figure. For the range of the sensor resistance from 20 to 100kΩ(which corresponds to about 70 to 93% humidity), the output voltage measured by the module (1V range used) should be approx. from 0.47V (for humidity up to 75%) to 0.94 V (for humidity up to 93%).

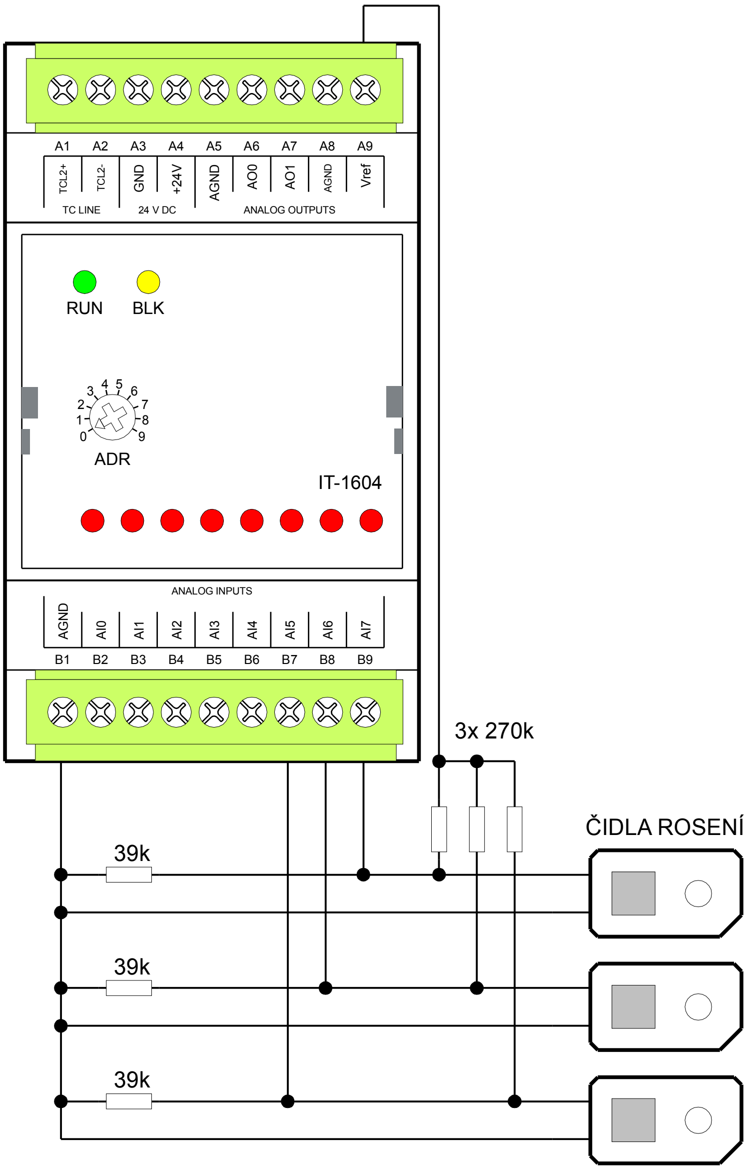


Fig. 11.4.2.1 Connecting several SHS sensors to the IT-1604 module.

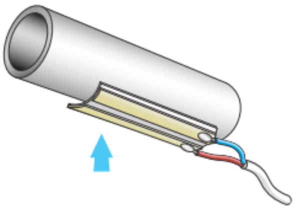
Notes:

1) The 39k and 270k resistors may have a 5% tolerance, with no additional requirements.

2) The supply cable can be extended up to approx. 30 m. You should use a shielded cable, e.g. the SYKFY 2x2x0.5, or J-Y(St)Y 1x2x0.6.
3) When the sensor is being mounted, care should be taken to maintain quality conductive connection with the monitored surface, and to avoid damaging the active surface of the sensor.
4) Analogically as per the example, as many as 8 sensors can be connected to the AI1 to AI8 inputs.

11.4.3 Dew point monitoring (condensation on the distribution system of fan-coils, etc.).

The condensation probes, based on the principle of insulated electrodes, can also be used for monitoring condensation. These probes are supplied e.g. by manufacturers of air conditioning equipment, cooling systems, etc., as part of their products (e.g. the UNIVERSA, a dew point sensor 450 650, or the plasterboard version 450 651).



The sensor consists of a conductive layer usually deposited on a flexible substrate. It should be attached by a self-adhesive layer or by tightening straps to the bottom part of the piping.

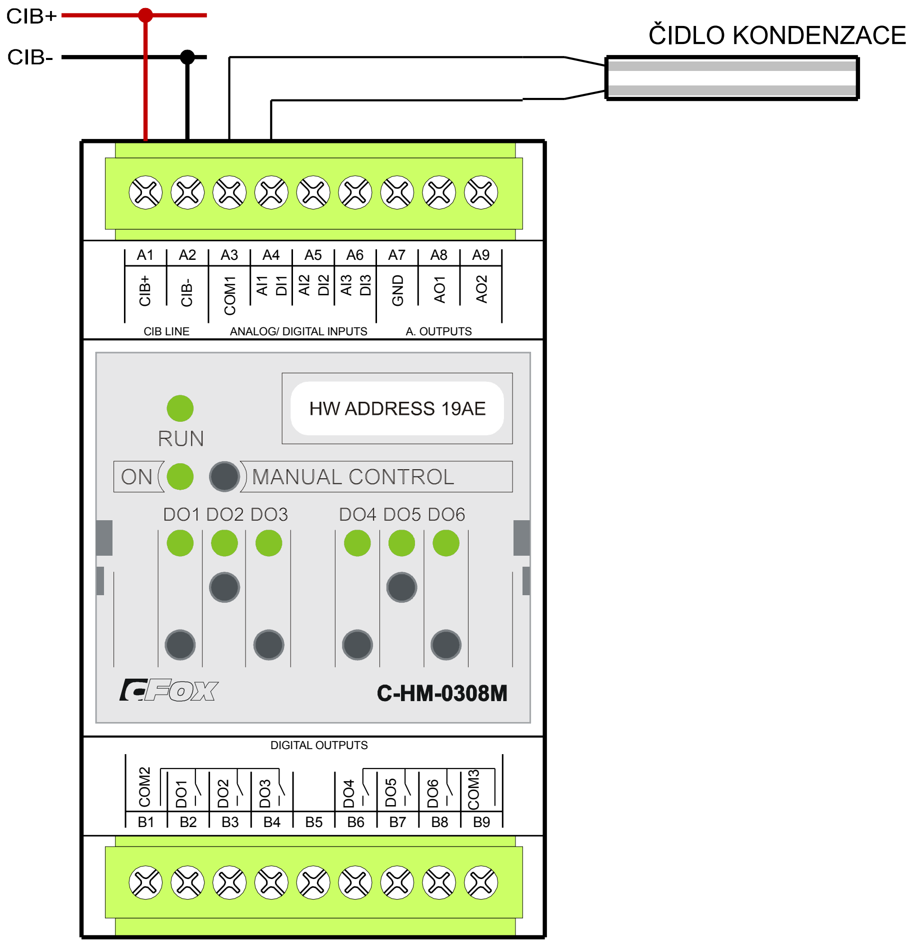


Fig. 11.4.3.1 An example of connecting the condensation sensor to the C-HM-0308M module.

Notes:

1) The condensation sensor can be connected to any input of the module (AI1 to AI3).
2) The supply cable can be extended up to approx. 20m. You should use a shielded cable, e.g. the SYKFY 2x2x0.5, or J-Y(St)Y 1x2x0.6.
3) When the sensor is being mounted, care should be taken to maintain quality conductive connection with the monitored surface, and to avoid damaging the active surface of the sensor.

One system input enables parallel connection of several sensors (up to 5). The system input then evaluates the state, when any sensor has recorded the formation of condensation.

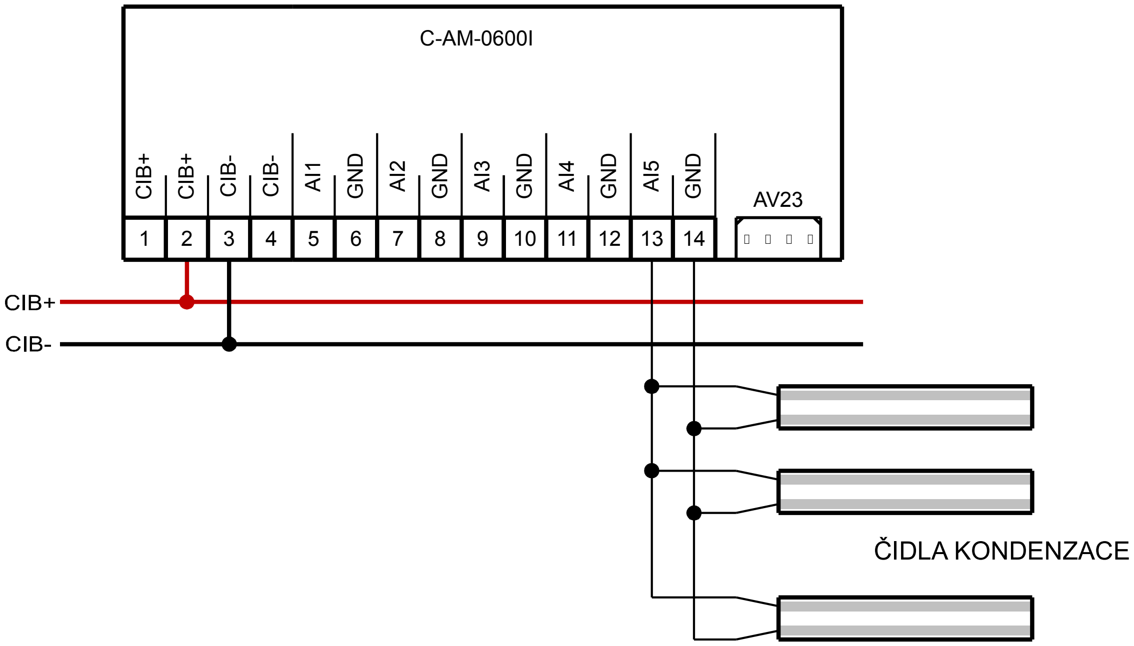


Fig. 11.4.3.2 An example of the connecting several condensation sensors to the C-AM-0600I module.

Notes:

1) The condensation sensors can only be connected to the AI5 input.
2) The supply cable can be extended up to approx. 20m. You should use a shielded cable, e.g. the SYKFY 2x2x0.5, or J-Y(St)Y 1x2x0.6.
3) When the sensor is being mounted, care should be taken to maintain quality conductive connection with the monitored surface, and to avoid damaging the active surface of the sensor.

11.5 Measuring the lighting

The **intensity of lighting** (also **illuminance** in accordance with ČSN EN 12665) is a photometric value defined as the luminous flux incident on a particular surface. It is the quotient of the luminous flux (in lumens) and the area (in square meters). It is denoted as **E**. Its unit is a lux (lx), which is illumination caused by luminous flux 1lm incident on an area of 1m².

A normal value of indoor light ranges from 100 ÷ 2,000 lx, on a sunny summer day outdoors it can reach up to 70,000 lx (at the latitude of the Czech Republic).
A clear moonlit night with the full moon represents the illumination of up to 0.5lx.
Human sight is so adaptable that a person is able to read a clear text at approx. 10-8lx.

Requirements for artificial lighting

Illuminance [lx]	The place and the activity
75	Communication in a flat
100	Living kitchens, bathrooms, toilets
150	Halls, reading in bed
50 ÷ 100	Total or graded illumination of the living room with local lighting
200 ÷ 500	Total or graded illumination of work areas without local lighting
200 ÷ 300	A common meal
300	Studying, writing, drawing, kitchen work, etc.
500	Delicate manual work, homework, blackboard in the classroom, office

The recommended ranges of illumination defined by the International Commission on Illumination (CIE):

Illuminance [lx]	
20 ÷ 50	Basic orientation in the environment
50 ÷ 100	Simple orientation, short simple activities
100 ÷ 200	Social spaces, short-term work
200 ÷ 500	Routine work-related tasks (offices, schools)

The main requirements and criteria for the lighting of the interior of flats are: good orientation in space, visual comfort and colour rendering fidelity. This is what the parameters of lighting intensity are based on, as well as the type of lighting fixtures (incandescent bulbs, fluorescent lamps, discharge lamps, LEDs). The recommended maximum ratio of illuminance of adjacent spaces in the flat is 1: 5.

The level of outdoor lighting and indoor illumination is measured by the C-RI-0401S module, or its variants, e.g. the C-RI-0401R-design, or the C-RI-0401I.

11.5.1 Measuring the interior lighting

The light intensity indoors can be measured by the C-RI-0401R-design module, which consists of two parts: The first, recessed part (corresponding to the C-RI-0401S), is placed in the flush box, typically under the second wall-mounted design part.
The second wall-mounted part, by default in ABB Time design (other types of designs, or other mechanical arrangements can be customized), is equipped with the sensors of illumination, interior temperature, the IR transmitter and the receiver. In the customized versions, some sensors can also be left out (e.g. the IR sensor).
The module measures the interior illumination levels, with the range of the measured light intensity from 0 to 50,000lx.

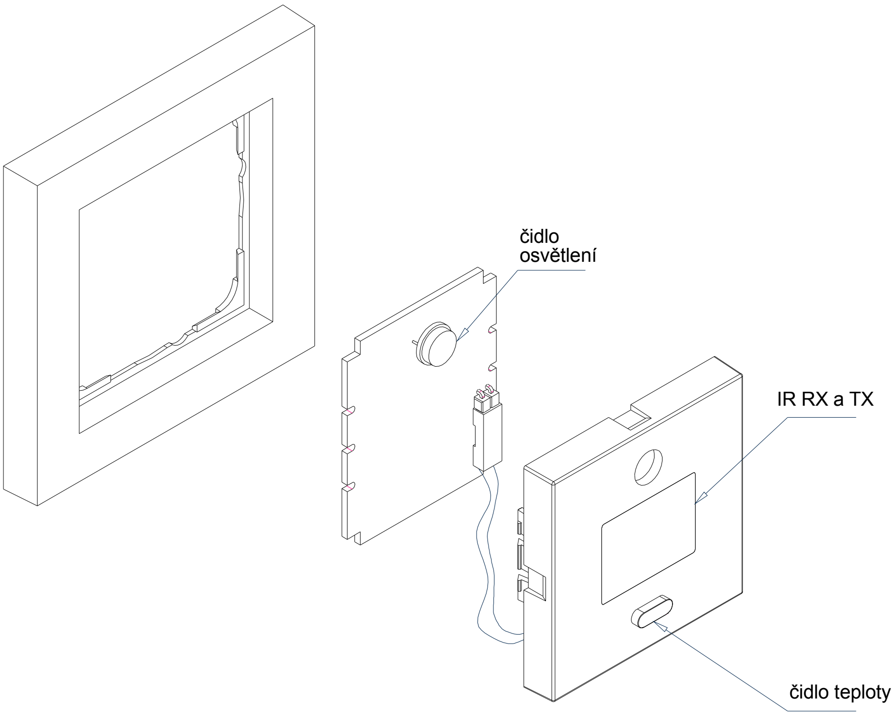


Fig. 11.5.1.1 An example of the design of the sensor of lighting, temperature and IR control in the GIRA design (system 55)

Notes:

1) The figure shows the second part of the module, i.e. the design part with sensors. In this case it illustrates the GIRA design cover, electronics is by default installed inside the cover (both parts are for better clarity separated from each other); on the left a standard frame is shown.
2) The appearance and the method of mounting on the wall varies according to the particular design. Both parts of the module are connected with a connector-terminated ribbon cable (on the side of the design part is a connector allowing a separation of both parts). The cable shown is the figure is from the temperature sensor; it is firmly mounted in the supplied module and it cannot be disassembled.

11.5.2 Measuring the intensity of outdoor lighting

The intensity of outdoor lighting (N.B.: it serves for the measurement of indirect illumination - it is not a sun sensor!) is measured by the RI-C-0401I module, which is designed as a separate wall-mounted module with a higher protection. In addition to the lighting sensor, the module also includes a terminated outdoor temperature sensor.
Inside the box is located the C-RI-0401S module, whose detailed description is given at the end of this manual, where the module C-RI-0401S is described. The actual sensor of lighting and temperature is connected to this module, which only needs to be connected to the CIB bus. This connection is enabled by the output of the C-RI-0401S module with a terminal block.

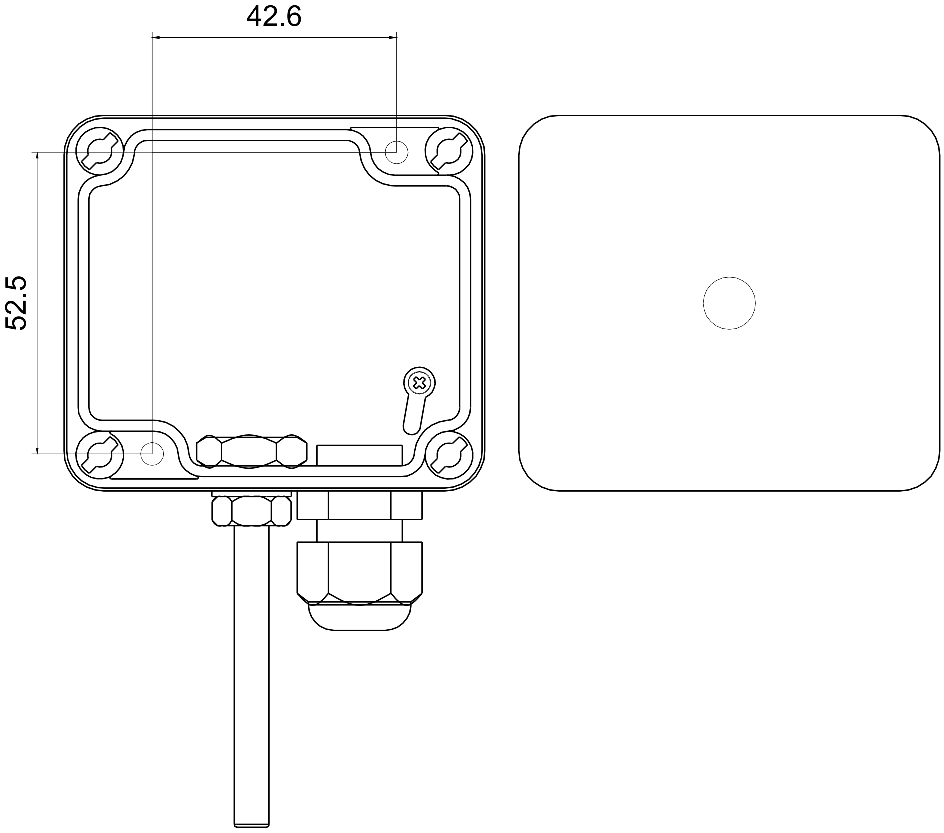


Fig. 11.5.2.1 A view the C-RI-0401I module (on the left is the module itself with the temperature sensor and a gland for the CIB cable, on the right is the housing with the light sensor), including the mounting holes.

Notes:

1) The box is equipped with 4 bayonet screws; the cap and the body of the box are connected with a cable.
2) Be cautious when handling with the internal circuits during the assembly and closing the box (to avoid damaging wires or squashing them under the lid when closing the module).
3) A standard cable for the CIB can be used as a supply cable, with regard to the placement.
4) When installing the C-RI-0401I module you must take into account the surge protection - avoid installation near the conductive grid of the lightning conductor, or close to large metal structures of the house (minimum distances must be observed) . If necessary, it is possible to install the over-voltage protection on the CIB bus on the zones boundary.
5) The temperature sensor in the module (the stem is 60mm) is the Pt1000 type, W_{100} = 1.385

11.5.3 Measuring outdoor lighting, the sensor is installed by the customer

The outdoor lighting is measured by the C-RI-0401S module, whose built-in version is placed in the flush box; it is terminated with a connector, to which the BPW21 lighting sensor itself should be connected (it has to be ordered separately).
The lighting sensor must be mechanically fastened in such a way, that its front part monitors the lighting and the rest of the housing is protected from mechanical impacts and the weather conditions. The positive (+) terminal of the lighting sensor (see the dimensions of the sensor in the figure) should be connected to the pin 7 (grey), and the negative pole to the pin 6 (blue).
During the handling with the sensor and the installation, caution is necessary, as this is an electronic component with fine outlets (the pins must not be bent close to the housing due to the risk of breaking).
A more detailed description of the C-RI-0401S module, including inputs and outputs connection, can be found at the end of this manual in the description of the C-RI-0401S module.

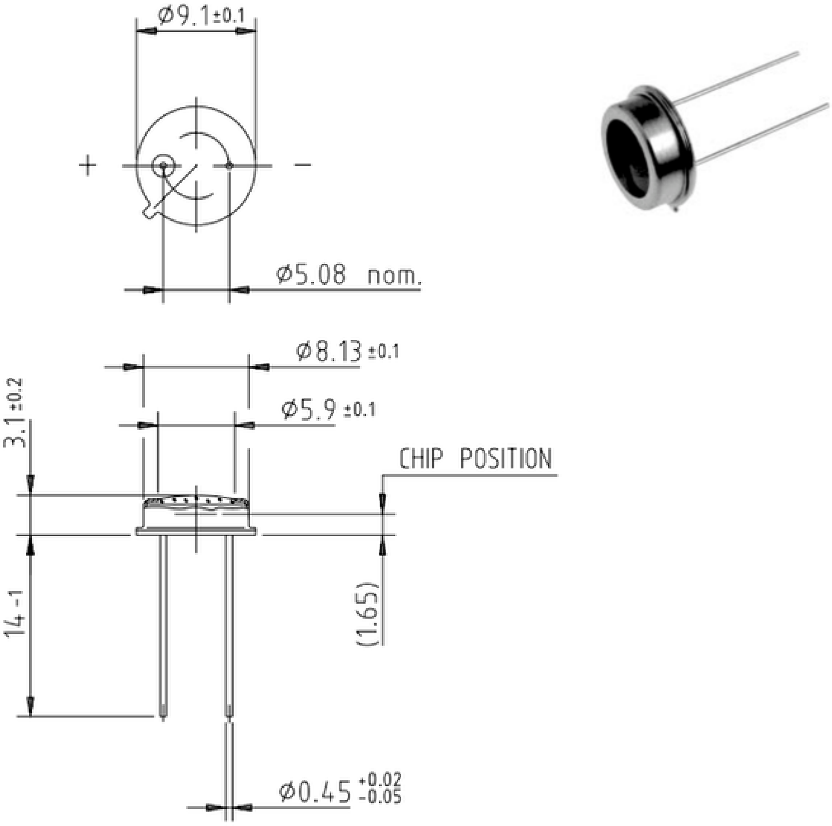


Fig. 11.5.3.1 The dimensions of the lighting sensor BPW21, including the polarity of the outlets.

Notes:

1) The sensor terminals (pins) must not be bent close to the housing; the sensor must be handled with care.
2) Regarding the inlet cable from the sensor to the module, it is recommended to use a shielded cable, e.g. the SYKFY 2x2x0.5, which can be extended to max. 2m.
3) During the installation of the BPW21 sensor, and subsequently the C-RI-0401S module, you must take into account the surge protection - avoid installations near the grid of the lightning conductor, or close to large metal structures in the house. If necessary, it is possible to install the over-voltage protection on the CIB bus on the zones boundary.

11.6 Meteorological measurements – wind, precipitation, the sunlight

In this chapter, basic information on the measurement of meteorological variables is provided, including examples and recommendations. The variables include wind speed and direction, rainfall, intensity of solar radiation, etc.
The basic examples present solutions, which are suitable for the measurements done by the average users; these are not professional meteorological measurements, although methodological rules of the Czech Hydrometeorological Institute are respected, wherever possible.

Meteo sensors should be installed in an open area, which is not overshadowed by trees and buildings, if possible.
The outdoor temperature and air humidity is measured at the height of 2m above the ground, the ground minimum temperature is measured 5cm above the ground. The sensors should be placed so as not to be affected by the radiation component (the sensor must not be exposed to direct sunlight) - the small shields of cheap meteo sensors are generally unsuitable and when they are lit by the sun, the error of the measurement is extensive. A precondition for accurate measurement is also adequate air flow around the sensor (the installation should avoid various nooks, alcoves, etc.). When you are measuring in the open area, it is recommended to utilize the Stevenson screen (also called the instrument shelter). It is a white wooden or plastic box, with double louvered walls, a roof and perforated bottom, which allows natural ventilation. It is painted both from the outside and the inside with a white glossy paint).

The speed and direction of wind is measured at 10m above the ground (the so-called surface wind). The speed of wind measured lower than 10m above the ground must be recalculated with a correction coefficient for meteorological purposes.

If the required height of measurement above the ground cannot be met, a correction factor is used for the calculation of the speed of wind as per this formula:

V10/Vh = 1/(0.233 + 0.656 * log10(h+4.75))

V10/Vh the correction factor, by which the measured wind speed is multiplied.
h the height of your sensor above the ground in meters (e.g. if your anemometer is 5 meters above the ground, V10/Vh will be 1.134).

Precipitation is usually measured 1m above the ground.
Precipitation is classified according to its rate:

very light rainfall	< 0.25mm/hour
light rainfall	> 0.25 mm/hour and < 1.0mm/hour
moderate rainfall	> 1.0 mm/hour and < 4.0 mm/hour
heavy rainfall	> 4.0mm/hour and < 16.0mm/hour
very heavy rainfall	> 16.0mm/hour and < 50.0mm/hour
torrential rainfall	> 50.0mm/hour

Temperature
For more information on temperature sensors, see Chapter 10.
Conversion of expressing temperature:

Absolute temperature (Kelvin $T[K]=t[^oC]+273{,}15$ scale):

Temperature can also be expressed in Fahrenheit scale: $T[^oF]=\frac{9}{5}t[^oC]+32$

Air pressure

The air pressure is measured absolutely, and subsequently it is converted into pressure which is relative to the sea level.
The unit of pressure used in meteorology is hPa (a hectopascal, before it was a millibar, mbar).

1 Pa=1 $N.m^{-2}$. (a Newton per square meter), or 1 hPa=100 $N.m^{-2}$.

Air humidity
Absolute air humidity :
indicates the amount of water vapour in grams in $1m^3$ of humid air ($g.m^{-3}$). In temperate latitudes and in lower layers of atmosphere, the values of absolute humidity fluctuate around $5g.m^{-3}$, in summer up to 15-20 $g.m^{-3}$.
Relative humidity:
It is the ratio of the actual content of water vapour in a particular volume of air to the maximum possible water vapour content at a given temperature. Relative humidity is expressed in %. 100% RH means that air is saturated with water vapour (the temperature at which the vapour contained in the air becomes saturated and is called the dew point).

Direct sunlight
It represents a bundle of virtually parallel rays coming from the sun. The basic phenomenon in the description of the direct solar radiation is its intensity I, which is defined as the quantity of radiant energy that during a time unit hits an area unit oriented perpendicularly to the sun rays.

The rainfall shows how many mm of rain will fall in an hour, if the current intensity of rain is maintained.

The wind chill
Mathematically, it is possible to express the perceived temperature on the surface of the body at a certain air temperature and wind velocity by the so-called wind chill factor. Wind chill expresses the cooling effect of wind acting on the body surface. E.g. at the external temperature of 10 °C and the wind speed of 30km/h, the perceived temperature on the surface of human body is only 3 °C. If the outdoor temperature is -10 °C and the wind speed is the same, the perceived temperature on the body surface is as little as -26 °C. Of course what applies here is a direct correlation between the wind speed and the loss of heat.

This value also takes into account the effect of wind on our perception of the outside temperature. When the temperature is below 37 °C, human body heats up the surrounding air. If there is no wind, the heated air does not move and thus creates a kind of insulating layer around the body. Once the wind starts blowing, it blows away the warm air and the feeling of cold increases.The effective (perceived) temperature is calculated on the basis of the actual temperature and the wind speed according to the following formula: :
$WCT = 13.13 + 0.62 * T - 13.95 * V^{0,16} + 0.486 * T * V^{0,16}$

WCT=effective temperature, T=real temperature, V=the speed of wind

Thermal comfort
Thermal comfort is a relative notion. Thermal comfort depends on the physical conditions and human activity. If a person is not too warm and does not feel cold, it can be said that s/he is in a state of thermal comfort. A basic condition for thermal comfort is adequate air temperature in the room, but it is not the only condition. The temperature of the room utilities, walls and humidity of air are also important factors. If the temperature of air is e.g. 20 °C, the surface temperature of the walls should not drop below 18 °C. At a lower temperature of surfaces, the air temperature would have to increase; this would cause condensation of the water vapours on the walls, and the thermal comfort would deteriorate. Insufficient thermal insulation of walls results in a low surface temperature. A recommended relative humidity in rooms is from 30 to 50%. When the humidity is lower, evaporation from human bodies increases, which cools them down; on the contrary, at higher humidity levels water evaporates badly, which results in sweating. During ventilation, the

relative humidity is increased by cooling the air. Heating the air decreases the relative humidity, so it is therefore advisable to increase it by evaporation of water from e.g. a vaporizer.
The difference of the surface temperature (walls, floors, windows, doors and equipment of the rooms) and the air temperature should not be higher than 4 °C. The sum of these temperatures should be around 38 °C.

11.6.1 Measuring the speed and direction of wind

The speed of wind (e.g. for controlling outdoor blinds and awnings - protection against strong wind) can be measured by a number of anemometers with a pulse output, which is further processed like other pulse meters (the flowmeter, etc.). You need to know the anemometer constant (the number of pulses/wind speed), which should be entered into the FB in Mosaic, and what you get is the current wind speed and other meteorological variables (maxima, minima, etc.).
The direction of wind can be measured by indicators of wind direction, equipped with a resistance output; then the indicator output signal is measured with the analogue system input.
The signal can be processed by a FB to Mosaic, which we will then recalculate the indicator resistance value to obtain the current wind direction.
The T114 anemometer and the T115 wind direction indicator have standard function blocks available, so there is no need to feed any other data in the system.

The **T114 anemometer**
is a standard vane anemometer, the two-wire output cable with a terminated contact output is approx. 40cm long, with an RJ connector. The anemometer is mounted behind a cylindrical mandrel with a diameter of about 18.5mm and the length 19mm.
It can be used separately or in conjunction with a wind direction indicator - then it is recommended to buy the complete set that includes an anemometer, a wind indicator and a rain gauge, as well as the basic mechanical parts for installation of sensors; see the following figure. If you install the anemometer together with the wind direction indicator, use a common holder for both sensors; it includes a vertical tube with the diameter of 20mm, which should be anchored to a suitable construction. The RJ connector of the anemometer should then be inserted in the prepared connector on the bottom side of the wind direction indicator; its cable can be used for both signals - see the wind direction indicator.

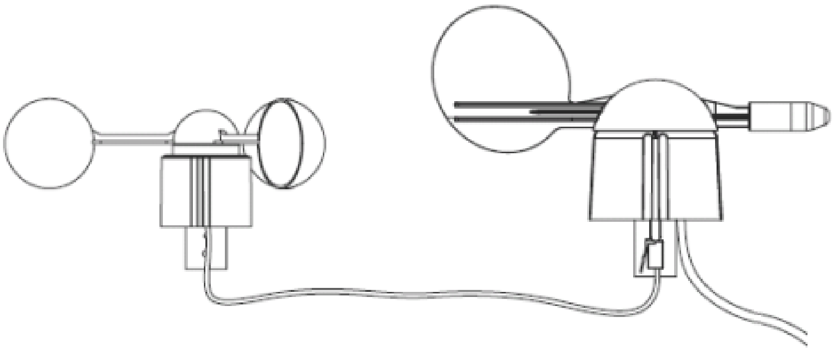


Fig. 11.6.1.1 Connection of the anemometer and the wind direction indicator

Basic parameters of the T114 anemometer

The measurement range	0 ÷ 160 km/h (up to 45m/s)
Output	switching contact
Operating voltage	maximum 24V
The pulse length	min. 15ms

The wind direction indicator T115
can be used separately or in conjunction with an anemometer. It can be mounted using a mandrel with approx. 18.5mm diameter and 37mm length. The output signal of the wind direction and the anemometer output (if it is connected) are terminated in a four-wire 2.6m long cable with an RJ connector.

The cable from the wind direction indicator - terminating signals:
internal wires (red and yellow) – the anemometer (a pulse output)
external wires (green and black) – the wind direction indicator (variable resistance)

Fig. 11.6.1.1 The assembly with the T114 anemometer, the T115 wind direction indicator, and the T116 rain gauge

Basic parameters of the wind direction indicator T115

The measurement range	from 0° to 360°
The wind rose	8 positions
The resistance value	1 ÷ 120 kΩ

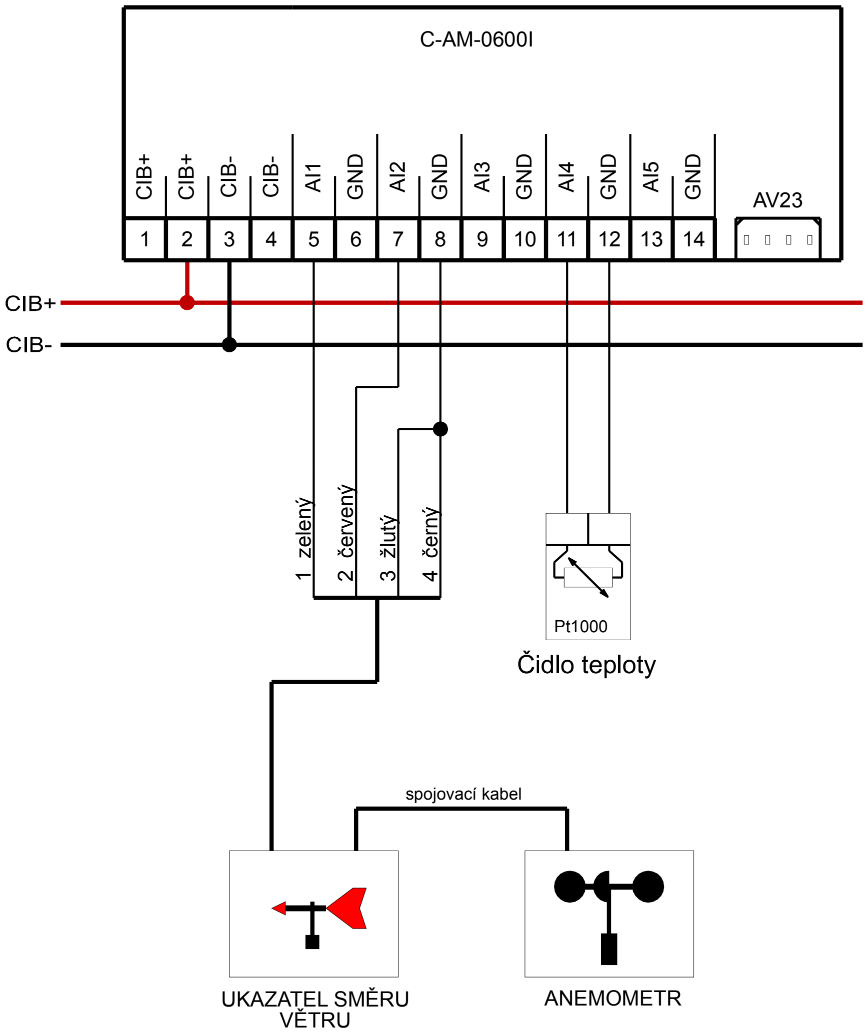


Fig. 11.6.1.1 An example of connection of the T114 anemometer with the T115 wind direction indicator T115

Notes:

1) The output cable from the anemometer and the wind direction indicator may be extended up to approx. 20m.
2) The RJ connectors at the termination of the cable are not really necessary and can be removed.
3) When the C-AM-0600I module is used (as in this example), its other inputs can also be utilized, e.g. for measuring the temperature of solar panels, the outdoor temperature, etc.
4) Other accessories, such as the tipping bucket rain gauge (measuring instruments with a pulse output), are connected in the same way as the anemometer.

11.6.2 Measuring the amount of precipitation, the tipping bucket rain gauge

Liquid precipitation can be measured by a simple sensing device - the rain gauge with a tipping bucket, whose tilting generates the pulses picked up by the control system. One pulse corresponds to a particular amount of rainfall, depending on the type of rain gauge.
Rain gauges with heating can be used in order to measure both liquid and solid precipitation (such as snow), and to achieve reliable operation in winter; they dissolve the solid precipitation, e.g. the rain gauges produced by Fiedler-Mágr, or the MR2 and MR2H gauges.

The measuring principle

Measurement of the amount of precipitation works on the principle of counting pulses from the tipping bucket, which is located under the outlet of the rain collector. Rain or melted snow always flows into the top of the bucket. When filled with a pre-defined quantity, the bucket tips, the water flows out and under the discharge the second half of the shuttle appears, into which the water flows again. Flipping switches a contact and it sends out a pulse, which is further evaluated. The whole cycle is repeated over and over again.

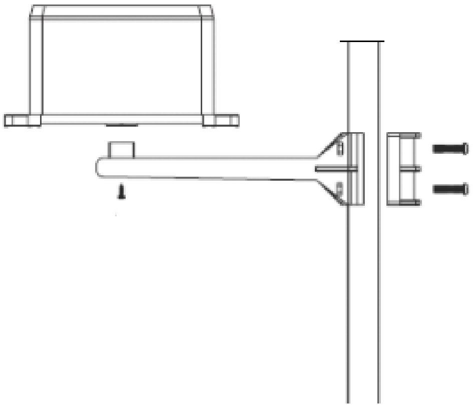
Installing a rain gauge

The rain gauge should be placed in a horizontal position in an open area, where the precipitation would not be affected by nearby objects. A standard placement of the rain gauge is 1m above the ground.
Due to the risk of the rain gauge being blocked by e.g. falling leaves, or internal physical contamination can occur (e.g. spider webs), it is recommended to position the gauge so that it can be checked, and if necessary also cleaned; therefore it is not practical to fix it to a mast on put it on the roof.

Connecting the rain gauge T116 to the Foxtrot system

The T116 rain gauge supplied by default, as well as the other gauges listed here, and also other rain gauges with a similar design, should be connected in the same way. It can be connected to any counter input of the system (i.e. the C-AM-0600 and IB-1301 inputs), or to standard digital inputs; however, in this case the minimum pulse width of the sensor must be verified, to avoid losing a pulse (e.g. the Fiedler-Mágr precipitation gauges as well as the T116 have the pulse width only 50ms). Then it is recommended for the sake of reliability to use the system counter inputs, or the inputs capable of capturing short pulses.
The T116 rain gauge is supplied by default as a part of the set, which also includes the T114 anemometer and the T116 wind direction indicator.

It can be fixed either to a vertical pipe with a diameter of about 20mm (see the Fig. .11.6.2.1), or it can be screwed to the centre of the bottom, or the handles on both sides of the bottom part can be mounted to any other suitable structure.
Care must be taken to ensure free water flow through the grilles on the underside of the housing.
Bearing in mind the falling debris and the occasional undesirable inhabitants inside the rain gauge (a spider), it is practical to position the rain gauge so that it can be easily inspected and cleaned.



Basic parameters of the T116 rain gauge:

The amount of precipitation necessary for the bucket to flip.	0.3mm
Output	switching contact

Operating voltage	maximum 24V
The pulse length	minimum 50ms
Dimensions	150 x 80 x 60mm

11.6.3 Measuring the intensity of solar radiation

Applications for measuring solar radiation (its intensity), e.g. for the evaluation of the effectiveness of PVPS, thermal panels, optimizing heating water in thermal panels, etc., utilize the solar radiation sensors: pyranometers, solarimeters and other sensors, which are sensitive to the required components of solar radiation.

Each type of sensor is sensitive to a certain range of the light spectrum:
Pyranometer: measures the total radiation, usually from 300nm to 2,800nm
Solarimeter: measures the radiation from about 300nm to 1000nm
Photodiode: the cheapest but the least accurate, with a limited range of measured radiation

A more accurate measurement requires a higher quality sensor, which has to be supplemented with temperature compensation, e.g. solar radiation is measured by a calibrated solar cell, including the temperature compensation of the measured values.

SOLARIMETER:
The solarimeter works on the principle of the photovoltaic effect, which generates an electrical signal proportional to the incident radiation (direct and diffuse solar radiation). However, a solar cell does not react with constant sensitivity to all wavelengths. It si important that it reacts to light in the same way as the PVP modules. The value measured in this way depends on the surface and the temperature of the sensing element. A high-quality solarimeter provides a compensation of the value based on the temperature of the sensor.

PYRANOMETER:
The pyranometer is an instrument for measuring total solar radiation (direct and diffuse radiation) on a flat surface. Its principle is based on measuring the temperature difference between a light surface and a dark surface by a thermocouple. It is mainly used for meteorological purposes.

Applications for monitoring the intensity of solar radiation, such as evaluating the effectiveness of PVPS, thermal panels, optimizing heating water in thermal panels, etc., can utilize a sensor for measuring the intensity of solar radiation with a temperature compensation (a solarimeter). Solar radiation is measured by the S-SI-01I sensor, whose core is a calibrated solar cell including a temperature compensation of the measured values; it is connected to the selected CFox or RFox modules, or directly mounted on the CIB bus of the C-IT-0200-SI module. (See some examples in the following chapters.)

11.6.3.1 Measuring solar radiation, the CFox sensor C-IT-0200I-SI

Measuring solar radiation can be done by the C-IT- 0200I-SI module, which comprises the inner part of the C-IT-0200I module fitted into the S-SI-01I sensor.
The solar radiation sensor uses for its own measurement of intensity a monocrystalline silicon solar cell with an integrated temperature sensor; it is used for a temperature compensation of the solar cell.
The level of intensity (W/m^2) is calculated using the function in the programming environment, which needs entering the specific sensor calibration constant; it is written on the label on the internal side of the cap, and **it should be copied before the sensor is mounted**.
The C-IT-0200I module must first be configured: AI1 measurement of 100 mV voltage; AI2: temperature measurement NTC 12k (these jumpers are set at the factory); in the same way, the module configuration must be done in the programming environment.

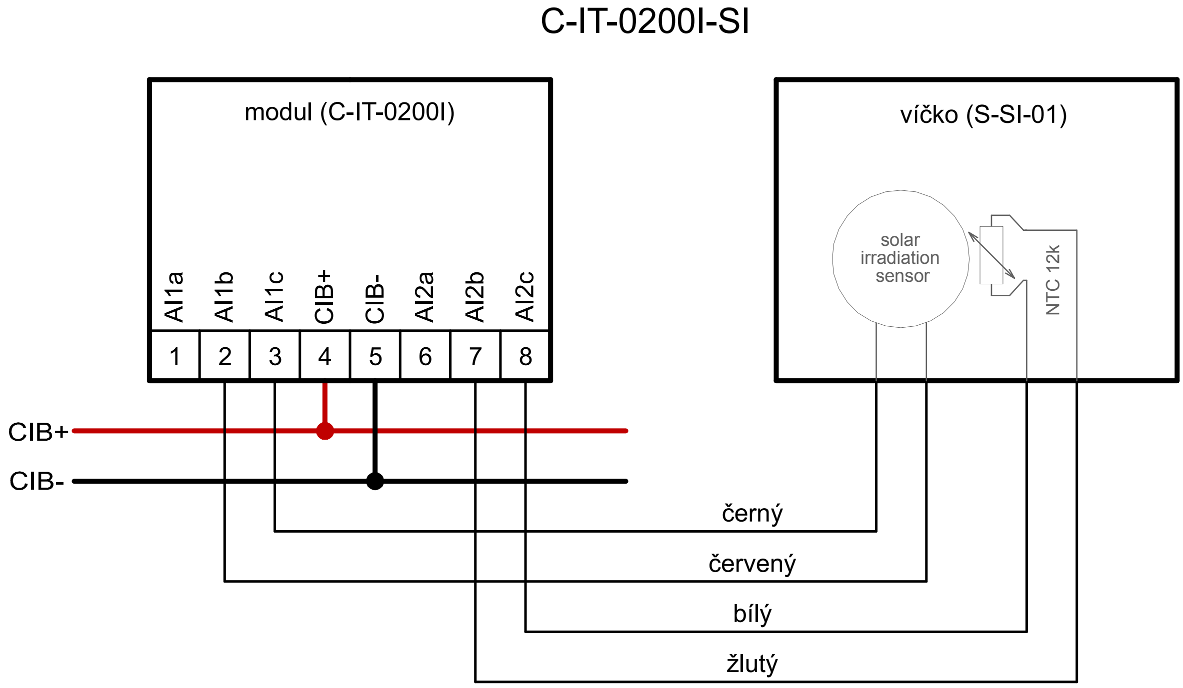


Fig. 11.6.3.1.1 Interior connection of the C-IT-0200I-SI sensor

Notes:

1. The intensity sensor output is connected to the AI1 input, the NTC 12k temperature sensor (used for the temperature correction of the measurement) is connected to the AI2 input. - N.B: It cannot be used for measuring the outdoor temperature!
2. In the same way, the separate modules C-IT-0200I and S-SI-01I can be connected, which then can be arranged separately.

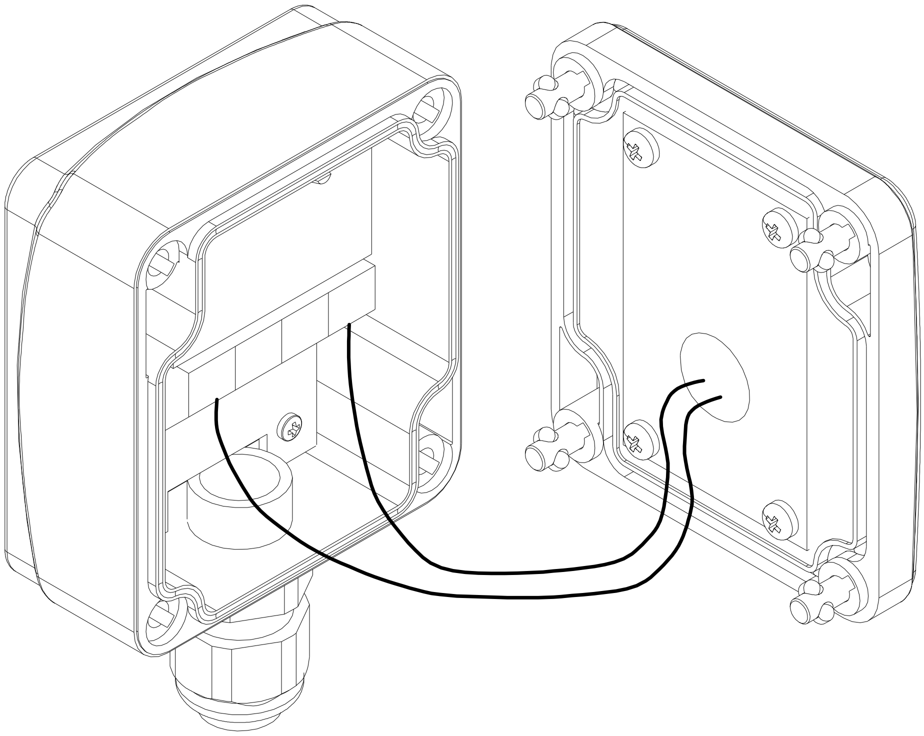


Fig. 11.6.3.1.2 A view of the connected parts of the C-IT-0200I-SI sensor

Notes:

1. The bottom of the box (in the left part of the image) contains the electronics of the C-IT-0200I module (the terminal blocks, jumpers and other properties have the same parameters as this module), the cap (the right-hand part of the image) contains its own sensor (S-SI-01I), and the sensor output wires are mounted directly in the module terminals.
2. During the assembly of the module, care must be taken to avoid squeezing the wires in the sealing of the box, as this would impair the degree of protection of the module.
3. The angle of a typical assembly should be similar to that of thermal or solar panels; ideally the sensor should be mounted directly next to the panels with the gland facing down.
4. On a label on the internal side of the cap is written the calibration constant, which should be copied and entered into the computing function in the Mosaic programming environment.

11.6.3.2 Measuring solar radiation by the S-SI-01I sensor with the C-HM-0308M module

Measuring solar radiation can be done by the S-SI-01I module, which should be connected to the analogue inputs of the modules C-HM-0308M, C(R)-HM-1113M or C(R)-HM-1121M.
The solar radiation sensor uses for its own measurement of intensity a monocrystalline silicon solar cell with an integrated temperature sensor; it is used for a temperature compensation of the solar cell.
The level of intensity (W/m^2) is calculated using the function in the programming environment, where you need to enter the specific sensor calibration constant; it is written on the label on the internal side of the cap, and it should be copied before the sensor is mounted.

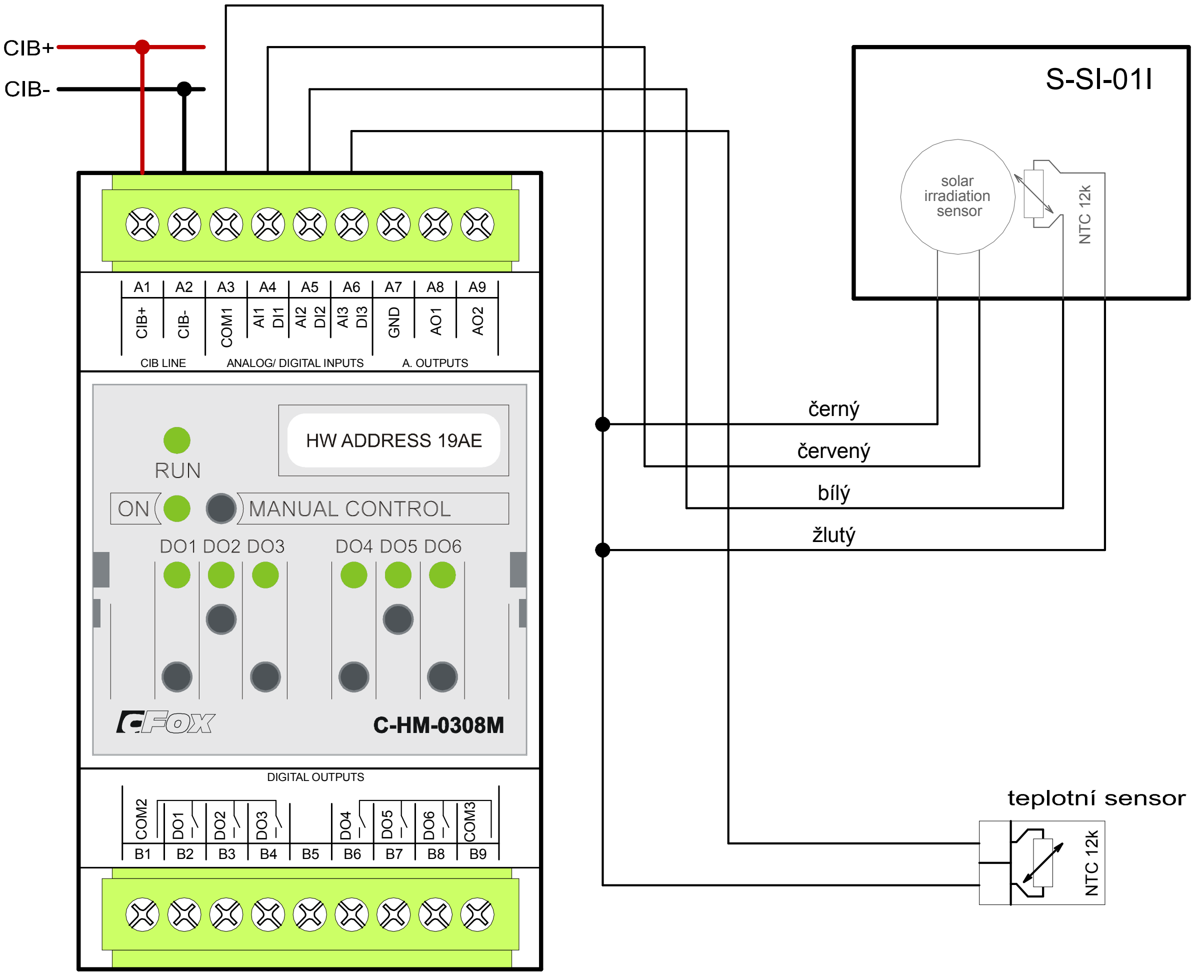


Fig. 11.6.3.2.1 Connecting the solar radiation sensor S-SI-01I to the C-HM-0308M module

Notes:

1. The intensity sensor output is connected to the AI1 input, the NTC 12k temperature sensor (used for the temperature correction of the measurement) is connected to the AI2 input. - N.B: It cannot be used for measuring the outdoor temperature!
2. In the example the temperature sensor is connected to the AI3 input (e.g. an outdoor temperature sensor).
3. The sensor outlets (terminated in the underside of the cap S-SI-01I) can be extended with a cable; a shielded cable is recommended, with the minimum diameter of the wire 0.5mm and a maximum

length approx. 10-20 meters (it can be even be longer, but then it is necessary to use a correctly connected shielded cable and avoid parallel layout with power lines).

11.6.4 The GIOM3000 weather station

The weather station (anemometer) GIOM3000 is intended for measuring the primary variables:
The speed and direction of wind, humidity, temperature, pressure and the derived values: Barometric altitude, relative pressure QNH/QFF, Beaufort, wind chill, saturated vapour pressure, absolute humidity g/m^3 and g/kg, the dew point.
The Foxtrot system provides support for integrating data from the weather station and its subsequent use for control, monitoring and display (the Foxtrot webserver, etc.).

The weather station is equipped with the ETHERNET 10M interface with the power supply POE, so it can be connected
directly into the SWITCH, which supports POE, provided the supply voltage does not exceed 30VDC.

Power supply can also be provided by the "POE Splitter" module with a network adapter; the POE Splitter combines a standard ETHERNET with powering towards the weather station. Then the weather station is powered by an power grid adapter from a regular mains plug and connected by a standard UTP cable to the ETHERNET installation.

Dimensions	250 x 277.6 x 77.9mm
Power supply	12V/60mA POE
Operating temperature	-30 to +60 °C

Fig. 11.6.41 The weather station GIOM3000

Notes:

1) The weather station is installed on a mast or a similar vertical structure (a clamping sleeve is included) or on a wall.
2) The weather station is equipped with a cable terminated with a standard RJ connector; the length of the cable is approx. 7m.
3) It is recommended to install the DTB4/100M 5cat/48V surge protection to provide protection against overvoltage. For more information on the DTB 4/100M 5cat/48V protection, wiring and installation principles, see the Chapter on Surge protection.

11.6.5 The S-RS-01I precipitation detector with the C-IS-0504M module

The S-RS-01I precipitation detector is designed to detect precipitation for automatic drawing of awnings or closing roof windows; it is connected to the C-IS-0504M module, which provides the power supply for the heating and measurement of the detector. The unused inputs and outputs can be used as general AI/DI and DO.

The module provides continuous heating and control of the sensor, which makes it possible to set the sensor so as to eliminate detection of fog and dew, or conversely, set the sensor so that also e.g. falling dew is detected. Similarly to the position of the solar radiation sensor, the detector should be preferably mounted with approx. 45° angle, so that water would run down and wash falling dirt.

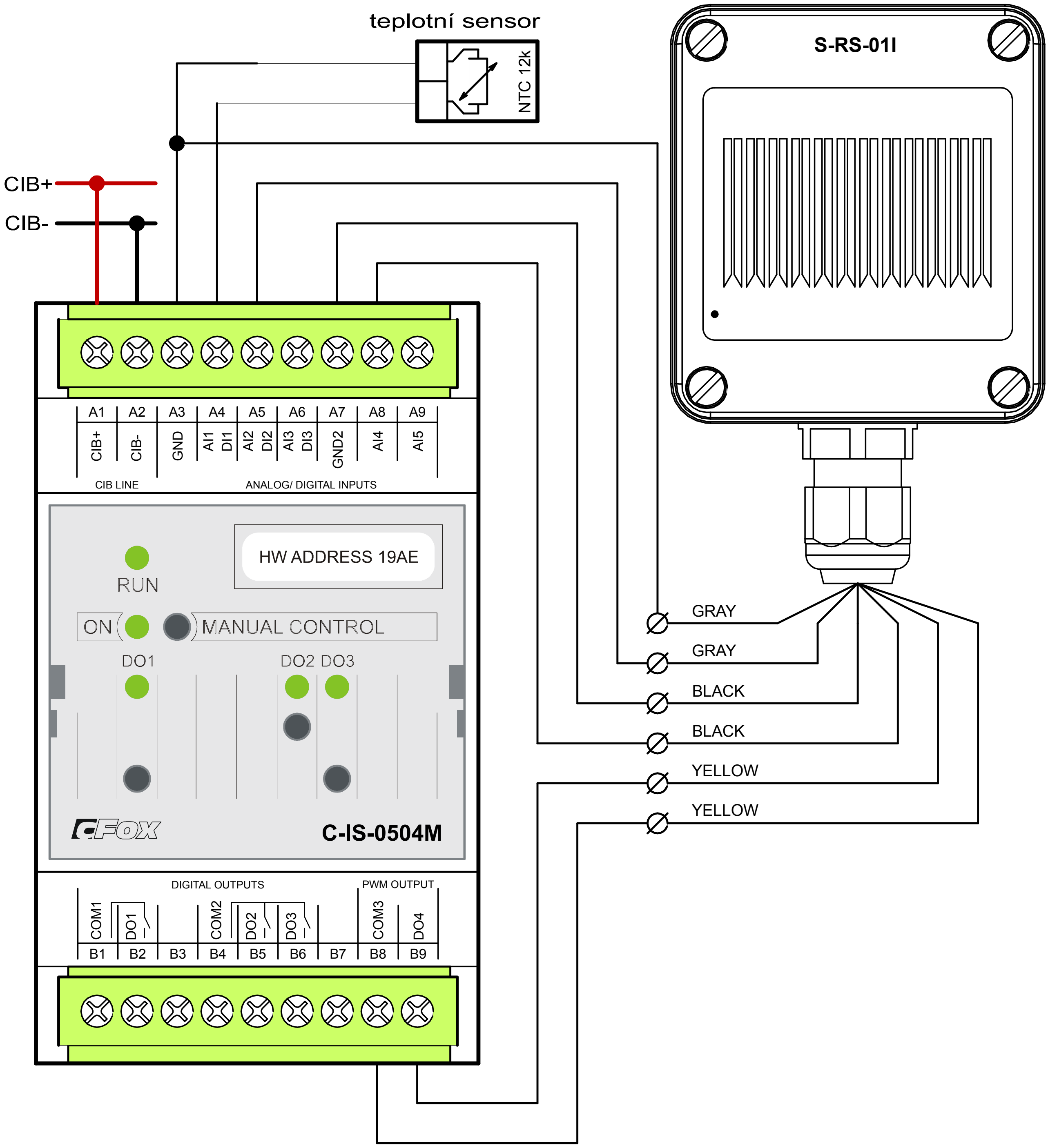


Fig. 11.6.5.1 Basic wiring of the C-IS-0504M module to the S-RS-01M precipitation detector.

Notes:

1. The length of the cable between the S-RS-01I sensor and the C-IS-0504M module may be up to approx. 20m; any cable will do, e.g. SYKFY, UTP, etc. It is necessary to take into account the placement of the cable in an outdoor environment.
2. The detector has a separately terminated NTC12k temperature sensor (grey wires), its owns moisture sensor (black wires) and the heating element (yellow wires), always without distinguishing polarity.
3. The temperature sensor is fitted with a standard 12k NTC thermistor; the humidity sensor is measured as resistance in the range of about ten kΩ (the wet sensor) up to 1 MΩ (the dry sensor), the heating element with 24VDC power supply has a power of approx. 2W.
4. All wires are inside a 100mm-long box, the stranded wires are terminated with a pressed-on sleeve.

11.7 Connecting devices with an M-bus interface

The M-Bus is designed for connecting heat meters and similar meters that can be powered from the bus and whose data can be read remotely.
The physical layer is defined by the EN 1434 (ČSN EN 1434) standard, the data link layer is defined by the IEC 870 standard and the application layer by the CEN TC 176 standard.
The bus is implemented by two wires, which can provide powering for the meters and along which the communication runs. The meters are connected in parallel on the bus; in most cases the polarity of connections is irrelevant (see the connection requirements in the manufacturer's documentation of the meters used), there is a bus topology, with the bus length up to 4kma; a maximum number of meters connected to the bus is 250 (each meter its own unique network address). Maximum communication speed is 38,400Bd (with limited length of the cable and the number of connected meters).

Open-circuit voltage on the bus is 36 V=. Master (in this case it is the SX-1181 module) transmits data by varying the voltage 36/24V= Slave (the heat meter) responds by changing the current consumption to 1.5/20 mA (at rest it draws in accordance with the standard 1.5mA).
Voltage and current curves on the bus are shown in Fig. 11.7.1. The logic levels are identified as Mark and Space.

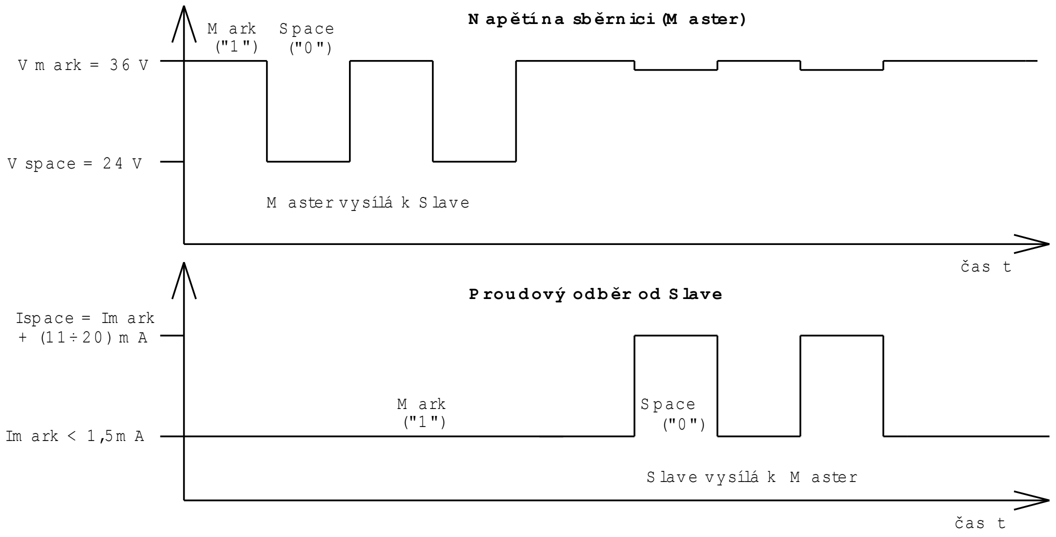


Fig. 11.7.1 The M-Bus

The "M-Bus Usergroup" standards and recommendations divide the modules providing the conversion on M-Bus interface into several categories.
The SX-1181 module corresponds with the medium variant of transducers, it is mounted on a DIN rail and it is usually connected to the CH1 of the Foxtrot basic modules fitted with the RS-232 interface.
There is also available the MR-0158 submodule, which is designed for only a small number of meters and it should be mounted in the CH2 position of the Foxtrot basic modules.

11.7.1 Connecting a slave device with an M-bus interface, the SX-1181 module

The SX-1181 module is designed for the connection of up to 64 devices equipped with an M-Bus (ČSN EN 1434) - usually heat meters, etc. The mechanical design is suitable for the installation on the U-rail ČSN EN 60715. The module is equipped with fixed screw terminals and it is designed to be connected to the serial port RS232 of the Foxtrot basic module. The M-Bus interface is terminated in the screw terminal block.
The M-bus interface is powered by 24VDC/30-150mA. The consumption depends on the number of devices connected. The RS232 interface and the M-Bus are galvanically separated with a 1kV isolation voltage.

An example of connection of the module to the Foxtrot basic module is shown in the following figure. The SX-1181 module is connected to the serial channel CH1 with the RS232 interface. If the modules are not placed next to each other, a shielded cable must be used. The M-Bus interface may be powered from the same source, if the heat meters do not need to be galvanically isolated. Otherwise, this part can be powered from a separate power supply.

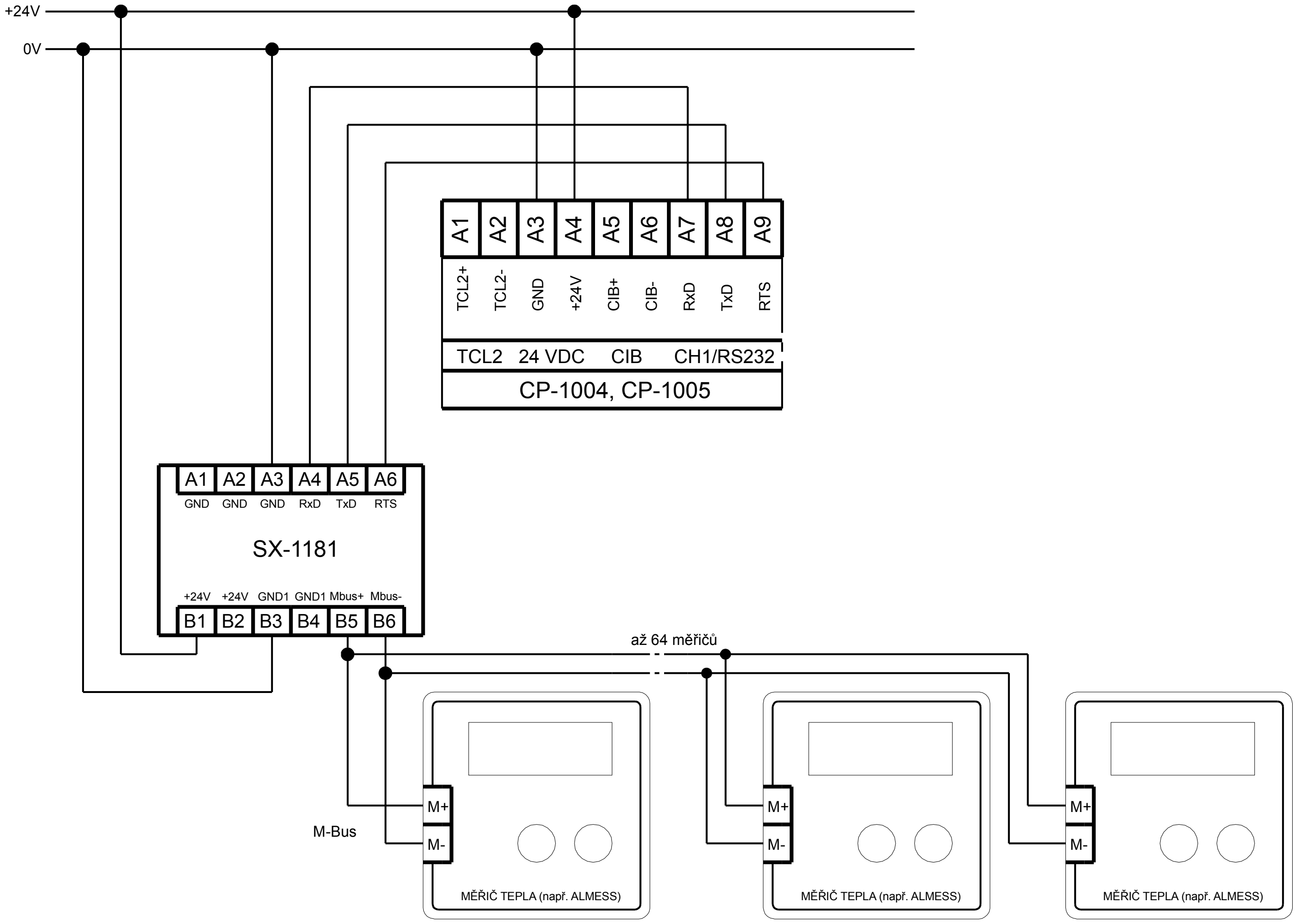


Fig. 11.7.1.2 Connecting the SX-1181 module to the CH1 interface of the CP-1004 module

Notes:

1) Up to 64 meters can be connected to the SX-1181 module, which implies a maximum quiescent current in the bus at 96mA, and the total consumption of the module max. 150mA.
2) A standard maximum length of the cable (the M-Bus) is 350m; if a maximum line resistance < 30 is observed, as well as a maximum capacity 0.82μF (maximum rate of 9,600 baud, recommended rate 2,400 baud), the total length of the line can be up to 4km.
3) The recommended cable is a standard telephone type, with the 0.8mm diameter, better shielded

(shielding should be connected on the side of the SX-1181 module to the protective earth PE). It is also recommended to use the J-Y(St)Y 1x2x0.8 cable.

4) The SX-1181 module is a device of the "modem" type, and it is also connected correspondingly: the TxD terminal on the SX-1181 should also be connected to the same TxD signal on the Foxtrot basic module; analogy, this also applies to the RxD and RTS (the signals do not interfere!)
5) The GND1 (B3, B4) and GND (A1, A2, A3) terminals are galvanically isolated. If the module is powered from a separate source (connected to the terminals + 24V and GND1), the GND terminal must be connected to the RS232 of the basic module (the terminal of the signal ground of the RS232 interface in the basic module).

11.7.2 Connecting a slave device with an M-bus interface, the MR-0158 submodule

The MR-0158 submodule contains the circuitry of the master physical interface for the connection to the M-bus (for a more detailed description of the M-Bus, see the previous chapter). This bus is the most frequently used for communication with heat meters, etc.
It is designed for systems of the series TC700, Foxtrot, TC650, TEMPO, etc., equipped with a serial interface for the submodules.
The length of the bus is limited by a maximum voltage drop in each wire (it should not exceed 0.5V), which depends on the consumption of slave modules in an idle state (the number of modules x 1.5 mA) and the wire cross-section. If the line is overloaded, the M-bus fuse disconnects the built-in converter for approx. 1second, and then try to activate it again to its normal function. This condition is signalled by a DCD signal (possibly also CTS) log.0. After the overloading subsides, the fuse itself returns to its normal function.
The module makes it possible to excite the standard M-Bus line with 20 slave stations. The M-Bus power supply is galvanically isolated from other circuits.
The CH2 interface (designed for being mounted with removable submodules - including the MR-0158) is terminated in the Foxtrot basic module connectors in accordance with the module type, see the following figures.

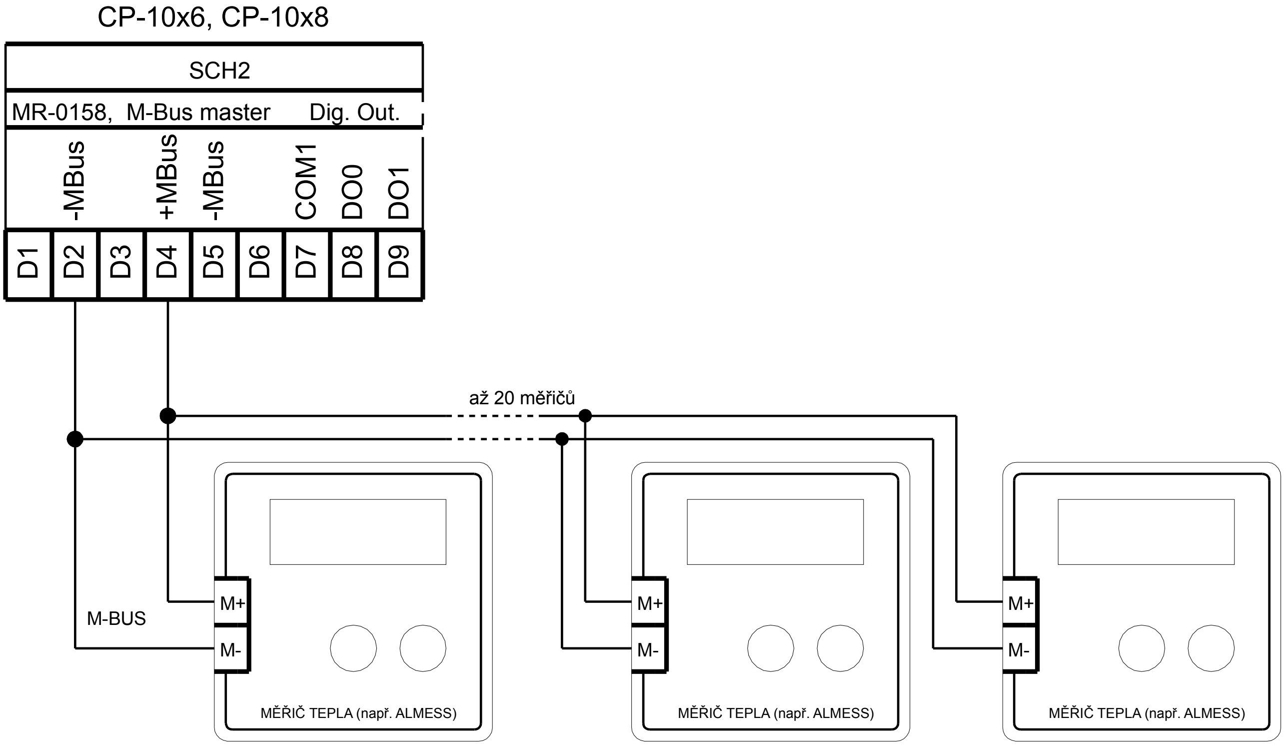


Fig. 11.7.2.1 Connecting M-Bus meters to the CH2 interface (MR-0158) of the modules CP-10x6 and CP-10x8

Notes:

1) Up to 20 metering devices can be connected to the interface fitted with the MR-0158 submodule.
2) A maximum length of the cable (the M-Bus) is by default 350m; if a maximum drop < 0.5V on each wire is observed, the total length of the line can be up to 4km.
3) The recommended cable is a standard telephone type, with the 0.8mm diameter, better shielded (shielding should be connected on the side of the Foxtrot module to the protective earth PE). It is also recommended to use the J-Y(St)Y 1x2x0.8 cable.

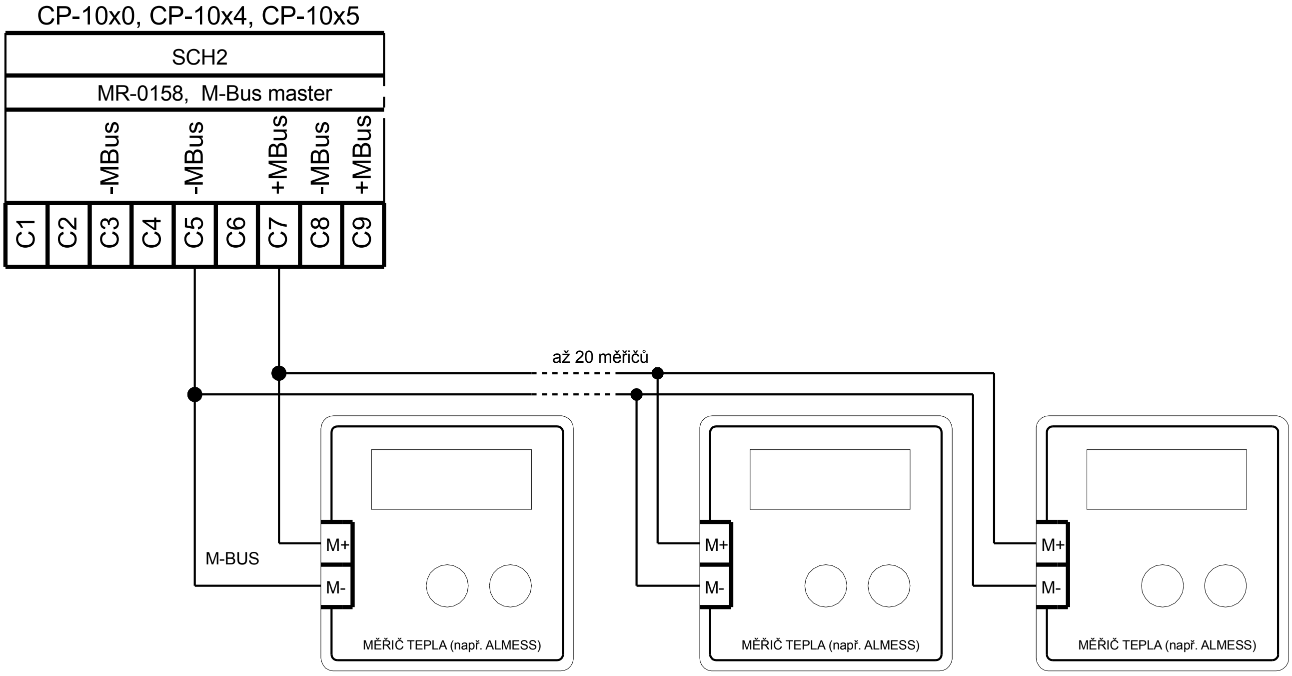


Fig. 11.7.2.2 Connecting M-Bus meters to the CH2 interface (MR-0158) of the modules CP-10x0, CP-10x4, CP-10x5

Notes:

1) Up to 20 metering devices can be connected to the interface fitted with the MR-0158 submodule.
2) A maximum length of the cable (the M-Bus) is by default 350m; if a maximum drop < 0.5V on each wire is observed, the total length of the line can be up to 4km.
3) The recommended cable is a standard telephone type, with the 0.8mm diameter, better shielded (shielding should be connected on the side of the Foxtrot module to the protective earth PE). It is also recommended to use the J-Y(St)Y 1x2x0.8 cable.

11.8 Measuring and monitoring the water level

Applications for measuring and monitoring water levels (in wells, tanks for irrigation, etc.) can utilize a variety of sensors for continuous or point level measurement.

We recommend using a **hydrostatic level sensor** for continuous water level measurement.
Hydrostatic sensors of surface level are basically pressure transducers, which measure the water level by measuring the hydrostatic pressure. The measurement is very accurate and stable over time; the thermal volume expansion can cause some inaccuracy, however, it is totally negligible for standard level measurements.

Hydrostatic level measurement has several advantages:
The sensor has no moving parts, and the measurement is not influenced by impurities and solid particles on the surface or at the bottom. Measurements of the level of polluted liquids is as exact as measuring in a very clean environment.

For open tanks there are available sensors which measure hydrostatic pressure as a gauge pressure against the atmosphere. Venting to the atmosphere is done via a tube with an open end (usually it is installed together with the power cable), which needs to be installed so as to prevent clogging (e.g. the free end of the tube can be placed below the tank cover and bent downwards).

If you need to monitor both the minimum and maximum water level in the reservoir (such as the well), you can also use point level sensors, which are cheaper than the continuous type, but only give you information whether a certain predefined level has been reached. If two levels must be monitored (e.g. MIN and MAX), the price of good-quality point level probes is close to that for continuous measurement devices, which are more advantageous. Before you buy some cheap and dilettantish solutions, you should first take into account the extreme conditions on the water level - humidity, condensation, the influence of flowing current on corrosion, etc. Therefore it is advisable to obtain a better quality product in spite of a higher acquisition price.

11.8.1 Continuous measurement of the water level in the well or a reservoir

Continuous level measurement of aggressive liquids in non-pressure reservoirs, boreholes, wells, pools, etc., can be done using a hydrostatic level meter, e.g. the HLM-25S. A liquid column up to the height of 100m can be measured with this instrument, which has a health certificate for contact with potable water and is fitted with an overvoltage protection inside the probe. The probe is suspended in the tank on a cable, which is terminated with a capillary (for atmospheric pressure compensation) and two wires (a current loop 4 to 20mA); an example of connection to the C-IT-0200I module is shown in the following figure.

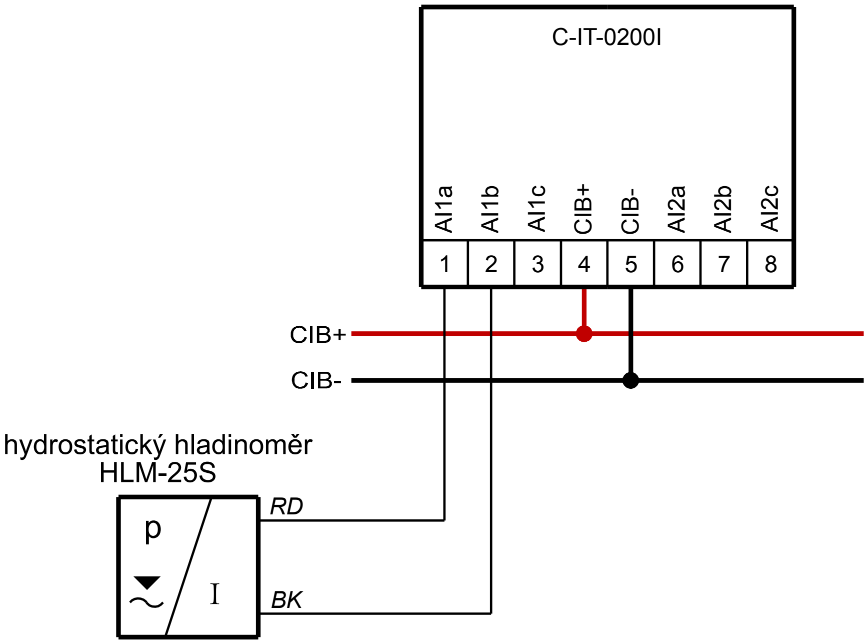


Fig. 11.8.1.1 Wiring the level meter HLM-25S

Notes:

1) The installation is done by suspending the probe into the measured space (tanks, boreholes); the probe is left hanging on the cable, or is placed on the bottom.
2) As the cable contains a compensation capillary, its connection to the extension cord should be done using a non-hermetic junction box; if you need to wind up the excessive cable, make sure that the diameter of the bundle is at least 30cm; the cable manufacturer recommends not to shorten or otherwise mechanically modify the cable.
3) The C-IT-0200I module can be placed in close proximity to the tank; it features a higher protection IP-65.
4) If the cable needs to be extended, it is recommended to use a shielded cable (e.g. J-Y(St)Y 1x2x0.8); the shielding should be connected as convenient - to the protective earth at the site of the module, etc.

11.8.2 Point level monitoring of water level in the well or in a tank

E.g. the minimum water level in the well can be monitored by a **capacitive level sensor** CLS-23S-11, which is a submersible (the IP-68 protection) level sensor for monitoring water levels in bores, wells, and reservoirs. It is a suspension sensor on a cord, with stainless steel protective basket preventing a mechanical damage of the electrode. A maximum immersion depth is 100m.

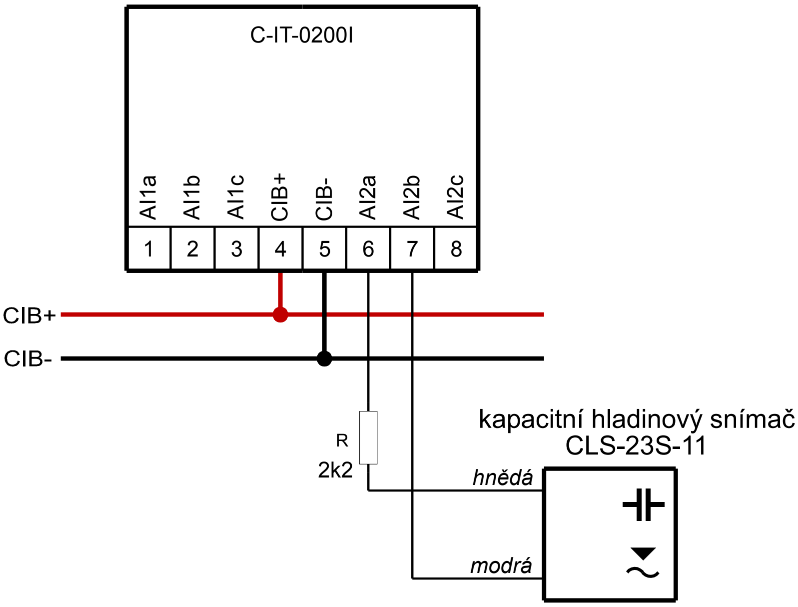


Fig. 11.8.2.1 Wiring of capacitive level sensor CLS-23S-11

Notes:

1) The sensor is connected to the input of the C-IT-0200I module configured for measuring the current loop 4 to 20mA via a 2k2 serial resistor.
2) The value of the resistor can be in the range from 1k8 to 3k3, and in relation to this value, the decision-making level of the measured analogue value (treated by the application programme) is also changed; any resistor can be used, even a miniature PTO type. It can be placed directly into the C-IT-0200I module in the terminal space.
3) It is recommended to connect the sensor cable (optional length up to 15m) directly in the C-IT-0200I module. If the cable needs to be extended, it is recommended to use a shielded cable (e.g. J-Y(St)Y 1x2x0.8); the shielding should be connected as convenient - to the protective earth at the site of the module, etc.

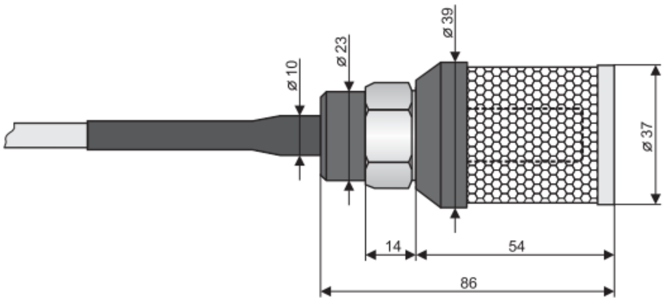


Fig. 11.8.2.2 Dimensions of the CLS-23S-11 sensor

Point level sensing in a tank can also be done by **conductive probes** (e.g. the CNP-18) connected to analogue inputs intended measuring condensation, e.g. the C-HM-0308M. Monitoring the minimum and maximum levels requires three probes with sufficient lengths of stems to allow evaluating both the upper and the lower limits. The resistance is always measured between two probes (in tanks made of conductive material, one probe can be substituted with the tank itself).

11.8.3 Submersible conductivity sensors - sensing of water level of electrically conductive liquids

The C-IS-0504M module can be used for monitoring water levels in the tanks, e.g. for control of irrigation systems, etc. Monitoring of level in water tanks by DC measurement of resistive sensor is not recommended due to the destruction of electrodes by electrolysis. The same applies to the flood detectors.
You can connect two conductivity probes to the module (e.g. the PS-2 and PS-3 immersion probes manufactured by MAVE), see the following Fig., and monitor e.g. the maximum and minimum water level. At the same time the module can directly control the pump of the irrigation system, and via two relay outputs it can also directly control valves for two irrigation circuits.
Three universal inputs can be used for metering water flow, measuring temperature, etc.

