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PROGRAMMABLE CONTROLLERS

PROGRAMMABLE LOGIC CONTROLLERS TECOMAT TC700

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TECOMAT TC700

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1. GETTING FAMILIAR WITH TECOMAT TC700 PLCS

1.1. INTRODUCTION

What is a programmable logic controller

A programmable logic controller (PLC) - is a digital control electronic system designed to control working machines and processes in industrial fields. Through digital or analog inputs and outputs, the PLC receives and sends information from / into the plant being controlled. Control algorithms are saved in the user program memory, which is executed in cycles.

Principles of user program execution

The control algorithm of the programmable logic controller is written as a sequence of instructions in the user program memory. The central unit reads stepwise the individual instructions from this memory, executes corresponding operations with the data in the scratch pad memory, or executes transitions in the sequence of instructions, if the instruction is from the group of operating instructions. After all instructions of the required algorithm are executed, the central unit updates the output variables into the output peripheral modules and updates the states from the input peripheral modules into the scratch pad memory. This is continuously repeated and we call it "program cycle" (fig. 1.1, fig. 1.2).

Unrepeated update of the states of the input variables within the entire program cycle avoids the possibilities of hazardous states that could occur in the control algorithm, while being solved (during computation, input variables cannot be changed).

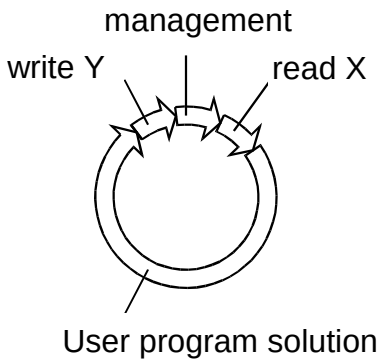


Fig. 1.1 Cycle of user program solution
Read X - transcription of values from PLC input modules into the X area in the scratch pad memory
Write Y - transcription of values computed by program from the Y area into the PLC output modules
Management - preparation of the PLC central unit for the solution of the next cycle program

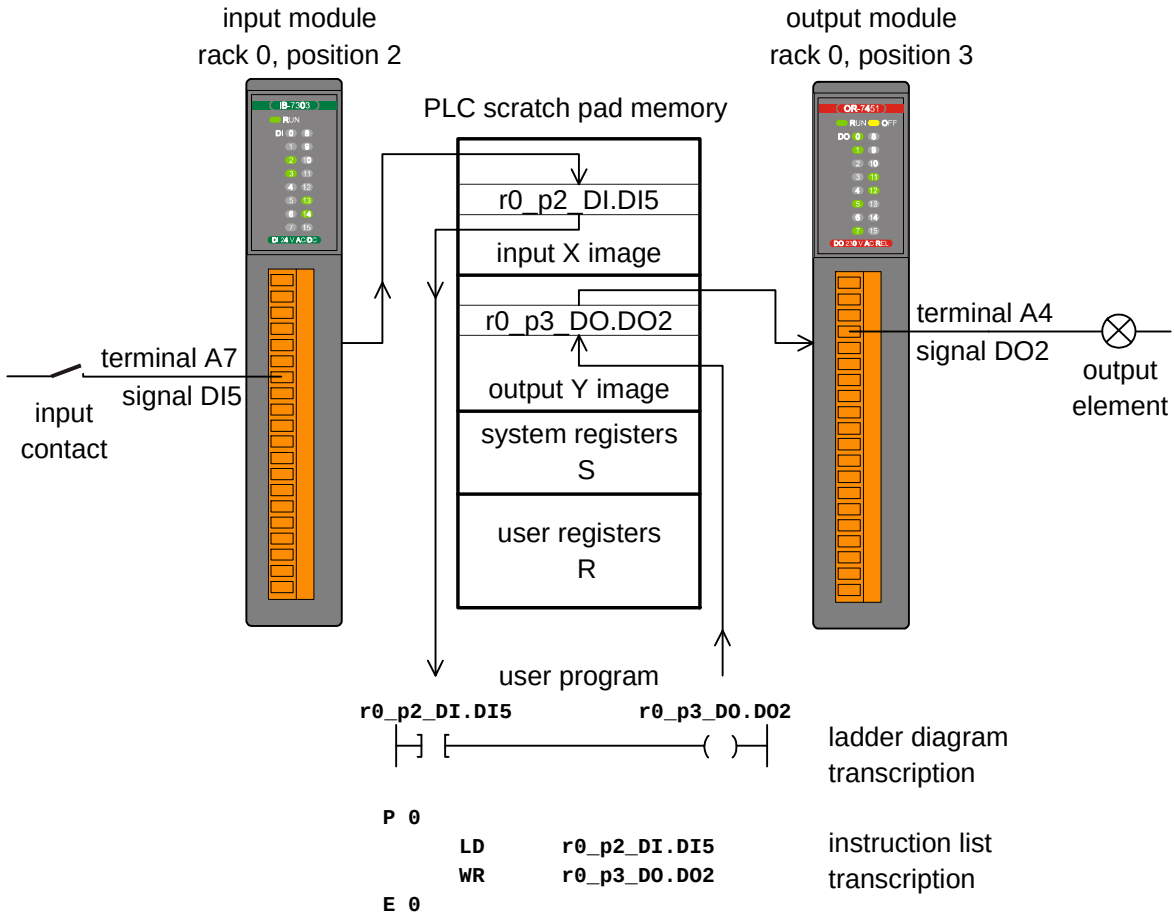


Fig. 1.2 Scheme of signal processing by the programmable logic controller (symbolic names of the signals are automatically generated by the Mosaic environment, users can change them)

1.2. TECOMAT TC700 SYSTEM FEATURES

Modular programmable logic controllers TECOMAT TC700 are designed to control technologies in various industrial and other branches. The user can select from a broad range of peripheral modules, which can be combined arbitrarily, available are also power supply sources from various voltages, various types of central units as well as different types of racks, into which all the parts of the system are installed. Consistent modularity allows to build up really custom-made applications, this is to say an optimum performance for an optimum price.

Racks are delivered in two variants with a different number of positions for peripheral modules. The modules are closed in plastic protective cases. Thanks to this, they can be handled without a danger of damage of sensitive CMOS components.

Communication

Data communication among the PLC and the superior PCs, among several PLCs, or among the PLC and other plants are usually realized through serial transmissions. The TC700 systems support basic transmissions by means of the Ethernet network or the EPSNET industrial network.

