System design guide

Tecomat Foxtrot
Programmable controller

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Designer's manual for FOXTROT and INELS systems.

Working draft

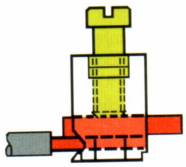
1. Basic and communication modules FOXTROT

1.1. Basic module CP-1004

The CP-1004 basic module is the smallest independent control system of the Foxtrot series.
Features:
Power supply 24 VDC, input power max. 8W (refer to chapter 1.1.1)
DI0-7 - 8 binary inputs, without galvanic isolation:
DI0 ÷ DI3 optionally special functions (refer to chapter 1.1.2),
DI4 ÷ DI7 optionally analog inputs 0÷10V (positive input terminal AI0÷AI3)
DO0-5 - 6 relay outputs, galvanically isolated from the other circuits
ETH - Ethernet 10/100 Mbit (standard RJ-45 connector), galvanically isolated from the other circuits
CH1 - Serial channel, fixed fitted with the RS232 interface, without galvanic isolation
CH2 - Serial channel, with possibility to be fitted with standard submodules (e.g. TC700 series).

The **terminal boards** of the basic module are standard cage-type fixed terminals with a spacing of 5.08 mm. To handle the terminal, a flat bladed screwdriver 3.5 mm wide can be used (a cross screwdriver can be used, too).

Table 1.1.1 Terminal parameters for basic module CP-1004

Terminal spacing		5,08
Terminal type		Screw-type cage terminal
		
Length of stripped conductor	mm	7
Conductor dimensions		
Fixing range	mm^2	0,08 ÷ 2,5
Wire [1)]	mm^2	0,5 ÷ 2,5
Cable [2)]	mm^2	0,5 ÷ 2,5
Cable with female header [3)]	mm^2	0,5 ÷ 2,5
Cable with female header and plastic collar [4)]	mm^2	0,5 ÷ 1,5
Nominal voltage	V	250
Nominal current	A	12

[1)] Wire, e.g. harmonised type H05(07) V-U
[2)] Cable, e.g. harmonised type H05(07) V-K
[3)] Cable, with copper female header according to DIN 46228/1
[4)] Cable with female header with plastic collar according to DIN 46228/4

Informative conversion table of cross-sections and conductor diameters

Nominal cross-section	Conductor diameter		
	Metric		AWG
	Wire	Cable	
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

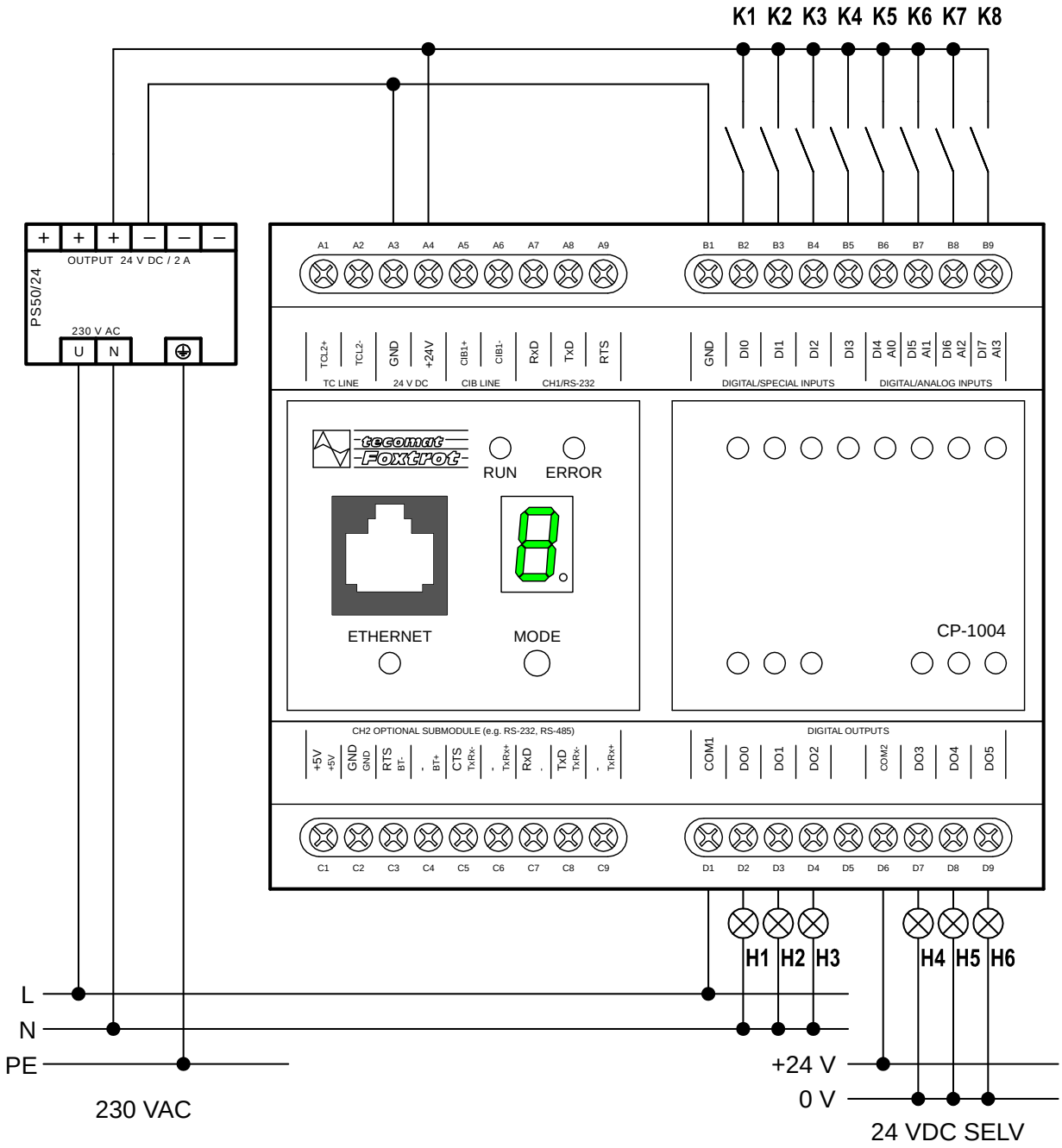


Figure 1.1.1 Basic connection example for basic module CP-1004

Notes for connection:

1. Groups of relay outputs (DI0÷2 and DI3÷5) can switch the circuits supplied from various sources. The groups are isolated by isolation corresponding to safe circuit isolation.
2. The optional functions of DI/AI inputs are set from the programming environment, some connection examples are shown in the following chapters.
3. The TCL2 bus is fixed terminated on the basic module and it always has to be at the end of the bus line (refer to chapter 3.2).
4. The power supply of the module, the interfaces TCL2, CIB and CH1 have common signal ground, the GND terminal (terminal A3). This terminal is connected to the common DI/AI terminal (terminal B1).
5. The analog inputs AI0÷AI3 are configured as inputs with common negative terminal GND.

1.1.1. Power supply of basic module CP-1004

For proper functioning, the module requires smoothed direct current supply voltage 24 VDC (in case of power supply backup by batteries, the system can be supplied by a 27.2 VDC source - we recommend to use the PS-50/27 power supply source). The maximum power consumption of the system (under full load - closing of relay inputs, with an additional submodule fitted and with active communication) is 8 W.

The module power supply is galvanically connected with the inputs DI0 ÷ DI7, the CH1 communication interface, the CIB1 interface and the TCL2 system channel. Also in case the CH2 channel is fitted with a submodule with galvanically non-isolated I/O circuits, these circuits are galvanically connected with the power supply of the system. The common pole is the GND terminal (terminals A3, terminals B1).

NOTE
When applying the system, the common pole (galvanic connection) of the above-mentioned I/O parts of the module should be taken in account – especially in case of supplying from more positions, more power supply sources or risk of occurrence of ground loops.

SELV:
If the power supply source fulfils the parameters of SELV sources according to ČSN 33 2000-4-41, than all I/O circuits of the system fulfil the SELV requirements. Also in cases when the relay outputs switch the low voltage circuits (isolation of relay outputs from the internal circuits of the system is 4 kV AC).

Source parameters:
Usually, most of power supply sources with 24V= output stabilised voltage comply for suit. An non-stabilised power supply source can also be used, but attention should be paid to the output voltage (for a power supply source with a high output, the output voltage might exceed the permissible value.

Source output determination:
A source with an output of min. 15W is optimal to supply an individual control system. If further circuits are supplied from this source, its output has to be increased proportionally. In case a source with non-stabilised output is used, the permissible range of the supply voltage should be followed, especially in cases when power supply sources with a high excess output are used.

Power supply protection:
The power supply input (terminal A4) is not protected by an internal fuse. We recommend using a front-end external fuse before the modules power supply with a recommended nominal value of T500L250V.

Increasing resistance of module power supply sources:
To ensure a trouble-free operation also in exceptional situations (thunder strokes, generally bad condition of the distribution network or effects of close of power devices having negative effects to the distribution network), we recommend using elements ensuring the resistance of the sources against unfavourable effects of the environment. Detailed information on methods how to increase the reliability can be found in the documentation TXV 001 08, chapter 2.

1.1.2. Special functions of binary inputs of module CP-1004

Besides the function of ordinary inputs, the binary inputs DI0, DI1 (counter 1) and DI2, DI3 (counter 2) can be set to one of special functions that allow the connection of an incremental position scanner, application of fast counters, period and phase shift measurement (e.g. for generator phasing), etc. The functions are described in detail in the manual Programmable controllers Tecomat Foxtrot, TXV xxx xx, where the functions are in tables together with concrete connection examples.

Counter 1

Mode	Function	DI0	DI1	DI2	DI3	Exam-ple
00	Counter off (inputs DI0 and DI1 – common binary inputs)	DI0	DI1	Acc. to counter 2		
01	One unidirectional counter	CI1	-	Acc. to counter 2		1.1.2.1
02	Two unidirectional counters	CI1	CI2	Acc. to counter 2		1.1.2.2
04	Bi-directional counter	UP1	DN1	Acc. to counter 2		
05	Counter with direction control	CI1	U/D1	Acc. to counter 2		
08	Incremental scanner (without clearing and interception)	V1	G1	Acc. to counter 2		1.1.2.3
14	Bi-directional counter with clearing and interception	UP	DN	RES	MEM	
15	Counter with direction control with clearing and interception	CI	U/D	RES	MEM	
18	Incremental scanner with clearing and interception	V	G	NI	MD	1.1.2.4
1C	Pulse length measurement	IN1	IN2	IN3	IN4	
1D	Phase shift and period measurement	PER1	PER2	PER3	PER4	

Counter 2

Mode	Function	DI0	DI1	DI2	DI3	Exam-ple
00	Counter off (inputs DI0 and DI1 – common binary inputs)	Acc. to counter 1		DI2	DI3	
01	One unidirectional counter	Acc. to counter 1		CI2	-	1.1.2.1
02	Two unidirectional counters	Acc. to counter 1		CI3	CI4	1.1.2.2
04	Bi-directional counter	Acc. to counter 1		UP2	DN2	
05	Counter with direction control	Acc. to counter 1		CI2	U/D2	
08	Incremental scanner (without clearing and interception)	Acc. to counter 1		V2	G2	1.1.2.3