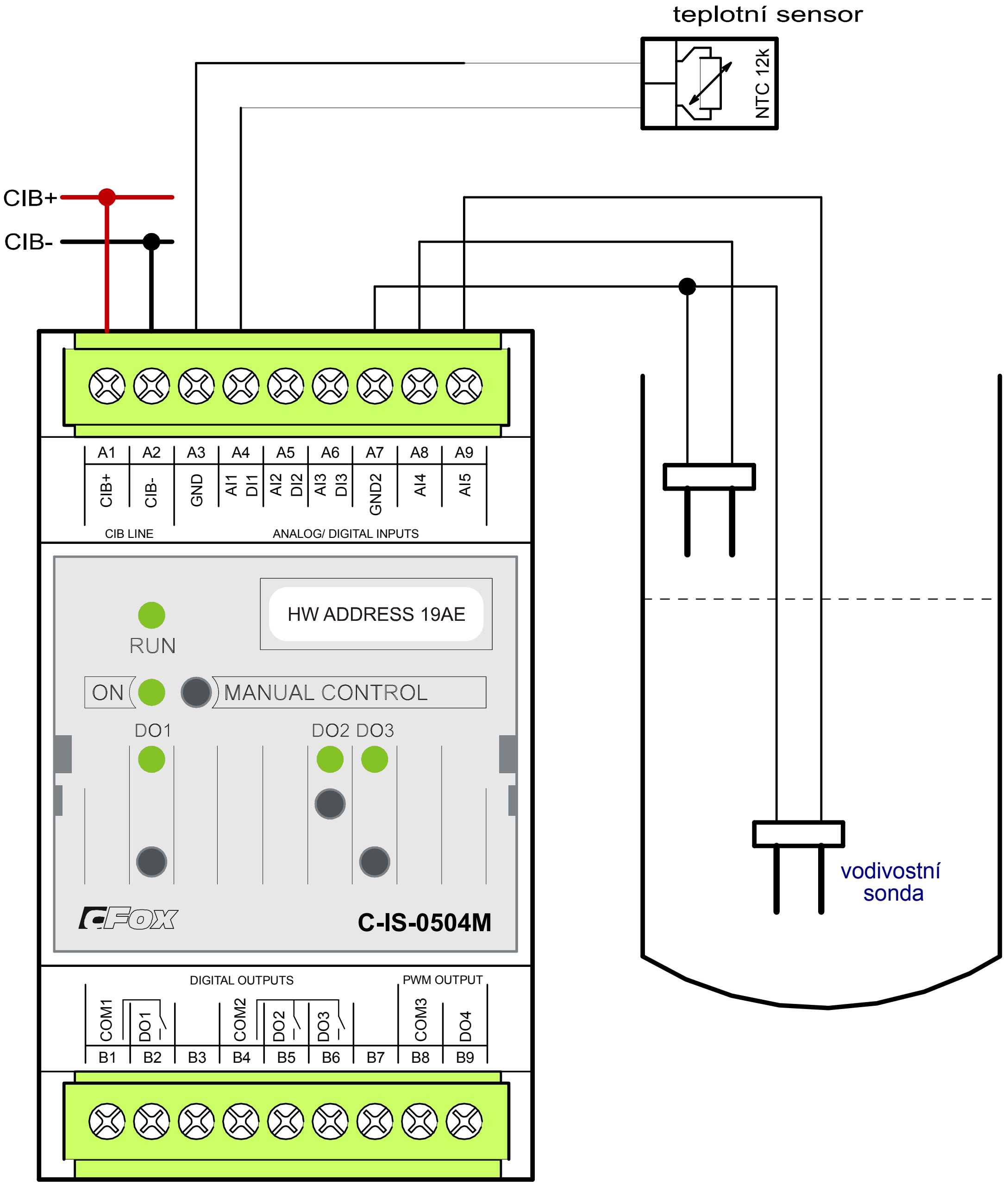


Fig. 11.8.3.1 Connecting the C-IS-0504M module with two conductivity probes for monitoring water levels.
Notes:

1. Flooded temperature sensors have resistance of tens of kΩ, emersed resistance electrodes exhibit a

resistance exceeding 100kΩ.

11.9 Measuring and monitoring water pressure (heating systems, etc.)

Pressure and its measurement:
Pressure is a prerequisite for circulation of liquids in heating or cooling systems, and it is created by pumps. The system pressure is positive (in terms of gauge pressure) in relation to the atmospheric pressure.
It is often expressed as a relative pressure with respect to atmospheric pressure (it also applies for the DMP 331 sensor), but it can also be expressed as an absolute pressure.

There are a number of units for measuring the pressure; the most commonly used are: Pa, kPa, bar and m. Pa, kPa, bar and m.

The ratios of these units are:

bar and kPa
1 bar = 100,000Pa = 100kPa (this value is approximately equal to the atmospheric pressure - 1000hPa)

Other units include lbf/in^2= psi (pounds per m^2) and mm of mercury (mmHG).
These units are specified as:

1psi = 6,895Pa
1mmHG = 133Pa

m
The m unit (the water column in meters) depends on the gravitational acceleration (g), which varies depending on the distance from the equator.

In standard usage, an approximate value of 1m = 10kPa, which is equal to the gravitational acceleration of 10m/s2.

Standard values of operating pressures:
Public water main 200 ÷ 400kPa
Central heating 150 ÷ 250kPa
Solar circuit approx. 200kPa (2 bars)

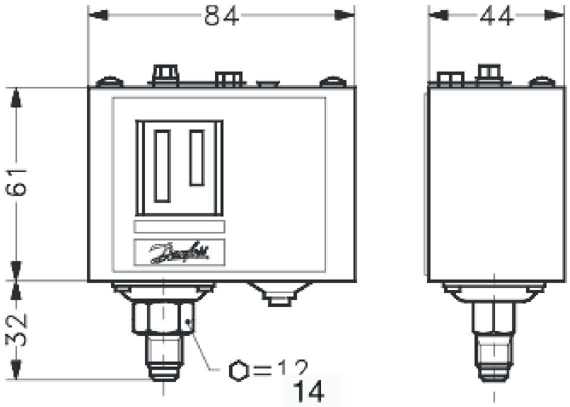
Pressure measurements can be utilized e.g. for monitoring of the heating system, where a lowering of pressure can indicate a leakage and an impending breakdown (some change in operating pressure of the heating system are normal - the pressure fluctuates with the temperature of the liquid).
The pressure in the heating system can only be monitored via a point level switch (although the precise pressure is not known, a decrease below a pre-set value can be measured) - see Chapter 11.9.1. Pressure can also be measured continuously, with the advantage of obtaining an instantaneous pressure value - see Chapter 11.9.2

11.9.1 Monitoring water pressure in the heating circuit

Monitoring the pressure of water in the heating circuit (monitoring any leakages) can be done using a pressure switch with a contact output, e.g. the Presostat KPI 35 (order number 060-121766) DANFOSS, or the 61214 ZPA EKOREG.
The Presostat KPI 35 enables setting the pressure range, within which the unit sends a signal, i.e. a differential pressure, when the contact system switches the contact on and off. The output changeover contact should be connected to the binary system input, e.g. the C-AM-0600I module.

Presostat KPI 35

The setting range	[bar]	-0.2 ÷ 8
The differential range	[bar]	0.4 ÷ 1.5
Connection		G¼A
Protection		IP 33
The material of the contacts		Ag
Ambient temperature	°C	– 40 to +65
The temperature of the medium	°C	– 40 to +100
Medium		air, oil, clean water
The cable gland	mm	6 – 14



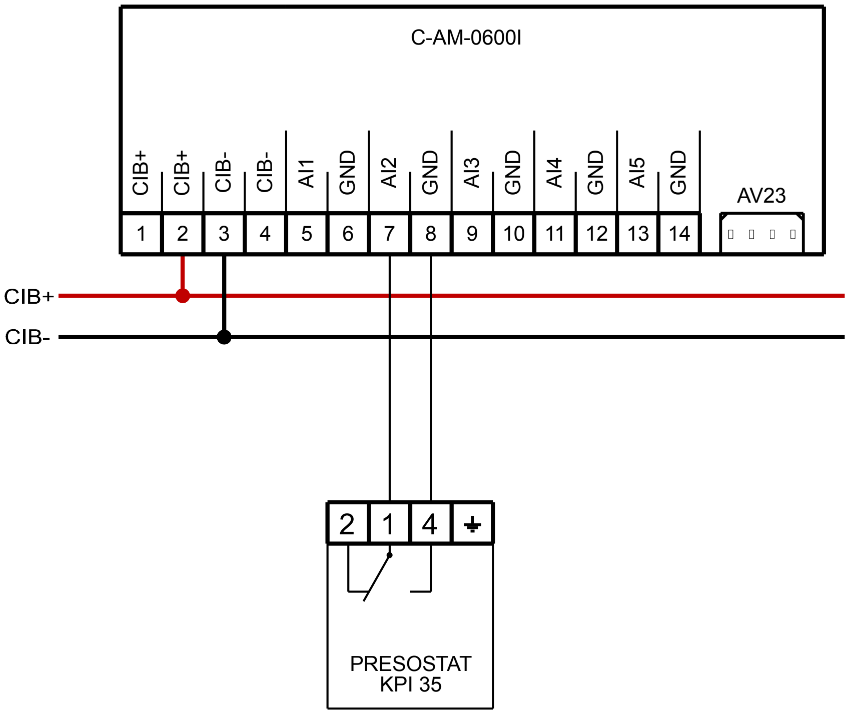


Fig. 11.9.1.1 Connecting the KPI 35 pressure switch to the C-AM-0600I module

11.9.2 Continuous measurement of water pressure in the heating circuit

Continuous measurement of water pressure in the heating circuit (monitoring a potential leakage of water, refilling, etc.) can be provided by the DMP 331 pressure sensor (order number is DMP 331 110-6001-1-3-100-100-1-000), which is designed to measure the pressure in the heating systems in the range from 0 to 600kPa.

The connection is designed as a standard current loop 4-20mA; it can be connected e.g.to the C-IT-0200I module (see an example in Chapter 11.8.1).

The type (order number)	DMP 331 110-6001-1-3-100-100-1-000
The range of the measured pressure	0 ÷ 600kPa
Connection	G 1/2 threading
output	4 ÷ 20mA

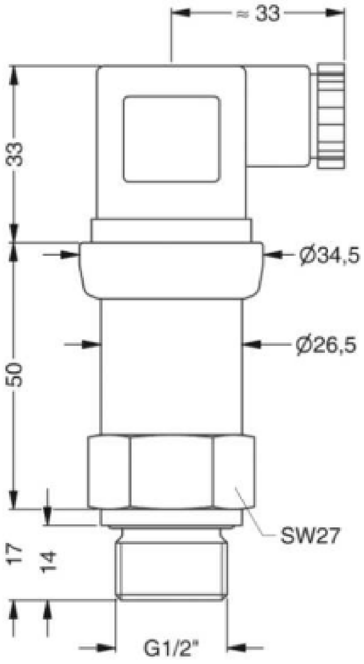


Fig. 11.9.2.1 Pressure sensor – mechanical design, threaded joint

11.10 Metering the consumption of natural gas

If you want to be able to meter the consumption of natural gas, first you need to solve the problem of monitoring the flow of gas in the fitted gas meter. The gas meter must be fitted with a sensor which allows the measurement of the gas flow; for example, the Elster meters enable this.

11.10.1 Metering the consumption, the Elster gas meters

The ELSTER gas meters series from the BK4 to G100 can be fitted with a reader module (a pulse transmitter) IN–Z61 or IN–Z62.

The pulse transmitter IN - Z61 is fitted directly on the body of the gas meter. The output are two signals - the pulses (the L output) and the alarm (the A output). The pulse output provides gas consumption data (the magnet mounted on the last wheel of the counter switches at each turn the reed contact in the transmitter) and the alarm output is actually a sabotage loop in case of manipulation with the sensor and supply (affecting the operation of the magnet, breaking the cable, etc.); it is permanently switched in idle mode.

The IN - Z62 pulse transmitter is only equipped with the pulse output (output I).

Operating voltage	maximum 24VDC
Current	maximum 50mA
Switching time	around 0.25s

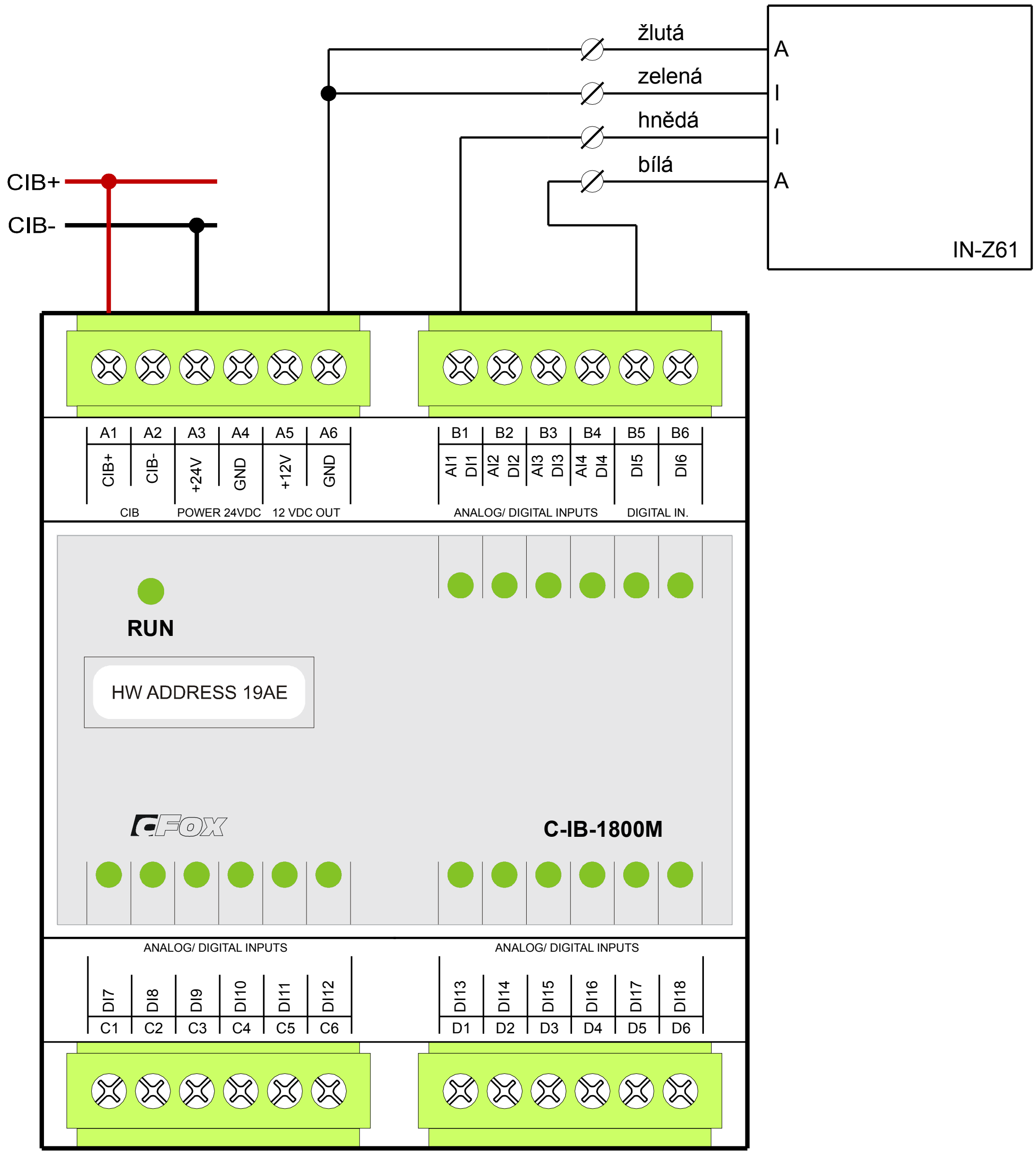


Fig. 11.10.1.1 Wiring the IN-Z61 transmitter to the C-IB-1800M module

Notes:

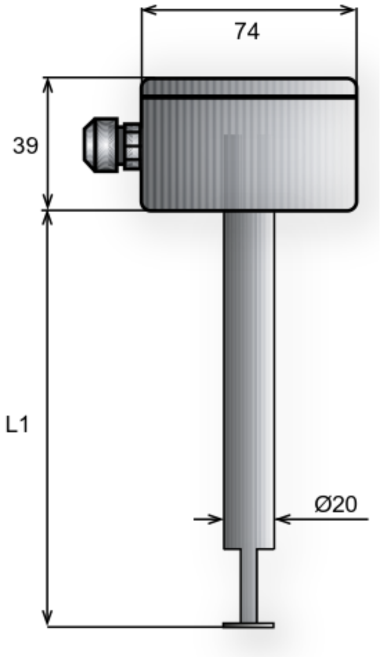
1. The transmitter is equipped with an RJ connector, where the cable with the free termination (with colour-coded outputs) is inserted.
2. The pulse output is connected to the input of the module, which can be configured as a pulse (AI1/DI1) input; the tamper (alarm) is connected to a conventional DI5 binary input. A number of other modules can also be used, e.g. the C-AM-0600I.
3. The cable can be extended in the order of meters; longer distances require a shielded cable, such as the SYKFY.

11.11 Measuring airflow

11.11.1 Measuring air velocity in ducts, the sensorPFLV12

The sensors are designed to measure air velocity in non-aggressive environment in air conditioning ducts (PFLV12) or on the facade of the windward side of the house (PFLV111). The PFLV111 type can be used e.g. for automatic closing of the shutters or retracting the awnings.
The velocity sensor itself is located at the end of the plastic ABS stem. For accurate measurement the sensor must be positioned parallel to the flowing air, as shown on the cap of the device. As the sensor is open, contact with heavier particles must be avoided to prevent damage.
The housing is manufactured from grey polycarbonate. The PFLV12 sensor includes a plastic central holder used for mounting the sensor to the wall of the air duct. The PFLV111 sensors are mounted directly on the wall of the house (protected from rain), and wind is detected by using the airflow along the wall.
Operating conditions require common chemically non-aggressive environment where sensors do not need servicing; however, it is advisable to regularly clean the sensor from dirt (dust, cobwebs, ...).

Supply voltage (Ucc)	15 ÷30VDC
Maximum power input	3VA
Sensitivity	0.01m/s
Maximum measurement range	0 ÷ 20m/s
Response speed	< 2s
Maximum measurement error (+25 °C)	± 0.5m/s (± 5% from the range)
Temperature sensitivity	< 0.1 %/K
Settling time	≥ 20 minutes
Operating temperature range of the sensing part	-20 ÷ 80 °C
Protection of the box	IP65
Protection of the sensor	IP00
The type of terminal blocks	COB (vodiče max. 1,5 mm
Gland /maximum Ø of the cable	PG9/8mm



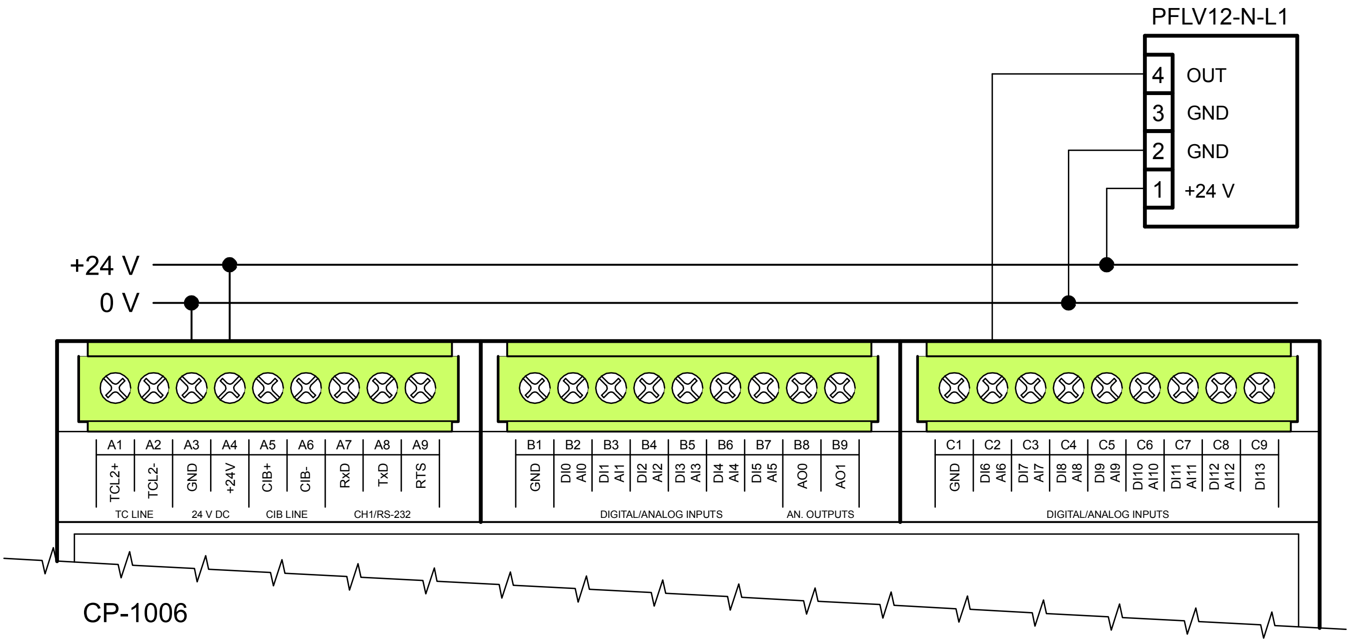


Fig. 11.11.1.1 An example of wiring the PFLV12 sensor with current output to the CP-1006 module

12 Controlling and monitoring other technologies

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12.1 Defrosting, protection of gutters and piping

Removing of snow from roads, pavements, stairs, ramps and emergency exits is implemented by electrical heating systems. Given the significant power consumption, it is advisable to use the optimum control (to limit the operation to the shortest necessary period); sometimes an appropriate coordination with other heat appliances is useful, i.e. avoiding parallel operation of several heating appliances (heating defrosting system, hot water electric heaters, a bivalent source of the heat pump, etc.) so as not to exceed the installed capacity (of the lowest possible value of the main circuit breaker) while maintaining the comfort; in some installations this may even be a necessity due to the low-voltage distribution system limitations in the area. The following chapter, Defrosting outdoor spaces, provides a basic example of integration and connection of sensors and actuators necessary for controlling the defrosting of outdoor areas.

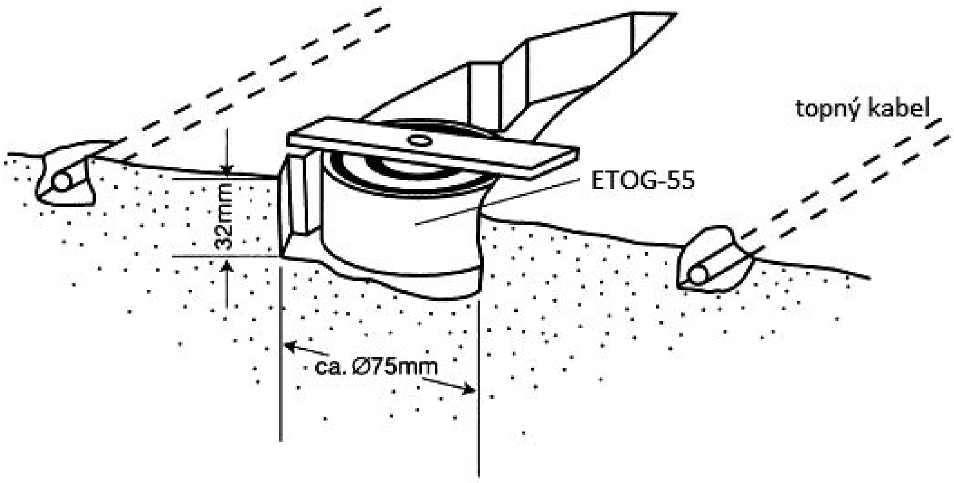
In some buildings it is highly recommended to install a heating system to protect gutters from frost to avoid damaging the roof, the gutters and protect people’s health. These systems are also suitable for integration into the Foxtrot control system by direct processing of the sensors input and by controlling the heating elements.
The Chapter Defrosting gutters presents a basic example of the connection of sensors and controls for the implementation of the heating system for the protection of gutters.

12.1.1 Defrosting outdoor spaces, the ETOG-55 sensor

The system of protection of outdoor spaces against snow and black ice can take advantage of the Foxtrot system with connected sensors ETOG-55 and heating control of cables in outdoor areas for detecting moisture and subsequent defrosting.

The ETOG-55 sensor is a stainless steel structure, which ensures its high mechanical strength as well as resistance to weathering. When they are dry, the detection metal plates are electrically isolated, but the presence of moisture results in their interconnection. Evaluating the presence of moisture is done by measuring the resistance of the sensor by the respective system inputs.

There is a heating element cast between the detection plates, which slightly heats the sensor, optimizing its function. This feature is required for the humidification of fresh snow, whose electric conductivity is not sufficient. The ETOG-55-55 sensor must be located in the heated part of the space between the heating cables in the place, where humidity usually remains the longest (the bottom part of the surface, or in heavily exposed areas) to be constantly in contact with flowing water from melting snow. But it also must be located so as to be freely exposed to precipitation - i.e. not close to the building or under the overhang of the roof. It must not be installed outside the heated area.



Larger areas can be fitted with multiple sensors, which may be connected in parallel or separately; the second option allows defrosting of individual zones separately.

Connecting several sensors in parallel also increases the reliability of detection of black ice, which may be distributed unevenly; activation of the defrosting system is then more reliable.

Heating of the ETOG-55 sensor has the power input of approx. 2.5W at 24V supply. Heating of the ETOG-55 sensor can be connected directly to the DO4 output of the C-IS-0504M module, which is primary intended to power the heating.If the heating of the ETOG-55 sensor is powered from another 24VDC source, it must be switched by other relay output within the system, e.g. by output on the C-IS-0504M module, to which the ETOG-55 sensors are also connected (max. 2 sensors per independent inputs of module) - see the following example of wiring.

In addition to measuring moisture, the ETOG-55 sensor is also equipped with a temperature sensor NTC 12k, which is terminated together with the moisture measurement and heating in a common cable. Temperature measurement helps to control heating of the ETOG-55 probe.

Measurement can also by done by the C-IS-0504M module, which has two inputs intended directly for measurements of conductivity; the measured resistance of the humidity sensor varies from less than 50kΩ (moisture is present) to hundreds of kΩ (dry sensor).

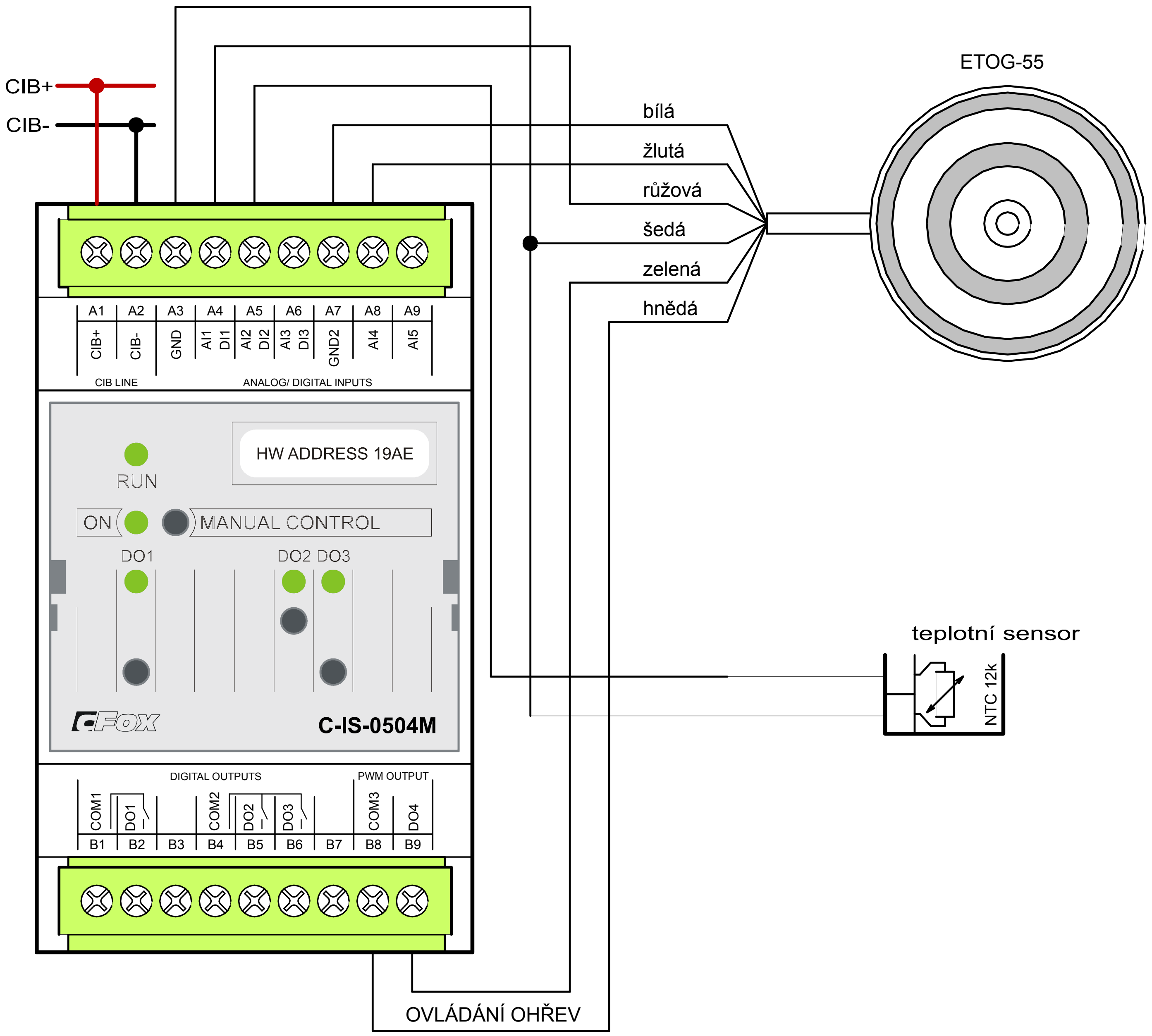


Fig. 12.1.1.1 The basic wiring of the ETOG-55 sensor, defrosting outdoor spaces

Notes:

1. A standard length of the supply cable is 10m, but it can be extended with a separate cable 6 x 1 mm^2 (e.g. the JYTY) to several dozen meters (a potentially higher resistance of the cable can be compensated by the system software).
2. Put a flexible tube (a gooseneck) with the inside diameter of at least 16mm in the place where the sensor should be located; the ETOG-55 sensor must be at least 5cm from the heating cables, to prevent the heat generated by the cables interfere with the operation of the sensor.
3. The heating of the sensor can be connected directly to a special DO4 output, or it can be supplied from the source of the Foxtrot system, or from a separate 24 ÷ 27VDC power supply.

12.1.2 Defrosting gutters, the ETOR-55 sensor

Detection of moisture in the system of protection of gutters and their subsequent defrosting can take advantage of the Foxtrot system with connected sensors ETOR-55 and control of the heating cables placed in the gutters.

When the brass detection plates are dry, they are electrically isolated from each other, but the presence of moisture causes their interconnection. Evaluating the presence of moisture is done by measuring the resistance of the sensor by the respective system inputs.

There is a heating element cast between the detection plates, which slightly heats the sensor, optimizing its function. This feature is required for the humidification of fresh snow, whose electric conductivity is not sufficient.

The ETOR-55 sensor should be put in the gutter in the place, where the moisture usually occurs first, or is present the longest (near the drainpipe, or in heavily exposed areas), to be constantly in contact with water flowing from the melting snow.

Never install the sensor outside the heated area; it must be in a horizontal position.

Place the sensor with the detection pads on the top and glue it with silicone.

It is recommended that two moisture sensors are connected in parallel and located in two different places. Larger areas can be fitted with multiple sensors, which may be connected in parallel or separately; the second option allows defrosting of individual zones separately.

Heating the ETOR sensor has the power input of approx. 2.5W at 24V supply. Heating of the ETOR sensor can be switched by the system relay output, e.g. the output of the C-IS-0504M module, to which the ETOR sensors are also connected (a maximum of 2 sensors per separate module inputs) - see the following wiring diagram.

The value of the outdoor temperature is required for the system to work properly; a separate outdoor temperature sensor can be put in the potentially coldest place of the roof (facing north), on the other hand, while the ETOR sensor should be installed in the hottest spot (facing south).

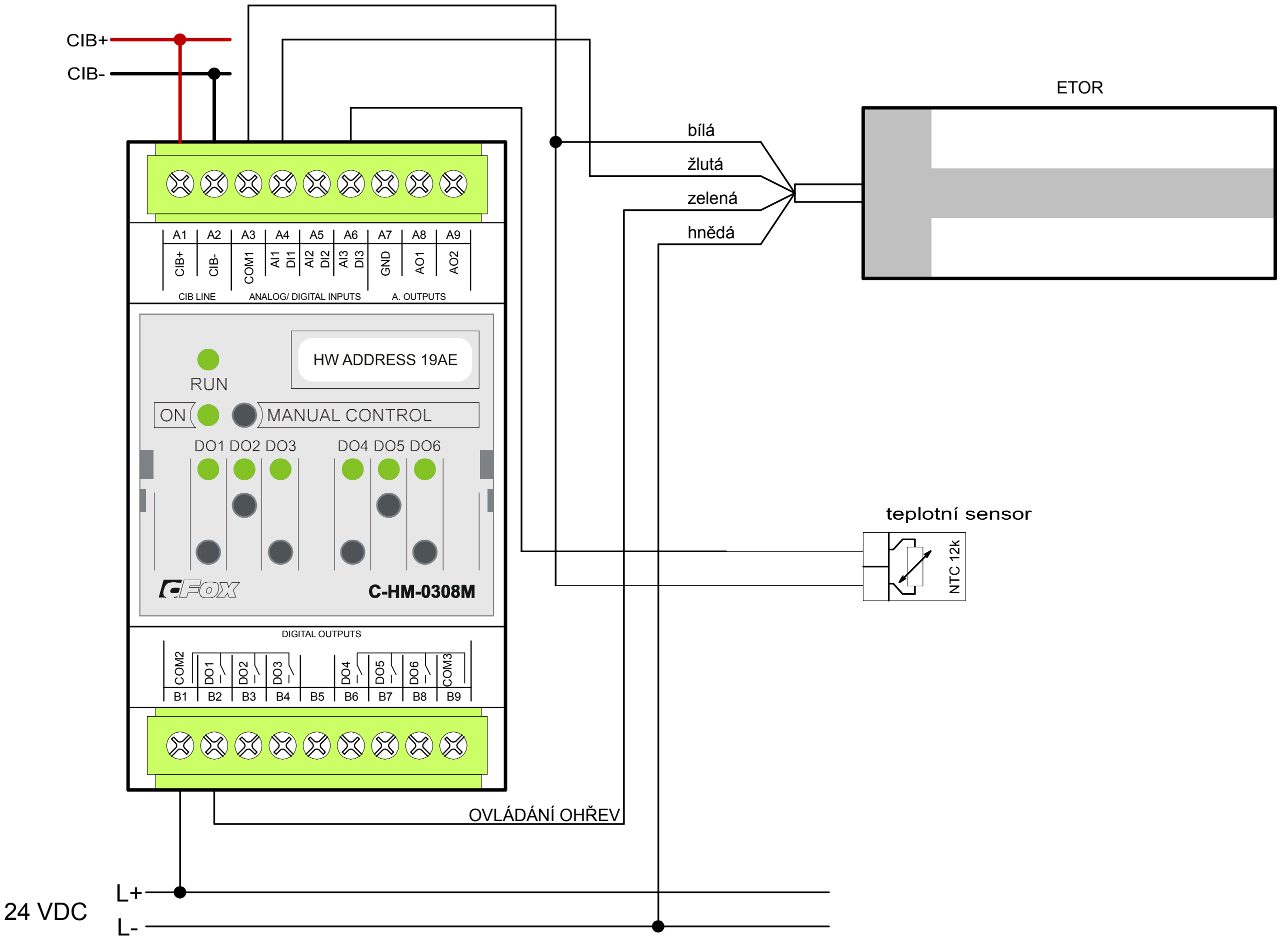


Fig. 12.1.2.1 A basic wiring of the ETOR sensor, defrosting of gutters.

Notes:

1. A standard length of the supply cable is 10m, but it can be extended with a separate cable 4 x 1 mm^2 (e.g. the JYTY) to several dozen meters (a potentially higher resistance of the cable can be compensated by the system software).
2. Heating of the sensor can be supplied from the Foxtrot system source, or from an independent power supply 24 ÷ 27VDC.

12.1.3 Defrosting outdoor spaces, the ESF 524 001 sensor

Defrosting of outdoor spaces is done using electric heating cables (Raychem, etc.) controlled according to the outdoor temperature and precipitation using temperature and humidity sensors mounted in the monitored area. The system is activated if the temperature sensor measures a temperature drop below the set value, while the ice and snow sensor detects the presence of snow or ice. The area is heated during the snowfall or freezing rain to a temperature above the freezing point, and black ice does not form. The system shuts down if ice or snow is no longer present or the temperature rises above the set value. A parallel connection of two humidity sensors is also possible, which increases the reliability of the system. Using two sensors prevents formation of the so-called tunnel effect, when a layer of snow on the sensor melts and an ice crust is formed, which prevents contact of the humidity with the sensor).
The wiring example uses a combined heated temperature and humidity sensor ESF 524 001 (or ESF 524 011, Eberle) and a separate temperature sensor (suitable for smaller areas); in larger areas, an unheated combined temperature and humidity sensor TFF 524 002 (or TFF 524 012), which should be connected in the same way. The heating cables can be controlled by any relay output of the control system (according to the switching power). The connection to the C-HM-0308M module is shown in the following figure.

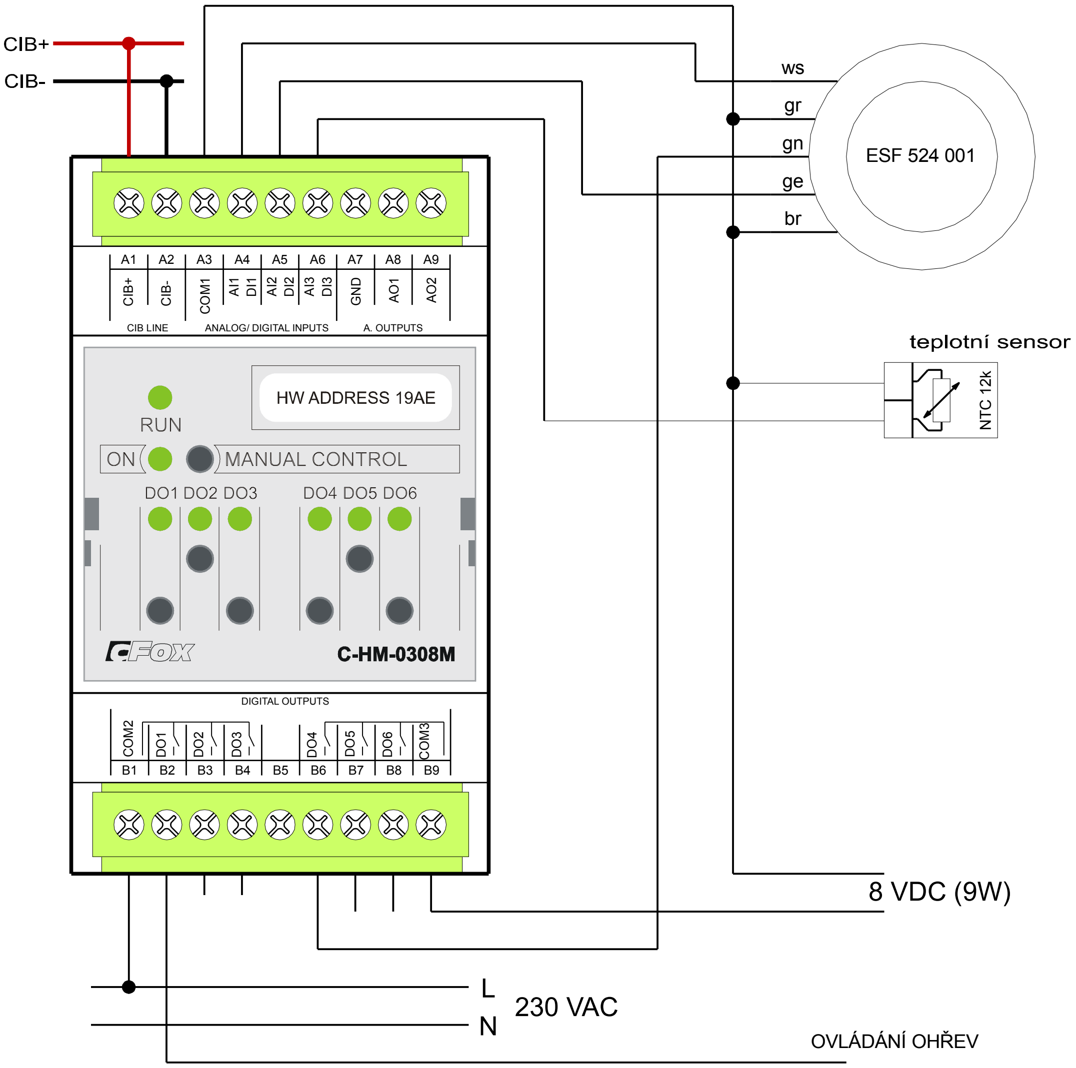


Fig. 12.1.3.1 A wiring example – defrosting of smaller areas

Notes:

1. The unheated sensor (TFF 524 002) is connected analogically, only the heating output is omitted.
2. Defrosting of areas and gutters can be combined, and both systems can be supplied from the same source.
3. Sensors made by other manufacturers should be connected in a similar way (according to the

company documentation).

4. The relay heating output must be adjusted (strengthened) according to the actual switching power.

12.1.4 Defrosting gutters, the ESD 524 03 sensor

Defrosting gutters is done using electric heating cables (Raychem, etc.) controlled according to the outdoor temperature and precipitation, using temperature and humidity sensors placed in the gutter. When the outdoor temperature drops below the set value, and simultaneously there is indication of moisture in any state (water, snow, ice ...), the heating cables are turned on. When the temperature rises above the set value, or the indication of humidity disappears, the heating is switched off (the heating cables are put out of operation).
The temperature sensor is located near the gutter and the humidity sensor is placed directly into the gutter, preferably near the drainpipe. If any state of humidity appears, the humidity sensor melts it via a 2W heating resistor and transmits the signal. It is recommended that two moisture sensors are connected in parallel for better reliability, and if moisture appears on one of them, the system is put into operation.

The wiring example shows a heated sensor ESD 524 003 (Eberle) and an NTC temperature sensor (it can also be the NTC 12k or e.g. the TFD 524 004 - an NTC 10k sensor). The sensors can be connected to any input of the control system with an appropriate range (the humidity sensor is connected to the input for condensation measurement). The connection to the C-HM-0308M module is shown in the following figure.

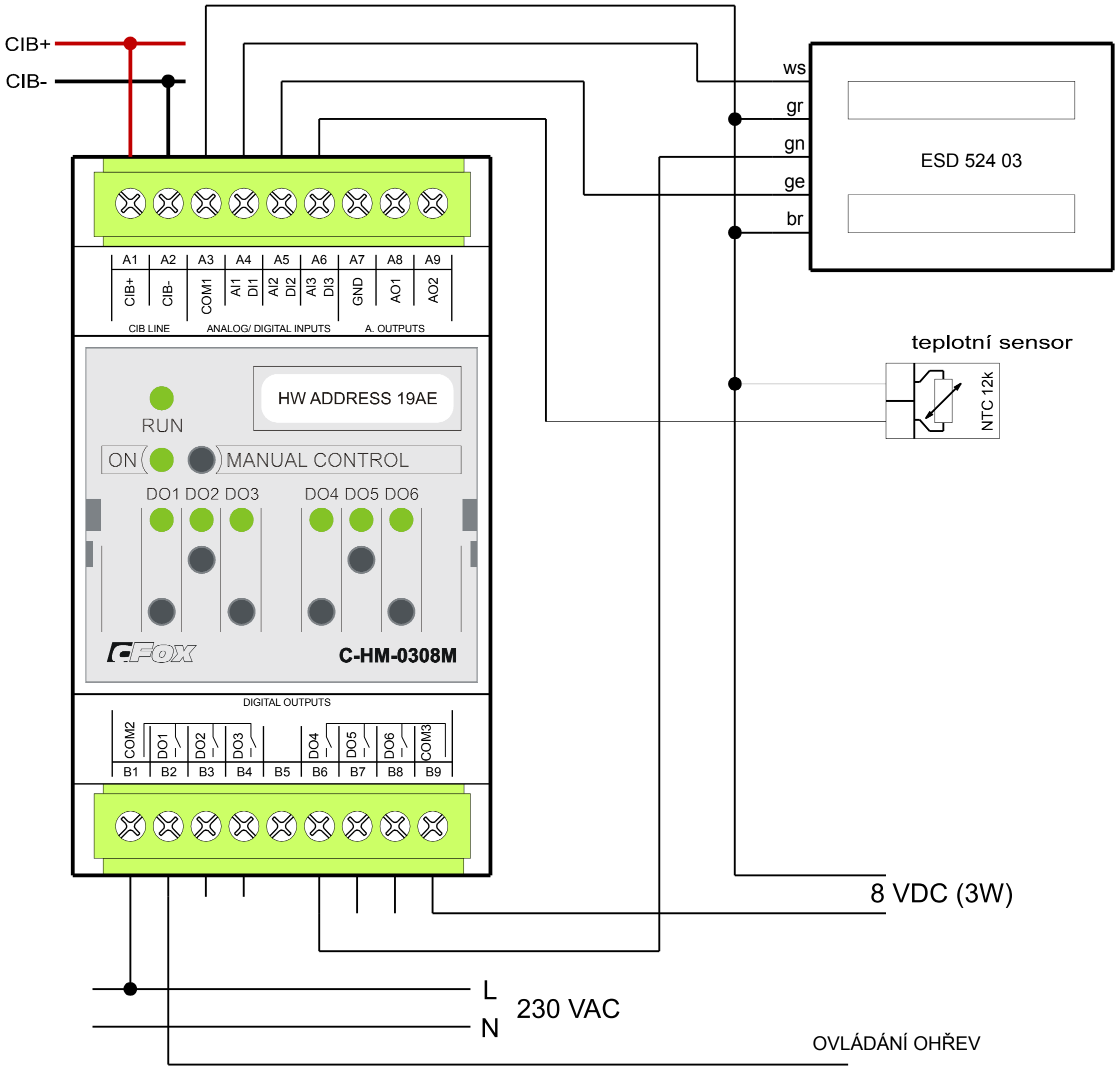


Fig. 12.1.4.1 A wiring diagram – defrosting gutters

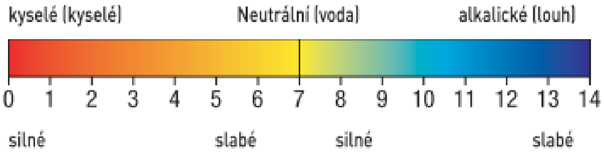
Notes:

1. Defrosting of areas and gutters can be combined, and both systems can be supplied from the same source.
2. The relay heating output must be adjusted (strengthened) according to the actual switching power.

12.2 Swimming pool technology

Measuring the quality of water:
Measurement of the acidity/basicity of solutions, of the concentration of a substance in solutions, is done using various types of probes, such as the pH or Redox probes. These probes have various types of outlets, which are mostly current loops or voltage outputs. It is recommended to use the C-IT-0200I module to process the signal from these probes, as it is suitable both for the measurement of the current loop and the voltage output of the probes. In the case of the current loop, the probe is equipped with an output that converts the measured value into the range of 0 to 20mA or 4 to 20mA.
In the case of the voltage output, it depends whether the output of the probe can convert the measured values into a standard range, such as 0 to 10V, or whether the probe only has a direct output.
In the case of a direct voltage output, the following ranges are used for measurements by the C-IT-0200I module: "HI -1V ÷ 1V" and "HI -100mV ÷ 100mV". In this case, the problem with the pH and Redox measurements is their high internal resistance. The C-IT-0200I module input then does not measure the open circuit voltage, but the voltage reduced by the decrease in the internal resistance of the probe. A necessity that arises from this fact is the calibration of values of the measured data. Calibration of both types of probes is done using calibration solutions. First, dip the probe into the solution with a known value of the measured variable, and subtract the corresponding voltage. Then repeat this procedure with different values of the measured variable. In this way you obtain a set of values that can express the transfer characteristics of the sensor. The measured value of the variable can then be calculated from the obtained relation. The calibration is not usually done in the whole range of the probe, but just for a few values, since the most common application is monitoring whether the limit value of the concentration of the substance or its pH have been exceeded. Therefore, you only need to know the values around the selected limit concentration of the solution, or its pH.

The pH value represents a measure of neutrality, acidity or pollution of the aqueous solution.
Pure water is neutral and its pH is 7.
Everything below this value is referred to as acid, everything above this value is alcalic.



12.2.1 Measuring pH

The pH can be measured by probes manufactured by the Elektrochemické detektory s.r.o. company, which supplies the whole range of probe designs, and also can help with expert advice on their selection and installation.

The following figure illustrates the connection of the pH 2+L probe to the C-IT-0200I module.

The best possible measurement conditions can be ensured by using only one input of the module for measuring the pH, and leaving the second input unconnected. In some installations there is an interaction with the second probe (REDOX) connected to the second input, which can be partly eliminated by suitable placement of two probes in the piping. However, if you do not wish to experiment, connect only one probe to one module.

Measurements performed in this way are only indicative and suitable for applications without high precision requirements.

Accurate measurements can be performed, e.g., by converters made by Mires, www.mires.cz.

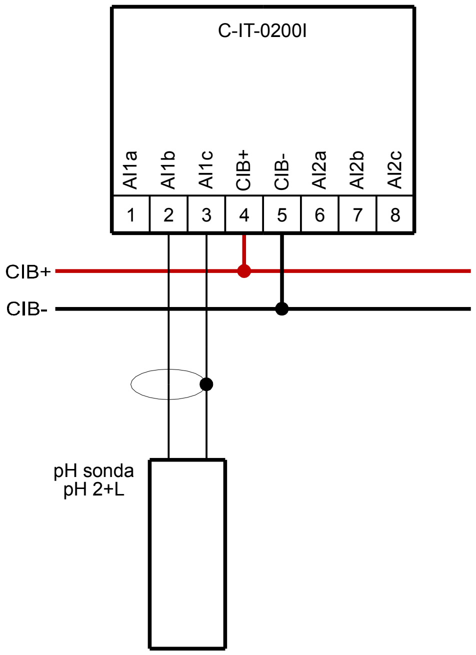


Fig. 12.2.1.1 1 An example of wiring the probe for measuring the pH to the C-IT-0200I

12.2.2 Measuring REDOX

Redox (and possibly also chlorine calculations) can be measured by probes manufactured by the Elektrochemické detektory s.r.o. company, which manufactures a wide range of probe designs, and also can help you by counselling on their selection and installation.

The following figure illustrates the wiring of the Pt 2+P probe to the C-IT-0200I module.

The best possible measurement conditions can be ensured by using only one input of the module for measuring the pH, and leaving the second input unconnected. In some installations there is an interaction with the second probe (REDOX) connected to the second input, which can be partly eliminated by suitable placement of two probes in the piping. However, if you do not wish to experiment, connect only one probe to one module.

Measurements performed in this way are only indicative and suitable for applications without high precision requirements.

Accurate measurements can be performed, e.g., by converters made by Mires, www.mires.cz.

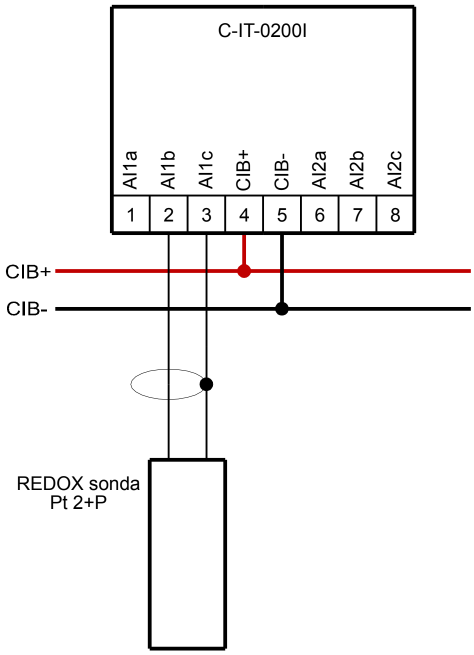


Fig. 12.2.2.1 1 An example of wiring the probe for measuring the pH to the C-IT-0200I

12.2.3 Measuring pH and Redox (chlorine)

The pH and REDOX can also be measured by the SEKO company probes. Both probes can be connected simultaneously to one C-IT-0200I module, but with some risk of mutual influence of the two probes. It is necessary to verify, or find, the optimum placement of the two probes, to eliminate interaction.

Measurements performed in this way are only indicative and suitable for applications without high precision requirements.
Accurate measurements can be performed, e.g., by converters made by Mires, www.mires.cz.

The probes used in the example include: The Redox probe SRH-1-PT-S6, cable 6m, and the pH probe SPH-1-S6, cable 6m (produced by SEKO):

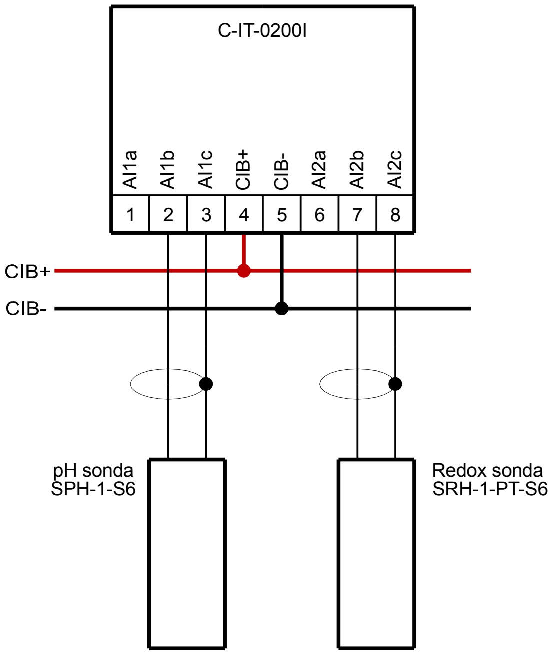


Fig. 12.2.3.1 An example of wiring – measuring pH and Redox, the C-IT-0200I module

12.3 Water – control, irrigation, flood monitoring

General recommendations for the installation of a water distribution system::
A detailed calculation of interior water supply is carried out in accordance with the CSN 75 5455 standard.
In buildings with a small-scale water distribution system (houses, apartment buildings with max. 5 floors and a single stairway, from which the apartments are directly accessible, and up to five-storey office buildings with one staircase), the internal water pipeline can be designed using a simplified method in accordance with the ČSN EN 806-3 standard.

The so-called discharge units (LU) for each place where water is used are determined by this standard; the computational flow (Qd) is determined on the basis of the sum of LU and its highest value, the length and the diameter of the piping. Furthermore, the diameter of the supply pipe is determined by the required flow rate. **The dimensions of the flowmeters and the stop-valves for water supply must also be determined by this flow rate.**

It is important to bear in mind that e.g. a standard shower requires about 18 ÷ 22 l/min., the washbasin mixer up to 12 l/min, and pressure flushing even significantly more. For example the main 3/4"(DN 20) supply at a standard pressure has a maximum flow rate 50 l/min.

Controlled valves operate at a standard water pressure in the piping from 0.5 - 8bar (0.05 ÷ 0.8 MPa). All flow rates in the technical specifications are given for the line pressure of 3bar (0.3MPa).
If you want to maintain a long life of electromagnetic valves and a reliable operation of the equipment, you should respect the cross-sections of supply piping and follow the installation principles in accordance with the ČSN-DIN-EN 806 standard.

It is recommended to maintain the pressure in the distribution system at 2 ÷ 5bar (0.2 ÷ 0.5MPa). It is also recommended (in some countries even mandatory) to include in the mains a full flow filter with a 90um mesh (or less), e.g. the SLF01 (D) - 03 (D), SANELA.

A brief explanation of terms:

Nominal clearance DN, the piping diameter
The threaded steel or cast-iron piping and the threaded and flanged fittings are indicated in the drawings with nominal clearances DN. The abbreviation DN is usually not stated. Nominal clearance DN is a number indicating the approximate value of the inner diameter of the pipes and fittings in millimetres.
Piping made of plastic, copper, stainless steel or multilayer materials (plastic-metal combinations) are marked in the drawings with the outer diameter x wall thickness (da x s), the marks da x s or Ø are usually not mentioned.
On the right, the table shows the values of DN in millimetres and the corresponding diameter in inches.

DN	
[mm]	[“]
6	1/8
8	1/4
10	3/8
15	1/2
20	3/4
25	1
32	1 1/4
40	1 1/2
50	2

The pressure range PN
The higher the number of the pressure range, the higher operating pressures are allowed.
The PN 20 range is recommended for the household distribution, the PN 16 pressure range is only used for the household distribution of cold and hot water (with limited maximum temperature).

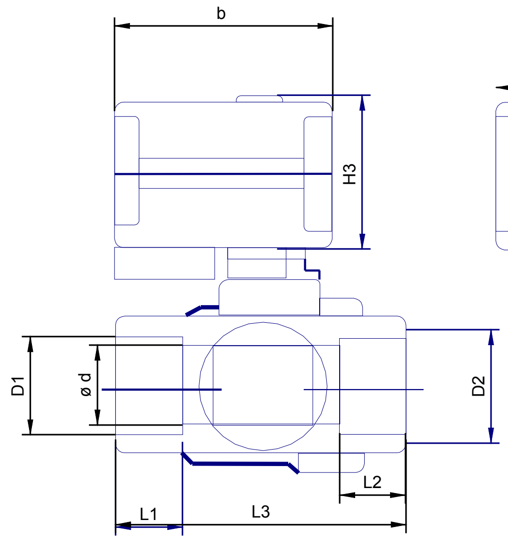
The G thread and the R thread, the difference
G-threads have a cylindrical form in accordance with the EN-ISO 228-1 standard. R-threads have a conical form in accordance with the ISO 7-1 standard. If the thread size is 1/8", for example, the threads are

specified as G1/8 or R1/8. Female G threads (cylindrical) can only be screwed into male G threads. Female R threads (conical) can only be screwed into male G or R threads.

12.3.1 **Valves for controlling water (the main water valve, etc.)**

The valve designed to control the distribution of drinking water (e.g. the main water valve), automatic control of irrigation systems, etc. Its design is also suitable for the so-called hard water. It is a good replacement of solenoids and pneumatic valves. The valve has a high torque and it is suitable both for drinking and contaminated water (with no solid particles). The valve is designed as a ball valve, which is used for opening and closing by an electric motor drive. The valve draws current only during its operation. During its operation, the valve consumes power from almost zero to approx. 5.5mA, and it is recommended to switch off the supply after its position has been changed. During a power failure the valve remains in its current position and it cannot be adjusted manually. Emergency manual adjustment is possible with the version of the valve, which is equipped with a controller for manual operation (the CWC-25-06-M).

Name	CWX-15-06	CWX-15-24	CWX-25-06	CWX-25-24
Clearance	DN15		DN25	
The screw fitting	G1/2"		G1"	
Nominal voltage	3 ÷ 6VDC	9 ÷24VDC	3 ÷ 6VDC	9 ÷24VDC
Operating current	typically 80mA	typ. 26mA	typ. 80mA	typ. 85mA
Duration of a cycle	approx. 3s at 3V supply	cca 3.5s	cca 3.5s	cca 3.5s
Operating pressure	0.8MPa (8bar)	0.8MPa	0.8MPa	0.8MPa
Output torque	1.5Nm			
The temperature of the medium	0 ÷ 95 °C			
The range of the ball valve	90°			
Operating medium	water, air, gas			
Protection	IP65			
Lifetime	100,000 cycles			
Assembly position	free			
Material:				
Body	stainless steel (or brass)			
Spherical valve	stainless steel			
Housing of the electronic part	ABS			
Sealing	PTFE and a silicone o-ring			



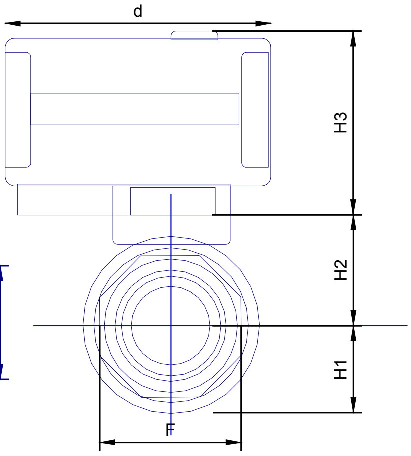


Fig. 12.3.1.1 Mechanical dimensions of the CWX valves.

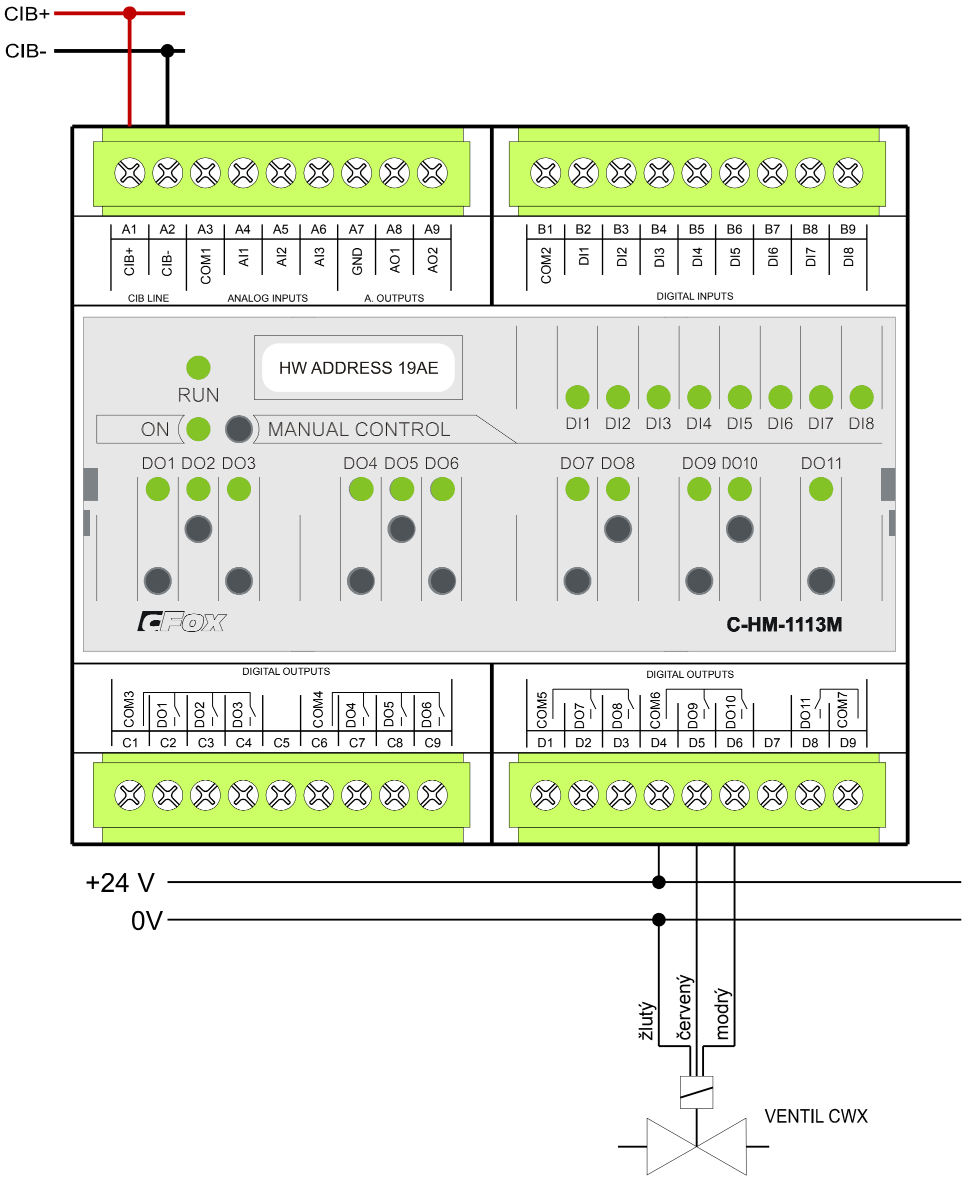


Fig. 12.3.1.1 Basic wiring of the CWX valve to the C-HM-1113M module

Notes:

1. The valve control is terminated in the cable with coloured insulated conductors with a tinned tip. The yellow wire represents the common terminal, the red wire voltage opens the valve (the DO9 output in the example), the blue wire voltage closes the valve (the DO10 close relay in the example).
2. N.B.: Both relays must not be switched at the same time - the valve could be destroyed. The valve is controlled in the same way as e.g. the blinds, and it is also possible to use the same output connections with mechanical interlocking switches of the two outputs, or a specialized module C-JC-0006M.

12.3.2 Measurement of soil moisture (irrigation systems)

The VIRRIB sensor is used for stationary measurements of volumetric moisture in the soil environment. The data is in a certain range practically independent of the soil type and its chemical composition. The response of the sensor to changes in humidity is immediate. Also the long-term stability of parameters is better, thanks to the principle of operation and materials used, as their parameters do not change in a humid environment.

The VIRRIB soil moisture sensor is produced in two shape modifications: a circular one with a diameter of 28cm, and a narrow one, which is approx. 20cm long and 6cm wide. The measured volume of the substrate reaches in the circular version 15 ÷ 20l.
The sensor consists of two concentric stainless steel electrodes connected in the sensor body, where the electronic part is placed. The electronic components together with the stainless steel electrodes are mechanically fixed in an embedding compound, which also prevents the penetration of water to the electronics. The sensor cannot be disassembled.

The basic technical parameters:

Sensor (order number)	VIRRIB LP A C	VIRRIB LP A N
Measuring range	5 ÷ 50	5 ÷ 50
The shape	circular, Φ 28cm	narrow, 20 x 6cm

The VIRRIB sensors are mostly used for direct continuous monitoring of soil moisture at a predetermined station. The sensors should be connected to the modules C-HM-0308, C-HM-1113 or C-HM-1121, see the wiring example.
An FB in the Mosaic environment is available for the measurement, providing proper handling and processing of the measured values. If power is supplied continuously, some electrochemical processes are started, which erode the structure of the measuring electrodes and thereby shorten the lifetime of the sensors. The recommended measuring interval is 15 minutes. Too frequent measurements may shorten the lifetime of the sensor! The connection of the sensors has been worked out in cooperation and as per the documentation[11].

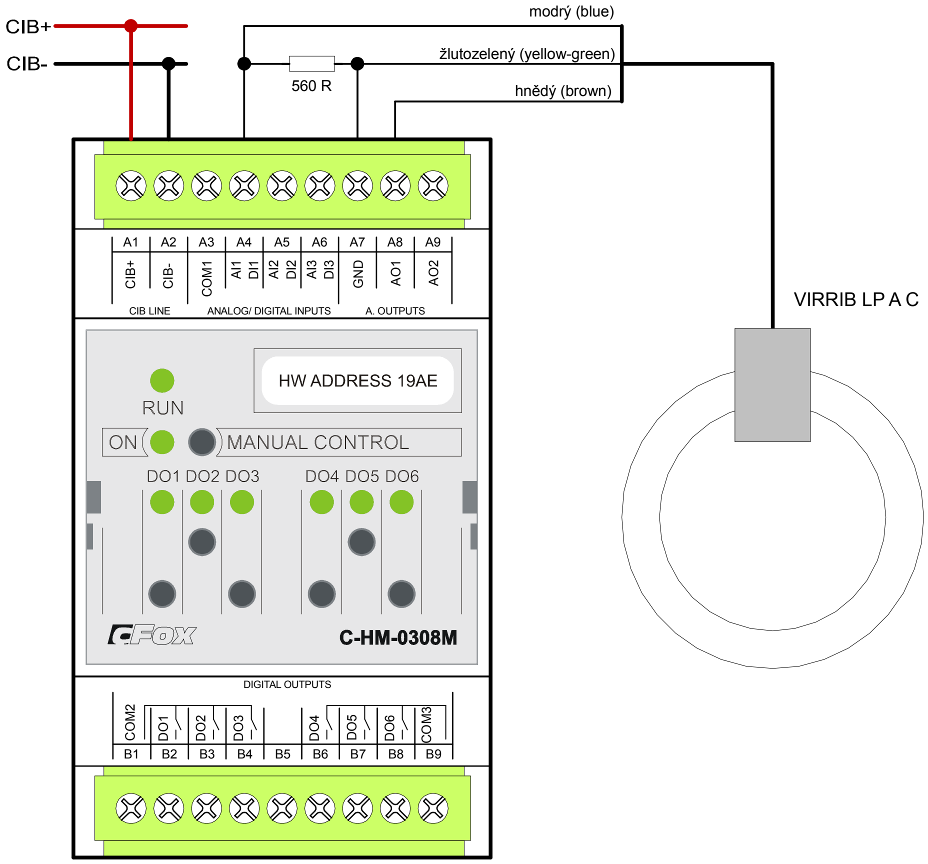


Fig. 12.3.2.1 Wiring the soil moisture sensor to the C-HM-0308M module.

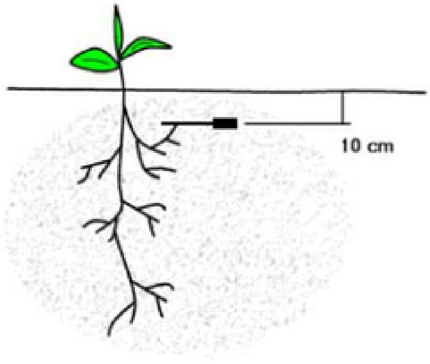
Notes:

1) The standard length of the supply cable is 2m. Other lengths can be supplied based on request.
2) The cable can be extended up to 300m. The recommended cable is, e.g. the J-Y(St)Y 2x2x0.6
3) The sensor can be connected to the AI and AO of the modules C-HM-0308, HM-C-1113 and C-HM-1121, for the wiring see the figure.
4) A 560Ω resistor should be fitted in parallel to the AI module input (a miniature resistor, accuracy is not critical, the load is minimal, 0.1W is sufficient).
5) Principles of the sensor installation are specified in the following text. More detailed materials concerning the usage of these sensors are available on request.

Placement of the sensor

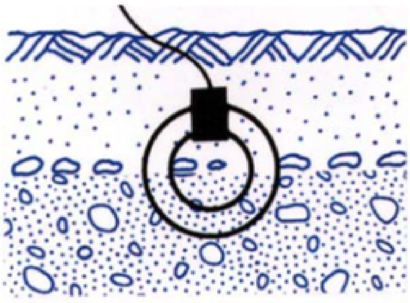
A general principle is that a VIRRIB sensor should be placed in each individually controlled irrigation section. The optimum placement should be selected with respect to typical soils prevalent in the particular property.

Installation in an area with drip irrigation



If you want to measure the soil moisture and also control drip irrigation, it is recommended to locate the sensor outside the line of the dripping tube and between two drippers. Do not place it directly under the dripper, as there is too much water movement, uncharacteristic for the environment. If the drippers dispense the volume from 2 to 4 litres/hour, the recommended distance is 30cm; at a lower spraying rate it is about 15cm. If the dripping pipe is positioned between two rows of crops, the sensor should be placed in the row below or between plants. In earthy and clayey soils, the diameter of the moistened soil is greater than in sandy soils, it is therefore necessary to take this into account when installing the sensor. The VIRRIB sensor measures the average moisture around its active parts, whether they are positioned vertically or horizontally. In most cases, its range increases by approx. 7cm on each side.

Orientation of the sensor



The sensors can be positioned in the soil profile vertically or horizontally; the horizontal placement is in most cases more advantageous. This method allows better filling the space around the active elements of the sensor with soil during the installation, and therefore the measured values reflect the reality better. The layer being measured exceeds the active elements by up to 7cm.

If the sensor is placed in a vertical position, it provides data on the average moisture content in the layer along its active parts. This placement may be suitable when one sensor is used for measuring the moisture in a layer that contains majority of active roots of the plant.

Please note: When the thickness of the layer to be measured is increased, what can happen is that the upper part of the layer is dry and the bottom one is moist. The data from the sensor shows the average humidity in this layer, so it may happen that if the roots are concentrated mostly in the upper part, the crops may still suffer from drought, even though the value of soil moisture is still sufficiently high.

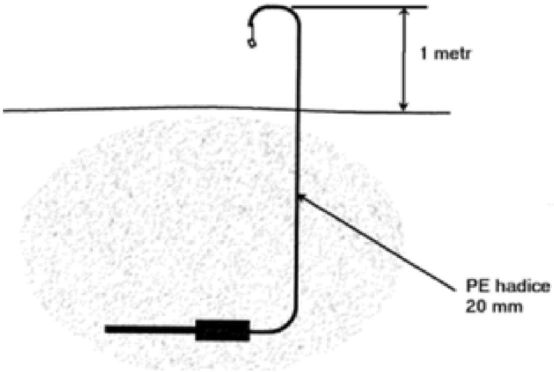
Special care must be taken when the sensor is being covered with soil,

to avoid formation of pockets of air between the soil and the active part of the sensor.

Installation of the sensor.

It is recommended first to place the cable from the sensor horizontally at least 5cm from the sensor, to avoid potential dripping of the irrigation water or rainwater along the cable into the measured area.

Protection of the cable



The cable from the sensor is suitable for being covered with soil or being exposed to the weather. Unfortunately, in nature cables are sometimes damaged by rodents, or during cultivation of crops or other activities. Most problems with sensors are caused by damaged cables. Therefore it is recommended to put on the cable a plastic protection. This protection should be put on the cable as shown in the figure, i.e. first pull it in the horizontal direction, then upward about one meter above the ground, and then turn the tip of the protective plastic downwards. The muzzle should then be bonded with a suitable silicone sealant. The soil around the protective tube should be hardened to prevent infiltration of water into the measurement space, which would distort the measured values.

How much water is in the soil (substrate)

Soil is composed of solid particles, the water with dissolved chemicals and the soil air. Mutual proportions of these three components dynamically change depending on the water balance, i.e. how fast the water is taken from or put into the relevant substrate sample. The following figure illustrates types of soil moisture in relation to individual hydrolimits and soil types. When the level of moisture exceeds the field capacity, the pores are filled with water and the soil contains hardly any air. This state is unfavourable for most plants, and the consequences tend to be more tragic than a lack of moisture. In the short term, it can be caused by too extensive irrigation, and the negative effect can be extended if excess water has nowhere to drain. Conversely, if the plants are not watered, the concentration of salt in the rest of the soil water reaches such values, that the suction force of plant roots cannot overcome them and it leads to permanent wilting. The value of soil moisture that corresponds to this state is referred to as the wilting point (WP). The difference between the field capacity and the wilting point is called the soils moisture holding capacity, which serves as a reference point for a reduced availability as a percentage of its value. It is mostly from 50 to 60% of soils moisture holding capacity; in hygrophilous plants it is more, in xerophilousu plants it is less.
The objective of the optimum irrigation control is to maintain soil moisture value in the interval from this point (60% of soils moisture holding capacity) up to the field capacity.

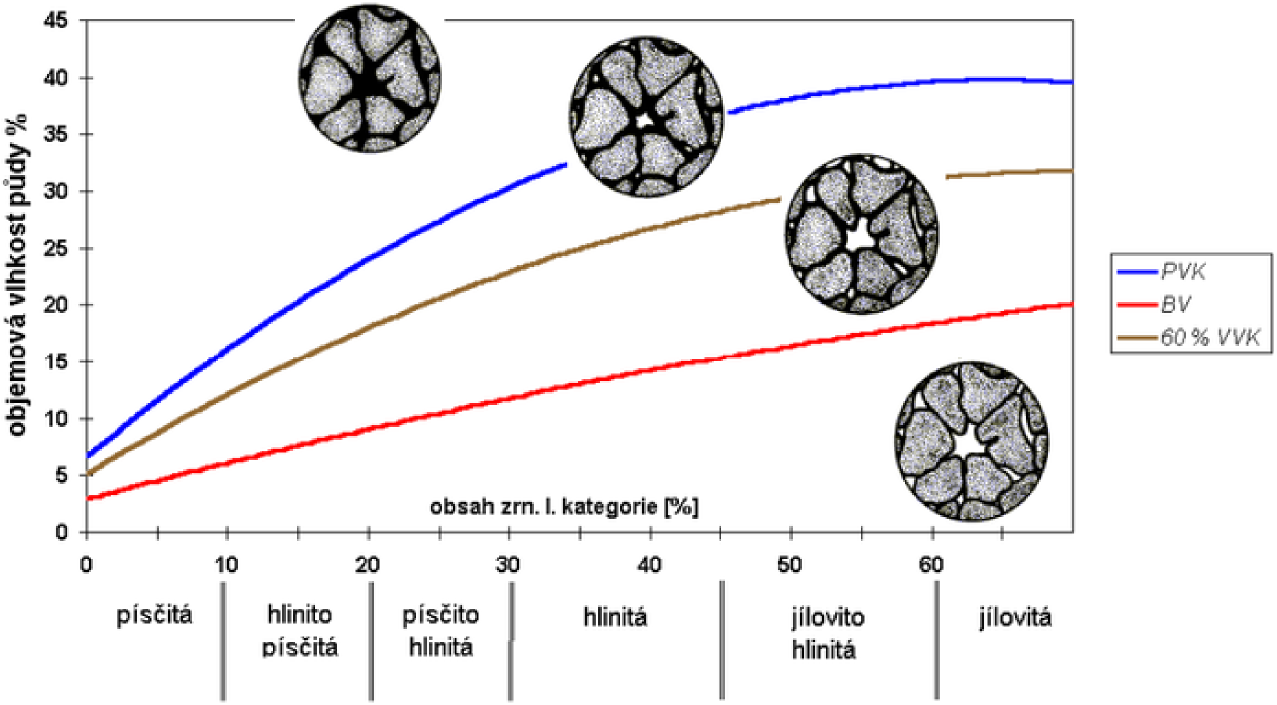


Fig. 12.3.2.2 A diagram of the relation between the soil water volume and the soil type, with displayed

hydrolimits.

12.3.3 Control of the 24V TORO valves for the irrigation systems

Controlling water for irrigation systems with the 24VAC TORO valves in the TPV series is shown in the following diagram. The wiring diagram illustrates the control of two valves by relay outputs of the CP-1006 basic module. The relay outputs of other modules can be used in the same way, e.g. the C-HM-0308M, etc. Thanks to the small initial and trickle currents, relay outputs fitted with a 5A and 16A contacts can be utilized for switching. If more than three valves are controlled by one 5A relay output, a protective element should be fitted (a varistor, an RC member) in order to secure a long lifetime of the relay contact.

TPV valves:

- Designed for home and commercial use in irrigation systems.
- Resistant to chloramine, it is suitable for systems using water with a high content of salt.
- The valve is used for polluted water or water containing impurities, sludge or sand.
- Manual operation without the use of the unit, the flow control allows precise adjustment and manual closing.
- A PVC design, a removable thumb wheel for regulating the flow (a measure against vandalism).
- The technology with a vibrating needle and a membrane, which allows the passage of small particles without clogging.

Basic parameters of the valves in the TPV series

Connection	1‟ male of 1‟ female thread
Flow rate	0.38 ÷ 150 l/min
Operating pressure	0>69 ÷ 12bar
Manual control	optional
Usage	potable water, slightly polluted water (sand, sludge)
Power supply	24VAC
Initial current	0.4A
Trickle current	0.2A

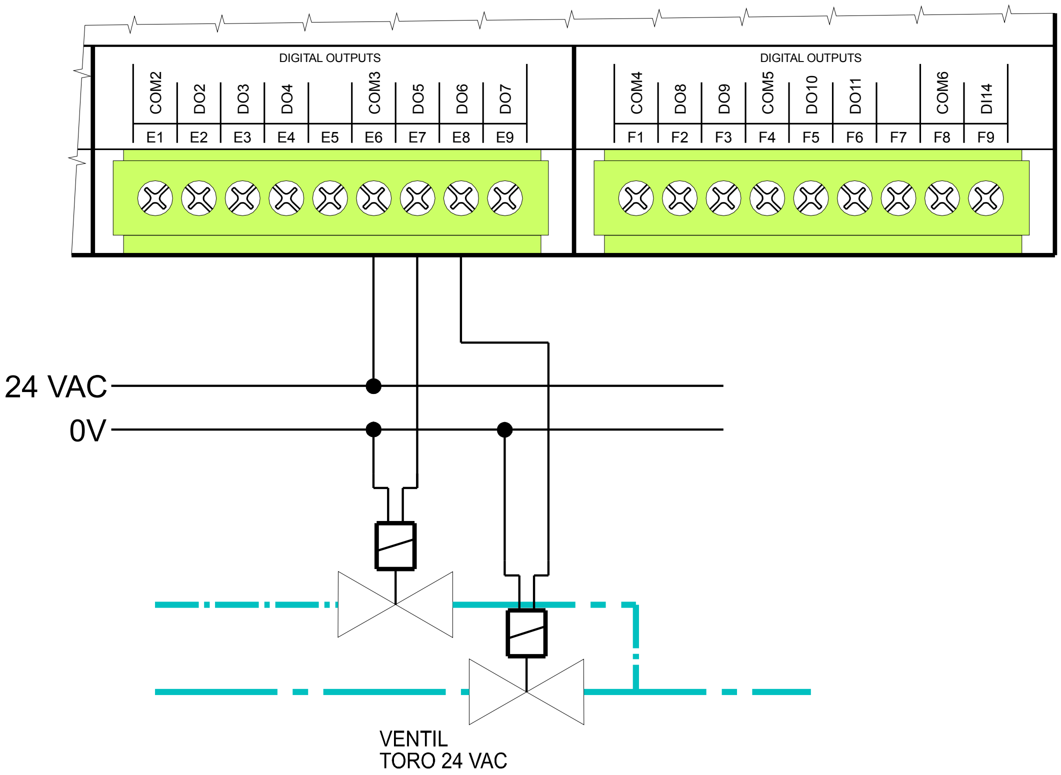


Fig. 12.3.3.1 An example of wiring the TORO valve to the CP-1006 basic module.

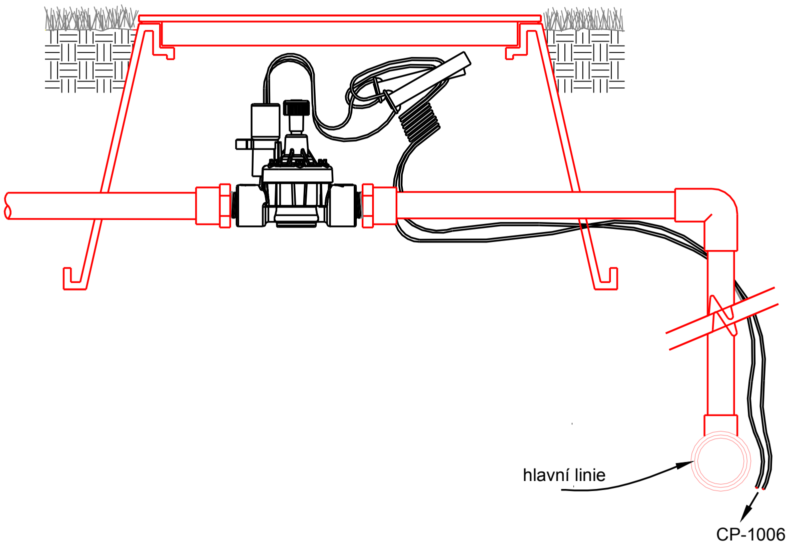


Fig. 12.3.3.2 An example of a standard installation of the TPV valve into a shaft

Notes:

1. The cable for connecting the valve can be as long as several dozen meters; a suitable type for laying in the ground should be used, and the cross-section should be at least approx. 0.75mm2 with respect to the voltage drops.

12.3.4 Controlled bistable valves for irrigation systems, CFox, RFox

Water distribution for irrigation systems can be controlled using miniature bistable valves, and similar applications can be dealt with by the CFx and RFox modules. We are preparing the R-EV-0001X module for wireless solutions, and the C-EV-0204M module to control the valves via the CIB bus.

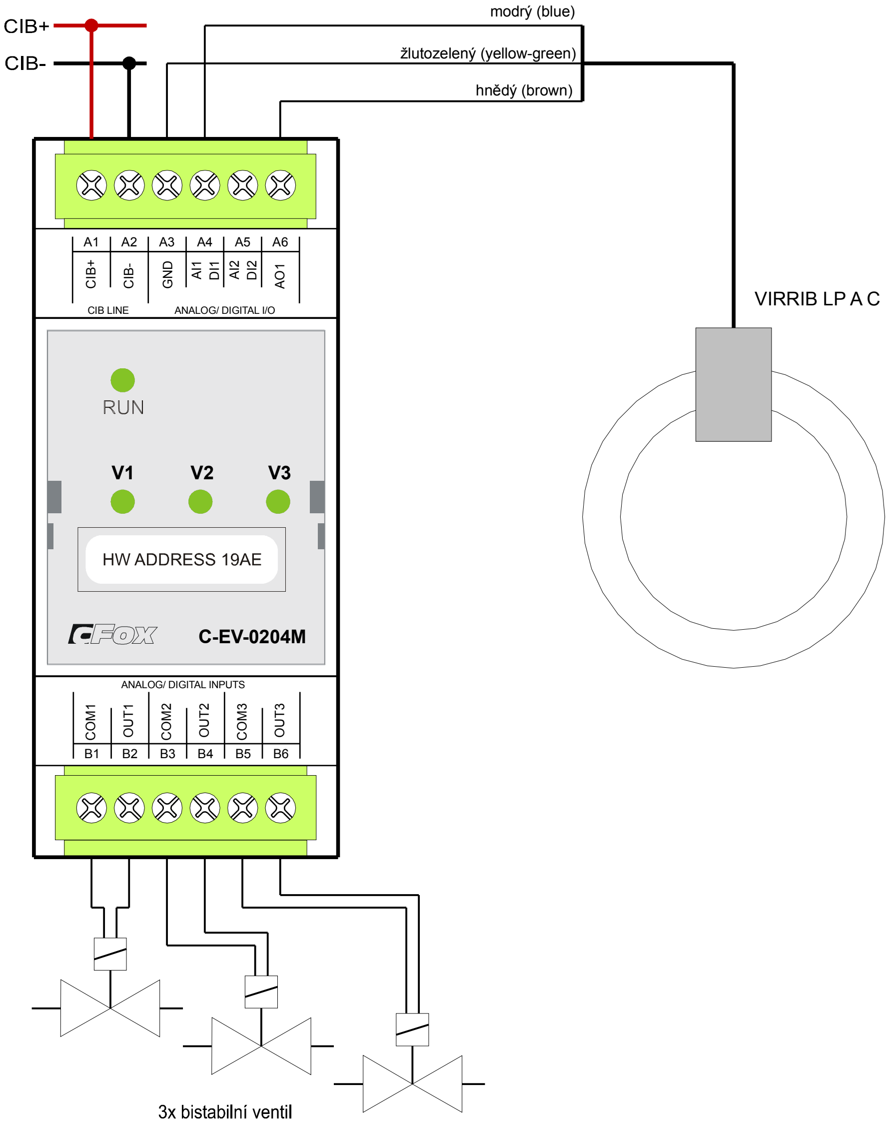


Fig. 12.3.4.1 Connecting the RPe valves to the C-EV-0204M module.

Notes:

1) The cables to the valves may be up to approx. 50m long; with respect to the pulse current values, the minimum recommended cross-section is 0.75mm^2.
2) The figure shows the connection of the sensors of volumetric soil moisture; the free AI2 input can be used e.g. for connecting the water meter (metering the consumed time, monitoring the system functions - the volume of flowing water, leakage, etc.).

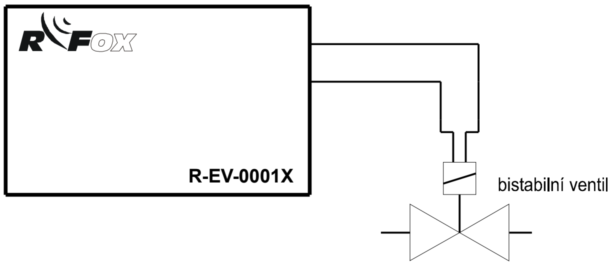


Fig. 12.3.4.2 Connecting the RPe valve to the R-EV-0001X module

Notes:

1) The module is supplied from a 9V alkaline battery, which is installed under the cover secured with 2 screws.

Basic features of the RPe bistable valves
Small bistable valves are designed to control pure water applications, where the need for a pressure drop does not matter (open-end pipe) - e.g. control water for showers, faucets, etc., and also irrigation systems. When using the valves, you should observe the operating temperatures.