Asynchronous serial channels are optionally fitted with various types of physical interfaces according to customer's request (RS-232, RS-485, RS-422). On one level of the EPSNET network can be up to 32 participants and the length of the serial line can be up to 1200 m, when using the RS-485 interface. Optionally, also other industrial protocols are

supported, e.g. MODBUS, PROFIBUS, CANopen, etc. Or, asynchronous communication through universal transmission channels controlled directly from the user program is possible. Some central units and communication modules are fitted with the Ethernet interface allowing operation of more logic connections at the same time.

All central units are also equipped with the USB interface for programming purposes, debugging and service interventions.

Building up an extensive system

Thanks to serial communication, individual parts of the entire TECOMAT TC700 system can be positioned in decentralized in such a way that the executive parts are located directly by the technologies being controlled and the control parts can be concentrated in the control room. Peripheral modules are equipped with their own intelligence and data exchange is carried out through a serial system bus. An advantage of the serial connection is that the peripheries can be located hundreds of metres from the central unit, this significantly reduces the price of cable laying in many cases.

Connection with a PC

The entire system as well as its parts can communicate with computers of PC standard. Again, the serial interface is optional. Thus, the computer can be used for monitoring of the process being controlled and at the same time, it is located outside the industrial environment in a control room or in a central control desk. The computer also serves as a programming instrument for the PLC.

In addition the PLCs of the TECOMAT TC700 series, also the computers of PC standard can participate in the communication (through a serial interface adapter) as well as another participants meeting the requirements of the EPSNET network (another TECOMAT PLC, operator panels, etc.).

Distributed control systems

The above mentioned facts enable to realize extensive systems of distributed or hierarchical control. But such systems can also be established through "gradual steps from underneath" in such a way that originally autonomous systems are gradually combined and added by the top control level or by central monitoring and data acquisition only. Such created systems are more stable and have longer life time than the systems created in "one single step from the top". An advantage of the distributed systems is primarily the possibility of autonomous control also during a control room failure, gradual putting of the entire system into operation, easier debugging, adding, cost saving and less laboriousness during installation (e.g. cable laying, switchgears).

Programming tool

As a programming instrument, a PC can be used. The computer configuration must be selected according the requirements of software (Mosaic, Reliance, ...). TECOMAT TC700 offers a wide range of useful system services, which facilitate and make programming comfortable. As an example we can name a broad range of time data, current date and time or system support to treat the states when PLC supply is switched on.

1.3. TECOMAT TC700 UNIT

Composition

The PLC unit consists of a flat rack and individual modules located in individual plastic cases, which are fixed to the rack by one screw. Each case has its door allowing access to

the removable terminal boxes of the modules and lead-in cables. The width of the individual cases is 30 or 60 mm according to the type of the module used.

PLC unit

PLC TECOMAT TC700 consists of the following (fig. 1.3):

- Rack RM-794x (2, 4, 8, 15 positions)
- Power supply PW-790x (PW-7901, PW-7902, PW-7903, PW-7904, PW-7908 takes 2 positions in the rack, PW-7906, PW-7907 are designated only for short racks (2 or 4 positions) and do not engage any position – they are fitted to the rack connectors)
- Central unit CP-700x
- System communication modules SC-710x for communication possibilities expanding
- System expanders SE-713x for redundant systems
- Peripheral modules

Possibilities of PLC configuration are stated in the chapter 3.

The order numbers of the parts of the unit can be found in the catalogue of the programmable logic controllers of series TECOMAT TC700.

1.4. PLC BASIC PARAMETERS

PLC TECOMAT TC700 are designed to be mounted into distributing frames. PLC basic parameters are specified in the table 1.1 to table 1.5. The parameters of the individual modules are specified in the documentation supplied with each module.

Table 1.1 Basic parameters

Product standard	IEC EN 61131-2
Protection class of electrical object CSN 33 0600	III
Type of equipment	built-in
Coverage (after installation into rack)	IP20 IEC EN 60529
Life time	10 years

Table 1.2 Operational conditions

Class of ambient influence - CSN 33 2000-3	normal
Operating temperatures range	0 °C to + 55 °C
Permissible temperatures during transport	–25 °C to +70 °C
Relative humidity	10 % to 95 % w/o condensation
Atmospheric pressure	min. 70 kPa (< 3000 m over the sea level)
Degree of pollution - IEC EN 61131-2	2
Overvoltage category of installation - CSN 33 0420-1	II
Working position	vertical
Type of operation	continuous
Vibration resistance (sinusoidal vibrations)	10 to 57 Hz - amplitude 0.075 mm
Fc according to IEC EN 60068-2-6	57 to 150 Hz - acceleration 1G
Electromagnetic compatibility:	
Emissions - IEC EN 55022*	class A
Immunity	table 16, IEC EN 61131-2

* This is a product of class A. In indoor conditions (i.e. such conditions, where using of radio and TV sets can be supposed in a distance of 10 m from the mentioned

equipment), the product can cause radio disturbances. It might be required in such cases that the user takes necessary measures to avoid this.