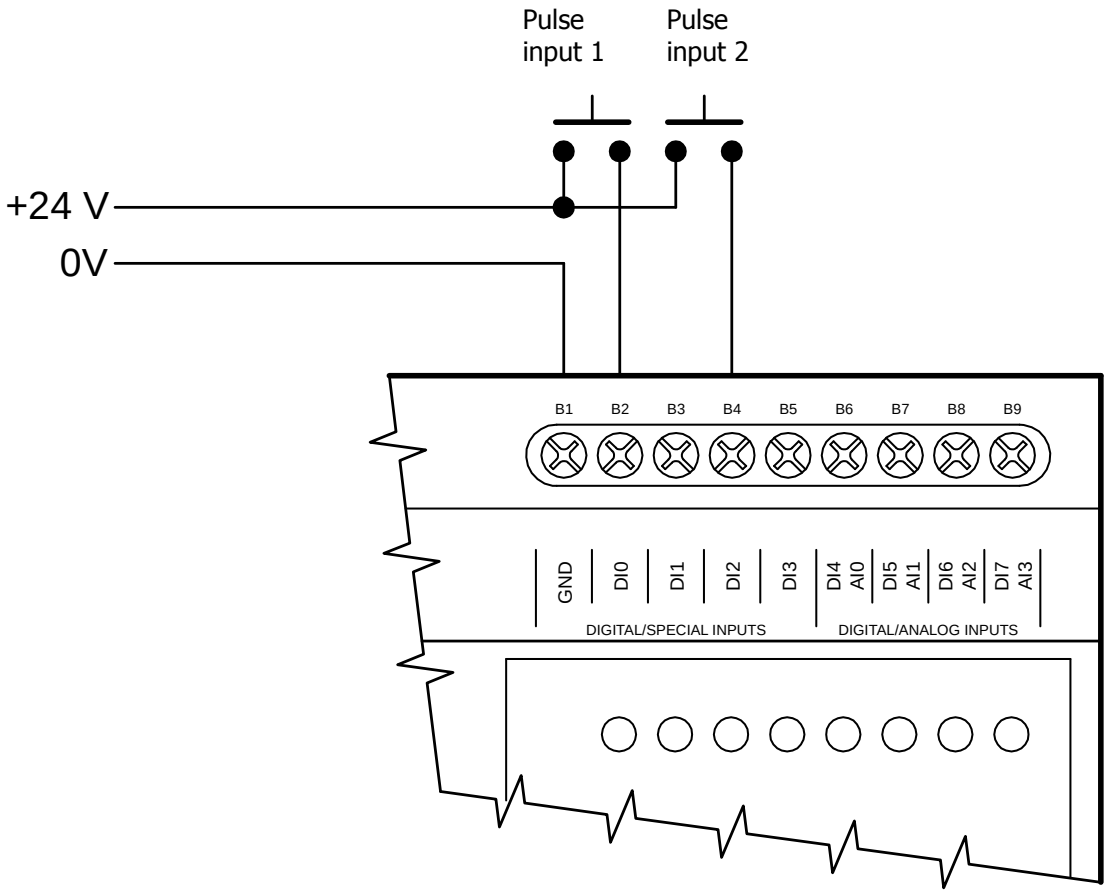


Figure 1.1.2.1 Example of scanner connection with pulse output (for counter 1 as well as counter 2)

Notes for connection:

1. The inputs are realized as fixed with common pole – (terminal GND – ATTENTION! – the terminal is galvanically connected with the negative terminal of power supply and signal ground of the interfaces TCL2, CIB and CH1).
2. The inputs require connection with a pulse output (with bounce treatment).

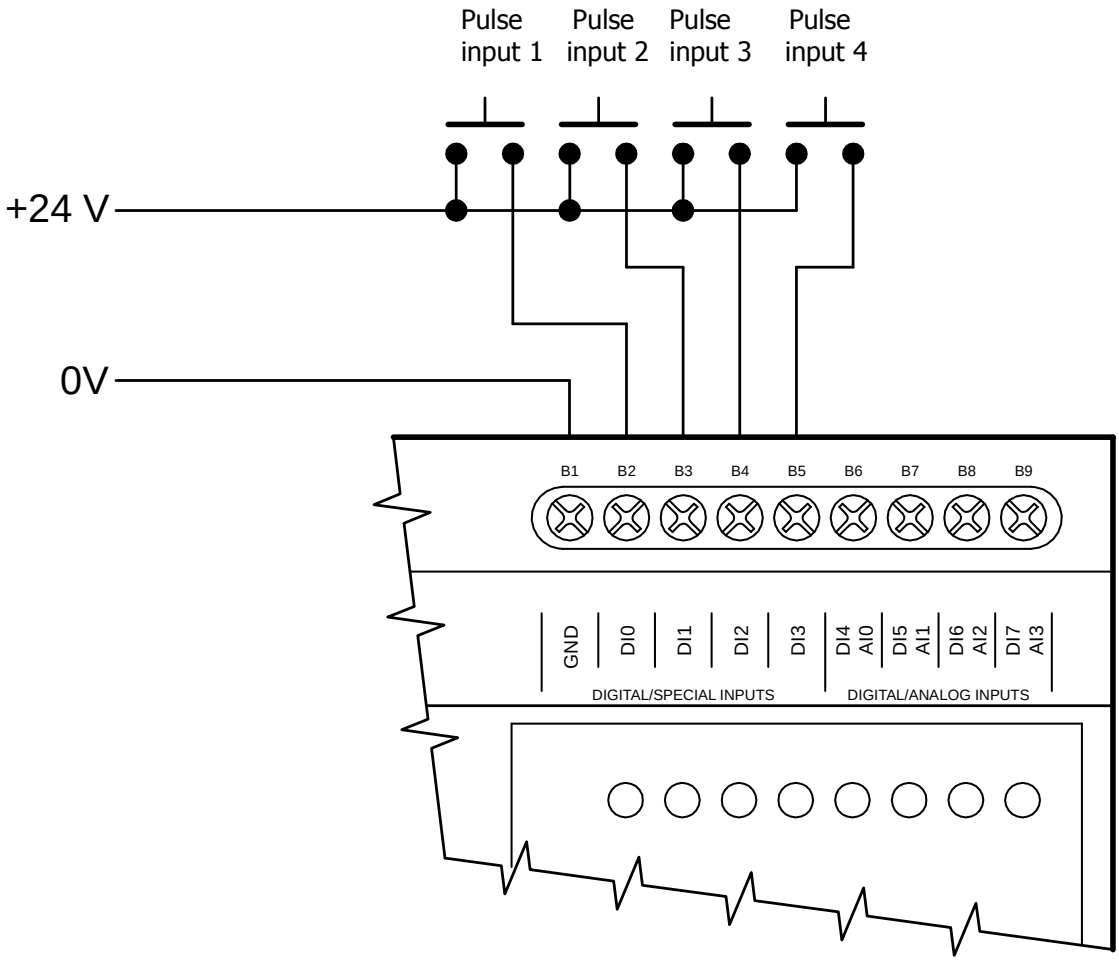


Figure 1.1.2.2 Connection example of a scanner with pulse outputs (for counters 1 to 4)

Notes for connection:

1. The inputs are realized as fixed with common pole – (terminal GND – ATTENTION! – the terminal is galvanically connected with the negative terminal of power supply and signal ground of the interfaces TCL2, CIB and CH1).
2. The inputs require connection with a pulse output (with bounce treatment).

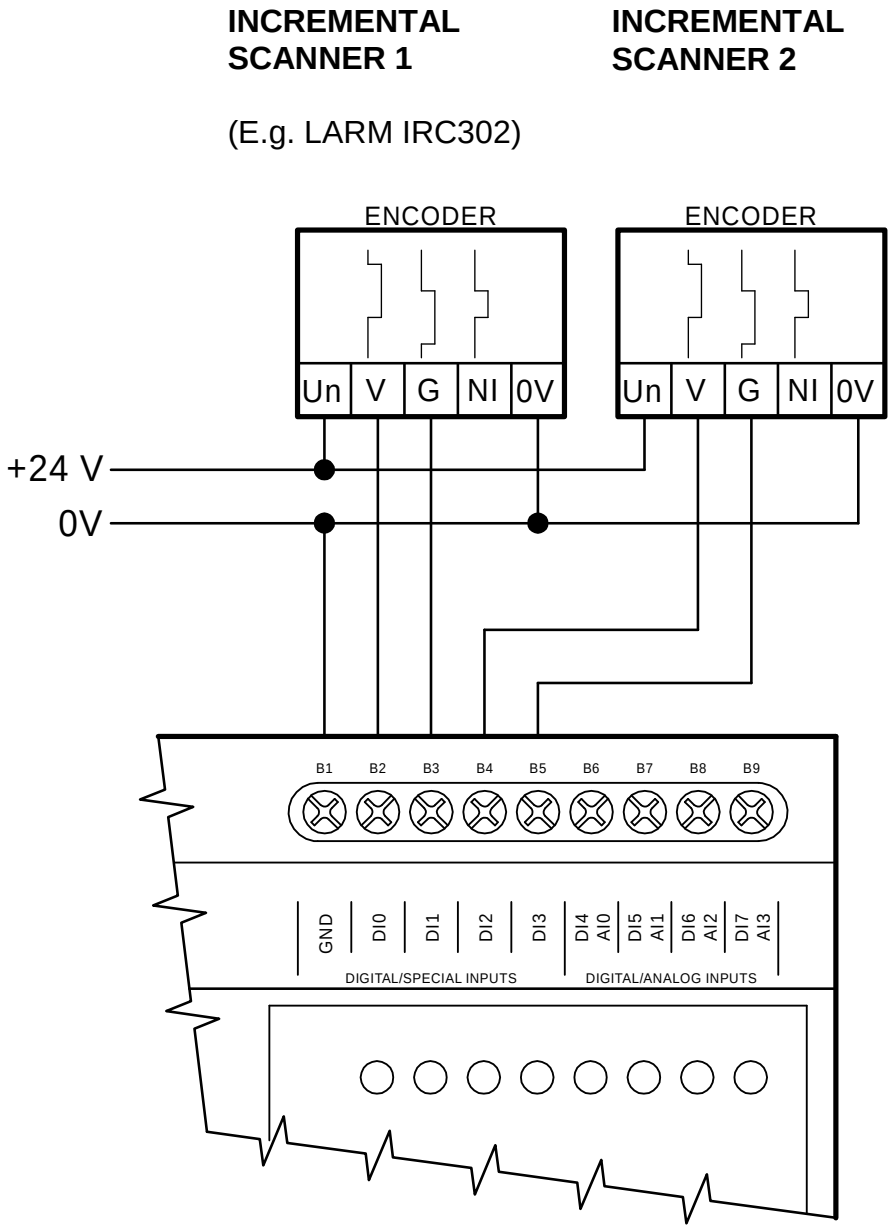


Figure 1.1.2.3 Connection example for incremental scanners (counter 1 as well as counter 2)

Notes for connection:

1. The inputs are realized as fixed with common pole – (terminal GND – ATTENTION! – the terminal is galvanically connected with the negative terminal of power supply and signal ground of the interfaces TCL2, CIB and CH1).
2. The module is designed for the connection of incremental position scanners (rotational, linear) with a 24V output (scanners with the 5V output cannot be connected!). In this mode, they scan only both tracks of the scanner. It is not possible to evaluate the zero pulse and the measuring contact (interception input).