Basic parameters of bistable valves:

Type	R Mini -411	R Mini -611	3-730
Clearance DN	11mm	11mm	25mm
Connection	3/8‟	3/4‟	1‟
Operating pressure	0.2.÷ 10bar	0.2.÷ 10bar	0.5 ÷ 10bar
Ambient temperature	0 ÷ 60 °C	0 ÷ 60 °C	0 ÷ 60 °C
Control	bistable	bistable	bistable
Connection	Faston 6.3 x 0.8mm	Faston 6.3 x 0.8mm	Faston 6.3 x 0.8mm

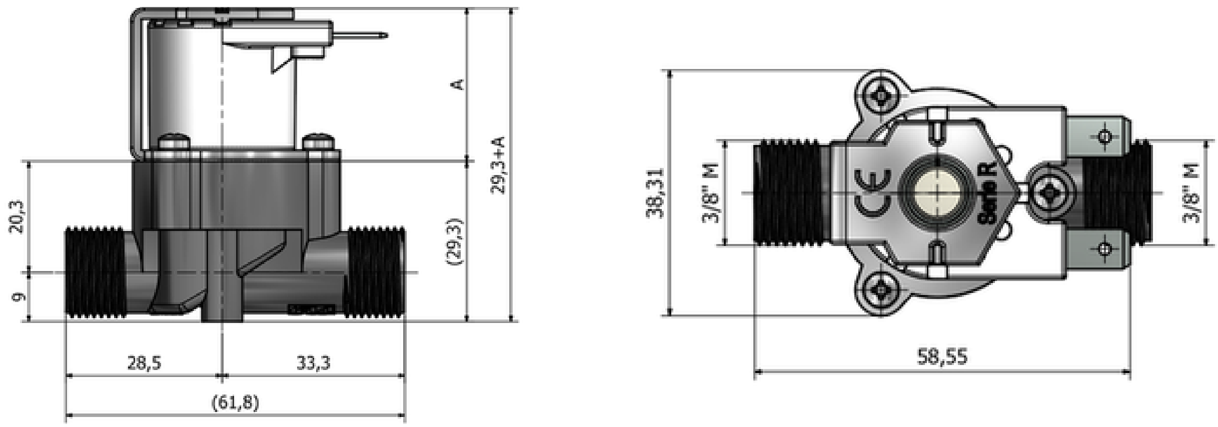


Fig. 12.3.4.3 Dimensions of the valves in the R Mini-411 series

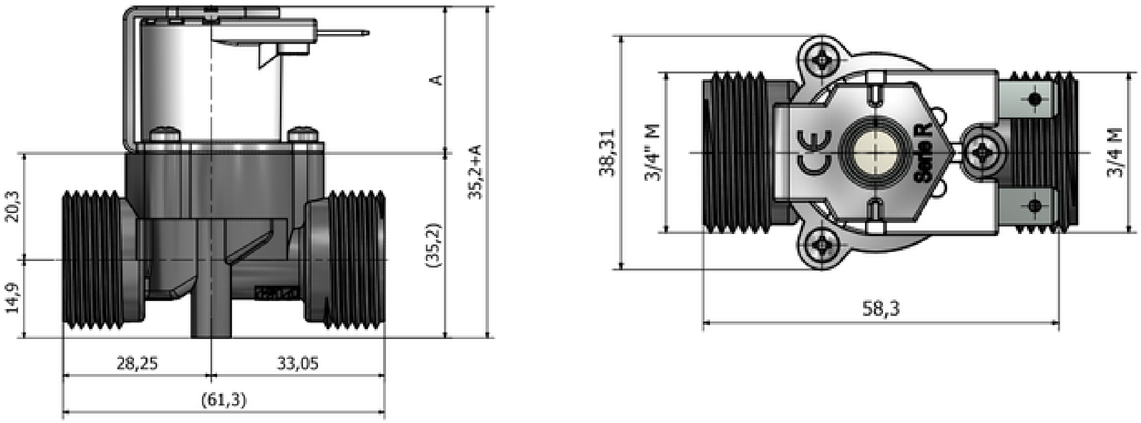


Fig. 12.3.4.4 Dimensions of the valves in the R Mini-611 series

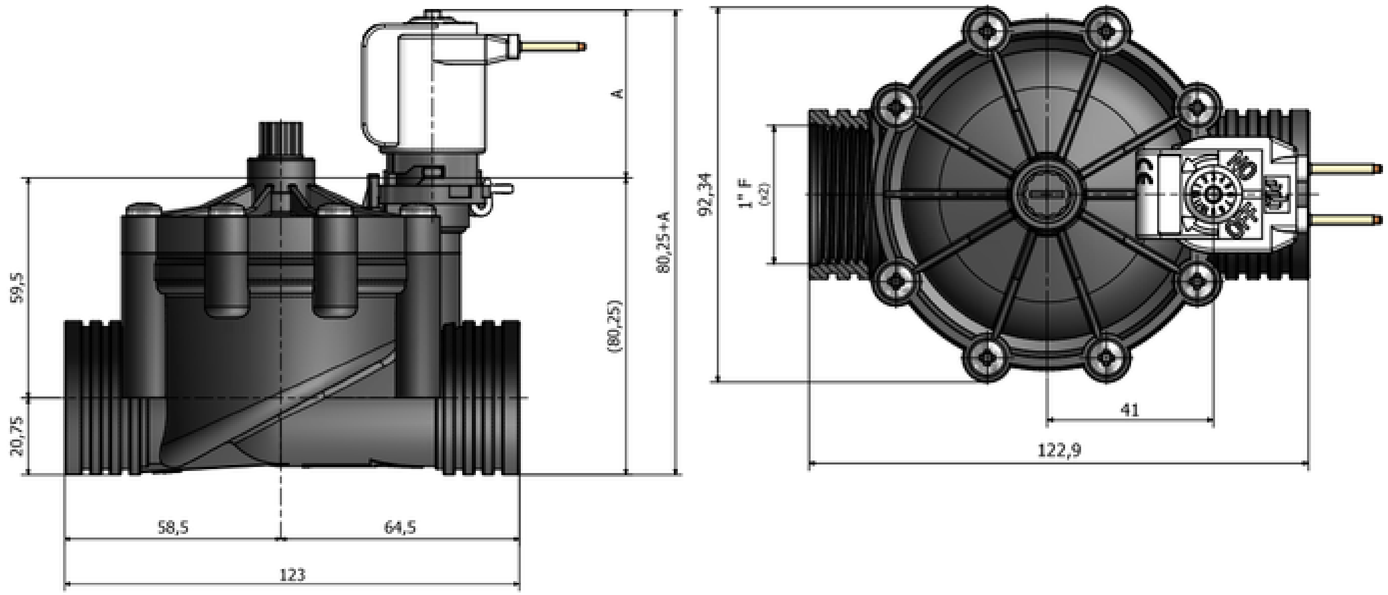


Fig. 12.3.4.5 Dimensions of the valves in the 3-730 series

12.3.5 Controlling valves (solenoid) for the irrigation systems, CFox

There are a number of other valves available for irrigation control; they are often designed as solenoid valves, which can be controlled by standard relay outputs of the Foxtrot system, as shown in the following figure. The TORO valves specified in Chapter 12.3.3. are controlled in a similar way.

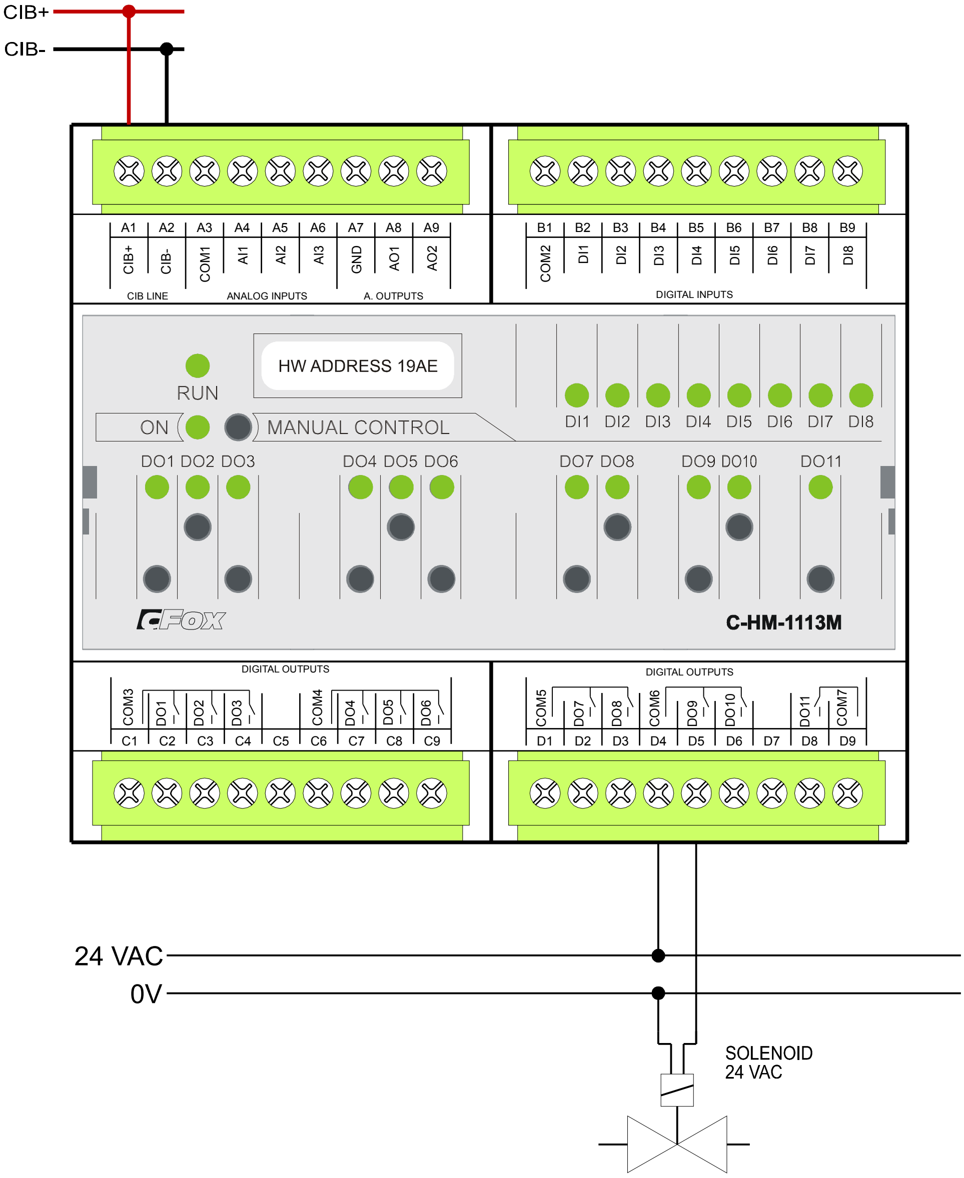


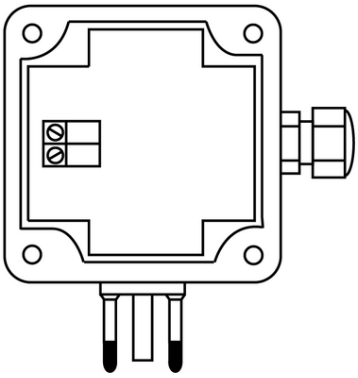
Fig. 12.3.5.1 Controlling the valves for the irrigation systems, the C-HM-1113M module

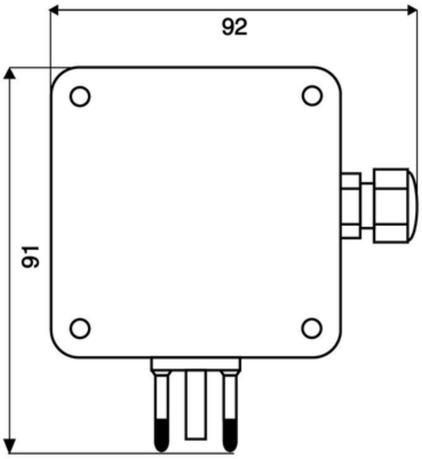
12.3.6 Flood monitoring – utility room, cellar

The flood sensor is designed to indicate breakdown situations (e.g. water leaks) in boiler rooms, heat exchangers and similar devices. The sensor is placed in a plastic case suitable for direct mounting on the wall with two screws. The sensor belongs in the category of conductivity types of sensors. When the electrodes placed in the bottom part of the sensor box are connected by a conductible medium, the connected module evaluates the status of the flooding, and the signal is transmitted to the control system. The actual DS sensor should be connected to the module with a respective input for flooding, e.g. the C-AM-0600I or the C-HM-0308M.

Parameters of the DS flood sensor

Ambient temperature	-30 to 60 °C
Protection	IP54
Connecting wires	Max. 15mm^2
External dimensions of the sensor box	92 x 91 x 36mm





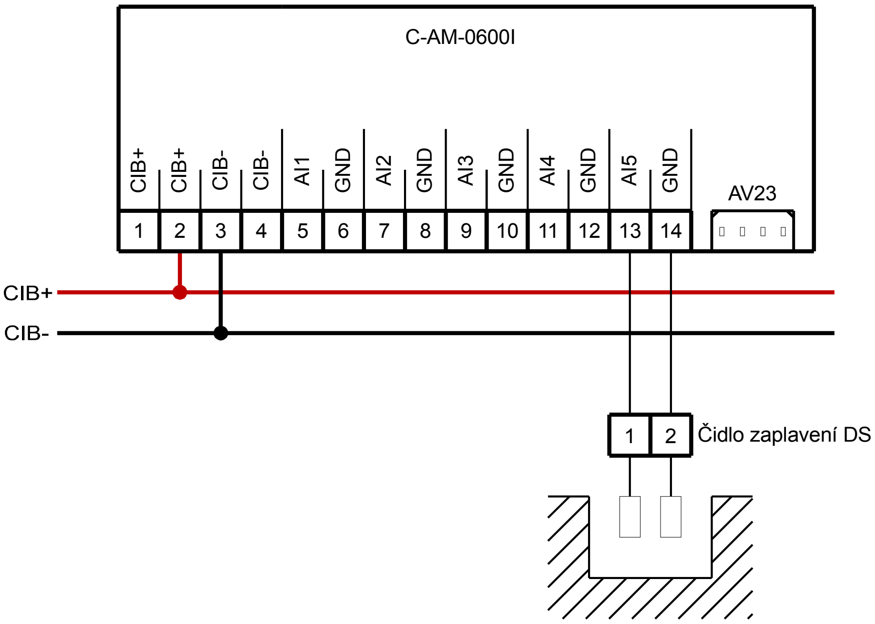


Fig. 12.3.6.1 Connecting the DS flood sensor to the C-AM-0600I module

Notes:

1) The probe should be connected to the module input with a two-wire shielded cable (maximum

recommended length 15m); the 0.5mm wire diameter is sufficient, e.g. the SYKFY 2x2x0.5. The polarity is irrelevant.

12.3.7 Flood control – the bathroom, kitchen (water leakage from appliances)

Flood control in living areas, usually fitted with tiles and similar smooth flooring (bathrooms, kitchens, but also utility rooms) can be done using the FLA2100 adhesive flood sensor.

The sensor should be glued on the flooring in the point where possible flooding should be monitored. The FLA2100 sensor is a 15mm-wide strip, which is fitted with conductive electrodes on the edges and with a self-adhesive layer on the underside. The strip is supplied in lengths of 2m and 50m; the required length should be cut off and output pins should be carefully soldered to the conductive electrodes. The pins should then be connected to the appropriate analogue Foxtrot system input. The strips can be connected in parallel and the presence of water can be monitored in several places, e.g.under the appliances in the kitchen unit, etc.

The strip may be connected either to special condensation measurement inputs,e.g. the C-AM-0600I or the C-HM-0308M (these two have a high sensitivity even for liquids with low conductivity, of a very short pieces of the strip can be used), or to the analogue inputs for standard measurement of water leakage, with the resistance up to 160k Ω (used e.g. for measurements of NTC temperature sensors, see Chapter 10). Resistance in the dry state is much higher than 160 k Ω; under flooding - depending on the amount of water, the tape length and the purity of the water - the resistance decreases in the order of dozens of kΩ, e.g. an immersed 10cm strip may have a resistance of about 80 to 100 kΩ, and if the immersed strip is longer, the resistance decreases even more.

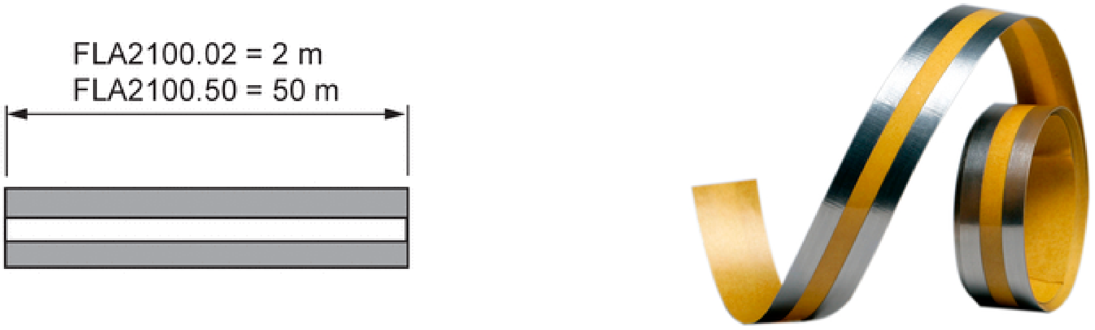


Fig. 12.3.7.1 The FLA 2100 flood sensor

Notes:

1. It is recommended to solder the insulated stranded wires (with 0.5 to 0.8mm diameter) to the electrodes; the length of the cable from the sensor to the measuring module may be dozens of meters, e.g. the SYKFY 2x2x0.5. The polarity is irrelevant.
2. The example of electrical connection is identical e.g. with the previous one; also the NTC resistive temperature sensors are connected in the same way (see Chapter 10), etc.

12.4 The ripple control signal, sensing and transmitting the signal

This chapter describes the characteristics and requirements of the ripple control, and the basic ways how to control the installation and the connection to the Foxtrot system. This chapter was written in cooperation with Pražská energetika, a. s.

Ripple control (mass remote control) is a load management system used by the power generation industry, which allows to transfer information via the grid, making it possible to remotely control electricity tariffs and blocked appliances directly at the supply point (SP). The current tariff structure works with two high tariffs (T1 in the electricity meter) and a low tariff (T2); occasionally you can come across up to four experimental tariffs, i.e. T3 and T4. Although controlling tariffs and blocked appliances is technically independent, the two-tariff supply follows the principle that the low tariff is only applicable when at least one blocked appliance is in operation.

The ripple control can be implemented in the electricity meter distribution cabinet as a stand-alone device that controls one or several supply points; it can also be designed as a built-in module in the electricity meter, or as the so-called smart meter (still in the experimentation stage), which does not utilize the ripple technology, but develops the idea of remote control improved by assigning AP addresses to each specific supply point and integrating a two-way communication. Finally, the distribution cabinet can contain a combination of a smart meter and a ripple control (this is typical for supply points with a photovoltaic power plant). However, it is a sole decision of the power company which specific equipment (a switching element) will be used, and the customer has no say in it, unless it is related to a contractual product that requires a specific solution.

The supply point equipped with appliances that are included in the load management system of the power company (water heating, storage heating, direct electric heating, mixed heating, a heat pump) and that are appropriately sized to comply with the characteristics of the supply point, requires more tariff measurements, and its electrical installation must be ready for individual control of the blocked appliances in a one-circuit or two-circuit connection. Separate circuits are required because the blockage of various appliances within 24-hour periods differs: heating water is blocked for 8 h, while mixed heating 16 h, direct electrical heating for 20 h and the heat pump for 22 hrs. The duration of blockage does not need to be continuous. There are also differences among the distribution companies, so e.g. ČEZ Distribution and E.ON Distribution control heat pumps by three point switching and require a separately controlled circuit for bivalent direct electrical heating. Detailed specifications including the number of circuits (the number of switching element commands) are listed in the technical terms of each of the power distribution companies, which are available on their websites.

The electricity meter cabinet is fitted with a switching element, which indicates individual commands by one to three control neutral wires, i.e. usually the status of individual appliances (such as heating water, accumulation heating, direct electrical heating, heat pump, etc.). A standard recommended cable is 3C CYKY 1.5, and if additional circuits are needed, the phase or the protective wire should be marked in light blue. When an appliance is unblocked, the switching element relay connects the neutral wire to PEN (N if a change of the network from TN-C to TN-C-S has been implemented already in the meter control panel, or in the TT network). On the side of the house distribution panel in a standard connection this results in energizing the contactor, which is connected to the phase via a protection element.

In terms of the Foxtrot system applications there are several options, which depend on the specific needs. If you only want to detect the low tariff, it is sufficient to sense the blocked circuit; in multi-command switching elements the circuit for accumulation heating, direct electrical heating and the heat pump (the others are only a low tariff subset of time.
If you also want to control the blocked appliances with Foxtrot, you should sense all circuits in the multiple command switching element. Technically the circuit can be scanned by a direct connection of the switching element to the 230V Foxtrot inputs, by parallel connection of the 230V CP input to the contactor coil (this only makes sense when detecting the low tariff); otherwise, auxiliary relays can be used, whose coils are connected as the contactors, but the contacts are controlled by Foxtrot inputs. It is also possible to select an

appropriate combination of these methods.

Notes:

1. The development in the power sector of EU countries is heading towards the use of smart meters. It can therefore be expected that within the AMM (Automated Meter Management) standard, the communication with the supply points will be replaced by the bus. Therefore it is advisable, especially in new supply points, where the investors plan installing an intelligent home control system, to install simultaneously 3C CYKY 1.5 and a shielded twisted pair, ideally the STP cat5e, from the supply point (the utility room with the control system) to the electricity control panel.
2. The Foxtrot system is already prepared for several options of a direct connection of the electricity meter, both with wired and wireless buses (Wmbus, etc.). These technologies are still being developed and are expanding.
3. Distribution companies have not reacted so far by changing their technical conditions to adapt to the requirements of the smart home systems, and still assume that the contactor coil is connected to the neutral wire in the supply point. When a worker of the power distribution company inspects the connection and does not detect the presence of the phase, e.g. due to the fact that the neutral wire is terminated directly on the ripple control of the Foxtrot input, a dispute may arise, in which the decisive factor is the mentioned technical condition of the connection. Direct control by the contactor also de facto means, that the power engineering does not allow for the situation that control could be shared by an algorithm in the Foxtrot system, and theoretically in marginal cases a dispute may also arise.
4. N.B.: There are still supply points, which are connected according to invalid standards, where the switching element commands are executed by L, and not by N.
5. Another option how to learn about the validity of a tariff and how to control appliances in PRE Distribuce territory would be to download data from the web PRE. A library is being prepared in the Mosaic development environment, which will take advantage of the communication with the PRE Distribuce interface and provide the users with the table listing the times for the specified command groups. The advantage is that the user program knows the future times and respond proactively.

The following chapters primarily illustrate the method of capturing the switching elements commands. The number of commands and the method is already an individual matter, which should be evaluated by the designer.

⚠ If the ripple control output switches several devices, they must be supplied from the same phase, otherwise there is a risk that if the output is switched off (the zero wire N is switched off), on some device can appear (almost) the 400V phase-to-phase voltage and destroy it.

12.4.1 Direct connection of the CP-1000 inputs to the switching element output

The following example shows a direct connection of two-command switching element to the CP-1000 basic module, whose power controls the blocked appliances and which also has information about the validity of the low tariff. The connection covers most switching element options, enabling Foxtrot to control also the blocked appliances.

The basic modules CP-1000, CP-10x6, CP-10x8 are equipped with a direct ripple control input, which is designed for a direct connection of the switching element (located in the electricity meter control panel) signal. As the control is implemented by the N signal, the L terminal (in the figure it is the F5 terminal) is permanently connected to the phase wire (L).

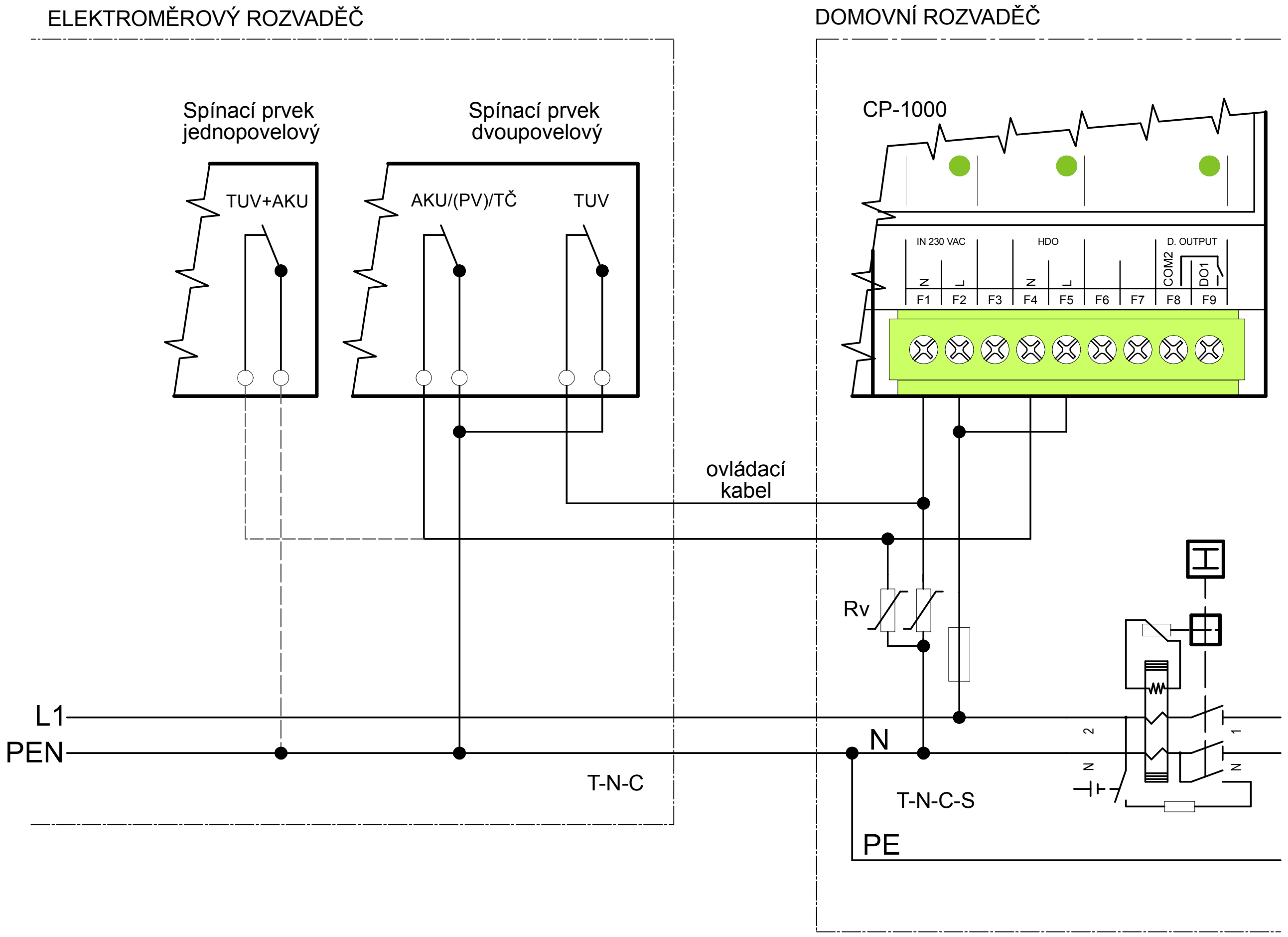


Fig. 12.4.1.1 Direct connection of a two-command switching element to the CP-1000 module

Notes:

1. The figure shows the TN-C network in the electricity meter control panel changed to TN-CS in the house control panel. In the distribution territory of ČEZ Distribuce the network can already be changed in the electricity meter control panel. In such a case the bifurcation of the PEN wire into N and PE should be drawn in the electricity meter control panel. In the distribution territory of E.ON Distribuce is also used the TT network. In this case, the N conductor and PE are completely isolated, and the PE starts with changed in the electricity meter control panel. The listed changes do not alter in any way in the illustrated sense of control by the N wire, nor in the surge protection.
2. There is also suggested an alternative use of one-command switching element (e.g. only in heating water, or heating water + accumulation heating up to the limit power input). Even when a one-command switching element is used, the installation in the house control panel should be prepared to simply switch to the two-command system, as the distribution tariffs or the technical

specifications may be changed, etc.

3. The SP signal is usually brought by the CYKY cable from the electricity meter control panel. Usually only the blue wire is used from the cable, or in multiple-command systems another wire should be re-marked blue (the switching element is controlled by the signal from N).
4. The ripple control input in the module (the F4 and F5 terminals) is specifically designed for 230V (i.e. it is a binary 230VAC input).
5. The example also illustrates the connection of the second 230BVAC input (the F1 and F2 terminals), which is usually used to monitor the presence of 230VAC supply voltage (if the system has a battery backup). If necessary, this input can be used as a second ripple control input (only the CP-1000 basic module). If there is a need to monitor the supply voltage, it may be better to leave the 230VAC input to its purpose (with the stated over-voltage problem in mind); an auxiliary relay then can be used for the second switching element command. Its contacts will control the CP digital inputs (see the following chapter).
6. If a third command of the SP should be captured, it is possible to add another auxiliary relay.
7. In cases where there is a risk of surge penetration into the control wires, it is recommended to include an SPD element. When the electric meter control panel is on the boundary of the property (LPZ 0), the control cable tends to run parallel with the power cable. If the protection is designed like this, co-action with the inlet protection is expected. For a selection of appropriate protective elements and a table with recommended types, see the Chapter on Interference suppression, application of suppression measures.
8. The phase fuse of the F2 and F5 terminals protects longer installation of the phase wire against possible short circuits, e.g. if the Foxtrot is located in a separate cabinet and not in the house control panel.
9. If there is a protective switch installed at the supply point, the 230V CP inputs must be connected upstream to avoid the generation of a false residual current.

12.4.2 Connecting a three-command switching element to the CP-1000 inputs.

The following figure shows an example of connecting a three-command switching element to the CP-1000 module, which has information on the validity of the low tariff; the power control of the blocked appliances can also be provided directly by contractors..

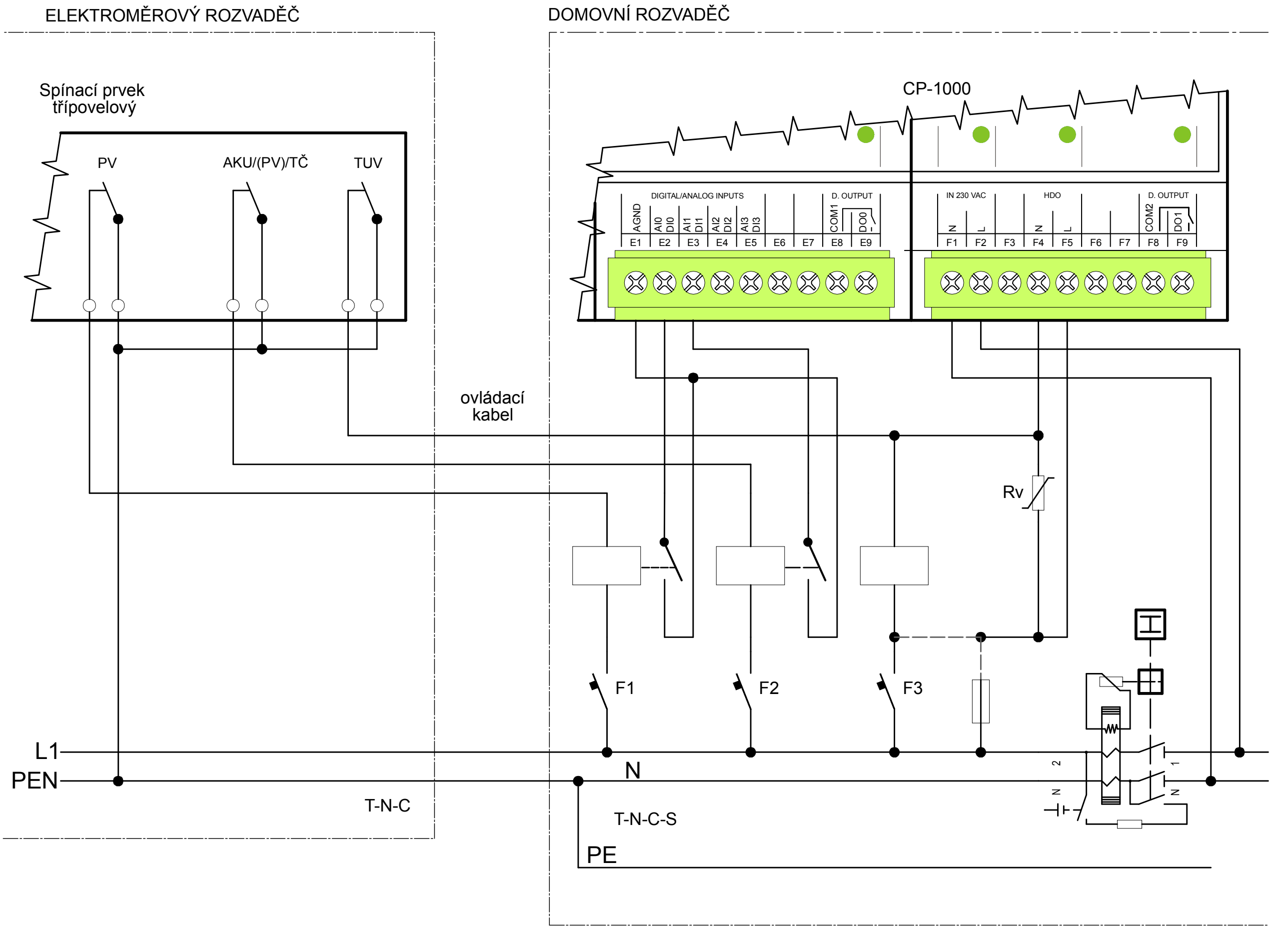


Fig. 12.4.2.1 Connecting a three-command switching element to the CP-1000 module

Notes:

1. The figure shows the TN-C network in the electricity meter control panel changed to TN-CS in the house control panel. In the distribution territory of ČEZ Distribuce the network can already be changed in the electricity meter control panel. In such a case the bifurcation of the PEN wire into N and PE should be drawn in the electricity meter control panel. In the distribution territory of E.ON Distribuce is also used the TT network. In this case, the N conductor and PE are completely isolated, and the PE starts with changed in the electricity meter control panel. The listed changes do not alter in any way in the illustrated sense of control by the N wire, nor in the surge protection.
2. The SP signal is usually brought by the CYKY cable from the electricity meter control panel. Usually only the blue wire is used from the cable, and the other wires should be re-marked blue (the switching element signal controls N).
3. The ripple control input in the module (the F4 and F5 terminals) is specifically designed for 230V (it is a 230VAC binary input), with the resistance of up to 400VAC, and it is supplemented with a varistor, which protects the ripple control input against surges resulting from the disconnecting of the switching element signal on the contractor coil and in co-action with the assumed surge protection of the inlet against induced overvoltage of the control wire.
4. For a selection of appropriate protective elements and a table with recommended types, see the Chapter on Interference suppression, application of suppression measures.

5. Contactors or relays of all commands must be supplied from the same phase (the figure shows a one-phase network, but the usage of three-phase networks must be assumed), otherwise there would appear phase-to-phase voltage on the terminals (downstream from the coils), which means it would also appear in the ripple control of CP input, and the recommended varistor would react.
6. Other commands are scanned via auxiliary relays, whose contacts are connected to standard binary inputs of the Foxtrot system (in this case directly the CP-1000 inputs, but any binary system input can be used).
7. The phase fuse of the F5 terminal protects a disconnection of the circuit in the case of the varistor failure; it also protects the phase wire against a potential short circuits, e.g. if the Foxtrot is located in a separate control panel, and not in the house control panel.
8. If there is a protective switch installed at the supply point, the 230V CP inputs must be connected upstream to avoid the generation of a false residual current.

12.4.3 Indirect connection of the C-AM-0600I input to the SP output via an auxiliary relay

The following figure shows an example of an indirect connection of one-command switching element to the C-AM-0600I module binary input, which provides the power control of the blocked appliances and also has information on the validity of the low tariff.

The connection can operate either independently, or it can be an appropriate complement to the variant of direct connection of the switching element to the CP ripple control input, where the 230VAC input cannot be utilized for another command, or where a third command needs to be captured, for which there is no more free 230V input (similarly to the previous chapter).

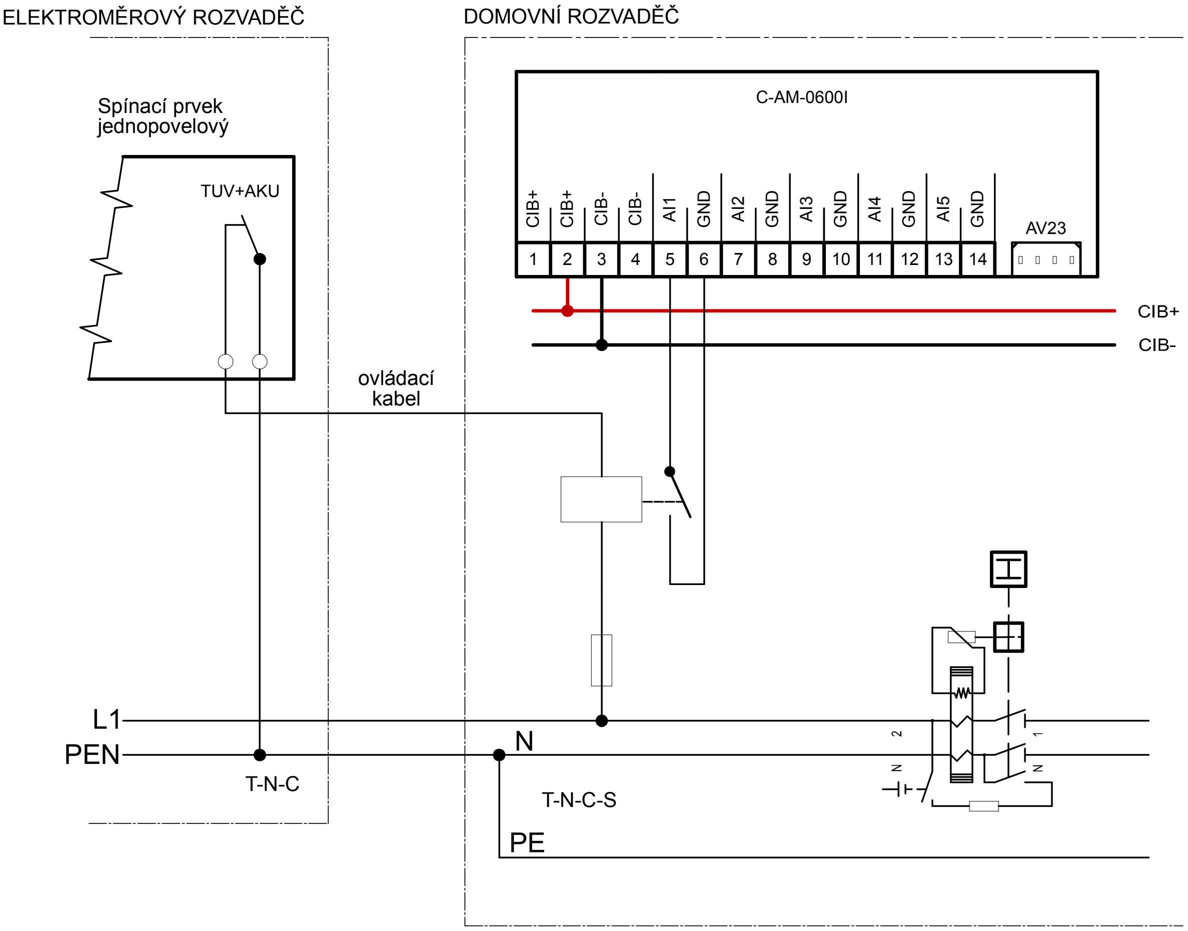


Fig. 12.4.3.1 Connecting a one-command switching element to the C-AM-0600I module

Notes:

1. The figure shows the TN-C network in the electricity meter control panel changed to TN-CS in the house control panel. In the distribution territory of ČEZ Distribuce the network can already be changed in the electricity meter control panel. In such a case the bifurcation of the PEN wire into N and PE should be drawn in the electricity meter control panel. In the distribution territory of E.ON Distribuce is also used the TT network. In this case, the N conductor and PE are completely isolated, and the PE starts with changed in the electricity meter control panel. The listed changes do not alter in any way the illustrated sense of control by the N wire.
2. This connection is recommended if you need to reliably protect the CP input against surge on the control wire. An auxiliary relay with adequate resilience should be selected (relays are usually less costly than the surge protection). This connection is also useful, if there is no free input on the CP, because in this case a standard digital input can be used.
3. If there is a protective switch installed at the supply point, the 230V CP inputs must be connected upstream to avoid the generation of a false residual current.

12.5 IP cameras

The Foxtrot system standard accessories also include IP cameras, whose video signal can be displayed on the Foxtrot website, in applications for smart devices, etc., and they can also be saved to SD cards, a snapshot can be sent by mail, etc.
A wide range of IP cameras can be connected to the Foxtrot system. The Teco company now offers its own brand of IP cameras for excellent price/performance ratio, with a high quality image processing and several variants of mechanical design. The cameras are mostly available in two versions with different image sensor resolution.The cameras are mostly available in two versions with different image sensor resolution.
For basic technical information and parameters, see the following chapters.

The cameras should be connected to the internal network in the building, like the Foxtrot control system itself; for basic information on the Ethernet, see Chapter 2.4 ETHERNET PLC Foxtrot (interfaces, cables).

If cameras are placed outside the building or in a place with a higher risk of surge, the Ethernet interface should be protected by SPD elements, like e.g. the weather stations with the Ethernet interface, WiFi AP, etc. For examples of SPD use, see Chapter 13.5.12 Ethernet Protection (weather stations, WiFi on the roof).

12.5.1 The Bullet version of the IP camera

An IP camera in Bullet design is fixed to the ceiling with the manual setting and IR lighting with up to 20m range.

	TC-IPB14718-IR/P	TC-IPB2719-IR/P
Scanning chip	$^{1}/_{3}$" CMOS with progressive scanning	CMOS with progressive scanning
Max. resolution	1280 x 1024 1.4 MP)	1920 x 1080 (2.1MP)
Focal distance	4mm, 6mm, 8mm, 12mm fixed lens (2.8 ÷ 12mm optional)	
Detection angle	92° ÷ 20°	
Max. aperture	F1.4	
Focus control	manually	
Sensitivity	0.01 Lux (colour), 0.001 Lux (monochrome)	0.05 Lux (colour), 0.005 Lux (monochrome)
Sensitivity with IR LED on	0 Lux	
Mounting the camera	On the ceiling	
Video compression	H.264, MJPEG	
Network interface	Ethernet, RJ-45 (10/100 Base-T)	
Operating temperature	-20 ÷ 60 °C	
Power supply	12VDC, POE (802.3af)	
Power consumption	max. 6W	
Dimensions	318mm x 110mm x 90mm	
The weight	0.7kg	
Protection	IP 66	

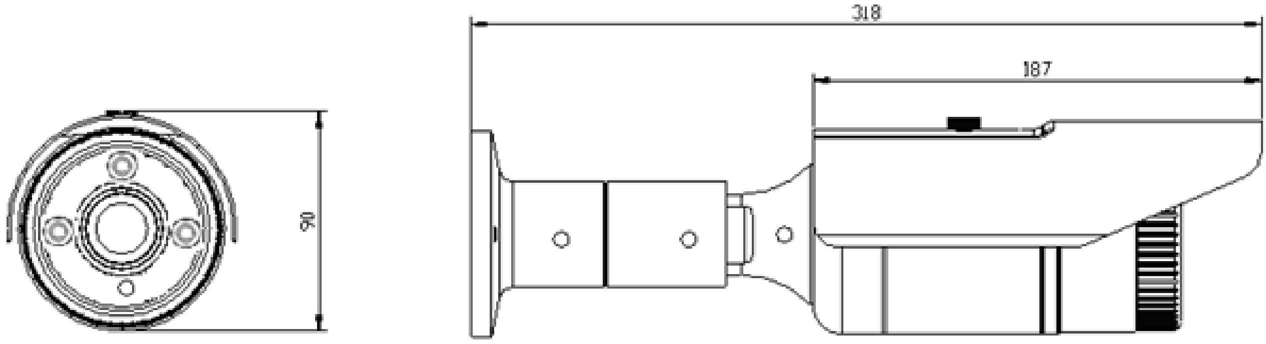


Fig. 12.5.1.1 Dimensions of the Bullet IP camera

12.5.2 The Box version of the IP indoor camera

	TC-IPBX14905/P/A	TC-IPBX2906/P/A
Scanning chip	$^{1}/_{3}$" CMOS with progressive scanning	CMOS with progressive scanning
Max. resolution	1280 x 1024 1.4 MP)	1920 x 1080 (2.1MP)
Sensitivity	0.01 Lux (colour), 0.001 Lux (monochrome)	0.05 Lux (colour), 0.005 Lux (monochrome)
Mounting the camera		
Video compression	H.264, MJPEG	
Network interface	Ethernet, RJ-45 (10/100 Base-T)	
Operating temperature	-20 ÷ 60 °C	
Power supply	12VDC, POE (802.3af)	
Power consumption	max. 3W	
Dimensions	152mm x 86mm x 56mm	
The weight	0.7kg	

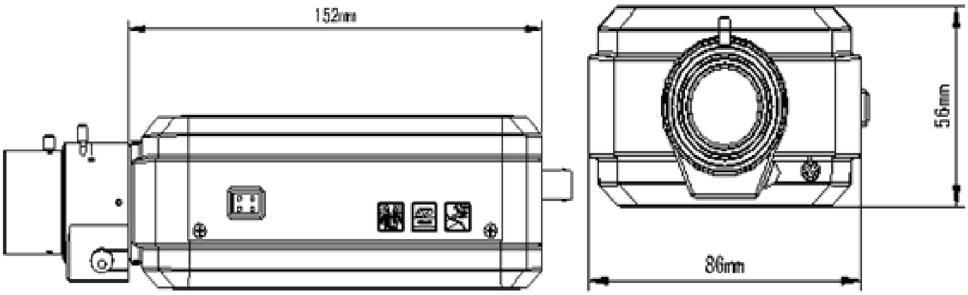


Fig. 12.5.2.1 Dimensions of the BOX IP camera

12.5.3 The Speed Dome version of the IP outdoor camera

The Speed Dome IP outdoor camera, mounting on the wall, with an optical zoom and IR LED with up to 150m range.

	TC-IPSD803-IR
Scanning chip	Exmor CMOS
Max. resolution	1920 x 1080 (2 MP)
Zoom	20x optical, 12x digital
Focal distance	4.7 ÷ 94mm
Setting	motorized direction and inclination, pre-set positions, etc.
Aperture	F1.6 ÷ F3.5
Sensitivity	0.5 Lux (colour), 0.095 Lux (monochrome)
IR LED	Yes, 150m range
Mounting the camera	on the wall
Video compression	H.264, MJPEG
Network interface	Ethernet, RJ-45 (10/100 Base-T)
Operating temperature	-40 ÷ 60 °C
Power supply	12VDC, 24VAC
Power consumption	max. 21W
Dimensions	ø212mm x 241mm
The weight	5.5kg
Protection	IP 66
Surge protection	internal surge protection, TVS 3000 V lightning protection

12.5.4 The mini Dome version of the IP camera

A standard IP camera in vandal resistant version, mounting on the wall or the ceiling, with manual setting (direction and inclination with 90° rotation).

	TC-IPD-14614-IR/P	TC-IPD-2615-IR/P
Scanning chip	$^{1}/_{3}$‟ CMOS with progressive scanning	CMOS with progressive scanning
Max. resolution	1280 x 1024 1.4 MP)	1920 x 1080 (2.1MP)
Focal distance	2.8 fixed lens (3.6mm optional)	
Detection angle	97° ÷ 67°	
Max. aperture	F1.4	
Focus control	manually	
Sensitivity	0.01 Lux (colour), 0.001 Lux (monochrome)	0.05 Lux (colour), 0.005 Lux (monochrome)
Mounting the camera	On the wall	
Video compression	H.264, MJPEG	
Network interface	Ethernet, RJ-45 (10/100 Base-T)	
Operating temperature	-20 ÷ 60 °C	
Power supply	12VDC, POE (802.3af)	
Power consumption	maximum 2W	
Dimensions	ø107 x 53,4mm	
The weight	0.5kg	

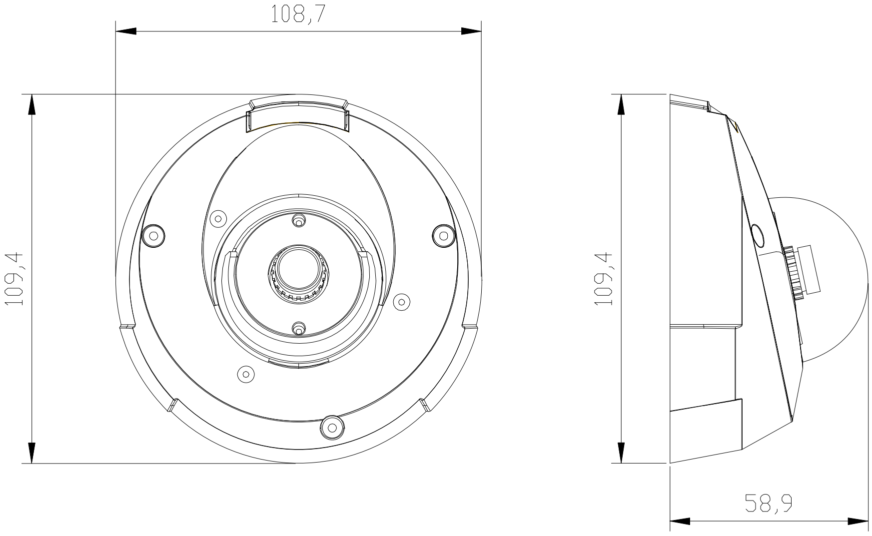


Fig. 12.5.4.1 Dimensions of the mini Dome IP camera

12.5.5 The Dome version of the IP camera

An IP camera, the Dome design, vandal resistant version, mounting on the wall or the ceiling, with manual setting along 3 axes and with IR LED lighting with up to 10m range.

	TC-IPD-14617-IR/F/P/A	TC-IPD-2618-IR/F/P/A
scanning chip	$^{1}/_{3}$" CMOS with progressive scanning	CMOS with progressive scanning
Max. resolution	1280 x 1024 (1.4MP)	1920 x 1080 (2.1MP)
Focal distance	4mm, 6mm, 8mm fixed lens (2.8 ÷ 12mm optional)	
Detection angle	97° ÷ 27°	
Max. aperture	F1.4	
Focus control	manually	
Sensitivity	0.01 Lux (colour), 0.001 Lux (monochrome)	0.05 Lux (colour), 0.005 Lux (monochrome
Sensitivity with IR LED on	0 Lux	
Mounting the camera	on the wall	
Video compression	H.264, MJPEG	
Network interface	Ethernet, RJ-45 (10/100 Base-T)	
Operating temperature	-20 ÷ 60 °C	
Power supply	12VDC, POE (802.3af)	
Power consumption	max. 5W	
Dimensions	Ø150.7mm x 109mm	
The weight	1.2kg	

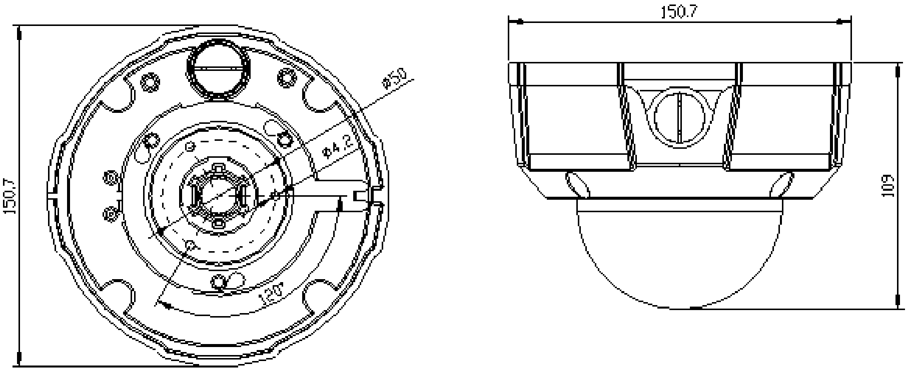


Fig. 12.5.5.1 Dimensions of the Dome IP camera

13 Design and installation information

The table of contents of the chapter

The following chapter provides summary information, which can assist in designing and preparing the assembly of the installation and of the control system (the sizes, power inputs, parameters of the terminals, surge protection information, interference suppression, recommended cables, etc.).

13.1 The power input of the CFox modules (consumption from CIB of from external supply)

	min. Příkon [W]	Odběr [mA]	max. Příkon [W]	Odběr [mA]	min. Příkon [W]	Odběr [mA]	max. Příkon [W]	Odběr [mA]	min. Příkon [W]	Odběr [mA]	max. Příkon [VA]	Odběr [mA]
CF-1141	-	-	-	-								
C-IT-0200R-ABB	0,3	13	0,4	17								
C-IT-0200R-design	0,3	13	0,4	17								
C-IT-0100H-A	0,2	8	0,3	13								
C-IT-0100H-P	0,2	8	0,3	13								
C-HM-0308M	0,5	21	2,1	88								
C-HM-1113M	0,6	25	3,5	146								
C-HM-1121M	0	0	0	0							13,8	60
C-IE-0100M												
C-IE-0300M												
C-IT-0200I	0,3	13	1,5	63								
C-DL-0012S	0,5	21	2	83								
C-IR-0202S	0,4	17	0,6	25								
C-IT-0200S	0,25	10	0,3	13								
C-IT-0504S	0,5	21	1,9	79								
C-HC-0101F												
C-WS-0200R-Time	0,3	13	0,4	17								
C-WS-0400R-Time	0,3	13	0,4	17								
C-RC-0002R	0,3	13	0,4	17								
C-IT-0908S	0,3	13	1,5	65								
C-FC-0024X	0	0	0	0	0,3	13	0,9	40				
C-VT-0102B	0,3	13	6	250								
C-AQ-0001R	2	83	2,5	104								
C-AQ-0002R	1,3	54	1,5	63								
C-AQ-0003R	1,1	46	1,3	54								
C-AQ-0004R	1	42	1,2	50								
C-DM-0006M-ULED	0,3	13	0,35	15								
C-DM-0006M-ILED	0,3	13	0,35	15								
C-RI-0401S	0,4	17	0,5	21								
C-HC-0201F-E	0,3	13	1,9	80								
C-RQ-0400S	0,4	17	0,5	21								
C-AM-0600I	1	40	2	80								
C-OR-0202B	0,3	13	1,2	50								
C-OR-0008M	0,6	25	3,5	146	0,6	25	3,5	146				
C-OR-0011M-800	0,6	25	4,8	200	0,6	25	4,8	200				
C-JC-0006M	0,6	25	1,8	78	0,6	25	1,8	78				
C-LC-0202B	0,3	13	1,2	50								
C-JC-0201B	0,3	13	0,8	34								

Notes:

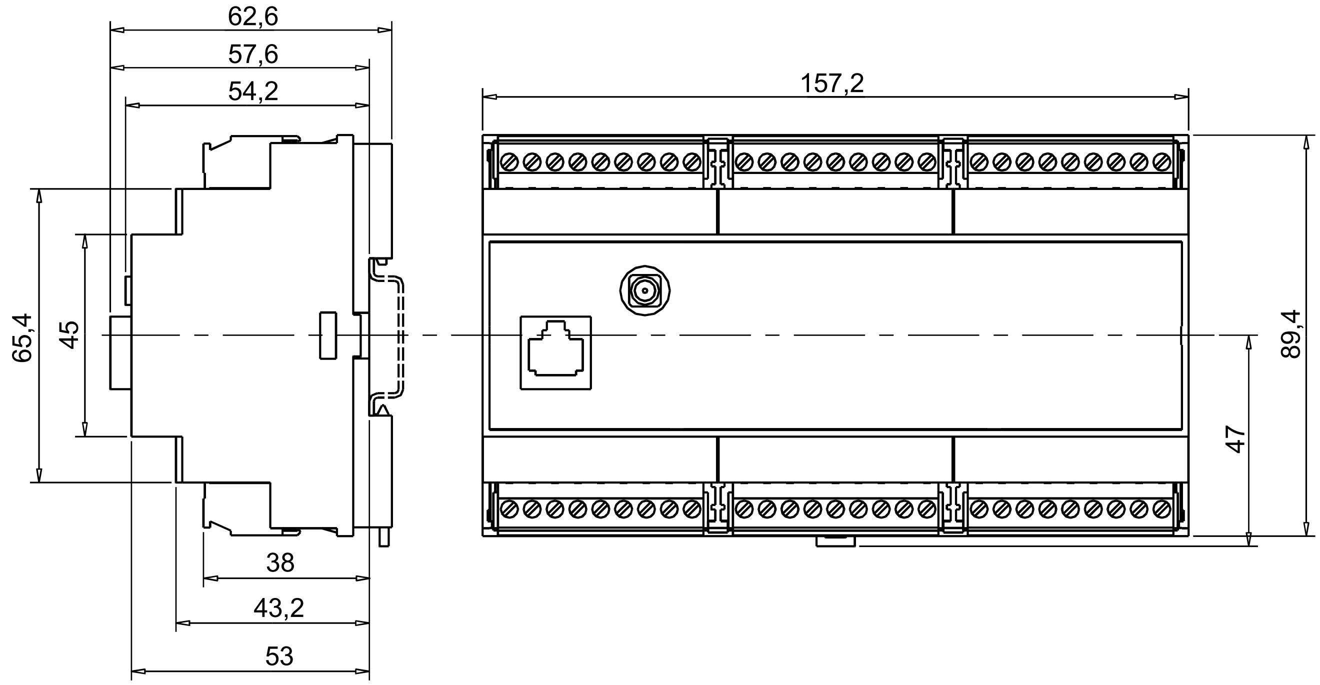
1) The consumption of the module is calculated at 24V nominal voltage.
2) The minimum power input is considered to be when the serviced module is switched on, all outputs are open and off, and the module does not supply any circuits.
3) A maximum power input is considered to be when all outputs (relays) are closed and excited to a

maximum current (Aout), all inputs are connected and on, and the external circuits are powered.

13.2 The dimensions of the modules

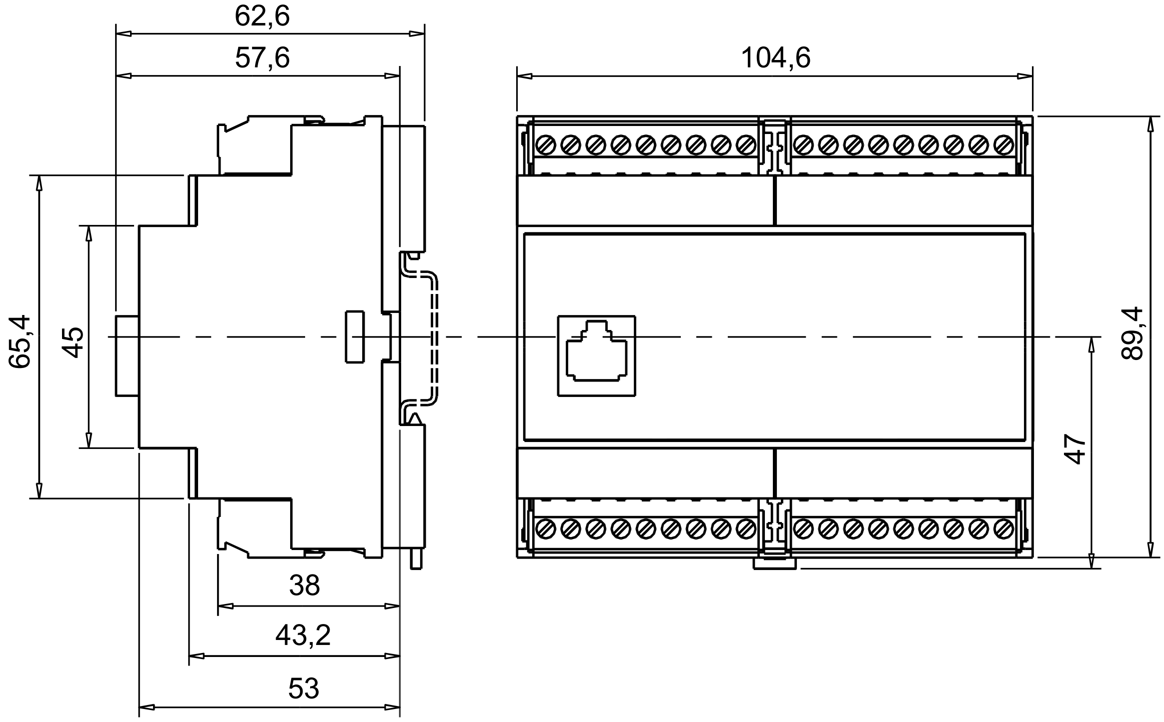
13.2.1 9M housing on a DIN rail (the TS 35 rail, in accordance with ČSN EN 60715)

The Foxtrot basic modules, the CFox and RFox peripheral modules



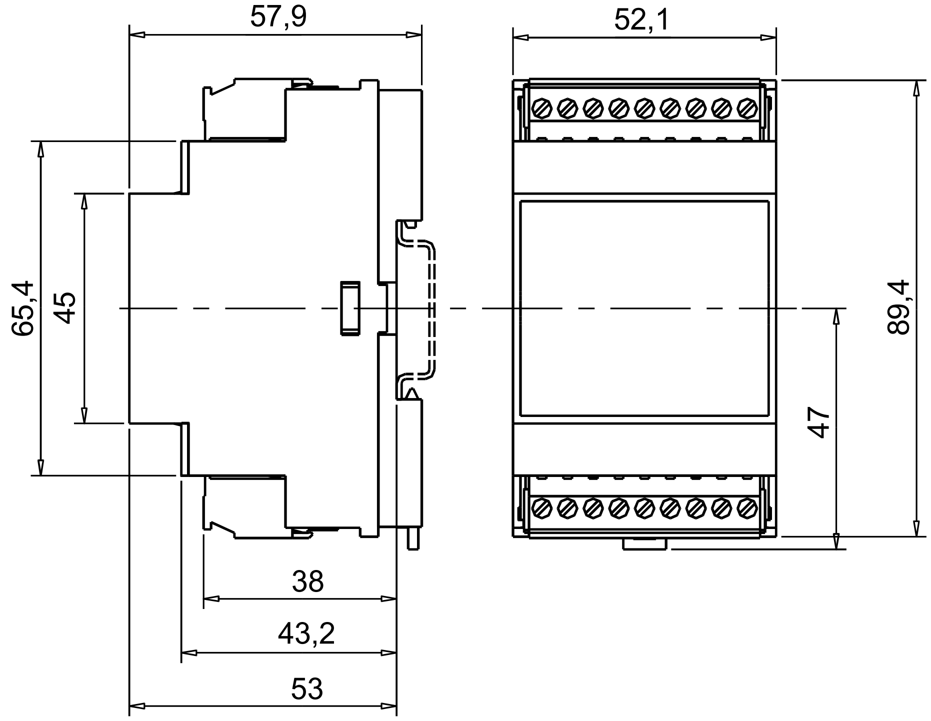
13.2.2 6M housing on a DIN rail

The Foxtrot basic modules, the CFox and RFox peripheral modules



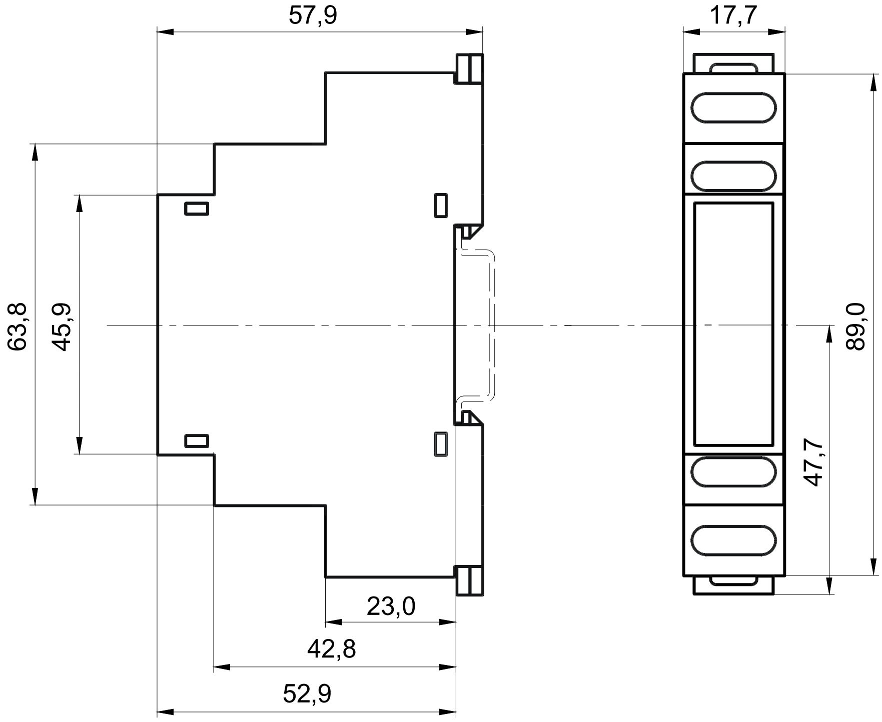
13.2.3 3M housing on a DIN rail

The CFox, RFox and Foxtrot peripheral modules



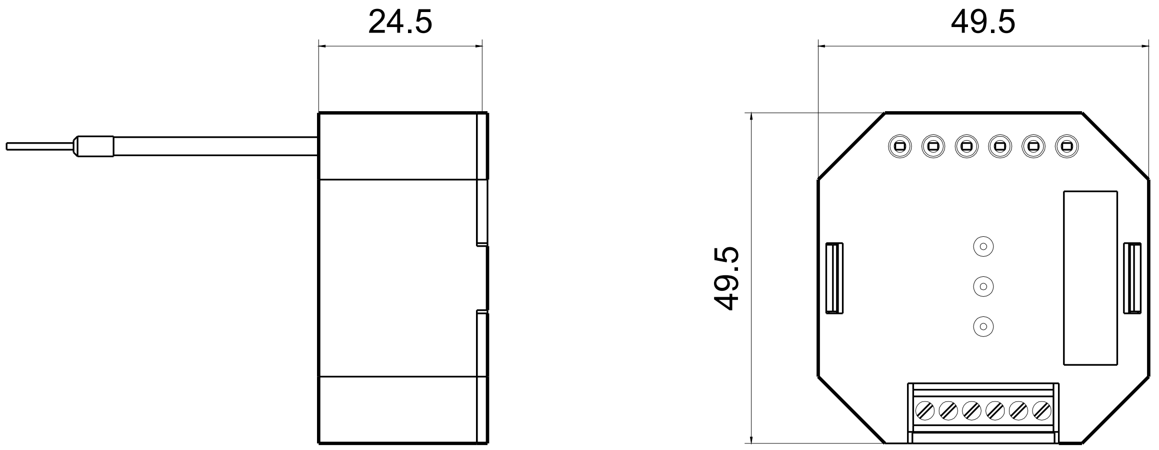
13.2.4 1M housing on a DIN rail

The CFox, RFox and Foxtrot peripheral modules



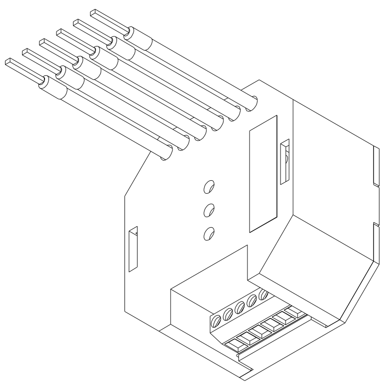
13.2.5 A module for the flush box (built in)

The CFox and RFox peripheral modules



Notes:

1) Depending on the model, the module is equipped with up to 6 separately terminated insulated wires (either a stranded conductor with a moulded sleeve on its tip, or a solid wire with a cross section according to the type of module).
2) A fixed screw cage terminal box can be placed opposite the terminated wires.
3) The module can be placed in a common flush box (if it has a cap); when it is installed under the a socked, a deep installation box should be used (such as the KOPOS CPR or CPR 68 68/L), or a box with a lateral space (e.g. the KUH 1 or KUH 1/L).
4) The parameters of the module terminals are listed in Chapter 13.3.3



13.2.6 A module with a higher protection with glands

The module is used in modules, which are located outdoors, in damp environment, etc. The module is made of grey UV resistant polycarbonate.

Mounting of the module:
The quick-release screws should be disengaged by pressing and turning 90°, then the lid of the head can be taken off. A supply cable with the recommended diameter should be put through the gland and attached to the terminal block.
Put the lid back, screw in the quick-release screws, press them again and turn back 90°. The assembly is completed and the sensor is ready for operation.
The actual box should be screwed on the wall or on some other surface, using two 3 x 30 screws. Make sure the sensor is facing downwards.

13.3 The parameters of connectors and module terminal blocks

The following chapters list the basic parameters of connectors and terminal blocks used in the CFox and RFox modules.

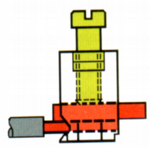
An informative conversion table of wire cross-sections and diameters.

Nominal cross-section	The wire diameter		
	Metric		AWG
	Solid wire	Stranded conductor	
mm^2	mm	mm	–
0.22	0.51	0.53	24
0.34	0.63	0.66	22
0.5	0.9	1,1	20
0.75	1.0	1.2	18
1.0	1.2	1.4	-
1.5	1.5	1.7	16
2.5	1.9	2.2	14
4.0	2.4	2.7	12

13.3.1 Connectors with screw terminals, 5.08mm spacing, modules on a DIN rail

The connectors of modules on a DIN rail are standard removable connectors with a cage terminal in the removable part, with the spacing of 5.08mm.
A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. For more detailed parameters of terminals, see the following table:

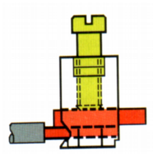
Table 13.3.1.1: The parameters of connector terminals of modules on a DIN rail

Spacing of terminals		5.08
The type of terminal		Screw cage
		
Wire stripping length	mm	7
Tightening torque for the terminal screws		0.5Nm
Conductor sizes		
Clamping range	mm^2	0.1 ÷ 2.5
	AWG	26 ÷ 12
Nominal voltage	V	450
Nominal current	A	10
Material		
Plastic material of the connector	Polyamide PA6.8, UL94-V0, CTI600V, GWT960 °C	
Contact	Nickel-plated phosphor-bronze	
Cage	Nickel-plated brass	
Screw	M3 - galvanized steel	

13.3.2 Terminal block 24A, modules on a DIN rail

Terminal blocks of peripheral modules are standard cage fixed terminals with 5.08 or 7.62mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. For more detailed parameters of terminals, see the following table:

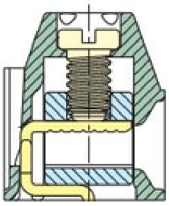
Table 13.3.2.1: The parameters of the 24A terminal block in modules on a DIN rail

Spacing of terminals		5.08 or 7.62
The type of terminal		Screw cage
		
Wire stripping length	mm	7
Tightening torque for the terminal screws		0.5Nm
Conductor sizes		
Clamping range	mm^2	0.5 ÷ 4
Nominal voltage	V	750
Nominal current	A	24
Material		
Plastic material of the connector	PA68 UL94VO	
Contact	CuZn37+Ni+Sn	
Cage	CuZn40 Pb2+Ni	
Screw	M3-C8R+Zn	

13.3.3 Terminal blocks, modules for the flush box

Terminal blocks of peripheral modules in a plastic box for the flush box are standard cage fixed terminals with the 3.5mm spacing. A flat-head screwdriver with the tip width of 3.5mm is recommended for manipulation with the terminal. For more detailed parameters of terminals, see the following table:

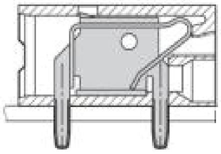
Table 13.3.3.1: The parameters of the terminal block in modules for the flush box

Spacing of terminals		3.5
The type of terminal		Screw cage
		
Wire stripping length	mm	5
Tightening torque for the terminal screws: recommended/maximum		0.2/0,25Nm
Conductor sizes		
Clamping range for a solid wire	mm²	0.05 ÷ 1.5
Clamping range for a stranded wire	mm²	0.05 ÷ 1
Nominal voltage	V	300
Nominal current	A	17,5
Material		
Plastic material of the connector	PA 6.6 UL94VO	
Contact	tinned copper alloy	
Cage	nickel-plated copper alloy	
Screw	M2, nickel-plated copper alloy	

13.3.4 A miniature terminal block

The miniature terminals used by some built-in modules, such as the C-IT-0504S, and some other peripheral modules, e.g. the S-WS-0400R-Merten, are screwless (spring) fixed terminals with a 2.5mm spacing. The wire can be removed from the terminal using a flathead screwdriver with the width of 1.8mm, or another appropriate tip (a long needle, a pin).. For more detailed parameters of terminals, see the following table:

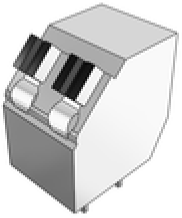
Table 13.3.4.1: The parameters of the miniature terminal block

Spacing of terminals		2.5
The type of terminal		Screwless
		
Wire stripping length	mm	5
Conductor sizes		
Clamping range for a solid wire	mm^2	0.14 ÷ 0.5
Clamping range for a stranded wire	mm^2	0.2 ÷ 0.5
Clamping range for a stranded wire with a sleeve	mm^2	0.25 ÷ 0.5
Nominal voltage	V	200
Nominal current	A	6
Material		
TBD		

13.3.5 The spring terminal blocks "Push In" 5.08 mm

The terminal blocks used e.g. by the modules with a higher protection - the C-RQ-0400I, and some other peripheral modules, are screwless (with springs) fixed terminals with a 5mm spacing and the Push-In technology. The technology allows inserting the wire (a solid wire, or a stranded wire with a sleeve) without the use of any tools or another hand; in order to eject the wire, a button above the hole for the wire must be pressed (using a screwdriver or other tool, possibly also a finger). For more detailed parameters of terminals, see the following table:

Table 13.3.5.11: The parameters of the miniature terminal block

Spacing of terminals		5mm
The type of terminal		screwless, Push In
		
Wire stripping length	mm	8
Conductor sizes		
Clamping range for a solid wire	mm^2	0.2 ÷ 1.5
Clamping range for a stranded wire	mm^2	0.2 ÷ 1.5
\`The clamping range for a stranded wire with a sleeve	mm^2	0.25 ÷ 1.5
Nominal voltage	V	300
Rated current terminals	A	15
Material		
Insulant	LCP GF	
Contact	Alloyed copper	

13.4 Relay output parameters, the principles of proper use

The binary outputs of the system are divided into standard electromechanical relays, solid state relays (usually referred to as SSR), simple triac outputs, and DC semiconductor outputs (sometimes called "transistor outputs").

The outputs of the system designed as **electromechanical relays** are the most common and versatile outputs with high resistance and versatility; however, they also have their limitations and require adherence to certain principles:

1. The relay has a limited number of operations (expressed by the mechanical and electrical lifespan of the contact). It should be noted that the opening and closing relays in one-second intervals can destroy it within a few months! Switching more frequently than once every few minutes requires using a semiconductor output - usually the SSR.
2. The capacitive loads (switching LED power supplies, some fluorescent lamps ballasts, etc.) and inductive loads (coils of contactors or valves, etc.) significantly reduce the maximum switching capacity of each relay, and also the maximum number of operations (electrical lifetime of the contact). For more information about the impact of capacitive and inductive loads, see Chapter Interference suppression, application of suppression measures.
3. Common relays that do not have increased maximum switching current ("inrush current") are not suitable for switching capacitive loads. Suitable relays for capacitive loads are those with a 16A contact, which are either in the reinforced version, or with a tungsten fore-contact.
4. All relay outputs of the basic and peripheral Foxtrot, CFox and RFox modules are made without internal fuses, so a protection of circuits switched by relay outputs must be dealt with as part of the installation. Also the interference suppression and protective circuits must be configured as part of the installation, if necessary.
5. A disconnected relay does NOT represent a secure separation of circuits in terms of protection against injury (isolation voltage of the disconnected contact does not reach the values for secure separation of circuits).
6.

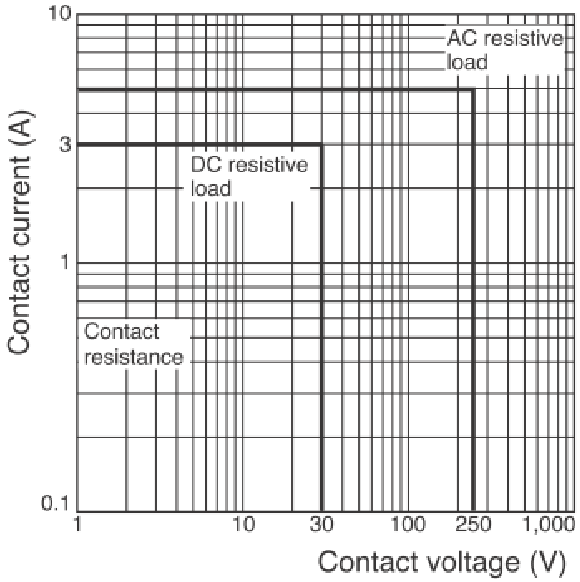
13.4.1 The 5A relays, the Foxtrot basic modules and the peripheral CFox modules

These relays are fitted in e.g. the Foxtrot basic modules (CP-1005, CP1006, etc.), the peripheral modules (C-HM-0308M, C-IR-0202S) and others (see information on the individual modules).

The parameters of the actual relay contact (each specific module can have different values!):

Maximum switching current	5A at 230VAC
	3A at 30VDC
Mechanical lifetime	Minimum 5,000,000 operations
Electrical lifetime (at 5A, 230VAC)	Minimum 100,000 operations
Electrical lifetime for DC13 inductive load	Minimum 100,000 operations
Electrical lifetime for AC15 inductive load	Minimum 100,000 operations
Switching time	Maximum 10ms
Opening duration	Maximum 10ms
Frequency of switching with nominal load	Maximum 20 operations/min
Minimum recommended switching voltage, current	5VDC, 100mA

The contact loading characteristics:



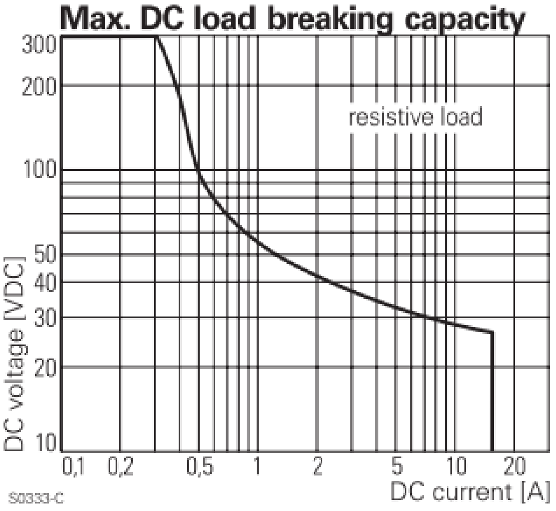
13.4.2 16 A relay (160A switching current), the CFox and RFox peripheral modules

These relays are fitted in e.g. the C-OR-0011M-800, C-LC-0202B, C-HM-1121M, R-HM-1121M peripheral modules, and others (see the information on the individual modules).

The parameters of the actual relay contact (each specific module can have different values!):

Nominal current		16A at 230VAC or 24VDC
Maximum transmitted current		16 A
Maximum switching inrush current (incandescent bulbs) (fluorescent lamps)		165A, maximum 20ms 800A, maximum 200µs
Maximum switching power	Resistance load, incandescent bulbs, halogenous 230V bulbs	3,680W
	Fluorescent lamps with an electronic ballast	1,000VA
	Fluorescent lamps with a maximum 64µF compensation	500VA
Mechanical lifetime		Minimum 5,000,000 operations
Electrical lifetime (at 16A, 230VAC, cosφ = 1)		Minimum 100,000 operations
Electrical lifetime (1.200W incandescent bulbs)		Minimum 6,000 operations
Electrical lifetime (620W discharge lamps - standard ballast)		Minimum 6,000 operations
Switching time		Maximum 10ms
Opening duration		Maximum 5ms
Minimum recommended switching voltage, current		5VDC, 100mA
Material of the contact		W (fore-contact) + $AgSnO_2$

The contact loading characteristics:



13.4.3 16 A relay (80A switching current), the CFox and RFox peripheral modules

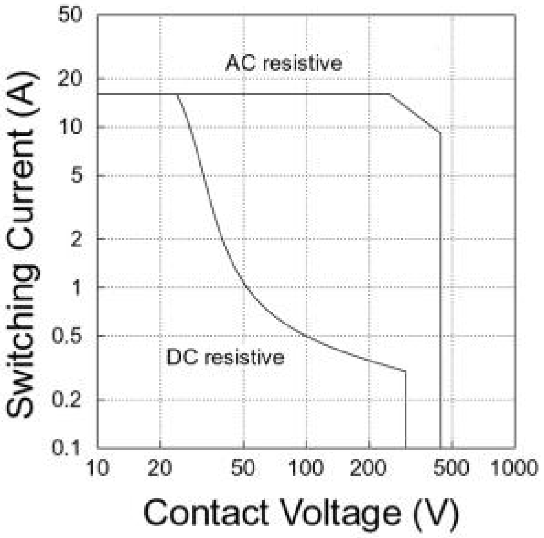
These relays are fitted in e.g. the C-OR-0008M, C-OR-0202B, R-OR-0001B peripheral modules, and others (see the information on the individual modules). The NO contact is designed as increased (inrush current 80A), the NC contact is standard, max. only 16A.

The parameters of the actual relay contact (each specific module can have different values!):

Nominal current		16A at 230VAC or 24VDC
Maximum transmitted current (cosφ = 1)		20A
Maximum switching inrush current (only the NO contact!) [1)]		80A, maximum 20ms
Maximum current for cosφ = 0.4		3.5A
Maximum switching power	Resistance load, incandescent bulbs, halogenous 230V bulbs	3,680W
	Fluorescent lamps with an electronic ballast	1,000VA
	Fluorescent lamps with a maximum 64μF compensation	500VA
Mechanical lifetime		Minimum 20,000,000 operations
Electrical lifetime (at 16A, 230VAC)		Minimum 100,000 operations
Electrical lifetime (80A switching current)		Minimum 10,000 operations
Electrical lifetime (the "lamp test‟ TV-5 according to UL 917)		Minimum 25,000 operations
Switching time		Maximum 15ms
Opening duration		Maximum 5ms
Minimum recommended switching voltage, current		5VDC, 100mA
Material of the contact		$AgSnO_2$

[1)] Only the NO contact (with 80A) is increased, while the NC contact has only 16A (even inrush current).

The contact loading characteristics:



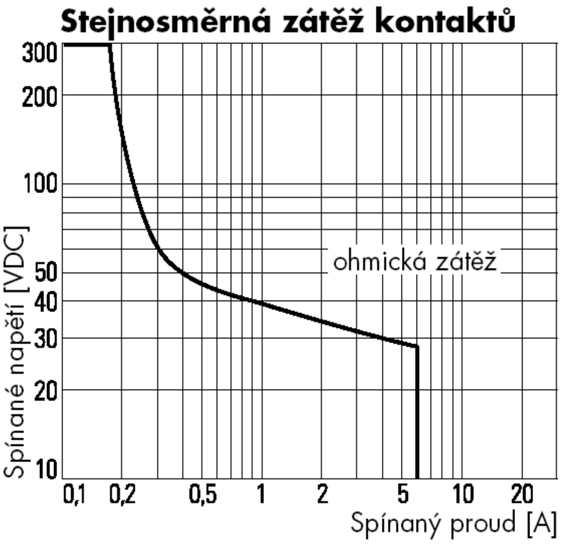
13.4.4 The 6A relays, the Foxtrot peripheral modules

These relays are fitted e.g. in the IR-1501 Foxtrot peripheral modules.

The parameters of the actual relay contact (each specific module can have different values!):

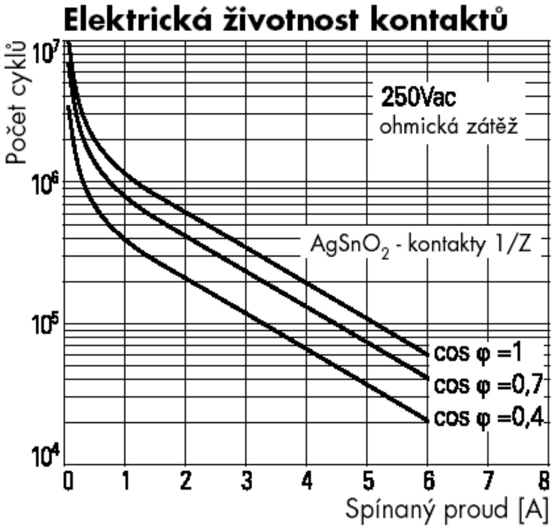
Nominal current	6A at 230VAC or 24VDC
Maximum switching inrush current	6A
Maximum current for cosφ = 0.4	6A
Mechanical lifetime	Minimum 5,000,000 operations
Electrical lifetime (at 16A, 230VAC)	Minimum 100,000 operations
Electrical lifetime for DC13 inductive load	Minimum 100,000 operations
Electrical lifetime for AC15 inductive load	Minimum 100,000 operations
Switching time	typically 10ms
Opening duration	typically 4ms
Minimum recommended switching voltage, current	12V, 500mA
Material of the contact	$AgSnO_2$

The contact loading characteristics:



The curve of the contacts electrical lifetime.

The curve shows the electrical lifetime (the number of operations) of the contact, depending on the nature of the switching AC loads (the power, cos).



13.4.5 The 1A semiconductor relay

These relays are fitted in e.g. the Foxtrot basic modules CP-10x6 and 10x8-CP (DO0, DO1)

The parameters of the actual switching element (each specific module can have different values!):

The rated current (at 25 °C)	1A
Maximum current at 50 °C ambient temperature	0.7A
The operating voltage range	20 ÷ 260VAC
Maximum switching inrush current	1A
Min. switching current	5mA
The residual current of a disconnected output	< 1mA
The residual voltage of a connected output	$< 1.6V_{ef}$

13.5 Surge protection, SPD selection and mounting

The following chapters deal with the protection of structures against lightning and surges in accordance with the ČSN EN 62305, briefly describing the principles of correct selection and installation of SPD (prepared in collaboration with SALTEK a HAKEL).

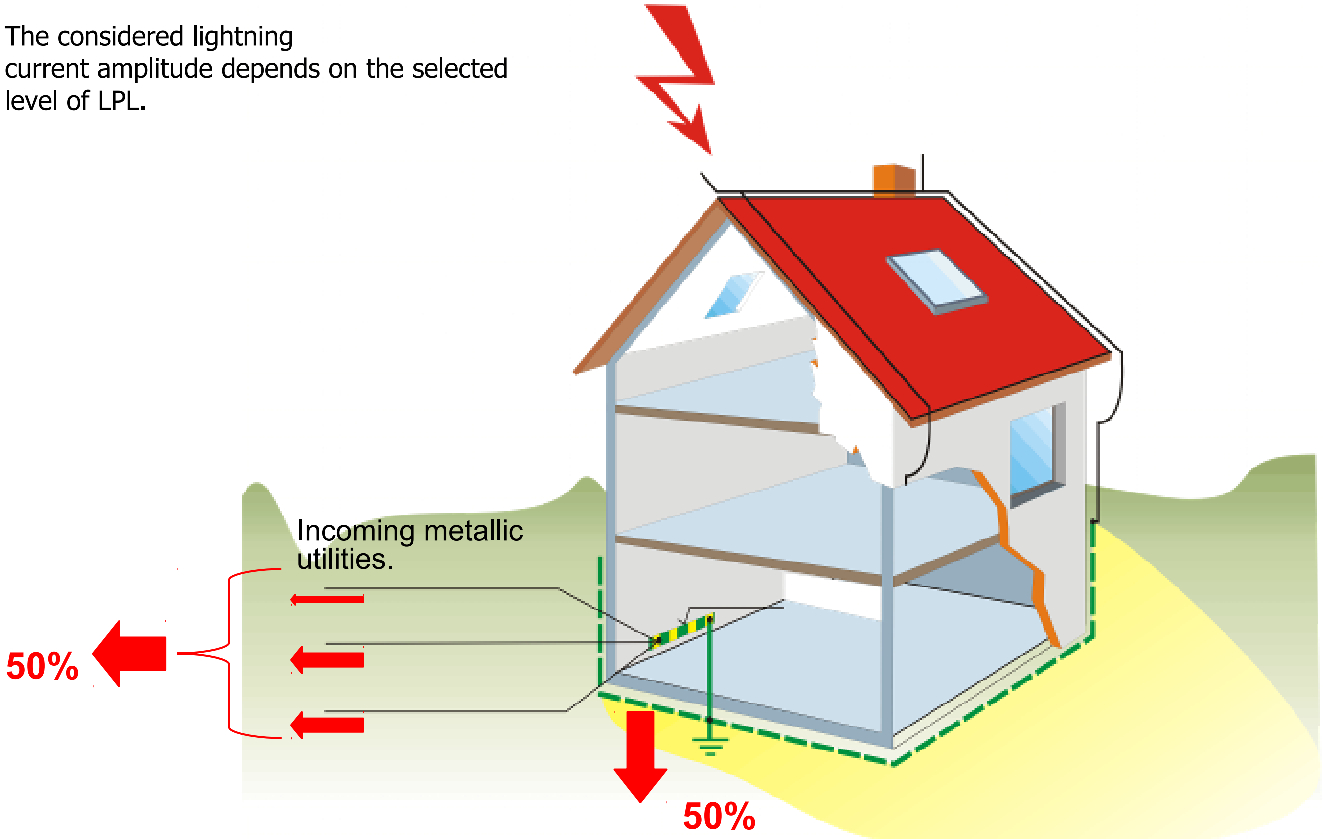
13.5.1 Basic concepts, defining the requirements for SPD

Four levels of protection against lightning (LPL) have been introduced to meet the requirements of the ČSN EN 62305 standard. Each level includes a set of maximum and minimum values.
Requirements for the design of the SPD are based on these values. The re quirements for suppressing capability of lightning current supressor in buildings on the LPL I level of protection are in total I_{imp} =100kA; on the LPL II level there is the requirement to supress safely 75 kA currents, and on the LPL III and IV level the total is 50kA.