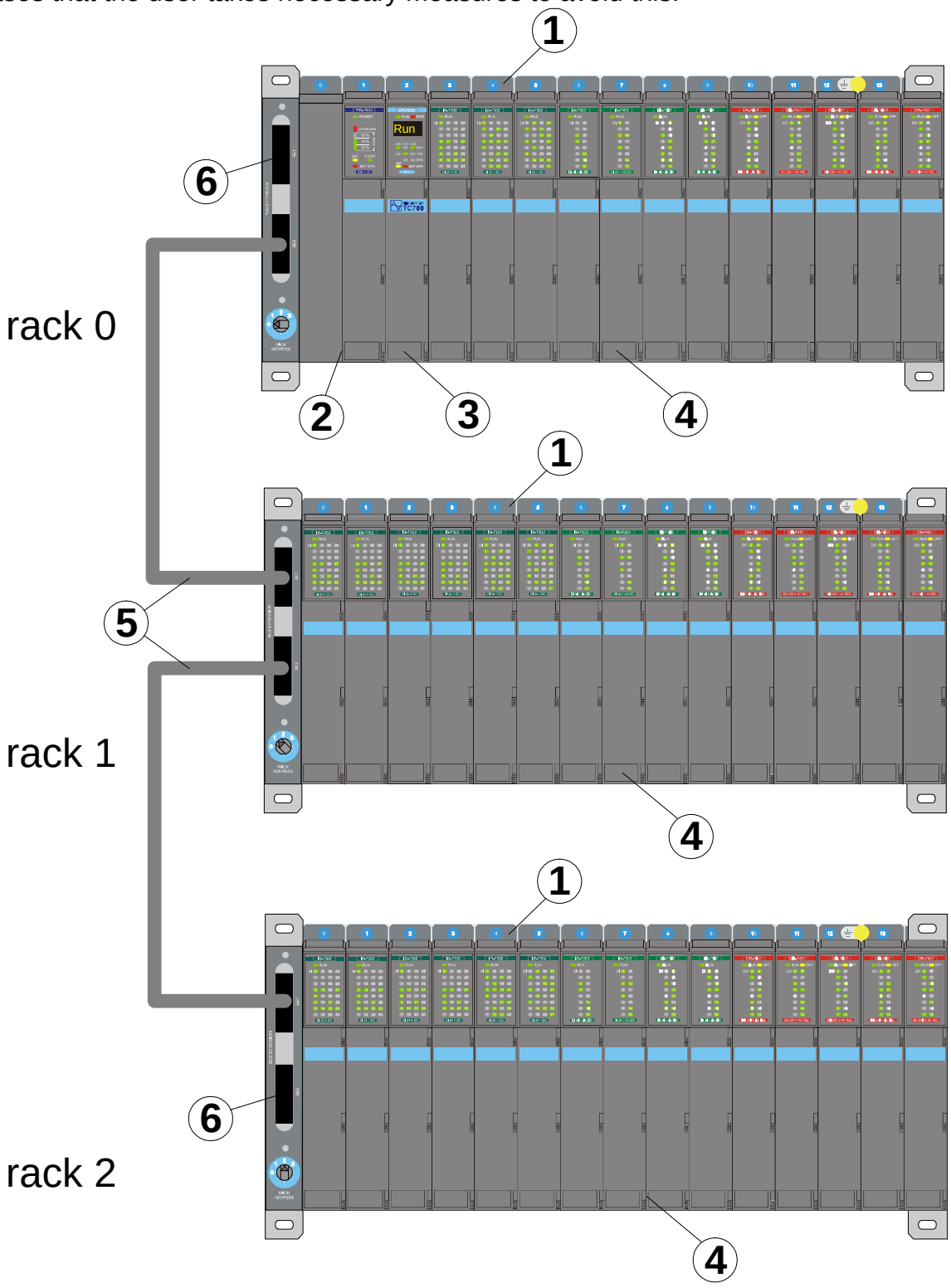


Fig. 1.3 PLC TECOMAT TC700 configuration
1 - Rack
2 - Power supply module
3 - Central unit
4 - Peripheral modules
5 - Connecting cable between racks
6 - Bus termination

Table 1.3 Storage conditions

Storage environment	dry, clean rooms without conducting dust, aggressive gases or acid vapours for the period not exceeding the guarantee period
Storage temperatures	–25 °C to +70 °C without temperature shocks
Relative humidity	max. 80% without vapour condensation

Table 1.4 Transport conditions

Transport environment	covered transport means, transport packaging must not be exposed to rain and snow
Transport temperatures	–25 °C to +70 °C

Table 1.5 System characteristics

User program execution • cyclic, multi-loop control with possibility of interruption from external events, time and error messages
User program memory • CMOS RAM, EEPROM
PLC modes • RUN - user program execution • HALT - user program execution stopped, PLC programming • possibility to change the mode by the command through the serial channel • possibility of redundant system assembly that works on the hot standby principle
Output locking • by the command via the serial channel • automatically during a fatal system error
Hardware diagnosis • processor check (watchdog) • power failure check, data protection during power failure • ensuring of serial communication protection • ensuring of data transmission via I/O bus
Software diagnosis • user program validation • user program cycle time watch • continuous check of user program correctness (non-existing jump target, memory structure overflow, division by zero, unknown instruction, etc.)
Communication • serial in EPSNET, MODBUS, PROFIBUS DP, CAN network • general serial asynchronous • USB interface, Ethernet, RS-232, RS-485, RS-422

Other functions (depend on the central unit type)

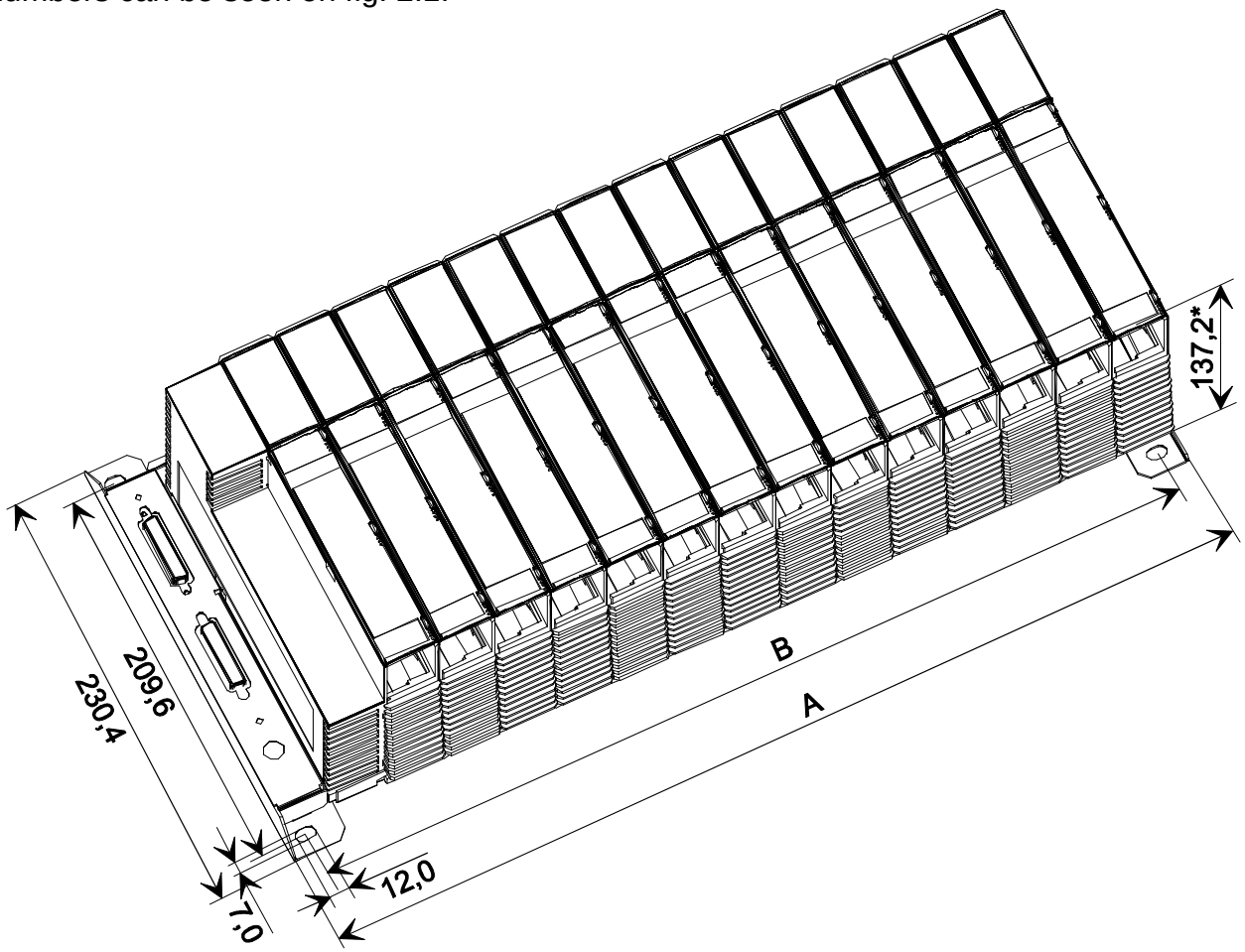
- automatic recognition of peripheral unit configuration
- EEPROM programming for user program backup
- communication support for data monitoring by superior system
- possibility of user program execution without activation of peripheral modules
- additional memory for data archiving DataBox
- RTC circle
- support for PLC variables analyzer
- possibility of forcing (fixation) of peripheral module inputs and outputs
- program on-line change under run (on-line editing)
- project archiving in the PLC memory
- PLC redundancy as a whole and its particular parts too
- SD / MMC card with FAT12 / FAT16 / FAT32 file system
- integrated Web server