INCREMENTAL SCANNER 1

(E.g. LARM IRC302)

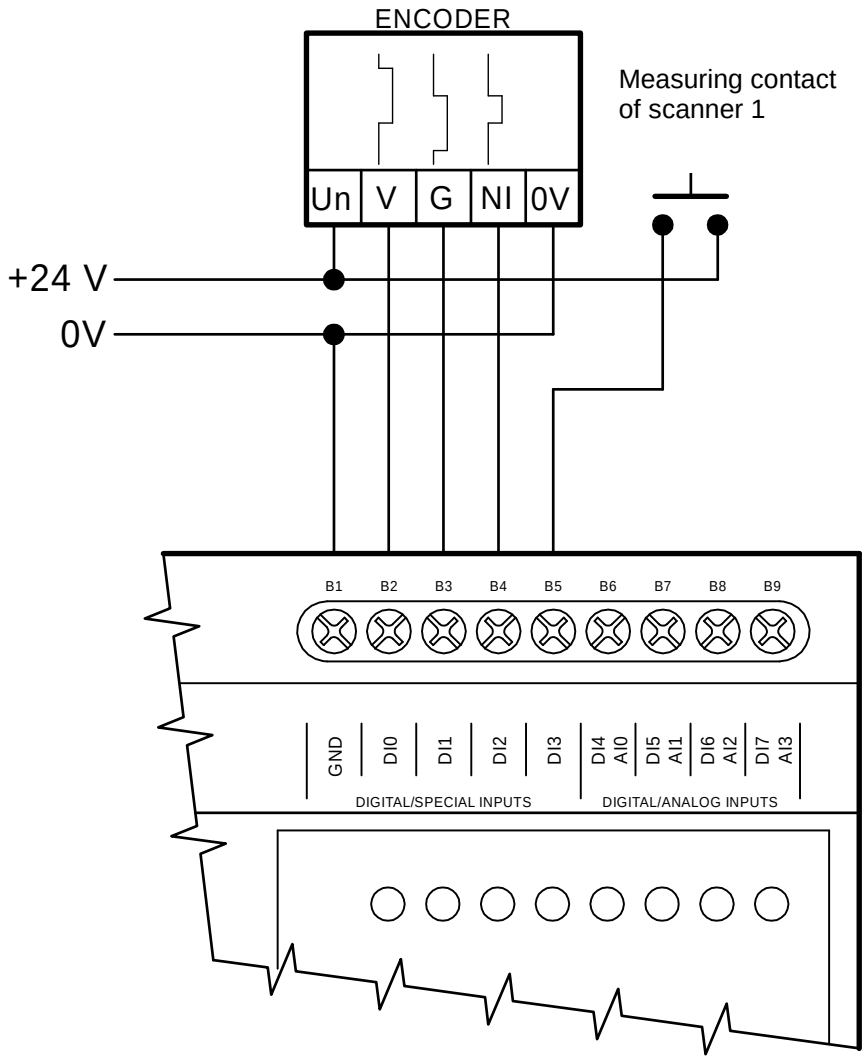


Figure 1.1.2.4 Connection example for an incremental scanner with clearing and interception

Notes for connection:

1. The inputs are realized as fixed with common pole – (terminal GND – ATTENTION! – the terminal is galvanically connected with the negative terminal of power supply and signal ground of the interfaces TCL2, CIB and CH1).
2. The module is designed for the connection of incremental position scanners (rotational, linear) with a 24V output (scanners with the 5V output cannot be connected!). In this mode, they scan both tracks, the zero pulse as well as the measuring contact of the connected scanner.

1.1.3. Communication interface CH1 of basic module CP-1004, interface RS-232

The CP-1004 basic module is fitted with asynchronous serial channels (CH1, CH2), the CIB1 interface, the TCL2 system channel and the ETHERNET interface. Each serial channel as well as the logic data channel LCH (one Ethernet interface can realize up to four LCHs) can be set to one of the communication modes and realize various networks and interconnections. Any of the channels in the PC mode can be used for PLC programming, but always one at a time!

The serial interface of the CH1 central unit is fitted with a fixed terminal board. A view of the terminal board (with the standard working position of the PLC on the switchgear panel) is on Figure 1.1.3.1.

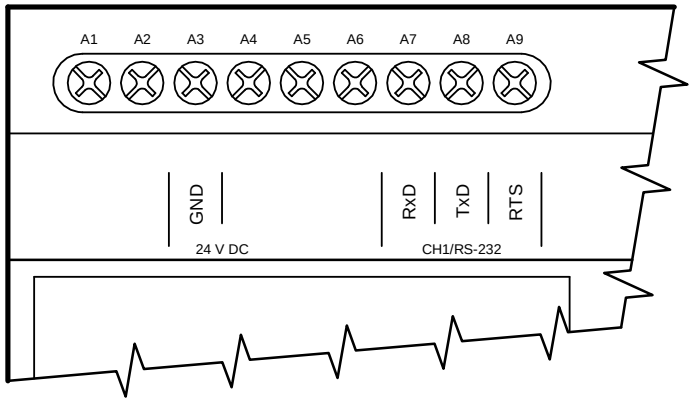


Figure 1.1.3.1 Terminal board A – connection of interfaces CH1, RS232.

Notes for connection:

1. The signal ground GND of the interface is common for module supply, the CIB and TCL2 buses (it is also common for the negative common terminal of the DI/AI inputs).
2. The RTS signal is the control signal (output), which is used by some devices (interface converters, etc.). The use of the signal is described in the manual Serial communication of programmable logic controllers Tecomat TXV 001 06.

1.1.4. Communication interface CH2, use of optional submodules

The CH2 communication interface is led-out to the C terminal board (refer to Figure 1.1.4.1) and standardly; it is not fitted by any module. According the interface required (RS232, RS485, CAN, M-bus etc.), the customer chooses the corresponding submodule and installs it to the prepared position inside the module (the procedure of submodule installation is described in the manual Programmable logic controllers Tecomat Foxtrot.

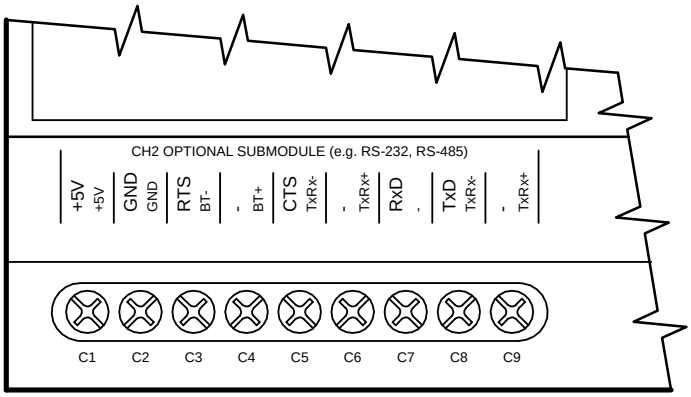
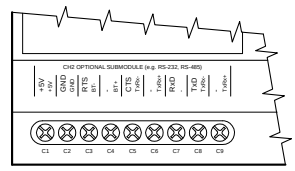


Figure 1.1.4.1 Terminal board C – connection of interface CH2, optional interface.

MR-0104 - interface RS-232, with galvanic isolation

The MR-0104 submodule is used for the transmission of the TTL signals of the serial interface to the RS-232 interface, including galvanic isolation. This interfaces is designed only for the connections of two participants (point-to-point connection). It can be advantageously used for example to realize a connection of a TECOMAT PLC with a PC for short distances (to 15 metres). The galvanic isolation of the serial interface is ensured by a built-in converter and no external power supply is required. Detailed information on the submodule, its internal connection and setup are described in the documentation TXV 101 04.

Table 1.1.3.1 Terminal board C connection of serial channel CH2 with fitted submodule MR-0104

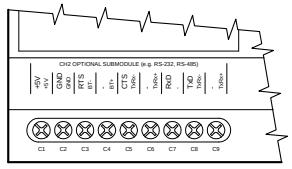
Terminal board C	Terminal	Signal	Type of signal	Used as
	C1	+ 5V	power supply output	
	C2	GND	signal ground	
	C3	RTS	output	control signal 1)
	C5	CTS	input	control signal 1)
	C7	RxD	input	data signal
	C8	TxD	output	data signal

1) The use of the signal is described in the manual Serial communication of Tecomat programmable controllers TXV 001 06. The quiescent state of the signal corresponds to log. 1.

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

The MR-0114 submodule is used for the transmission of the TTL signals of the serial interface to the RS-485 interface with galvanic isolation. This interface works in the semi-duplex mode and allows multidrop interconnection of participants. For proper functioning, the communication line has to be terminated correctly (see the following paragraphs). The galvanic isolation of the serial interface is ensured by a built-in converter and no external power supply is required. Detailed information on the submodule, its internal connection and setup are described in the documentation TXV 101 04.

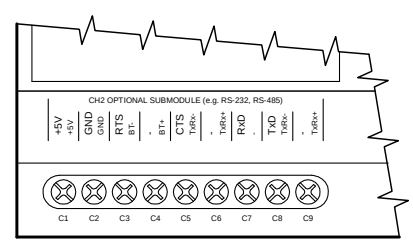
Table 1.1.3.2 Terminal board C connection of serial channel CH2 with fitted submodule MR-0114

Terminal board C	Terminal	Signal	Type of signal	Used as
	C1	+ 5V	power supply output	
	C2	GND	power supply	signal ground
	C3	BT–	– output of termination	RS-485 bus termination
	C4	BT+	+ output of termination	RS-485 bus termination
	C5, C8	TxRx–	– input/output of RS-485	data signal
	C6, C9	TxRx+	+ input/output of RS-485	data signal

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

The MR-0124 is used for the transmission of the TTL signals of the serial interface to the RS-422 with galvanic isolation. The interface allows the connection of two co-operating devices (point-point). Each line (RxD as well as TxD) has to be terminated at the line end by terminators 120 Ohm.
The galvanic isolation of the serial interface is ensured by a built-in converter and no external power supply is required. Detailed information on the submodule, its internal connection and setup are described in the documentation TXV 101 04.

Table 1.1.3.3 Terminal board C connection of serial channel with fitted submodule MR-0124

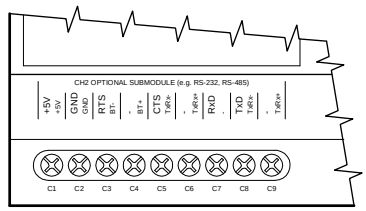
Terminal board C	Terminal	Signal	Type of signal	Used as
	C1	+5V	power supply output +5V	
	C2	GND	signal ground	
	C3	CTS–	input	control signal [1)]
	C4	CTS+	input	control signal [1)]
	C5	RxD–	input	data signal
	C6	RxD+	input	data signal
	C8	TxD–	output	data signal
	C9	TxD+	output	data signal

[1)] The use of the signal is described in the manual Serial communication of Tecomat programmable controllers TXV 001 06. The quiescent state of the signal corresponds to log. 1.

MR-0150 – interface 2x CAN, with galvanic isolation

The MR-0150 submodule allows the connection of the PLC TECOMAT Foxtrot to two CAN networks with transmission rates of 500, 250, 125, 50, 20 or 10 kBd. It can be used in modes CAN, CAS and CAB. The CAN line termination is led-out only for one channel (arbitrary). The second channel has to be terminated externally by a connected resistor 120Ω.

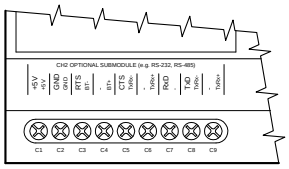
Table 1.1.3.4 Terminal board connection of serial channel with fitted submodule MR-0150

Terminal board C	Termi-nal	Signal	Type if signal
	C1	+5V	power supply output +5V
	C2	GND	signal ground
	C3	BT1–	– output of CAN line termination
	C4	BT1+	+ output of CAN line termination
	C5	TxRx1–	received and transmitted data of channel 1 (level –)
	C6	TxRx1+	received and transmitted data of channel 1 (level +)
	C8	TxRx2–	received and transmitted data of channel 2 (level –)
	C9	TxRx2+	received and transmitted data of channel 2 (level +)

MR-0151 - interface CAN, with galvanic isolation

The MR-0151 submodule allows the connections of the PLC TECOMAT Foxtrot to the CAN network with transmission rates of 500, 250, 125, 50, 20 or 10 kBd. It can be used in modes CAN, CAS and CAB.

Table 1.1.3.5 Terminal board connection of serial channel with fitted submodule MR-0151

Terminal board C	Terminal	Signal	Type of signal
	C1	+5V	power supply output +5V
	C2	GND	signal ground
	C3	BT–	– output of CAN line termination
	C4	BT+	+ output of CAN line termination
	C5, C8	TxRx–	received and transmitted data (level –)
	C6, C9	TxRx+	received and transmitted data (level +)

MR-0152 - interface PROFIBUS DP, with galvanic isolation

The MR-0152 submodule allows the connection of PLC TECOMAT Foxtrot to the PROFIBUS DP network as a slave station (subordinated) with a transmission rate of up to 12 MBd. It can be used in the DPS mode. Since the physical interface of the PROFIBUS bus corresponds to the RS-485 standard, the connection of the connector of the serial channel is identical as with the fitted MR-0114 submodule (refer to Table 1.1.3.2) including the possibility of termination.