Examples of connections and the recommended elements described in the following chapters only consider the LPL III and LPL IV levels of protection.
For these levels, the value of the peak current is I= 100 kA.

The separation of the lightning current during a discharge into a building.
In a simplified way it can be said that 50% of the lightning current is dissipated via the LPS into the ground, and the remaining 50% may end up at random in various leakages and conductive inlets; it is split approximately evenly, provided the diameter of the leads is sufficient to conduct a partial lightning current. Data networks, due to the small cross section of wires, can only absorb a maximum of 5% of the total lightning current.

The considered lightning current amplitude depends on the selected level of LPL.



The current is again split into individual wires almost evenly. In the TN-CS networks, the partial lightning currents in individual conductors are considered as in the TN-C. In TN-S, the currents can be in some cases divided into 5 wires.

An example: If the 3ph TN-C (3+0) supply to the house is considered, and the utilities (water,

gas) use plastic pipes, so they are not considered. A possible telephone cable can be ignored. The resulting value of the lightning current at the house inlet is 50 kA (50% of the peak current).

A table for the selection of leakage capabilities I_{imp} for power lines:

An example: for LPL III and LPL IV, a 50kA lightning current and the TN-C 3+0 network, the resulting SPD suppressing capability is 12.5kA

			Low voltage network			
LPL	Maximum current in the particular LPL	The number of wires (n)	TN-C	TN-S		
				The connection mode		
				CT1	CT2	
			L-PEN	L-PE N-PE	L-N	L-PE
1 or unknown	200kA		I_{imp} (kA)			
		5	-	20	20	80
		4	25	-	-	-
		3	-	33.3	33.3	66.7
		2	50	-	-	-
2	150kA		I_{imp} (kA)			
		5	-	15	15	60
		4	18,8	-	-	-
		3	-	25	25	50
		2	37.5	-	-	-
3 or 4	100kA		I_{imp} (kA)			
		5	-	10	10	40
		4	12,5	-	-	-
		3	-	16,7	16,7	33.3
		2	25	-	-	-

An example: for LPL III and LPL IV, a 50kA lightning current and the TN-C 3+0 network, the resulting SPD suppressing capability is 12.5kA

In accordance with IEC 61643-11, the surge suppressors (SPD) are designated:
Type 1 (sometimes referred to as B), Type 2 (C), Type 3 (D)

Decisive parameters defining the SPD

1) The supply network

Network – TN - TN-C
- TN-CS
- TN-S

Network - TT - SPD (1+1; 3+1) TN-S (cannot be used (2+0; 4+0) TN-S)

Network - IT - special SPD for the IT network

2) A maximum continuous operating voltage U_c

The highest voltage that can be continuously connected to SPD terminals must be equal to or higher than the nominal voltageof the network. Keep in mind the DC for PV systems!

3) Impulse current I_{imp} (10/350μs)

For the classification of the SPD type 1

- The SPD must safely divert this current underground - without any apparent damage
- without departing from the thermal stability
- it must not show signs of a breakdown or a flashover

4) **A MAXIMUM DISCHARGE CURRENT I_{max} (8/20µs)**

- the peak value of current flowing through the SPD (8/20)

For the SPD classification type 1 and type 2

The SPD must safely direct this current underground - : - with no apparent damage
– without departing from the thermal stability
- it must not show signs of a breakdown or a flashover
- - it must not show any signs of a breakdown

5) Rated discharge current I_n (8/20µs)

The peak value of the current flowing through the SPD with the shape of a current pulse 8/20 is used for the classification of SPD tests for type 1 and type 2. The SPD must be able to discharge this current at least 15 times without any substantial changes of properties.

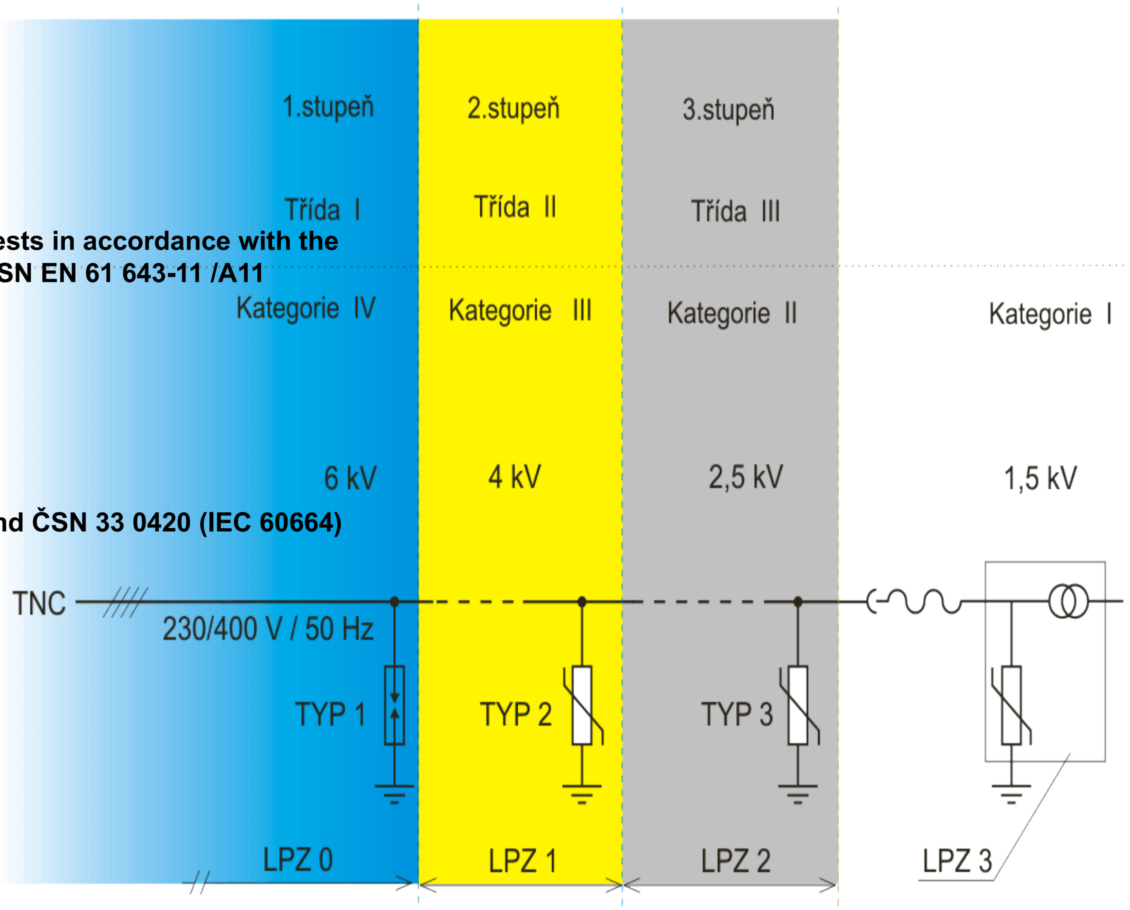
6) Voltage protection level U_p

A maximum level of the voltage measured at the SPD terminals during the application of the test pulses with a set waveform and amplitude.

U_p – must be lower than the pulse withstand voltage U_W of the protected device !

7) Impulse withstand voltage U_W

The $U_W$impulse withstand voltagefor power lines and terminals should be specified in accordance with the IEC 60664-1. The telecommunication lines and terminal facilities are guided by the ITU-T K20 and K21, other lines and terminals according to information obtained from the manufacturer.



Tests in accordance with the ČSN EN 61 643-11 /A11

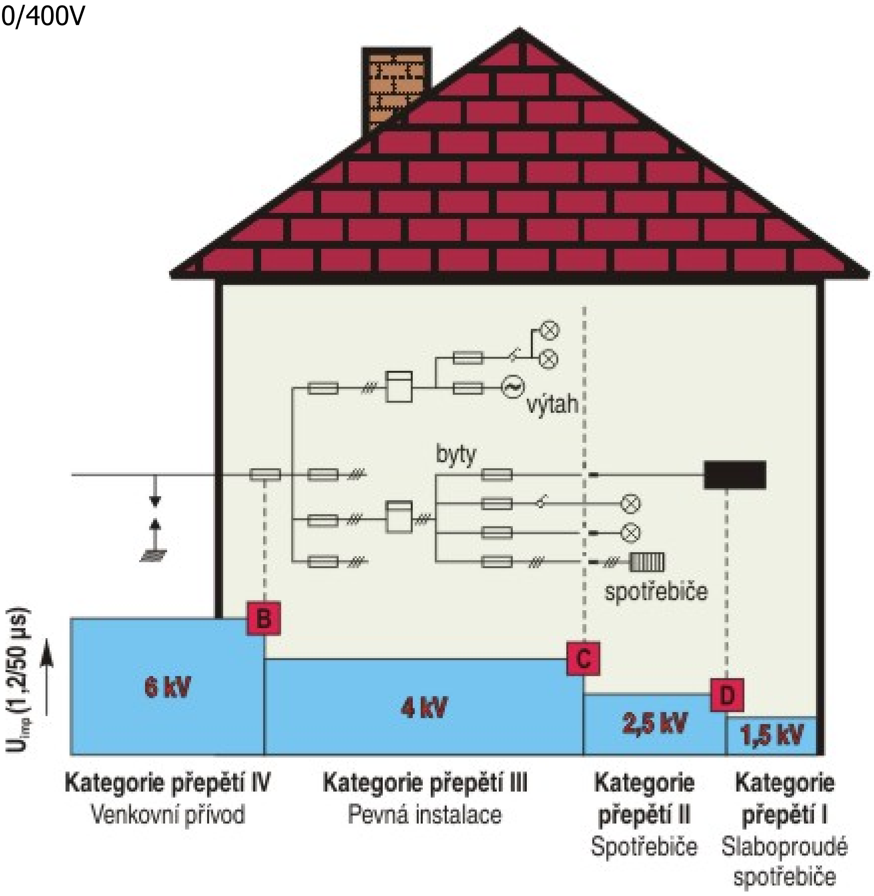
and ČSN 33 0420 (IEC 60664)

Surge protection

Overvoltage
The voltage exceeding the maximum permissible value of the operating voltage in an electrical circuit.

Types of overvoltage
switching overvoltage
atmospheric overvoltage

Pulse withstand voltage Uimp
ČSN EN 60664-1
for low voltage networks 230/400V



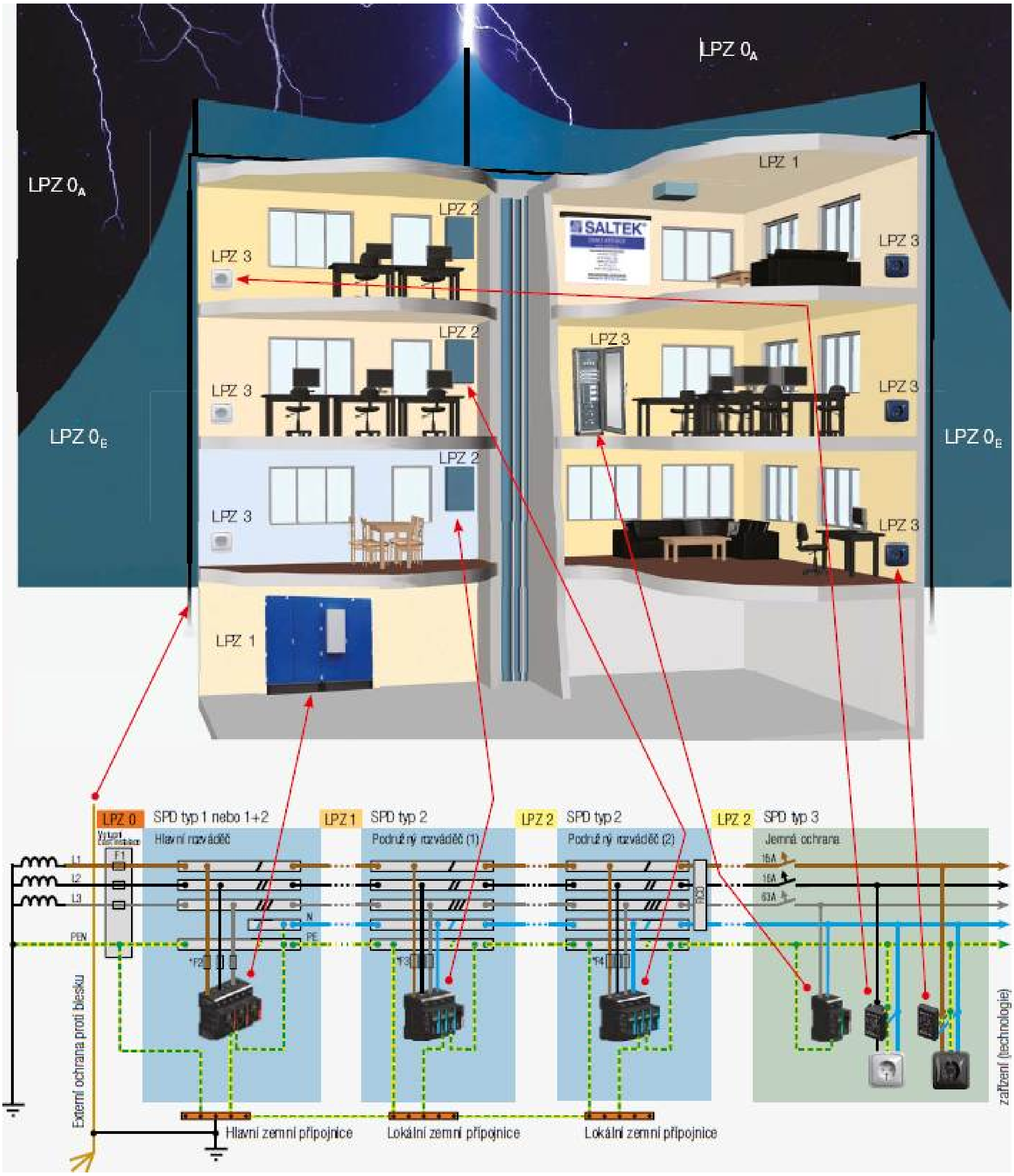
The pulse withstand category IV 6kV equipment is intended for use at the beginning of electrical installations in buildings. Examples of such equipment include electricity meters, circuit breakers, fuses, RCDs, etc.

The pulse withstand category III 4 kV equipment is a part of the fixed electrical installations; it also includes facilities with special requirements for reliability and usability. Examples of such devices may include, among others, electrical appliances (e.g. circuit breakers, fuses, disconnectors, contactors, RCDs, etc.).

The pulse withstand category II 2.5 kV equipment is intended for connection to the fixed electrical installations.
Examples of such equipment include portable electrical tools, household appliances, etc.

The pulse withstand category I 1.5kV equipment (the category of overvoltage I) is intended for connection to the circuits, in which measures have been taken to reduce transients overvoltages to the required low level.

The division of the building into so-called Lightning protection zones (LPZ) and the placement of SPD.



The principle of reducing the surge using zones involves a gradual reduction in the level of surge to a safe level that does not harm the equipment or technology. In order to achieve safe levels of surge, the entire building is divided into individual zones and on the boundaries between zones, SPD is installed.

LPZ 0_A :

The zones whose points are exposed to being directly struck by a lightning, and therefore they could carry the full lightning current. An unattenuated electromagnetic field occurs here..

LPZ 0_B :

The zones whose points are not exposed to direct strikes of a lightning, there are unattenuated electromagnetic fields.

LPZ 1 :

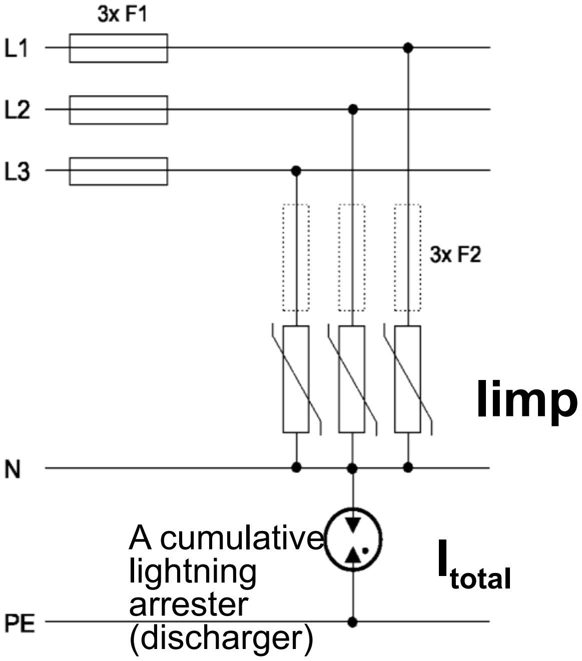
The zones whose points have not been directly struck by a lightning, and where the currents in all conductive parts have been significantly reduced compared with zones LPZ 0A and LPZ 0B. In these zones the electromagnetic field may be attenuated.

The subsequent zones (LPZ 2, etc.):

If further reduction of leakage currents or electromagnetic fields is required, it is necessary to design the so-called subsequent zones.

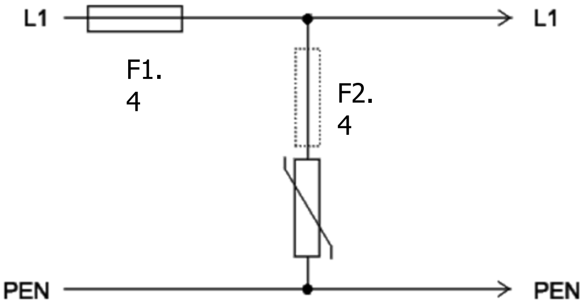
A standard recommendation is to insert the so-called 1st degree of protection at the LPZ 0 → 1 interface, specifically the I. class lightning surge suppressor tested by the lightning current I_{imp}(10/350). The LPZ 1 → 2 interface should be fitted with the 2nd degree of protection - a class II surge voltage arrester tested by the test impulse I_n (8/20). It is further recommended to fit in the LPZ 2 → 3 interface and also along the continuing line every approx. 10 meters the so-called 3rd stage of protection, class III, also tested by the test impulse I_{max}(8/20).

Connecting in the mode"3+1"



Backup fuse

If the main fuse F1 has a higher value than the recommended backup fuse of the manufacturer, the recommended F2 backup fuse should be put upstream from the SPD (fuses with the characteristics gL/gG).



13.5.2 An example of a three-level coordinated protection in power distribution systems.

Using a three-stage protection suits virtually all types of applications.
Wiring the protection of Type 1 (lightning current suppressor) of the mains for objects with the main fuse up to 63A connected by an earth cable, the TN-C network for LPL III (houses, small office buildings, agricultural buildings and residential buildings) and LPL IV (buildings and halls free of people and internal equipment).

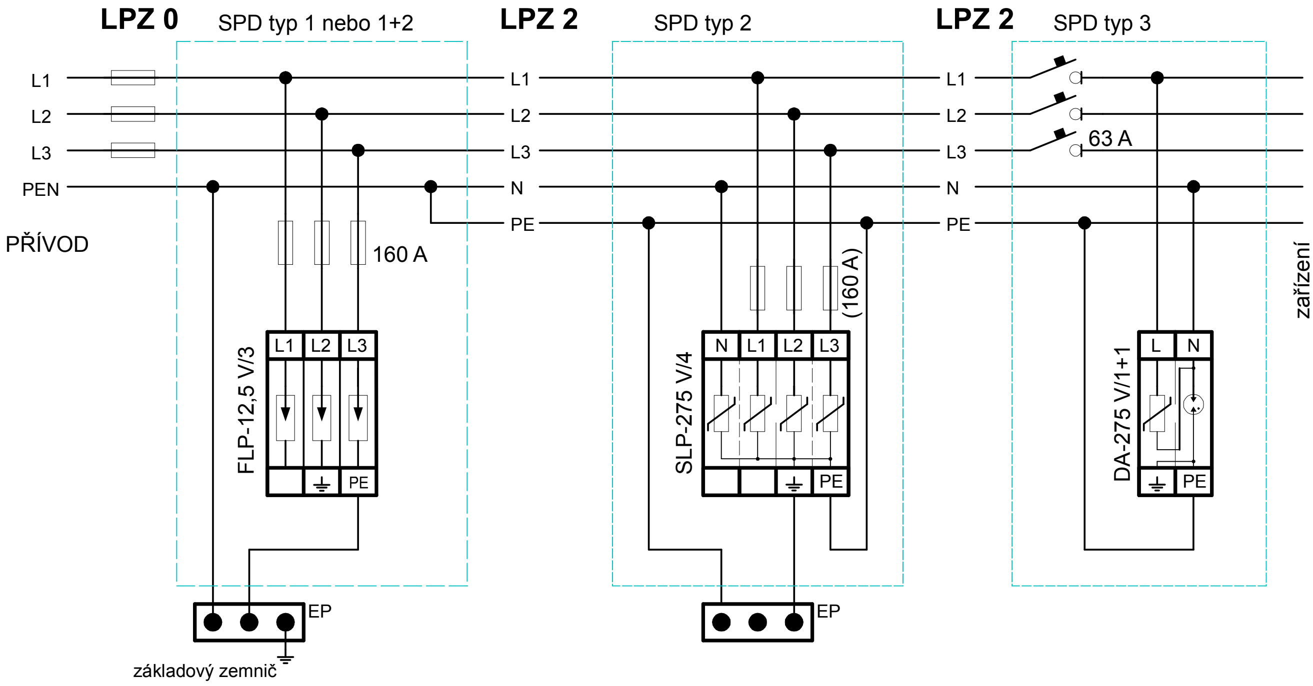


Fig. 13.5.2.1 An example of wiring coordinated three-level protection of power distribution systems

Notes:

1. The example shows the placement of SPD in individual jednotlivých distributors.
2. Protecting the surge suppressor is only necessary if the main backup fuse is more than 160A (in industrial applications it is recommended to use it every time, due to periodic inspections).
3. Proper coordination between the Type 1 and Type 2 of the SPD requires the cable length of at least 10 meters, or using a decoupler (for a correct solutions of the SPD coordination - see the example below).

13.5.3 Coordination of SPD with the control systems in the main switchboard or in close vicinity.

The application with the control system uses the Type 3 of SPD with a high frequency filter, which protects the system both against overvoltage, and also against noises that occur in the low voltage networks. The SPD type 3 with a high frequency filter can be connected as follows:

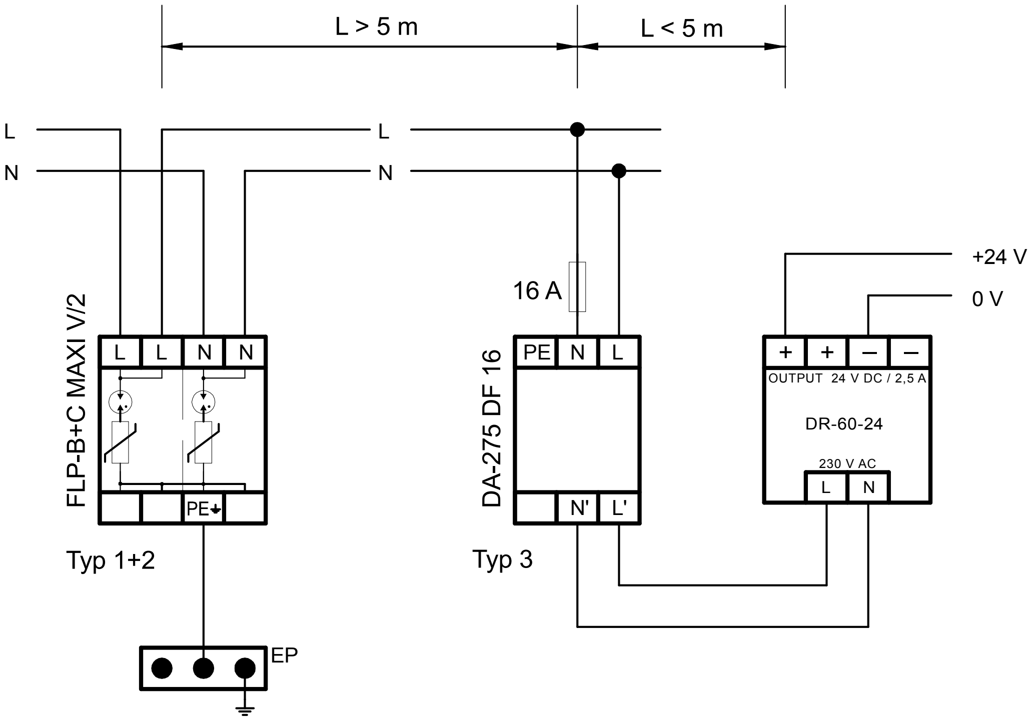


Fig. 13.5.3.1 An example of connection of coordinated protection by SPD Type 1+2 and SPD Type 3 with HF filter

Notes:

1. The example illustrates the coordination (observing the correct cable lengths) between SPDs in individual control panels (distribution boards).
2. If the coordination distance between individual steps cannot be observed, an RTO decoupler must be used (see "Securing proper coordination of SPDs").

13.5.4 SPD with the control system in a subsidiary control panel

The application with the control system uses the Type 3 of SPD with a high frequency filter, which protects the system both against overvoltage, and also against noises that occur in the low voltage networks. The SPD Type 3 with an HF filter can be connected as follows:

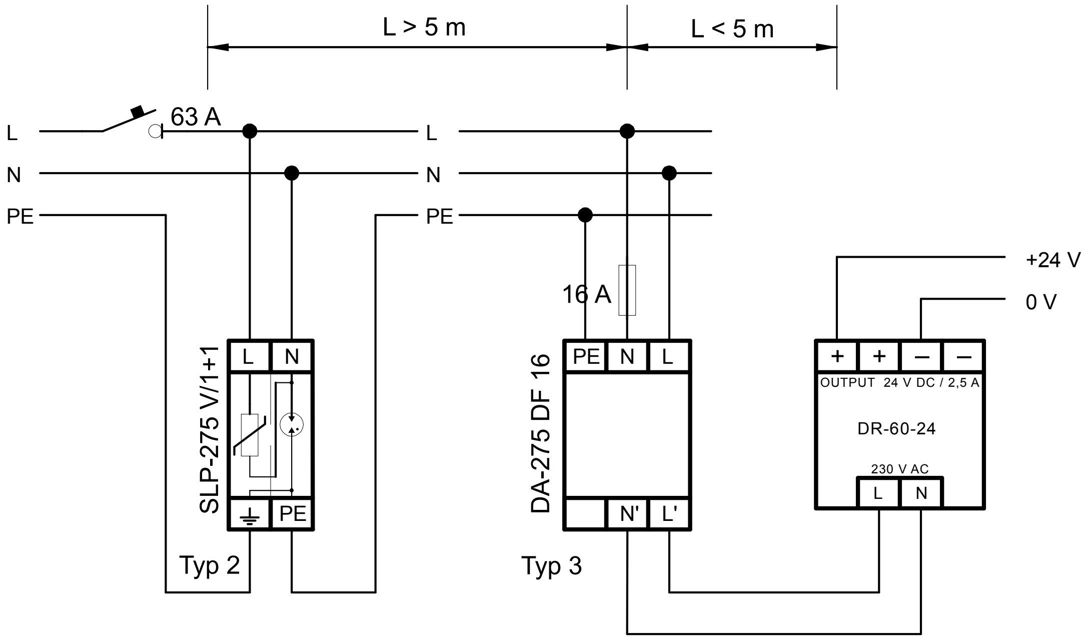


Fig. 13.5.4.1 An example of connection of coordinated protection by SPD Type 2 and SPD Type 3 with a HF filter

Notes:

1. The example illustrates the coordination (observing the correct cable lengths) between SPDs in individual control panels (distribution boards).
2. If the coordination distance between individual steps cannot be observed, an RTO decoupler must be used (see the Chapter Coordination of SPD).

13.5.5 **Protection of the mains TN-C, 3ph, 230V and the interface LPZ 0/1, Type 1**

Wiring the protection of Type 1 (lightning current suppressor) of the mains for objects with the main fuse up to 63A connected by an earth cable, the TN-C network for LPL III (houses, small office buildings, agricultural buildings and residential buildings) and LPL IV (buildings and halls free of people and internal equipment). Proper coordination between T1 and T2 requires a cable at least 10m long, or using a surge separating inductor (PI-L).

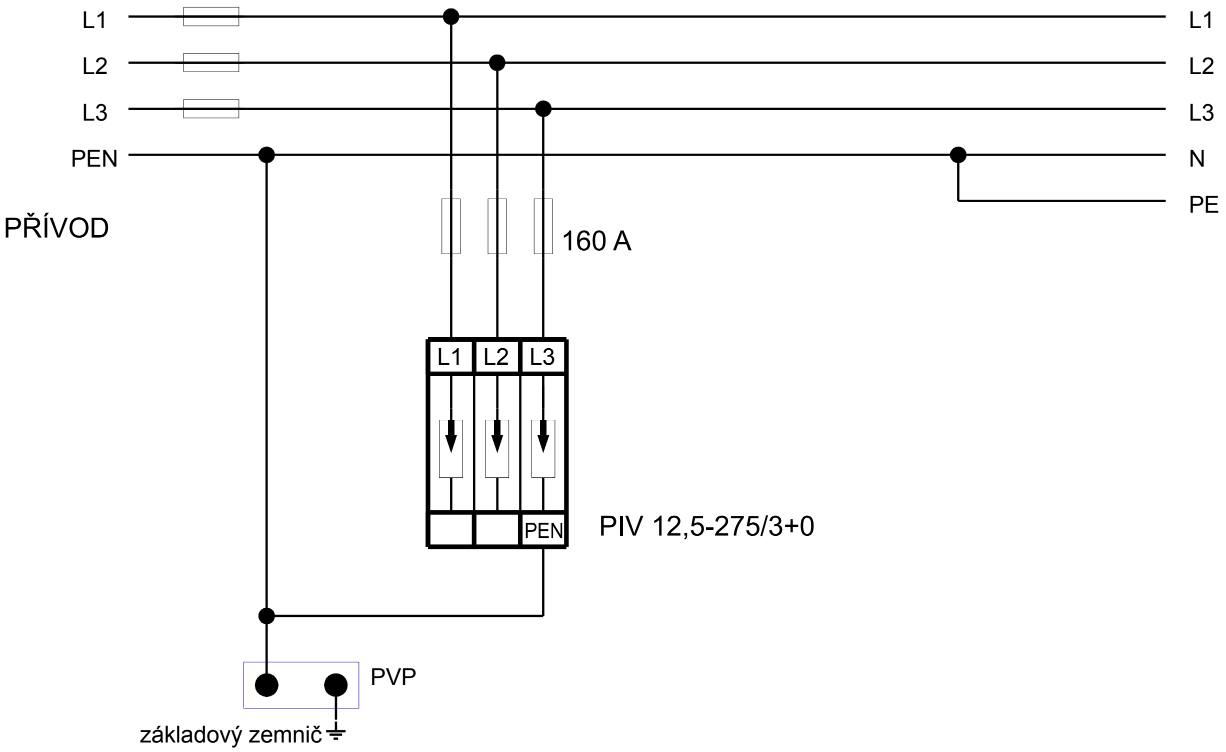


Fig. 13.5.5.1 An example of connection of the PIV 13.5-275/3+0 lightning surge suppressor

Notes:

1) Protecting the surge suppressor is only necessary if the main backup fuse is more than 160A (in industrial applications it is recommended to use it every time, due to periodic inspections).

13.5.6 Protection of the mains TN-C, 3ph, 230V and the interface LPZ 0/1, Type 1+2

Wiring the protection of Type 1 +2 (lightning current suppressor) of the mains for objects with the main fuse up to 63A connected by an earth cable, the TN-C network for LPL III (houses, small office buildings, agricultural buildings and residential buildings) and LPL IV (buildings and halls free of people and internal equipment).

Coordination between T1 and T2 established by the manufacturer, maximum pulse current (10/350) 12.5kA. The SPC 12.5/3+0 is a suppressor of lightning currents of the Types 1+2 in accordance with the IEC 61643-1 standard. It should be installed on the LPZ 0-1 interface (in accordance with the IEC 1312-1 and EN 62305), where it provides ballancing of potentials and elimination of switching surges, which occur in power supply systems entering the building, especially in the TNC (3 + 0, or 1 + 0) power supply systems. In other operating systems, such as the TN-S and TT in the 1+1 or 3+1 mode, the SPC hardware is complemented with a power surge suppressor for equipotential bonding between N and PE.

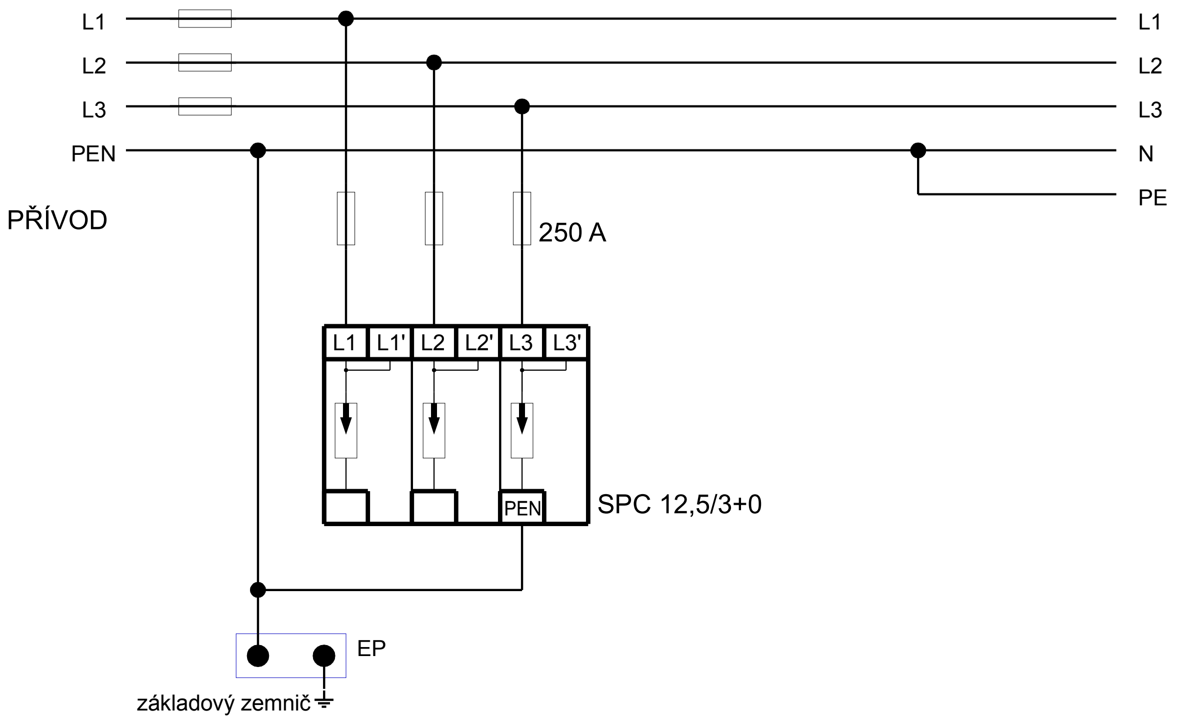


Fig. 13.5.6.1 An example of connecting the SPC 12.5/3+0 lightning current suppressor

Notes:

1) Protecting the surge suppressor is only necessary if the main backup fuse is more than 250A.
2) The double terminals of the device (L1, L2) enable the "V" connection with the load capacity up to 63A (protecting the suppressor in "V" connection is up to 63A).

13.5.7 Protection of the supply network TN-S, 3ph, 230V, the LPZ 1/2 interface, Type 2

Protecting the supply network on the LPZ 1/2 interface, Type 2, can be facilitated by installing a surge suppressor in the subordinate switchboard, e.g. the PIIIM-275/3+1, which is a varistor surge suppressor for 3ph networks TN-S, with a maximum discharge current (8/20) 50 kA.

The PIIIM **Vseries** is a varistor surge suppressor of the Type 2 in accordance with the ČSN EN 61643-11 standard. It should be installed on the interface of the LPZ zones 1-2 (in accordance with the IEC 1312-1 and ČSN EN 62305 standards), where it provides equipotential bonding and elimination of switching surges, which occur in supply networks entering the building.The PIIIM **Vseries** surge suppressor is mainly used in all areas of industrial and in residential buildings. They are installed into the subordinate switchboards or the control panels.The M designation specifies a design version with a removable module.

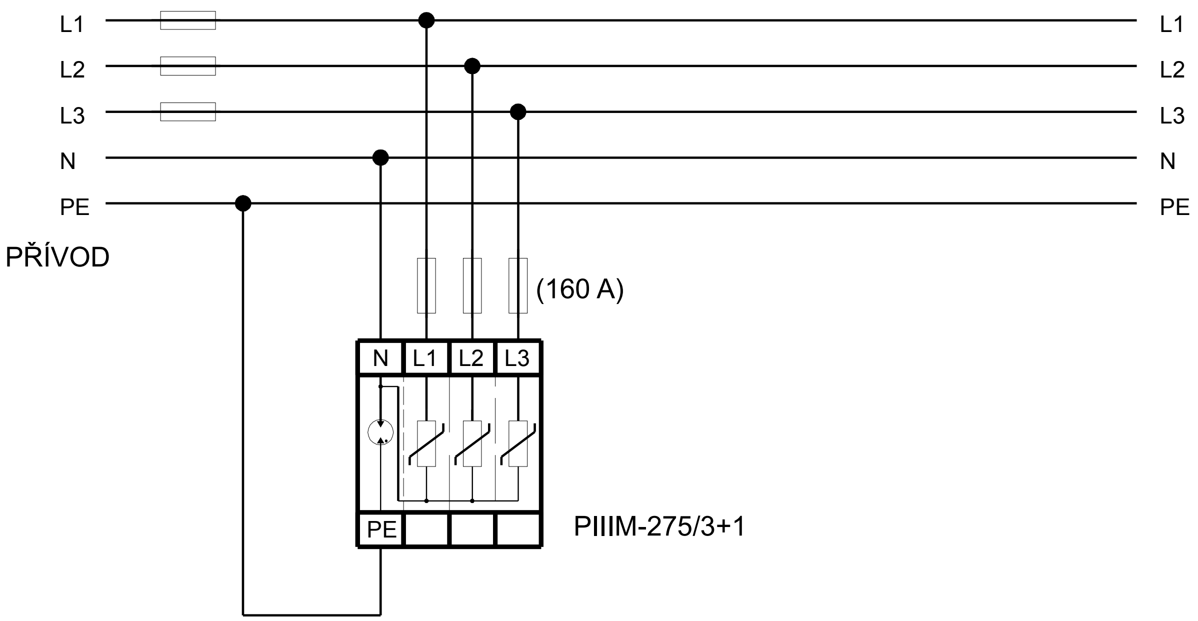


Fig. 13.5.7.1 An example of connecting the surge suppressor PIIIM-275/3+1

Notes:

1) You can also use the suppressor 4 + 0, but due to a higher risk of transverse overvoltage (L-N) it is preferable to use the 3+1 protection.

13.5.8 Protection of 1ph, 230 V devices, the LPZ 2/3 interface, Type 3

In order to protect a device powered from the 230V grid, you should install a surge suppressor in the control panel, which is as close as possible to the protected device; it should be SPD Type 3, e.g. the PI-k8.
The PI-k is a single-phase surge suppressor of the Type 3, in accordance with the EN 61643-11 standard, which is supplemented by
a high-frequency filter. It is manufactured in a comprehensive range for the nominal currents 8, 16, 25 and 32, intended for application in the TN-S networks. The protection is adapted for mounting on a 35mm a DIN rail. The PI-k are designed to protect single-phase electronic appliances in LV supply distribution systems against transient overvoltage and high frequency interference. They are equipped with a light indication of functioning correctly (the green light). Should there be a request to disconnect the protected circuit in case of a surge suppressor failure, there is another option, which is the Pi-k8 OFF; during a breakdown the output terminal connectors are disconnected and the power supply is interrupted.

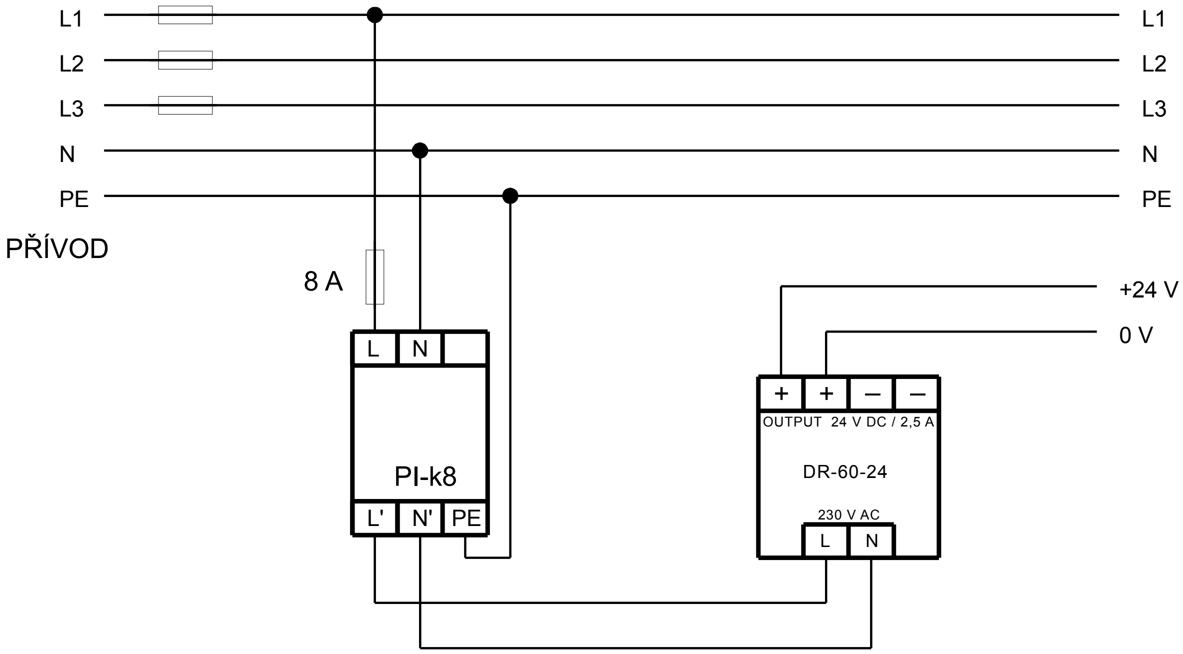


Fig. 13.5.8.1 An example of connecting the surge suppressors PI-k8 – protection of the system power supply

Notes:

1. Protection can be strengthened by using a max. 8A backup fuse, or the B6A circuit breaker.

13.5.9 Coordination of SPD, decouplers

The SPDs in the installation can only function properly if proper mutual coordination between them is provided - i.e. ensuring minimum required impedance between individual stages of SPD. This is achieved either by the minimum length of the cable (Fig. 13.5.91), or by inserting an RTO decoupler (Fig. 2). 13.5.9A correct selection of decouplers should be based on the documentation of the SPD manufacturer.

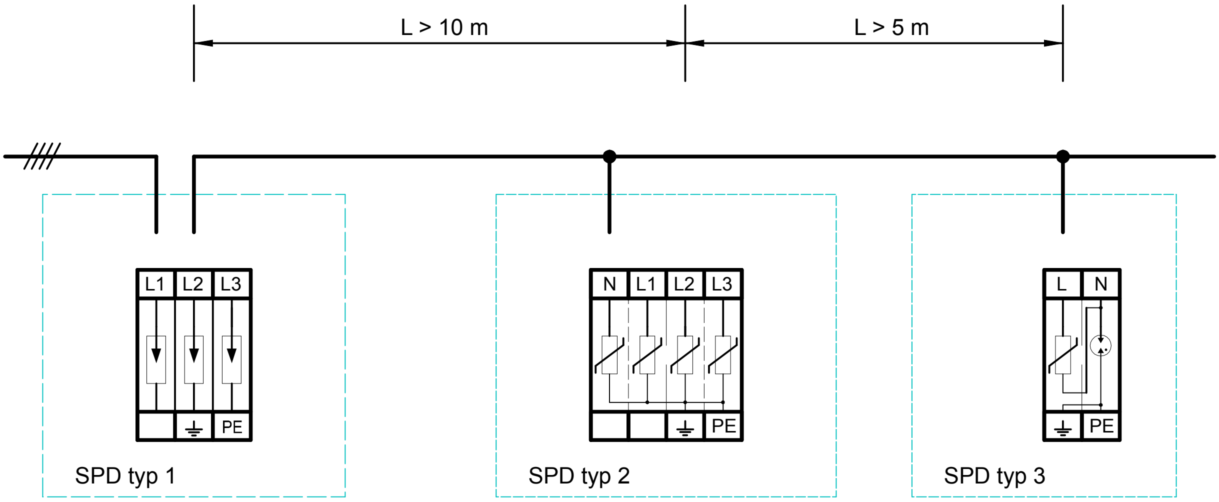


Fig. 13.5.9.1 Coordination provided by the length of the wire among individual stages of SPD

If the required coordination length of wires is not observed, the RTO decouplers must be inserted between individual stages:

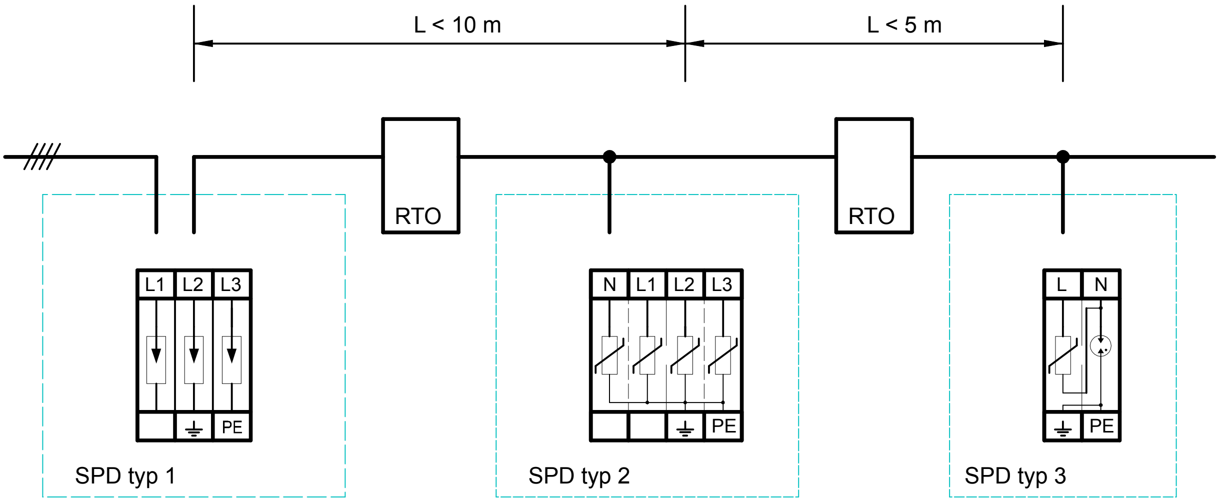


Fig. 13.5.9.2 Coordination is provided by installing an RTO decoupler

13.5.10 Protection of socket circuits

The socket circuits can be protected by Type 3 of SPDs, either in the version with an HF filter (this is a better solution for sensitive electronics), or with basic protection without an HF filter.
To ensure proper protection, the distance from the socket to an SPD element should not exceed 5m. Compliance with this condition can be achieved either by installing an SPD to each socket, or by suitable layout of SPDs so that the distance to any socket would be shorter than 5m.

The example in Fig.13.5.101 shows a solution with the socket circuit shorter than 5 meters, so by using one SPD Type 3 with an HF filter into the distribution board you protect all sockets in the circuit.

The example in Fig13.5.10. 2 shows a solution with the socket circuit longer, where correct protection of sockets is again provided by an SPD Type 3 in the distribution board (at the beginning of the circuit) and then, where necessary, directly under the sockets (into a deeper flush box) are installed other SPDs (a miniature DA-275A).

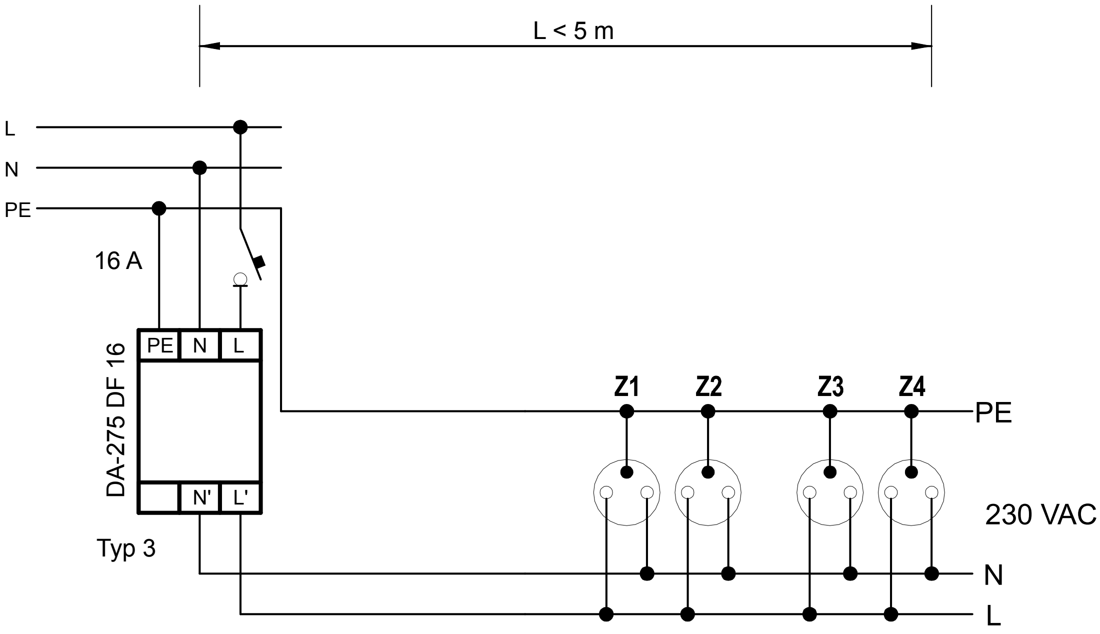


Fig. 13.5.10.1 Protection of a socket circuit up to 5m

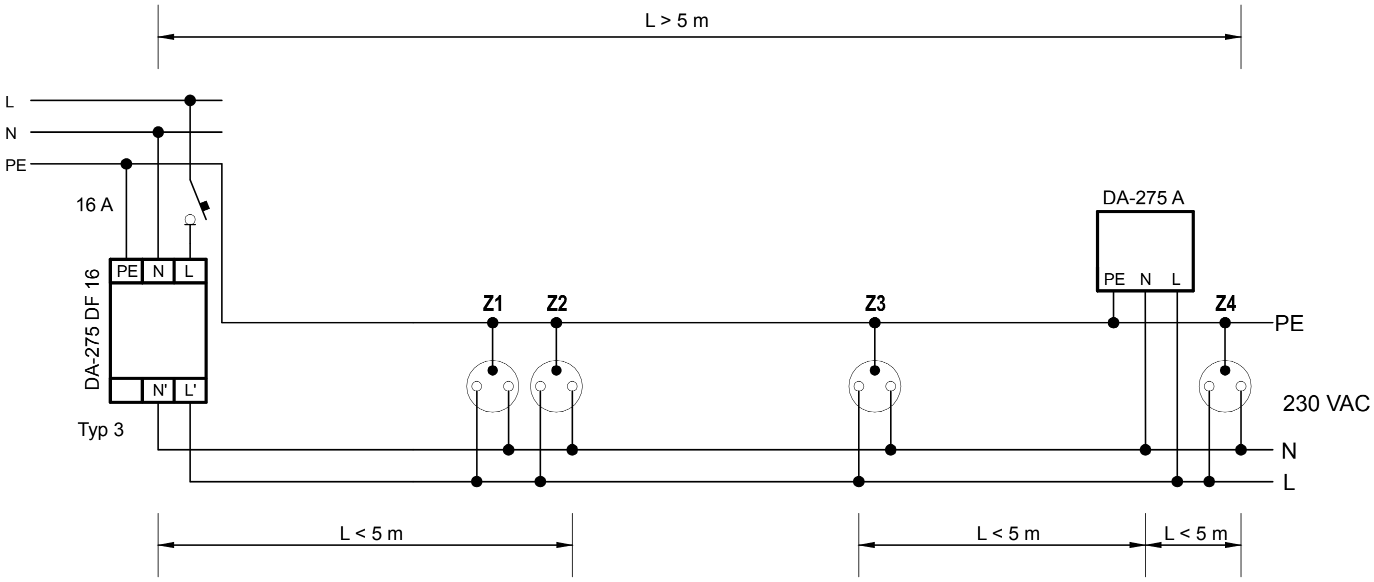


Fig. 13.5.10.2 Protection of a socket circuit by several SPDs

The DA-275 A

The Type 3 SPD - surge protection module

Surge protection for a subsequent installation in devices, machines, equipment, etc., designated for protection of all types of electric and electronic low-voltage equipment against pulse overvoltage.

It is suitable for single-phase supply networks, where the L, N wiring does not have to be observed in the assembly.

It can also be used for single-phase power supply networks with a decoupling transformer.

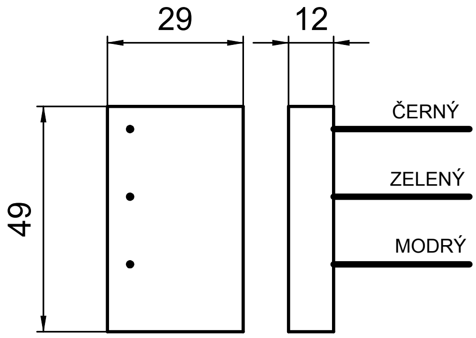


Fig. 13.5.10.3 Dimensions of the DA-275 A surge protection

13.5.11 Surge protection of the RS485 (RS232) communication interface

If there is a risk of overvoltage (parallel cabling), it is recommended to increase the resilience of the systems by using the surge protection (SPD) with each connected system. In cases of outdoor cabling, the SPD should always be used!

Always use surge protection equivalent to the level of signals in the cable; you should always protect all signal conductors in the cable. The surge protection earth terminal should be always properly connected to the protective earth in the control panel (close to the supply from the grid); if several protection elements are used for different signals, all their ground terminals should be unified in one point).

Recommended SPDs manufactured by SALTEK:

The protection recommended for the RS485 interface:

The BDM-006 V/1 R1 on a DIN 35	rail mounting	(manufactured by SALTEK)
The BDM-006 V/1 R1 on a DIN 35	rail mounting	(manufactured by SALTEK)

The protection recommended for the RS232 interface:

2x the BDM-012 V/1 R1 on a DIN 35	rail mounting	(manufactured by SALTEK)
The DM-012 V/2 R1 on a DIN 35	rail mounting	(manufactured by SALTEK)

BDM is a comprehensive range of surge protection devices designed for protection of data, communication, measuring and control lines against surge effects. They are recommended for use on interfaces of protection zones ZBO $0_{A(B)}$-1 in accordance with the ČSN EN 62305 standard. All types provide effective protection of the connected equipment against transverse and longitudinal surges in accordance with the IEC 61643-21 standard. Nominal operating current of individual protected lines I_L < 1A.

The 1st degree is designed using three-pole arresters, 2nd degree using transils. The number of protected pairs is optional (1 to 2). They are designed for the nominal operating voltages from 6V to 170V. For this type, the maximum leakage current is 10kA (8/20).

Recommended SPDs manufactured by HAKEL:

The protection recommended for the RS485 interface:

DTE 1/6-L	the version on the TS35 rail	(produced by HAKEL)
DTB 1/6	the version in a plastic box	(produced by HAKEL)

The protection recommended for the RS232 interface:

DTE 2/12	the version on the TS35 rail	(produced by HAKEL)
DTB 2/12	the version in a plastic box	(produced by HAKEL)

These types of protection are available in the basic version with a maximum discharge current of 10kA (e.g. DTE 1/6), or in a strengthened version (with the letter L added, e.g. DTE 1/6-L) with a maximum discharge current of 20kA (for more vulnerable installations).

DTE is a comprehensive range of surge protection devices designed for protection of data, communication, measuring and control lines against surge effects. They are recommended for use on interfaces of protection zones ZBO $0_{A(B)}$-1 in accordance with the ČSN EN 62305 standard. All types provide effective protection of the connected equipment against transverse and longitudinal surges in accordance with the IEC 61643-21 standard. Nominal operating current of individual protected lines IN < 0.1A.

The 1st degree is designed using three-pole arresters, 2nd degree uses transils. The number of protected pairs is optional (1 to 2). They are designed for the nominal operating voltages from 6V to 170V. For this type, the maximum leakage current is 10kA (8/20).

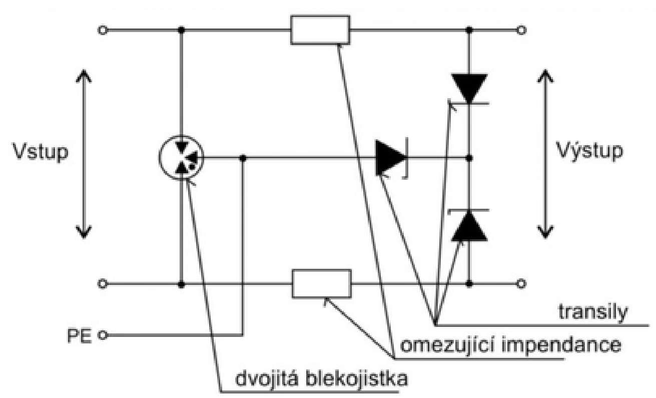


Fig. 13.5.11.1 Internal connection of the DTE surge protection

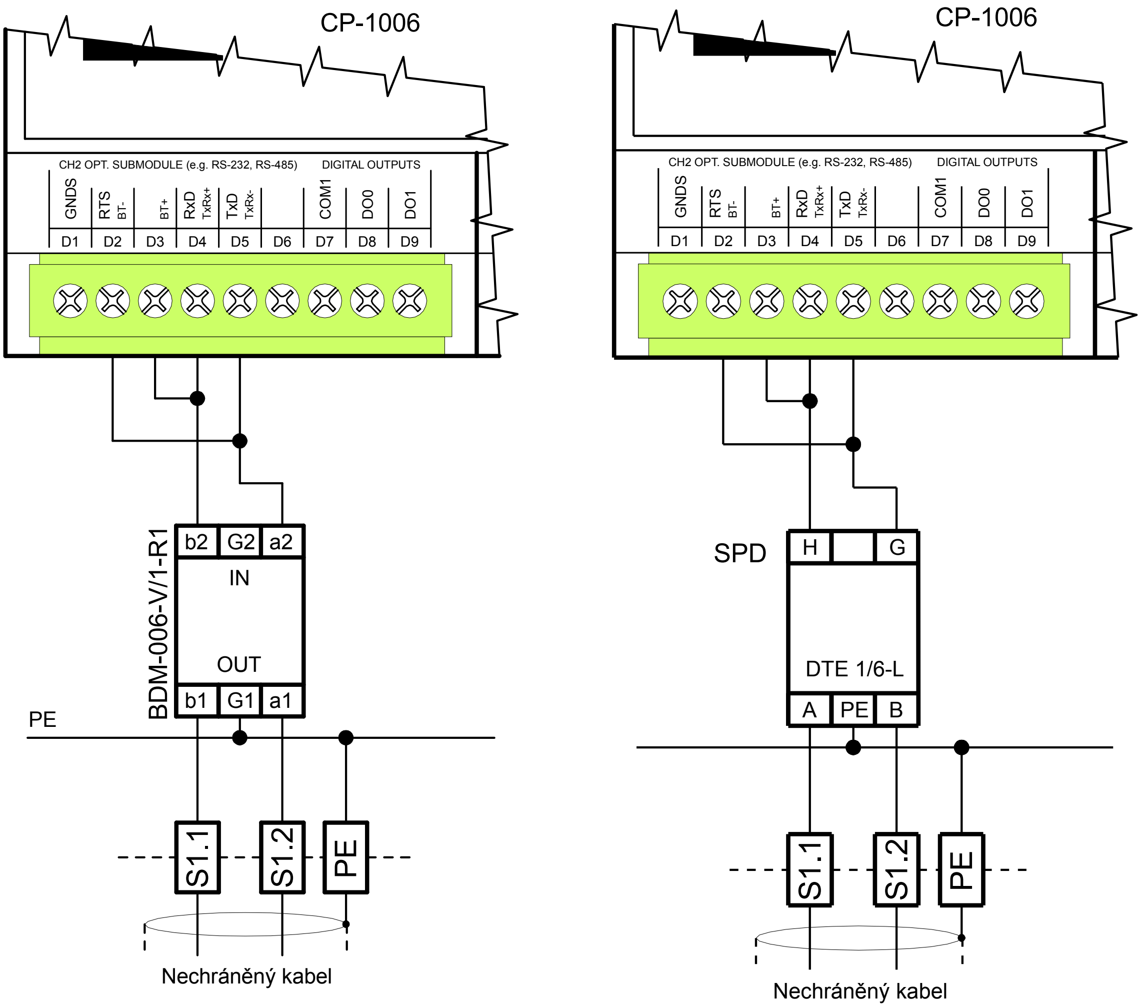


Fig. 13.5.11.2 An example of connecting surge protection of the RS-485 communication interface in CP-1006

Technical parameters of SPDs BDM-006, BDM-012 and DM-006, DM-012 (SALTEK)

SPD		BDM-006-V/1-R1	DM-006-V/1-R1	BDM-012-V/1-R1	DM-012-V/2-R1
The number of pairs		1	1	1	2
The placement of SPD		ST 1+2+3	ST 2+3	ST 1+2+3	ST 2+3
Nominal operating voltage	U_N	6 VDC	6 VDC	12 VDC	12 VDC
The highest continuous operating voltage	U_C	8.5 VDC	8.5 VDC	15 VDC	16 VDC
The rated loading current (at 25 °C)	I_L	1A	1A	1A	1A
D1 total discharge current (10/350 μs) strands-PE	I_{Total}	5kA	-	5kA	-
C2 rated discharge current (8/20 μs) per wire	I_n	10kA	10kA	10kA	10kA

C2 protective voltage level in the wire-wire mode with In	U_P	25V	-	40V	-
C3 voltage protection level in the wire-wire mode with 1kV/µs	U_P	12V	12V	22V	22V
Response time	t_A	1ns	1ns	1ns	1ns
Boundary frequency wire-wire	f	0.8Mhz	0.8Mhz	2Mhz	2Mhz
Serial resistance on the wire	R	0.8Ω	0.8Ω	0.8Ω	0.8Ω
Operating temperature		-40 °C ÷ +70 °C			
Level of protection		IP 20			
The cross-section of connected wires (solid) - max.		0.14 ÷ 4mm^2			
The cross-section of connected (stranded) - max.		0.14 ÷ 2.5mm^2			

Technical parameters of SPD DTE 1/6-L (HAKEL)

The number of pairs		1
Nominal operating voltage	U_N	6V
Maximum continuous operating voltage	U_C	7.2V
Nominal current	I_N	100mA
D1 Lightning cumulative current (10/350)	I_{imp}	5kA
D1 Lightning (10/350) line/PE	I_{imp}	2.5kA
C2 Maximum discharge current (8/20)	I_{max}	20kA
C2 Nominal discharge current (8/20)	I_n	1kA
C2 Voltage protection level at In	U_P	15V
C2 Voltage protection level at 1kV/µs	U_P	9V
Response time	t_A	< 30ns
Data transfer rate		1 MBit/s
Insertion impedance		1.5 ÷ 10Ω
Parasitic capacitance	C	1,5nF
Operating temperature		-40 °C ÷ +80 °C
Level of protection		IP 20
Recommended cross-section of the connected wires		0.25 - 1.5mm^2
Maximum torque of the terminals		0.4Nm
Tested in accordance with the IEC 61643:21-2000standard.		A2, B2, C2, C3, D1

13.5.12 **Protection of the Ethernet (the weather station, WiFi on the roof)**

To ensure surge protection of devices placed on the roof (under the roof) and connected to the Ethernet network, it is recommended to install the DL-1G RJ 45 (SALTEK) surge protection, or the DTB 4/100M 5cat/48V (HAKEL) surge protection.

The **DL-1G RJ45** is suitable for wall mounting and protects all 4 pairs, both data and power (PoE).
It protects the Ethernet electronic circuits against damage caused by overvoltage at the interfaces of protection zones LPZ 0A(B)-1 and higher, in accordance with the ČSN EN 62305 standard. It is recommended to place the protection at the inputs of the protected equipment (at the transition of zones). The protected lines pass through the protection, e.g. the weather station cable should be connected to the DL-1G RJ45 surge protector.Design:The DL-1G RJ45 is suitable for wall mounting; it protects all 4 pairs of wires, both data and power.It is supplied in a metal box, which can be mounted on a DIN rail.
The input and output of the surge protection is fitted with the RJ-45 connectors.

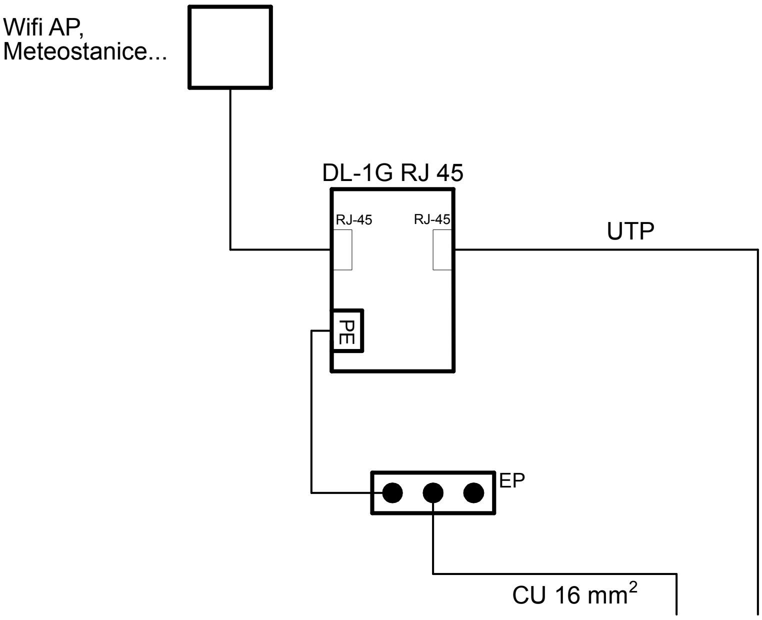


Fig. 13.5.12.1 An example of installation of SPD under the roof of a house (in the loft)

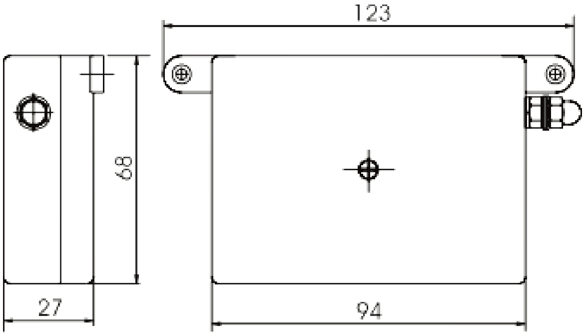
Basic parameters of DL-1G RJ 45:

The number of pairs		4
Type of SPD		ST 1+2+3
Connection input/output		RJ-45/RJ-45
The highest continuous operating voltage	U_C	60VDC
Nominal current	I_L	0.5A
C2 total discharge current (8/20) PE wires	C	10kA
D1 total discharge current (10/350) PE wires	I_{Total}	2kA
C3 protection voltage level wire-wire with In	U_p	110V
C3 protection level PE wire with 1kV/µs	U_P	350V
Category		CAT. 6
Operating temperature		-40 °C ÷ +60 °C
Level of protection		IP 20

The **DTB 4/100M 5cat/48V** is suitable for wall mounting, and it protects all 4 pairs, both data and power (PoE).
It protects the Ethernet electronic circuits against damage caused by overvoltage at the interfaces of protection zones ZBO 0A(B)-1 and higher, in accordance with the ČSN EN 62305 standard. It is recommended to place the protection at the inputs of the protected equipment (at the transition of zones). Protected lines pass through the protection, e.g. the weather station cable should be connected to the DTB4/100M 5cat/48V surge protector.
Installation:The DTB 4/100M 5cat/48V protector is suitable for mounting on the wall. It protzects all four pairs of wires. It is supplied in a plastic box that can be screwed on the wall, or glued with its rear side directly on the protected
equipment (using double-sided adhesive tape).
The input and output of the surge protection is fitted with the RJ-45 connectors.

Basic parameters:

The number of pairs		4
Connection input/output		RJ-45/RJ-45
Nominal operating voltage	U_N	48V
The highest continuous operating voltage	U_C	56V
Nominal current	I_N	0.3A
C2 Maximum leakage current (8/20)	I_{max}	2kA
C2 Nominal leakage current In (8/20)	I_n	1kA
Voltage protection level at In	U_p	10V
Voltage protection level at 1 kV/µs	U_P	< 10V
Maximum data transfer rate		100 MBit/s
Operating temperature		-40 °C - +80 °C
Level of protection		IP 20

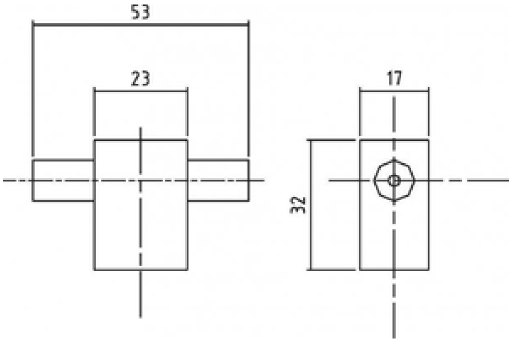


13.5.13 Protection of TV signal distribution system (coax cables)

The TV cable from the areal on the roof can be protected by the FX-090 B75 F/F (SALTEK) coaxial surge protection, or by the KO-10P (HAKEL), system, which is designated to protect equipment connected to the antenna system via coaxial cables.
Using special lightning arresters and a maximum leakage current Imax (8/20) = 10kA ensures a reliable protection of receiving and transmitting systems, and also against the effects of lightning strikes nearby. It is recommended to use on the interface of protection zones the ZBO 0A(B)-1 and higher, in accordance with the ČSN EN 62305 standard.

Protection FX-090 B75 F/F is fitted with an BNC connector both at the input and output (a version with an F connector is also possible). It is equipped with a grounding terminal that provides connection to protective earth.
It is designed to protect coaxial lines, and should be installed at the boundary of LPZ 0A and LPZ 1 zones at the line input to the building.It is suitable as the first stage of surge protection, provided coordination with the SX type is observed. The supply includes: a universal plastic adapter for assembly on a DIN rail, – the holder GND 2.

The KO-10P protection is equipped on the inlet and outlet with a standard TV connector. The connection with the protective earth is implemented with a screw and a nut.



13.6 Recommended cables

13.6.1 A cable for the CIB bus, the J-Y(St)Y

The CIB installations require shielded cables with twisted pairs, with the wire diameter of at least 0.6mm, preferably 0.8mm, e.g. the JY(St)Y1x2x0.8, or YCYM 2x2x0.8.

The J-Y(St)Y1x2x0.8 cable:
The cable is designed for internal fixed wiring in communication, measuring and control technology. It is suitable for installations where lines are expected to run in parallel (the power and communication lines). The wire insulation is made of PVC. The wires are twisted in pairs, the cable core is wrapped up in foil, the static screening is made of alluminum-laminated plastic film with copper drain wires, the outer sheath is made of PVC.

Basic parameters:

	J-Y(St)Y1x2x0.6	**J-Y(St)Y1x2x0.8**
The wire diameter	0.6mm	0.8mm
The wire cross-section	0.28mm²	0.50mm²
Maximum loop resistance	130Ω/km	73.2Ω/km
The external diameter of the cable	5mm	6mm
The minimum bend radius	50mm	60mm
Maximum operating voltage	300V	
Testing voltage	Wire/wire: 800V	
	Wire/shielding: 800V	
The temperature range (fixed installation)	-30 °C to +70 °C	

13.6.2 The ETHERNET outdoor installation (WiFi, cameras, and such like)

For underground and outdoor installations, the ETHERLINE® CAT.5 FD BK cable can be used (produced by the LAPP GROUP).
The cable meets the standards EIA/TIA-568, TSB-36 and ISO/IEC IS 11801.

Basic parameters:

Order number		CE217489
The minimum bend radius		95mm
The temperature range:		
	The mobile usage	-5 °C to +50 °C
	Fixed installation	-40 °C to +70 °C
Wire		Bare copper wire 0.14mm² (19x 0.10), (26AWG)
The wire insulation		Foam PE, maximum external diameter 1.0mm
Twisting		2 wires twisted in pairs, 4 pairs together
Internal coating		Halogen-free thermoplastic elastomer
Shielding		Braid of tinned copper wires, 85% ± 5 covered

The outer sheath	Halogen-free PUR, black
External diameter	6.3mm

13.6.3 Cables for connecting temperature sensors, the SYKFY

The SYKFY cables are suitable for connecting temperature sensors and for other measurements without high requirements for data transfer speed and transmitting current. .
The SYKFY is a cable composed of pairs of solid copper wires of 0.5mm diameter, with PVC insulation. Two conductors (wires) are always twisted into pairs, and the pairs (depending on the number) are twisted into a so-called cable core. The core is shielded by an aluminum foil with two CuSn drain wires. The sheath is made of PVC.
The cable is designed for interior fixed installations.
It is supplied with a varied number of pairs, usually 2x2x0.5 (2 pairs), 3x2x0.5 to 50x2x0.5mm.

Basic parameters of the SYKFY 2x2x0.5 cable:

	SYKFY 2x2x0.5
The wire diameter	0.5mm
The wire cross-section	0.2mm²
Maximum loop resistance	195.6Ω/km
Maximum operating capacity	120nF/km
The external diameter of the cable	5mm
The minimum bend radius	50mm
Nominal voltage	100V
Test voltage wire/shielding and wire/wire	1kV
The temperature range (fixed installation)	-30 °C to +70 °C
The sheath colour	Grey or white

13.7 Increasing the resistance of applications.

All the operations of the control system (switching loads, speed control, etc.) and the surrounding technologies (heat pump compressors, electronics of poor-quality energy saving lamps, etc.) create interfering signals, which may adversely affect the quality of measurements of analogue values, decrease the quality of transmission on communication routes, reduce the lifetime of some elements, and sometimes even affect the stability of the entire application (communication failures, failures of some peripheral modules, or even failures of the control system basic module).
The following chapters outlines the basic selected activities that increase the durability, reliability and lifetime of the whole intelligent installation, or the installation of the control system.

13.7.1 Protection of the output elements (relays, etc.)

The most active element of the systems are still classic electromechanical relays with unprotected contacts. In addition to the standard resistive loads (heaters, etc.) and common inductive loads (motors, coils of contactors and relays, solenoids, wound transformers, etc.) there are increasingly more common loads with capacitive character (switching power supplies for LEDs, some ballasts for fluorescent lamps, etc.). Each of these types of loads acts in a specific way on the contacts switched by them, and on the surroundings (interference), and specific measures are required to mitigate these effects:

1. Resistive loads
They have the least detrimental impact on the switching circuits and on the surroundings. They do not require any special protection elements.

2. Inductive loads
They adversely affect the shutdown (disconnecting from the power supply voltage). At the time of the shutdown there may occur a strong voltage peak, which is proportional to the voltage, the circuit inductivity, etc. There are suppression elements that can be used to protect the switching circuits and reduce the generated interference, see Chapter 13.7.3.

3. Capacitive loads
It has a negative impact when switching on (connecting) the supply voltage.
At the time of switching (the "cold start") a high current curge can occur (in the order of dozens of amps in the switched power supplies), which can quickly cause a "sticking" of the relay contact of the switching circuit. In this case, it is not possible to simply use additional protection features. Switching these circuits requires the use of relays with special contacts (i.e. the "inrush" technology), where by doubling the contacts, the relay is equipped with a special "pre-contact" made of a material, which can withstand more than 100A for approx. 20ms, thus spanning the initial current surge.

13.7.2 Installation and laying cables

Cables with digital signals should be laid out of direct contact with the cables for analogue measurement and communication lines (the recommended distance is at least 15cm); they should be laied out of direct contact with the system. Digital output signals can be lead together with the binary input cables, powering the MaR parts, etc. .
The cable length depends on the type of transmitted signals (the voltage drop and its impact).
What must be rigidly done is to eliminate interference of all elements, which by their nature cause it (contactors, valves, large relays, etc.) and come into close contact (or their inputs) with the system circuitry.

During the installation of cables connected to power elements with a very strong radiated interference it is recommended to always lay those cables separately from cables with data signals (analogue, communication, etc.) and the electronic equipment, in order to increase the resilience of the systems. If the cables are laid outdoors, it is important to avoid laying them in parallel with power lines, lightning conductor current leakages and long metal objects. If you are not able to meet these requirements, you should supplement the line upstream from the system with some surge protection device.

13.7.3 Interference suppression, application of interference suppression elements

If the system controls power elements with inductive character (valves, contactors, larger relays, smaller motors, etc.), you should always ensure the most effective suppression of formation and radiation of interference field. Therefore a suppression element should always be mounted directly on the terminals of the switched element. The cables between the suppression element and the protected device must be as short as possible.

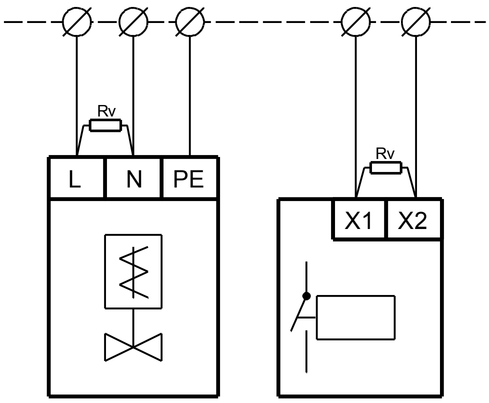
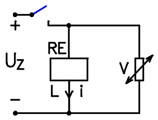
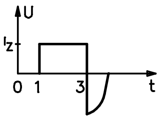
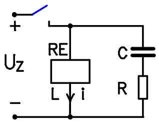
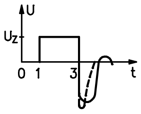


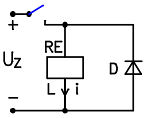
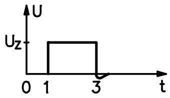
Fig. 13.7.3.1 An example of connecting the suppression element to the load

Notes:

1) Always install the suppression components as close to the load (the interference source) as possible.
2) Suitable suppressor elements are described in the following tables.

Table 13.7.3.1: Recommended methods of handling the inductive load.

Nominal voltage	Description	Type	Wiring diagram of the element	The voltage on the load curve
DC and AC : typically 24VDC 24VAC 230VAC	The most commonly used, less suitable if the network is bad, the drawback of ageing.	VARISOTR		
DC and AC : typically 24VDC 24VAC 230VAC	Universal usage for a larger range of voltages, suitable for bad networks.	RC member		

DC typically 24VDC	Only for DC circuits, drop-out delay of the protected relay should be counted with (dozens of ms); it can be mitigated by a	**DIODE**		

When selecting varistors, you should use the type for the appropriate nominal voltage of the circuit (e.g. at 24VAC, a varistor for 45VAC voltage must be used). There are sets of varistors available ready to use for standard voltage values. For the list of the sets, see Table 13.7.3.2.
For certain voltages and load currents it is possible to calculate the optimum values of resistor and capacitor, that each RC element consists of (a diagram for the calculation is shown in Fig. 13.7.3.2).
Typical applications with the Foxtrot systems are supported with ready-to-use sets. The RC elements are provided for a greater range of voltage, and they are already encased with two wire outlets for immediate use.
They are mostly used for interference suppression of relay coils and contactors. Standard diodes (e.g.1N4007) can be used for typical currents of dozens of mA.

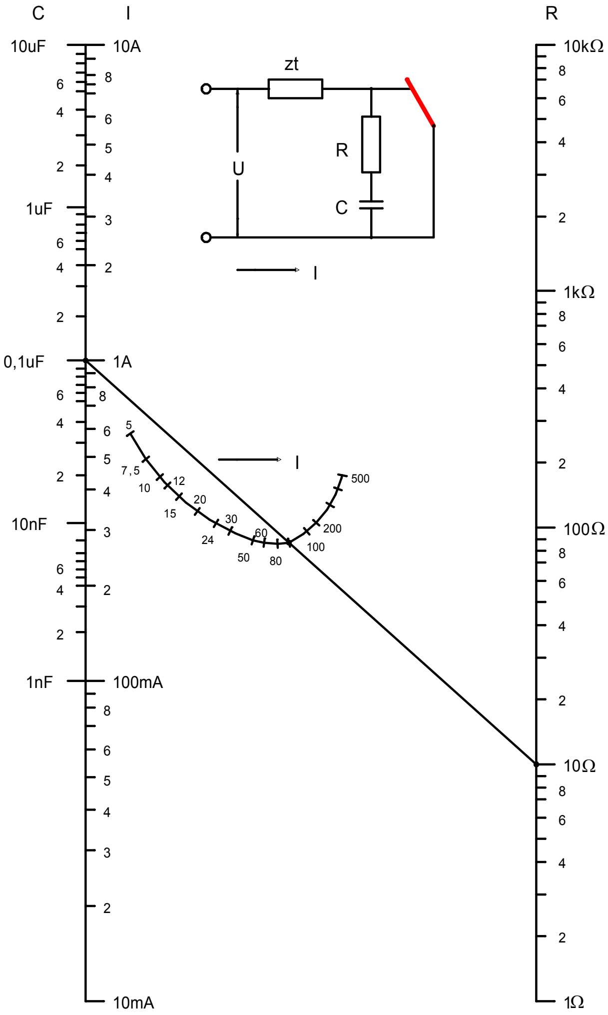
A diagram to determine the value of the RC element.
Using a graph, it is possible to determine the values of RC members for a specific circuit parameters.

The value of C follows directly from the switched current (the left axis).

The value of R can be found by leading a straight line through the respective points of I axis of the U curve; the value of resistance should be subtracted at the intersection of the line with the R axis (the right axis).

The measured or estimated value of the overvoltage resulting from the switching off the circuit with an inductive load (typically 2÷5 times nominal voltage) should be substituted as the U voltage value.

An example: U = 90V, I = 1A
What follows for the condenser capacitance is the value 0.1μF; the resistance value can be determined by a straight line drawn to 10Ω.



This method is too complicated for common applications, so we supply directly the RC members that suit most applications (contactors, valves, etc.). Their summary in listed in the Table 13.7.3.2

Fig. 13.7.3.2 A diagram to determine the value of the RC member.

Table 13.7.3.2: A diagram to determine the value of the RC member.

Name	**The order number**	**Table of contents**	**Nominal voltage of the load**
The interference suppression set	TXF 680 00	8x varistor	24V =, 24V ~
The interference suppression set	TXF 680 01	8x varistor	48V =, 48V ~
The interference suppression set	TXF 680 02	8x varistor	115V ~
The interference suppression set	TXF 680 03	8x varistor	230V ~
The interference suppression set	TXF 680 04	8x RC member	24 ÷ 48V =, 24 ÷ 48V ~
The interference suppression set	TXF 680 05	8x RC member	115 ÷ 230V ~

The parameters of varistors used in interference suppression sets

the energy that can be captured by the I^2t varistor (t is the duration of the blanking pulse in ms)	< 80
current in varistor I	< 25A
medium value of power loss P	< 0.6W

13.7.4 Principles of application of shielded cables

- The shielding of the external and internal cables of the control panel should always be connected to the main protective earth (with grounded frame of the control panel) only on one side of the cable.
- In metal control panels, the shielding of the external cables should best be connected on the input of the control panel with its grounded casing.
- In plastic control panels, the shielding of the external cables should be connected as close as possible to the control panel input with the grounded mounting plate.
- The shielding should be connected with its largest cross-section directly to the grounded surfaces of the control panel (or the mounting plate, etc.); if terminals are used, the shielding must first be unbraided, twisted and then directly connected to the terminals, with no other wires used.
- The shielding should never be connected using other wires.

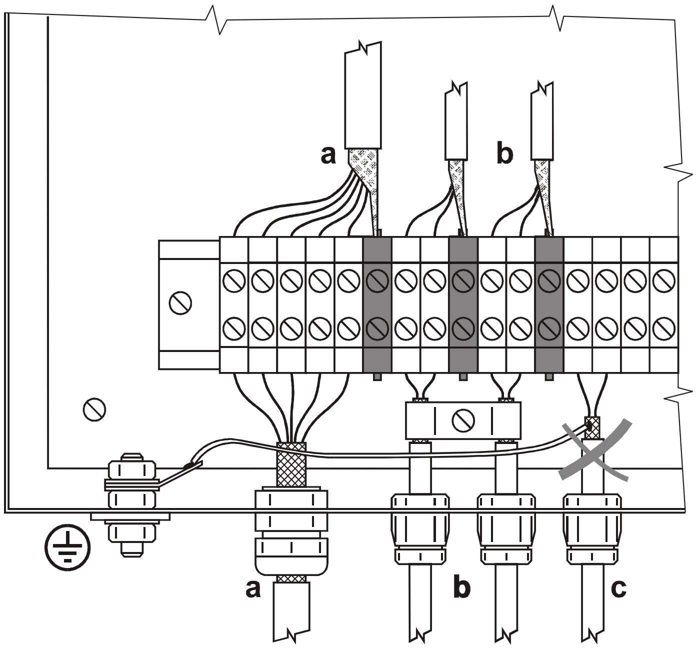


Fig. 13.7.4.1 An example of connecting cable shielding in the control panel

Options:

a) The shielding of the external cable is connected to the ground via a metal grommet designed for the connection of the shielded cables, the outer shell of the cabinet and the protective terminal. This method is the most efficient, because it reduces to the minimum the interference radiated into the cabinet. Suitable bushings are supplied e.g. by the IES company (and cable glands by Progress MS EMV). The shielding of the internal cable is connected to the ground via metal clamps, mounting plates and protective terminals.

b) The shielding of the external cables is connected to the ground via a metal clamp, a mounting plate and a protective terminal. The shielding of the internal cable is connected to the ground via metal clamps, mounting plates and protective terminals. This method, or any other similar one, is suitable mainly for plastic control panels with a metal mounting plate.