2. PARTS OF THE PLC BASIC UNIT

2.1. RACKS

The supporting base of all PLC TECOMAT TC700 units is a flat rack supplied in four dimensional variants. The bus with connectors for peripheral modules, the switch for setting of the rack address and connectors for connection of other racks are part of the rack. The way of installation and rack interconnection are described in chapter 3.3.

The mounting dimensions of the racks (height including fitted modules) and their order numbers can be seen on fig. 2.1.



Rack type	Order number	No. of positions	A [mm]	B [mm]
RM-7942	TXN 179 42	15	485.2	461.8
RM-7941	TXN 179 41	8	272.3	249.0
RM-7946	TXN 179 46	4	150.7	1274
RM-7944	TXN 179 44	2	89.9	66.6+

Fig. 2.1 Mounting dimensions of fitted racks
** The dimension specifies the unit depth*
+ there are mounting holes in the upper left and bottom right corner only on the RM-7944 rack

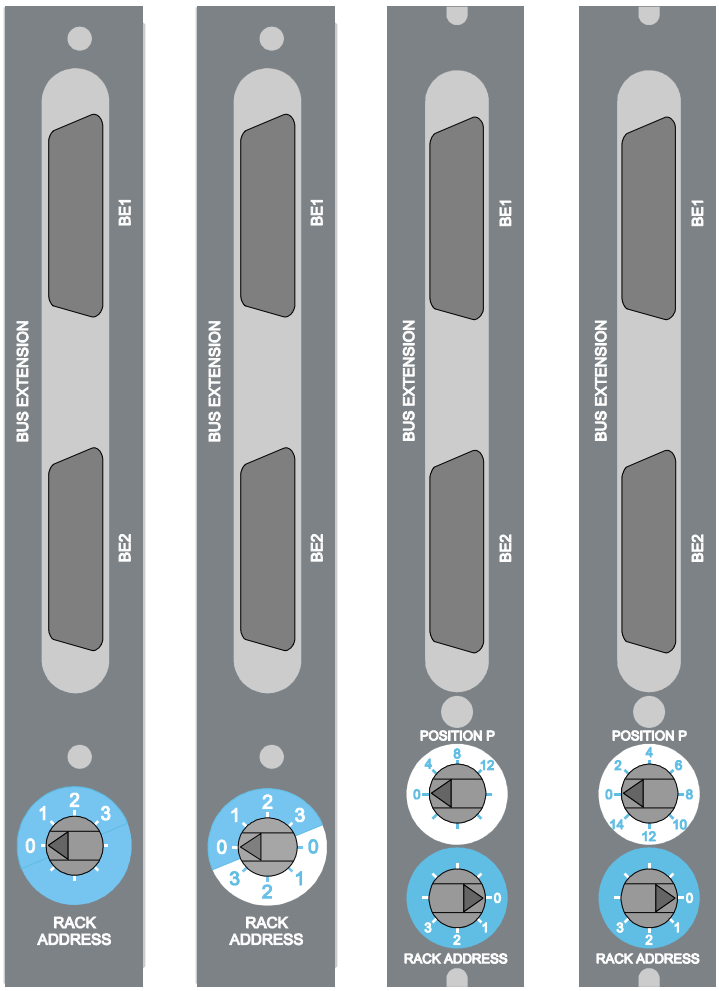


Fig.2.2 Rack panels with connectors and address switches

Connectors BE1 and BE2 in the left part of the rack are designated for the next rack connection or bus termination is placed there (see chapter 3.3.).

Warning ! It is prohibited to manipulate with bus interconnecting cables when the system is on.

RM-7941 and RM-7942 racks address is set by the rotary switch. Address variants are described in the table 2.1.

Table 2.1 Possible RM-7942 and RM-7941 rack address setting

Rack type	Switch	Rack address	Positions addresses
RM-7942 (15 positions)	0	0	0 - 14
	1	1	0 - 14
	2	2	0 - 14
	3	3	0 - 14
RM-7941 (8 positions)	0 (blue area)	0	0 - 7
	1 (blue area)	1	0 - 7
	2 (blue area)	2	0 - 7
	3 (blue area)	3	0 - 7
	0 (white area)	0	8 - 15
	1 (white area)	1	8 - 15
	2 (white area)	2	8 - 15
	3 (white area)	3	8 - 15

RM-7944 and RM-7946 rack address is set by the bottom rotary switch. The address range is set by the upper rotary switch. Possible address variants are shown in the table 2.2.