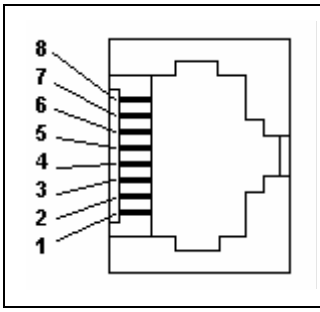
1.1.5. Interface ETHERNET PLC Foxtrot (interfaces, cables)

The central module is standardly fitted with the Ethernet interface, 10/100 Mbit, RJ-45 connector, refer to chapter 1.1.5.1. Each Ethernet physical interface (i.e. one physical connection to the PLC) can realize up to 4 logic data channels (labelled as LCH1 to LCH4), which can be set to several modes and which allow various system interconnection (further information refer to TXV xxx xx) and they are fully independent from the other PLC communication interfaces (with the exception of system services in the PC+ mode, which can be active at one moment only on one of the communication channels (physical as well as logic).

1.1.5.1. Physical interface ETHERNET PLC Foxtrot

The Ethernet interface is fitted with the standard RJ-45 connector with standard signal distribution. The connector is ready to be used with common UTP patch cables (for cable connection refer to chapter 1.1.5.2).

Table 1.1.5.1 Connection of Ethernet interface of TC700 modules (front view of PLC connector)



Pin	Signal	Wire colour
8	unused	brown
7	unused	white / brown
6	RD–	green
5	unused	white / blue
4	unused	blue
3	RD+	white / green
2	TD–	orange
1	TD+	white / orange

1.1.5.2. Connection of direct and crossed ETHERNET UTP cables

The TP (twisted pair) connecting cables are either direct connecting cables (UTP patch cables) or crossed cables.

The direct TP cable is the most commonly used cable designed primarily for connection HUB - terminal (PC network card, PLC Foxtrot, etc.). It is standardly produced and available. The cable is fitted by the RJ-45 connectors on both ends (8 pins). Only 4 signals are functional (for commonly used 10Base-T interfaces), the other conductors are not used (outlined by dashed lines on Figure 1.1.5.1).
A twisted pair cable has to be used (a phone line non-twisted cable cannot be used!) and one twisted pair has always to be used for one data flow direction. For Ethernet cables, the colour coding TIA568B for conductors in the cable is standardized and most frequently used, see table 1.1.5.1 (for direct cable).

The data UTP cables (non-shielded) and STP cables (shielded - the shielding is not connected on the PLC side) are produced in several categories, numbered by 3 to 6. For 10/100 Mbit Ethernet (10Base-T), any of the categories can be used, but at least the category 5 is recommended.
The basic product range of direct cables is supplied under the order number TXN 102 05.xx (the numbers behind the point specify the cable length according to the product line - see the TC700 catalogue). The maximum length of the TP cable is limited to 100 metres.

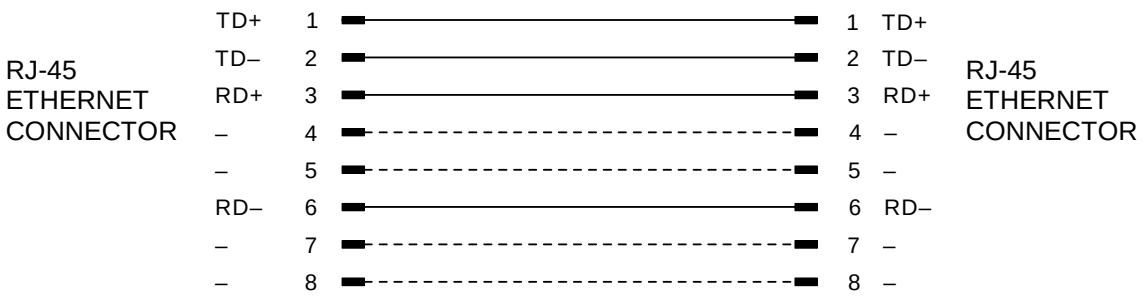


Figure 1.1.5.1 Connection of direct cable (ETHERNET UTP patch cable)

Crossed cables are used for direct connection of two equivalent devices (e.g. HUB - HUB (without the uplink port on HUBs), Foxtrot - PC, Foxtrot - Foxtrot). They are not commonly available and they have to be ordered with an expressed request for a crossed cable. The cable is fitted by the RJ-45 connectors on both ends (8 pins).

Only 4 signals are functional (for commonly used 10Base-T interfaces), the other conductors are not used (outlined by dashed lines on Figure 1.1.5.2). A cable with twisted pairs has to be used (a non-twisted phone line cable must not be used!) and one twisted pair has to always be used for one data flow direction.

The basic product line of crossed cables is supplied under the order number TXN 102 06.xx (the numbers behind the point specify the cable length according to the product line - see the TC700 catalogue).

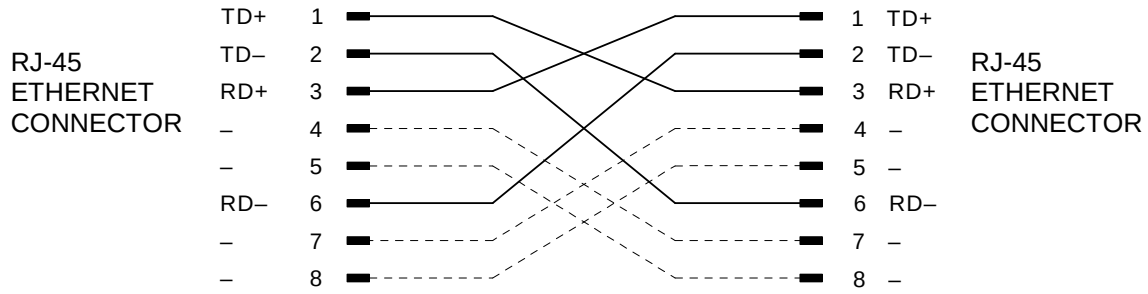


Figure 1.1.5.2 Connection of crossed TP cable ETHERNET

1.1.5.3. Recommended UTP (FTP) cables for ETHERNET

TP cables (twisted pair) can be used as non-shielded (UTP) or shielded (FTP). The FTP shielded cables can be very well used also for RS-485 distribution (see chapter 1.1.3).

UTP cables, recommended types:
PCEY 4x2x0,5 (PCEY 4x2x0,6), manufacturer VUKI a. s. (distributor ISOKAB s.r.o.)
UTP data cable – class 5, manufacturer KABLO ELEKTRO, a. s. Vrchlabí
UTP Cat. 5, manufacturer PRAKAB

FTP cables, recommended types:
PCEHY 4x2x0,5 (PCEHY 4x2x0,6), manufacturer VUKI a. s. (distributor ISOKAB s.r.o.), refer to chapter 3.6.2.
FTP data cable – class 5, manufacturer KABLO ELEKTRO, a. s. Vrchlabí
UNITRONIC EtherLine-H CAT. 5, manufacturer LAPP KABEL
FTP Cat. 5, manufacturer PRAKAB

1.1.5.4. Principles of installation for ETHERNET distribution

General principles for installation of UTP cables:

When installing cables, sharp bends must be avoided. The cable should not be broken in corners, the manufacturer specifies a minimum bending radius for each cable type – typically, the bending radius is six times the diameter of the cable as minimum. Do nod bend the cable more than 90 degrees.

The cables must not be exposed to mechanical pressures. When drawing cables through holes or bars, the permissible tensile strength must not be exceeded. Pulling the cables by excessive power more than 10 kg causes their damage by expansion of their twisting, which leads to failures (a higher error rate)!

The cables have to be mechanically protected, do not tense them, they should be left free. Also frequent movements damage the cables.

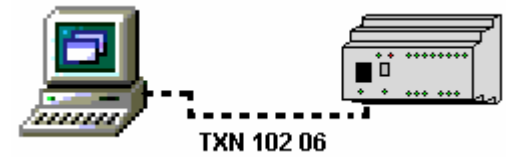
If these principals of cable laying are not followed, data transmission could be slowed down and the cable line could be interrupted. With respect to high frequencies, yet a small change to the geometrical arrangement of the wires in the cable can cause data throughput problems (even if the cable can be ohmicly in good order). The transitions of the cable to the connector are especially sensitive to mechanical damage. In such cases, the cable can be protected from forced bending by axial tension.

For outdoor distribution, the cables should be laid into metal conduits with good ground connection and overvoltage protection should be fitted on both ends of the cable (common for TP distribution of computer networks). In case of a higher interference risk, paralleling, etc., shielded FTP cables are recommended (STP, see chapter 1.1.5.3) together with active network elements (HUB, switch, etc.) with the cable shielding connected to the safety grounding (only on one side of the cable!!).

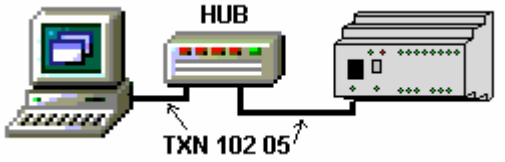
Paralleling with other cables:
It is not permissible to lay the UTP cables close to power lines. If the minimum distance of (0.15 m) cannot be followed, especially if the distribution is done in bars and plastic conduits, shielding channels have to be used for computer distribution lines (conduits made from zinc-coated sheet metal). These conduits have to be well connected within the whole distribution system to be conductive and they have to be connected with the ground conductor of the power lines. The UTP cables have to be in a sufficient distance (50 mm) from any part of the low voltage circuits (230 VAC).

1.1.5.5. Connection examples of ETHERNET networks

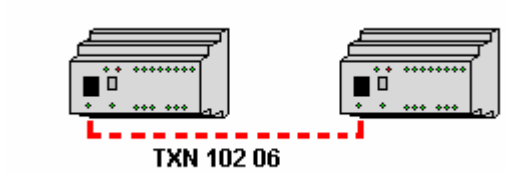
Basic connection, ETHERNET network realization
PC-PLC basic connection
E.g. use of a notebook
It is necessary to use the crossed cable, TXN 102 06 (for connection refer to Figure 1.1.5.2)
Max. 100 m



Connection via HUB (standardly used HUBs or SWITCHes)
Direct cables TXN 102 05 (connection refer to Figure 3.10.3.1)

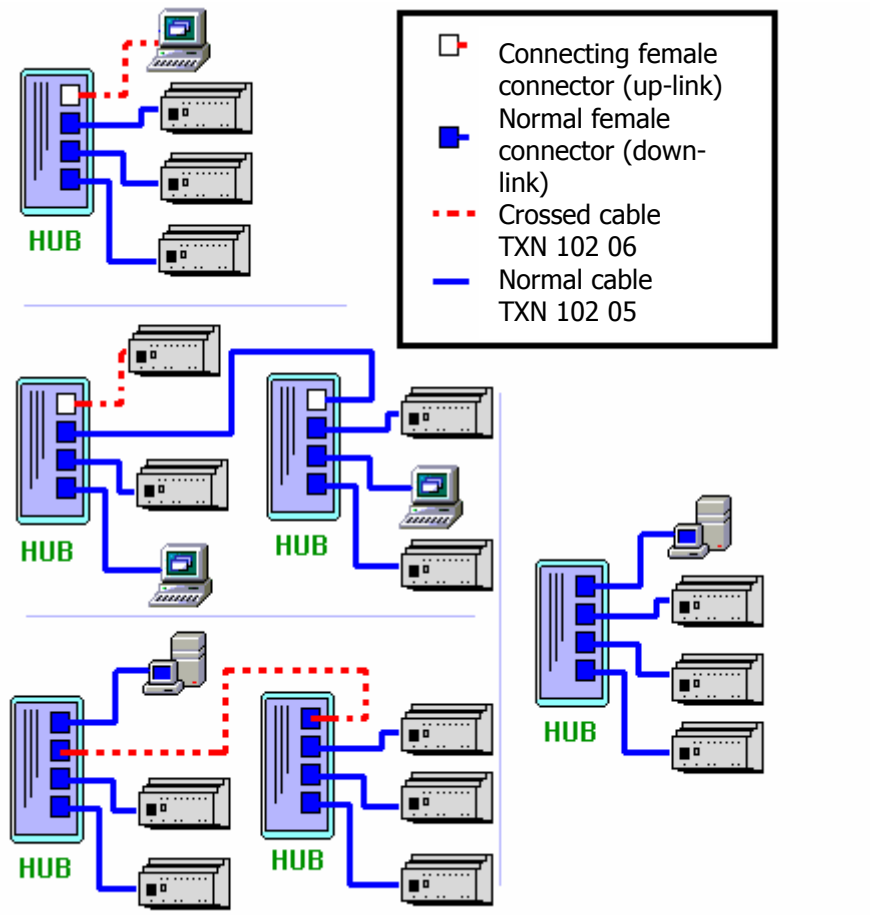


Direct connection of two 2 PLCs
Crossed cable



Interconnection, use of the HUB modules (or SWITCH modules)

The following diagram illustrates the possibilities of connections system - HUB according to the HUB female connector used (i.e. normal female connector - downlink, or connecting female connectors used primarily for the connections of HUBs into a cascade - uplink. Based on the type of connections, either direct (normal) or crossed cables have to be used. The diagram shows the connections of HUBs using the uplink female connector on one of the HUBs (than, we use a direct cable), or using of normal female connectors (downlink) for both HUBs (than, we use a crossed cable).