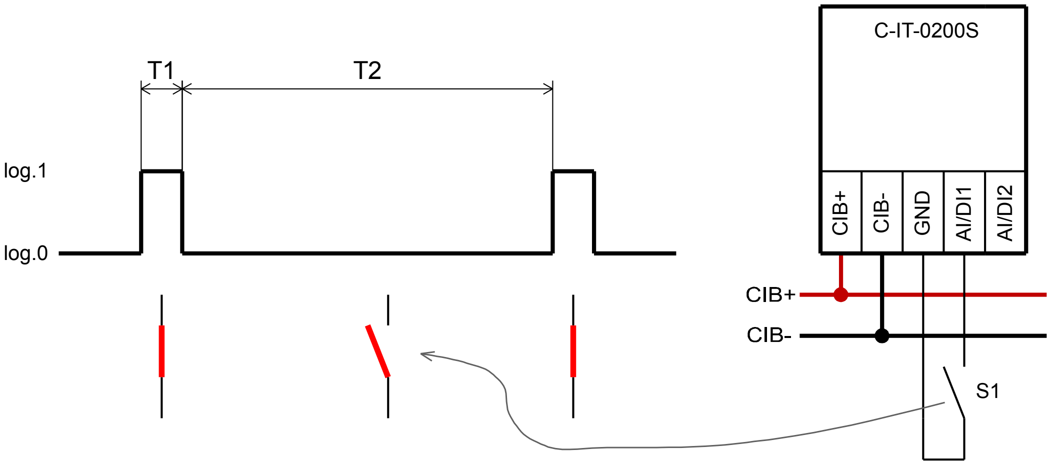
c) Here is illustrated an inappropriate connection. Although the cable shielding is connected to the protective terminal, the wire connection degrades the shielding effectiveness and the long loop causes an introduction and radiation of electromagnetic interference into the control panel.

13.8 The parameters of analogue and digital inputs of the CFox and RFox modules.

The following chapter provides detailed technical information for an informed decision on the suitability and connection of inputs and outputs of the Foxtrot system CFox and RFox modules. Further information (on internal wiring of input and output circuits of the relevant module, etc.) are listed in the descriptions of specific modules in Chapter 14.1.

13.8.1 Binary inputs – a reliable assessment of short pulses

The CFox and RFox modules (DI) digital inputs provide a reliable assessment even of a short switching. A short pulse T1 is extended, so that for at least one cycle of the system, max. 500 ms (depending on the type of module and the system setup) is log. 1 in the corresponding bit variable of the input DI. It is always a short switching! The opening duration T2 must be long enough for the system to evaluate it reliably (about 250ms at least [1]).



T1 time of switching the input, min. 5 ÷ 30ms according to the type of module (the system automatically extends the pulse).

T2 duration of opening the input, min. 250-550ms [1]) (for a reliable assessment).

log.1 input (the connected contact S1) switched (the system variable displays it as "1" or "True").

log.0 input (the connected contact S1) open (the system variable displays ii as "0" or "False").

[1]) The opening duration depends on the length of the previous switching - a short pulse (T1) is automatically extended up to 500ms, and only afterwards the system can evaluate the switching off (log. 0). So correct assessment of the opening can only be done if the total time is observed - T1 + T2, at least 750ms (500 + 250ms).

13.8.2 Binary inputs – voltage levels DI/AI, the requirements for the switching circuit

The AI/DI universal inputs on the CFox and RFox modules (this does not apply to DI modules C (R)-HM-1113M and C(R)-HM-1121M), which will be used as D1 digital inputs (designed as inputs for potential-free contacts) need for a proper assessment of the switching
(sometimes referred to as the log. 1) to keep a maximum voltage at their own input. In other words, the maximum values of the input resistance of the input circuit have to be observed, and analogically, after opening the input (log. 0) it is necessary to comply with the minimum
necessary voltage on the input, or the minimum input resistance.

Input DI:	The voltage U1 on the input	The resistance R of the Input circuit
Switched (log. 1)	< 0.6V	< 0.5kΩ
Open (log. 0)	> 1.3V	> 1.kΩ

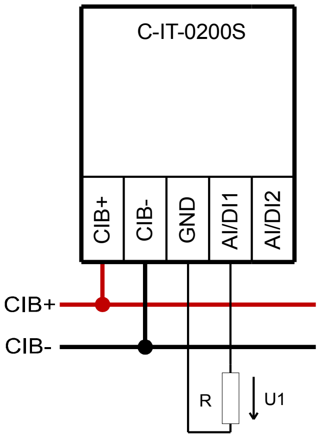


Fig. 13.8.2.1 The binary input circuit – measuring the parameters

Notes:

1. The module in the figure is C-IT-0200S. The same connection applies to all modules that have the DI inputs switched against the ground terminal GND, i.e. it does not apply to the DI of the modules C(R)-HM-1113M and C(R)-HM-1121M.

13.8.3 Single balanced inputs – voltage levels, evaluation

Connection of a single-balanced loop (input) is shown in the following diagram.
The ALARM contacts (the output is open on the detector activation) and TAMPER (the conact is switched off when there is a sabotage attempt) are always NC - i.e. the switched contact represents the idle state.
The idle state is always transmitted into the system as a log. "0" (though it actually means a switched contact of the detector!).

The loop resistance:

The state	A typical value	Permitted range	ALARM contact	TAMPER contact
Idle state	0	0 ÷ 1250Ω	switched	switched
Activation	2k2	1,750 ÷ 2,500Ω	open	switched
Sabotage	∞	> 7kΩ	x	open

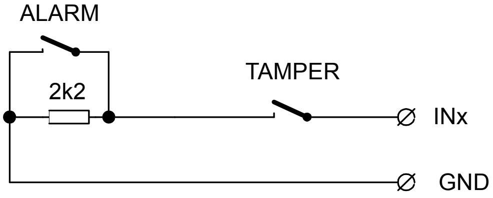


Fig. 13.8.3.1 The basic connection of the circuit of a single balanced loop

Notes:

1. The loop resistance is measured by the relevant module input, and the module evaluates the measured value and transmits two binary variables, ALARM (the idle value corresponds to log "0") and TAMPER (the idle value corresponds to log "0").
2. The values of the resistors have a tolerance band of approx. 10%, to avoid a problem of bad evaluation resulting from a higher tolerance value of resistance, or fluctuation of the resistance value, e.g. due to temperature.

13.8.4 Double balanced inputs - the voltage levels, evaluation.

By using two resistance values, the idle state and the activation of the detector are transmitted. The idle state is determined by the basic value of resistance, and doubling this value results in activation. A short circuit or disconnecting the loop is considered as a sabotage of the loop or opening the cover of the detector.
The ALARM contacts (the output is open on the detector activation) and TAMPER (the conact is switched off when there is a sabotage attempt) are always NC - i.e. the switched contact represents the idle state.
The idle state is always transmitted into the system as a log. "0" (though it actually means a switched contact of the detector!).

The loop resistance:

The state	A typical value	Permitted range	ALARM contact	TAMPER contact
Sabotage	0	0 ÷ 100Ω	The loop short circuit	
Idle state	1k1	870 ÷ 1,250Ω	switched	switched
Activation	2k2	1,750 ÷ 2,500Ω	open	switched
Sabotage	∞	> 7kΩ	x	open

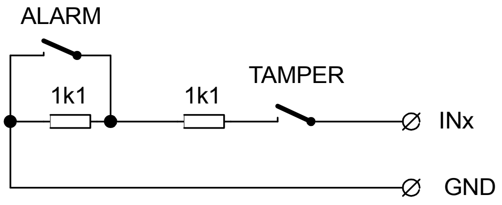


Fig. 13.8.4.1 The basic connection of the circuit of double balanced loop

Notes:

1. The loop resistance is measured by the relevant module input, and the module evaluates the measured value and transmits two binary variables, ALARM (the idle value corresponds to log "0") and TAMPER (the idle value corresponds to log "0").
2. The values of the resistors have a tolerance band of approx. 10%, to avoid a problem of bad evaluation resulting from a higher tolerance value of resistance, or fluctuation of the resistance value, e.g. due to temperature.

13.8.5 The analogue inputs – the resolution and the measurement accuracy of the temperature sensors

Individual temperature sensors differ not just in the temperature measurement range, but above all in their sensitivity and characteristics. This also influences the measurement accuracy and resolution of the measured value (the smallest measurable step).

The sensors with high accuracy and stability - the Pt1000, Ni1000 - have also the lowest sensitivity, so if universal measurement inputs are used (mostly AI/DI on the CFox and RFox modules) they have a worse resolution; usually the smallest measurable step is 0.3 °C. Softening the step can be achieved by turning on

the filtration in the module configuration, where the unit filter (e.g. 5 seconds) visibly smoothes the movement of the measured value, which is suitable e.g. for the heating control loop, etc.
Conversely, e.g. the NTC sensors (NTC 12k and others) achieve a higher resolution - typically better than 0.1 °C, but in turn they have a higher measurement absolute error.

13.9 Protection of electrical wiring, the characteristics of a modular circuit breaker

Tripping characteristics in accordance with the ČSN EN 60898 standard:

Tripping characteristics B, short-circuit release 3 ÷ 5 I_n (resistive load)
C 5 ÷ 10 I_n (incandescent bulbs, motors)
D 10 ÷ 20 I_n (motors with a heavy start)

characteristics B:

tripping current	tripping time
I_n x 1,13	"fixed non-tripping current" – the circuit breaker must never switch off
I_n x 1,45	"fixed tripping current" – the circuit breaker must switch off within 1 hour
I_n x 2	approx. 30s
I_n x 3	10s (the short-circuit release can already trip)

Breaking capacity is the magnitude of current (short-circuit current) that the circuit breaker is able to switch off repeatedly with no damage (e.g. 6kA, 10kA, 15kA).
All three types of characteristics (B, C and D) differ from each other only by setting the electromagnetic (short-circuit) release. The thermal release area up to the point of the electromagnetic trigger tripping, the shape of the tripping characteristics is identical for all the characteristics.Therefore it is irrelevant from the point of view of long-term loading of the line by small over-current what type of circuit breaker (regarding the tripping characteristics) is used.

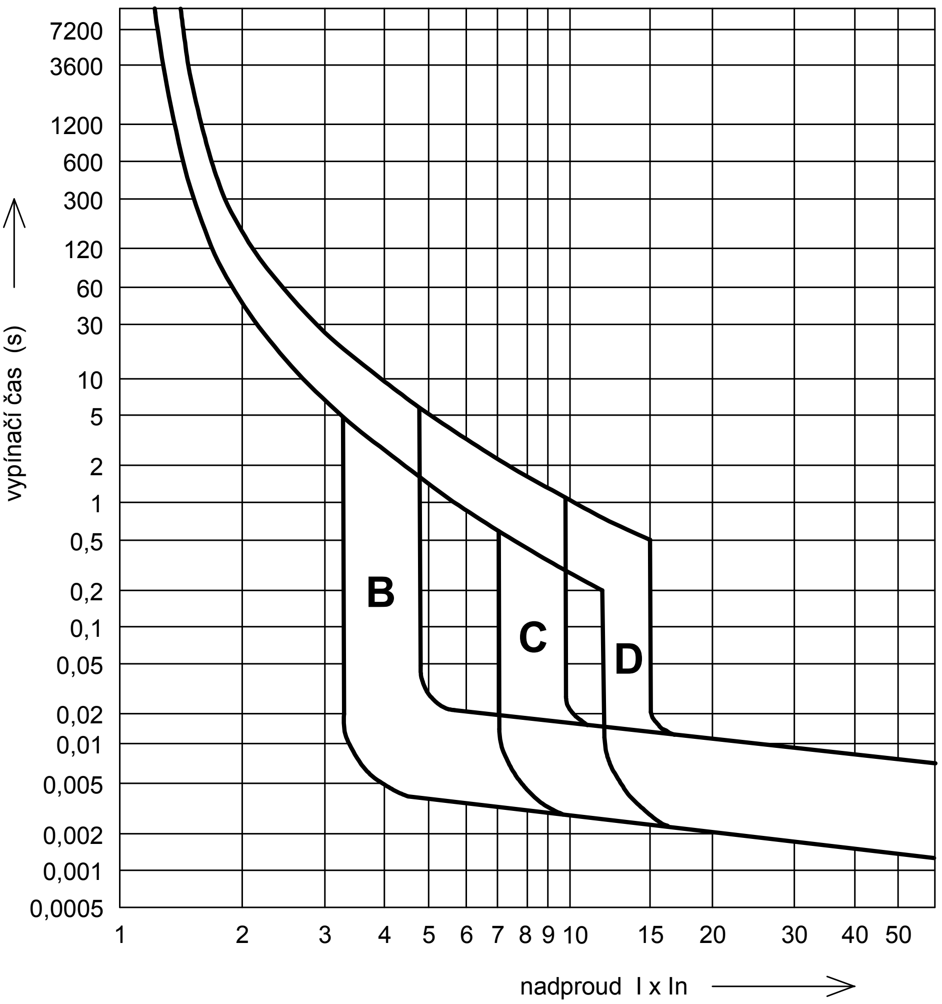


Fig. 13.9.1 Tripping characteristics of modular circuit breakers B, C and D

14 Supplements

The table of contents of the chapter

Chapter 14.1 provides detailed technical information on the CFox and RFox modules. It does not contain all the technical information and it does not replace the essential concise documentation of each individual module, but it contains important information for designing and usage of the modules, which is partly listed also in other documentation, but some only in this manual - both in the next chapter and in the chapters describing specific usage of individual modules.

14.1 An overview and basic examples of connection of the CFox and RFox modules.

The following chapter provides a brief description, an example of connection and possibly also technical details of individual CFox and RFox modules.

The chapter is divided into subchapters according to the name of the module.

A brief explanation of the structure of the CFox and RFox module names:

R-OR-0001B-2A

The type of bus (communication)

R	RF (wireless module)
C	CIB bus
S	simple elements with no bus

Type of module (function)

IB	a module with binary (two-valued) inputs
OR	a relay output module
IR	a module with binary inputs and relay outputs
HM	a combined module (AI, AO, DI, DO)
OS	a module with semiconductor outputs
RC	room control modules
KF	key rings
IL	lighting sensors
IE	sensors for metering electrical current
AQ	air quality sensors
IS	a module with binary inputs and semiconductor outputs
KX	an adapter for the KNX elements
DL	a master DALI bus
HC	a head for the central heating valve
WS	a wall-switch
VT	a fan-control module inVENTer
FC	a control fancoil (revolutions, etc.)
EV	electromagnetic valves control
DM	a dimming module for the lighting
RI	a module for IR control (Rx, Tx)
RQ	a module for scanning the environment in the room (CO_2, PIR, RH, etc.)
AM	a module for metering energies (heat, temperature, flow, electrical power)
WG	Wiegand and other proximity inputs

...

The number of inputs or the serial number in special modules

05 – the module has in total 5 inputs (analogue and binary)

The number of outputs or the serial number in special modules

12 – the module has in total 12 outputs (analogue and binary)

Mechanical version

B	a module for the flush box
M	a module on a DIN rail
I	a module with higher protection (wall-mounted, outdoor version, etc.)
R	a wall-mounted interior module
H	a sensor with a head
T	a table (portable) version
S	a miniature built-in version
F	a free version – in the space (a central heating head, etc.)
W	a version for the 230V mains socket
X	a special mechanism (sheet metal, etc.)

Module versions (optional)

2A	maximum current in the 2A output
A	an aluminium head
P	a plastic head
GIRA	elements on the wall in GIRA design

14.1.1 C-OR-0202B , relay outputs and analogue inputs

The C-OR-0202B module is equipped with 2 relays with a switching contact, each is separately terminated with insulated conductors, their length is approx. 100mm. Continuous current in each 16A output, switching inrush current up to 80A (maximum 20ms, it only applies to the NO1 switching contact,) – see more detailed information about the relays used). The module is in a plastic box in the version for the flush box (built-in design).

The module is designed for switching the capacitive (electronic power supplies for LED lamps, switching power supplies, etc.) and inductive loads. The changeover contacts can be used for secure three-point control of e.g. blinds motors, actuators, etc. (Switching both outputs simultaneously is impossible).

The module is also equipped with two universal inputs. Each input can be configured for one of the ranges: The sensors Pt1000, Ni1000, NTC 12k, NTC generally up to 160kΩ, the KTY81-121, a potential-free contact.

The module is powered directly from the CIB bus.

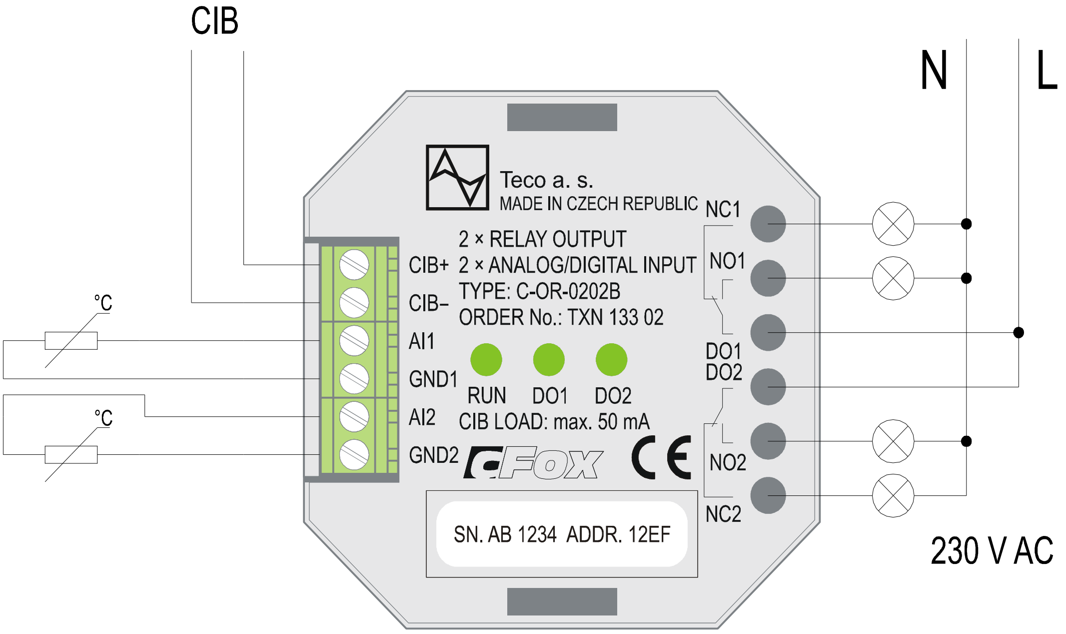


Fig. 14.1.1.1. The basic connection of the C-OR-0202B module

Notes:

1. The isolation voltage between the outputs and Internal circuits is 4,000VAC.
2. The isolation voltage among groups is 4,000VAC.
3. The isolation voltage between contacts is 1,000VAC.
4. Inductive load is dealt with (if necessary) by an external element: an RC member, a varistor, a diode (DC), see the Interference suppression, Chap. 13.7.3.
5. The relay outputs are terminated by insulated wires (black) with a stranded core with the cross-section of 1.5mm^2 (CYA 1.5), the length approx.100mm, terminated with a pressed-on sleeve without a collar.
6. The CIB and both universal inputs are terminated on a fixed cage terminal block.

14.1.2 The R-OR-0001B, a 230VAC relay output

The R-OR-0001B module is equipped with 1 relay with a switching contact and a 230VAC switching output. Both the power supply and the output of the module are terminated by 100mm long insulated wires. Continuous current on each output is 16A, brief inrush current up to 80A (for max. 20ms) - see more detailed information about the relays used. The module is in a plastic box in the version for the flush box (built-in design).

The module is designed to switch the capacitive (electronic power supplies for LED lamps, switching power supplies, etc.) and inductive loads. It is also suitable to switch 1ph sockets.

The module is powered directly from the 230VAC grid.

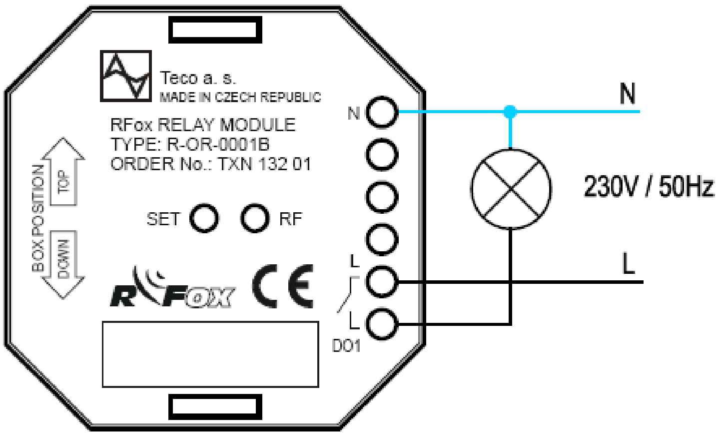


Fig. 14.1.2.1. The basic connection of the C-OR-0001B module

Notes:

1. The grid power supply voltage (L) is switched directly on the DO1 output, and it also powers the module internal circuitry.
2. The isolation voltage between the outlet contacts is 1,000VAC.
3. Inductive load is dealt with (if necessary) by an external element: an RC member, a varistor, a diode (DC), see the Chapter Interference suppression, application of interference suppression elements.
4. The module is designed for assembly in the flush box - a deep box under the socket, or in an independent standard box KU68, etc.
5. The contact of the relays used is 16A for continuous current, an inrush current up to 800A.
6. The module inputs and outputs are terminated by insulated wires with a stranded core with the cross-section of 1.5mm^2 (CYA 1.5), the length approx.100mm, terminated with a pressed-on sleeve without a collar.

14.1.3 The C-LC-0202B, a module for lighting control

The C-LC-0202B module is equipped with 2 relays with a switching contact; each is separately terminated by approx. 100mm long insulated wires. Continuous current in each output is 16A, inrush current up to 800 A (max. for 200 μs) – see more detailed information on the relays used).). The module is in a plastic box in the version for the flush box (built-in design).

The module is designed to switch the capacitive (electronic power supplies for LED lamps, switching power supplies, etc.) and inductive loads.

The module is also equipped with two binary inputs, which are served during normal operation as standard binary inputs, but if the module is powered and there is no communication (the system is not programmed yet, or it is faulty), the inputs control directly the relay outputs. This enables the local function of the one-touch control of lighting (the DI1 input controls the DO1 output, the DI2 input controls the DO2 output).

The module is powered directly from the CIB bus.

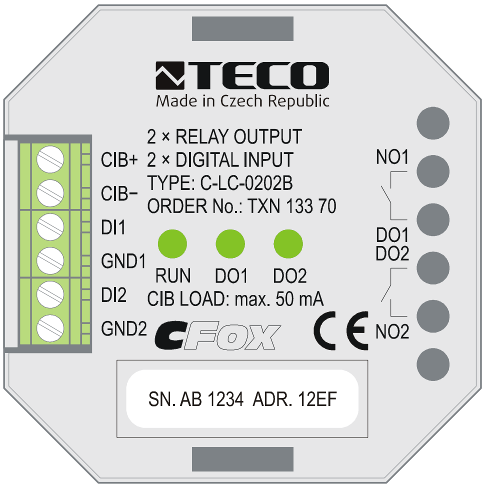


Fig. 14.1.31. The C-LC-0202B module

Notes:

1. The isolation voltage between the outputs and Internal circuits is 4,000VAC.
2. The isolation voltage among groups is 4,000VAC.
3. Inductive load is dealt with (if necessary) by an external element: an RC member, a varistor, a diode (DC), see the Chapter Interference suppression, application of interference suppression elements.
4. The relay outputs are terminated by insulated wires (black) with a stranded core with the cross-section of 1.5mm^2 (CYA 1.5), the length approx.100mm, terminated with a pressed-on sleeve without a collar.
5. The CIB and both universal inputs are terminated on the terminal block.

14.1.4 The C-JC-0201B, a module for blinds control

The C-JC-0201B module is equipped with one output intended for standard blinds control - i.e. the so-called three-point-control: opening-idle-closing. The module can also be used for three-point valve control, etc. The module is internally equipped with 2 relays with a fixed connection for blinds control via terminated 100mm long insulated wires. Continuous current on each output is 16A, see detailed information about the relays used). The module is in a plastic box in the version for the flush box (built-in design).

The module is suitable for switching inductive loads.

The module is also equipped with two binary inputs, which are served during normal operation as standard binary inputs, but if the module is powered and there is no communication (the system is not programmed yet, or it is faulty), the inputs control directly the output of the blinds. This enables a local function of blinds control (the DI1 input controls the DO1 output, the DI2 input controls the DO2 output).

The module is powered directly from the CIB bus.

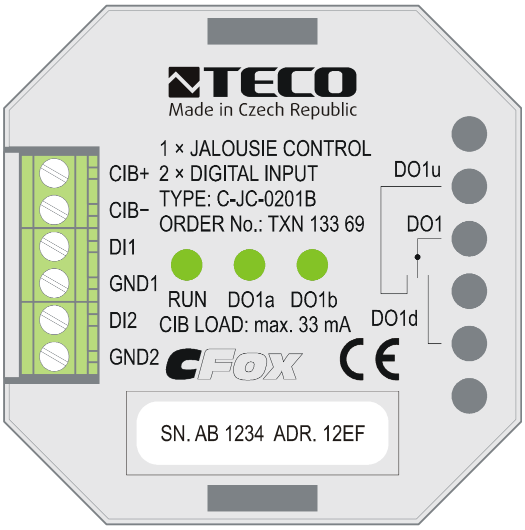


Fig. 14.1.4.1. Modul C-JC-0201B

Notes:

1. The isolation voltage between the outputs and Internal circuits is 4,000VAC.
2. The isolation voltage among groups is 4,000VAC.
3. Inductive load is dealt with (if necessary) by an external element: an RC member, a varistor, a diode (DC), see the Chapter Interference suppression, application of interference suppression elements.
4. The relay outputs are terminated by insulated wires (black) with a stranded core with the cross-section of 1.5mm^2 (CYA 1.5), the length approx.100mm, terminated with a pressed-on sleeve without a collar.
5. The CIB and both binary inputs are terminated on the terminal block.

14.1.5 The C-OR-0008M, relay outputs

The C-OR-0008M module is equipped with 8 relays; each is separately terminated with a changeover contact. Continuous current on each output is 16A, inrush current up to 80A (for max. 20 ms, it applies ONLY for the switching contact)- see the details on the relays used. The module is in a 6M box.

The module is designed to switch the capacitive (electronic power supplies for LED lamps, switching power supplies, etc.) and inductive loads.

The changeover contacts can be used for secure three-point control of e.g. blinds motors, actuators, etc. (Switching both outputs simultaneously, e.g. if the programme is not correctly configured, is mechanically ruled out).

The module can be powered directly from the CIB (its power input limits the number of modules on one branch of the bus), or it can be powered from a separate 24VDC supply (which can be used for multiple modules placed immediately next to each other); then the CIB bus is not loaded. When the module is powered directly, it is necessary to make sure that the module supply voltage is not lower than the voltage of the CIB bus connected to the module, otherwise the module will start drawing supply current from the CIB bus. This does not harm the module, but the CIB bus will be unnecessarily loaded.

Isolation voltage:

between individual connectors and between the DO1 and DO2 outputs is 4,000VAC (safe isolation of circuits),

among the DO3, DO4 and DO5 outputs, the isolation voltage is 1,000 VAC,

among the DO6, DO7 and DO8 the isolation voltage is 1,000VAC,

The module is fitted with a relay with a 16A continuous current and terminal blocks with a maximum wire cross-section 4mm^2.

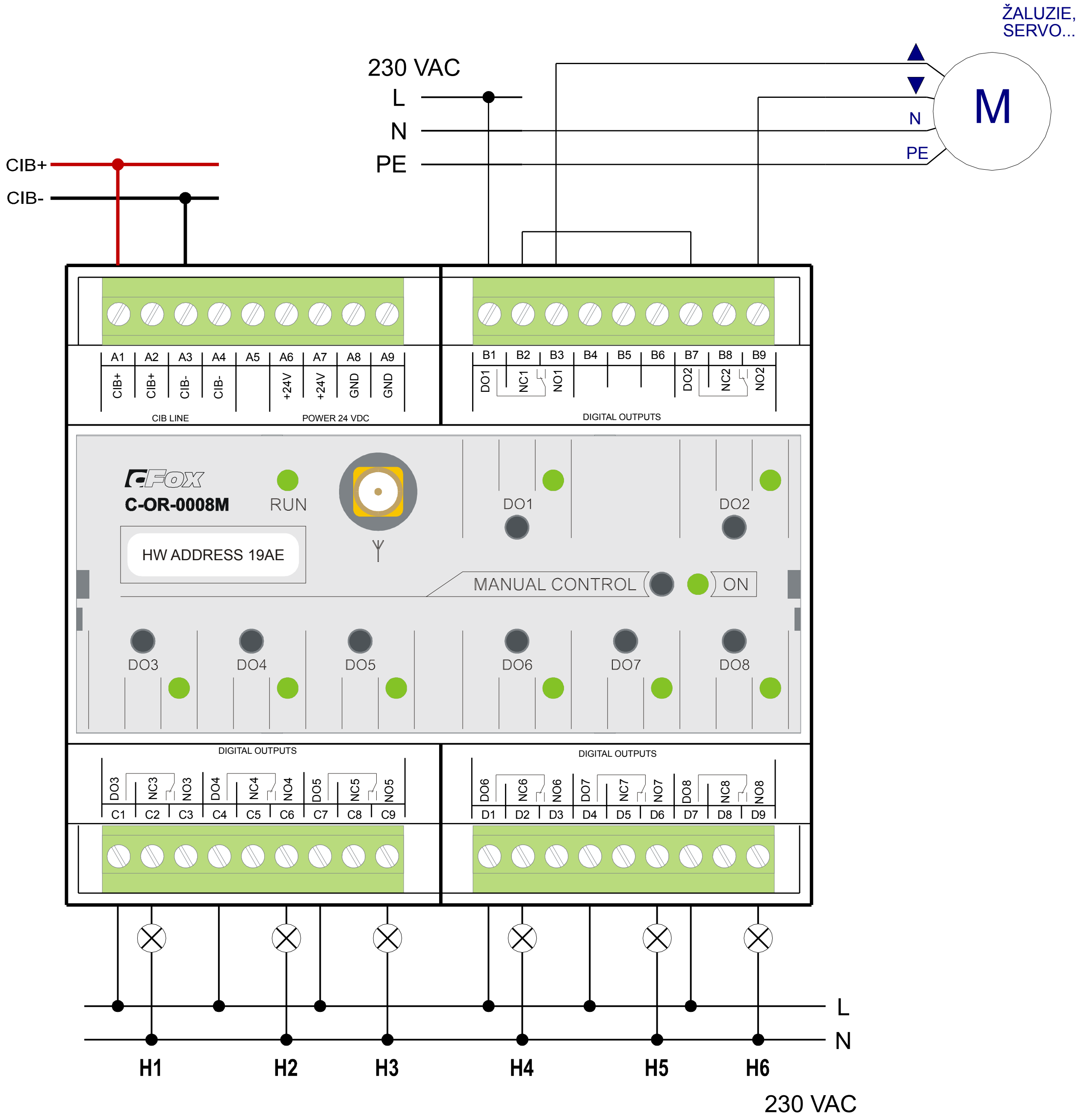


Fig. 14.1.5.1. The basic wiring of the C-OR-0008M module

14.1.6 The R-OR-0008M, relay outputs

The R-OR-0008M module is functionally fully consistent with the C-OR-0008M module (identical inputs, outputs). The only difference is in communication. The module is in a wireless version – a periphery module of the RFox network.
It is powered from a 24VDC supply (similarly to the C-OR-0008M module).
The label C-OR-0008M shows an SMA connector for external antenna, which is also in the R-OR-0008M module.

14.1.7 The C-OR-0011M-800, relay outputs

The C-OR-0011M-800 module is equipped with 11 relays, separately terminated, with a switching contact. Continuous current in each output is 16A, brief switching current up to 800 A (max. for 200 µs) – see detailed information on the relays used).). The module is in a 6M box on a DIN rail.

The module is designed to switch the capacitive (electronic power supplies for LED lamps, switching power supplies etc.) loads, socket circuits and inductive loads.

The module can be powered directly from the CIB (its power input limits the number of modules on one branch of the bus), or it can be powered from a separate 24VDC supply (which can be used for multiple modules placed immediately next to each other); then the CIB bus is not loaded.

If you connect an external 24V supply to the A6 terminal (or A7, as the terminals are internally connected) and A8 (or A9), the module power supply will be automatically switched to the source connected to these terminals. To switch the power supply, a higher voltage than 19.2V must be brought to the A6 terminal.

External 24VDC power supply (the A6 or A7 terminal).	19.2 ÷ 30VDC
Maximum consumption from the 24VDC external power supply connected to the A6 or A7 terminal.	200 mA

Isolation voltage:

among individual connectors and among the outputs divided at least by one free terminal (e.g. DO5, DO6, DO7) is 4,000V AC (safe isolation of circuits),

between the outputs DO1 and DO2 the isolation voltage is 1,000VAC.

between the outputs DO3 and DO4 the isolation voltage is 1,000VAC.

between the outputs DO8 and DO9 the isolation voltage is 1,000VAC.

between the outputs DO10 and DO11 the isolation voltage is 1,000VAC.

The module is fitted with a relay with a continuous current of 16A and terminal blocks with a maximum wire cross-section of the wire 4mm^2.

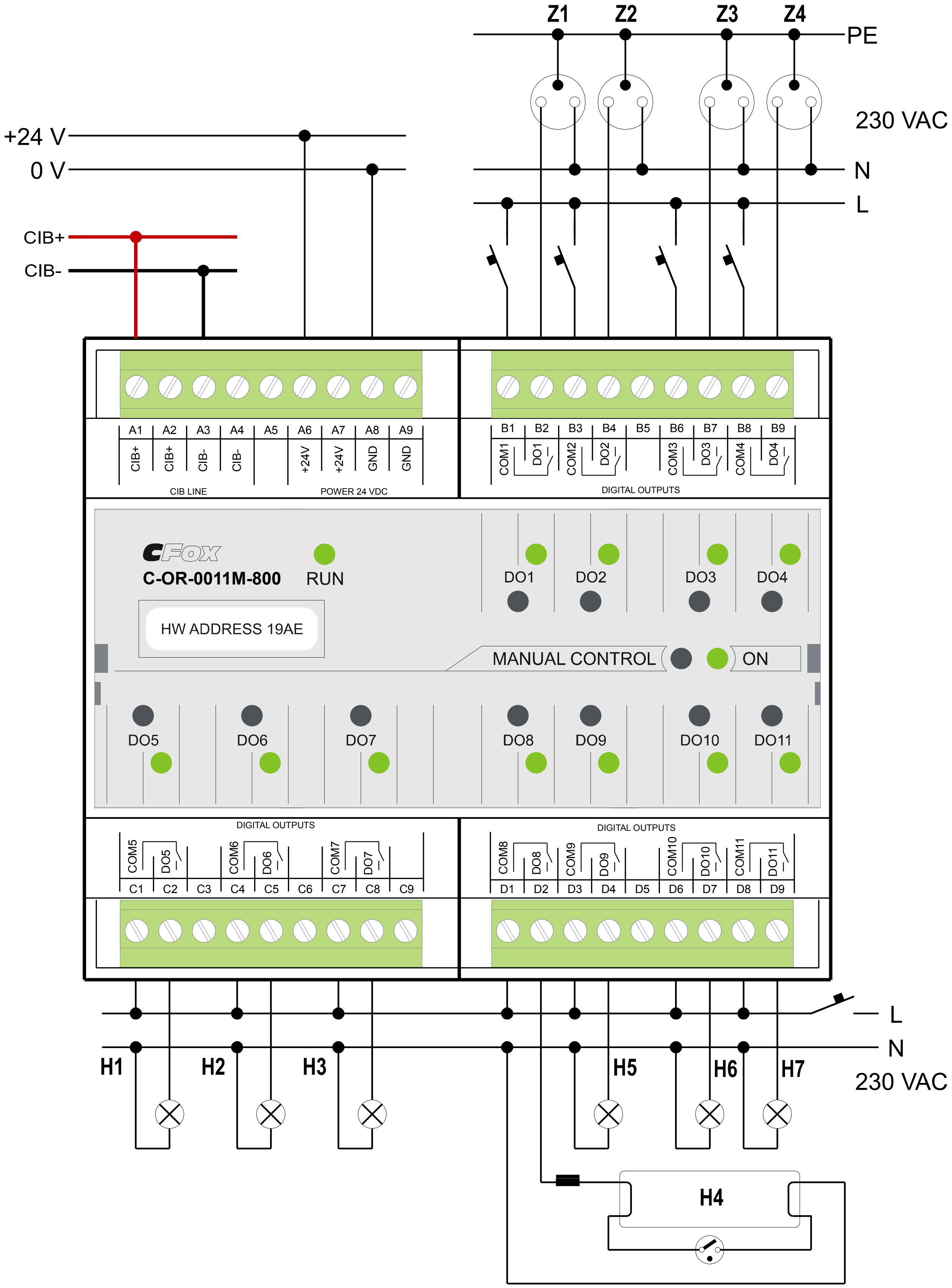


Fig. 14.1.7.1 The basic wiring of the C-OR-0011M-800 module

14.1.8 The C-JC-0006M

The C-JC-0006M module is equipped with6 outputs designed for standard blinds control – i.e. the so-called three-point-control: opening-idle-closing. The module can also be used for three-point valve control, etc. The module is internally fitted with 6x2 relays with a fixed connection (including the mechanical blocking of simultaneous switching of both outputs) for blinds control, terminated on the module connectors. Continuous current in each output is 3A, see more detailed information on the relays used). The module is in a4M box on a DIN rail. There are LED indicators on the front panel (indicating the movement up/down) and push-buttons, which allow manual control of shutters if there is a communication breakdown; if it is allowed by the configuration, a switchover to manual mode is also possible during normal operation of the system.

The module is suitable for switching inductive loads, the type of blinds motors; depending on the load it is recommended to supplement the system with protection varistors (not needed for ordinary blinds motors).

The module can be powered directly from the CIB (its power input limits the number of modules on one branch of the bus), or it can be powered from a separate 24VDC supply (which can be used for multiple modules placed immediately next to each other); then the CIB bus is not loaded.

If you connect an external 24V supply to the A5 and A6 terminals, the module power supply will be automatically switched to the supply source connected to these terminals. To switch the power supply, a higher voltage than 19.2V must be brought to the A5 terminal.

External 24VDC power supply (the A5, A6 terminal)	19.2 ÷ 30VDC
Maximum consumption from the 24VDC external power supply connected to the A5 or A6 terminal.	63mA

Isolation voltage:

between individual connectors is 4,000VAC (safe isolation of circuits),

between the outputs DO1 and DO2 the isolation voltage is 10,00VAC.

between the outputs DO3 and DO4 the isolation voltage is 10,00VAC.

between the outputs DO5 and DO6 the isolation voltage is 10,00VAC

The module is equipped with a relay with continuous current 3A and terminal blocks with a maximum wire cross-section 2.5mm.^{2}

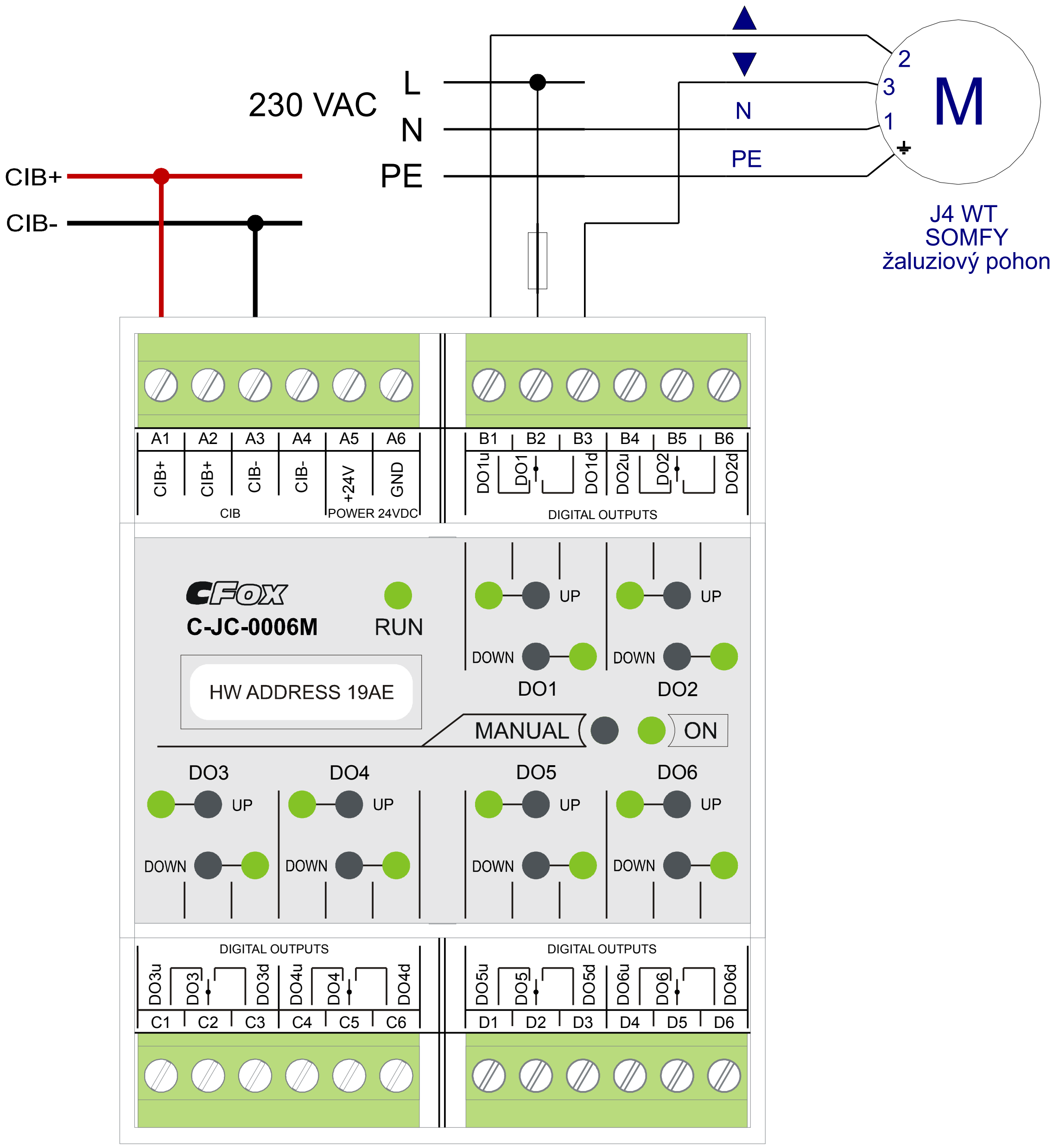
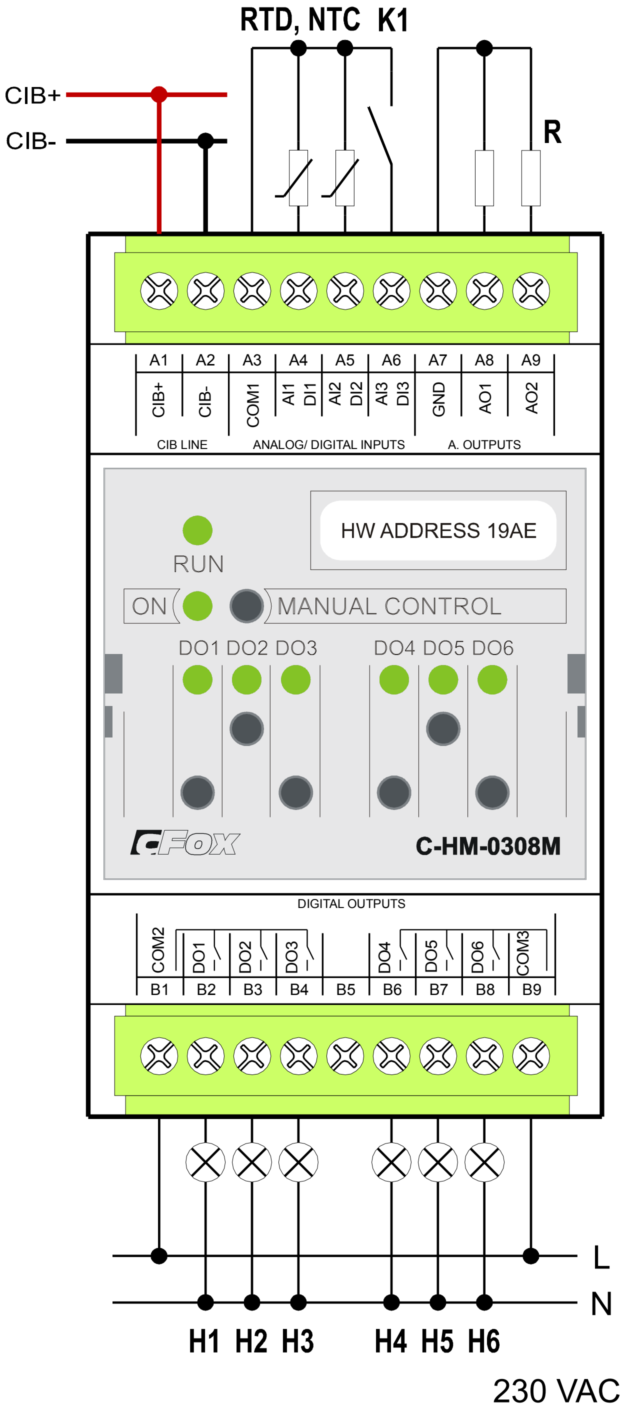


Fig. 14.1.8.1 The basic connection of the C-JC-0006M module

14.1.9 The C-HM-0308M

An example of connection and the conditions of the module usage:



Notes:

1) The analogue inputs AI1 to AI3 are intended for connecting the temperature sensors and condensation sensors. The actual sensor should be connected between the input AI and the reference terminal COM1. The COM1 terminal has the +2.5V reference voltage terminated (opposite the GND terminal).
2) The relay outputs are divided into two groups. Maximum currents and isolating voltages are listed in the following description:

The relay outputs are divided into two groups. The groups are separated from each other and from other circuits by isolation voltage of 3,750VAC, so they meet the conditions of safe isolation of circuits.
It is possible e.g. to switch the 230VAC circuits by the outputs DO1 to D03, and the circuits of safe low voltage can be switched by the DO4 to DO6 outputs.
Each relay output is designed for a maximum continuous current of 3A (short current 5A); a maximum current on the common terminal COM2, or COM3, is 10A.

The relay contacts have a lifetime of approx. 100,000 operations under full load, and a maximum of 20 operations per minute. This must be taken into consideration when using relay outputs. .

The parameters of the connectors used are listed in Chap. 13.3.1

The module is in a 3M box on a DIN rail.

Fig. 14.1.9.1. The basic connection of the C-HM-0308M module

The basic parameters of inputs and outputs. :

The type of input (a connected sensor), the inputs **AI/DI1, AI/DI2, AI/DI3**	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 600kΩ	0 ÷ 630kΩ
Maximum resistance 6MΩ	0 ÷ 6.5MΩ
Voltage 2V	0 ÷ 2.1V
Voltage 1V	0 ÷ 1.05V
Voltage 100mV	0 ÷ 105mV
Voltage 50mV	0 ÷ 52.5mV
The input resistance of inputs for voltage ranges.	1kΩ
Binary input, the current in active input (switched contact)	2.5mA

The analogue outputs AO1, AO2	
Nominal output voltage U_{JM}	10V
Adjustable range of output voltage	0 ÷ 105% U_{JM}
Loading resistance	>1kΩ
Maximum load capacity	50nF

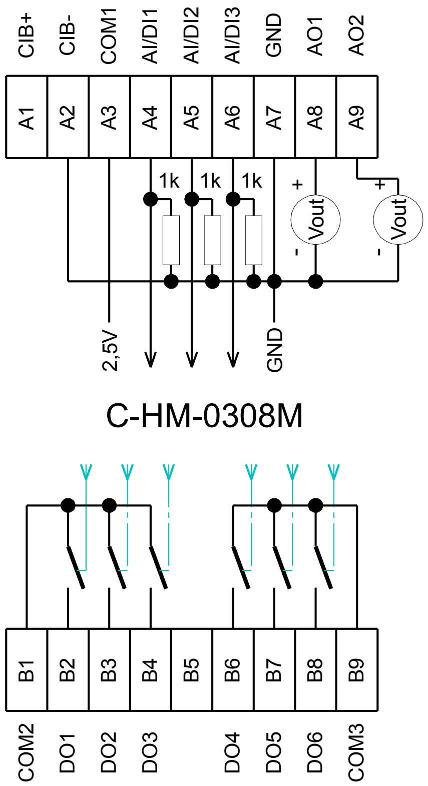


Fig. 14.1.9.2. Internal wiring of the C-HM-0308M module

14.1.10 The C-HM-1113M

An example of connection and the conditions of the module usage:

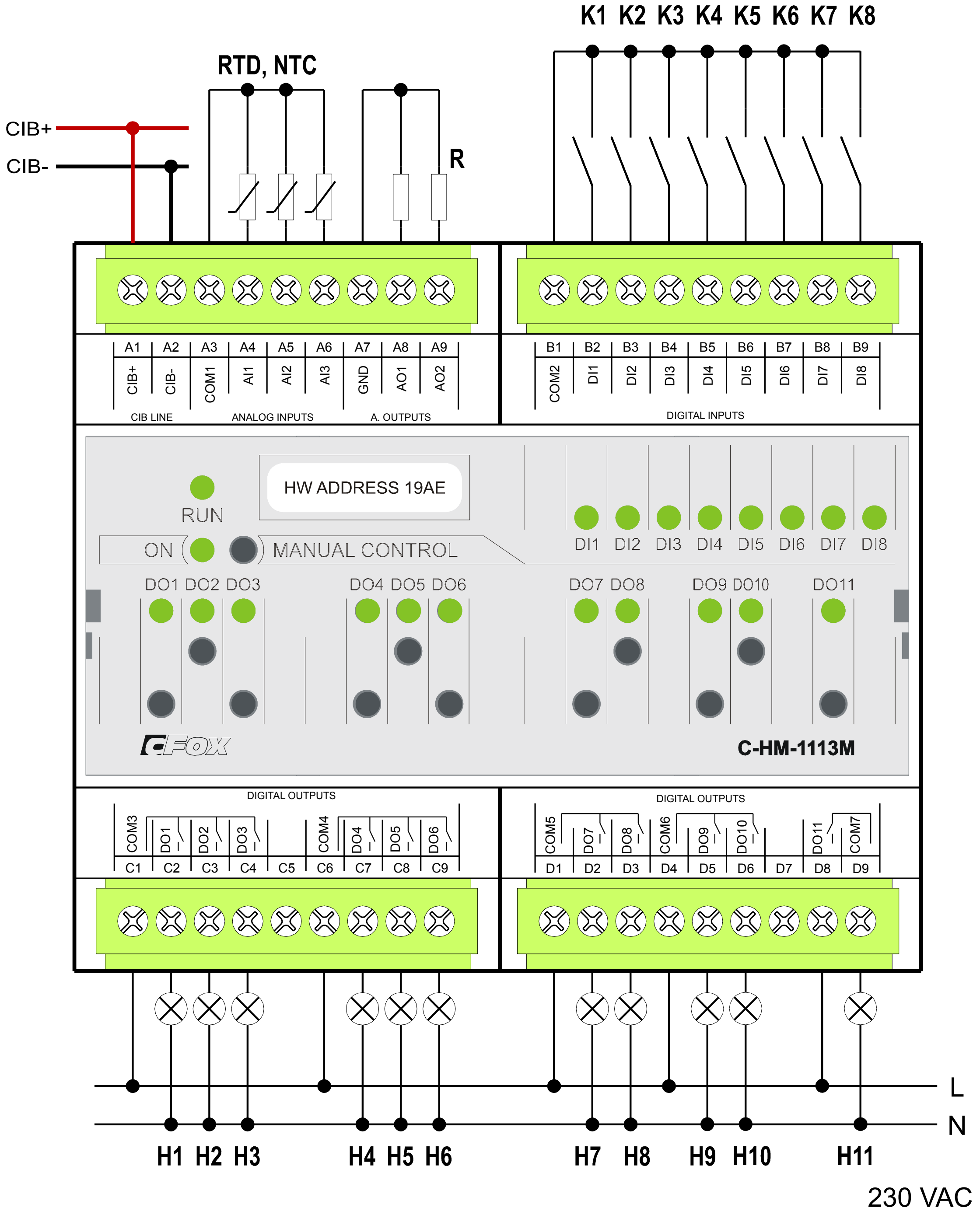


Fig. 14.1.10.1. The basic connection of the C-HM-1113M module

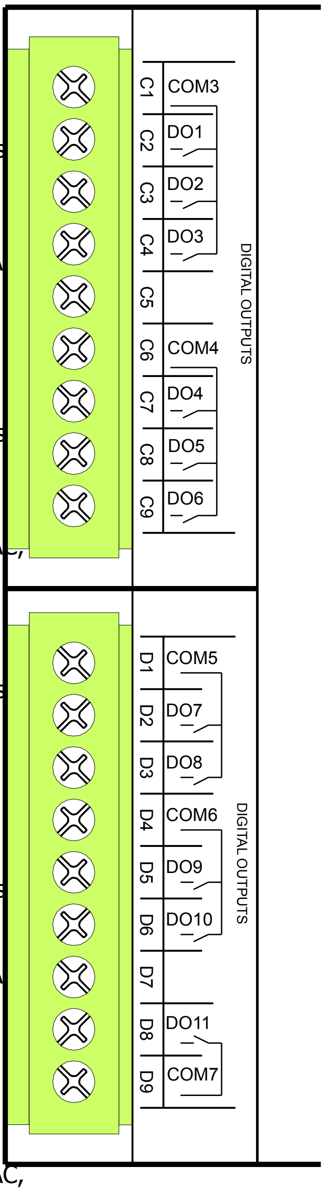
Notes:

1) The DI1 to DI8 inputs are intended only for connecting potential free contacts. The voltage on the COM2 common terminal opposite the GND terminal (analogically also CIB-) is +10V, and the DI inputs with the switched contacts are connected to this reference voltage. When the input is excited, typically 1.5mA current flows through the contact.
2) The analogue inputs AI1 to AI3 are intended for connecting the temperature sensors and condensation sensors. The actual sensor should be connected between the input AI and the reference terminal COM1. The COM1 terminal has the +2.5V reference voltage terminated (opposite

the GND terminal).

3) The relay outputs are categorized into groups. Maximum currents and isolating voltages are listed in the following description:

The relay outputs of the C-HM-1113M module:



The DO1÷DO3, outputs with a common terminal, continuous current in the 3A output, inrush current 5A, maximum continuous current on the common terminal COM3 is
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VA
i.e. safe isolation of circuits.

The DO4÷DO6, outputs with a common terminal, continuous current in the 3A output, inrush current 5A, maximum continuous current on the common terminal COM4 is
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VA
i.e. safe isolation of circuits.

The DO7, DO8, outputs with a common terminal continuous current in the 3A output, inrush current 5A, maximum continuous current on the common terminal COM5 is
more detailed information on the relay contacts

There is only 1750 VAC working isolation among these groups

The DO9, DO10, outputs with a common terminal continuous current in the 3A output, inrush current 5A, maximum continuous current on the common terminal COM6 is
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VA
i.e. safe isolation of circuits.

The DO11, a separate output, switching contact, continuous output current 10A (also loads DC13, AC15), short-term overloading 160A (max. 10ms)

isolation voltage from the other circuits and outputs is 3,750VAC, i.e. safe isolation of circuits.

Except for the output groups DO7, DO8 and DO9, DO10 (which are isolated only by working isolation), individual groups of outputs can arbitrarily switch low voltage circuits (even different phases) and the circuits of small safe voltage. Only groups DO7, DO8 and DO9, DO10 must be powered from a single phase, and both must be used either for circuits of small safe voltage, or low voltage in the same phase.

The relay contacts under full load have a lifetime of 100,000 operations, and the maximum number of operations per minute is 20 (DO11 only 6 operations per minute). This must be taken into consideration when using relay outputs. .

The parameters of the connectors used are listed in Chap. 13.3.1

The module is in a 6M box.

The basic parameters of inputs and outputs. :

The type of input (a connected sensor), the inputs **AI1, AI2, AI3**	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 600kΩ	0 ÷ 630kΩ
Maximum resistance 6MΩ	0 ÷ 6.5MΩ
Voltage 2V	0 ÷ 2.1V
Voltage 1V	0 ÷ 1.05V
Voltage 100mV	0 ÷ 105mV
Voltage 50mV	0 ÷ 52.5mV
The input resistance of inputs for voltage ranges.	1kΩ

The analogue outputs AO1, AO2	
Nominal output voltage U_{JM}	10V
Adjustable range of output voltage	0 ÷ 105% U_{JM}
Loading resistance	>1kΩ
Maximum load capacity	50nF

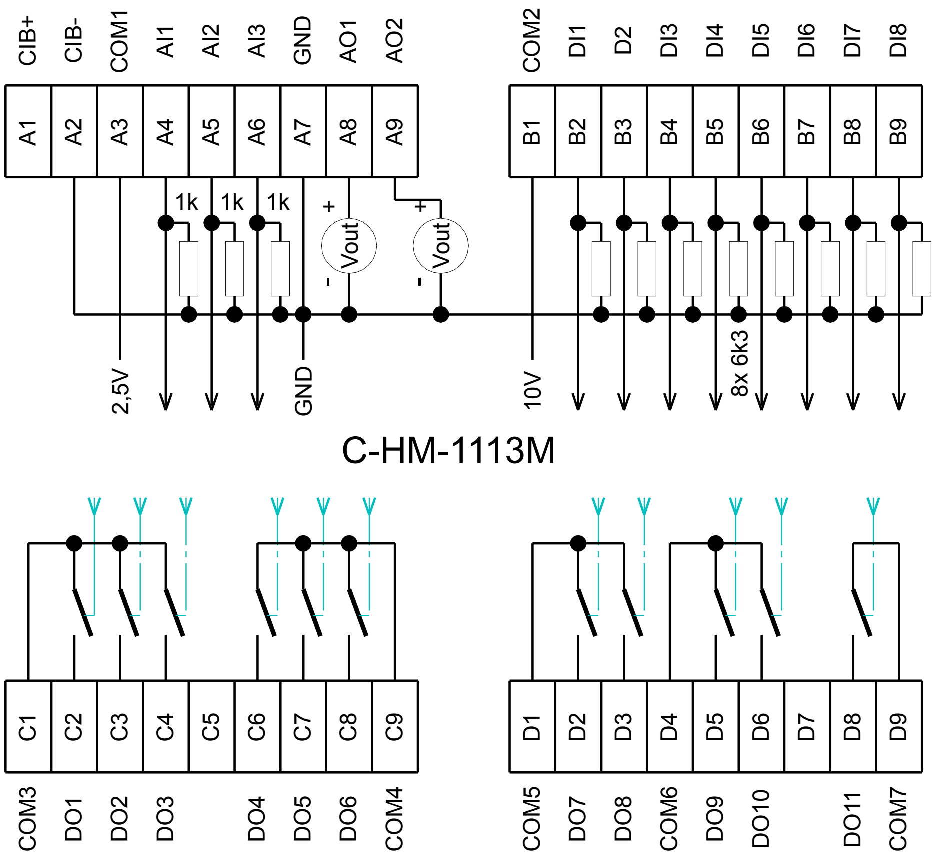


Fig. 14.1.10.2. Internal wiring of the C-HM-1113M module

14.1.11 The C-HM-1121M

An example of connection and the conditions of the module usage:

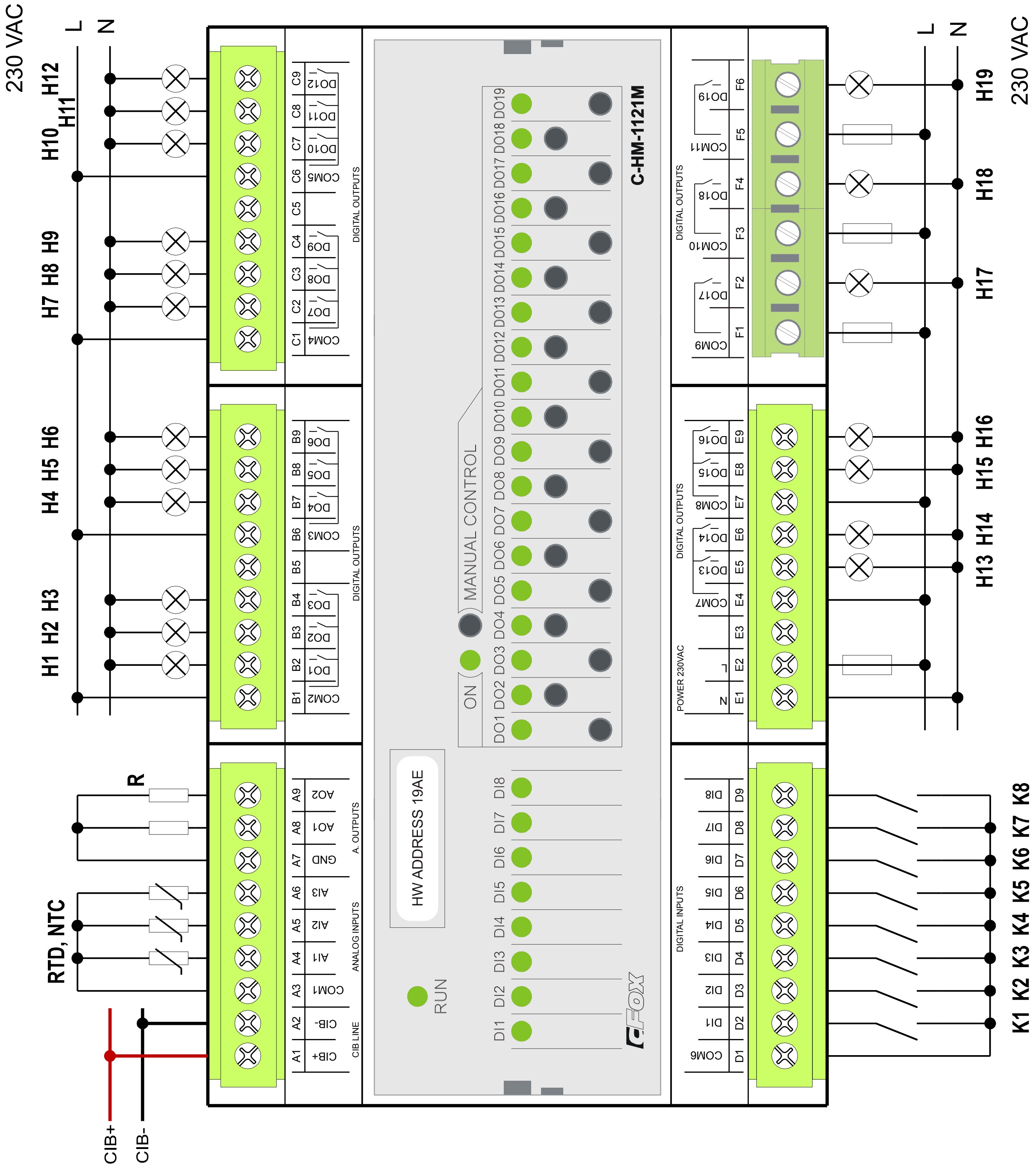
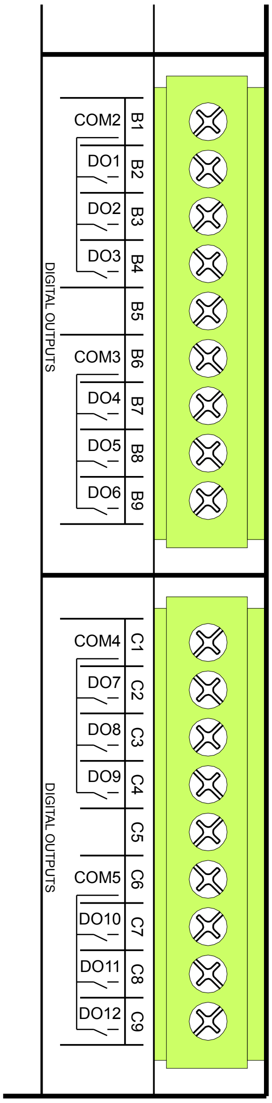


Fig. 14.1.11.1. The basic connection of the C-HM-1121M module

Notes:

1) The DI1 to DI8 inputs are intended only for connecting potential free contacts. The voltage on the COM2 common terminal opposite the GND terminal (analogically also CIB-) is +10V, and the DI inputs with the switched contacts are connected to this reference voltage. When the input is excited, typically 1.5mA current flows through the contact.
2) The analogue inputs AI1 to AI3 are intended for connecting the temperature sensors and condensation sensors. The actual sensor should be connected between the input AI and the reference terminal COM1. The COM1 terminal has the +2.5V reference voltage terminated (opposite the GND terminal).
3) The relay outputs are categorized into groups. Maximum currents and isolating voltages are listed in the following description:

The relay outputs of the C-HM-1121M module:



Connectors B and C

The DO1÷DO3, outputs with a common terminal,
continuous current in the 3A output, inrush current 5A,
maximum continuous current on the common terminal COM2 is 10A,
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO4÷DO6, outputs with a common terminal,
continuous current in the 3A output, inrush current 5A,
maximum continuous current on the common terminal COM3 is 10A,
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

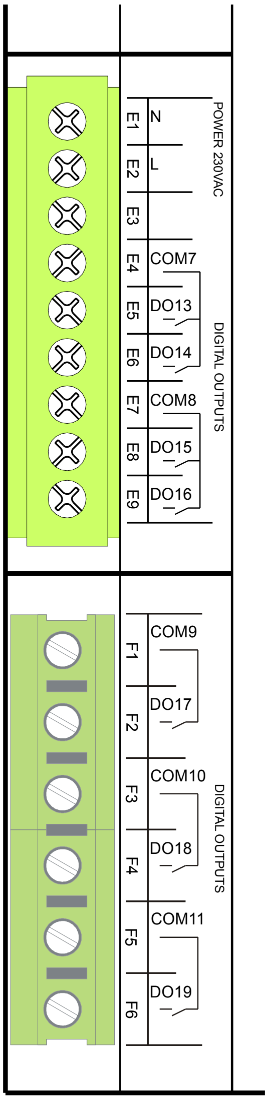
The DO7÷DO9, outputs with a common terminal,
continuous current in the 3A output, inrush current 5A,
maximum continuous current on the common terminal COM4 is 10A,
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO10÷DO12, outputs with a common terminal,
continuous current in the 3A output, inrush current 5A,
maximum continuous current on the common terminal COM5 is 10A,
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The E connector and F terminal block



supply terminals of the module, supply voltage is 230VAC

isolating voltage from other circuits and outputs is 3,000VAC,
i.e. safe isolation of circuits.

The DO13, DO14, outputs with a common terminal
continuous current in the 3A output, inrush current 5A,
maximum continuous current on the common terminal COM7 is 10A

There is only 1750 VAC working isolation among these groups

The DO15, DO16, outputs with a common terminal
continuous current in the 3A output, inrush current 5A,
maximum continuous current on the common terminal COM8 is 10A

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO17, a separate output, switching contact,
continuous output current 16A (also the load DC13, AC15),
short-term overloading 160A (max. 10ms)

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO18, a separate output, switching contact,
continuous output current 16A (also the load DC13, AC15),
short-term overloading 160A (max. 10ms)

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO19, a separate output, switching contact,
continuous output current 16A (also the load DC13, AC15),
short-term overloading 160A (max. 10ms)

Except for the output groups DO13, DO14 and DO15, DO16 (which are isolated only by working isolation), individual groups of outputs can arbitrarily switch low voltage circuits (even different phases) and the circuits of small safe voltage. Only groups DO13, DO14 and DO15, DO16 must be powered from a single phase, and both must be used either for circuits of small safe voltage, or low voltage in the same phase.

The relay contacts under full load have a lifetime of approx. 100,000 operations, and the maximum number of operations per minute is 20 (DO17 DO18 DO19 only 6 operations per minute). This must be taken into consideration when using relay outputs. .
More detailed information on the contacts of relays DO13 to DO16.

The parameters of the connectors used (except for the terminal block F) are stated in Chap. 13.3.1
The parameters of the F terminal block are stated in Chap. 13.3.2
The module is in a 9M box.

The parameters of the analogue inputs and outputs (including their internal wiring) are consistent with the C-HM-1113M module (see the previous chapter).

14.1.12 The R-HM-1113M

The R-HM-1113M module is functionally fully consistent with the C-HM-1113M module (the inputs, outputs). The only difference is in communication. The module is in a wireless version – a periphery module of the RFox network.
It is supplied from a 24VDC power supply, which is connected to the A1 and A2 terminals (the C-HM-1113M module has a CIB interface in these terminals).
An SMA connector for an external aerial is terminated on the label of R-HM-1113M.

14.1.13 The R-HM-1121M

The R-HM-1121M module is functionally fully consistent with the C-HM-1121M module (the inputs, outputs). The only difference is in communication. The module is in a wireless version – a periphery module of the RFox network.
It is powered from a 230VAC power supply as the C-HM-1121Mmodule.
An SMA connector for an external aerial is terminated on the label of R-HM-1121M.

14.1.14 The C-IR-0203M (order no. TXN 133 59)

The C-IR-0203M is a module on the CIB bus, which comprises of two universal analogue or binary inputs, two relay outputs with a changeover contact (each is separately terminated) and one output optionally adjustable as analogue, with the range from 0 to 10V, or with a PWM output with adjustable amplitude and frequency.
The C-IR-0203M is implemented in a 1.5M box (dimensions $1^1/_2$ of a single-phase circuit breaker) on a DIN rail.

Basic parameters of the analogue inputs and outputs:

The type of input (connected sensor), inputs **AI/DI1, AI/DI2**	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 160kΩ	0 ÷ 160kΩ
Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	The loop resistance 2x 1k1

An analogue output AO1	Range 0÷ 10V	Range PWM
Nominal output voltage U_{JM}	10V	-
The output signal amplitude	-	10 ÷ 24V
Adjustable range of output voltage	0 ÷ 130% U_{JM}	-
The frequency of PWM output	-	100 ÷ 2000 Hz
Loading resistance	>1kΩ	
Maximum load capacity	50nF	
Galvanic isolation of the output from CIB	No	

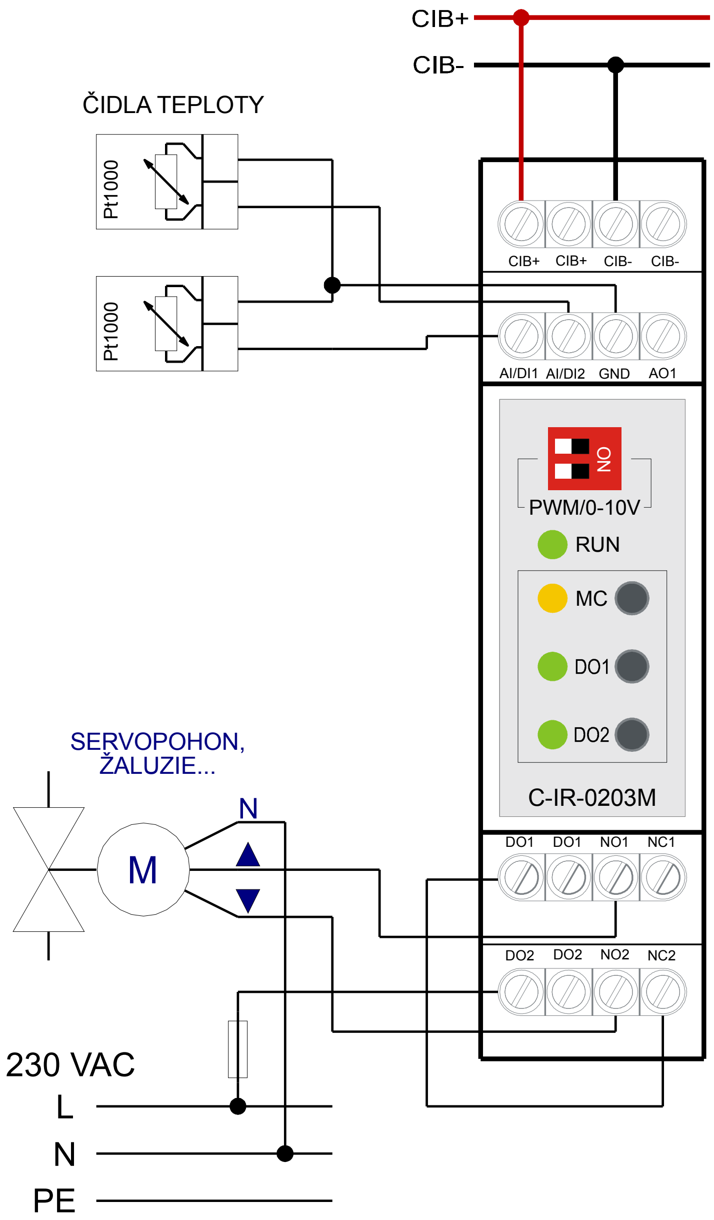
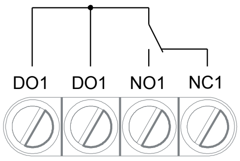


Fig. 14.1.14.1 An example of wiring the C-IR-0203M module.

Notes:

1. The relay outputs DO1 and DO2 are fitted with relays with changeover contacts 16A
2. The analogue output AO1 can be configured by a switch on the front panel either as a standard output 0 ÷ 10V, or as an active output PWM with adjustable frequency1 00 Hz to 2 kHz and with the amplitude 10 to 24 V.

Connecting the changeover contact.
of the relays on the module



terminals

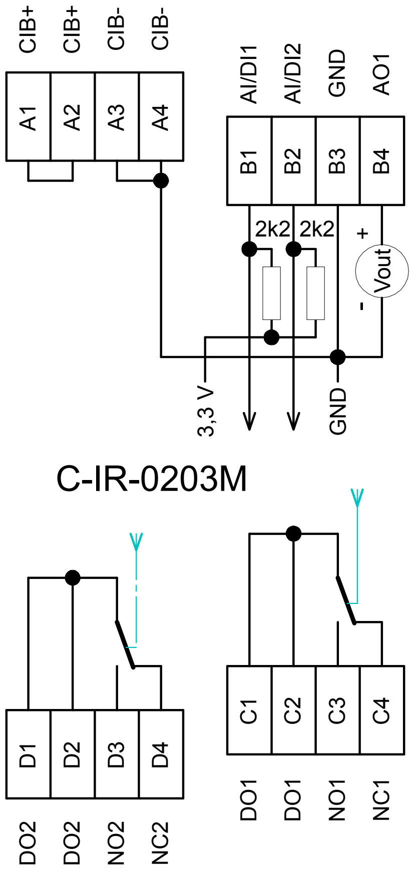


Fig. 14.1.14.2 Internal wiring of the C-IR-0203M module

Notes:

1. The range AO1 (0 to 10V or PWM) is set via the jumpers on the front panel and in the software configuration.

14.1.15 The C-DM-0006M-ULED

A module for voltage-controlled dimming of LEDs, typically LED strips.

The supply voltage of 12 or 24V should be selected with regard to the LED light source used (LED strips). The outputs for LED strips have a **common positive power supply pole** (anode) labelled as LED +. In LED+ outputs it is necessary to keep the maximum current of a single terminal at 10A.
An example of the module connection is provided in Chapter 6.3.1 Dimming RGB, monochrome and two-colour LED strips.

There are more and more LED strips emerging on the market, which are designed to be powered by nominal current (they achieve higher efficiency than the strips powered by nominal voltage). These strips must not be connected to the outputs of the C-DM-0006M-ULED module, as the LEDs could be destroyed! These LED strips powered by nominal current must be dimmed by the C-DM-0006M-ILED module.

Powering the LEDs	A 12 or 24VDC external power supply, 24A max.
The outputs for LED light sources.	
The number of outputs	6
Output voltage	12 or 24V (depending on the power supply source).
A maximum current of one output (LED1 to LED6).	6A
A maximum current in the common terminal (each LED+ terminal).	10A
A maximum total output current consumed from the LED source.	24A
Thermal protection	Yes
Overcurrent and short-circuit protection	NO

NB: - The module is not equipped with overload and short circuit protection. A short circuit on the module's output (terminals LEDx against LED+) will destroy the module.

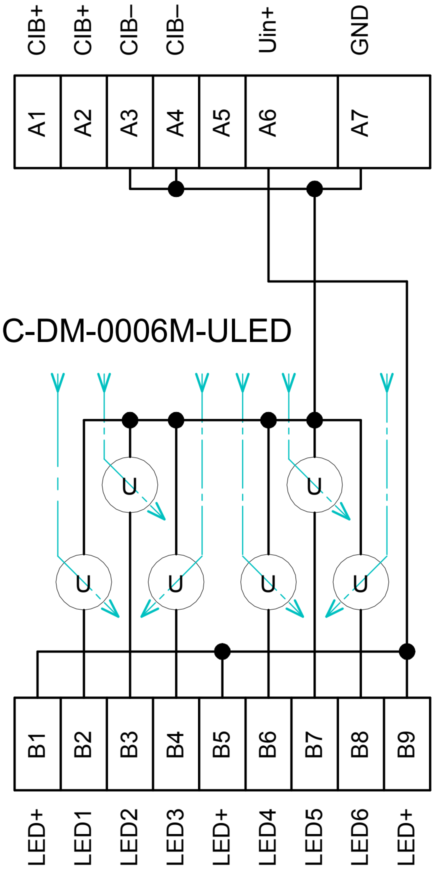


Fig. 14.1.15.2. Internal wiring of the C-DM-0006M-ULED module

14.1.16 The C-DM-0006M-ILED (order no. TXN 133 46)

A module for dimming current-controlled LEDs, typically power LED chips.

The supply voltage (the power supply used) from 4.5 to 48V should be selected with regard to the LED light sources used.
The greater the difference between the power supply voltage and the voltage of the LED lights, the greater the power loss of the module and the bigger the problem with cooling.
E.g. if there are two power chips (1,000mA) with a loss of approx. 3V per chip connected in series to each output, with maximum current at 700mA and power input approx. 2.1W per chip, it is sufficient to power the module from a 12VDC, 4.5A supply, e.g. the MeanWell DR-60-12. For a similar example, see Chapter 6.4.2 An example of dimming power LED CREE chips using the C-DM-0006M-ILED module.
The outputs for LED light sources have a common positive power pole (anode) labelled as LED +.
It is necessary to keep the maximum current of a single terminal at 10A in LED+ outputs.
For an example of connecting the module, see Chapter 6.4.1 Dimming LED with the rated currents: 150, 350, 500 or 700 mA.

Powering the LEDs	External power supply 4.5 ÷ 48.V, 5A max.
The outputs for LED light sources.	
The number of outputs	6
The output current (adjustable individually for each channel)	150mA
	350mA
	500mA
	700mA
A maximum total output current consumed from the LED source.	4.2A
Thermal protection	Yes

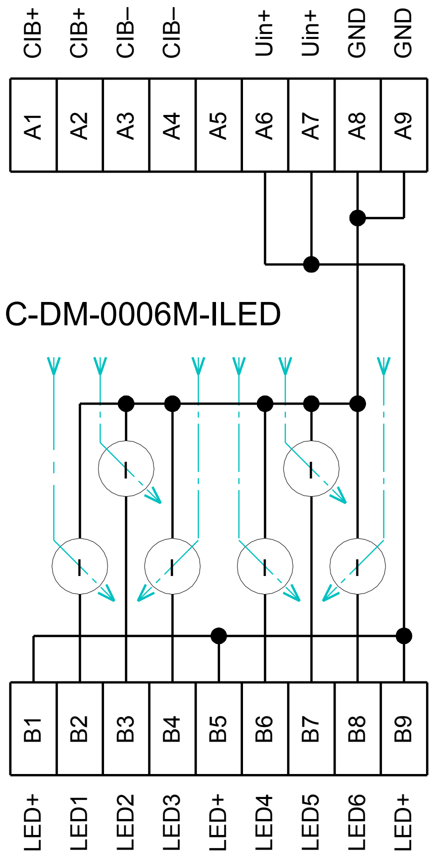


Fig. 14.1.16.2. Internal wiring of the C-DM-0006M-ILED module.

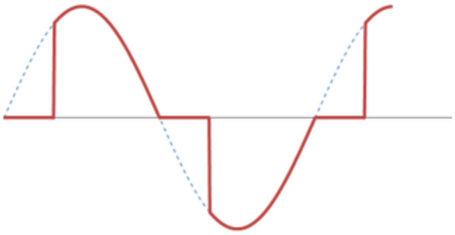
14.1.17 The C-DM-0402M-RLC

The C-DM-0402M-RLC is a dimming module for the CIB bus, fitted with 4 inputs and 2 outputs. The outputs are two independently phase-controlled and managed 230 VAC channels, each for loads up to 500VA. The dimmer and its control algorithm is designed with an emphasis on reliability and immunity to interference in the network, and in particular immunity to interference by the ripple signal.

The dimmer version is RLC, i.e. it can handle both standard resistive load as well as inductive and capacitive loads. The type of load (RL or RC) is set in the software configuration and it is indicated on the front panel by LEDs:

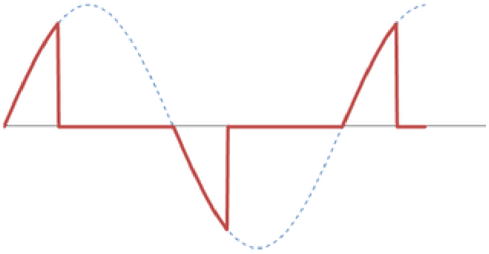
RL - RL - an inductive and resistive load - it is switched on during the half-wave, and switches off at zero.

Typically they are inductive transformers and incandescent bulbs.



RC - a capacitive and resistive load - switching on at zero and switching off during the half-wave: ´

These are usually electronic transformers, dimmable switching power supplies and incandescent bulbs.



LED/CFL – it lights up along with the selected type of load (i.e. it lights together with the RL or RC signalling), if there is a need to limit the dimming range and the parameter MINIMUM (light on threshold) is set on a non-zero value.

The MINIMUM parameter is used to control dimmable compact fluorescent lamps (CFL) or LED bulbs due to an inability to function from the zero output voltage - if the dimmer output is set to a smaller than recommended value of MINIMUM, they behave abnormally, flash, etc. The type of load that should usually be set for these sources is **RL**.

Dimming of various types of sources.
Incandescent bulbs can be dimmed up to the full power input of 500VA; a parallel operation can also be utilized up to the overall power input of 2,000 VA (see the following paragraph).

LED bulbs can be dimmed up to a total power input of 250VA; dimming multiple LED bulbs connected in parallel is possible up to 16 pieces, but what must be taken into account are the technical parameters defined by the manufacturer (a limit for the number of simultaneously dimmed bulbs).

Compact fluorescent lamps (CFL) can be dimmed up to a total power input of 250VA.

Inductive transformers can be used up to the 250VA power input, provided the minimum continuous load is 80% of the transformer nominal power output.

The stated inputs are valid for the 230VAC network. In the case of using dimmers in the 110VAC (50 or 60Hz) network, all power outputs and inputs are only half!

Dimming higher power.

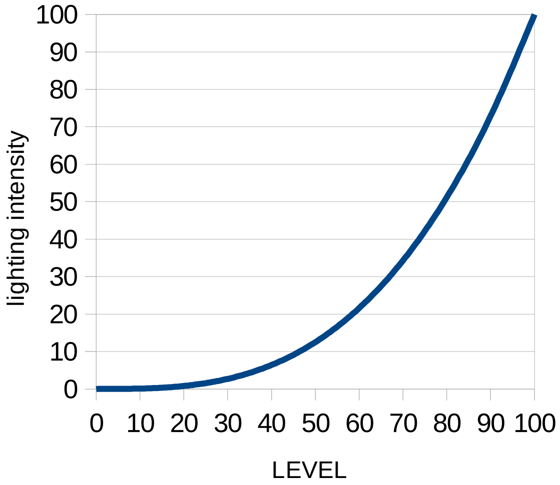
The C-DM-0402M-RLC dimmer is prepared for parallel operation of up to 4 channels, so it can dim loads up to 2kVA (valid only for resistive loads - incandescent and halogen bulbs). It is possible to connect in parallel two channels (1kVA output), three channels (1.5kVA) and maximum 4 channels with a total dimmed output of 2kVA.

The modules must always be on the same CIB branch (thus taking care of their mutual synchronization).

From the perspective of the power load, which causes warming of the modules, it is preferable to spread the load evenly among the modules; i.e. if there is 1 lamp with a 900A power input and 2 lamps with a 60VA power input, is would be appropriate to combine two channels of two separate dimmers for the 900VA output (e.g. OUT1 outputs of both modules) and to use the second channel of each dimmer (OUT2) for the 60VA load, then each C-DM-0402M RLC module would be loaded with max. 510VA, which would significantly reduce the thermal load of each dimmer module.

The output curve.

There are two optional characteristics implemented in the dimmer: either linear, or logarithmic dimming characteristics (see the curve in the chart on the right); the second one reflects better a great sensitivity of human sight in minimum light intensity, so the light intensity control is more pleasant for your eyes.



The **front panel** contains an indication of CIB bus communication labelled RUN, as well as control and indication of the manual function control. The transition to the manual mode during a standard operation of the module can be made by pressing the button, and the switching to manual mode is indicated by a yellow LED. This control can be disabled in the configuration of the module. Furthermore, each channel has a push-button on the panel, which switches the channel on in the manual mode (100% intensity) or off (0%).

The ON and ERR indication informs you about the current status of each channel, e.g. that one of the protection elements has tripped - the thermal protection or the overload protection.

The dimmer module has also 4 universal inputs AI/DI. You can connect dry contacts, resistive temperature sensors or double balanced loops with intrusion (ESS) detectors . Their functionality is enabled by the user program and it is not directly related with dimmer function.

The parameters of the AI/D inputs:

The input type (sensors):	Binary, PT1000, Ni1000, NTC12k, KTY81-121, 160k, balanced inputs
Binary inputs	Log0: >1.5kΩ, log1: <0.kΩ
Balanced inputs	2x 1.1kΩ (see Chapter 13.8.4)
The PT1000 input	-90 °C ÷ +320 °C

The Ni1000 input	-60 °C ÷ +200 °C
The NTC12k input	-40 °C ÷ +125 °C
The KTY81-121 input	-55 °C ÷ +125 °C
The resistance input	0 ÷ 160kΩ

Synchronization of lighting scenes control .

If you require synchronization of multiple independently dimmable light sources (sync-controlled lights according to pre-programmed scenes, etc.), you can use the C-DM-0402M-RLC module, which provides their automatic synchronization within one CIB branch. The synchronization ensures that the commands (the requirement for the brightness value) to all modules are executed at the same time. This only applies to one CIB branch, i.e. a maximum of 32 C-DM-0402-RLC modules.

Operating temperature and warming up of the C-DM-0402M-RLC module.

The module is heated during the operation by the heat dissipated due to the load management, which is proportional to the dimming power of both channels and the nature of dimming.
It is equipped with an internal controlled fan, which is automatically switched on if the internal temperature is increased, and provides sufficient ventilation until the maximum allowable ambient temperature of 55 °C is reached.
The module is also equipped with **internal thermal protection**, which reduces the output level of both channels if the temperature inside the module reaches 70 °C. This prevents thermal damage of the module and does not immediately and completely put the lighting out of operation. The thermal overload is indicated in the status of the module and it can be announced to the user, or the system can react differently. Should the temperature rise further, the module is switched off completely, and after the internal temperature decreases again, it resumes its standard function.

A stable operation of the module is ensured by defining a **maximum ambient temperature**, which 55 °C.

If multiple dimmers are installed together (such as lighting in larger buildings), or the ambient temperature is high, a maximum performance can be reached using additional external active cooling of the control panel, which provides controlled ventilation within the panel.

Installation of dimmers

The C-DM-0402M-RLC modules loaded by a power output approaching 500W should be placed in the control panel in such a way, that there is enough **space among them to allow ventilation** (the gaps should be at least 15mm), and the space above and below them should not be unnecessarily obstructed and impair the airflow.
It is also recommended to place the dimmers so that their dissipated heat does not effect modules with precise analogue measurement, or the basic module of the system (e.g. the CP-1000, as it is equipped with electronic thermal fuses of CIB buses, which should prevent reaching a maximum permissible current of the buses, and which could be activated by the increasing heat).