Table 2.2 Possible RM-7946 and RM-7944 rack address setting

Rack type	Bottom switch	Rack address	Upper switch	Position addresses
RM-7946 (4 positions)	0	0	0	0 - 3
	1	1	4	4 - 7
	2	2	8	8 - 11
	3	3	12	12 - 15
RM-7944 (2 positions)	0	0	0	0 - 1
	1	1	2	2 - 3
	2	2	4	4 - 5
	3	3	6	6 - 7
			8	8 - 9
			10	10 - 11
			12	12 - 13
			14	14 - 15

RM-7941 racks (commencing year 2007), RM-7944 and RM-7946 allow to fit PW-7906 and PW-7907 power supplies directly to connectors BE1 and BE2 in the left part of the rack. Then these connectors are brought out at the power supply top panel. Address switches are covered.

Rack installation on the U-bar

RM-7941 (commencing year 2007), RM-7944 and RM-7946 racks can be mounted on the U-bar according to IEC EN 50022 (width 35 mm) by means of the removable holders. Set SM-9024 (order no. TXF 790 24) contains one holder including specified screws. RM-7944 rack (2 positions) demands one holder of this type, other racks two.

2.2. SUPPLY MODULES

Table 2.3 Overview of supply modules with order numbers

Source type	Modification	Order number
PW-7901	feeder from 24 V DC, 50W	TXN 179 01
PW-7902	feeder from 24 V DC, 50W, with UPS circuits	TXN 179 02
PW-7903	feeder from 230 V AC, 50W	TXN 179 03
PW-7904	feeder from 230 V AC, 50W, with UPS circuits	TXN 179 04
PW-7906	feeder from 24 V DC, 24W designed for RM-7941, RM-7944, RM-7946 racks	TXN 179 06
PW-7907	feeder from 230 V AC, 24W designed for RM-7941, RM-7944, RM-7946 racks	TXN 179 07
PW-7908	feeder from 115 V DC, 50W	TXN 179 08

Supply modules are designed to supply TECOMAT TC700 units. In case of a PLC TC700 with more racks, these racks can be fed from one supply module under observation of certain rules, or we can use more supply modules than it is necessary due to power supply backup (power supply redundancy).

2.2.1. Supply modules PW-7901, PW-7902

Supply modules PW-7901 and PW-7902 are designed to supply PLC TECOMAT TC700 units from 24 V DC with a power output of 50 W in a case 60 mm wide. Usually, they are fitted into the first position of the rack from the left, but this is no condition. The parameters can be found in table 2.4.

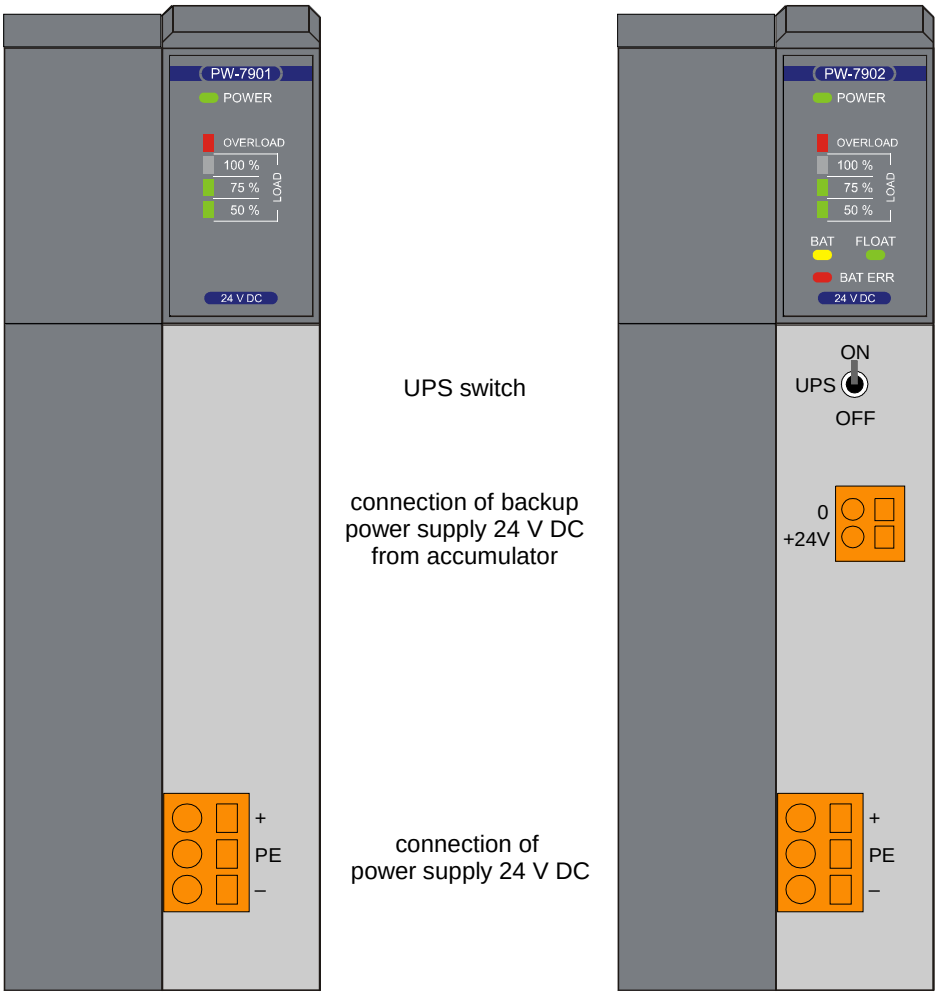


Fig. 2.3 Front panel of supply modules PW-7901 and PW-7902 after opening the door

Supply modules are pulse-controlled modules with an output level of 24 V SELV (circuits with protection by low safe voltage) with a permanent total output power of 50 W. The module also has a block for network voltage failure watch. The output level is fitted with by protective overvoltage components.

The PW-7902 power supply module contains a UPS block (Uninterruptible Power Supply) allowing to backup the TECOMAT TC700 PLC run after connection of external lead-batteries. The PW-7902 power supply module has all functions of UPS including charging control , battery condition monitoring, etc. Important information on the condition of the module, batteries and module consumption are transmitted to the central unit and are available to the user for processing (e.g. messages reporting the necessity to replace batteries, etc.). For debugging purposes, the UPS block can be switched off by the switch on the front panel of the supply module under the door.

The connectors for connection of 24 V DC supply voltage and for connection of the backup battery are screwless. Detailed information on connection, instructions for correct installation, examples of connection and principles for increasing resistance and reliability can be found in the Manual for designing TXV 001 08.02.

Attention! For correct functioning in case of parallel run of more supply modules it is necessary to ensure a minimum consumption of 4.8 W. Otherwise, stable functioning of the modules will not be ensured.