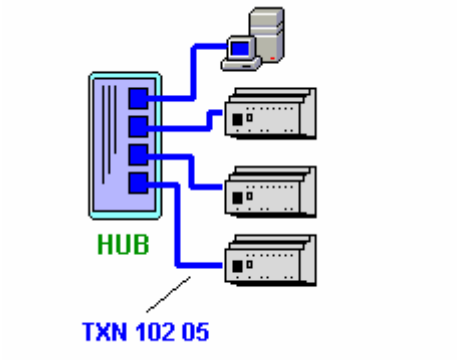


ATTENTION! Some HUBs commonly available have one of the standard female connectors (downlink) common with the connecting female connector (UPLINK). In case we use the female connector UPLINK to interconnect HUBs among each other, than we cannot use the corresponding standard female connector (and vice versa). For more details see the documentation of the HUB used.

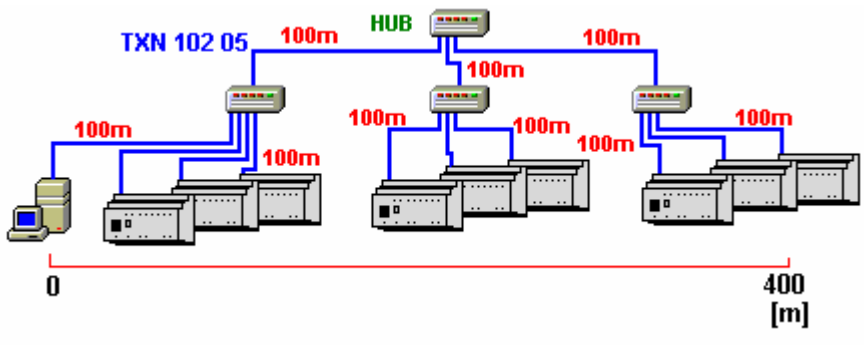
Cable length, possibilities of creation of wide areas networks

The following schemes show the maximum lengths of the cables and thus the range of the network of the systems for common ETHERNET 10Mbit distribution (TP or coaxial).

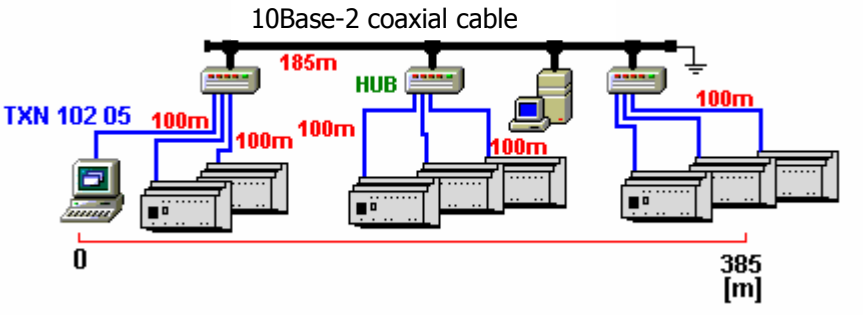
Network with one HUB
Each cable max. 102 m
Any HUB



A wider network, more HUBs
Always max. 3 HUBs between two arbitrary systems



Connection of HUBs through a coaxial cable, again max. 3 HUBs between two arbitrary systems

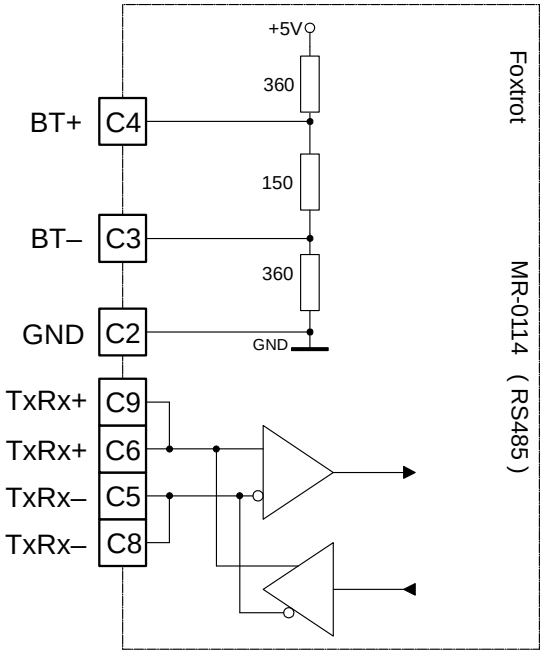


1.1.6. TECOMAT Foxtrot PLC connection examples

The examples show basic recommended connections, which of course are not the only possible way of connection.

Interface RS-485 (submodule MR-0114) of the CH2 communication interface

The RS-485 serial interface submodule (type MR-0114, order number TXN 101 14) is fitted with a complete circuit of bus termination, led-out to terminals (signal BT+) and C3 (signal BT–) refer to Figure 1.1.6.1. The termination is connected to the bus by interconnecting the terminals BT+ and TxRx+, or BT– and TxRx– (refer to the example on Figure 1.1.6.3).



BT+	Positive terminal of bus termination circuit
BT–	Negative terminal of bus termination circuit
GND	Signal ground (common pole) of the interface
TxRx+	Positive signal terminal of the RS-485 interface
TxRx–	Negative signal terminal of the RS-485 interface

Notes

1) Terminal (signals) labelled identically are interconnected inside the submodule.
2) The terminating impedance of the bus is realized by a 150 Ω resistor.
3) All terminals are galvanically isolated from the other system circuits.

Figure 1.1.6.1 Connection of interface RS-485 of the MR-0114 submodule and lead-out to terminal board C

Interconnection of two Foxtrot systems by the RS-485 interface (submodule MR-0114)

The interconnection of two Foxtrot systems by a serial channel with the RS-485 interface is illustrated on Figure 1.1.6.2. The interconnection assumes two systems and thus the bus termination is realized on both sides. In case of interconnection of more systems, the termination (terminals BT+ and BT-) will be connected only on the end systems connected to the bus. Further parameters (conductors, principals of installation) are valid according to the previous paragraphs relating to RS-485.

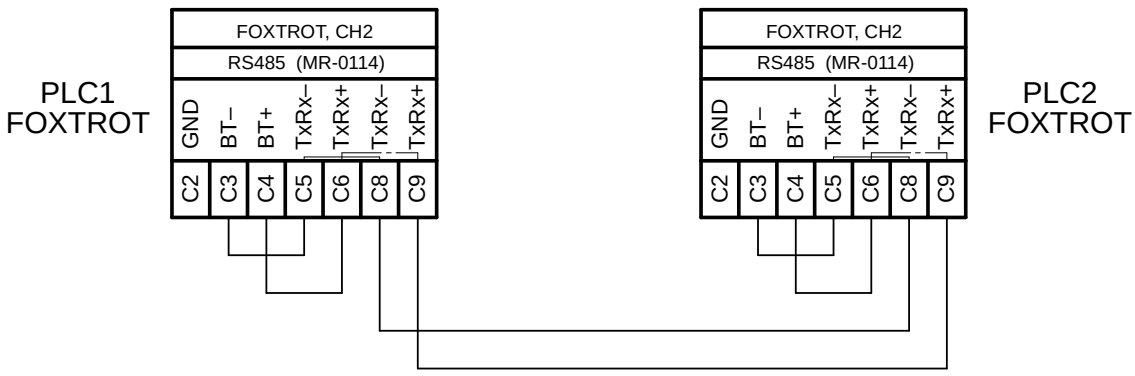


Figure 1.1.6.2 Connection diagram of two Foxtrot systems with the RS-485 interface (submodule MR-0114)

Interconnection of systems TC700 and Foxtrot via the RS-485 interface
The interconnection of systems TC700 and NS950 by a serial channel with the RS-485 interface is illustrated on Figure 1.1.6.3. The interconnection assumes two systems and thus the bus termination is realized on both sides. In case of interconnection of more systems, the termination will be connected only on the end systems connected to the bus.

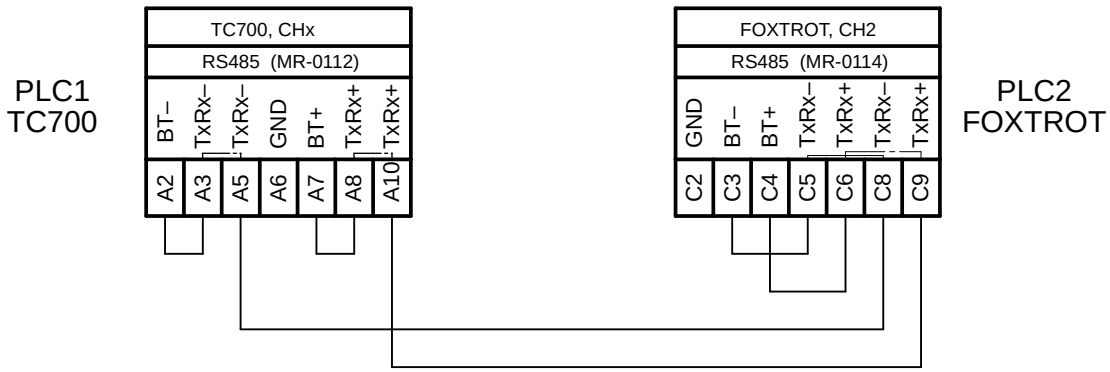


Figure 1.1.6.3 Connection diagram of systems TC700 and Foxtrot with interface RS-485

Connection of system Foxtrot to PC, interfaces RS-232, CH1
If we want to connect the Foxtrot system by a serial channel to a PC (e.g. for programming – if we do not want or cannot use the ETHERNET interface), we can use the RS-232 interface and the cable connected as illustrated on Figure 1.1.6.4. The CH1 interface of the Foxtrot basic module is fixed fitted with the RS-232 interface.