Basic parameters

The power loss of the module at the maximum load of 2 x 500VA.	maximum 2 x 4.5W
Maximum load (resistive load) 1) 2) 3)	2 x 500VA
Minimum load	0 VA
Internal protection	electronic fuse

	thermal fuse 105 °C
Consumption form the CIB bus	maximum 35mA
Operating ambient temperature	- 20 °C ÷ 55 °C
The protection class of the electrical device	II

[1] Inductive transformers can be used up to the 250 (125) VA power input, provided the minimum continuous load is 80% of the transformer nominal power output.

[2] When LED bulbs or electronic ballasts are used, the maximum load can reach only 250 (125) VA; do not connect the channels in parallel.

[3] A parallel connection of module channels is only possible for a resistive load (incandescent lamps) up to the power output of 2(1)kW; the modules must be on the same CIB line. If manual control of outputs and inputs is applied, the remaining active outputs can be overloaded.

14.1.18 The C-IB-1800M

The C-IB-1800M is a module on a CIB bus; it has 14 binary inputs, which can be configured in the mode of the balanced loop evaluation (for ESS detectors), and 4 universal AI/DI inputs, any of which can be adjusted to one of the following ranges: a binary input, single balanced loop, a double balanced loop, an analogue input for a passive temperature sensor , a pulse input (pulse counters - power meters).

The C-IB-1800M module is implemented into a 4M box on a DIN rail. It is equipped with a 12VDC power supply to power the connected intrusion (ESS) detectors. The module can be powered from a CIB or from an external 24VDC power supply (saving the CIB load).

Powering

If you connect an external 24V power supply to the A3 and A4 terminals, the power supply will by automatically switched from the internal 12V supply (the output is on terminals A5 and A6) on the CIB to this external supply. To switch the power supply, a higher voltage than 19.2V DC must be brought to the A3 terminal.

External 24VDC power supply (the A3 terminal)	19.2 ÷ 30VDC
Maximum consumption from the external 24VDC power supply connected to the A3 terminal.	230mA
The 12VDC power output (the A5 terminal)	11 ÷ 12.5VDC
Maximum consumption with CIB power supply (the A3 terminal is not connected).	150mA
Maximum consumption with a 24VDC external source power supply connected to the A3 terminal.	250mA

Basic parameters of inputs of the C-IB-1800M module:

The input type (connected sensor)	**AI/DI1 ÷ AI/DI4**	**DI5 ÷ DI18**	The range of measured values
PT1000	yes	-	-90 °C ÷ +320 °C
Ni1000	yes	-	-60 °C ÷ +200 °C
NTC 12k	yes	-	-40 °C ÷ +125 °C
KTY81-121	yes	-	-55 °C ÷ +125 °C
Maximum resistance 160kΩ	yes	-	0 ÷ 160kΩ
The pulse input (counter)	yes	-	max. 20Hz 1)
Binary input	yes	yes	log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	yes	yes	The loop resistance 2x 1k

1) The minimum pulse duration is 30ms

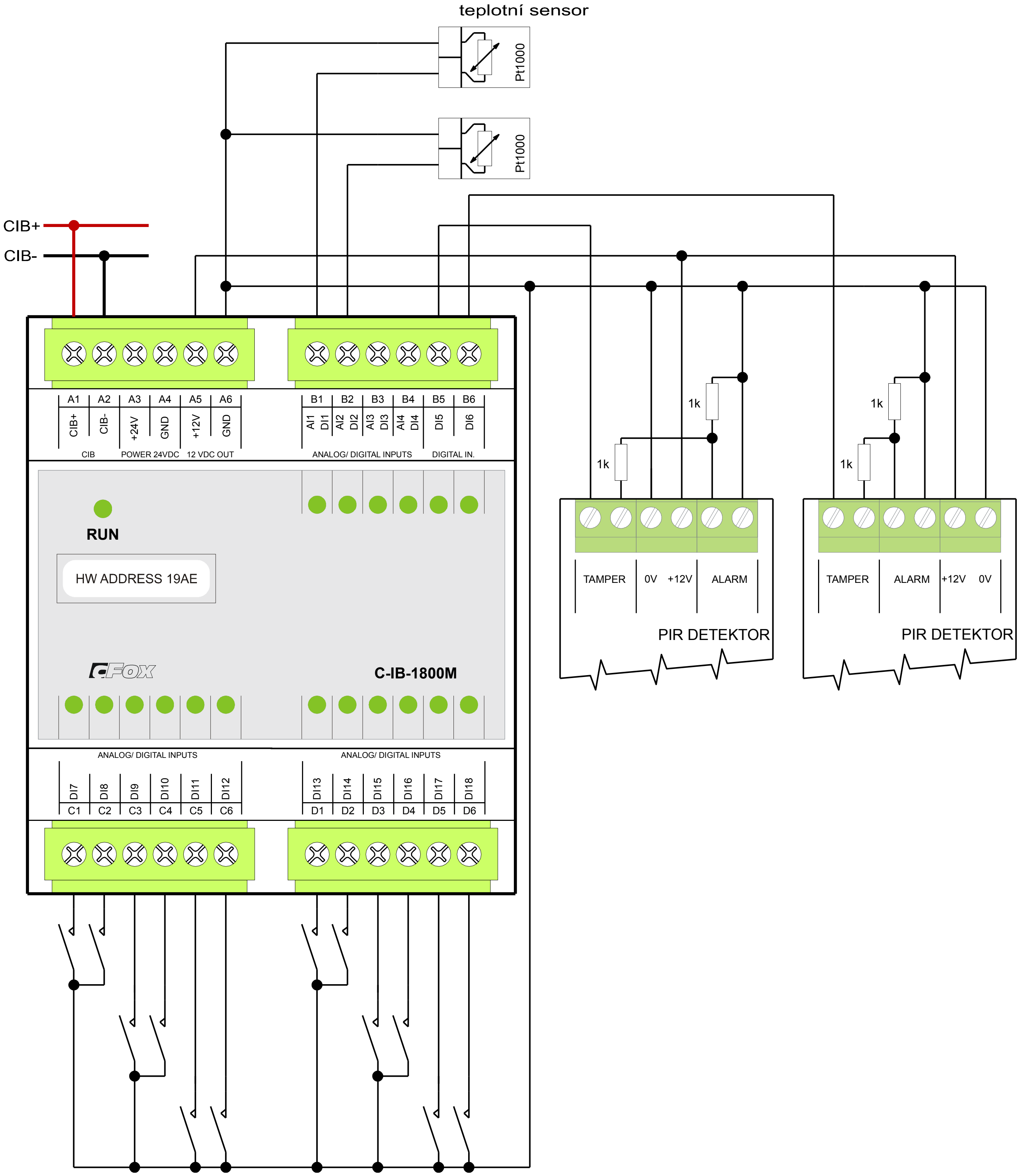


Fig. 14.1.18.1 An example of connecting the C-IB-1800M module

Notes:

1. The module can be powered from a CIB bus or from an external 24V (or 27VDC) power supply.

2. The 12VDC output is available for powering the ESS detectors connected to the alarm module. If the module is powered from the CIB bus, the 12V output can be loaded with a max. of 150 mA current; if there is an external power supply (the A3 and A4 terminals), it is possible to consume up to 250mA from the 12V output.
3. The supply voltage applied to the A3 and A4 terminals must be at least 19V, then the module will automatically switch to this power supply and disconnect the powering from the CIB bus.
4. The AI/DI1 to AI/DI4 inputs can be configured as analogue (for direct connection of temperature sensors Pt1000, Ni1000, NTC 12k, KTY81-121, a resistor up to 160 kΩ) or pulse (the input is equipped with a pulse meter) - a connection of electricity meters, water meters, etc., or balanced inputs for ESS, and also as simple binary inputs (connecting a contact input).
5. The DI5 to DI18 inputs can be configured as simple binary inputs (for connecting contact inputs) or balanced (single and double) inputs for connecting the ESS detectors.

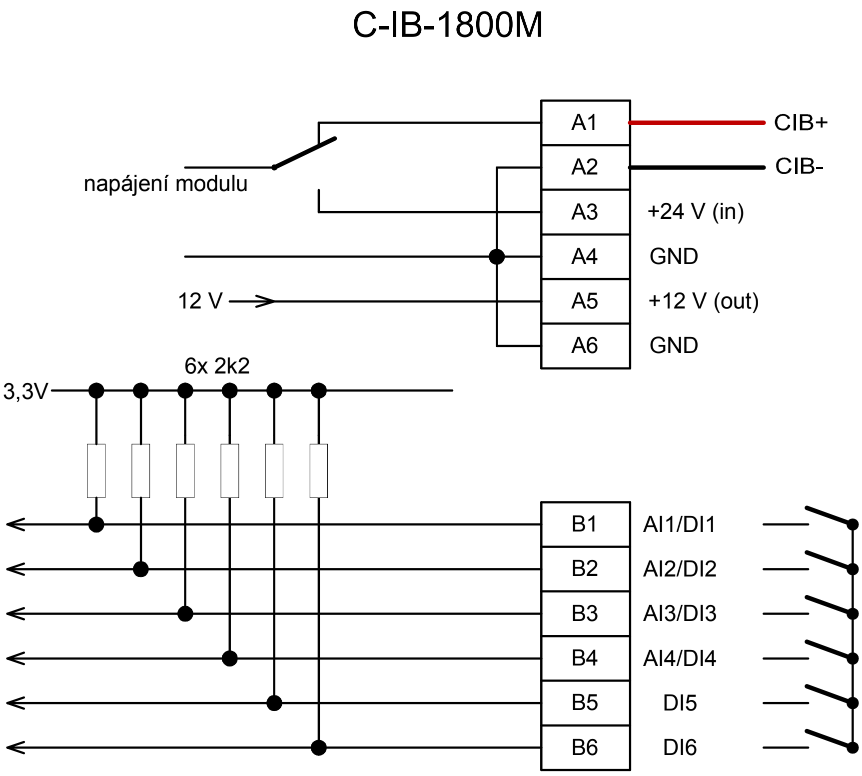


Fig. 14.1.18.2 Internal wiring of the C-IB-1800M module.

Notes:

1. The C and D connectors have the same internal circuitry as the B connector.
2. Powering of the module, including the 12V output level, is automatically switched according to the presence of supply voltage at the A3 terminal; for a detailed description powering the module, see the beginning of this chapter.

14.1.19 **The C-IT-0200S**

The C-IT-0200S module (order number TXN 133 29) is used for connecting two temperature sensors or binary signals directly on the CIB bus. The signals from the module are brought by a strip conductor. The Pt1000 or Ni1000 resistance sensors can be connected to the measurement inputs to measure temperature. Also the NTC12k sensor with a thermistor can be used, or the KTY81-121, against a common GND wire. The resistance is converted in the unit directly into the numerical value of temperature and transmitted to the central unit over the CIB. Other types of RTDs can use the resistance range from 0 to 160kΩ, but the conversion to temperature and the linearization must be done on the programme level

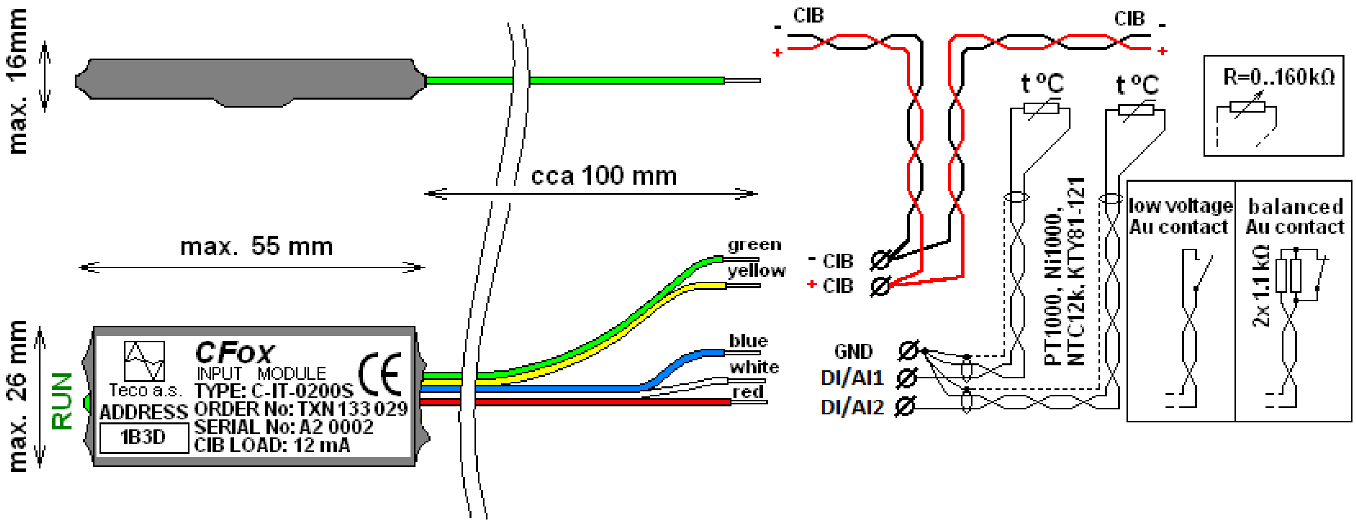


Fig.14.1.191.The signal layout of the C-IT-0200S module, the wire colour coding and the basic connection (the old version before November 2012)

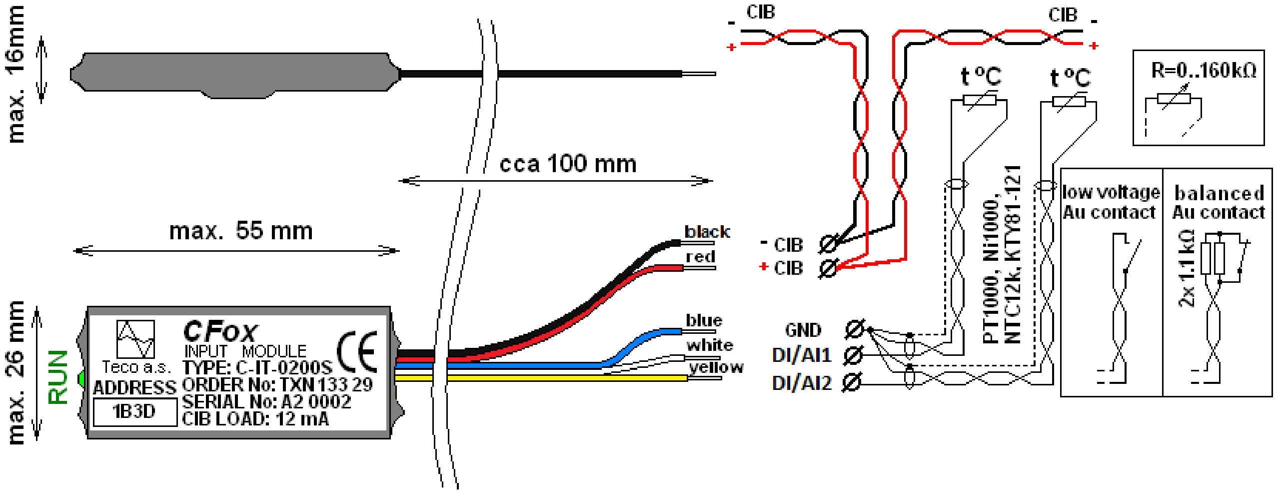


Fig. 14.1.19.2. The signal layout of the C-IT-020S module, the wire colour coding and the basic connection (the new version after November 2012)

Notes:

1. The module outputs are insulated wires with a 0.14 mm^2 cross section, the length approx. 10cm, terminated with a pressed-on sleeve H0,25/10.

The input parameters DI/AI1, DI/AI2

The input type (connected sensor)	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 160kΩ	0 ÷ 160kΩ
Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	The loop resistance 2x 1k1

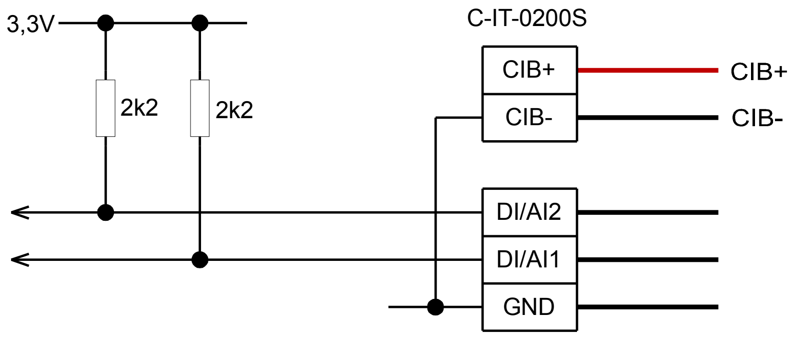


Fig. 14.1.19.3. Internal wiring of the C-IT-0200S module.

14.1.20 The C-IR-0202S

The C-IR-0202S module is designed to connect two temperature sensors or binary signals, power relay contact control, and control analogue voltage directly on the CIB bus. The signals from the module are terminated by a strip conductor.
The PT1000 or Ni1000 resistance sensors can be connected to the measurement inputs to measure temperature. Also the NTC12k sensor with a thermistor can be used, or the KTY81-121, against a common GND wire. The resistance is converted in the unit directly into the numerical value of temperature and transmitted to the central unit over the CIB. Other types of RTDs can use the resistance range from 0 to 160kΩ, but the conversion to temperature and the linearization must be done on the programme level.

Binary signals are connected to the inputs only as free contacts against the common GND wire.
The analogue output voltage from 0 to 10V is terminated on a wire against the common GND wire.
The output relay switching contact is terminated by two separate wires with enhanced insulation.

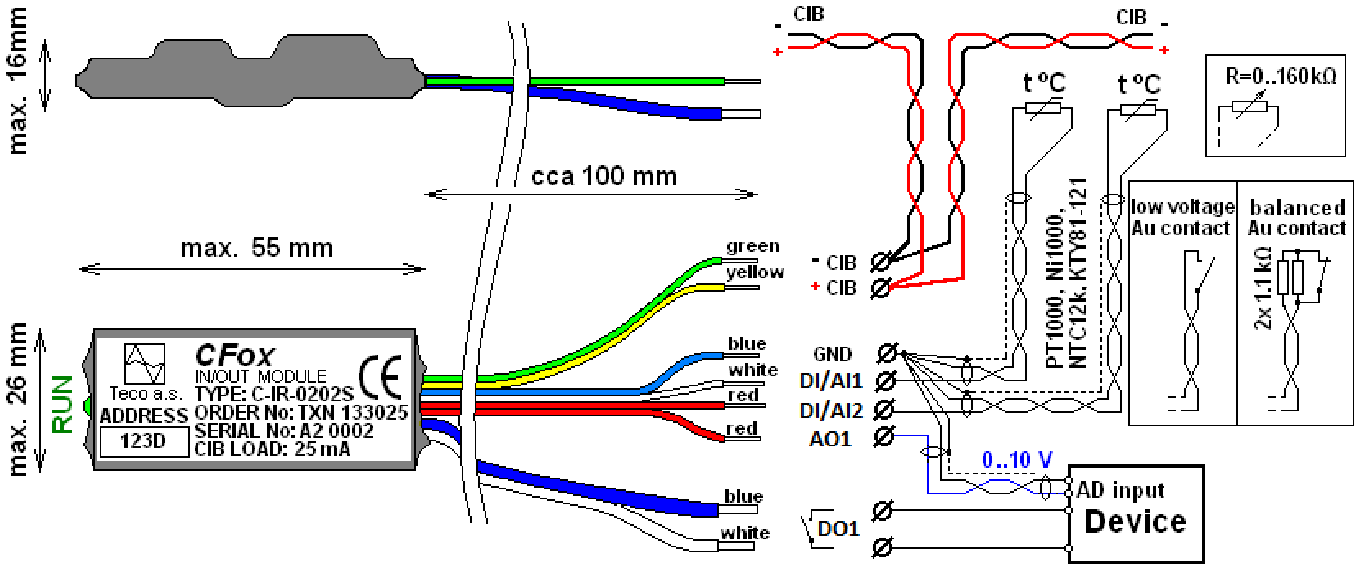


Fig.14.1.201.The signal layout of the C-IR-0202S module, the wire colour coding and the basic connection (the old version before November 2012)

Notes:

1. The module outputs (except for the DO1 relay contact) are insulated wires with a 0.14 mm^2 cross section, the length approx. 10cm, terminated with a pressed-on sleeve H0,25/10.
2. The DO1 relay outputs are insulated wires with a 0.5 mm^2 cross section, the length approx. 10cm, terminated with pressed-on sleeves with a collar.

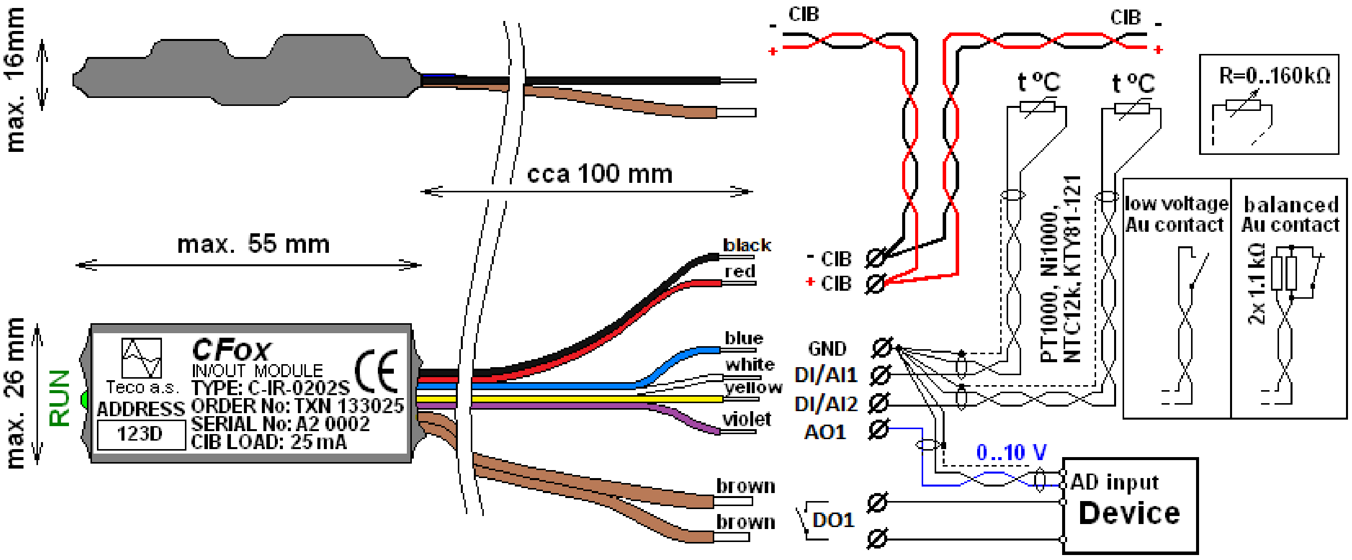


Fig. 14.1.20.2. The signal layout of the C-IR-0202S module, the wire colour coding and the basic connection (the new version after November 2012)

Basic parameters of the DI/AI1 and DI/AI2 inputs

The input type (connected sensor)	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 160kΩ	0 ÷ 160kΩ
Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	The loop resistance 2 x 1k1

Basic parameters of the analogue output AO1

Nominal output voltage U_{JM}	10V
Adjustable range of output voltage	0 ÷ 130% U_{JM}
Loading resistance	>1kΩ
Maximum load capacity	250nF

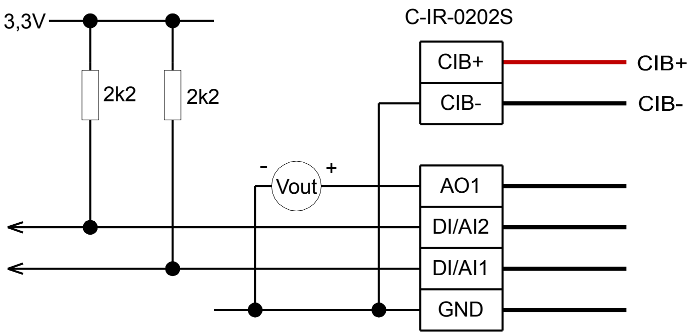


Fig. 14.1.20.3. Internal wiring of the C-IR-0202S module.

14.1.21 The C-IR-0203S

The C-IR-0203S module is designed to connect two temperature sensors or binary signals, controlled by the power relay contact; it is fitted with two analogue outputs directly on the CIB bus.
The PT1000 or Ni1000 resistance sensors can be connected to the measurement inputs to measure temperature. Also the NTC12k sensor with a thermistor can be used, or the KTY81-121, against a common GND wire. The resistance is converted in the unit directly into the numerical value of temperature and transmitted to the central unit over the CIB. Other types of RTDs can use the resistance range from 0 to 160kΩ, but the conversion to temperature and the linearization must be done on the programme level.

Binary signals are connected to the inputs only as free dry contacts against the common GND wire.

The analogue outputs voltage 0÷10V is terminated on the terminal block against the common GND signal.

The output changeover relay contact is terminated in a separate terminal block, the maximum continuous output current is 3A. The module is equipped with a relay with the maximum current of 16A on the contact, the switching contact enables a short-term current of up to 80A. The module is suitable e.g. for switching and control of electronic ballasts or as direct lighting control (sensing the push-buttons on the wall, and direct switching of the light sources).

The parameters of the universal inputs.

The input type (connected sensor)	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 160kΩ	0 ÷ 160kΩ
Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	The loop resistance 2x 1k1

Basic parameters of the analogue outputs

Nominal output voltage U_{JM}	10V
Adjustable range of output voltage	0 ÷ 105% U_{JM}
Loading resistance	>1kΩ
Maximum load capacity	250nF

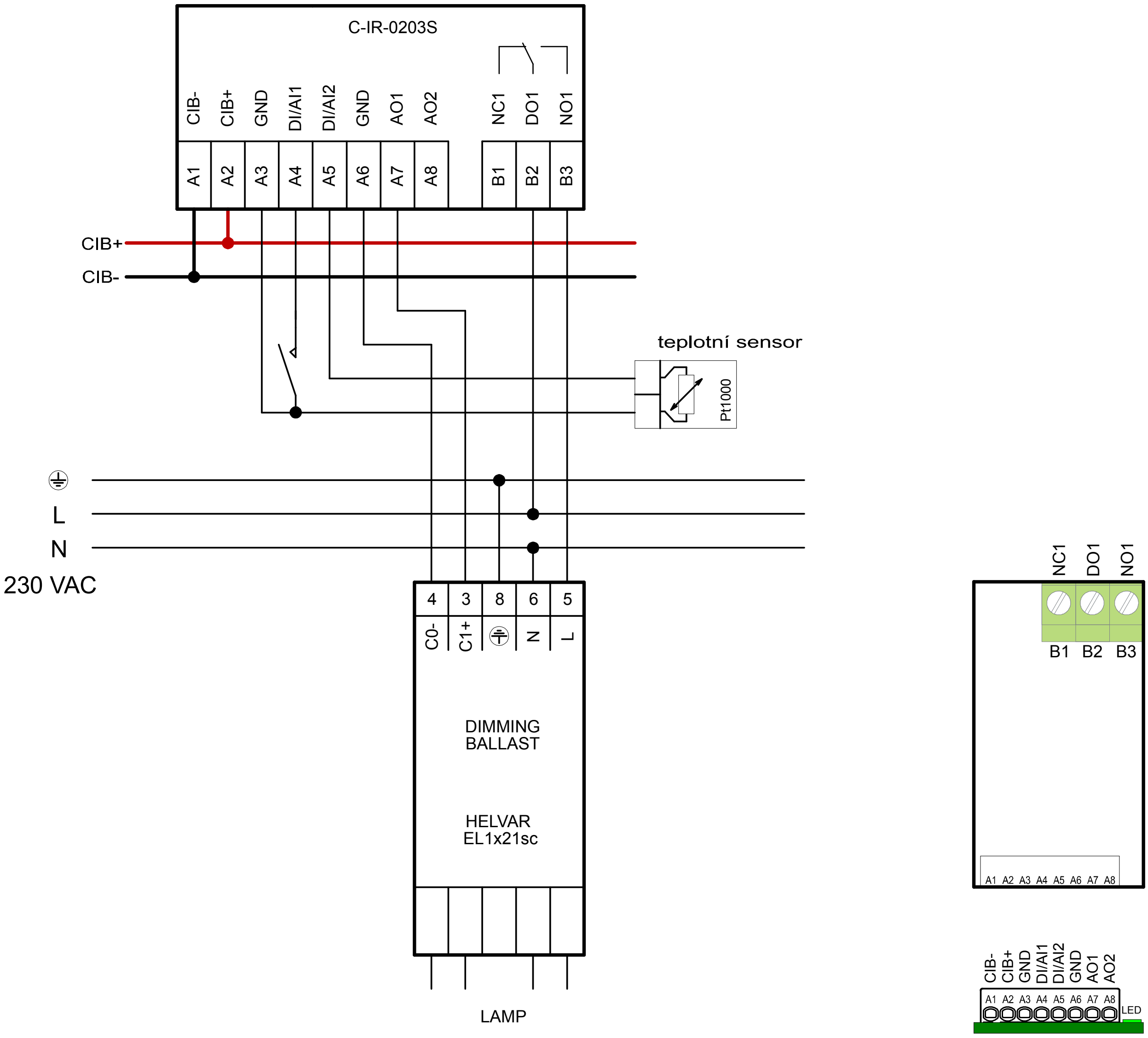


Fig. 14.1.21.1. An example of connecting the C-IR-0203S module and an illustration of the module terminals layout.

Notes:

1. The module inputs and outputs (except for the relay output) are terminated on a miniature terminal block.
2. The terminal block allows the release of the wire using a narrow screwdriver, or even a common pin: insert it into the hole above the space for the wire and then pull the wire.
3. The LED is next to the terminal block and it is partly hidden under the housing of the module.
4. The relay output is terminated in a separate screw terminal block; the wire cross section (a solid wire) is 0.12mm÷ 1.5mm^2.

14.1.22 **The C-IT-0504S**

The C-IT-0504S module (order number.: TXN 133 26) is designed to connect analogue or digital signals and analogue outputs 0 - 10V directly on the CIB bus. The inputs, outputs and the CIB bus should be connected to the module via a fixed terminal block.

The universal inputs can be set to binary or analogue in the SW configuration of the module in two groups. The first group contains 4 inputs, the second 1 input. The setup is common for the whole group. E.g. one temperature sensor (AI) and four input contacts (DI), or one input contact (DI) and four temperature sensors (AI).

The temperature measurements are made using the PT1000 and Ni1000 resistive sensors, and the NTC12k or KTY81-121 thermistor against the common GND wire. The resistance is converted in the module into a numerical value of temperature and transmitted to the central unit via the CIB bus. Other types of RTDs can use the resistance measurement range from 0 to 160kΩ, but the conversion to temperature and the linearization must be done on the user programme level.

Binary signals are connected to the inputs only as free (dry) contacts against the common GND wire. The binary input can also operate in the mode of balanced input.

The analogue outputs voltage 0 ÷ 10V is terminated on the terminals against the common GND wire.

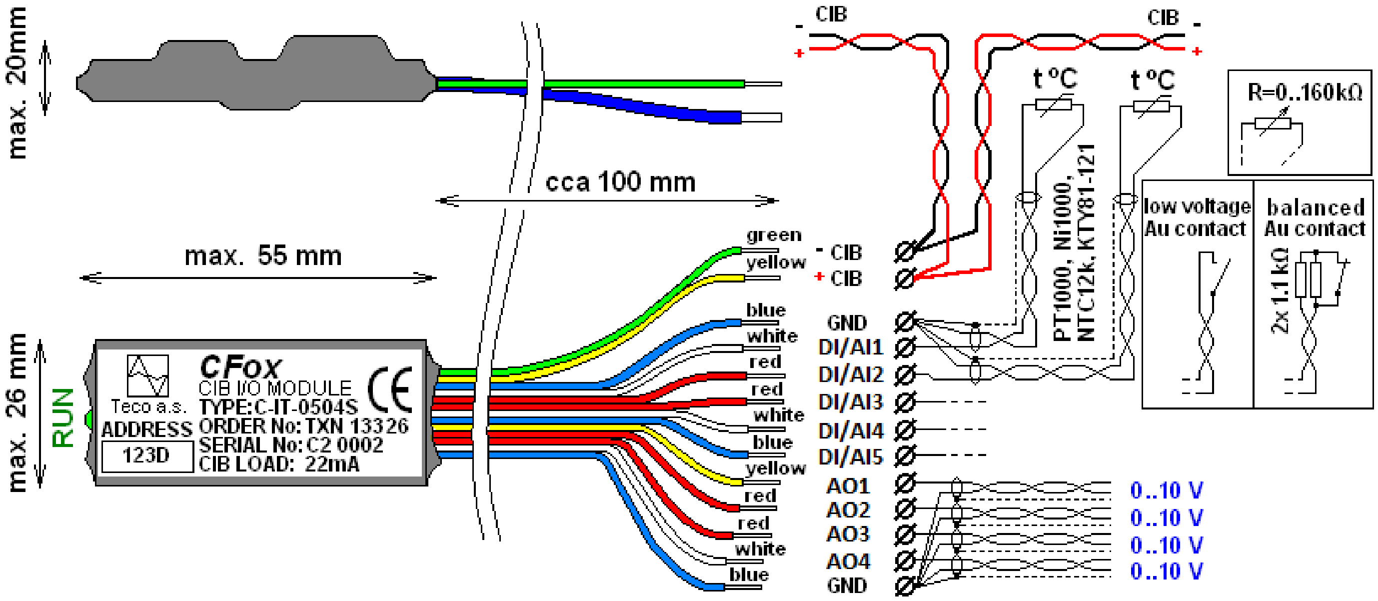


Fig. 14.1.22.1. The signal layout of the C-IT-00504S module, the wire colour coding and the basic connection

(the old version before November 2012)

Basic parameters of the DI/AI1 - DI/AI5 inputs.

The input type (connected sensor)	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 160kΩ	0 ÷ 160kΩ
Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	The loop resistance 2x 1k1

Basic parameters of the analogue outputs AO1 ÷ AO4

Nominal output voltage U_{JM}	10V
Adjustable range of output voltage	0 ÷ 130% U_{JM}
Loading resistance	>1kΩ
Maximum load capacity	250nF

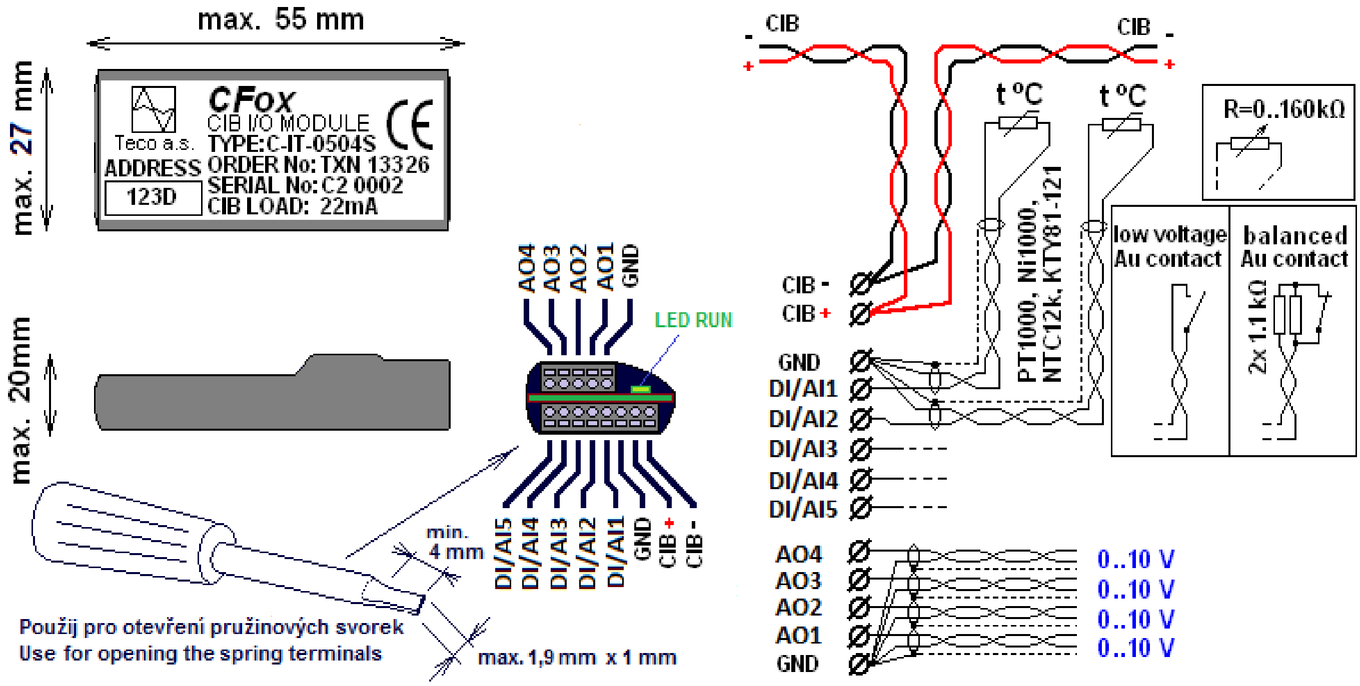


Fig. 14.1.22.2. The signal layout of the C-IT-0504S module, the wire colour coding and the basic connection (the new version after November 2012)

Notes:

1. The inputs and outputs of the module are terminated in a miniature terminal block
2. The terminal block allows the release of the wire using a narrow screwdriver (see the figure), or even a common pin: insert it into the hole above the space for the wire and then pull the wire.
3. The LED is next to the terminal block and it is partly hidden under the housing of the module.

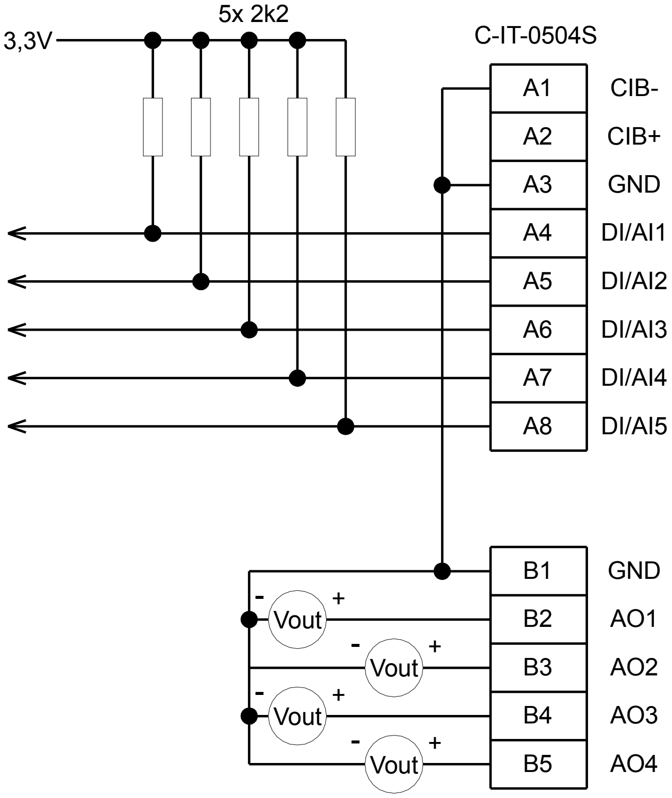


Fig. 14.1.22.3. Internal wiring of the C-IT-0504S module

14.1.23 **The C-IT-0908S**

The C-IT-0908S module (order. no.: The TXN 133 52) and its variant with a reversed outputs polarity, the C-IT-0908S-NPN (TXN 133 52.01), are designed to connect analogue or digital input signals and to control output binary signals for energizing LEDs. The module inputs, outputs and buses are terminated on free insulated wires.
The DI1 to DI6 inputs are only binary,
the DI7/AI7 and DI8/AI8 inputs can be set up as binary or analogue.
The AI9 input can only be set up as analogue.
For example: one temperature sensor (AI) and eight inputs potential free contact (DI) or six inputs the contact type (DI) and three temperature sensors (AI).
The temperature sensors PT1000, Ni1000, NTC12k and KTY81-121 can be connected to the analogue inputs, or a general resistance 0 to 160kΩ against the common GND wire.
The binary signals can be connected to the inputs only as a free (dry) contact, against a common GND wire; the binary input can also operate in mode of balanced inputs.
Eight digital outputs are designed to excite the LEDs connected in a group with common cathodes (C-IT-0908S-PNP or C-IT-0908S, order number TXN 133 52) or common anodes (C-IT-0908S-NPN , order number 133 TXN 52.01), see the example in Fig. 14.1.23.2.

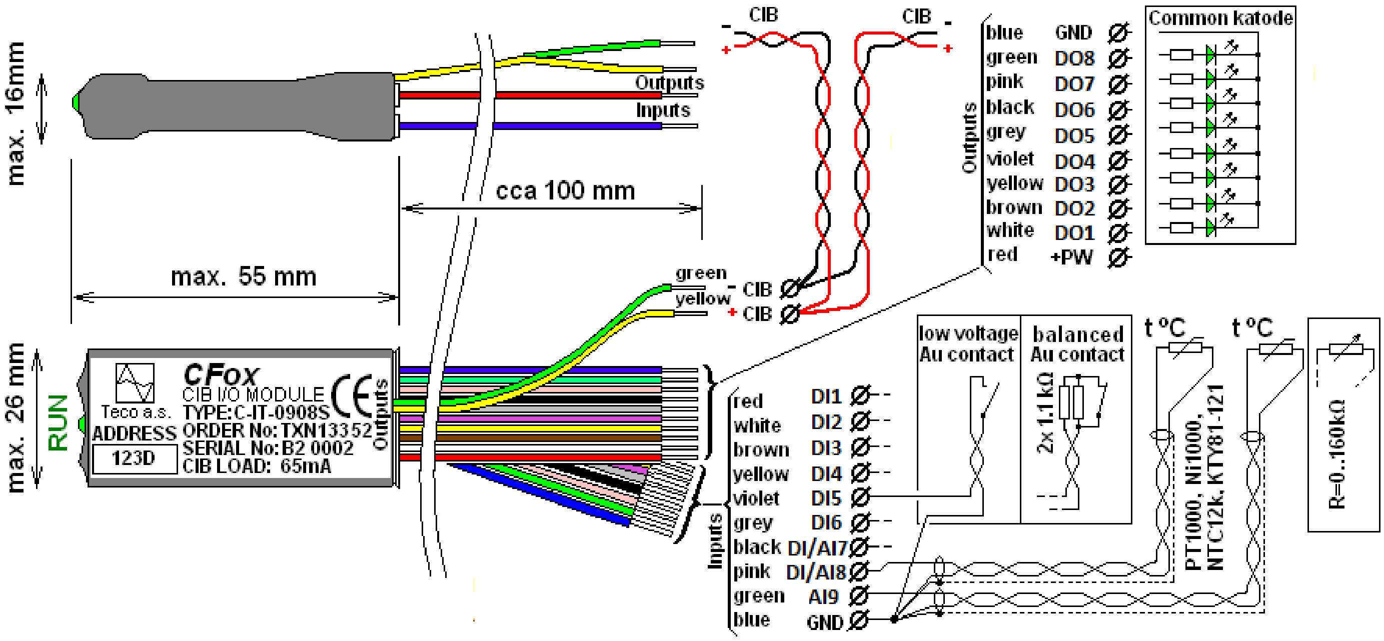


Fig. 14.1.23.1. The signal layout of the C-IT-0908S module, the wire colour coding and the basic connection (the old version before November 2012)

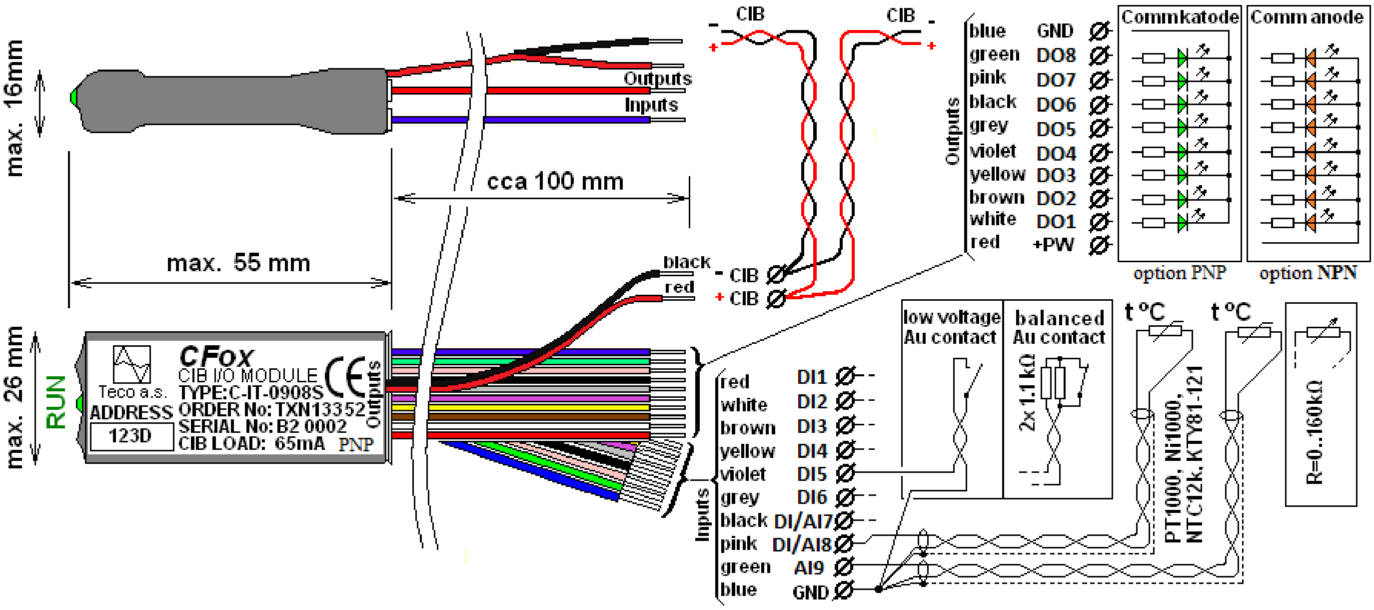


Fig. 14.1.23.2. The signal layout of the C-IT-0908S module, the wire colour coding and the basic connection (the new version after November 2012)

Notes:

1. The module is terminated with two connectors with moulded separate coloured wires with the length of approx. 100mm (inputs and outputs), the wire tips are not terminated.
2. The CIB bus is terminated separately on two wires.
3. The inputs are against the common GND terminal.
4. The DO1 to DO8 outputs generate positive (the PNP design) or negative (the NPN design) voltage against the GND terminal for exciting the LEDs.

Basic parameters of the input and outputs of the C-IT-0908S module:

The input type (connected sensor)	DI1 ÷ DI6	DI/AI7, DI/AI8	AI9	The range of measured values
PT1000	-	yes	yes	-90 °C ÷ +320 °C
Ni1000	-	yes	yes	-60 °C ÷ +200 °C
NTC 12k	-	yes	yes	-40 °C ÷ +125 °C
KTY81-121	-	yes	yes	-55 °C ÷ +125 °C
Maximum resistance 160kΩ	-	yes	yes	0 ÷ 160kΩ
Binary input	yes	yes	-	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	yes	yes	-	The loop resistance 2x 1k

Binary outputs DO1 to DO8	
Maximum voltage on the output	27V

Maximum output current	3mA

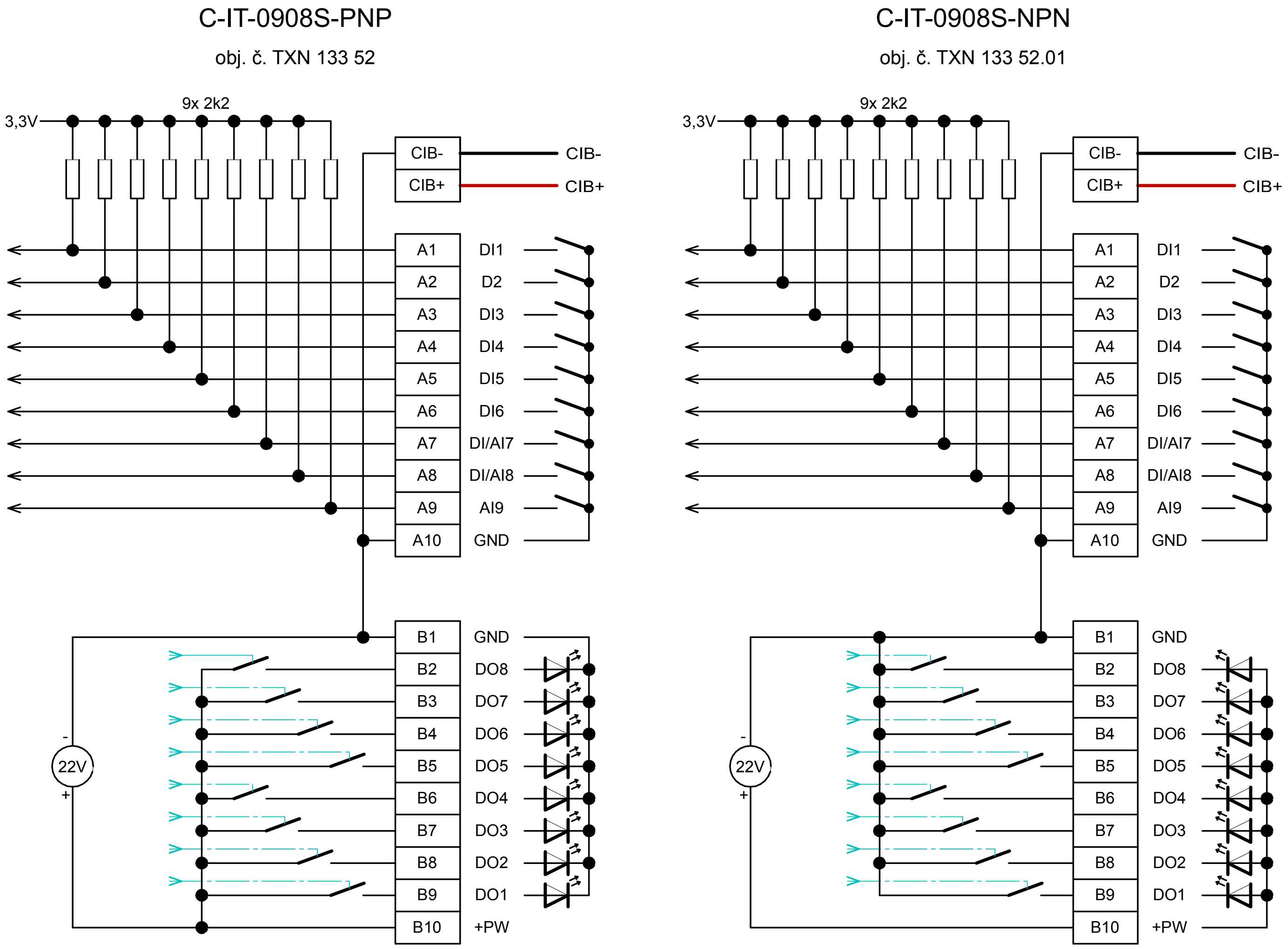


Fig. 14.1.23.3. The Internal wiring of the C-IT-0908S-PNP and C-IT-0908S-NPN modules.

14.1.24 **The C-DL-0012S**

The C-DL-0012S is a converter of protocols CIB - DALI. It is intended for the connection of lighting devices with the DALI protocol according to the specification: NEMA Standards Publication 243-2004 Digital Addressable Lighting Interface (DALI) Control Devices Protocol PART 2-2004.
The CIB and DALI buses signals are brought by a strip wire with colour identification. The module is powered from the CIB bus; the module does not provide galvanic isolation of buses.

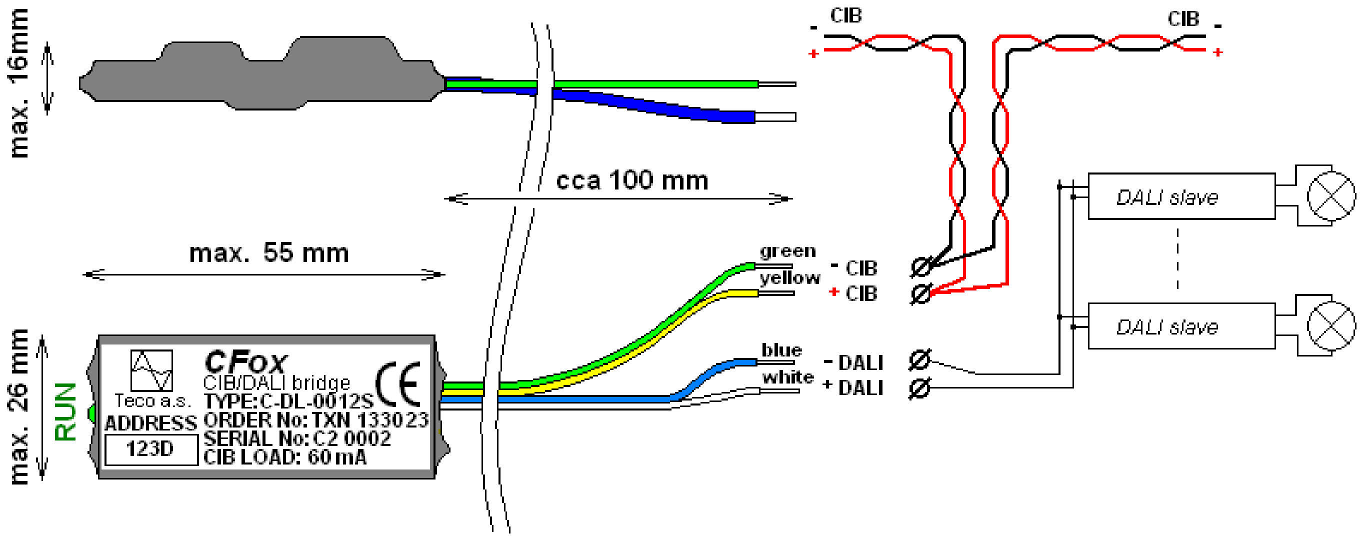


Fig. 14.1.24.1. The signal layout of the C-DL-0012S module, the wire colour coding and the basic connection

(the old version before November 2012).

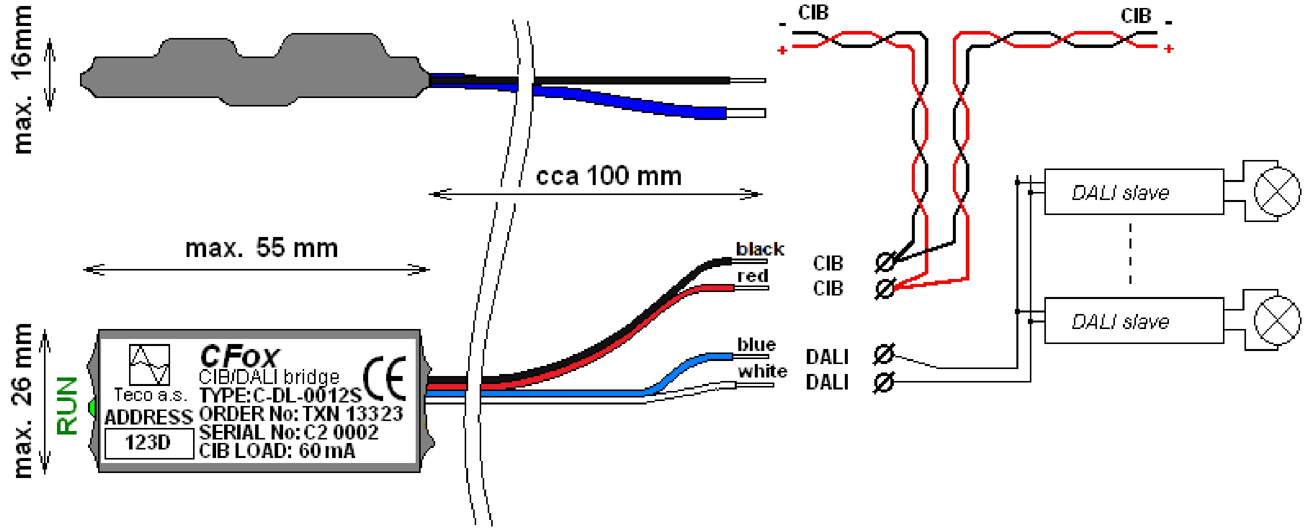


Fig. 14.1.24.2. The signal layout of the C-DL-0012S module, the wire colour coding and the basic connection (the new version after November 2012).

Notes:

1. The module outputs are via isolated wires with the cross-section of 0.14mm^2, the length approx. 10cm, terminated with crimped ferrules H0.25/10.

14.1.25 The C-DL-0064M

The module always requires for its functionality an external 24VDC power supply (the communication part and circuits of the DALI interface are powered only from an external supply).
The maximum consumption from this source (with full DALI installation) is 320mA.
A typical current without a load on DALI output is 30mA.
The negative power supply terminal (A4) is internally connected with the CIB- terminal (A2). The input of the supply 24V voltage (terminal A3) is protected by an internal resettable fuse.

The DALI+ output is protected against a short circuit by an internal electronic resettable fuse.

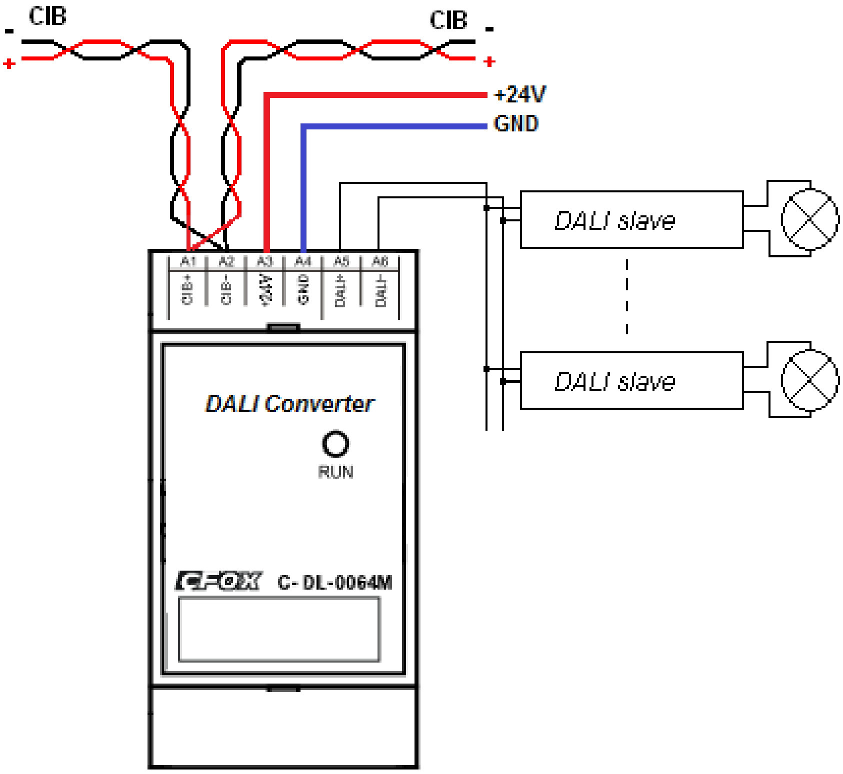


Fig. 14.1.25.1. The signal layout on the C-DL-0064M module terminals.

14.1.26 The C-BM-0202M

The C-BM-0202M is a module on the CIB bus designed to monitor and balance the $LiFePO_4$ cells, especially for stationary energy storage (storage of surplus power generated by PVPS, by backup power supply systems, etc.).
An integral part of the module are the B-BM-0201X balance mini-modules, which are attached on each cell and provide the measurement and power balancing of each battery cell.

The C-BM-0202M module is equipped with an AI1 input for measuring the battery current using the Hall effect sensor. The module also provides the 24VDC and 5VDC supply voltage for the Hall sensor.It is also equipped with a terminal block for connecting the B-BM-0201X mini-modules for monitoring and balancing individual cells, and two relay outputs DO1 and DO2 designed for an emergency disconnection of the battery and the charger independently of the control system.

The B-BM-0201X sensor of the cell is mounted directly onto the battery cell; the module measures the temperature and the cell voltage, communicates with the C-BM-0202M CIB module via a special bus and also controls the resistance load for balancing the cell during charging or discharging.

Detailed information on how to connect the Hall sensor to AI1 will be supplemented.

The module is designed as a 1.5M box mounted on a DIN rail, fitted with fixed terminals and normally supplied from a CIB bus.

Basic parameters of the AI1 input and 24V and 5V outputs:

The type of input/output	**The range of measured values**
The AI1input	The Hall sensor input
24V power output	24VDC, max. consumption 50mA
Power output 5V	5VDC, max. consumption 50mA
Galvanic separation form other circuits and the CIB	No
Protection of the 5V and 24V internal outputs	No

The parameters and an example of wiring the Hall sensor will be supplemented.

The relay outputs of the C-HM-0202M module:

The DO1, a separate output, switching contact,
continuous current in the 3A output, inrush overload 5A
more detailed information on the relay contacts

There is only 1,750 VAC working isolation between these outputs.

The **DO2** a separate output, switching contact,
continuous current in the output is 3A, short-time overload 5A
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

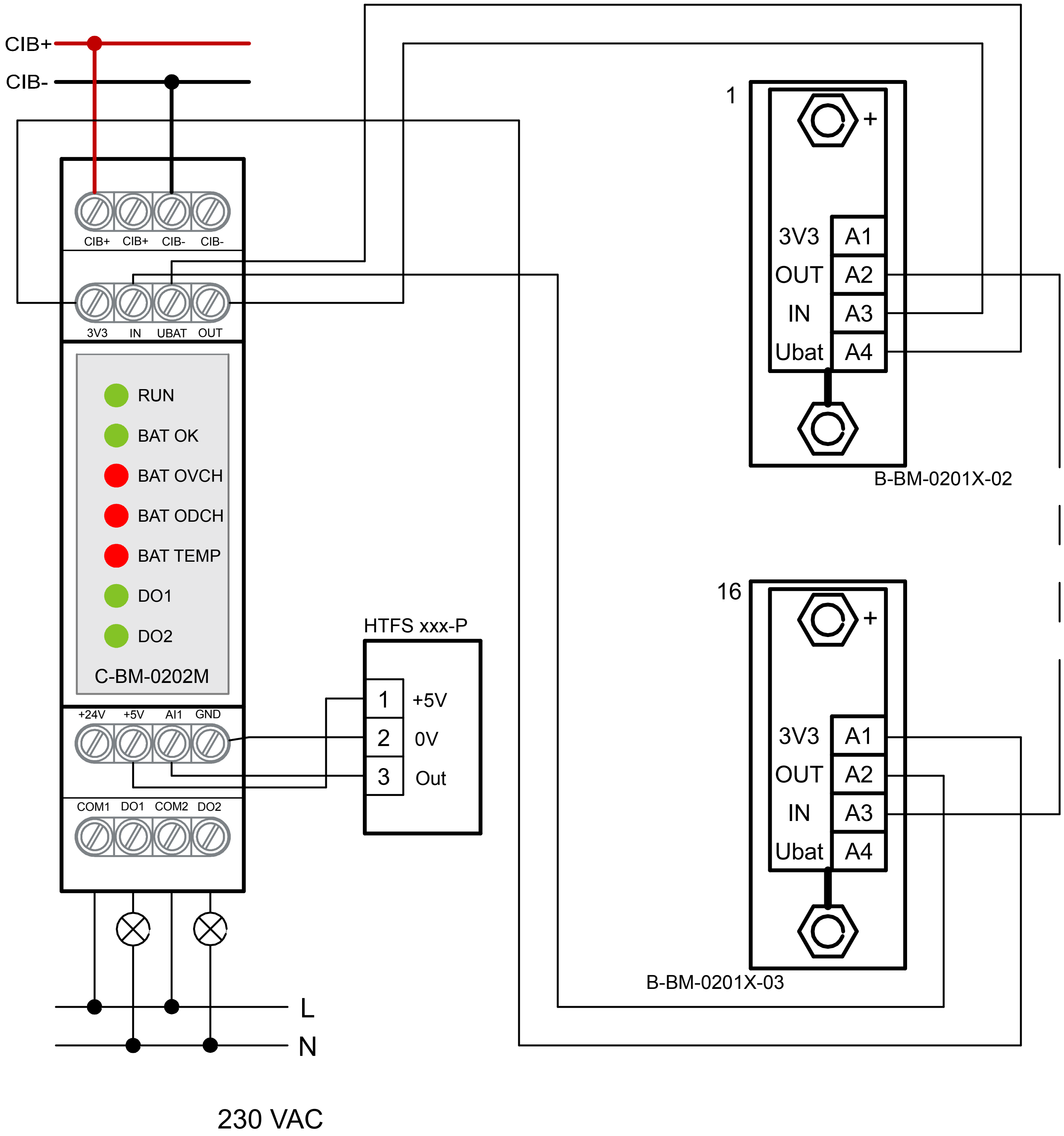


Fig. 14.1.26.1 The basic connection of the C-BM-0202M module

14.1.27 The C-BM-0504M

The module is designed to supply power for controlled heating and for the measurements of the precipitation detector S-RS-01I, also for heating and measurements of the 24V rated voltage icing sensors (mainly products of the V-system company), see Chapters xxx, including switching the defrosting cables.It is also possible to connect 2 probes for level measurement to the module, e.g. for monitoring water level limits in the tank. The inputs and outputs can be used as general AI/DI and DO.

The module contains 5 analogue inputs, of which 3 are designated for connecting resistive sensors, or as standard digital inputs; 2 analogue inputs are designed for AC resistance measurement in sensors for icing, precipitation and point level probes.
Furthermore, the module is fitted with a PWM output DO4 intended for supplying and controlling heating of the sensors. The output is only intended to power these sensors with a power input about 2W; the output circuits have no overload protection.
The C-IS-0504M module is also equipped with 3 relay outputs, 1 x 16A and 2 x 5A, e.g. for switching heating cables for defrosting, and the like.
Individual re lay outputs can be manually locally controlled via the buttons on the module panel.

The basic parameters of inputs and outputs:

The type of input (a connected sensor), the inputs **AI1, AI2, AI3**	The range of measured values
Pt1,000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 100kΩ	0 ÷ 100kΩ
Voltage 2V	0 ÷ 2,100mV
The input resistance of inputs for voltage ranges.	approx. 100kΩ, see the Fig. internal wiring
16-bit pulse counter (water meters, etc.)	> 30ms pulse, frequency max. 20Hz

The type of input (a connected sensor), the inputs **AI4, AI5**	The range of measured values
resistance, AC measurement	0 ÷ 1000kΩ
The input resistance of inputs for voltage ranges.	approx. 100kΩ, see the Fig. internal wiring

The DO4 output	
Nominal output voltage U_{JM}	24VDC
Adjustable duty cycle of the PWM output	0 ÷ 100%
Output current	maximum 80mA
The PWM frequency	100Hz
Short-circuit and overload protection	No

The relay outputs of the C-IS-0504M module:

The DO1, a separate output, switching contact,
continuous current in the output is 16A, short-time overload 80A (max. 20ms)
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO2, DO3, outputs with a common terminal, switching contact, continuous switching current 5A,
more detailed information on the relay contacts

The parameters of the connectors used are listed in Chap. 13.3.1

The module is in a 3M box.

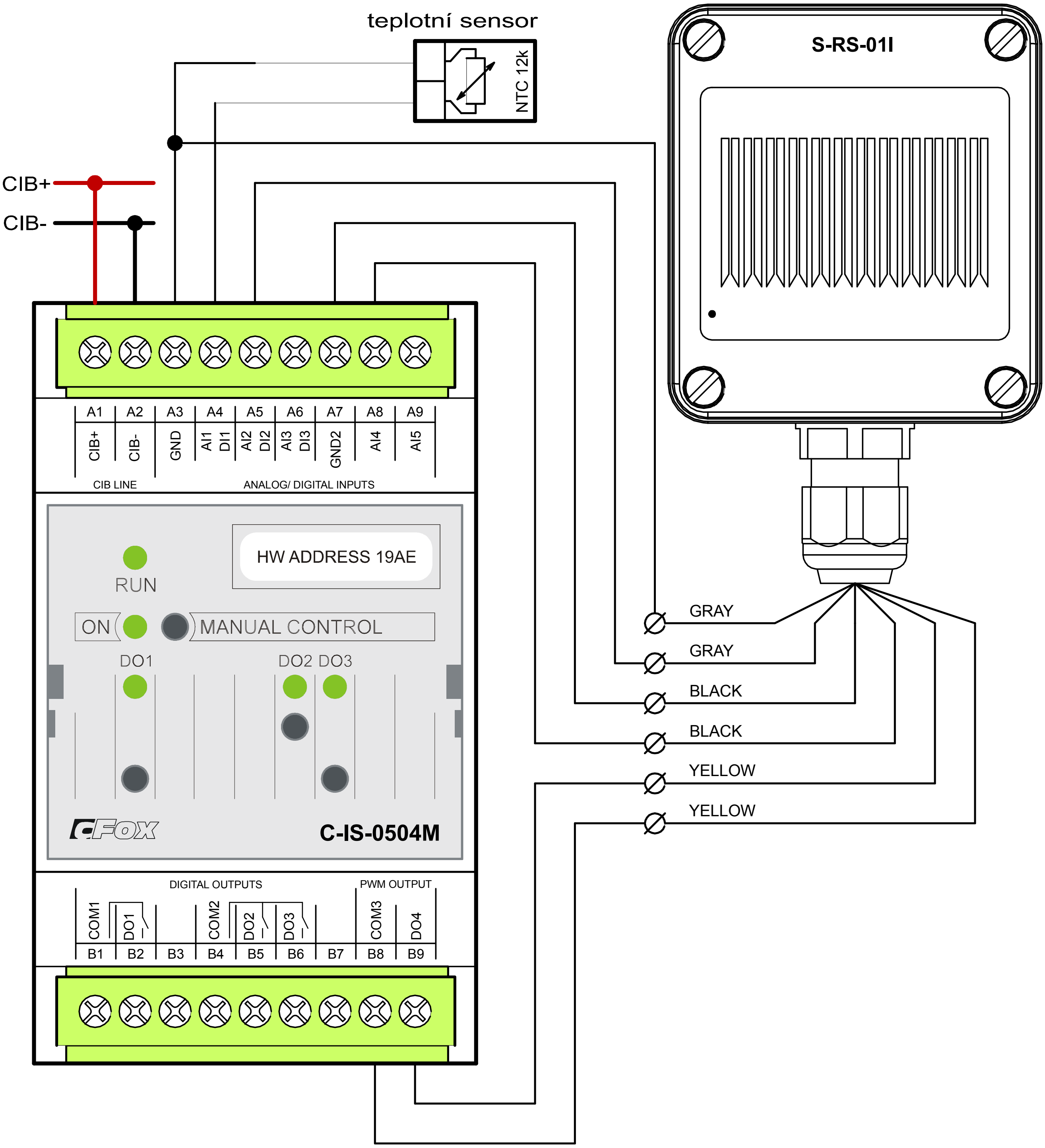


Fig. 14.1.27.1 Basic wiring of the C-IS-0504M module with the S-RS-01M precipitation detector

Notes:

5. The D04 output is designed solely for the heating of sensors with the power up to 2W, 24VDC.
6. The AI4 and AI5 inputs measure the resistance using AC voltage of approx. 3.3V; the input is intended solely for the measurement of conductivity sensors and probes - it is not designed to measure temperature or other parameters.

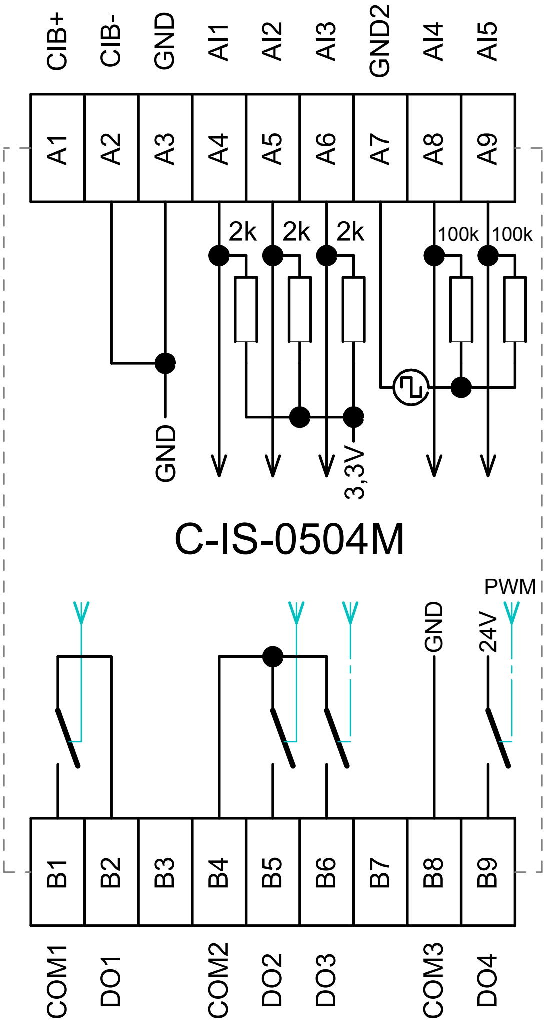


Fig. 14.1.27.2 Internal wiring of the C-IS-0504M module

14.1.28 C-RM-1109M

The design of the module is suitable for controlling rooms, hotel rooms (lighting, heating, sockets, etc.) and other applications, where the combination of inputs and outputs can be utilized - in particular with the requirement to switch loads with a capacitive character: lighting circuits, socket circuits, etc.

The module contains 8 binary inputs for connecting switching contacts, 3 analogue inputs for connecting resistive sensors, 8 relay outputs and one voltage analogue output (0 ÷ 12V). Individual re lay outputs can be manually locally controlled via the buttons on the module panel.
The module is fitted with relays designed to switch capacitive loads, 4x relays with a 16A contact and 4 relays with a 10A contact.

Powering the module
If you connect an external 24V power supply to terminals A3 and A4, the powering will be automatically switched from the CIB to this external source. To switch the power supply, a higher voltage than 19.2V DC must be brought to the A3 terminal.

If the module is powered from an external power supply (terminals A3, A4), the CIB line could be overloaded during a power failure (e. g. if there is a power outage in the 230VAC grid as well as in the CIB power supply backup).The module in this configuration allows activation of the mode, which blocks (opens) the switched contacts during a power failure; it prevents overloading the line (the module power consumption decreases to 25mA).

The basic parameters of inputs and outputs:

The type of input (a connected sensor), the inputs **AI1, AI2, AI3**	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 100kΩ	0 ÷ 100kΩ
Voltage 2V	0 ÷ 2,100mV
The input resistance of inputs for voltage ranges.	2kΩ, see the Fig. internal wiring
16-bit pulse counter (water meters, etc.)	> 30ms pulse, frequency max. 20Hz

An analogue output AO1	
Nominal output voltage U_{JM}	10V
Adjustable range of output voltage	0 ÷ 105% U_{JM}
Loading resistance	>1kΩ
Maximum load capacity	50nF

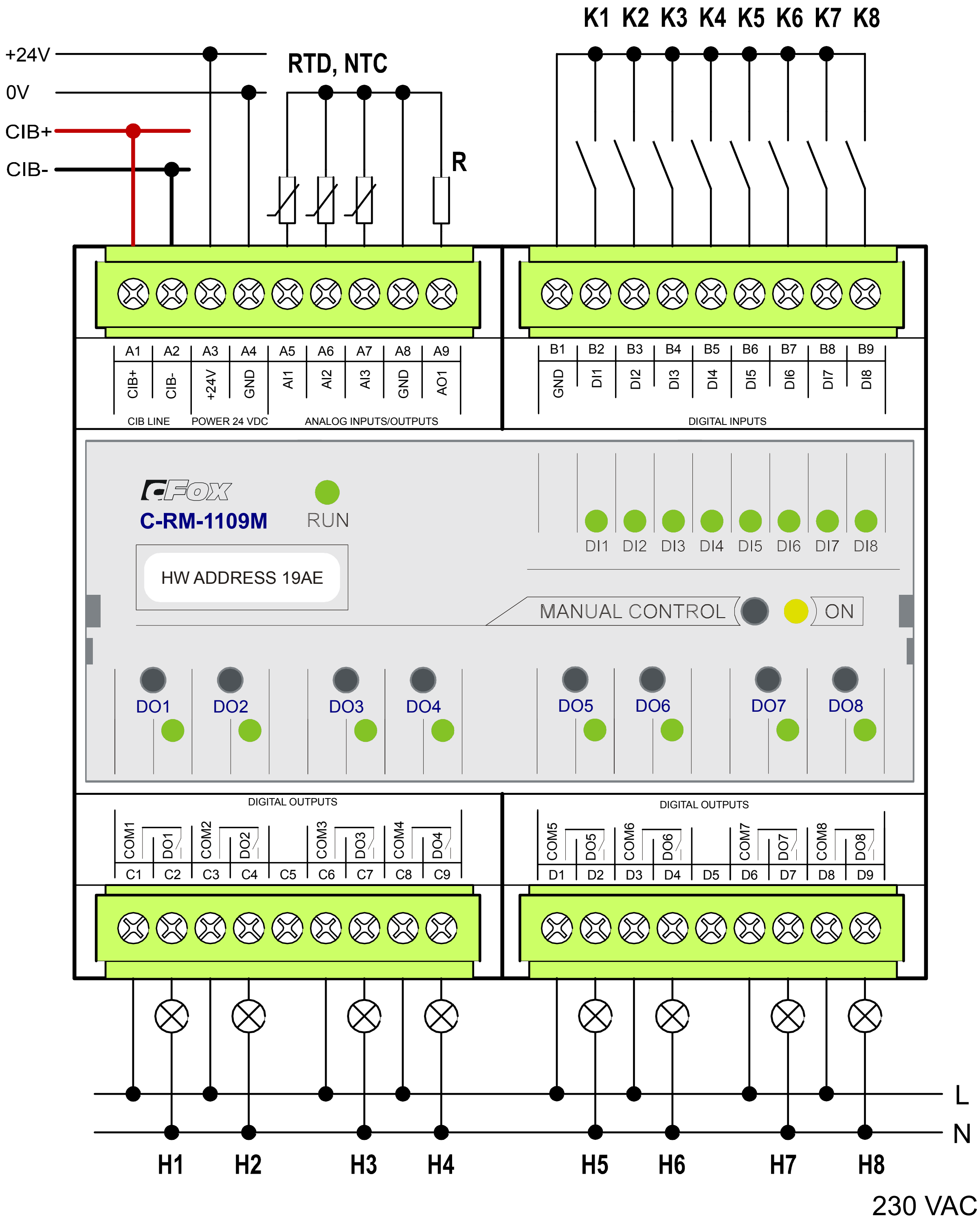
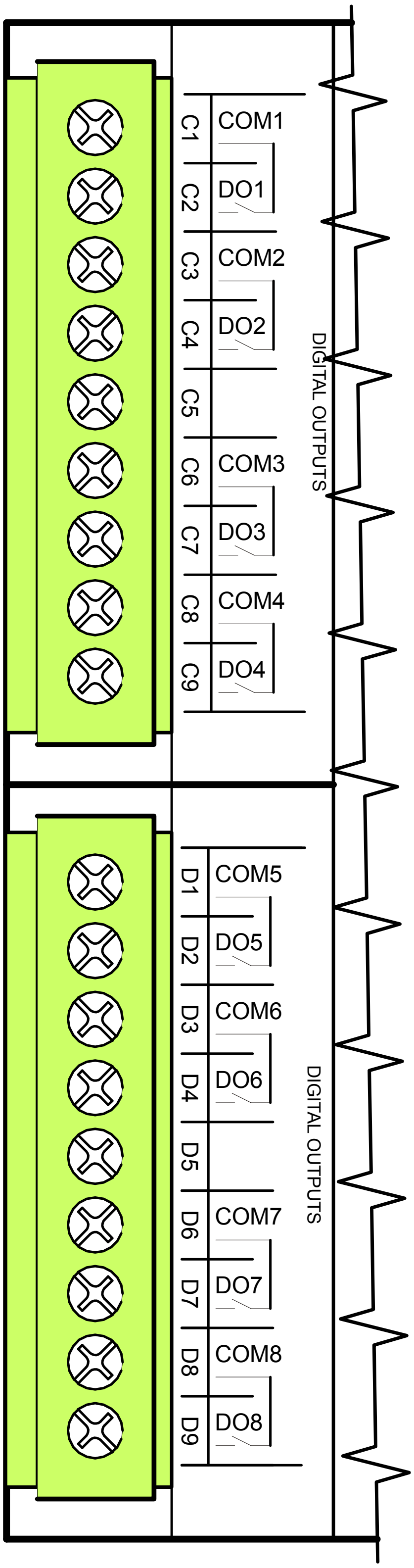


Fig. 14.1.28.1 An example of connecting the C-RM-1109M module.

Notes:

1. The GND and CIB- terminals are interconnected, see the internal wiring in Fig. 14.1.28.2

The relay outputs of the C-RM-1109M module:



The DO1, a separate output, switching contact,
continuous current in the output is 16A, short-time overload 80A (max. 20ms)
more detailed information on the relay contacts

There is only 1,750 VAC working isolation between these outputs.

The **DO2**, a separate output, switching contact,
continuous current in the output is 10A, short-time overload 50A (max. 20ms)
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO3, , a separate output, switching contact,
continuous current in the output is 16A, short-time overload 80A (max. 20ms)
more detailed information on the relay contacts

There is only 1,750 VAC working isolation between these outputs.

The DO4, a separate output, switching contact,
continuous current in the output is 10A, short-time overload 50A (max. 20ms)
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO5, a separate output, switching contact,
continuous current in the output is 16A, short-time overload 80A (max. 20ms)
more detailed information on the relay contacts

There is only 1,750 VAC working isolation between these outputs.

The DO6, a separate output, switching contact
continuous current in the output is 10A, short-time overload 50A (max. 20ms)
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The DO7, a separate output, switching contact
continuous current in the output is 16A, short-time overload 80A (max. 20ms)
more detailed information on the relay contacts

There is only 1,750 VAC working isolation between these outputs.

The DO8, a separate output, switching contact
continuous current in the output is 10A, short-time overload 50A (max. 20ms)
more detailed information on the relay contacts

isolation voltage from the other circuits and outputs is 3,750VAC,
i.e. safe isolation of circuits.

The parameters of the connectors used are listed in Chap. 13.3.1

The module is in a 6M box.

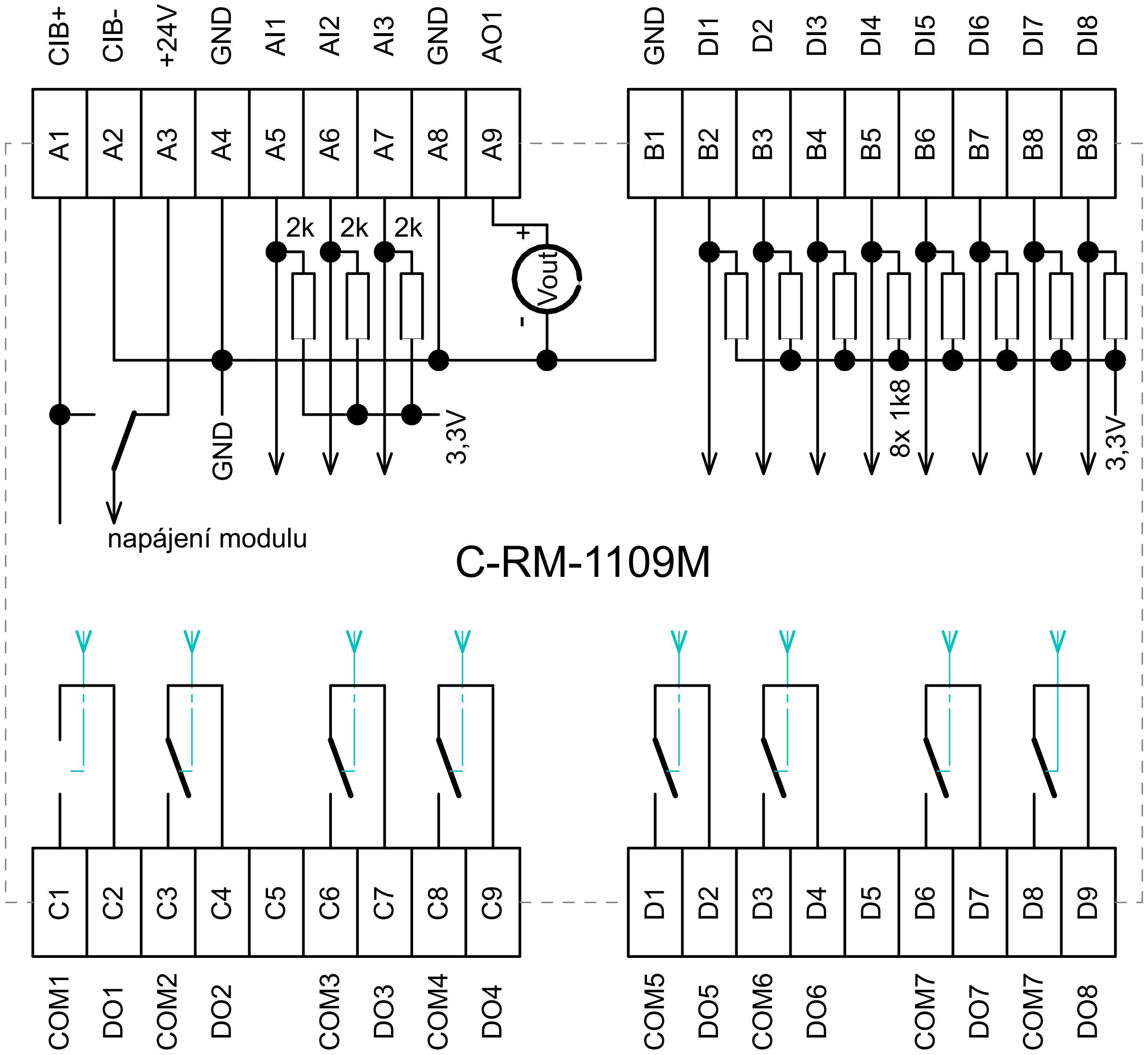


Fig. 14.1.28.2 Internal wiring of the C-RM-1109M module

14.1.29 The C-EV-0302M

The module is designed to control AC charging of electric vehicles (EV) from conventional grid 230/400VAC. The module for charging control utilizes the CP (Control Pilot) signals and PP (Proximity function) signals in accordance with the EN 61851-1 standard. Both signals are terminated together with the ground terminal on the B connector of the module.
This connector also contains the terminal of the DO2 relay output switching the power contactor, which connects the mains voltage to the charging cable.

The PP signal is used by the car electronics as information about the connected charging cable; the signal is controlled by the C-EV-0302M module.

The CP signal is used both to control the charging current in the range from about 5% to 100%, while providing feedback on the charging and connections status such as "the car is connected", "charging", charging while cooling", "fault".This information is transmitted by the C-EV-0302M module via the bus to the system for further processing, and is also displayed by LED indicators on its panel.

The module is equipped with two universal inputs AI/DI1 and AI/DI 2, which allow you e.g. to connect control buttons START and STOP; you can place them on the door of the cabinet with control electronics to control local charging (e.g. after arrival or departure), or you can use the inputs to connect temperature sensors and the like.The third input DI3 is intended primarily for the connection of the S0 electricity meter output for applications, where you want to keep track of the amount of energy supplied to the vehicle, or to have a better overview of charging, or it may be used as a standard binary input.
The module is also equipped with a binary output DO1 intended only for a LED indicator, which can be placed on the cabinet door next to the buttons to indicate charging in progress.

The parameters of the connectors used are listed in Chap. 13.3.1
The module is in a 3M box.