Attention! **It is not allowed to remove or plug in a switched on supply module into the system!** When handling a supply module, **it has to be off!** The system can be switched on provided it is supplied from another supply module.

Table 2.4 Parameters of PW-7901 and PW-7902 supply modules

Feeder type	**PW-7901**	**PW-7902**
Input voltage		
nominal value	24 V DC	
permissible range	19 - 36 V DC	
Maximum input power	72 W	
Primary circuit protection	fuse T4A	
Typ. efficiency	85 %	
Output voltage	24.3 ± 0.1 V DC	
Maximum permanent output power	50 W	
Short-circuit protection	electronic	
Galvanic isolation	yes	
Max. power supply interruption period that does not affect system run	50 ms (UPS switched off)	
UPS circuits	no	yes
External battery	-	1.3 to 12 Ah, lead, maint.-free
Battery voltage	-	24 V
Input protection for battery connection	-	fuse T2A
Electrical resistance of isolation		
input / output - 1 min.	1500 V DC	
input against protective earthing terminal	500 V DC	
Emissions IEC EN 55022	class B	
Case dimensions	137 x 60 x 198 mm (2 positions in the rack)	

2.2.2. Supply modules PW-7903, PW-7904

The PW-7903 and PW-7904 supply modules are designed to feed TECOMAT TC700 PLC unit from 230 V AC network with an output of 50 W in a case 60 mm wide. Usually, they are fitted into the first position of the rack from the left, but this is no condition. The parameters can be found in table 2.5.

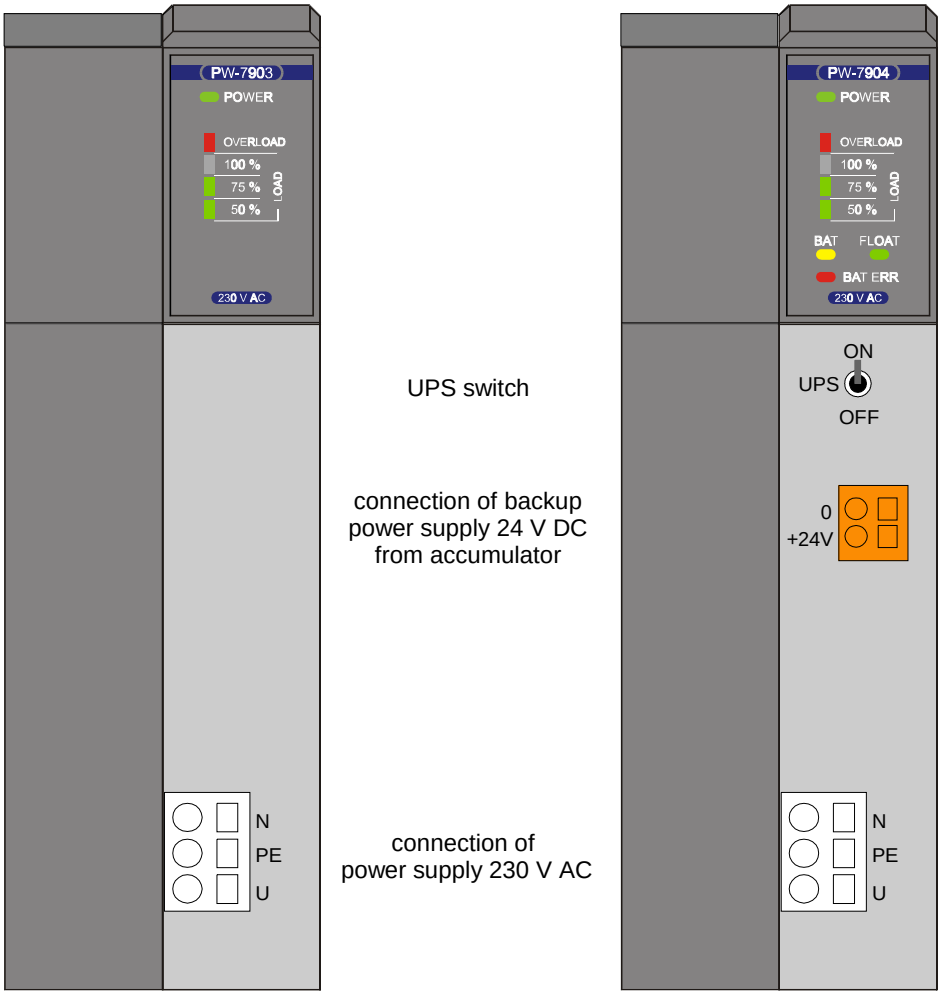


Fig. 2.4 Front panels of PW-7903 and PW-7904 supply modules after opening the door

Supply modules are pulse-controlled modules with an output level of 24 V SELV (circuits with protection by low safe voltage) with a permanent total output power of 50 W. The module also has a block for network voltage failure watch. The output level is fitted with by protective overvoltage components.

The PW-7903 and PW-7904 modules are electrical devices of class I and allow connection to the TN-S as well as TN-C network (zero-voltage protection).

The PW-7904 power supply module contains a UPS block (Uninterruptible Power Supply) allowing to backup the TECOMAT TC700 PLC run after connection of external lead-batteries. The power supply module PW-7904 has all functions of UPS including charging control , battery condition monitoring, etc. Important information on the condition of the module, batteries and module consumption are transmitted to the central unit and are available to the user for processing (e.g. messages reporting the necessity to replace batteries, etc.). For debugging purposes, the UPS block can be switched off by the switch on the front panel of the supply module under the door.

The connectors for connection of 230 V AC supply voltage and for connection of the backup battery are screwless. Detailed information on connection, instructions for correct

installation, examples of connection and principles for increasing resistance and reliability can be found in the Manual for designing TXV 001 08.01.

Attention! For correct functioning in case of parallel run of more supply modules it is necessary to ensure a minimum consumption of 4.8 W. Otherwise, stable functioning of the modules will not be ensured.

Attention! **It is not allowed to remove or plug in a switched on supply module into the system!** When handling a supply module, **it has to be off!** The system can be switched on provided it is supplied from another supply module.