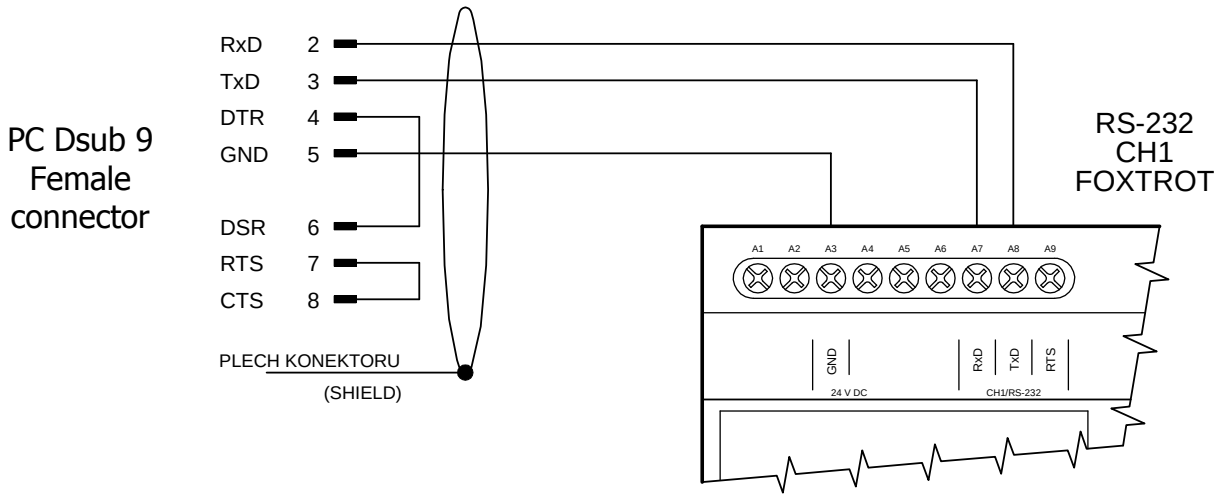


Figure 1.1.6.4 Connection diagram of Foxtrot to PC, interface RS-232, CH1

Module XL-0471 – connection example for Foxtrot, interface RS-485
If we require an interconnection of the Foxtrot communication channels (e.g. realization of a PLC network with the RS-485 interface) or if we want to connect another device to the communication interface of the Foxtrot system or if we require increasing overvoltage resistance, we can us the XL-0471 module. The module has a hub of the RS-485 interface, the through connection (terminal boards A and B) go directly through the module and the branch (terminal board C) is protected against overvoltage (arresters, transil).
An example of connection of the module can be seen on Figure 1.1.6.5. At the same time, the module allows direct connection of cable shielding. The shielding of through branches is interconnected and brought to the G1 terminal (e.g. for a through cable, the shielding does not need to be grounded on the module, the shielding of the branch is connected to the G2 terminal, to which also the overvoltage protection is connected and its connection to the switchgear grounding is assumed (grounding for work).

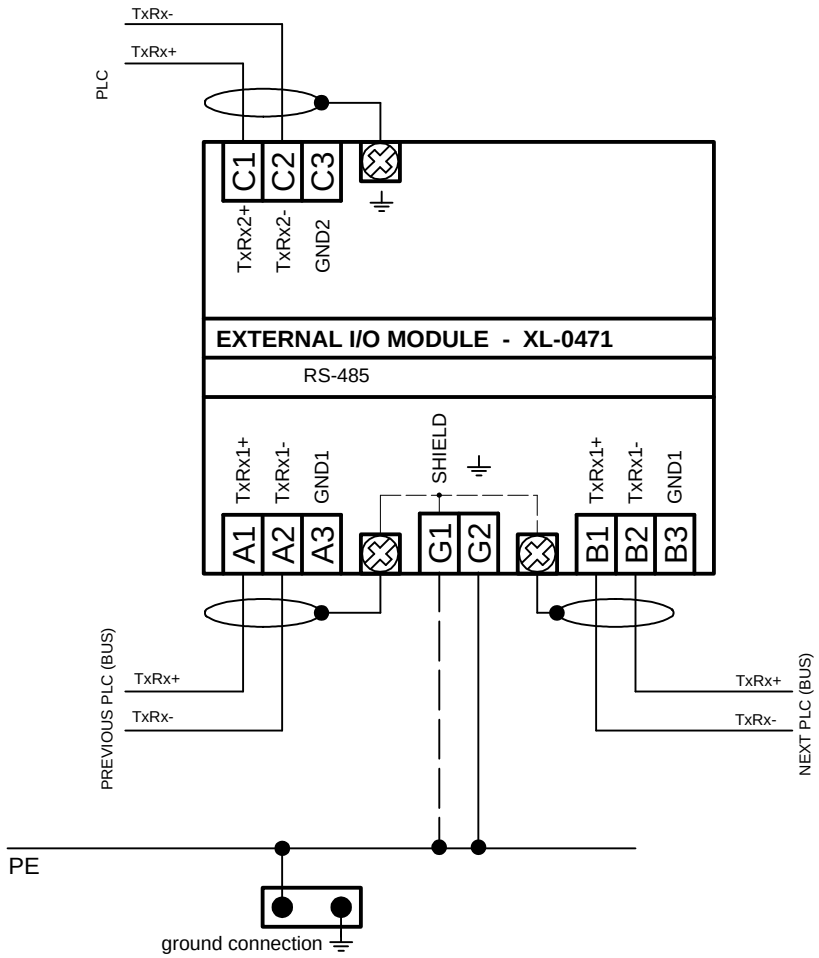


Figure 1.1.6.5 Connection diagram of the XL-0471 module (connection of systems Foxtrot, RS-485)

2. FOXTROT peripheral modules

2.1. Expansion module IB-1301

The IB-1301 expansion module is designed for scanning of up to 12 binary signals 24 V DC / AC with common pole (according to connection minus, plus or alternating power supply), type 1. The module is fitted with a fixed terminal board (for terminal parameters refer to Table 1.1.1). The inputs DI0÷DI3 allow to realize special functions identical with the inputs of the CP-1004 basic module (detailed information on the functions and connection examples are described in chapter 1.1.2. The inputs DI4 ÷ DI11 are standard binary inputs with an input filter of 5 ms. The inputs are galvanically isolated from the internal circuits (power supply and communication to the basic module) and the groups of inputs are isolated among each other, the status of each input is indicated on the front panel of the module.

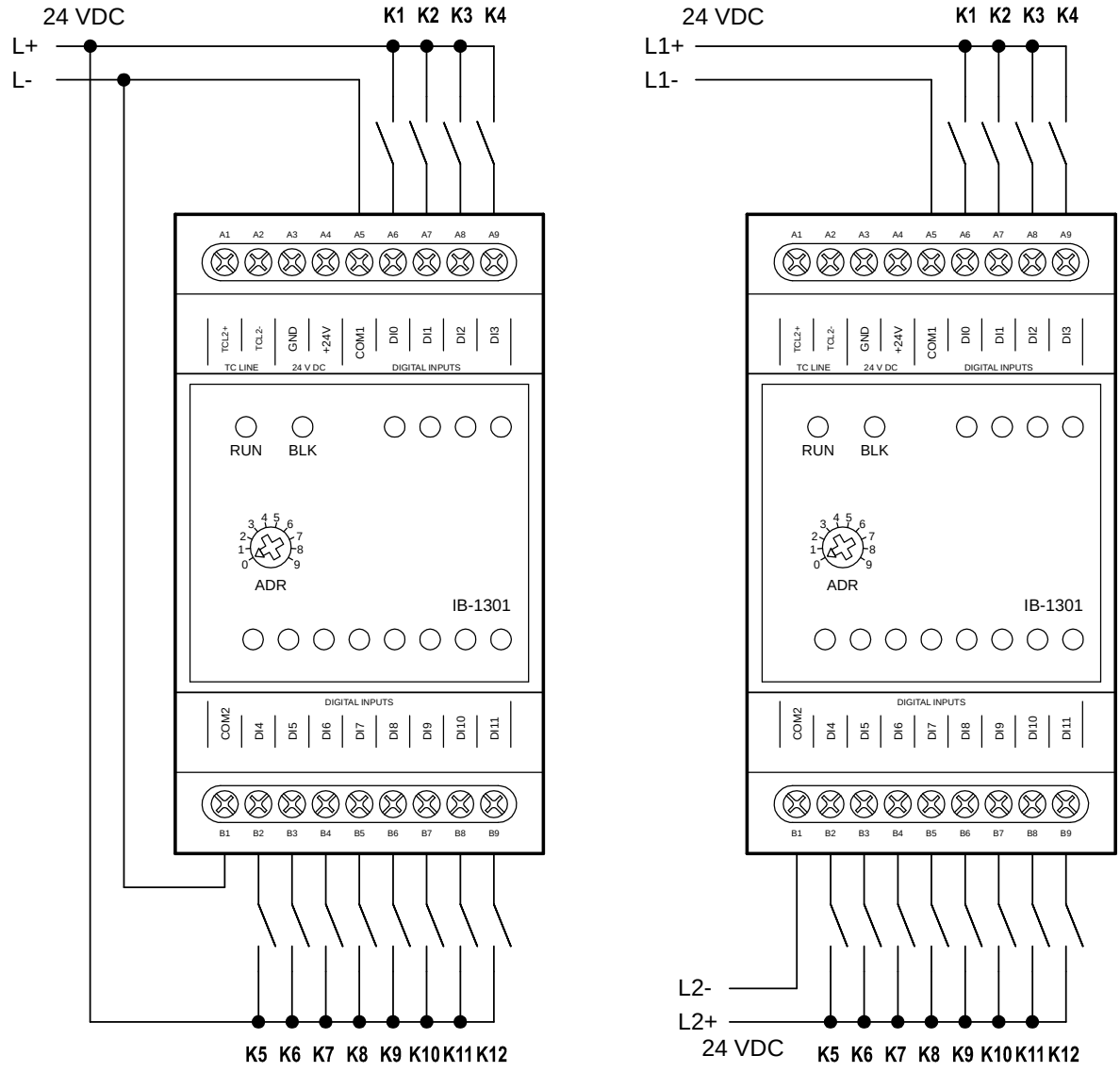


Figure 2.1.1 Basic connection diagram of the IB-1301 module

Notes for connection:

1. The inputs DI0 ÷ DI3 allow to realize special functions (connection of incremental scanners, counters, etc.), detailed information can be found in chapter 1.1.2.
2. The groups of inputs (DI0÷3 and DI4÷11) are galvanically isolated from each other.

2.2. Expansion module IR-1501

The IR-1501 expansion module is designed for scanning of up to 4 binary signals 24 V DC / AC with common pole (according to connection minus, plus or alternating power supply), type 1. The module has 8 relay outputs with a make contact and common pole. The module is fitted with a fixed terminal board (for terminal parameters refer to Table 1.1.1). The inputs DI0÷DI3 allow to realize special functions identical with the inputs of the CP-1004 basic module (detailed information on the functions and connection examples are described in chapter 1.1.2. The relay outputs can close max. 230 V AC, 3 A (the current through the common pole is max. 10 A). The inputs are galvanically isolated from the internal circuits (power supply and communication to the basic module) and the inputs are isolated from the outputs, the status of each input is indicated on the front panel of the module.

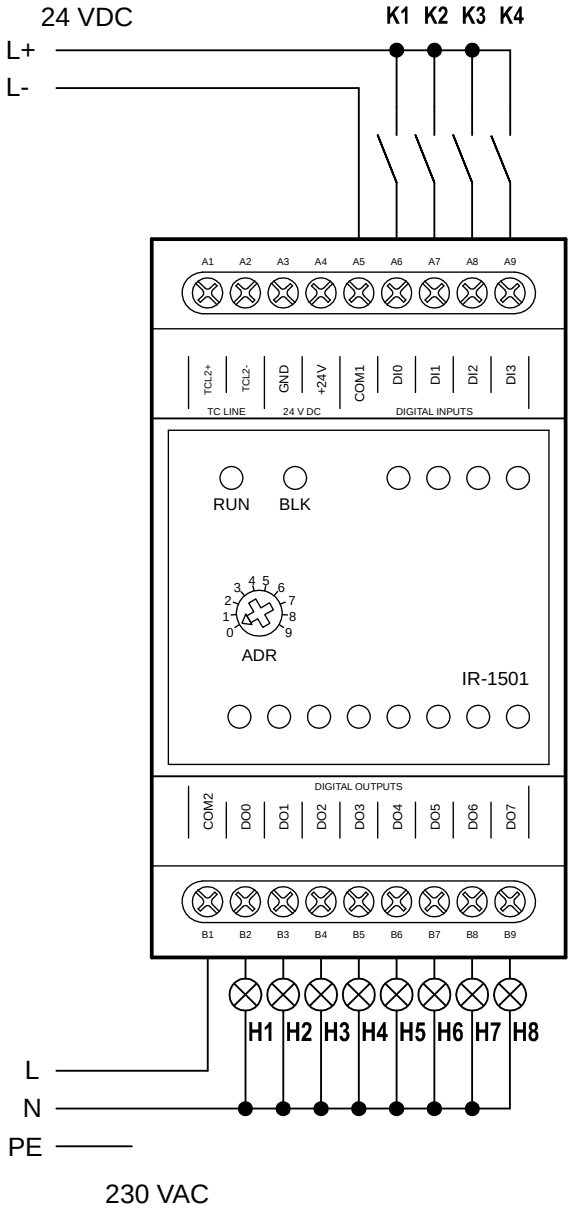


Figure 2.2.1 Basic connection diagram of the IR-1501 module

Notes for connection:

1. The inputs DI0 ÷ DI3 allow to realize special functions (connection of incremental scanners, counters, etc.), detailed information can be found in chapter 1.1.2.
2. The relay outputs are isolated from the other circuits by a 4kV isolation.