The basic parameters of inputs and outputs:

The type of input (connected sensor), inputs **AI/DI1**, **AI/DI2**	The range of measured values
Pt1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 100kΩ	0 ÷ 100kΩ
Voltage 2V	0 ÷ 2100 mV
The input resistance of inputs for voltage ranges.	approx. 100kΩ, see the Fig. internal wiring

The type of input (a connected sensor), the input **DI3**	The range of measured values
16-bit pulse counter (electricity meter with an S0 output)	> 30ms pulse, frequency max. 20Hz
The input excitation voltage	15V
Input current in log. 1	Typically 5mA

The DO1 output	
Nominal output voltage U_{JM}	15VDC
Maximum output current	20mA

The DO2 output is fitted with a standard 5A relay, switching contact.

Outputs CP, PP	
Nominal voltage output voltage	±12VDC
Maximum output current	30 mA
Signal curves on the outputs	In accordance with EN 61851-1

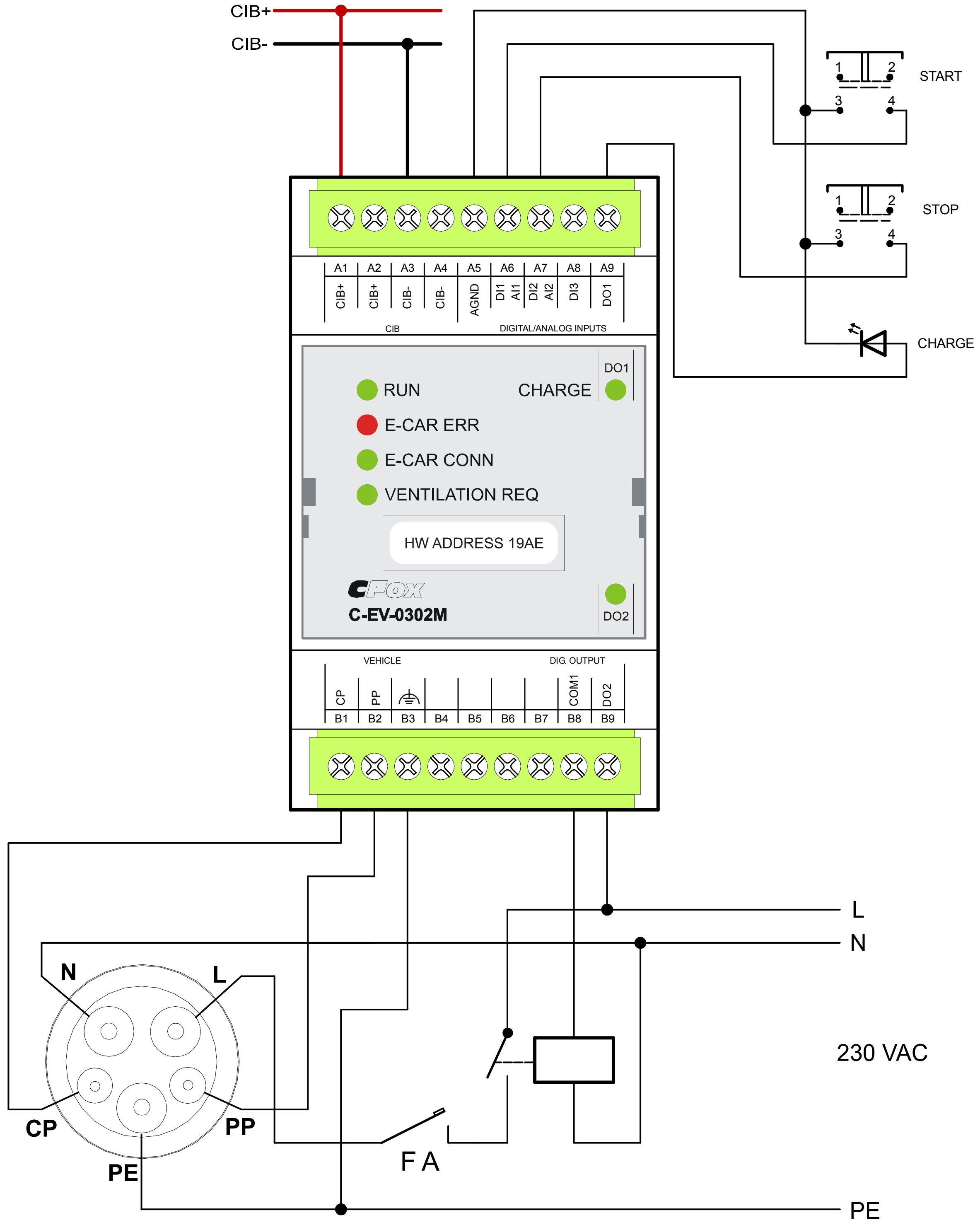


Fig. 14.1.29.1 An example of connecting the C-EV-0302M module.

14.1.30 C-IT-0200R-design, order no. TXN 133 20

The C-IT-0200R-Design module is a temperature sensor in selected interior designs, which can be directly connected to the CIB bus. The module is designed for assembly on the wall in the flush box

Construction of the module C-IT-0200R-design consists of two parts. The design part contains a temperature sensor and features a selected interior design. The second part is an embedded module, which is located in the flush box and enables the connection to the CIB bus.

The module contains two analogue measurement inputs.
The first is permanently connected to the internal temperature sensor, which is a part of the design.
The second input is terminated by wires on the embedded module and a stand-alone external sensor can be connected to it, such as the NTC 12k or an NTC within the range of the measured resistance up to 100k .

Basic parameters of the IN input of the C-IT-0200R-design module:

The range (the sensor type)	Resolution	The measurement error	The measurement range
NTC 12k	0.1 °C	0.5 °C	0 ÷ +90 °C
The resistance sensor	0.1kΩ	0.5 kΩ	0 ÷ 25kΩ
	0.2kΩ	0.5 kΩ	25 ÷ 50kΩ
	0.5 kΩ	1kΩ	50 ÷ 100kΩ

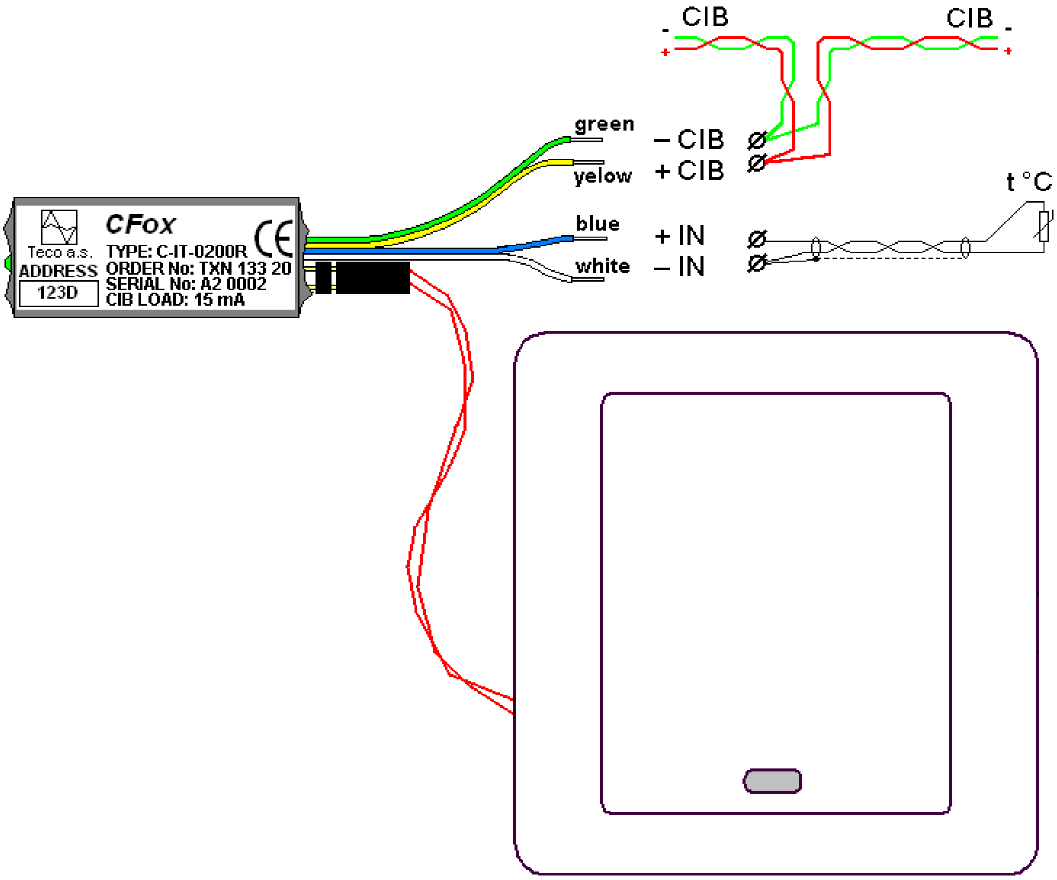


Fig.14.1.30.1. The signal layout of the C-IT-0200R-design module, the wire colour coding and the basic connection

(the old version before November 2012)

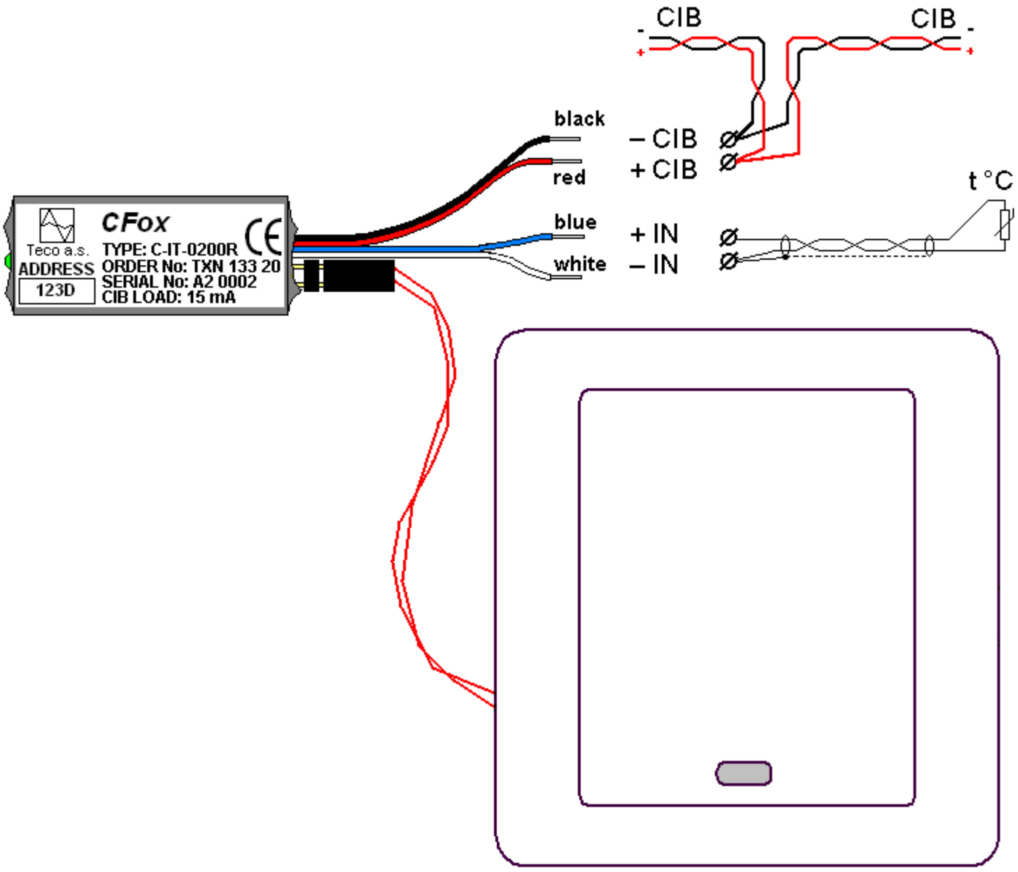


Fig. 14.1.30.2. The signal layout of the C-IT-0200R-design module, the wire colour coding and the basic connection

(the new version after November 2012)

Notes:

1. vývody modulu jsou izolovanými vodiči o průřezu 0,14 mm^2, délky cca 10 cm, zakončeny nalisovanými dutinkami H0,25/10.

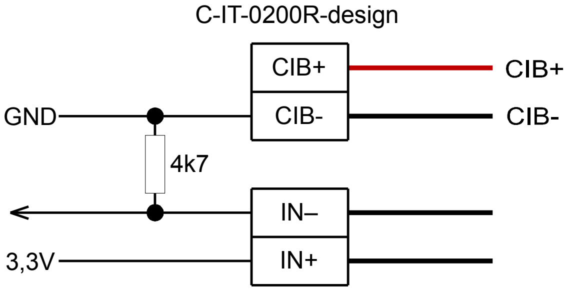


Fig. 14.1.30.3. Internal wiring of the C-IT-0200R-design module.

14.1.31 **The C-RC-0002R-design**

The C-RC-0002R module is an indoor control unit designed for simple control of room temperature; the control unit is supplied in a number of interior designs, and it can be connected directly to the CIB bus. The module is designed for assembly on the wall in the flush box The C-RC-0002R construction consists of two parts: The first part contains the user interface in various interior designs. The second part is the module, which is placed in a flush box and facilitates the connection to the CIB bus. Both parts are interconnected with a cable. The user interface includes a 3-digit 7-segment LCD display, 3 push buttons and a LED for indication. The module also contains two measurement inputs. The first is permanently connected to the internal temperature sensor. The second input is terminated by wires on the embedded module and a stand-alone external temperature sensor can be connected to it.

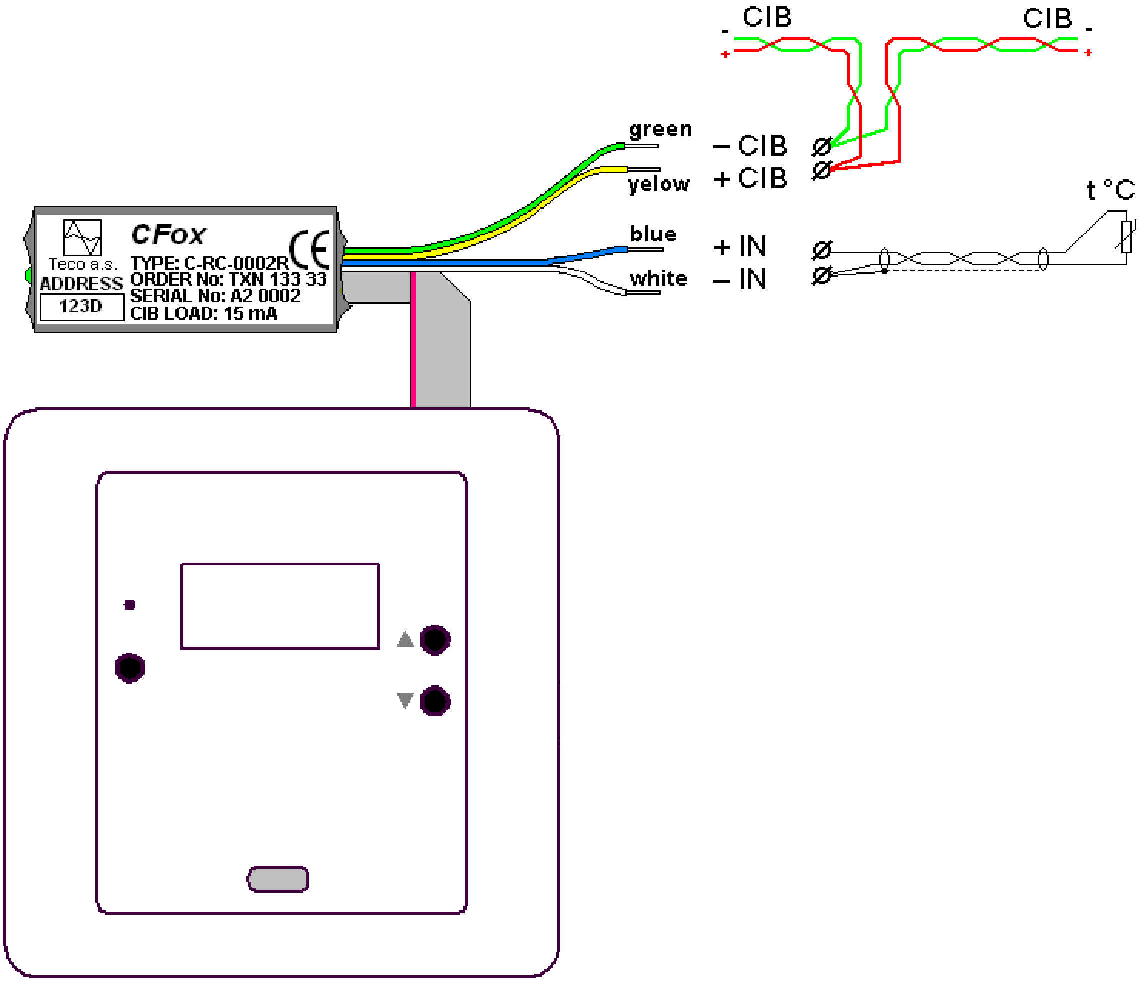


Fig. 14.1.31.1. The signal layout of the C-RC-0002R-design module, the wire colour coding and the basic connection
(the old version before November 2012)

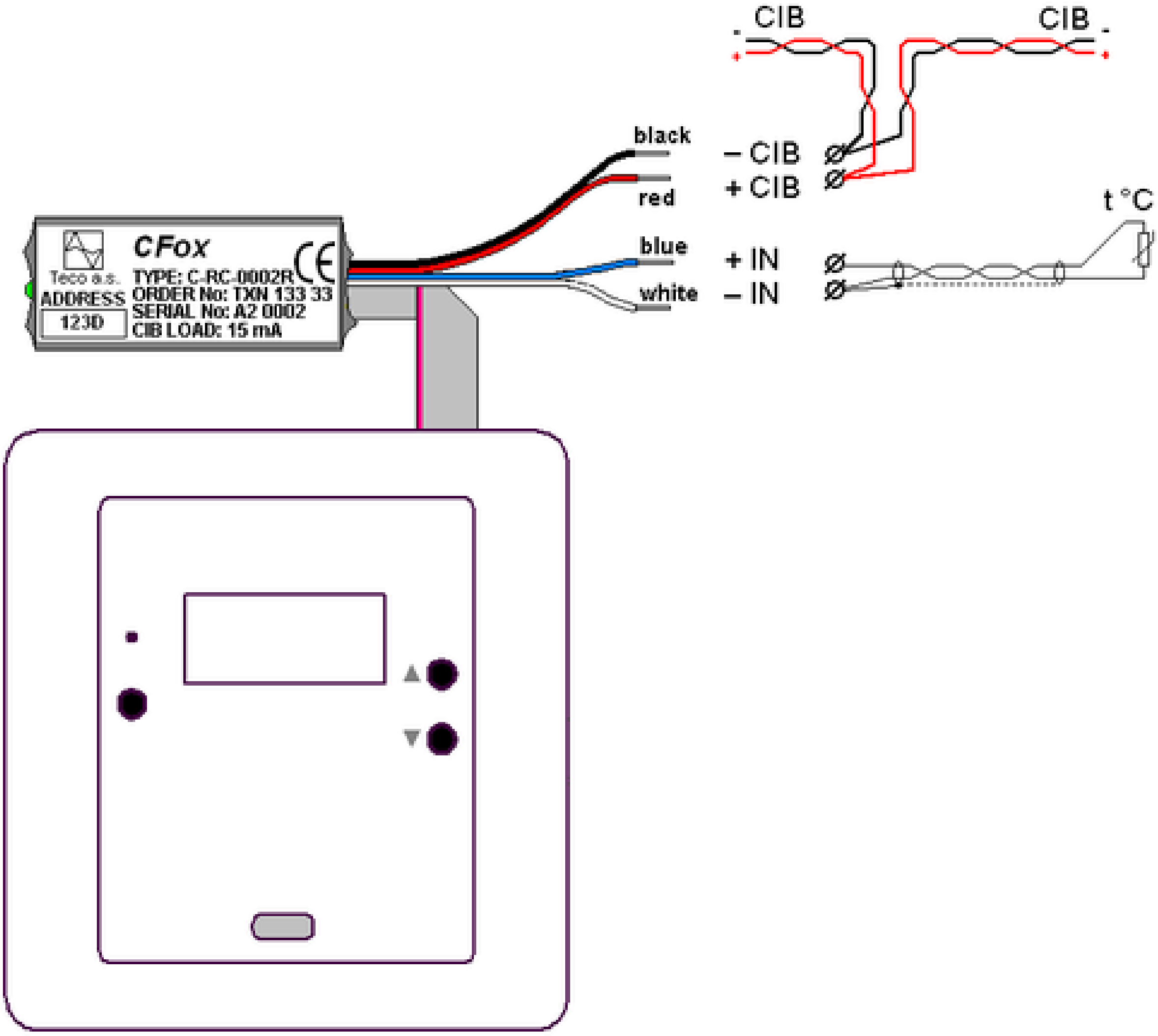


Fig. 14.1.31.2. The signal layout of the C-RC-0002R-design module, the wire colour coding and the basic connection
(the new version after November 2012)

Notes:

1. The module outputs are via isolated wires with the cross-section of 0.14mm^2, the length approx. 10cm, terminated with crimped ferrules H0.25/10.

Basic parameters of the IN input of the C-RC-0002R-design module:

The range (the sensor type)	Resolution	The measurement error	The measurement range
NTC 12k	0.1 °C	0.5 °C	0 ÷ +90 °C
NTC 5k	0.1 °C	0.5 °C	0 ÷ +90 °C
NTC 10k	0.1°C	0.5°C	0 ÷ +90 °C
NTC 15k	0.1°C	0.5 °C	0 ÷ +90 °C
NTC 20k	0.1 °C	0.5 °C	0 ÷ +90 °C

The resistance sensor	0.1kΩ	0.5 kΩ	0 ÷ 25kΩ
	0.2kΩ	0.5 kΩ	25 ÷ 50kΩ
	0.5 kΩ	1kΩ	50 ÷ 100kΩ

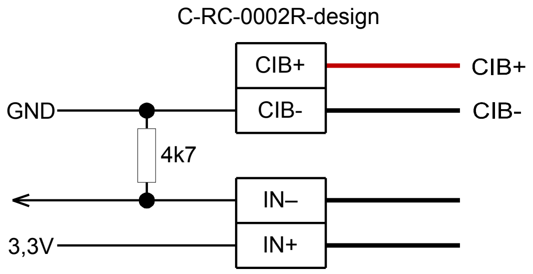


Fig. 14.1.31.3. Internal wiring of the C-RC-0002R-design module.

The available designs (the range is constantly expanding):

ABB	Tango, Alpha nea exclusive. Time, Element
Legrand	Galea, Galea Life, Valena and Cariva, Niloé
Bticino	Light, Light tech, Living a Axolute
Schneider Electric	Unica Colours, Basic, Plus, Top and Quadro
Moeller (NIKO)	Original, Intense and Pure
Merten	Antique
Berker	
Efapel	Logus

14.1.32 The C-RC-0003R-design

The C-RC-0003R module is an indoor control unit designed e.g. for simple control of room temperature, displaying the temperature, relative humidity, and the heating mode in the room; the control unit is supplied in a number of interior designs, and it can be connected directly to the CIB bus. The module always displays two values, including the units and several symbols from a fixed list in the module.
The module is designed for assembly on the wall in the flush box

The C-RC-0003R construction consists of two parts: The first part contains the user interface in various interior designs. The second part is an embedded module, which is located in the flush box and enables the connection to the CIB bus. Both parts are interconnected with a cable. The user interface includes a graphic LCD display with controlled white backlight (N.B.: displays in some design options have no backlight - e.g. UNICA) and 3 push-buttons.
The module also contains two measurement inputs. The first input is permanently connected to the internal temperature sensor and relative humidity sensor. The second input is terminated by wires on the embedded module and a stand-alone external temperature sensor can be connected to it.

The module is mounted an a standard flush box (e.g. the KU 68). The supporting part is usually fixed to the box (depending on the design), the built-in part of the module is put in the box, and the frame with the external part with the display is mounted to the supporting part.
During the installation it is recommended (if the wire outlets in the box permit) to put the built-in part as high as possible, and as far from the temperature/humidity sensor in the cover as possible. The built-in part has a certain heat loss, which to some extent affects the accuracy of measurements; it may cause an increase of the measured temperature by 0.6 °C, and humidity by about 1%. The error in measuring temperature can be corrected directly in the module SW configuration.
It is also necessary to realize that the backlight significantly increases the temperature in the module, and the 100% intensity of the backlight may cause a temperature rise of up to a few °C (and the corresponding reduction of RH by several %). Usually it is unnecessary to use the 100% intensity of backlight; if there is a requirement to reach exact measurement values, then it is recommended to set the permanent backlight at the maximum of 5 ÷ 10% of the value (the Light variable in the module data structure).

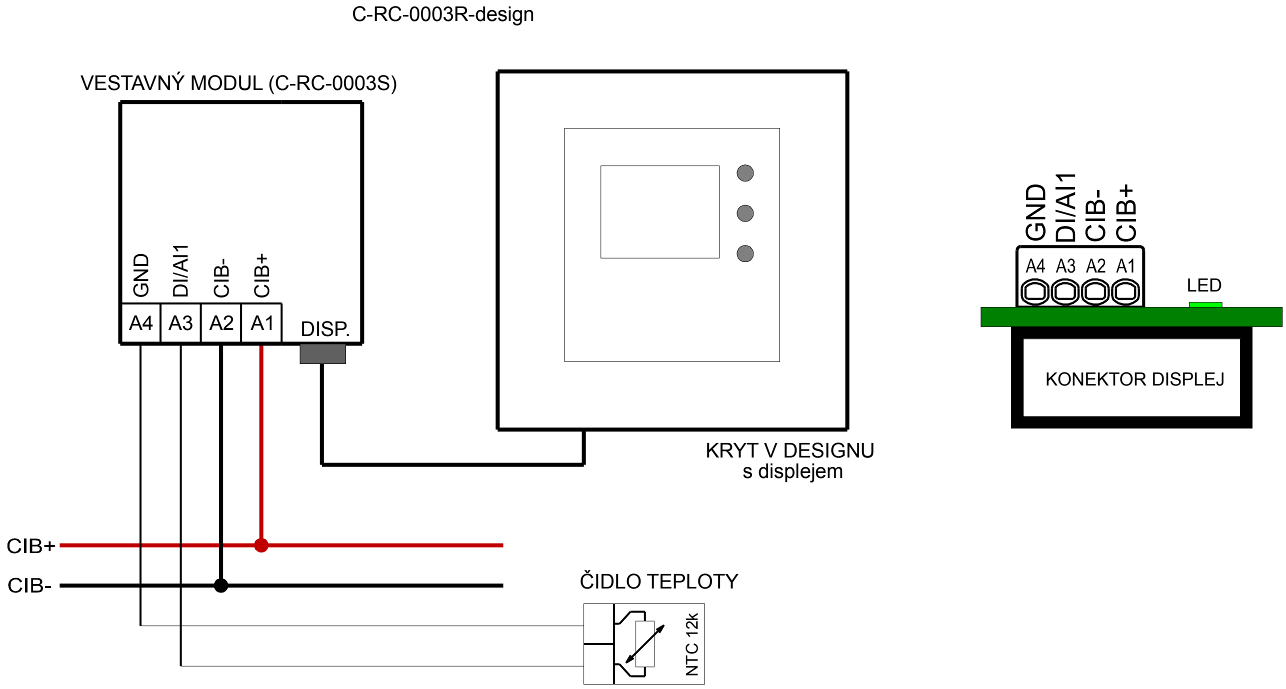


Fig. 14.1.32.1 An example of connecting the C-RC-0003R-design control module, including the external

temperature sensor

Notes:

1. The external temperature sensor must be Pt1000, Ni1000, KTY81-121, NTC 12k or other NTC with the resistance up to 160k; the connection cable can be up to dozens of meters long. A typical application is for a floor sensor. The recommended cables include e.g. the SYKFY or similar cables with at least 1x2 wires with 0.5mm diameter.
2. The module is designed as a small embedded module in a flush-box (KU68); it is terminated with the CIB bus terminal block and an external temperature sensor and a connector, into which should be inserted the temperature sensor cable from the top part of the module (the actual design cover with a mounted display, push-buttons, the temperature and a RH sensor.
3. Some design variants (e.g. UNICA) have displays without a backlight – a specific design and its characteristics have to be consulted with the Teco a. s. commercial department.

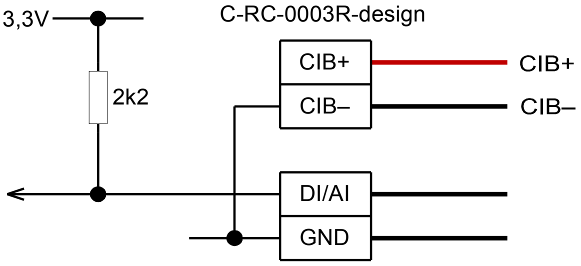


Fig. 14.1.32.2. Internal wiring of the C-RC-0003R-design module.

14.1.33 The C-WS-0x00R-Logus

Controllers in Logus design on the CIB bus are available in two versions:
The C-WS-0200R-Logus with one fingerboard (2 push-buttons – up and down).
The C-WS-0400R-Logus with two fingerboards (4 push-buttons – each fingerboard has a push-button up and down).

Both types of control units are equipped with an internal temperature sensor and they have two universal inputs terminated on the terminal block (measuring the temperature, binary inputs).
The module is fitted with LED indicators. Each fingerboard features a red and a green LED; their control depends on the application required by the customer.

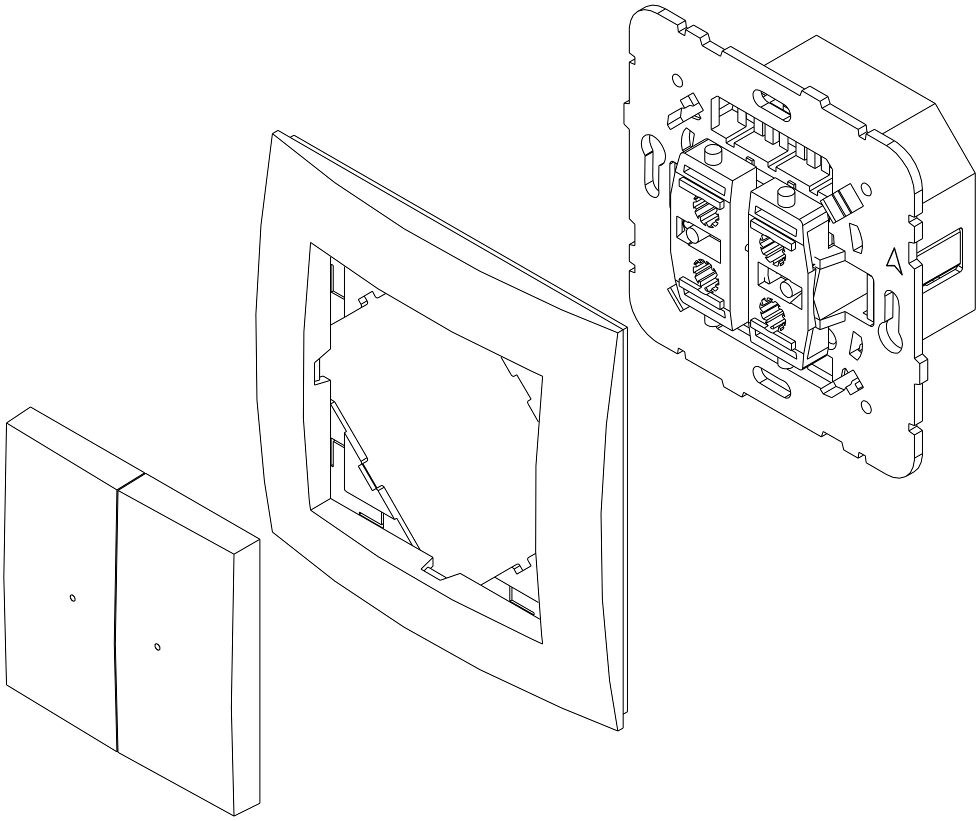


Fig. 14.1.33.1 The C-WS-0400R-Obzor control unit design (similarly also the C-WS-0200R-Obzor).

Notes:

1. The module consists of the fingerboards, a standard frame and the basic part with the electronics (in the figure left to right).
2. The rear part features a LED indicator (the module operation) and the terminated wires.

14.1.34 The C-WS-0x00R-ABB

The C-WS-0400R-ABB and C-WS-0200R-ABB control unit are also interior push-button control units for ABB designs. A comprehensive family of control units can be fitted with a number of fingerboards designed by ABB, e.g. Time Tango, Neo, Levit ... (for more variants see the Teco catalogue). Each control unit is fitted with an internal temperature sensor, which is located under the fingerboard. It means that the interior temperature can be measured directly, without the need for a separate sensor. However, the measurement accuracy is affected by the fact that the module tends to warm up. Therefore, after switching on and stabilizing the temperature, its correction should be made (the correction parameter is a part of the module configuration in the Mosaic environment).

The CIB bus is connected to the terminal block on the rear side of the module, where also the AI/DI universal inputs are terminated. Each of the universal inputs can be used separately either in the function of binary dry input, or as a balanced input, or as an analogue input for connecting a resistive temperature sensor.

The module is mechanically adapted for mounting on a standard flush box with 60mm spacing between the fixing screws.

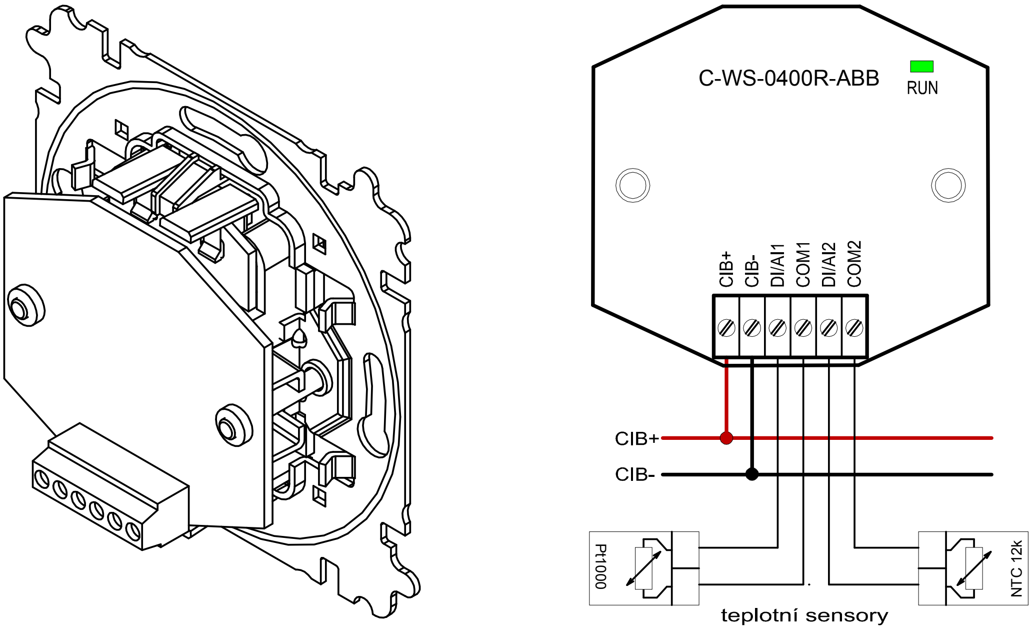


Fig.
14.1.34.1 A view of the rear part of the C-WS-0200R-ABB and C-WS-0400R-ABB modules with the terminal block

Notes:

1. The temperature sensor can be the Pt1000, NI1000, NTC 12k or any other NTC with a resistance up to 100k; the feeder cable length can be up to dozens of meters - a typical use is a floor sensor, cable used e.g. SYKFY or similar, with at least 1x2 wires with 1,5mm.
2. The module is designed as a standard installation element to be mounted on the flush box (KU68).
3. The terminal block is designed for conductors with a max. cross section 1.5mm^2

Basic parameters of the DI/AI1 and DI/AI2 inputs

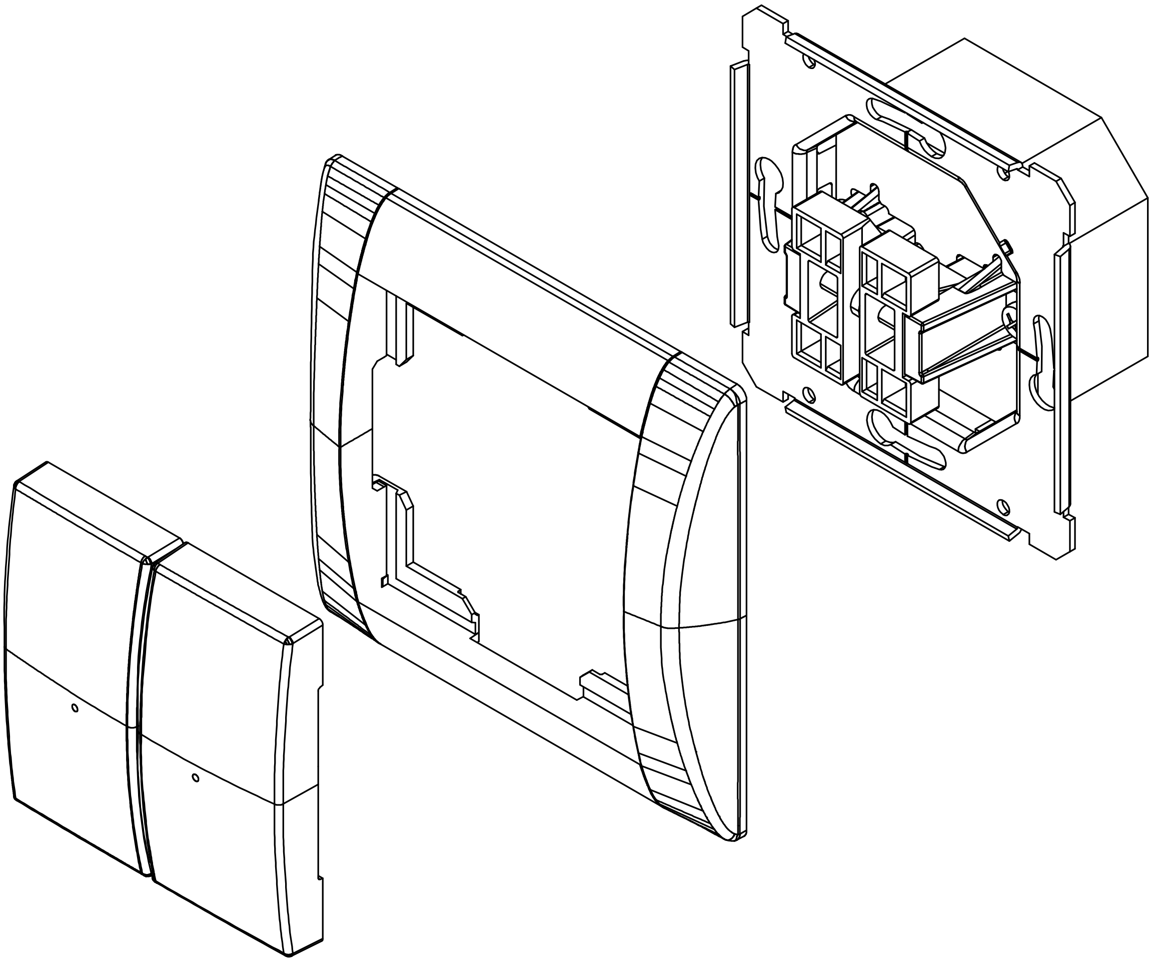
The input type (connected sensor)	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
The range of measuring resistance	0 ÷ 100kΩ
The voltage range	0 ÷ 2V

Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	The loop resistance 2x 1k1

14.1.35 The C-WS-0x00R-Obzor

The controller designs by Obzor Zlín (Decene, Elegant, Variant) on the CIB bus are available in two versions:
The C-WS-0200R-Obzor with one fingerboard (2 push-buttons – up and down).
The C-WS-0400R-Obzor with two fingerboards (4 push-buttons – each fingerboard has a push-button up and down).

Both types of control units are equipped with an internal temperature sensor and have two universal inputs terminated on the terminal block (measuring temperature, binary inputs).
The module is fitted with LED indicators. Each fingerboard features a green LED; its control depends on the application required by the customer.



F ig. 14.1.35.1 The C-WS-0400R-Obzor control unit design (similarly also the C-WS-0200R-Obzor).

Notes:

1. The module consists of the fingerboards, a standard frame and the basic part with the electronics (in the figure left to right).
2. The rear side of the module features a LED indicator (the module operation) and terminated wires from CIB and two universal inputs.
3. The figure show a frame design Elegant (the interjacent frame is not indicated, as it fixes the frame to the basic part).

14.1.36 The C-WS-0x00R-iGlass

The C-WS-0400R-iGlass control units are interior touch control units from the iGlass design series. A coherent group of control units includes variants with 1-6 backlit buttons, a circular sensor, or sometimes with a two-digit display (for see specific variants see the Teco catalogue). The control units are also equipped with an acoustic output and an integrated proximity sensor. All the design variants of the module also contain 2 universal AI/DI inputs. Each of the universal inputs can be used separately either in the function of a binary dry input, or as an analogue input for connecting a resistive temperature sensor.
The module is mechanically adapted for mounting on a standard flush box with 60mm spacing between the fixing screws. The terminal block for connecting the CIB bus and external AI/DI is on rear side of the module.
There are two basic mechanical versions of the control units: with an 80 x 80mm front glass (the standard controller shape), or 80 x 120mm.

The 80x80mm front glass is rectangular, the glass is black with a blue tinge. The variants:
1- push-button, order number TXN 133 72.01
2- push-buttons, order number TXN 133 72.02
4- push-buttons, order number TXN 133 72.04
a dimmer (a circular control unit) order number TXN 133 72.05
4- push-buttons with a display, order number TXN 133 72.07
a 230V socket, order number TXN 133 72.09

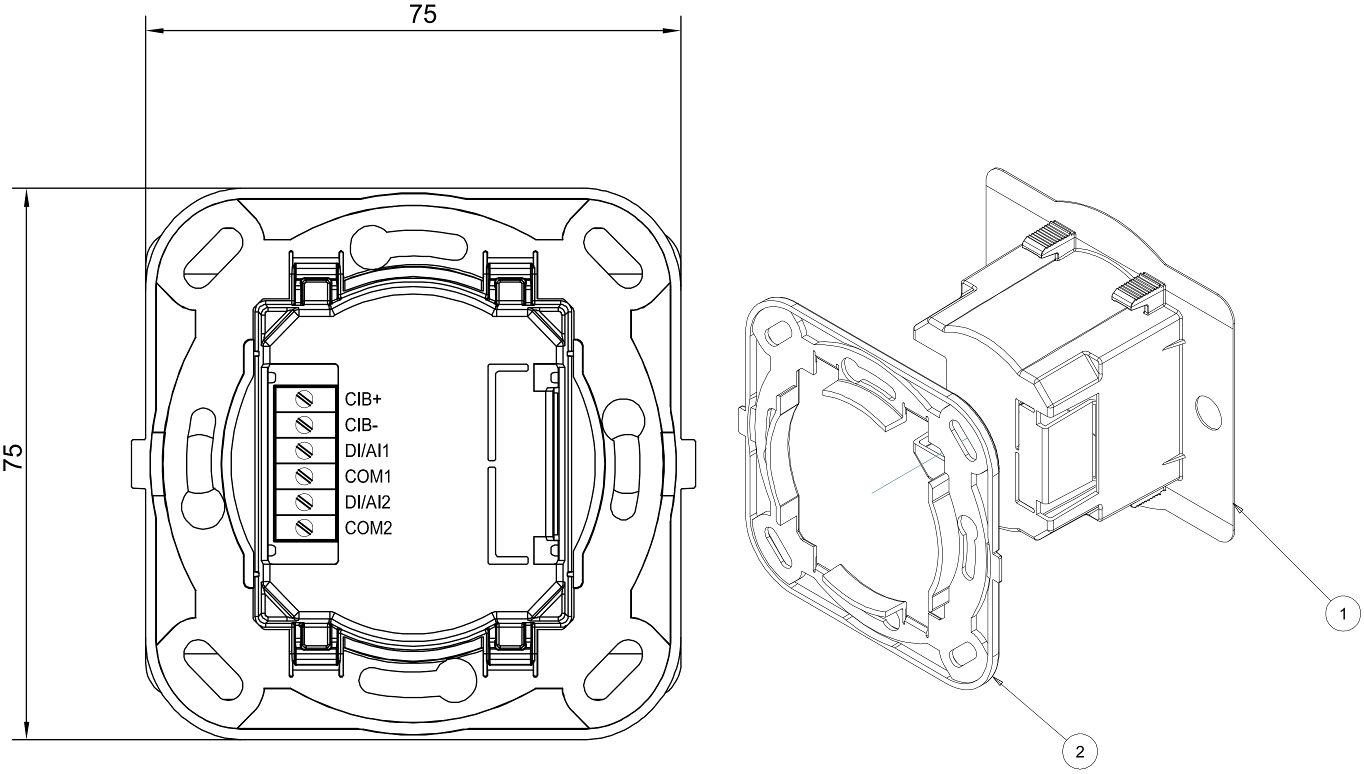


Fig. 14.1.36.1 The placement of the terminal block and the dimensions of the control units C-WS-0x00R-iGlass, the version 80 x 80mm

Notes:

1. The temperature sensor can be the Pt1000, NI1000, NTC 12k or any other NTC with a resistance up to 100k; the feeder cable length can be up to dozens of meters - a typical use is a floor sensor, the cable used e.g. SYKFY or similar, with at least 1x2 wires with 0.5mm diameter.
2. The module is designed as a standard installation element to be mounted on the flush box (KU68).
3. The CIB bus and both universal inputs DI/AI1 and DI/AI2 are terminated on the terminal block in the rear part of the module.
4. The C-WS-0x00R-iGlass

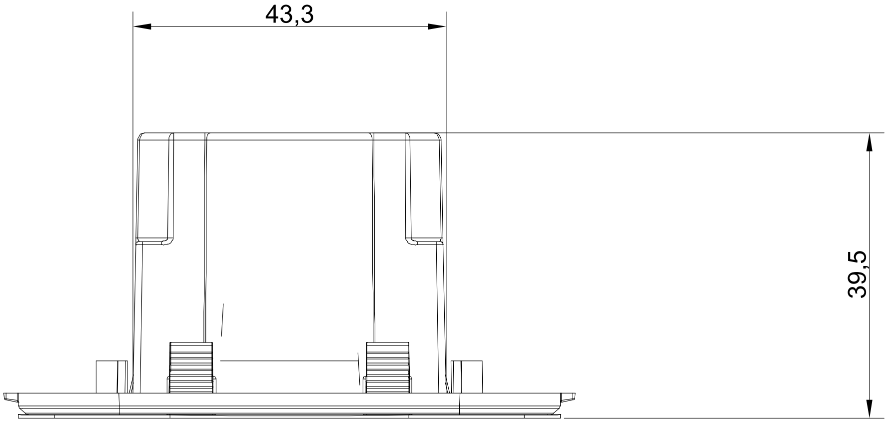


Fig. 14.1.4.2 The dimensions of the control units (the depth) C-WS-0x00R-iGlass, the version 80 x 80mm

The **80 x 120mm front glass** is rectangular, the glass is black with a blue tinge. The variants:

6 push-buttons order no. TXN 133 72.16
4-push-buttons with a display order no. TXN 133 72.17
a 230V socket, order number TXN 133 72.19

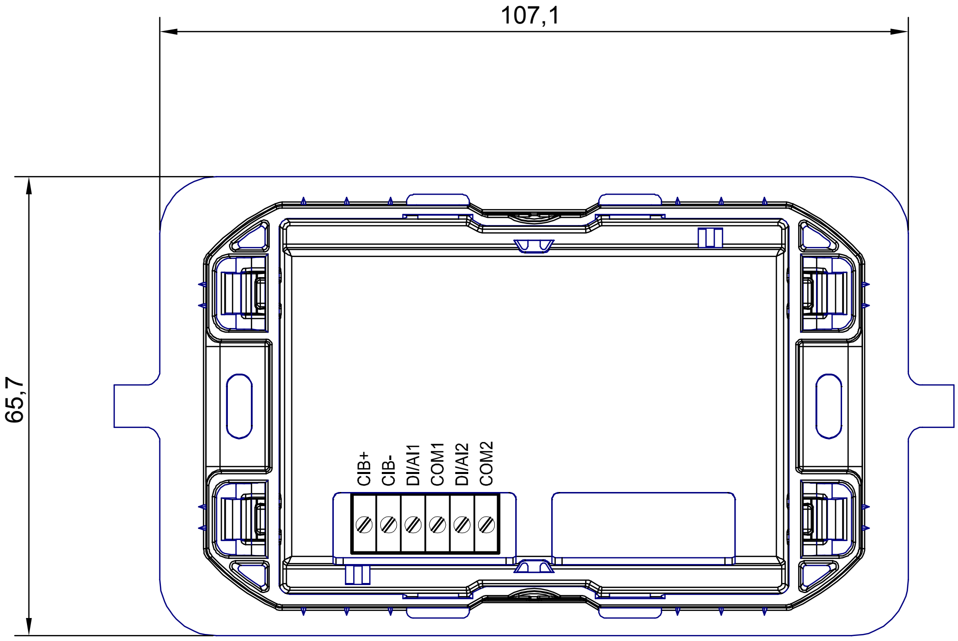
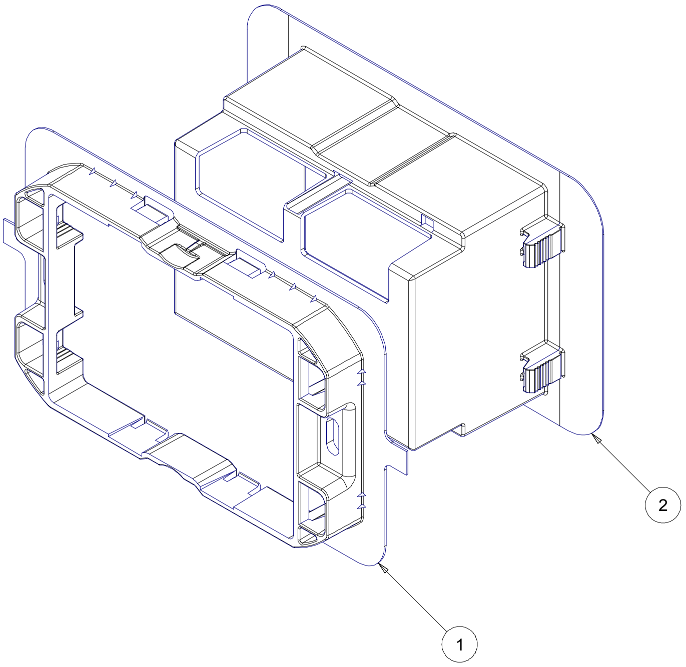


Fig. 14.1.36.3 The placement of the terminal block and the dimensions of the control units C-WS-0x00R-iGlass, the version 80 x 120mm

Notes:

1. The temperature sensor can be the Pt1000, NI1000, NTC 12k or any other NTC with a resistance up to 100k; the feeder cable length can be up to dozens of meters - a typical use is a floor sensor, the cable used e.g. SYKFY or similar, with at least 1x2 wires with 0.5mm diameter.
2. The module is designed as a standard installation element to be mounted on a rectangular flush box.
3. The CIB bus and both universal inputs DI/AI1 and DI/AI2 are terminated on the terminal block in the rear part of the module.



F ig. 14.1.36.4 The C-WS-0x00R-iGlass control unit, the version 80 x 120mm.

Notes:

1. Component 2 is the supporting frame in the flush box, into which the body of the control unit (component 1) is gently pressed. The top part with the glass is not shown in the Fig.

Basic parameters of the DI/AI1 and DI/AI2 inputs

The input type (connected sensor)	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
The range of measuring resistance	0 ÷ 100kΩ
The voltage range	0 ÷ 2V
Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	The loop resistance 2x 1k1

Touch sensors

Capacitive push-buttons	1 ÷ 6 (according to the type of control unit)
Circular touch sensor	1
Proximity sensor	1 (sensitivity on approx. 2cm)
A seven-segment display	2 digits, 2 decimal points

Basic parameters of the **module**

Dimensions	80 x 80 x 50mm or 120 x 80 x 50mm
Operating temperature	-10 ÷ +55 °C
Storage temperature	-25 ÷ +70 °C
Connecting the screw-type terminal	Cross-section of wires max. 1.5mm^2

14.1.37 The C-RS-0200R

The C-RS-0200R-design is a rotary interior control unit with the one-button function with a connection to the CIB bus. At the same time it is fitted with two universal inputs terminated in the terminal block on the rear side of the module, e.g. for interconnection of the floor temperature sensors, auxiliary push-buttons (S-WS-0200R) etc.

Basic parameters of the module

Power supply	from the CIB bus
Power supply tolerance	24 nebo 27VDC ± 10%
The number of external inputs	2 (DI1/AI1 and DI2/AI2)
The ranges of external sensors	voltage-free contact Pt1000: -90 °C ÷ 320 °C Ni1000: -60 °C ÷ 200 °C NTC 12k: -40 °C ÷ 125 °C KTY81-121: -55 °C ÷ 125 °C 0 ÷ 100kΩ 0 ÷ 2V
Measurement accuracy	± 1 °C

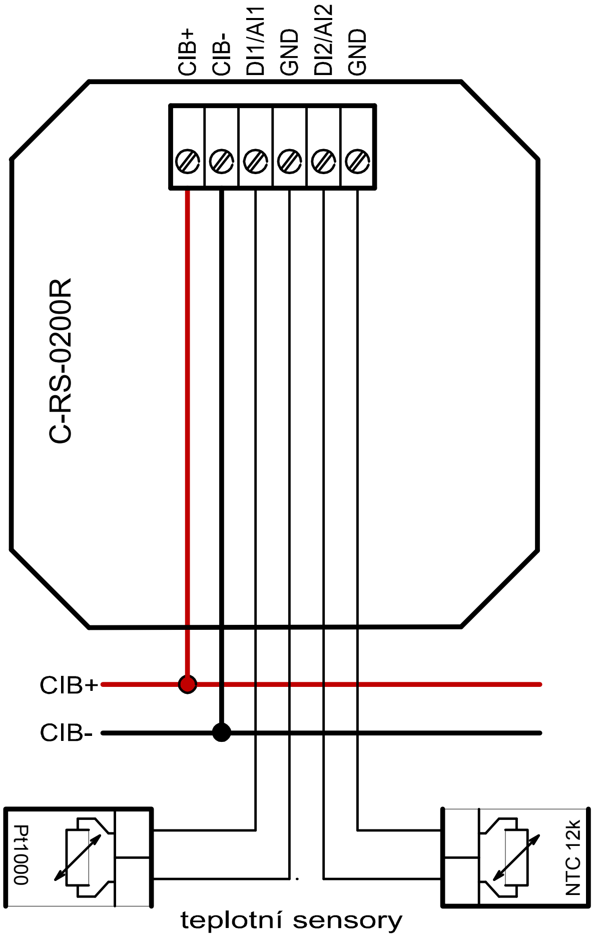


Fig. 14.1.37.1 An example of connecting the rotary

The module is supplied in several versions for the designs: ABB, Logus and Obzor. Each variant has a given design of the rotary control shaft (for proper insertion of the control unit). The ABB design includes a clamp in its standard accessories, which secures housing with the frame to the module itself. The housing for this design also includes screws to fix the Logus and Obzor design housing and the frame.

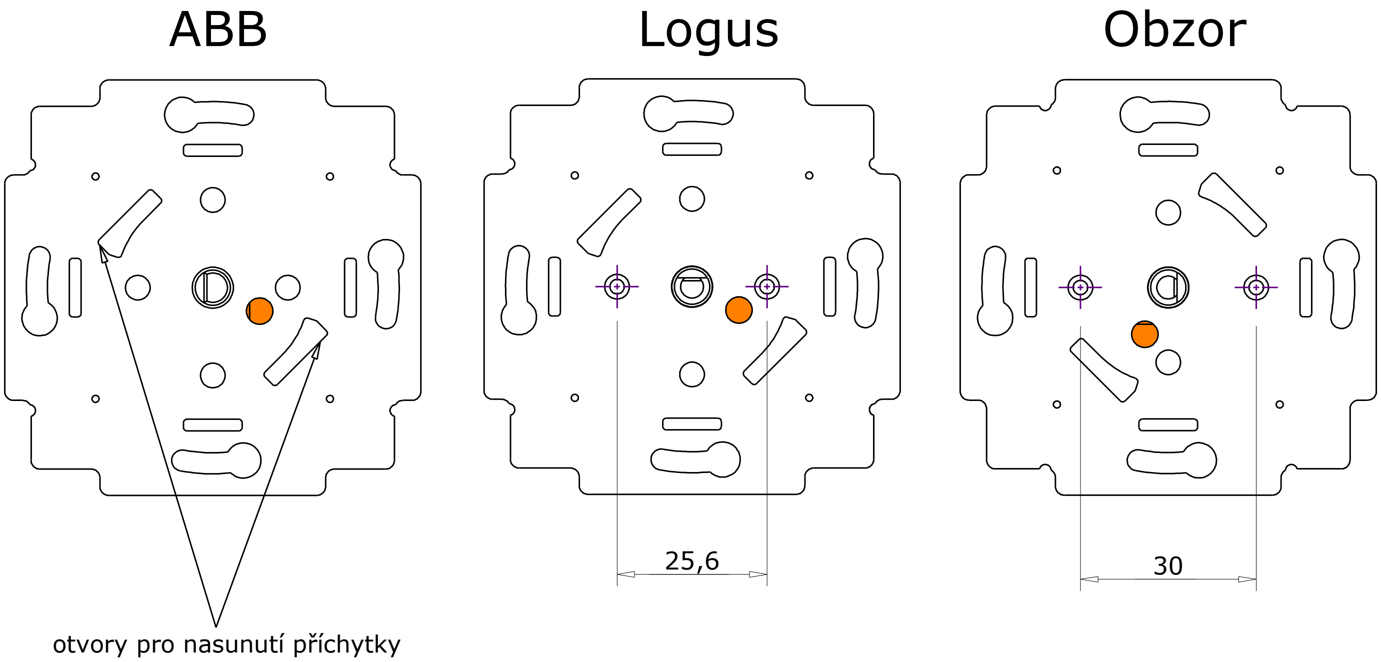


Fig. 14.1.37.2 The fixing holes for the C-RS-0200R module for individual designs

Notes:

1. The left image shows the holes for pushing in the clamp for fixing the housing and the frame for ABB designs. The clamp is a standard part of the C-RS-0200R-ABB module.
2. The middle figure shows the orientation of the module and the correct holes for screwing on the frame in the Logus design.
3. The figure on the right has highlighted screw holes for the housing in the Obzor design.
4. The coloured circle represents the temperature sensor in the hole in the module, that can also help you find the right orientation when mounting the module onto the flush box (assuming it is a standard type KU 68).

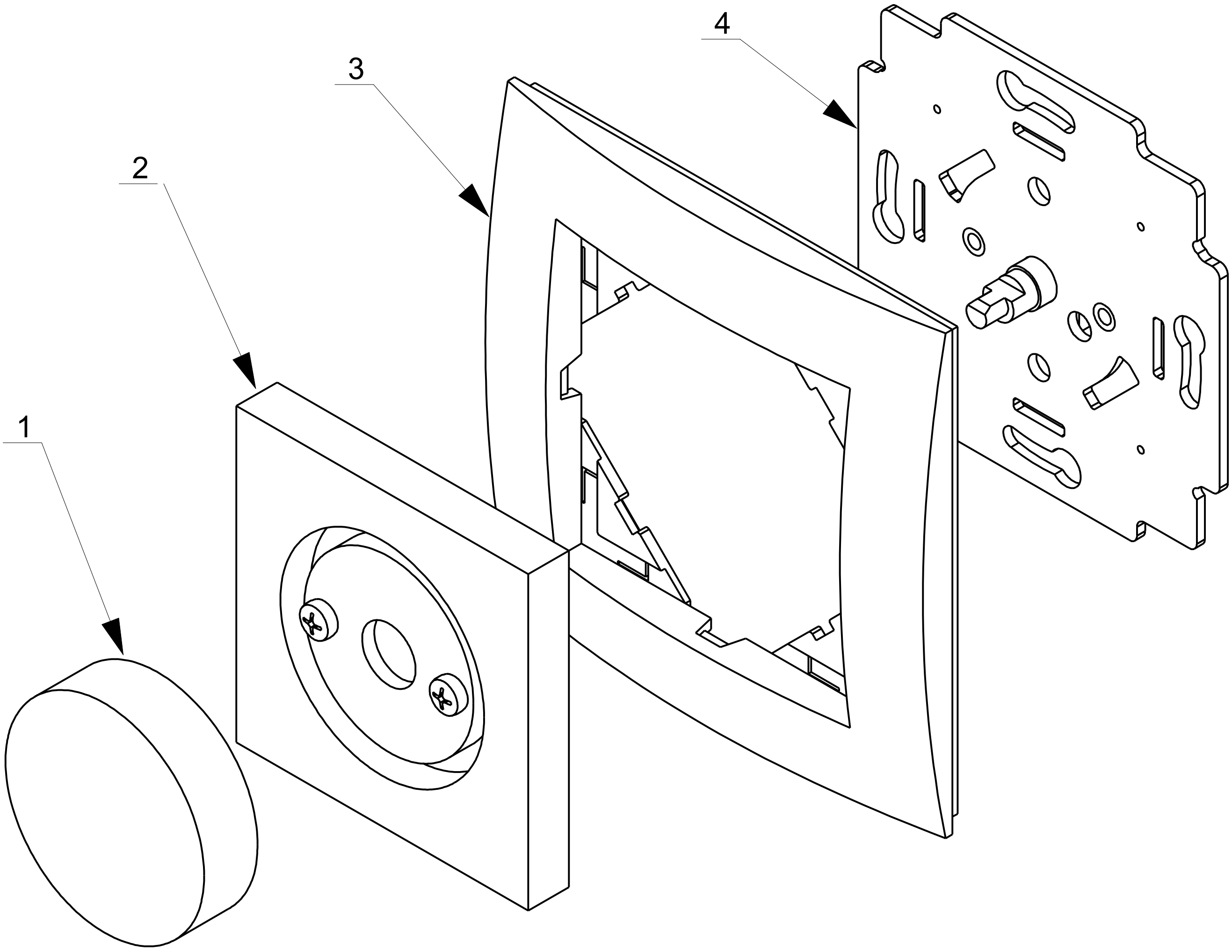


Fig. 14.1.37.3 The assembly of the C-RS-0200R rotary control unit in Logus and Obzor designs

1. the rotary control unit, a part of the housing in the selected design
2. the dimmer housing in the selected design and colour: 90721 Txx (Logus), DSD00-2700xx (Decente), DSE00-270xx (Variant and Elegant)
3. the frame in the selected design and colour
4. the body proper of the C-RS-0200R-Logus or C-RS-0200R-Obzor module

Mounting of the module:
Screw the C-RS-0200R-Logus or C-RS-0200R-Obzor module onto a standard flush box (e.g. the KU 68 - part 4 in the figure).The orientation of the module according to the design is indicated in Fig. 14.1.37.2.
Screw the housing (part 2) onto the module; this will help you to fasten the frame (part 3) to the module. In Lotus design, use the housing of the two-way dimmer 90721 T, and a frame according to the selected colour.The Obzor designs require the dimmer housing with a rotary push-button switch DSD00-270XX for the Decente deign, or the DSE00-270XX for the Elegant and Variant designs.
As the last part of the assembly, push the rotary control (part 1) onto the module shaft; the rotary control is a part of the housing in the selected design.

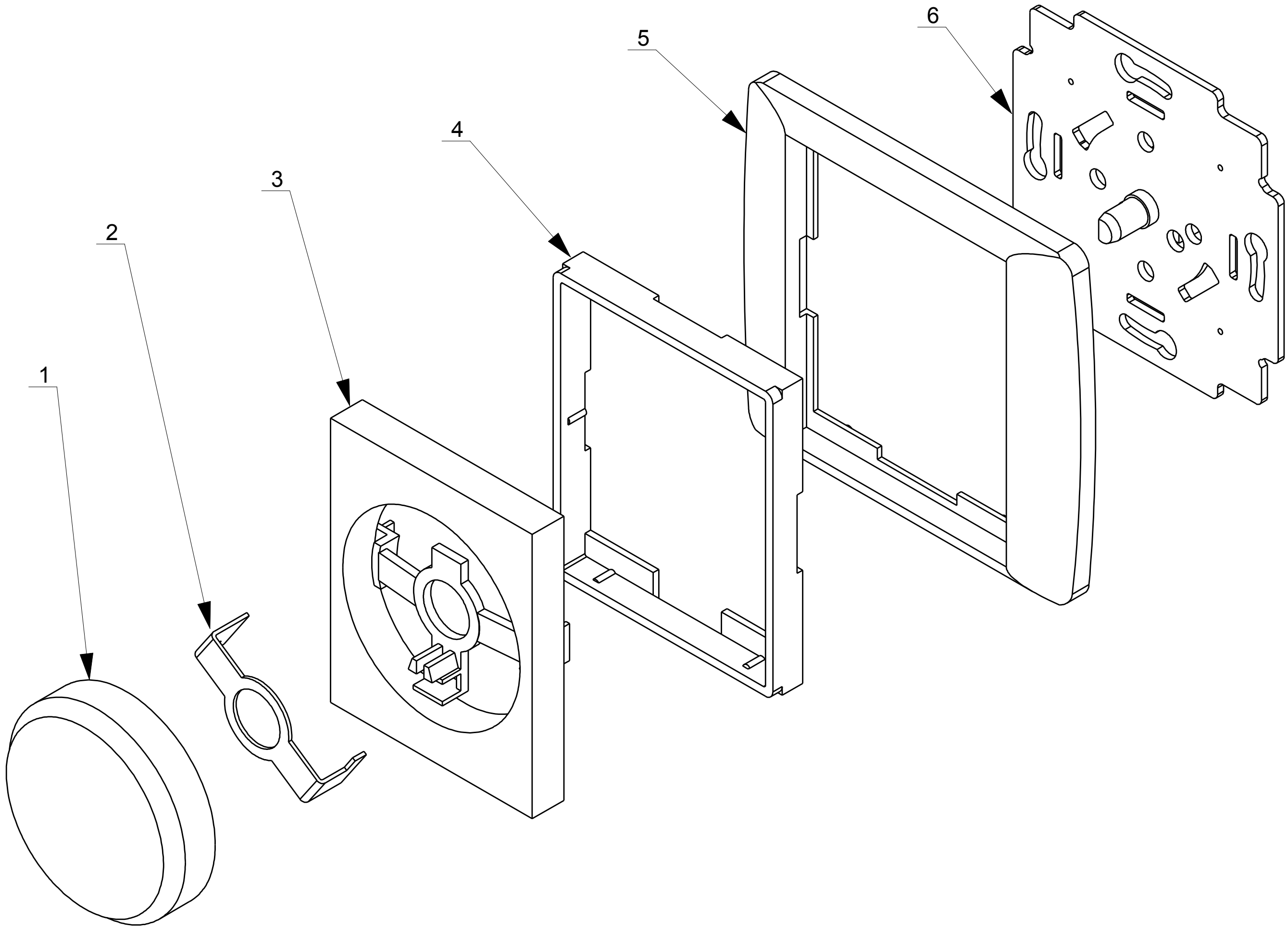


Fig. 14.1.37.1 An assembly of the C-RS-0200R rotary control unit in the ABB version (in the figure is the Time design)

1. the rotary control, a part of the housing in the selected design
2. the clip of the housing is a part of the package of the C-RS-0200R-ABB module
3. the dimmer housing in the selected design and colour; here it is the Time design:3294E-A00123 xx
4. the interjacent frame (doesn´t have to have other designs)
5. the frame according to the selected design and colour
6. the body proper of the C-RS-0200R-ABB module

Mounting of the module:

Screw the C-RS-0200R-ABB (part 6 in the figure) onto a standard flush box (e.g. the KU 68). The orientation of the module according to the design is indicated in Fig. 14.1.37.2.
Put the dimmer housing with the rotary control onto the module - the design in the example is Time 3294E-A00123 xx (part 3) together with the interjacent frame (part 4) and the frame (part 5). Fasten the housing on the module using a clip (part 2), which should be inserted into the holes in the module (see Fig14.1.37.2), then slightly pushed and turned counter-clockwise.Now the housing with the frame is properly attached to the C-RS-0200R-ABB module.

As the last part of the assembly, push the rotary control onto the module shaft (part 1); the rotary control is a part of the housing in the selected design.

14.1.38 The C-RI-0401S

The C-RI-0401S (order no TXN 133 47) is a combined module designed for a connection on the CIB bus. The module contains 2 universal analogue/binary inputs; it is possible to connect either passive resistive temperature sensors to them, or they can be used as potential-free contacts. It also includes an input for measuring illumination and includes a transmitter and a receiver of infra-red signal. The module is terminated with 10 connector pins with a counterpart, with terminated colour-coded wires with sleevings. Compatible components of the IR transmitter and receiver are connected to the module (included in the supply), as well as a lighting sensor.
Also external temperature sensors (Pt1,000, W_{100}=1.385) can be connected, as well as dry contacts. Connecting elements to the wires of the module is indicated (including the colours) in the following figure.

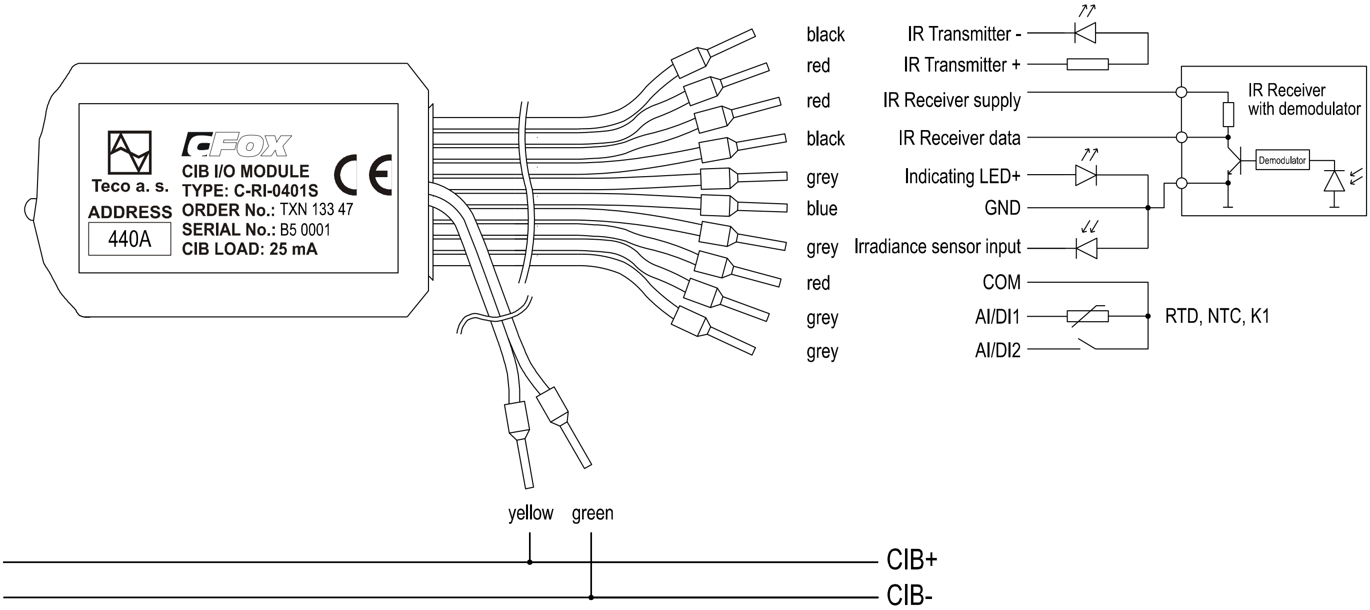


Fig. 14.1.38.1. Connecting the C-RI-0401S outputs (including the order and colours of the wires).

Notes:
1) IR receiver (IR Rec) and IR transmitter (IR LED) are included in the supply of the C-RI-0401S module.
2) LED (black and grey wires) is a common LED for the indication of reception of IR (the anode on LED+).
3) LS is an input of the lighting sensor (irradiance input).
4) The AI/DI1 inputs and 2 are optionally analogue (Pt1000, Ni1000, NTC) or contact inputs.

The basic parameters of inputs and outputs:

IR transmitter	maximum 3.3V, 100mA, the LED transmitter is normally a part of supply.
IR receiver	a demodulator 36kHz, it is normally a part of supply.
The lighting	the BPW21 sensor, the measurement range is 0÷50,000lx.
AI/DI	AI - Pt1000, Ni1000, NTC 12k, KTY81-121, resistance up to 160k, DI – the current excited by the input typically 3.3mA
LED:	LED indicator (controlled as a binary output).

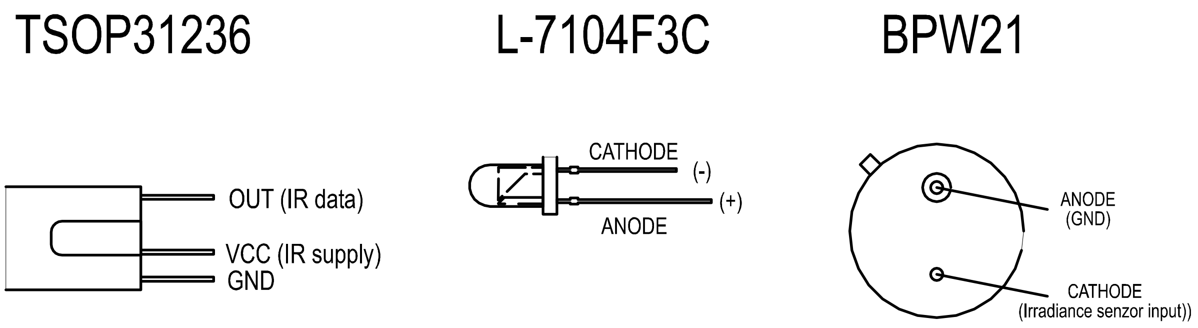


Fig. 14.1.38.2. Outlets of the IR receiver TSOP31236, the IR transmitter L-7104F3C and the lighting sensors BPW21

Calculation of the external resistance for the IR transmitter

The internal resistance is 22Ω, the external resistance is added according to the required current of the transmitting diode. The minimum recommended current is approx. 100mA.
The connection with the L-7104F3C diode (voltage in the forward direction approx. U_F = 1.2V) and an external serial resistance R = 100Ω (normally fitted in the C-RI-0401R-design) works with the current I_F approx. 30mA:

$$I_F = \frac{5 - UF}{22 + R}$$

calculation of the current I_F flowing through the transmitting diode during the transmission.

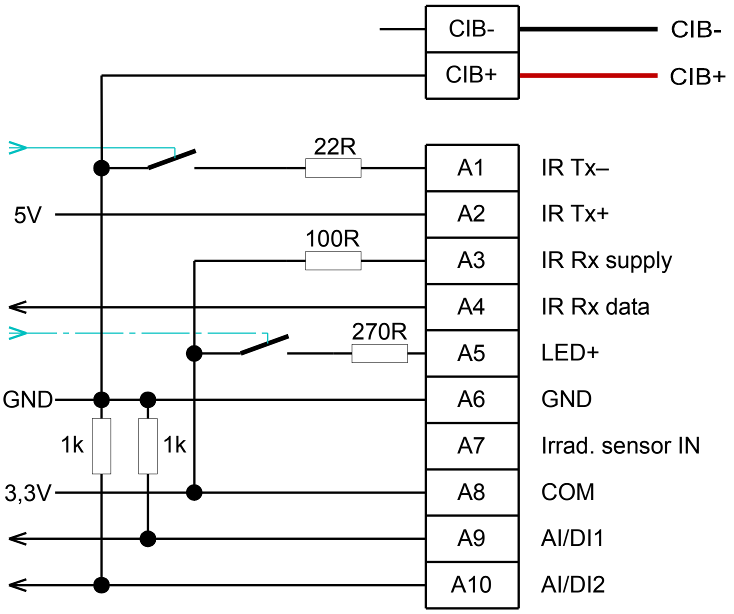


Fig. 14.1.38.3. Internal wiring of the C-RI-0401S module. y

14.1.39 The C-RI-0401R-design

The IR receiver and transmitter module, measurement of the lighting and 2x AI/DI designed according to customers´ requirements for the design elements - switches, sockets, etc.), the C-RI-0401R consists of two parts:

The first part - the actual module (it corresponds with the C-RI-0401S module) - is placed in the flush box, which enables the connection to the CIB bus and provides processing of all connected sensors and elements.

The second part is the housing in the selected interior design (ABB Time, Logus, and other custom-made designs), which is mounted on the flush box. Both parts are interconnected via a cable, which is terminated on both ends with an identical connector. This part of the module is normally fitted with an IR transmitter and receiver, a lighting sensor, an interior temperature sensor and terminals for connecting another temperature sensor (e.g. measuring the floor temperature).
Other versions with different devices can e also be custom-made, such as IR Rx and Tx, lighting, AI/DI - e.g. push-button, indication LED (IR indicator, etc.), depending on the specific wish of the customer.

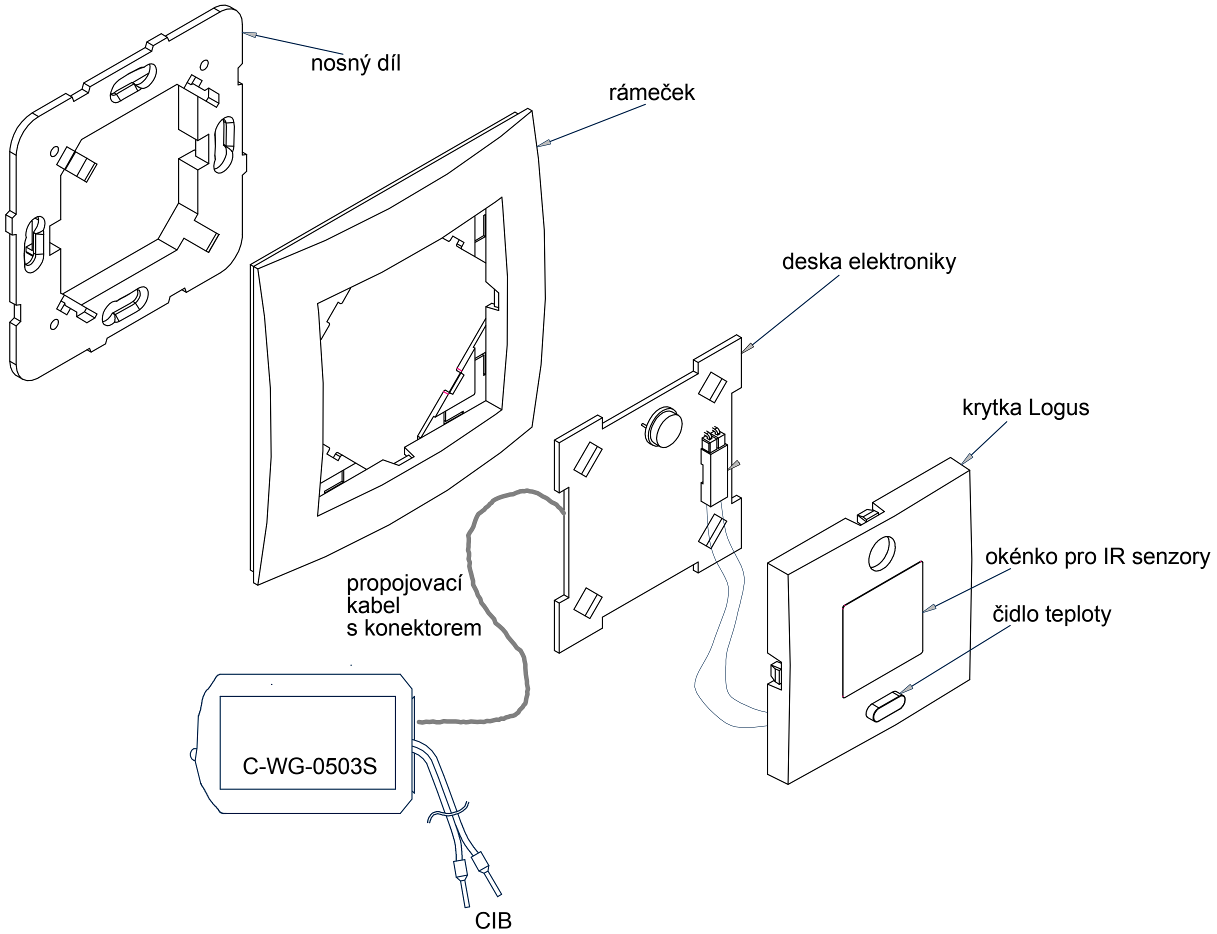


Fig. 14.1.39.1. The C-RI-0401R-design module assembly

14.1.40 The C-WG-0503S

The module is designed to connect readers of proximity RFID identifiers with the Wiegand protocol (e.g. Aktion AXR-100, AXR-110, Samsung SSA-1001, SSA-R2000V, and others) and the intrusion detectors (ESS/FAS sensors including the 12VDC power supply).
In addition to signals for connecting readers (communication, display) the module also contains 1 dry binary input and 2 universal inputs.
Each of the universal inputs can be used separately either in the function of binary dry input, or as a balanced input (connecting ESS sensors), or as an analogue input for connecting a resistive temperature sensor. The signals for connecting a reader can also be reconfigured for the function of 2 digital inputs and 3 digital outputs. Possible configuration options of the module inputs and outputs are shown in Table 14.1.40.1.
The mechanical design of the module is intended for installation under the cover of the IP10B module. The module signals are terminated on a removable connector with loose wires.

The type of coding

The module allows processing codes via the protocol Wiegand 26, Wiegand 34 or Wiegand 42 bits and the transparent transfer 40 bits.

Table14.1.40.1: Configuration options of the C-WG-0503S module (to be set in the module software configuration).

Possible configurations:	**DI1**	**DI2**	**DI3**	**DO1**	**DO2**	**DO3**	**DI/AI4**	**DI/AI5**
Wiegand, 1x DI, 2x AI/DI, 3x DO	DI	Data1	Data0	DO	DO	DO	AI/DI	AI/DI
3x DI, 2x AI/DI, 3x DO	DI	DI	DI	DO	DO	DO	AI/DI	AI/DI

Table14.1.40.2: The basic parameters of the inputs and output of the C-WG-0503S module:

Binary inputs **DI1, DI2, DI3**	
Type	TTL 5V
Pull-up resistor	3.9kΩ
Galvanic isolation	No
The Wiegand interface	26/34/42 bit (3/4/5 bytes) and 40bits transparent
Binary outputs (**DO1, DO2, DO3**)	
Type	open collector NPN
Switching voltage	maximum 30V
Switching current	maximum 30mA
Galvanic isolation	No
Analogue and binary inputs (**AI/DI4, AI/DI5**)	
The range (the type of connected sensor):	Pt1000, W_{100} = 1,385, -90 to +320 °C Pt1000, W_{100} = 1,391, -90 to +320 °C Ni1000, W_{100} = 1,617, -60 to +200 °C Ni1000, W_{100} = 1,500, -60 to +200 °C NTC 12k, -40 to +125 °C KTY 81-121, -55 to +125 °C OV160k, general resistance 0 ÷ 160kΩ potential free contact (the input value 0 for >1.5kΩ/1 for <0.5kΩ) single or double balanced input for ESS sensors, resistance 2x 1k1
Output 12VDC (**+12V**)	
Output current	maximum 60mA (medium value of the output current)

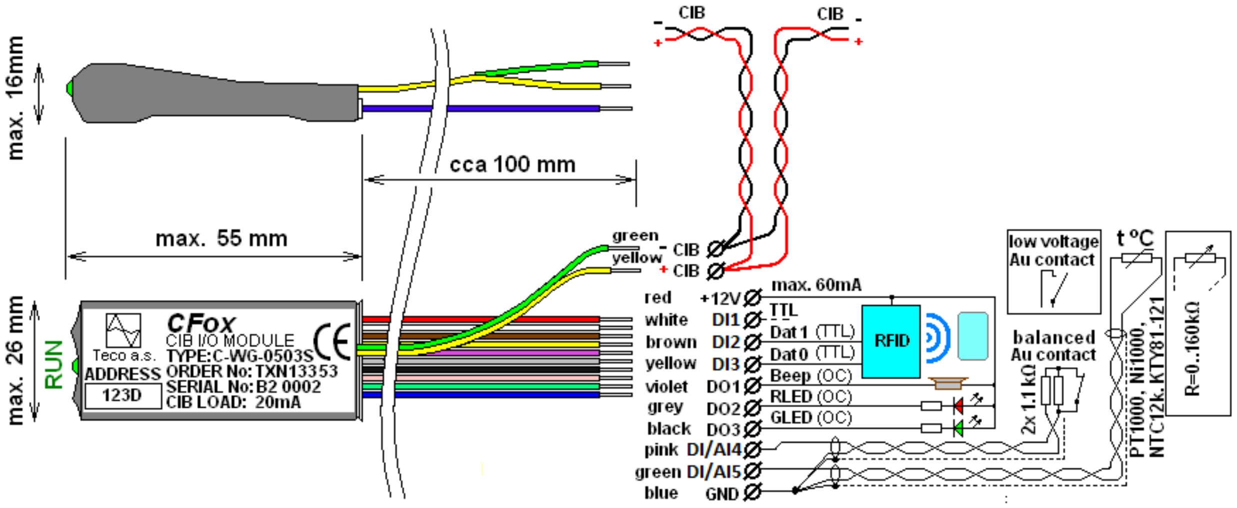


Fig. 14.1.40.1. The signal layout of the C-WG-0503S module, the wire colour coding and the basic connection (the old version before November 2012)

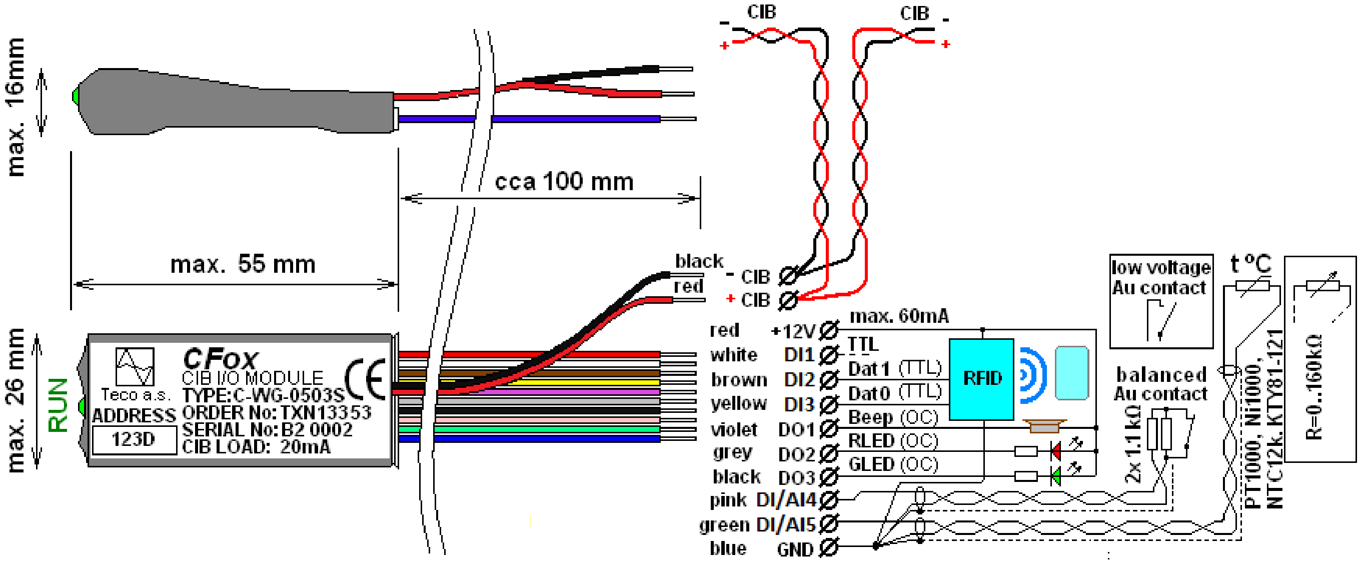


Fig. 14.1.40.2. The signal layout of the C-WG-0503S module, the wire colour coding and the basic connection

(the new version after November 2012)

Notes:

1. The +12V output has a 12VDC output voltage available, the maximum medium value of continuous output current is 60mA for powering readers or ESS and FAS sensors (a short-term load can reach approx. 80mA).
2. The module is terminated with a connector with moulded separate colour-coded 100mm long wires.
3. The CIB bus is terminated separately on two insulated wires.
4. The inputs are opposite the common GND terminal, the outputs switch against the +12V terminal.
5. **The DI1, DI2 and DI3** are only binary inputs, which can be connected either as dry contacts, (3K9 pull-out resistance from the 5VDC voltage, where the input is switched against GND), or as an TTL compatible input (DI2 and DI3 also allow the connection of a Wiegand device, depending on the configuration).
6. The **DI/AI4 and DI/AI5** inputs can be configured to one of these ranges: The sensor Pt1000, Ni1000, NTC 12k, NTC generally up to 160kΩ, KTY81-121, a potential-free contact, single or double-balanced loop (the input is excited by the 3.3V voltage via a 2k2 resistor); the input signal is always

connected against GND.