Table 2.5 Parameters of PW-7903 and PW-7904 supply modules

Feeder type	PW-7903	PW-7904
Input voltage		
nominal value	230 V AC	
permissible range	180 - 264 V AC	
frequency	48 - 63 Hz	
Maximum input power	72 VA	
Primary circuit protection	fuse T1A	
Typ. efficiency	80 %	
Output voltage	24.3 ± 0.1 V DC	
Maximum permanent output power	50 W	
Short-circuit protection	electronic	
Galvanic isolation	yes	
Max. power supply interruption period that does not affect system run	50 ms (UPS switched off)	
UPS circuits	no	yes
External battery	-	1.3 to 12 Ah, lead, maint.-free
Battery voltage	-	24 V
Input protection for battery connection	-	fuse T2A
Current surge after switching on the module	max. 15 A, t < 10 ms	
Electrical resistance of isolation		
input / output - 1 min.	3.75 kV AC	
input against protective earthing terminal	1.85 kV AC	
Emissions IEC EN 55022	class B	
Emissions of harmonic currents IEC EN 61000-3-2	class A (P.F.>0.99)	
Case dimensions	137 x 60 x 198 mm (2 positions in the rack)	

2.2.3. Supply module PW-7906

Supply modul PW-7906 is designed to supply PLC TECOMAT TC700 units from 24 V DC with a power output of 24 W. The module is fitted to the bus connectors of RM-7941 (commencing year 2007), RM-7944 and RM-7946 racks entirely. The parameters can be found in table 2.6.

Supply module is pulse-controlled module with an output level of 24 V SELV (circuits with protection by low safe voltage) with a permanent total output power of 24 W. The module also has a block for network voltage failure watch. The output level is fitted with by protective overvoltage components.

The module occupies original bus connectors on the rack. The connection of other racks is possible due to pair of identical connectors at the power supply front panel. The

rotary switches setting rack address and the number of the first position on the rack are hidden by the power supply module. Therefore there are labels on the front panel where you can write information about set address.

The connectors for connection of 24 V DC supply voltage are screwless. Detailed information on connection, instructions for correct installation, examples of connection and principles for increasing resistance and reliability can be found in the Manual for designing TXV 001 08.02.

Attention! For correct functioning in case of parallel run of more supply modules it is necessary to ensure a minimum consumption of 4.8 W. Otherwise, stable functioning of the modules will not be ensured.

Attention! **It is not allowed to remove or plug in a switched on supply module into the system!** When handling a supply module, **it has to be off!** Stejně tak je **zakázáno manipulovat s propojovacími kabely sběrnice při zapnutém systému**.
Also **it is forbidden to handle bus connectors when system is on.**

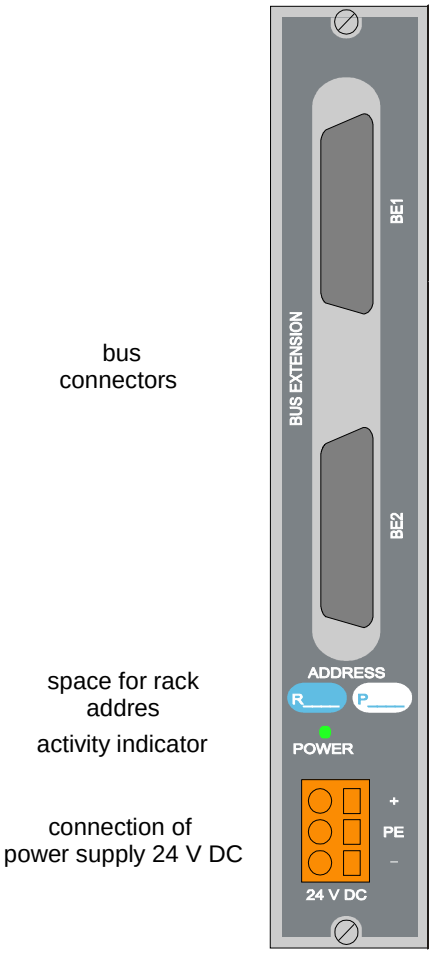


Fig.2.5 Front panel of supply module PW-7906

Table 2.4 Parameters of PW-7906 supply module

Feeder type	PW-7906
Input voltage	
nominal value	24 V DC
permissible range	19 - 36 V DC
Maximum input power	28 W
Primary circuit protection	fuse T2A
Typ. efficiency	85 %

Output voltage	24.3 ± 0.1 V DC
Maximum permanent output power	24 W
Short-circuit protection	electronic
Galvanic isolation	yes
Max. doba přerušení napájení bez vlivu na chod systému Max. period of power supply interruption that does not influence the system run	50 ms
UPS circuits	no
Electrical resistance of isolation	
input / output - 1 min.	1500 V DC
input against protective earthing terminal	500 V DC
Emissions IEC EN 55022	class B
Case dimensions	75 (bez zasunutých konektorů) x 27 x 198 mm with unplugged connectors

2.2.4. Supply module PW-7907

The PW-7907 supply module is určen designed to feed PLC TECOMAT TC700 unit from 230 V AC network with an output of 24 W. Modul se osazuje výhradně na propojovací konektory rámů RM-7941 (provedení od roku 2007), RM-7944 a RM-7946. Modul is assembled only with connectors of frames RM-7941 (model commencing year 2007), RM-7944 and RM-7946. The parameters can be found in table 2.7.

Supply module is pulse-controlled module with an output level of 24 V SELV (circuits with protection by low safe voltage) with a permanent total output power of 24 W. The module also has a block for network voltage failure watch. The output level is fitted with by protective overvoltage components.

The PW-7907 module are electrical devices of class I and allow connection to the TN-S as well as TN-C network (zero-voltage protection).

Modul obsazuje původní propojovací konektory rámu. Propojení dalších rámů je možné díky dvojici identických konektorů na čelním panelu napájecího modulu. Otočné přepínače nastavující adresu rámu a první pozice rámu jsou napájecím modulem zakryty. Na čelním panelu jsou plošky, na které lze informaci o nastavené adrese zapsat.

Modul occupies original frame connectors. Other frames connection is possible due to double identical connectors based on supplying modul front panel. Turning switches that set frame address and first frame positions are coverred by supplying modul.

The connectors for connection of 230 V AC supply voltage are screwless. Detailed information on connection, instructions for correct installation, examples of connection and principles for increasing resistance and reliability can be found in the Manual for designing TXV 001 08.01.

Attention! For correct functioning in case of parallel run of more supply modules it is necessary to ensure a minimum consumption of 4.8 W. Otherwise, stable functioning of the modules will not be ensured.

Attention! **It is not allowed to remove or plug in a switched on supply module into the system!** When handling a supply module, **it has to be off!** Stejně tak je **zakázáno manipulovat s propojovacími kabely sběrnice při zapnutém systému**. Also it is forbidden to handle bus connectors when system is on.