2.3. Expansion module OS-1401

The OS-1401 expansion module has 12 solid-state outputs with a make contact and plus common pole (VDO+). The module is fitted with a fixed terminal board (for terminal parameters refer to Table 1.1.1). The outputs DO0÷DO3 allow switching max. 24 VDC, 2A per output (the sum of the loads of all four outputs must not exceed 4.4 A), the outputs DO4÷DO11 allow switching max. 24 VDC, 0.5 A per output. The outputs are galvanically isolated from the internal circuits (power supply and communication to the basic module) and the groups of outputs are galvanically connected, they have common power supply and positive common pole (VDO+), the status of each input is indicated on the front panel of the module.

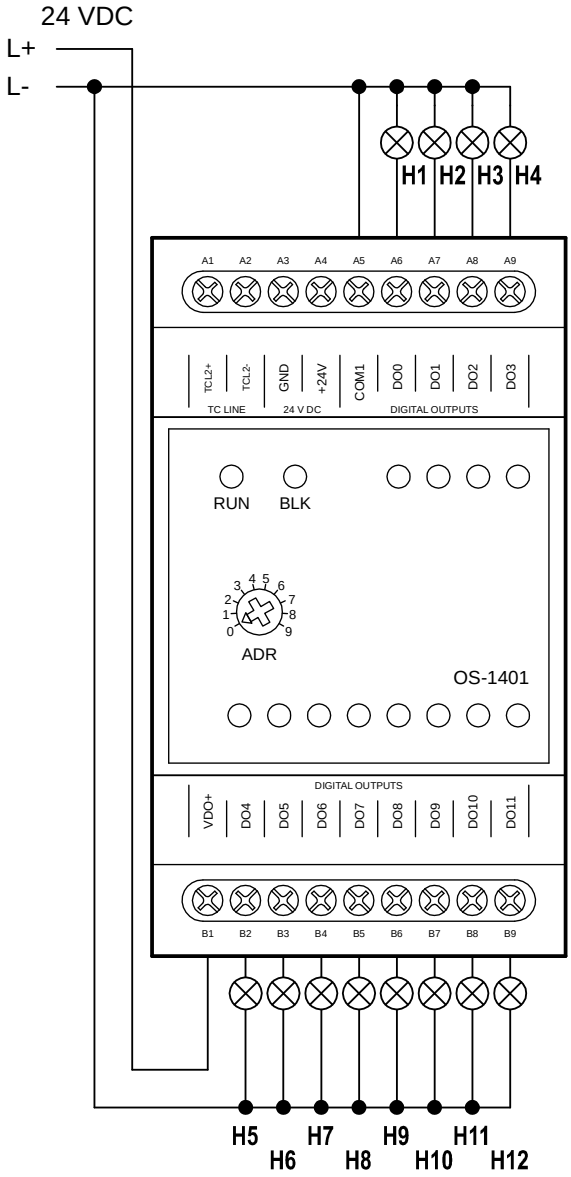


Figure 2.3.1 Basic connection diagram of the OS-1401 module

Notes for connection:

1. The outputs close against the VDO+ common pole (max. current through the terminal is 9 A)
2. The outputs are realized by solid-state switches with internal protection against current and thermal overload. To increase resistance and lifetime, the switched loads have to be treated by corresponding interference elimination elements (see the corresponding paragraphs of the documentation).
3. The power supply of 24 VDC connected to terminals VDO+ and COM1 is necessary for good functioning of the output switches!

2.4. Analog expansion module IT-1601

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

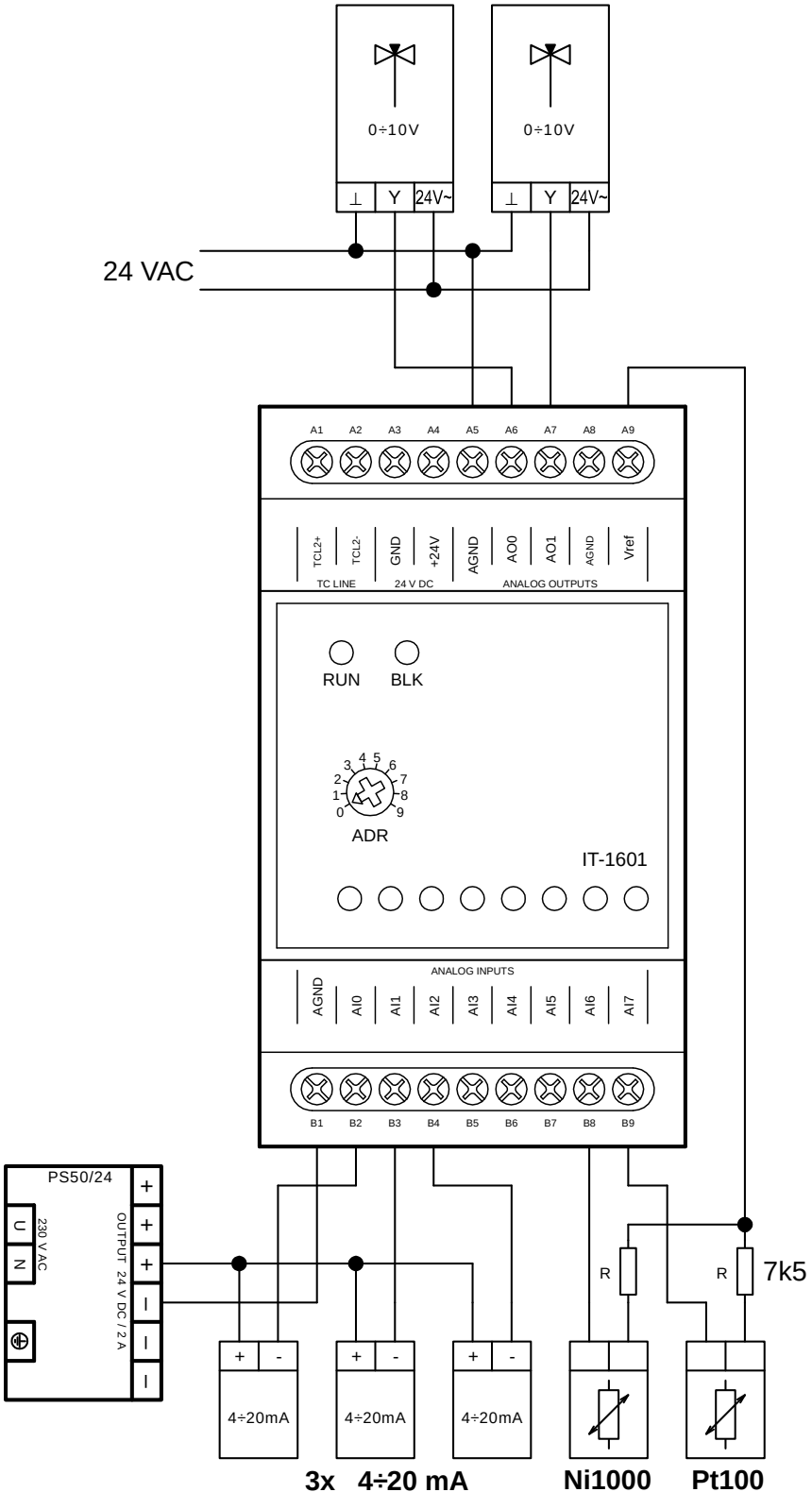


Figure 2.4.1 Basic connection diagram of the IT-1601 module

Notes for connection:

1. The analog inputs and outputs are with the AGND common pole.
2. On the terminal Vref, there is available the current voltage of +10,0 V, which is available for supplying of passive resistance sensors (by means of an external serial resistor).
3. The passive resistance sensors connected with two wires are supplied through a 7k5 resistor from the Vref terminal. The resistor has to b e fitted outside the module in the switchgear.
4. The current ranges (20 mA, etc.) can be switched-over from the Mosaic programming environment (the module is not fitted with internal jumpers).

3. Bus TCL2 (connections of peripheral modules)

All modules of one Foxtrot PLC assembly (i.e. all peripheral modules controlled by one basic module) have to be interconnected by bus interconnection, which is connected to the terminals on the left upper edge of the module (the TCL2 bus and eventually power supply). The interconnection of the modules has to be done linearly (this is to say the module have to be interconnected in series in succession, a branch cannot be realized), the central module has to be at one end of the bus, the second end has to be fitted with a 120Ω terminator (it is part of the enclosure of the Foxtrot system module).

The particular Foxtrot modules are interconnected by cables designed for the RS-485 bus, min. two pairs (interconnection only for the communication bus, refer to chapter 3.2), or cables including power supply (for the TCL2 bus, we have to again use a cable designed for the RS-485 bus (interconnection including power supply - refer to chapter 3.1). In case of a longer distance (typically more than 10 metres), only the communication bus without power supply is always interconnected (refer to chapter 3.2).

The modules can also be interconnected by optical cables or by combination of optical and metallic cables. To realize the interconnection by the optical cable, a converter for optics KB-0552 has to be used (for connection refer to chapter 3.4). The modules are interconnected by standard ST-ST patch cables. An optical cable ensures galvanic isolation and therefore, an independent power supply source has to be used for supplying the following module. A detailed procedure for the calculation of maximum lengths of the optical cables is described in the documentation TXV 004 02, chapter 3.3).

The following table summarizes the features of possible interconnections of the Foxtrot modules into assemblies. The mentioned possibilities can be combined among each other.

Table 3.1 Possibilities of interconnection of Foxtrot system modules Foxtrot - summary.