7. **The DO1, DO2 and DO3 outputs** are designed as open collectors NPN, i.e. the output wire is switched against GND directly by the transistor, without resistance in series and other protection elements - the switched load (a LED, a buzzer) must be connected with the other end to the supply voltage (typically 12VDC in keypads, readers, etc.).
8. The module outputs are insulated wires with the cross-section of 0.14mm2, the length of approx. 10cm, terminated with crimped ferrules H0.25/10.

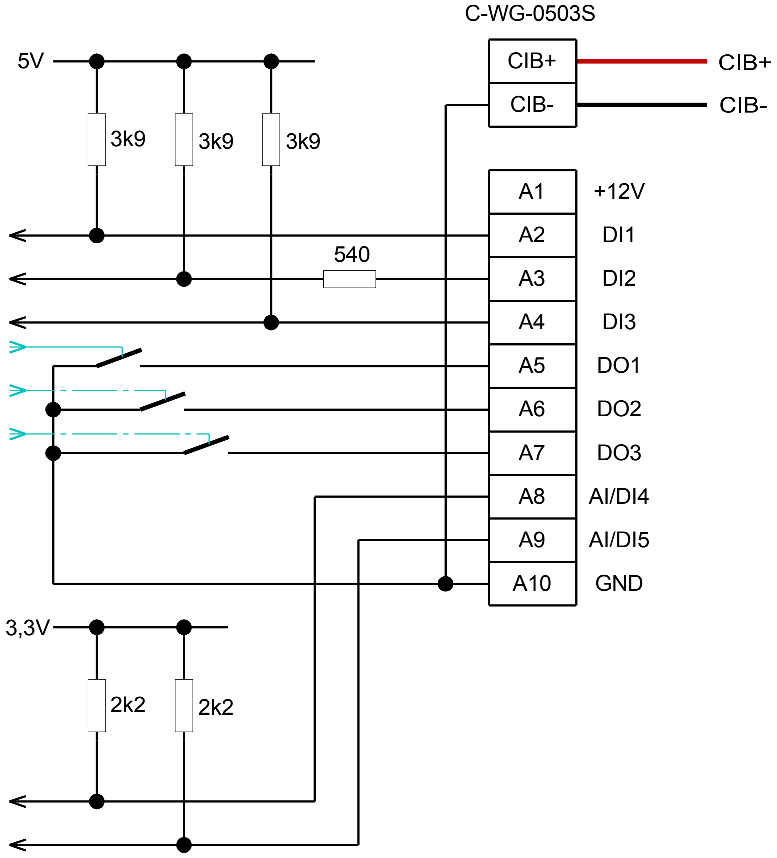


Fig. 14.1.40.3. Internal wiring of the C-WG-0503S module

14.1.41 The C-RQ-0600S

The C-RQ-0600S module is a basis for several versions of modules designed to connect temperature and humidity sensors, CO2 sensors, infrared motion sensors and universal analogue or binary signals.

The universal AI/DI inputs can be set to binary or analogue with a possibility to measure the temperature sensors: The resistance sensors PT1000, Ni1000, or the sensor with the thermistor NTC12k or KTY81-121 against the common GND wire. Other types of resistance sensors can use the resistance measurement range from 0 up to 160kΩ, but the conversion into temperature and the linearization must be carried out by the user programme.
Binary signals are connected to the inputs only as potential free contacts against the common GND wire. The binary input can also operate in the mode of a balanced input.

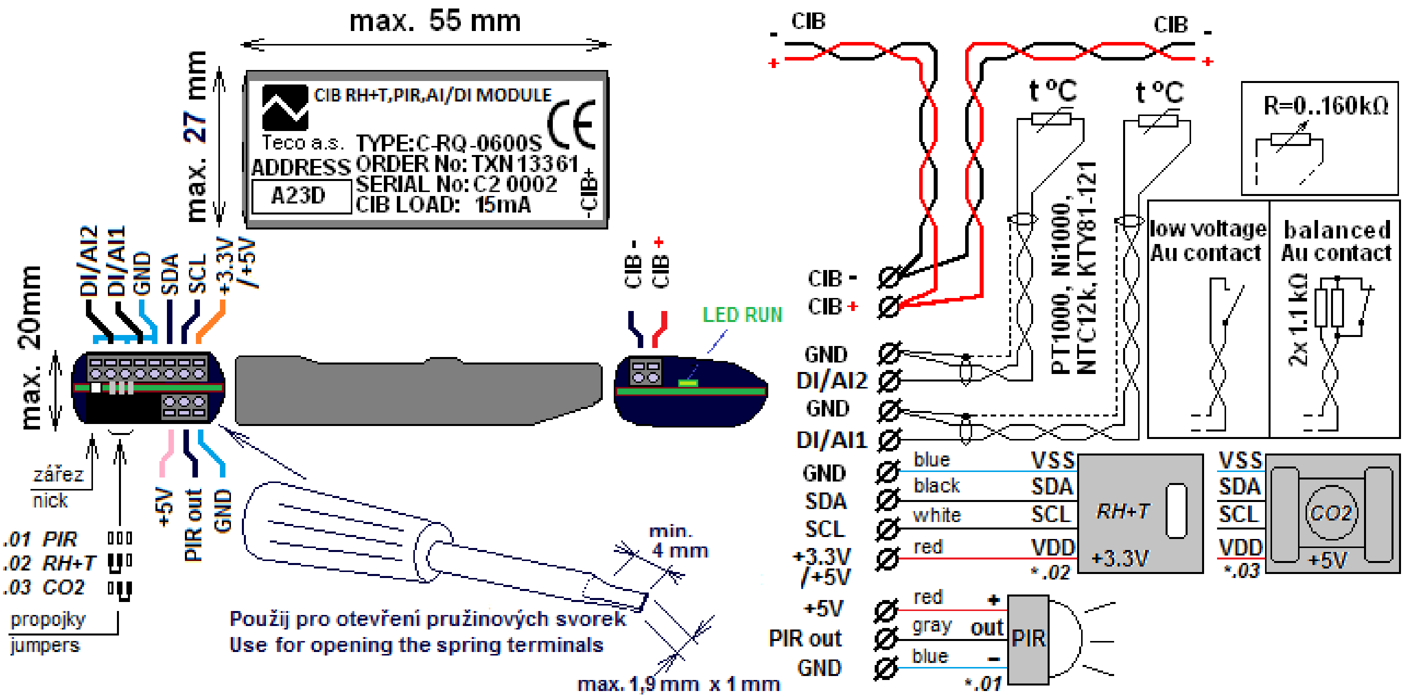


Fig. 14.1.41.1. The signal layout of the C-RQ-0600S module, the wire colour coding and the basic connection

Notes:

1. The inputs and outputs of the module are terminated in a miniature terminal block
2. The terminal block allows the release of the wire using a narrow screwdriver (see the figure), or even a common pin: insert it into the hole above the space for the wire and then pull the wire.
3. The LED is next to the CIB terminal block and it is partly hidden under the housing of the module.

Basic parameters of the DI/AI1 and DI/AI2 inputs

The input type (connected sensor)	The range of measured values
PT1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 160kΩ	0 ÷ 160kΩ
Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ
A balanced contact	The loop resistance 2x 1k1

Basic parameters of the PIR input.

Nominal supply voltage	5 V DC
Binary input	Log. 0 >1.5kΩ / log 1 <0.5kΩ

Basic parameters of the I^2C (the RH+T or CO_2 sensor)

Nominal supply voltage	3.3 V or 5VDC
Galvanic isolation of the output fro the CIB	No

The modules are marked with number suffixes, according to their function: *.01 PIR sensor, *.02 RH+T sensor, (*.03 sensor CO2). The module is supplied in the dummy plate housing in a wall-mounted switch, in optional designs.

14.1.42 The C-RQ-0600R-PIR

As a standard, the C-RQ-0600R-PIR module is fitted with a PIR detector; a temperature sensor or a combined temperature and humidity sensor can be added on request. The module consists of the inbuilt bus part C-RQ-0600S and the design part, which includes the mechanical segment (a dummy plate) in a specific design and a mounted sensor, see Fig. 14.1.42.1. This part is customized according to the required design and customers are asked to raise a query.

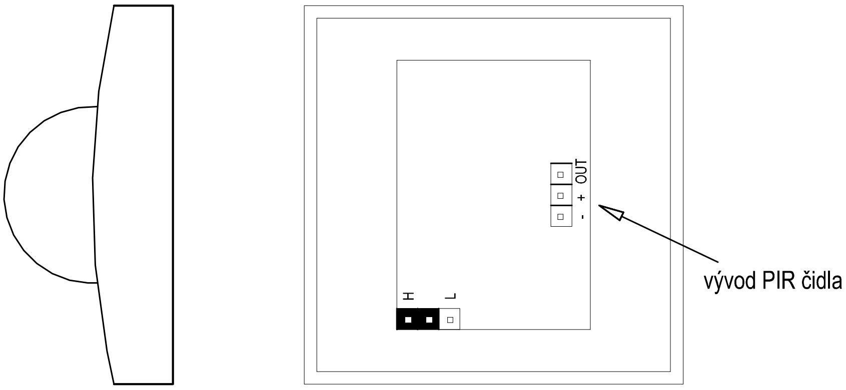


Fig. 14.1.42.1 Terminating signals from the PIR sensors in the module mechanical part.

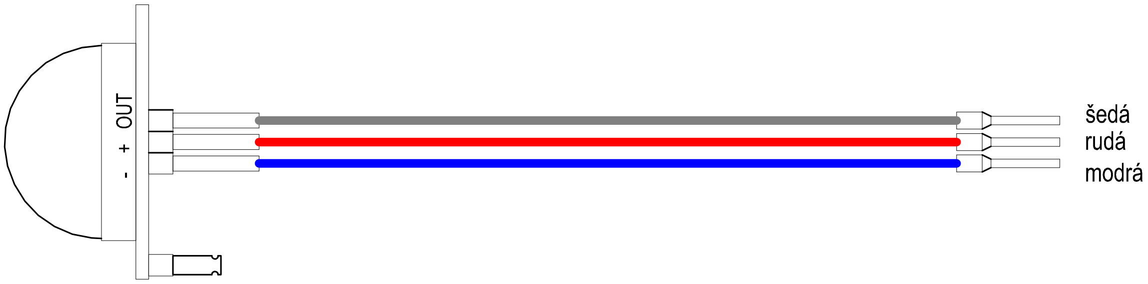


Fig. 14.1.42.2 The PIR sensor output towards the module C-RQ-0600S

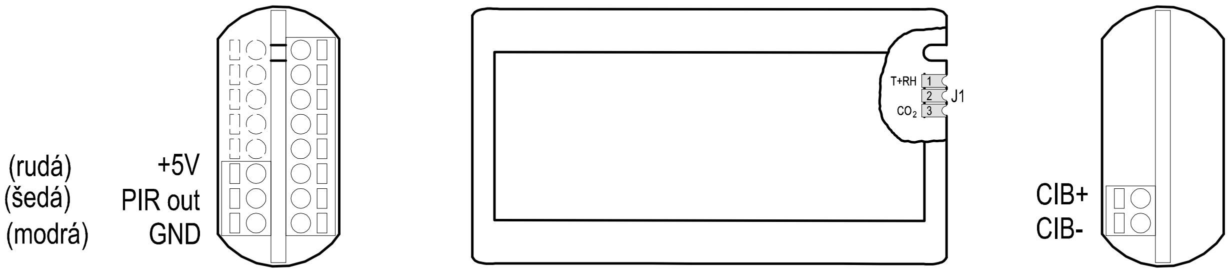


Fig. 14.1.42.3 Terminating signals on the terminal block of the C-RQ-0600S module for the C-RQ-0600R-PIR version.

14.1.43 The C-RQ-0600R-RHT

As a standard, the C-RQ-0600R-RHT module is fitted with a combined temperature and relative humidity sensor. The module consists of the inbuilt bus part C-RQ-0600S and the design part, which includes the mechanical segment (a dummy plate) in a specific design and a mounted sensor, see Fig. 14.1.43.1. This part is customized according to the required design and customers are asked to raise a query.

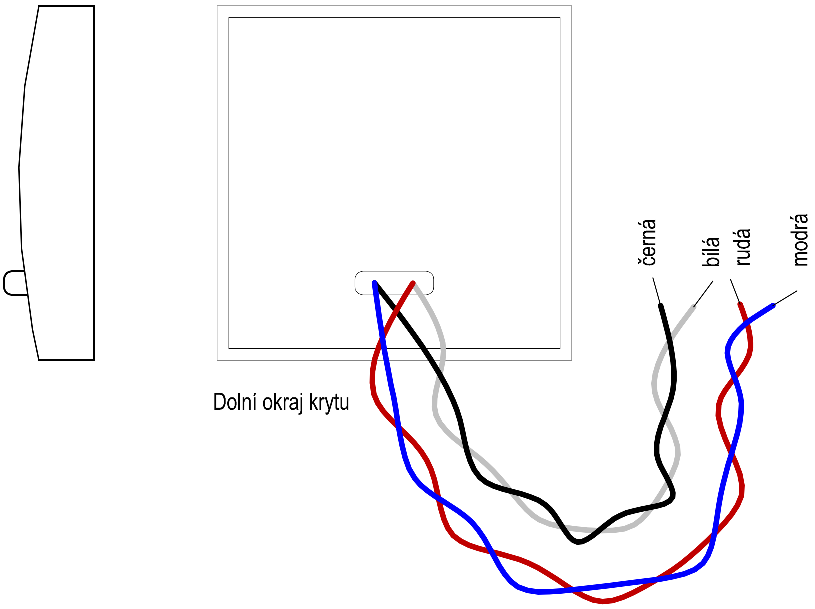


Fig. 14.1.43.1 Terminating the signals from the humidity and temperature sensor towards the C-RQ-0600S module

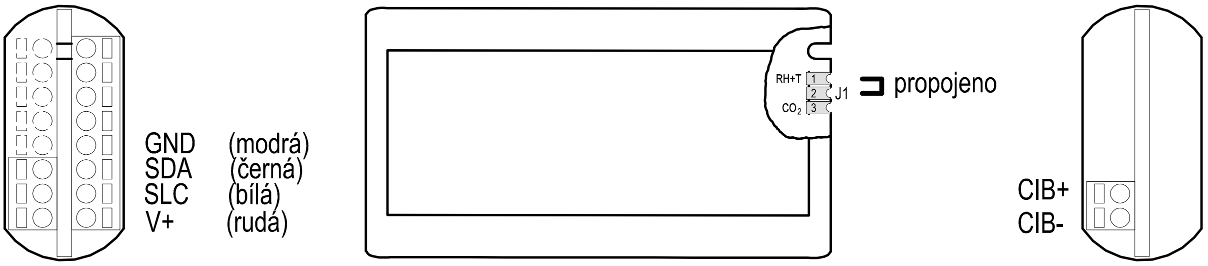


Fig. 14.1.43.2 Terminating signals on the terminal block of the C-RQ-0600S module for the C-RQ-0600R-RH version

Notes:

1. The V+ terminal provides a 3.3V supply voltage, which is required for the function of the sensor and it is set by the J1 jumper (in the figure on the right).

14.1.44 **The C-AM-0600I**

The C-AM-0600I is a universal input module designed to measure temperature, pulse inputs, flowmeters and water meters, gas meters and electricity meters with the S0 output (class A, measuring current of approximately 10mA). At the same time the module allows connecting a flooding sensor (condensation), or a dewing sensor and a flowmeter with an integrated thermometer AV23. For an overview of the signals measured, see the table below.

The module is housed in a wall-mounted plastic box with a higher protection, with 7 soft self-sealing cable glands. For an easy assembly, the module is equipped with side fitting for screwing or tightening with cable ties. The lid of the box can be fixed into place by snapping.

An overview of the measuring sensors, pulse and analogue signals:

The measuring sensors and ranges	**AI1**	**AI2**	**AI3**	**AI4**	**AI5**	**AI6**
Measuring temperature: Pt1000, Ni1000, NTC 12k, NTC up to 200 kΩ	●	●	●	●	●	
Standard signals: 0÷20mA, 4÷20mA, 0÷1V, 0÷2V, 0÷10V	●	●	●	●	●	
Pulse inputs of flowmeters, water meters and gas meters	●	●	●	●	●	
Pulse inputs of S0 electricity meters	●	●	●	●		
Condensation sensor					●	
Flooding sensor					●	
Dewing sensor					●	
Resistance up to 450kΩ					●	
VFS (AV23) – a combined flowmeter and thermometer						●

Basic technical data:

Level of protection	IP 55 (ČSN EN 60529)
Ambient temperature	-20 ÷ +70ºC
Material	cap: PP-C, grey
	Box: PP, TPE glands
Dimensions:	85 x 85 x 37mm (with no fitting)
Gland	self-sealing, the cable diameter 2 ÷ 14mm
Terminal block	the push-In type, wire cross-section maximum 1mm²

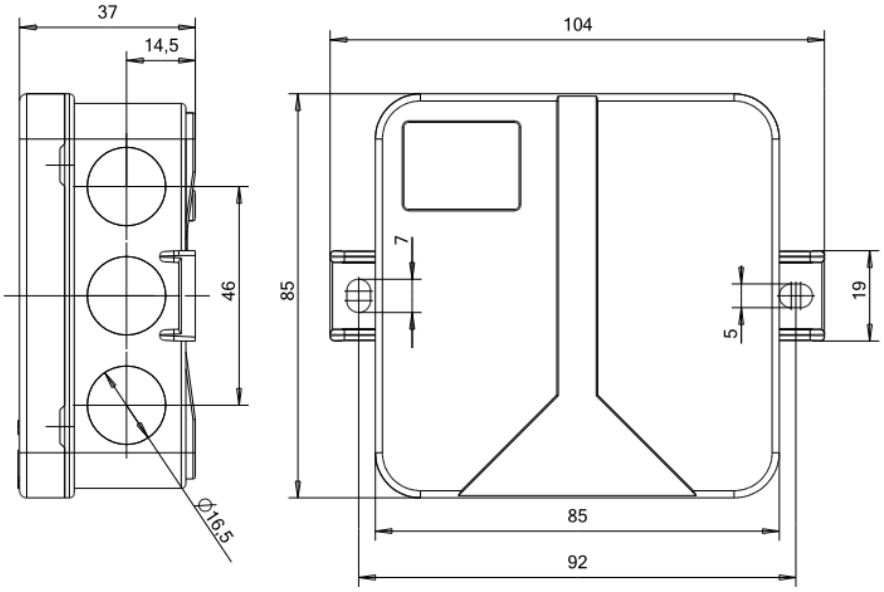


Fig. 14.1.44.1. The dimensions of the C-AM-0600I module

Notes:

1. On each side of the module there are always three self-sealing glands. Before installing the cable, simply make a hole in the box and gently push the cable in (see the main axes of the glands in the following figure).
2. Mount the box on the wall using the side fittings. The box can also be mounted using cable ties, for which the side fitting have openings to put the ties through.
3. The cap can be opened using a screw driver. There are grooves visible on the side of the box for the screwdriver; if you twist it, the cap opens.
4. The box is made of flexible material. Rough handling, twisting or bending the box may damage the module internal electronics.

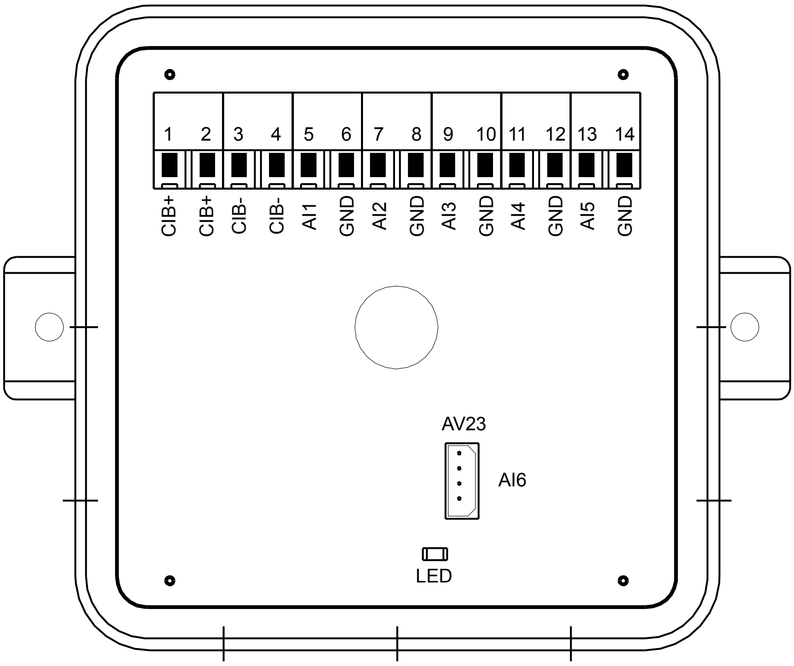


Fig. 14.1.44.2. Layout of the terminals in the C-AM-0600I module.

14.1.45 **The C-IT-0200I**

The C-IT-0200 is a module on the CIB bus containing 2 analogue inputs. The inputs can be configured for measurement of resistance temperature sensors, thermocouples, resistance, voltage or current.
The module power supply (including powering the current loops 4 to 20mA) is from the CIB. The module is in the version with a higher protection IP-65, in a box fitted with glands, the external dimensions are 125x100x38mm.
Configuration of the measurement range is done by connecting the sensor to the relevant terminals and by setting the jumpers. Examples of connection of the terminals and configurations of the jumpers for various ranges are shown in Figure 14.1.45.2.
Measurement ranges and the input resistance of the module analogue inputs.

Input resistance	According to the range: RTD, NTC, OV 0÷10V, 0÷5V,-2÷2V, -1÷1V TC, HI -1÷1V, HI -100mV÷100mV Current loop 0÷20mA, 4÷20mA	 4.7kΩ 54.6kΩ 4 MΩ 50Ω
Measurement ranges	Pt1000 – W100=1.385 Pt1000 – W100=1.391 Ni1000 – W100=1.500 Ni1000 – W100=1.617 NTC12k KTY81-121 TC – type J TC – type K TC – type R TC – type S TC – type T TC – type B TC – type N Voltage input 0÷10V Voltage input 0÷5V Voltage input -2÷2V Voltage input -1÷1V Voltage input HI -1÷1V V. in. HI -100m÷100mV Current loop 0÷20mA Current loop 4÷20mA OV 200k	-90 °C ÷ 320 °C -90 °C ÷ 320 °C -60 °C ÷ 200 °C -60 °C ÷ 200 °C -40 °C ÷ 125 °C -55 °C ÷ 125 °C -210 °C ÷ 1,200 °C -200 °C ÷ 1,372 °C -50 °C ÷ 1,768 °C -50 °C ÷ 1,768 °C 200 °C ÷ 400 °C 250 °C ÷ 1820 °C -200 °C ÷ 1,300 °C 0mV ÷ 10,000mV 0mV ÷ 5,000mV -2,000mV ÷ 2,000mV -1,000mV ÷ 1,000mV -1,000mV ÷ 1,000mV -100mV ÷ 100mV 0mA ÷ 20mA 4mA ÷ 20mA 0kΩ ÷ 200kΩ

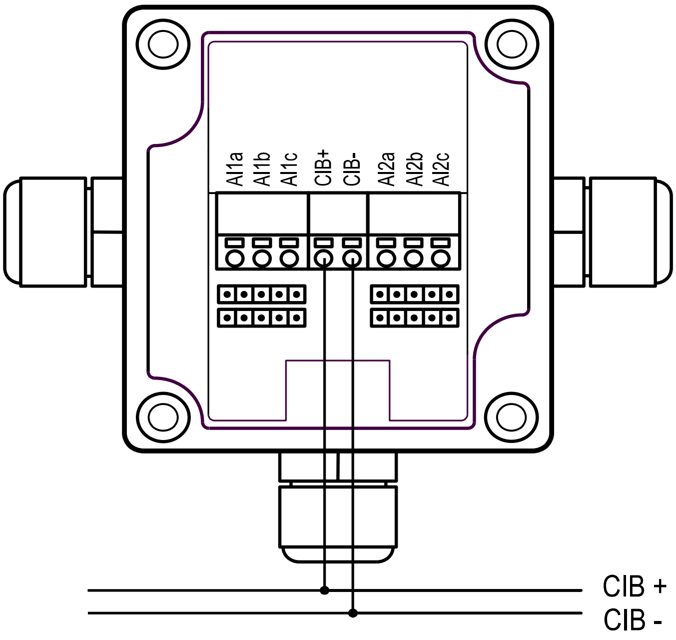


Fig. 14.1.45.1. Connecting the C-IT-0200I to the CIB bus, the placement of the terminal block and the

jumpers.

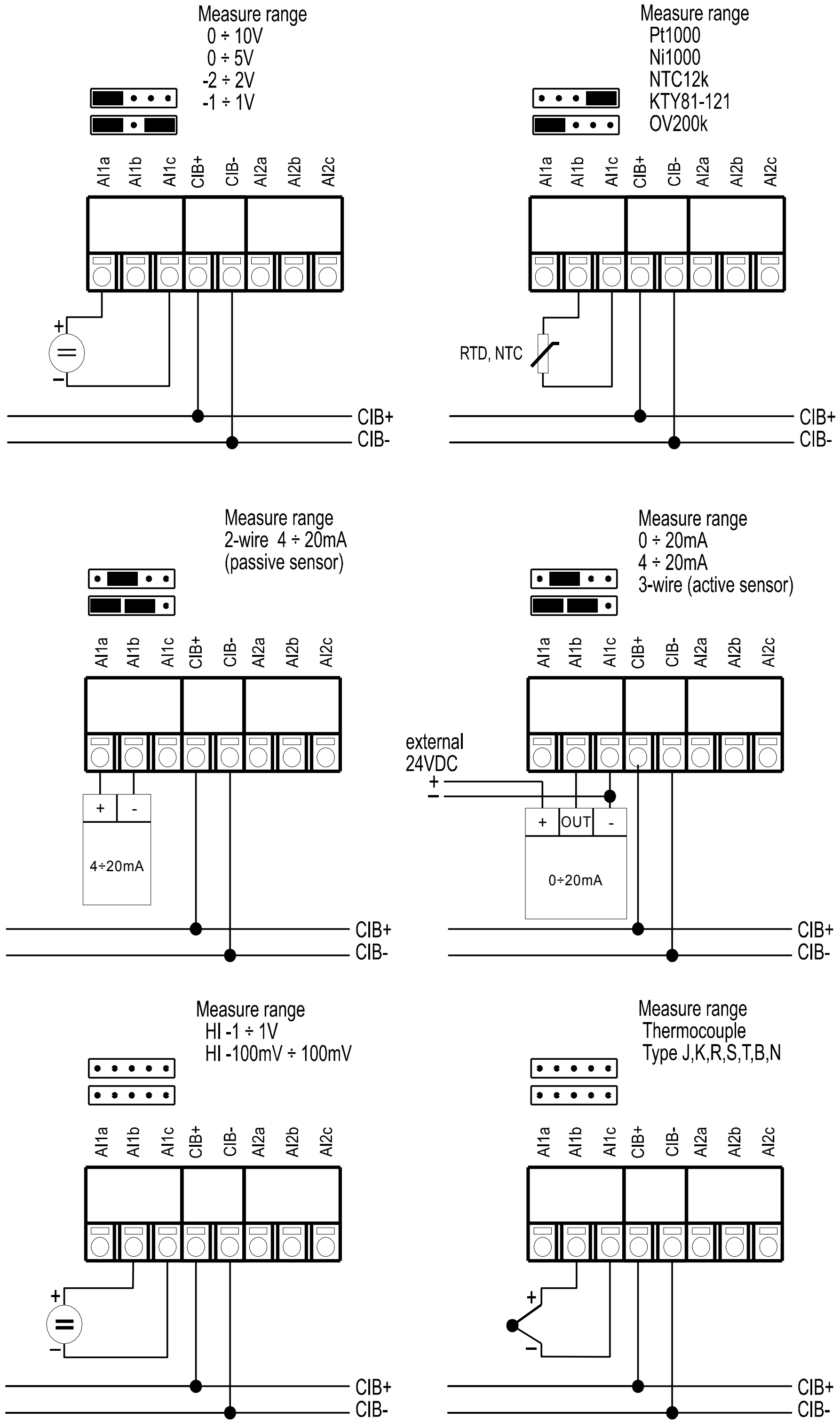


Fig. 14.1.45.2. Connecting the input circuit and setting the jumpers of C-IT-0200I according to the type of signal.

Notes:

1. The jumpers are always in horizo■l position (i.e. plugged in).
2. The two-wire sensor 4-20mA is supplied from the C-IT-0200I module internal supply with the approx. 24VDC voltage (a passive two-wire sensor); it should be connected between the a and b terminals. The externally powered sensor 0-20mA or 4-20mA should be connected between the b

and c terminals (only a passive module input).

14.1.46 **The C-IT-0100H-P**

The C-IT-0100H-P module is a temperature sensor in a plastic head, which can be connected directly to the CIB bus. The module contains two measurement inputs. One input (the master) is permanently connected to the resistance temperature sensor in the stem (Pt1000), which is used for primary temperature measurement. The second input is connected to the resistance sensor that measures the temperature inside the head and is used for information about the operating conditions of the module. The resistance is converted in the module directly into the temperature numerical value and transmitted to the central unit over the CIB bus. The software - firmware - is optimized to increase the accuracy and linearization of the measuring range of the sensor directly in the unit. The processing principle eliminates distortion or possible measurement errors, when the external sensor is connected over a long distance.
The module is supplied in several versions: a sensor inside the piping, a sensor with a stem, an outdoor sensor and a contact temperature sensor. For details of the options, including the mechanical dimensions, see the Chapter Measuring temperature.

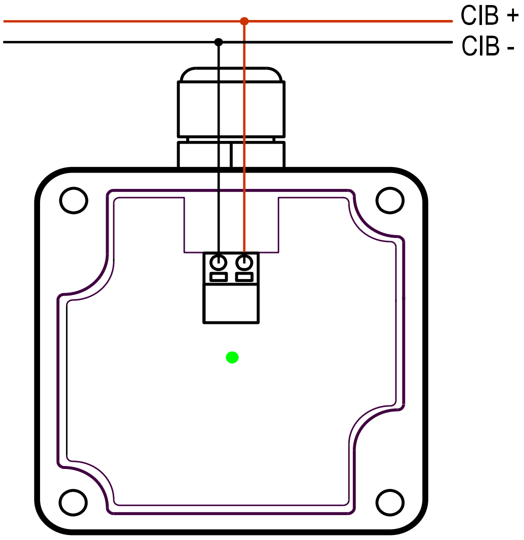


Fig. 14.1.46.1. Connecting the C-IT-0100H-P to the CIB bus, the placement of the terminal block under the lid

Notes:

1. Connecting the wires in the bus is done using a gland in the terminal block, which is accessible after the cap is taken off the head.
2. The cap is secured with four bayonet screws (they can be released by turning anti-clockwise).

Basic parameters of the C-IT-0100H-P module.

Terminal block	screw-less, the Push In type
Gland	PG9, the cable diameter 4 ÷ 8mm
Supply voltage	24/27VDC (from the CIB bus)
Maximum power consumption	0.3W
Galvanic separation of the power supply from the internal circuits.	No
Protection – ČSN EN 60529:1993 (idt IEC 529:1989)	IP65
The weight	130g
Dimensions	maximum 90 x 66 x 155mm (this applies for the 120mm stem).
the main analogue input.	the temperature of the Pt1000 sensor in the stem
An additional analogue input	the temperature of the internal sensors in the head
The range of temperature measured by the sensors in the stem	−50 °C ÷ + 200 °C
Resolution	0.1 °C

Basic measurement accuracy	0.5 °C
Settling time of the temperature measured	30 minutes
The head operating temperature range.	-25 °C ÷ +80 °C

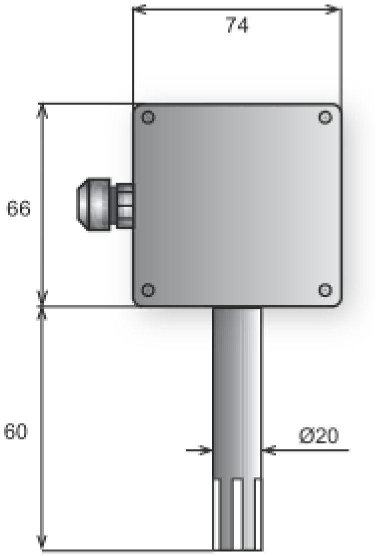
14.1.47 The C-RQ-0400I

Measuring outdoor relative humidity and temperature can be done using the C-RQ-0400I sensor.
The actual temperature and humidity sensor is located in a plastic ABS stem, which is terminated with a dust filter. The electronic component, including the terminal block (CIB, 2x AI/I) is located inside the plastic head made of polycarbonate.
For an example of connection, see the Chapter Measurement of outdoor relative humidity and temperature, CFox module C-RQ-0400I.

Exposure to atmospheric conditions should be avoided by correct placement of the sensor, e.g. under the roof (the sensor is not designed for direct contact with water).

Basic parameters

Resolution of temperature/humidity	0.1 °C / 0.1%RH
Maximum temperature measurement error	± 0.5 °C (20 ÷ 40 °C), ± 1 °C (0 ÷ 60 °C)
Maximum humidity measurement error	(+25 °C) ± 3% (20 ÷ 80%RH)
The operating temperature/relative humidity range of the sensing part	maximum 80 °C, see the chart in the next chapter.
The operating temperature range of the electronics in the head.	-20 ÷ +60 °C
The range of the storage temperature/relative humidity	-20 ÷ +60 °C / 20 ÷ 80 %RH
Ingress protection of the box / and the sensor:	IP65 / IP40, filter 100μm
Terminal block	screwless, the Push In type
The gland/max. Ø cable	PG9/8mm



The properties of the temperature and relative humidity sensor:
The sensor used (identical with a number of other sensors, such as the RQ-C-0400 or C-RQ-0600R) measures the temperature and relative humidity (RH). The application ranges of the sensor defined by the manufacturer are illustrated in the following chart:

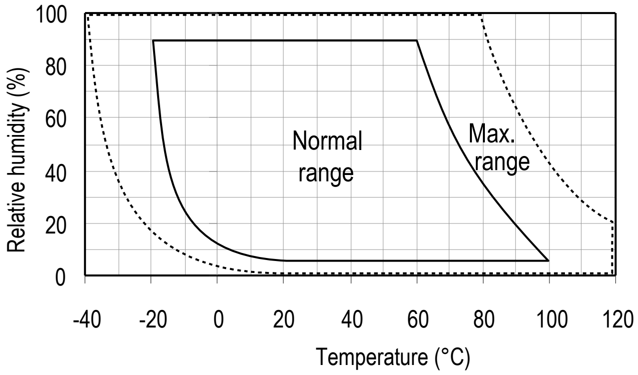


Fig. 14.1.47.1 A chart of the sensor operating temperature

In a normal operating range the sensor works with standard accuracy. If the sensor has been exposed to conditions outside the normal range for a long time, especially in terms of relative humidity> 80%, the measurement error may temporarily increase up to 3% RH. After the conditions return to the normal range, the measurement accuracy gradually returns to standard values.
Long-term exposure to extreme conditions may accelerate the ageing process of the sensor.

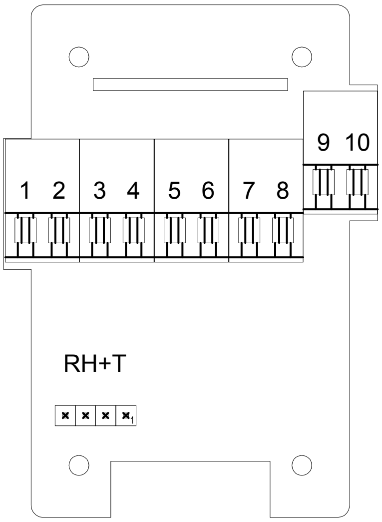


Fig. 14.1.47.2 Layout of the terminals in the C-RQ-0400I module.

Notes

1. The glands are fitted in the factory with plugs, which should be removed if necessary. The unused glands provide sufficient protection of the module.
2. The module is fitted with a screwless terminal block of the Push In type.
3. The connector in the bottom left corner should be used for connecting the combined temperature and humidity sensor.
4. The chapter with the description of the C-RQ-0400I-xx module also presents a diagram of the mechanics of the module with the glands and the terminals layout.

14.1.48 The C-RQ-0400I-xx

The sensor for measuring humidity in an environment with the risk of water flowing down, condensation of humidity, etc., the C-RQ-0400I-05 (05 - the cable length 0.5m) consists of a box (like the C-RQ-0400I sensor) and an external sensor, which is located in a small plastic box with a moulded cable outlet into the module.
An example of connection is shown e.g. in the Chapter on Measurement of outdoor relative humidity and temperature with a detached sensor.

The sensor should be fitted through an opening in the plastic cover; the actual sensor is located under a covering membrane, which prevents direct contact of the sensor with flowing water.

The characteristics of the temperature and humidity sensor, especially with regard to adverse climatic conditions, are listed in the section describing the C-RQ-0400I module.

Basic parameters

Resolution of temperature/humidity	0.1 °C / 0.1%RH
Maximum temperature measurement error	± 0.5 °C (20 ÷ 40 °C), ± 1 °C (0 ÷ 60 °C)
Maximum humidity measurement error	(+25 °C) ± 3% (20 ÷ 80%RH)
The operating temperature/relative humidity range of the sensing part	maximum 80 °C, see the chart in Chapter on the C-RQ-0400I.
The operating temperature range of the electronics in the head.	-20 ÷ +60 °C
The range of the storage temperature/relative humidity	-20 ÷ +60 °C / 20 ÷ 80 %RH
Ingress protection of the box / separated sensor:	IP65 / IP67
Terminal block	screwless, the Push In type
The gland/max. Ø cable	PG9/8mm

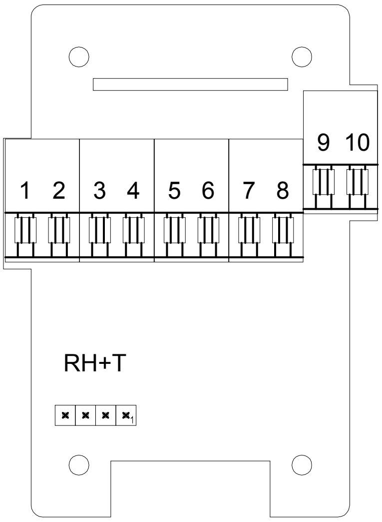


Fig. 14.1.48.2 The layout and marking of the terminals in the C-RQ-0400I-xx module.

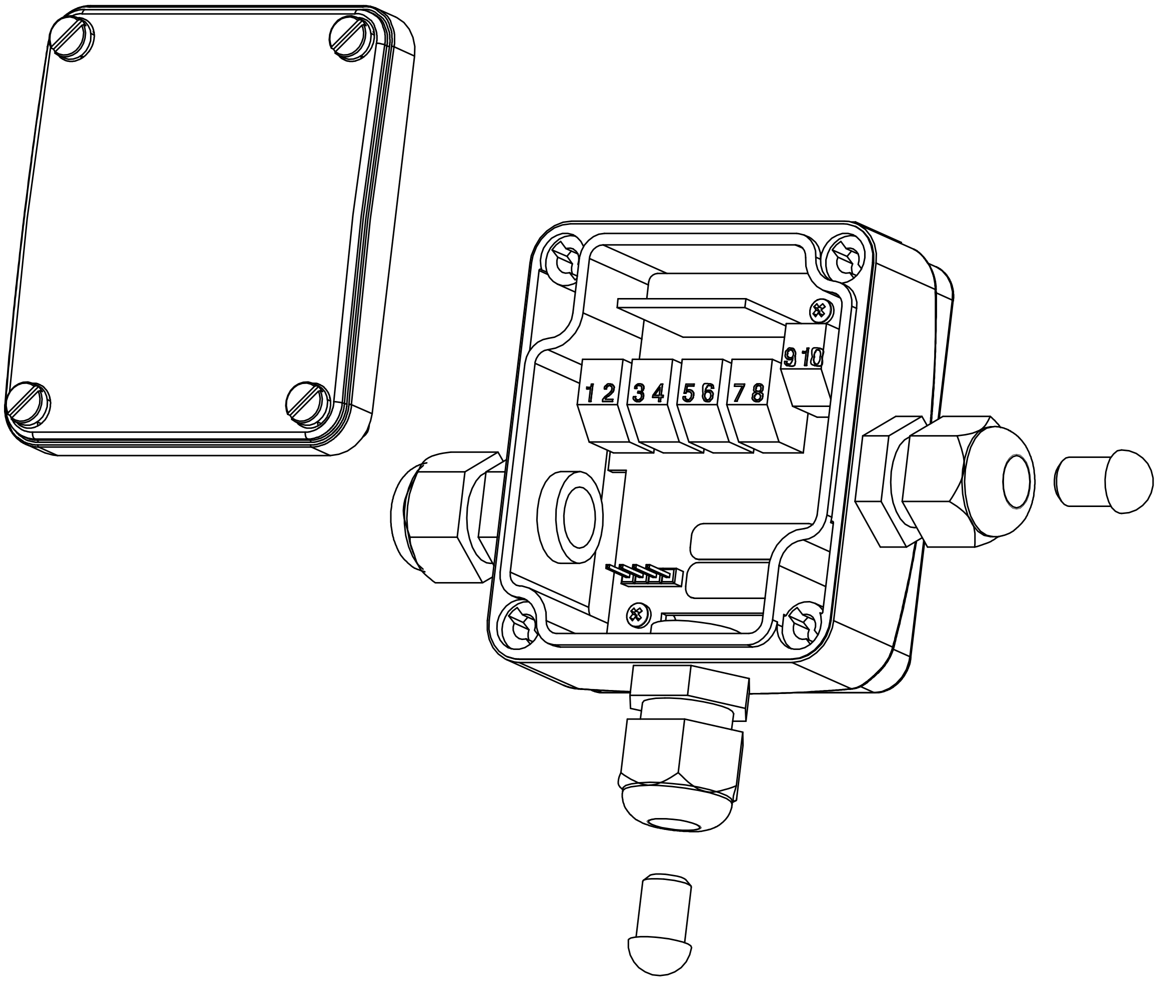


Fig. 14.1.48.2 Mechanical design of the C-RQ-0400I-xx, module, the placement of the terminals and glands for cables

Notes

1. The glands are fitted in the factory with plugs, which should be removed if necessary. The unused glands provide sufficient protection of the module.
2. The module is fitted with a screwless terminal block of the Push In type.
3. The connector in the bottom left corner is used for connecting the combined temperature and humidity sensor for variants of the C-RQ-0400H-P and the C-RQ-0400I modules; here it is not used. The cable of the external sensor is connected to the terminals 1 to 4.

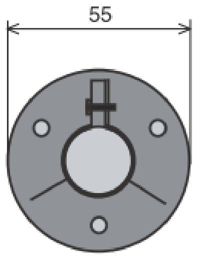
14.1.49 The C-RQ-0400H-P

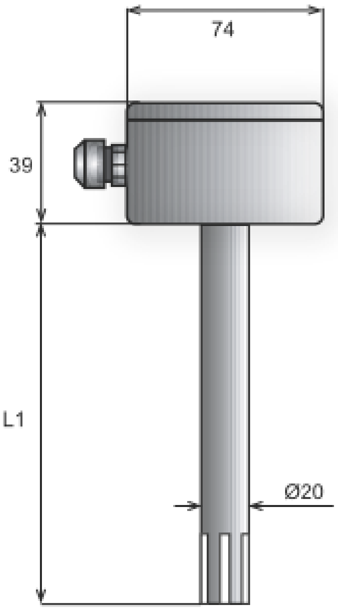
This is a sensor for measuring relative humidity and temperature of air with no aggressive substances in air conditioning ducts and ventilation ducts; an example of connection is shown e.g. in the Chapter on Measurement of relative humidity and temperature in the air ducts.

The actual temperature and humidity sensor is located in a plastic ABS stem, which is terminated with a dust filter. The electronic component, including the terminal block (CIB, 2x AI/I) is located inside the plastic head made of polycarbonate. The sensors in the air duct system include the central plastic holder used for mounting the sensor on the duct wall.

The sensor is designed for conventional chemically non-aggressive environments, it requires no service, only the dust filters should be regularly cleaned; they are located in the plastic part of the sensor that can be unscrewed.
The characteristics of the temperature and humidity sensor, especially with regard to adverse climatic conditions, are listed in the section describing the C-RQ-0400I module.

Mounting and connecting the sensor:
The sensor should be mounted using a holder (on the right in the figure), which should be screwed on the wall of the air duct at the point of measurement, and the actual stem of the C-RQ-0400H-P sensor should be inserted through a hole in the bracket (and the duct).





Basic parameters of the sensor:

The resolution of the temperature/humidity	0.1 °C / 0.1%RH
Maximum temperature measurement error	± 0.5 °C (20 ÷ 40 °C), ± 1 °C (0 ÷ 60 °C)
Maximum humidity measurement error	(+25 °C) ± 3% (20 ÷ 80%RH)
The operating temperature/relative humidity range of the sensing part	maximum 80 °C, see the chart in Chapter on the C-RQ-0400I.
The operating temperature range of the electronics in the head.	-30 ÷ 60 °C
The range of the storage temperature/relative humidity	-20 ÷ 60 °C/20 ÷ 80%RH
Ingress protection of the box/sensor:	IP65 / IP40, filter 100μm
Terminal block	screwless, the Push In type
The gland/max. Ø cable	PG9/8mm

Standard lengths of the stem L1:
180mm
240mm

The connection of the terminal block of the module is identical with that of the C-RQ-0400I-xx module; the chapter describing it also includes a diagram of the mechanical design of the module with the glands and the layout of the terminals.

14.1.50 The R-OR-0001W

The R-OR-0001W module is equipped with an internal relay that switches the output (the phase wire) of the mounted socket. The neutral wire (N) and protective earth (PE) remain permanently through. The continuous current in the adapter is 16A, the short-time switching current is up to 8 A (with a duration of max. 20 ms) – see detailed information on the relays used). The module is in a plastic box, designed as an adapter for a standard 230V socket outlet.

The adapter is fitted with the fork type of the combined E/F (standard CEE 7/16 „Europlug‟ EN50075, CEE 7/7). The socket on the adapter is the E type.

The module is designed to switching standard capacitive and inductive loads.

The module is powered directly from the 230VAC grid.

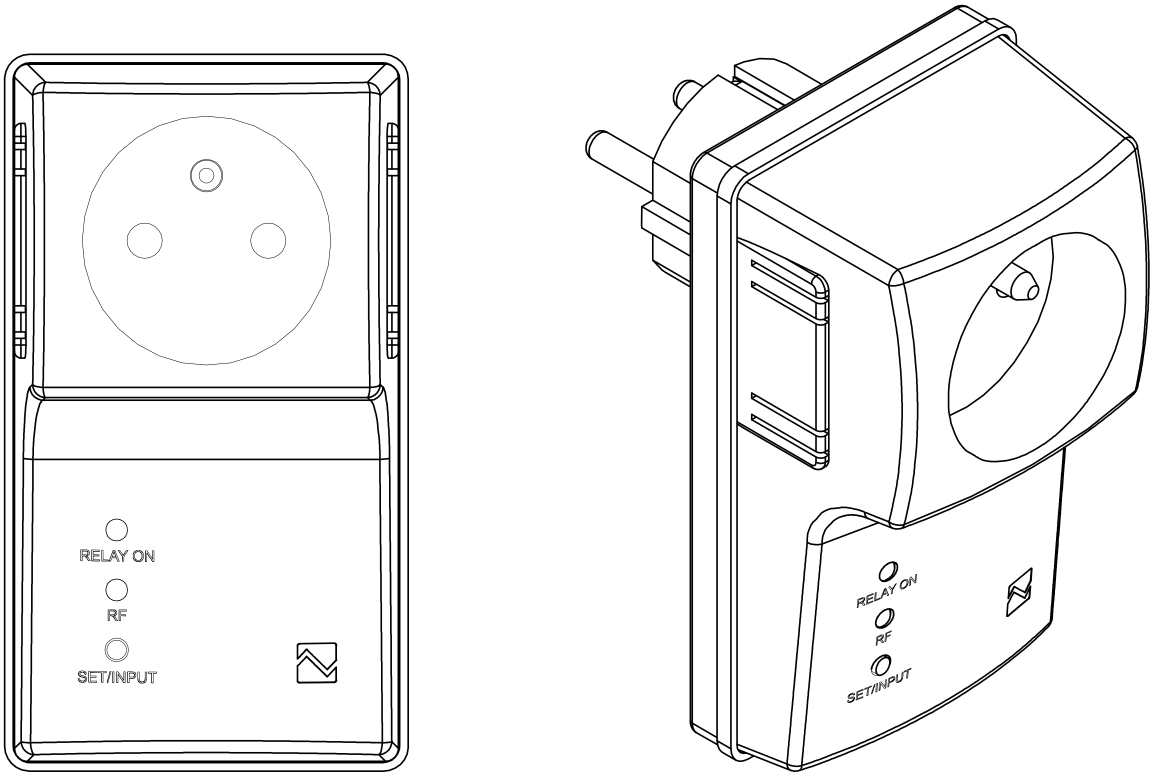


Fig. 14.1.50.1. the R-OR-0001W adapter

Notes:

1. There are LED indicators on the front side indicating the switching of the relay and the RF activity; there is also a push-button of the adapter plug manual control.
2. The module is light grey with a matte finish of the housing.

14.1.51 The RCM2-1

The RCM2-1 is a control wall-mounted module designed primarily for heating or interior air conditioning control. It is also available in a wireless RFox version under the name R-RC-0001R.

The module offers a comfortable, and yet very simple and clear control of heating - temperature correction, changing the heating mode, manual fan speed control (stepped and smooth), outdoor temperature indication and the time. Some other functions can be added, such as indication of the heating status, preparation of hot water, lighting control, etc.

The module is equipped with an internal temperature sensor and allows connecting an external temperature sensor (a standard one from the CFox selection).

The module can also be fitted with an SSR output with max. 60VAC/DC, 600 mA (heating control, etc.).

The module is designed for operation in a normal and chemically non-aggressive environment. It does not require any maintenance. It consists of two parts: the bottom with the terminals and the housing with a printed circuit and a control panel. It should be flush-mounted with 2 or 4 screws into a 60mm-diameter box, or on the wall. The bottom part of the housing has an aperture for cable entry.

The module is designed as a standard unit on the CIB bus (or in the RFox network), integrated into the FoxTool and Mosaic environment.

The module is equipped with a character display with special symbols controlled by the module processor (in Mosaic environment you can arbitrarily control individual graphic symbols and enter numeric values on the display):

Basic parameters of the module

Display	the LCD is not backlit, the active area is 60 x 60mm,
Dimensions	see the fig. below
Protection	IP 20
Housing	ABS, RAL 9010
Terminals	screw terminals for wires with the cross-section of 0.14 – 1.5mm^2

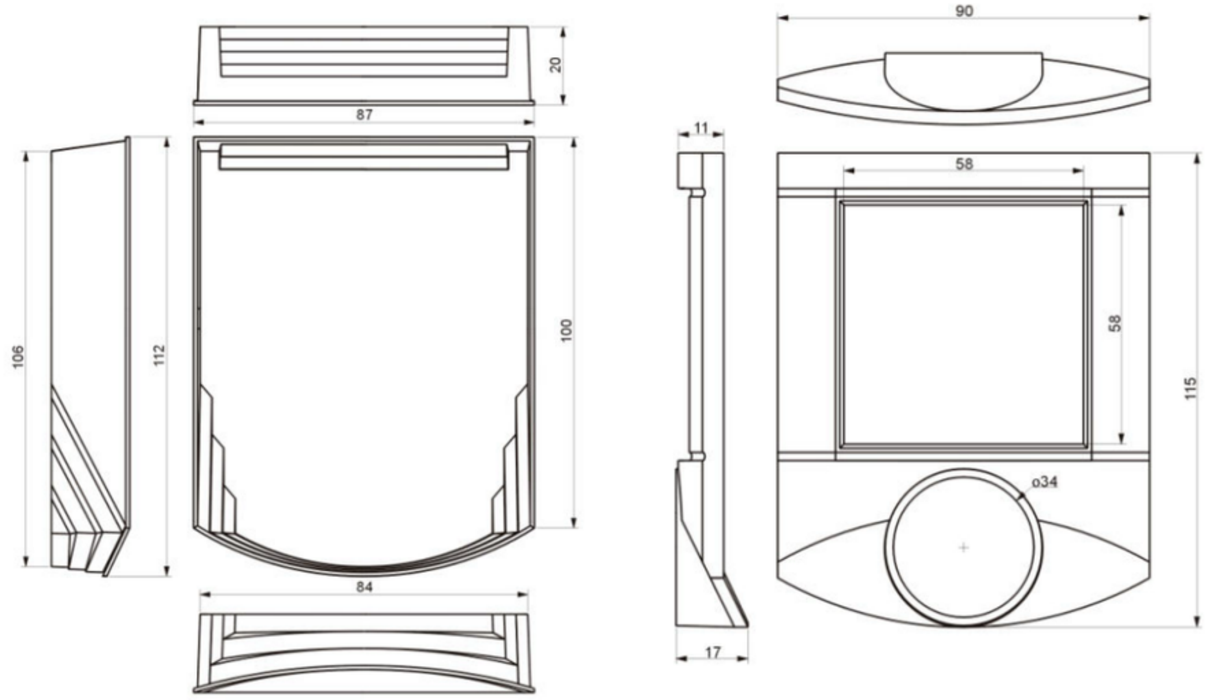


Fig. 14.1.51.1. Mechanical dimensions of the RCM2-1 and R-RC-0001R modules

14.1.52 The C-RC-0005R

The hotel control unit the C-RC-0005R is equipped with capacitive buttons (see the picture below), and an OLED display.
The buttons allow you to easily and intuitively change the required room temperature, the ventilation or air conditioning parameters, as well as allow local setting of alarms and "Do not disturb" and well as "Clean up the room" notices on the external side of the door (provided the facility allows this).
It will be possible to supply the module with customized glass - variable basic colour of the module, inscriptions, logos, etc.
The module measures the room temperature and humidity, and it is also equipped with two inputs AI/DI1 and AI/DI2 for connecting additional temperature sensors, window contacts, etc.
The module is placed in a plastic box with a glass front surface, which is pushed onto the holder bolted to the rectangular installation box (a standard flush-mounted installation box or a hollow-wall box).

The parameters of the connectors used are listed in Chap. 13.3.1

Basic parameters of the inputs:

The AI/DI1 ÷ AI/DI2 inputs	The range of measured values
Pt1000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Maximum resistance 100kΩ	0 ÷ 100kΩ
Voltage 2V	0 ÷ 2100 mV
Binary input	Voltage-free contact

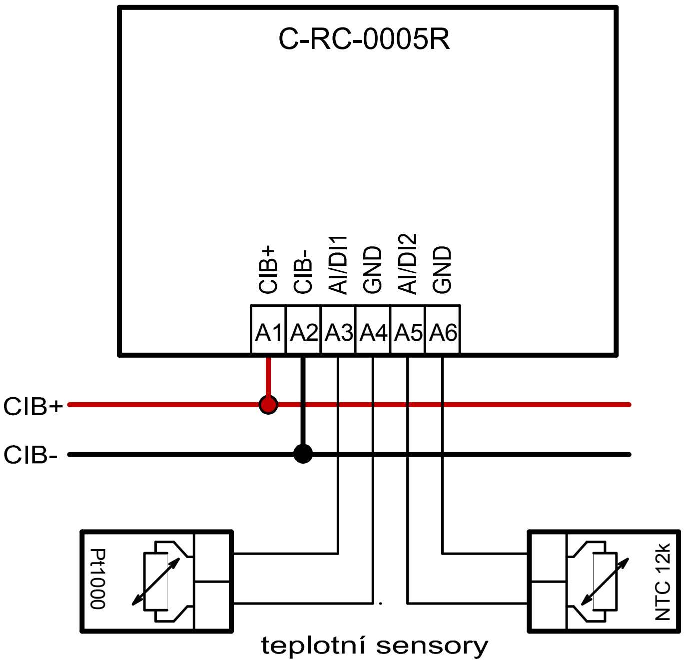


Fig. 14.1.52.1 A basic example of connection of the C-IR-0005R module

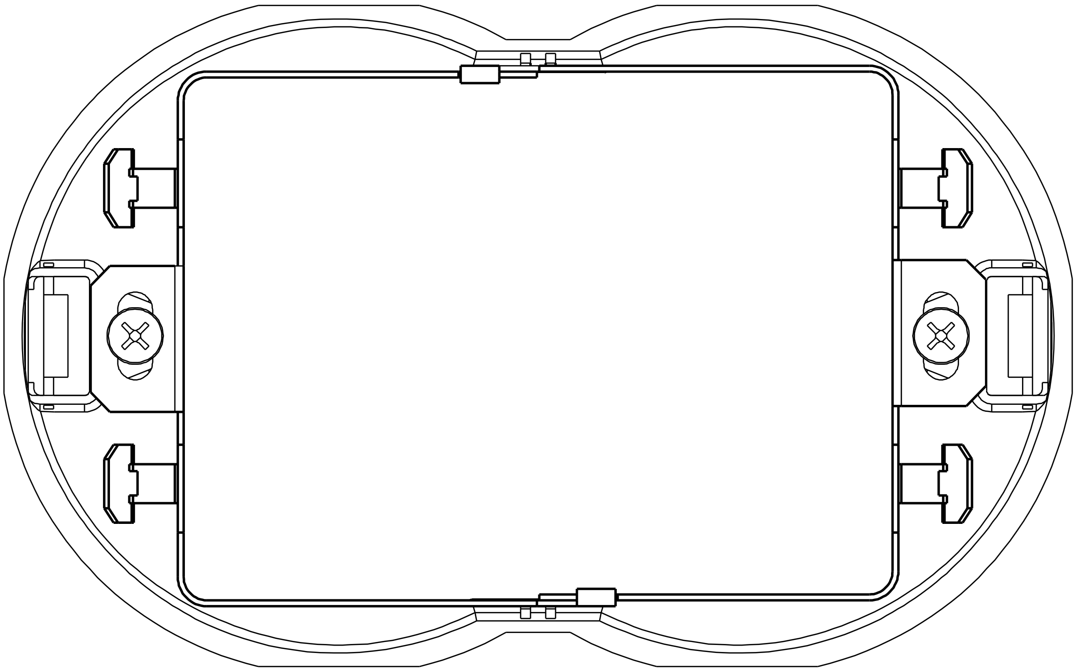


Fig. 14.1.52.2 Mounting the C-RC-0005R module holder onto the flush box; the example feature the PB503 flush box

Notes:

1. The control unit holder is mounted into the holes in a standard flush box with the 83.5mm spacing (the screw heads are indicated in the fig.).
2. When mounting the C-RC-0005R module, make sure that you observe its correct orientation.Put the module proper with the display correctly into its holder - see Fig. 14.1.52.3; the Teco logo on the inside housing must not be reversed.
3. **Suitable electrical junction boxes** are e.g. the BTicino 503E flush boxes (106 x 71 x 52mm), or the BTicino hollow-wall boxes, type PB503 (106 x 71 x 52mm).

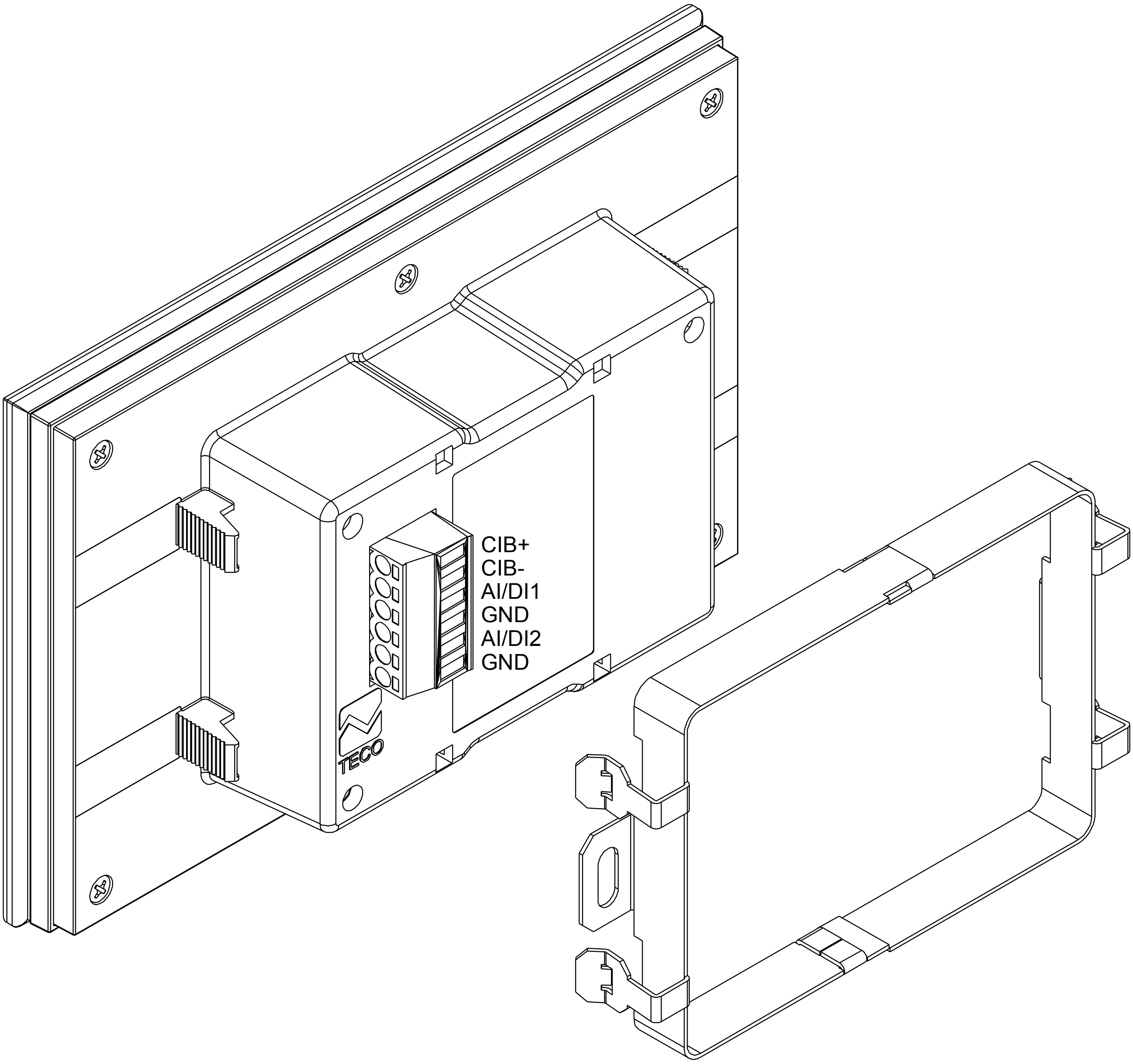


Fig. 14.1.52.3 The placement of the connector on the rear side of the housing of the C-RC-0005R module
Notes:

1. The figure shows the support piece, which should be screwed onto the flush box. The display module itself should be pushed in by applying light pressure. It can be released again by pulling more strongly.

14.1.53 The C-RC-0011R

The C-RC-0011R interior control unit with an LCD display and 5 touch buttons is designed primarily for local control of heating, cooling and ventilation systems for office buildings, such as remote control for heating systems, etc. The display is equipped with a number of symbols (see Fig. 14.1.53.4), which allow you to comfortably see and easily change the basic parameters of the heating system. The module is also ready for changing the weekly time schedule, which is available in the form of a function block in the Mosaic environment, and it is compatible with the Foxtrot website and can be controlled from the application iFoxtrot, SCADA in the Reliance environment.

The control unit has five touch buttons on the display that control the functions. The module is designed as a standard peripheral on the CIB bus.

The module is further equipped with an internal temperature and humidity sensor of the interior and it is fitted with an analogue AI1 input that allows the connection of e.g. a floor temperature sensor, or an outdoor temperature sensor.

The parameters of the connectors used are listed in Chap. 13.3.1

Basic parameters of the AI1 input:

	The range of measured values
Pt1,000	-90 °C ÷ +320 °C
Ni1000	-60 °C ÷ +200 °C
NTC 12k	-40 °C ÷ +125 °C
KTY81-121	-55 °C ÷ +125 °C
Odpor max. 100kΩ	0 ÷ 100kΩ
Voltage 2V	0 ÷ 2100 mV

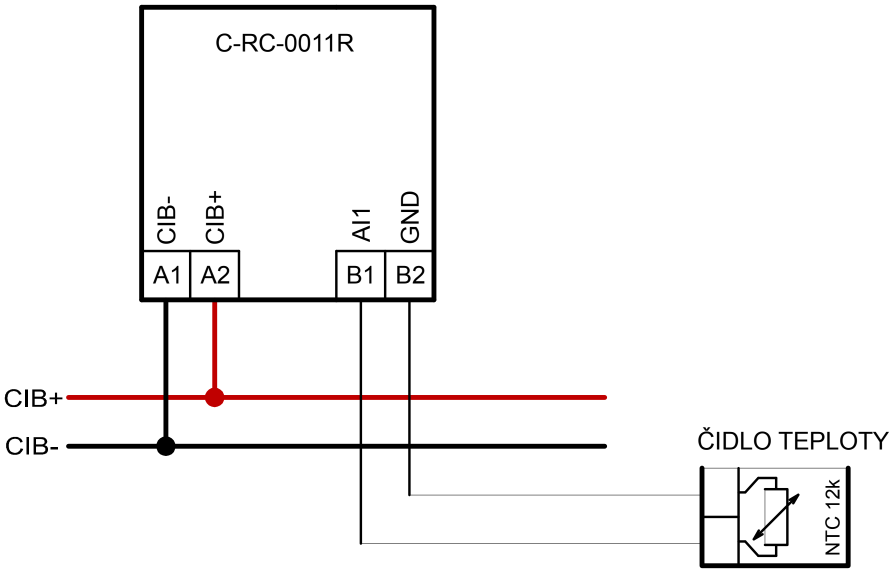


Fig. 14.1.53.1 A basic example of connecting the C-RC-0011R module

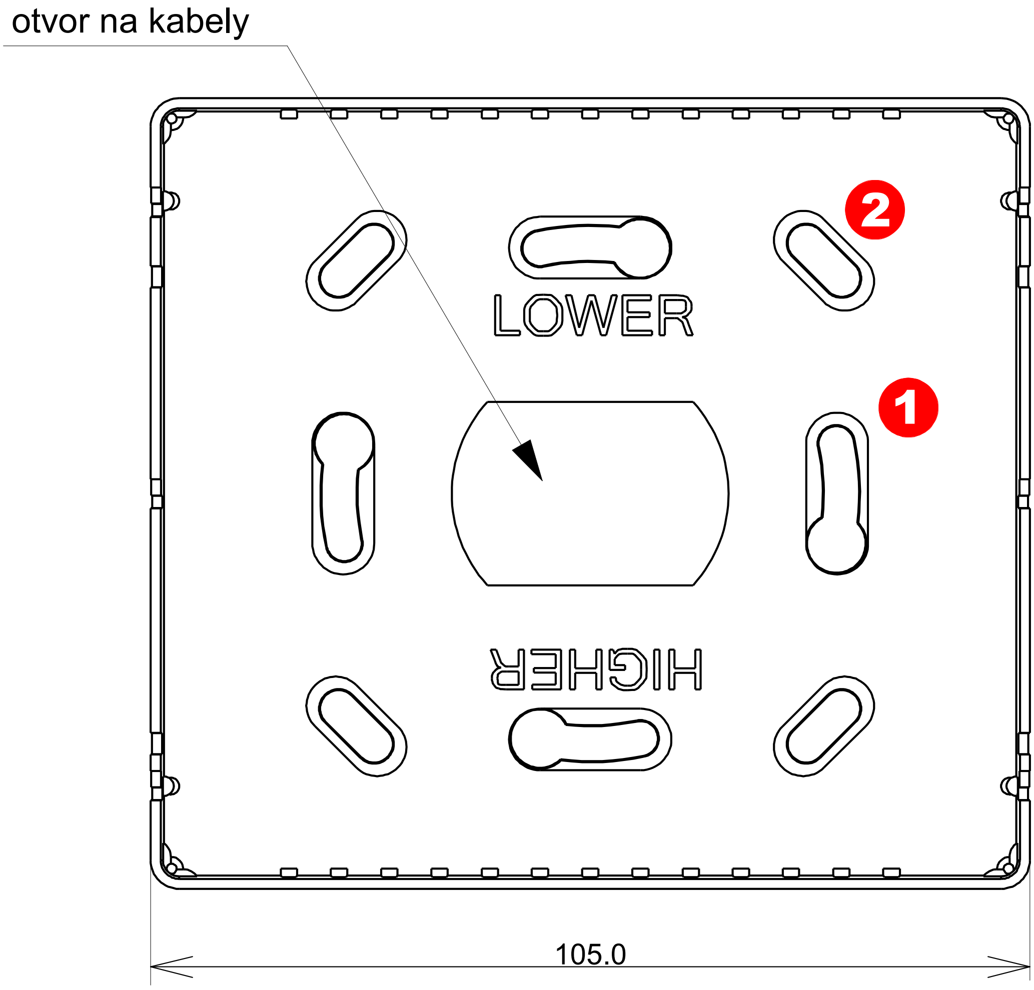


Fig. 14.1.53.2 Holes for mounting the C-RC-0011R module on the wall or in a flush box
Notes:

1. The support part of the control unit is mounted using the pressed holes in a standard flush box with 60mm spacing (in the figure holes ①), or in flush boxes with the spacing used e.g.in Switzerland (in the figure the holes in the corners ②), or on a flat surface using bolts or screws. The central hole is intended for pulling through the cables to the module terminals.
2. Correct orientation of both parts must be observed during the mounting. The support part of the C-RC-0011R module must be mounted on the wall exactly as shown in the fig. - the text "LOWER" must be properly oriented. The housing with the display must again be properly mounted onto the support part. See Fig. 14.1.53.3, for correct orientation. The Teco logo on the inside of the housing must also be correctly oriented.

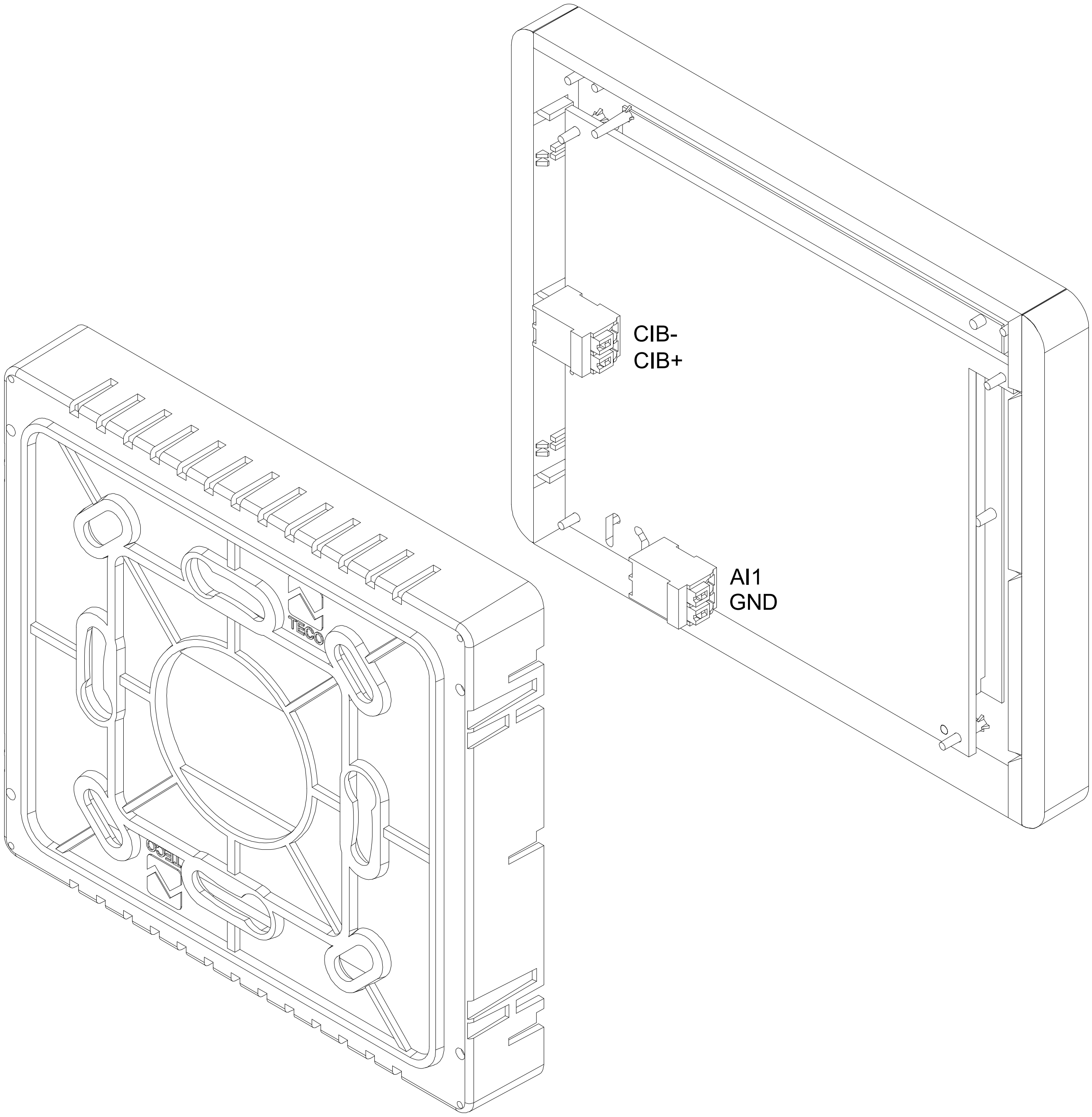


Fig. 14.1.53.3 The placement of the connector on the rear side of the housing of the C-RC-0011R module

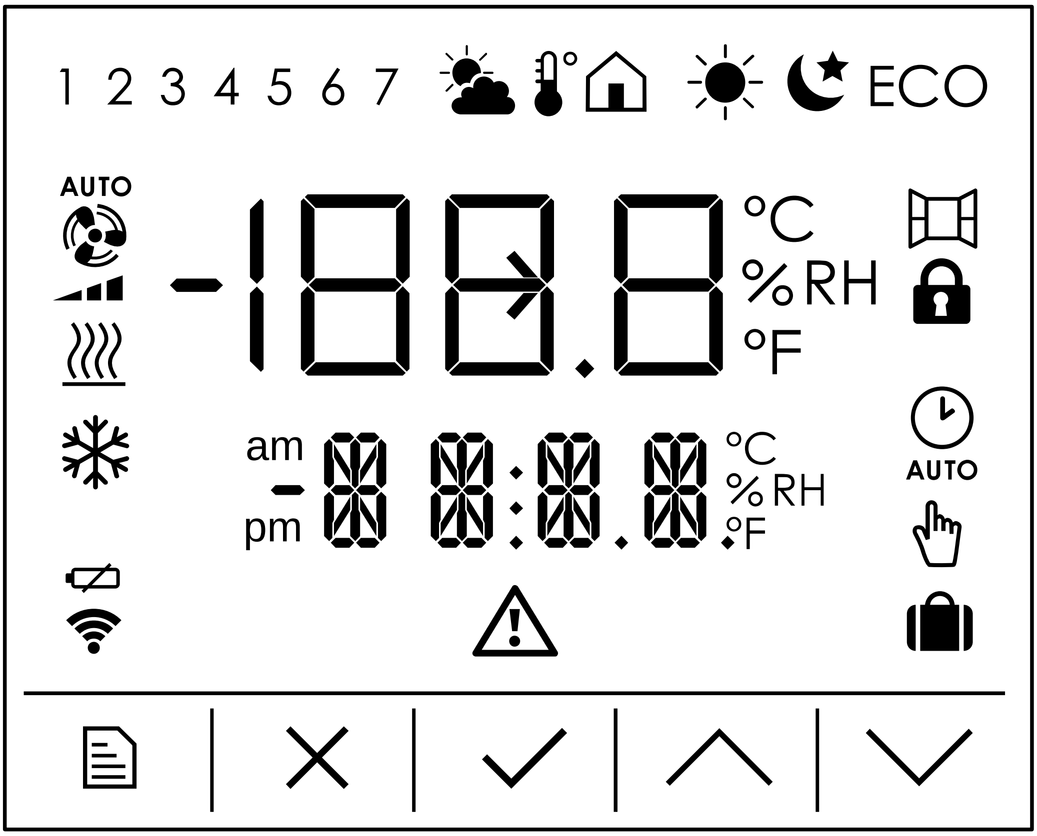


Fig. 14.1.53.4 A complete set of symbols on the C-RC-0011R module display

Notes:

1. The bottom row of symbols also represent capacitive buttons for operating the module.
2. The module can be operated either using the prepared function blocks, or if necessary, each symbol can be operated individually from the user program - see the module SW manual.

14.1.54 The S-SI-01I

The sensor of solar radiation (intensity), order no. TXN 134 07, uses for its measurements a monocrystalline silicon solar cell with an integrated temperature sensor; it is used for temperature compensation of the solar cell.

The module is supplied in a plastic box made of UV-resistant polycarbonate. The sensor is placed in the cap housing under the resistant cover glass. The measurement includes a temperature compensation of the intensity sensor.
The output of the measuring element and the temperature sensor is terminated by insulated strings with colour insulation with stripped and tinned ends. The length of the wires is about 100mm.

The sensor is available either as part of a complete CIB module C-IT0200I-C-SI, or it can be installed separately and connected to the analogue inputs (measuring of the output voltage of the sensor itself and the NTC 12k temperature sensor) of the modules C-IT-0200I, C-HM-xxxxM, R-HM-xxxxM, C-AM-0600I.

The level of intensity (W/m^2) is calculated using the function in the programming environment, where you need to enter the specific sensor calibration constant; it is written on the label on the internal side of the cap, and it should be copied before the sensor is mounted.

The basic parameters:

Measuring the intensity of solar radiation	0 ÷ 1500 W/m^2
Spectral sensitivity	380 ÷ 110nm
The visual angle of the sensor	179°
Typical accuracy of the intensity sensor	±5 %*
Maximum temperature measurement error	±2 °C
The operating temperature of the sensor	-30 ÷ +70 °C
Calibration of the sensing element in STC (Standard Test Condition)	25 °C, 1,000W/m^2, spectrum AM 1.5

* Calibrated by a simulation calibrator, comparison with the Kipp & Zonen CMP11 pyranometer (ISO secondary standard).

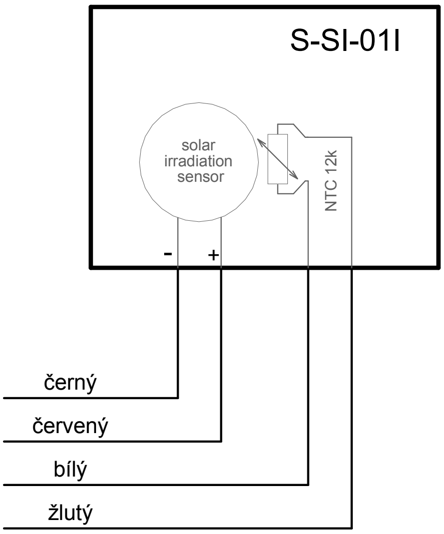


Fig. 14.1.54.1 Terminating the signals of the sensor of solar radiation S-SI-01I

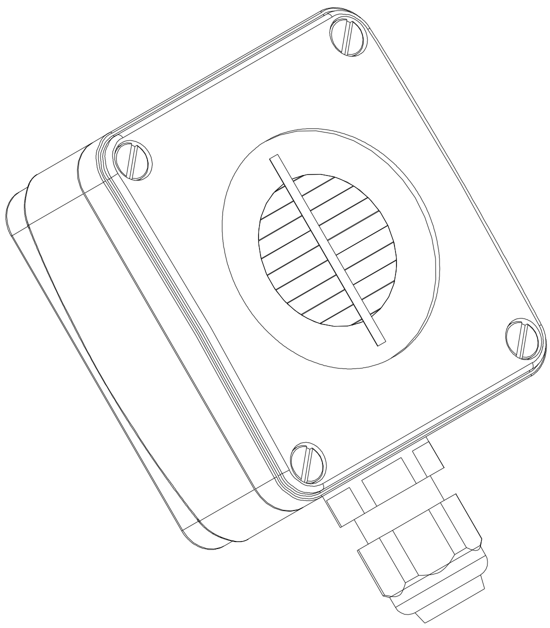


Fig. 14.1.54.2 The solar radiation sensor S-SI-01I

Notes:

1. During measurements relating to the PVPS or thermal solar panels, the sensor should be placed close to the panels, and it should also be oriented in the same way, ideally with the gland downwards, see the figure.
2. Fix the module with two screws, which can be fitted after removing the module cover - see a detailed description of the box in the Chapter .
3. The sensor signals are brought out from the box from the underside of the cap in wires with colour-coded insulation; the wire tips are stripped and tinned, the length is approx. 100mm.
4. The sensor outlets can be extended as necessary, ideally with a shielded cable of 0.5 mm minimum diameter and approx. 10-20 meters maximum length. Even a longer cable can be used, but it must be shielded, correctly connected and it should not run in parallel with power lines.

5. There is a label on the underside of the cap, which contains the sensor calibration constant. It should be copied prior to the module assembly. This constant is then entered as a parameter of the function that implements the necessary calculations.

14.2 Explanation of terminology and abbreviations

The symbols of signal and protective ground:

⏚	the mechanical frame	a terminal connected with the frame of the system, optionally usable for shielding connection
(⏚)	safety earthing	a terminal dedicated for the connection to the PE terminal in the control panel
⏚	working earthing	a terminal connected to the earthing of the cabinet; it has only an operational significance, e.g. for the connection of shielding
⊥	signal ground	it usually refers to one pole of power supply, or the signal ground of the circuit

Marking the terminals and the system signals:

GND	signal ground	for communication, powering of the system
GNDx	a common terminal of binary outputs	a common terminal of I/O inputs or outputs of the system
AGND	signal ground of the analogue circuits	
COMx	a common terminal of the binary inputs	
DI0, DI1,...	binary input signals	the sensor or contact output is connected to this terminal
DO0, DO1,...	binary output signals	the input of the controlled device is connected to this terminal
IN0+, IN1+ AI0+, AI1+	analogue positive input terminals	it applies to differential inputs
IN0–,IN1– AI0–, I1–	analogue positive input terminals	it applies to differential inputs
AIx, INx	analogue input terminal	the terminal to which the output of the signal of the measured device or a temperature sensor is connected
AOx	analogue output terminal	the terminal to which the analogue input of the controlled device is connected
Iout0,...	specific current output	an output terminal with terminated power supply source for powering passive resistance sensors, or see the following
Vref	the output terminal of the source of reference voltage	A terminal with an output of constant reference voltage for the circuits of analogue inputs or outputs
RxTx+	a positive terminal of the RS485 interface	together with the negative terminal it implements the RS485 bus
RxTX-	a negative terminal of the RS485 interface	together with the positive terminal it implements the RS485 bus
RxD+/TxD+	a positive terminal of the RS485 interface	together with the negative terminal it implements the RS485 bus , a different marking
RxD-/TxD-	a negative terminal of the RS485 interface	together with the positive terminal it implements the RS485 bus , a different marking
RxD	the receiver RS232 terminal	a terminal with this designation for systems is the input of the receiver of communication RS232 (N.B.: e.g. in modems, the meaning of this signal may be opposite)
TxD	terminal of the transmitter RS232	a terminal with this designation for systems is output of the transmitter communication RS232 (N.B.: e.g. in modems, the meaning of this signal may be opposite)
RTS	a terminal for the direction control RS232	a terminal with this designation for systems is an output for the communication direction control RS232 (N.B.: e.g. in modems, the meaning of this signal may be opposite)

$+U_{SS}$	powering binary units	a terminal with this designation should be connected to the positive pole of power supply for binary circuits (DC units)
$-U_{SS}$	powering binary units	a terminal with this designation should be connected to the negative pole of power supply for binary circuits (DC units)
U_{ST}	powering binary units	a terminal with this designation should be connected to one pole of power supply for binary circuits (AC units)

15 References

[1] A handbook of a Tecomat and Tecoreg systems designer, order number TXV 001 08
[2] A handbook of Programmable Tecomat control units Foxtrot, order number TXV 004 10
[3] The handbook Serial communication of Tecomat systems, order number TXV 004 03
[4] The SALTEK company documentation
[5] The HAKEL company documentation
[6] www.thermoprozess.cz
[7] The Jablotron company documents
[8] www.pasivnidomy.cz,
[9] The ETATHERM company documents
[10] The OVENTROP company documents
[11] The AMET company documents, www.amet.cz
[12] technical information concerning the products listed in the handbook
[13]

16 List of changes to the document

Rev.3d:

- Added characteristics and examples of the following modules: CP-1091, C-RM-1109M, C-RC-0005R, C-RC-0011R, C-IS-0504M, C-EV-0302M
- Added an example of connecting consumption control of PVPS with the CP-1091 basic module
- Added information and an example of connecting the EV charging control.
- Modified a description and connecting the C-BM-0202M and B-BM-0201X modules
- Added examples of connecting the sensing of level probes.
- The example of connecting the sensors of defrosting outdoor areas
- Added an example of connecting the measurement of the S-RS-01I precipitation detector.
- Added an example of measuring the air flow speed

Rev.3c:

- Added and modified Chapter 5 FVE, HFVE, Heating water including a description of new modules.
- Added a description of the module: 5.5.1 The C-BM-0202M module for charging and protection control of LiFePO4 batteries
- Added Chapter 2.9 The operator panels
- Added Chapter 12.5 IP cameras
- Added a description of a CIB electricity meter: 11.1.9 Metering the generation and consumption of electrical energy, 3ph fast metering, the C-EM-0401M electricity meter
- Added information concerning the rotary control unit: 9.1.13 A rotary control unit on the CIB, the C-RS-0200R

Rev.3b:

- Modified Chapter 13.5.
- Added Chapters on blinds and the Somfy roller blinds control.
- Added Chapters on LED panels and power LED sources control.
- Added new electricity meters PA 144 and examples of use.
- Supplemented information on protection and properties of modular circuit breakers.
- Supplemented information on iGlass control unit and added new ABB control units.
- Added connection of PVPS inverters and consumption control of PVPS (continuous power output control).

teco
Objednávky a informace:
Teco a. s. Havlíčkova 260, 280 58 Kolín 4, tel. 321 737 611, fax 321 737 633

TXV 004 16.01

The manufacturer reserves the right to change documentation. The latest updated edition is available on the Internet: www.tecomat.cz