Solution	**1**	**2**	**3**
HW (additional)	-	-	KB-0552
Transmission medium	Cable (2x twisted pair)	Twisted pair + GND (2x twisted pair)	Optical cable
Power supply distribution	YES	NO	NO
Galvanic isolation of bus	NO	NO	YES
Used cable	Acc. to RS-485 specification	Acc. to RS-485 specification	Standard patch cable ST-ST
Connector	Screw-type terminals	Screw-type terminals	2x ST
Damping c.	-	-	3,5 dB/km
Wave length	-	-	820 nm
Fibre type	-	-	glass multimode 62.5/125 mm
Max. number of I/O modules to one CP	10	10	10
Max. length of one bus segment	10 m	400 m	max. 1,7 km
Max. total bus length	10 m	400 m	Acc. to number of segments
For detailed information see	Chapter 3.1	Chapter 3.2	TXV 004 02, chapter 3.3, chapter 3.4

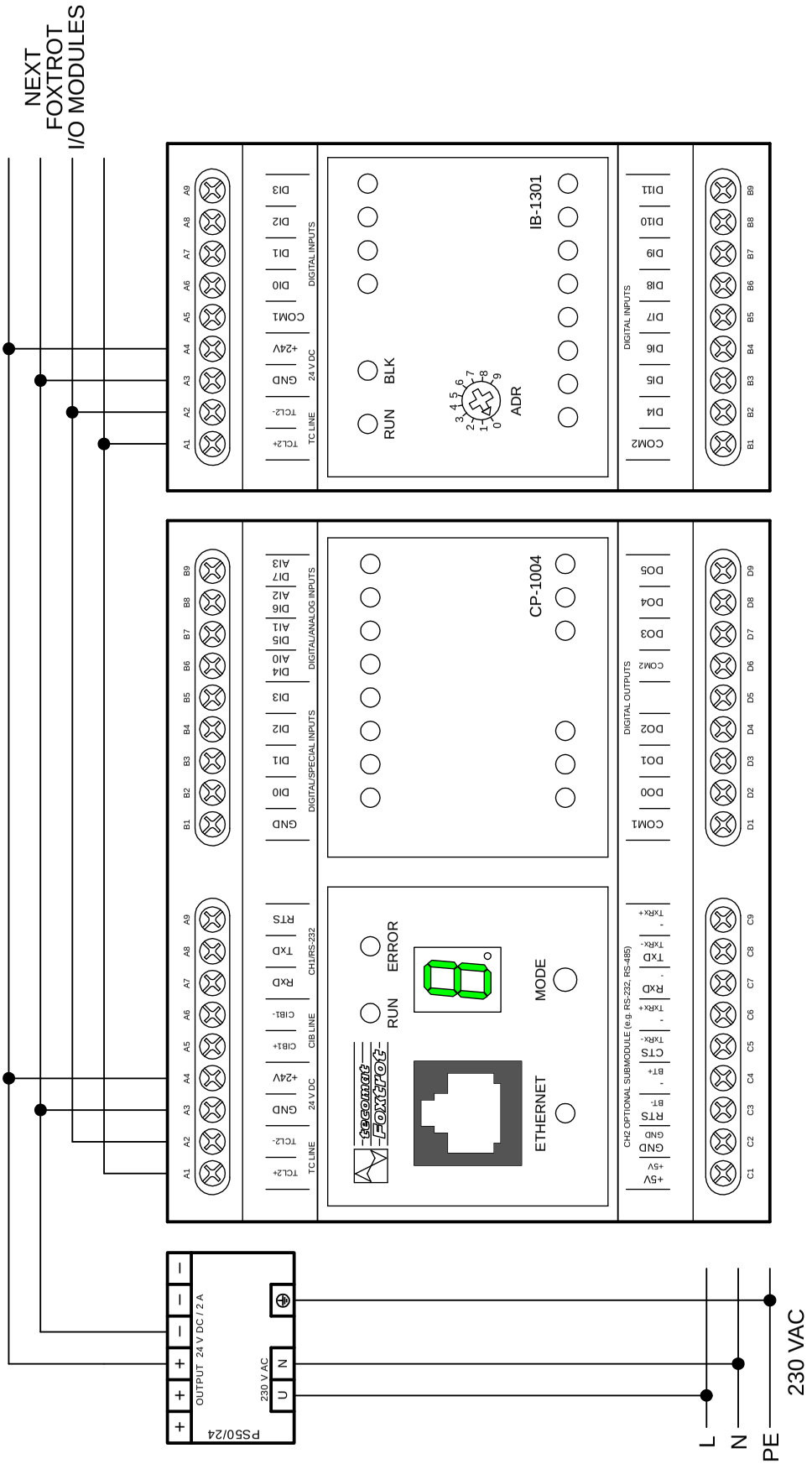
Notes for individual solutions:

1. Basic method of interconnection including power supply. Suitable for assemblies with several racks in one switchgear. This solution is limited by the max. bus length (power supply line).
2. Connection in case of longer distances between modules – the control system is distributed in several boxes in the technology, etc. Each module (or a group of modules) has to have its own

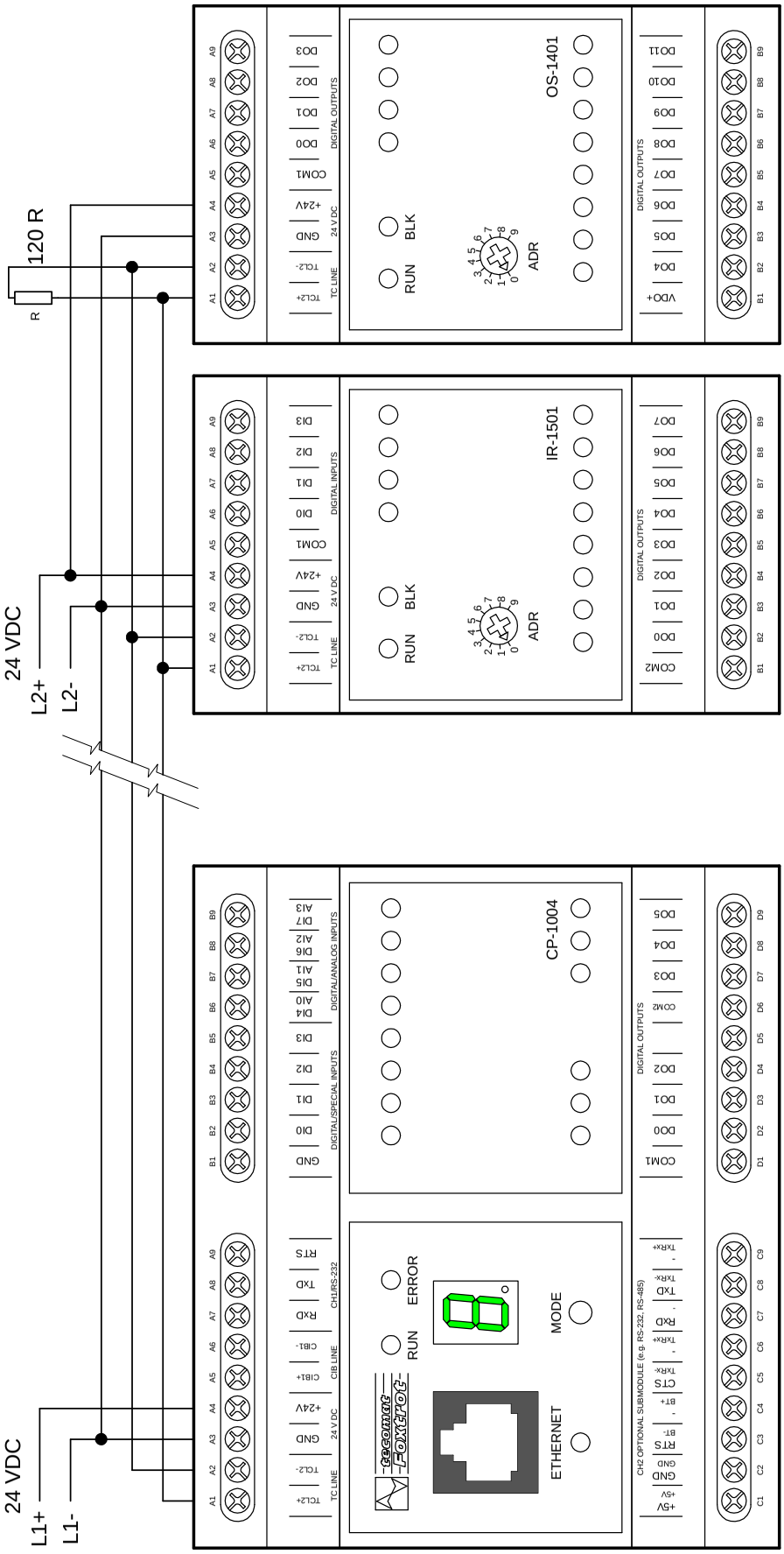
power supply source. The interconnection of the TCL2 bus allows using any cable fulfilling the requirements for the RS-485 bus, drawn through the channels, the bushings of the switchgears.

3. Interconnection for longer distances (the best solution). Since the lengths of the individual segments are summed, up to kilometre distances of the bus of the entire system can be achieved. The optical cable ensures galvanic isolation and therefore a power supply source has to be installed in each module (a group of modules) connected by the optical cable. A detailed procedure for the calculation of maximum lengths of the optical cables is described in the documentation TXV 004 02, chapter 3.3).

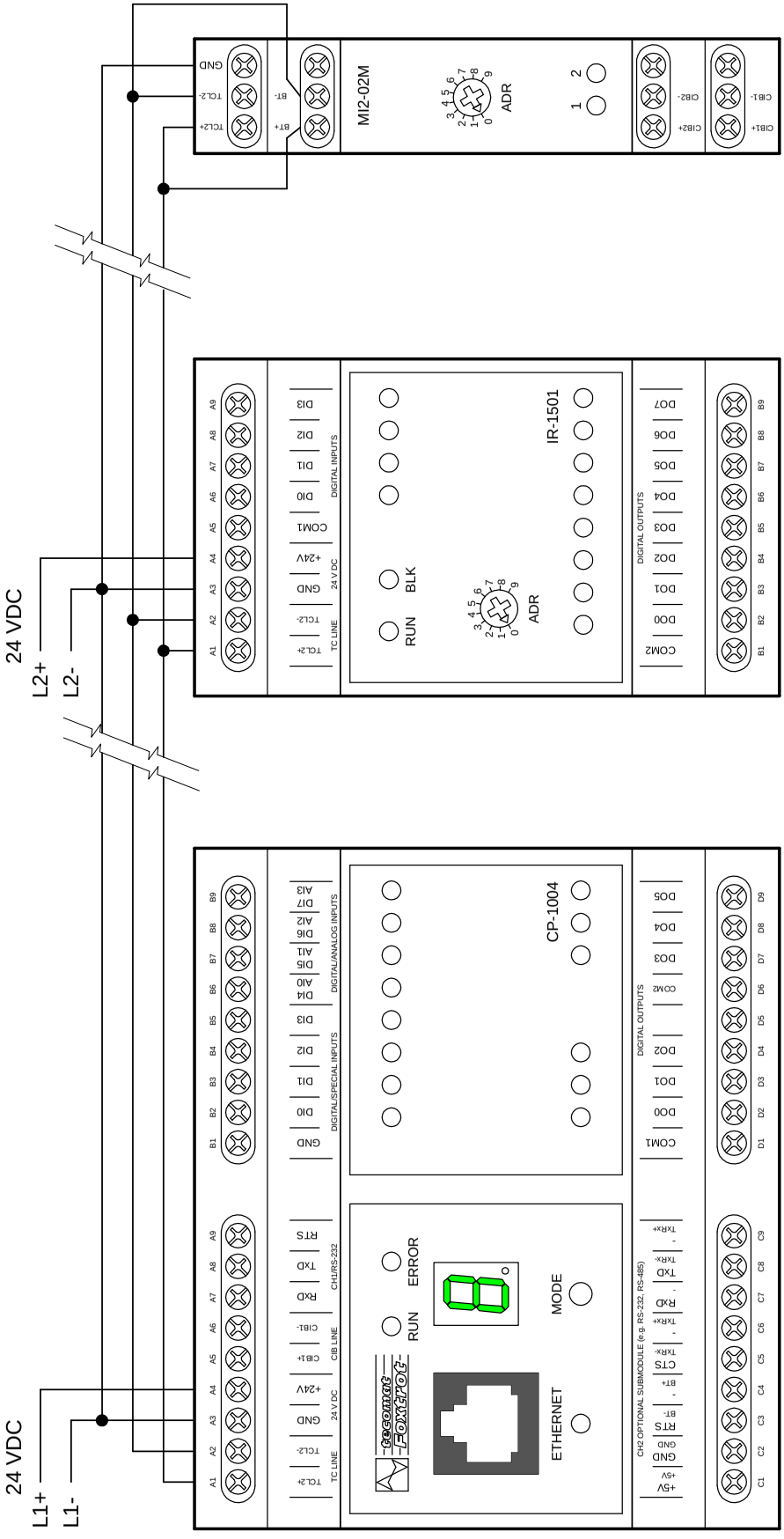
3.1. Connection of expansion modules to the FOXTROT system (bus TCL2 with power supply)



3.2. Connection of remote peripheral modules FOXTROT (bus TCL2 without power supply)



3.3. Connection of remote peripheral modules FOXTROT and module MASTER of bus INELS



3.4. Connection of peripheral modules FOXTROT by optical cable (converter KB-0552)