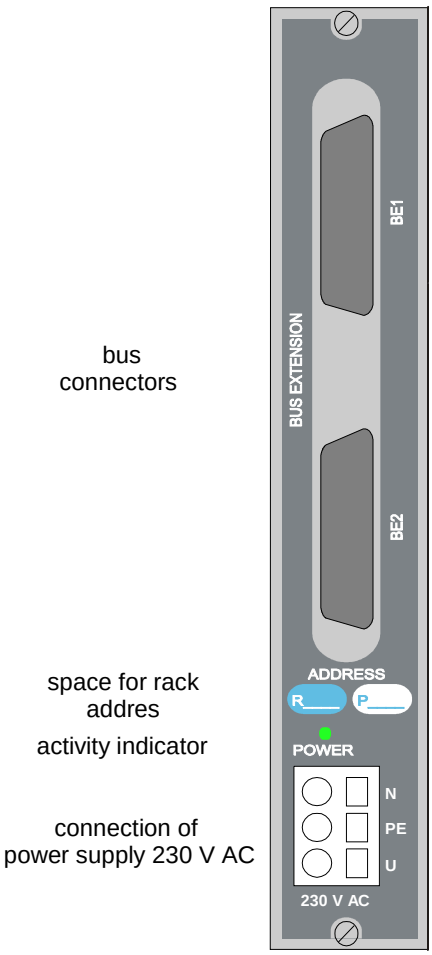


Fig.2.6 Front panel of supply module PW-7907

Tab.2.5 Parameters of PW-7907 supply module

Feeder type	PW-7907
Input voltage	
nominal value	230 V AC
permissible range	180 - 264 V AC
frequency	48 - 63 Hz
Maximum input power	35 VA
Primary circuit protection	fuse T1A
Typ. efficiency	80 %
Output voltage	24.3 ± 0.1 V DC
Maximum permanent output power	24 W
Short-circuit protection	electronic
Galvanic isolation	yes
Max. doba přerušení napájení bez vlivu na chod systému Max. period of power supply interruption that does not influence the system run	50 ms
UPS circuits	no
Current surge after switching on the module	max. 8 A, t < 10 ms
Electrical resistance of isolation	
input / output - 1 min.	3.75 kV AC
input against protective earthing terminal	1.85 kV AC
Emissions IEC EN 55022	třída B
Emissions of harmonic currents IEC EN 61000-3-2	class A (P.F.>0.99)
Case dimensions	75 (bez zasunutých konektorů) x 27 x 198 mm with unplugged connectors

2.2.5. Supply module PW-7908

The PW-7908 supply module is designed to supply PLC TECOMAT TC700 units from 115 V DC with a power output of 50 W in a case 60 mm wide. Usually, they are fitted into the first position of the rack from the left, but this is no condition. The parameters can be found in table 2.8.

Supply module is pulse-controlled module with an output level of 24 V SELV (circuits with protection by low safe voltage) with a permanent total output power of 50 W. The module also has a block for network voltage failure watch. The output level is fitted with by protective overvoltage components.

The connectors for connection of 115 V DC supply voltage are screwless. Detailed information on connection, instructions for correct installation, examples of connection and principles for increasing resistance and reliability can be found in the Manual for designing TXV 001 08.02.

Attention! For correct functioning in case of parallel run of more supply modules it is necessary to ensure a minimum consumption of 4.8 W. Otherwise, stable functioning of the modules will not be ensured.

Attention! **It is not allowed to remove or plug in a switched on supply module into the system!** When handling a supply module, **it has to be off!** The system can be switched on provided it is supplied from another supply module.

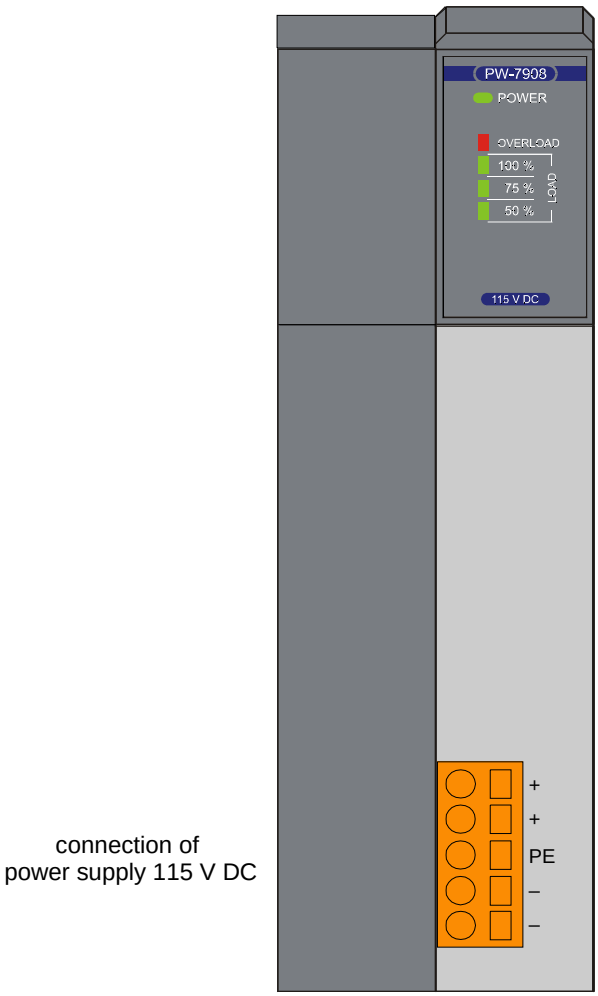


Fig. 2.7 Front panel of PW-7908 supply module after opening the door

Table 2.8 Parameters of PW-7908 supply module

Feeder type	**PW-7908**
Input voltage	
nominal value	115 V DC
permissible range	96 - 131 V DC
Maximum input power	72 W
Primary circuit protection	fuse T2A
Typ. efficiency	85 %
Output voltage	24.3 ± 0.1 V DC
Maximum permanent output power	50 W
Short-circuit protection	electronic
Galvanic isolation	yes
Max. doba přerušení napájení bez vlivu na chod systému	50 ms
Max. period of power supply interruption that does not influence the system run	
UPS circuits	no
Electrical resistance of isolation	
input / output - 1 min.	1500 V DC
input against protective earthing terminal	500 V DC
Emissions IEC EN 55022	class B
Case dimensions	137 x 60 x 198 mm (2 positions in the rack)

2.2.6 Indication of supply modules

At the top of the front plate indication LEDs (fig. 2.8, table 2.9) are shown. The PW-7906, PW-7907 modules have indication LED POWER only.

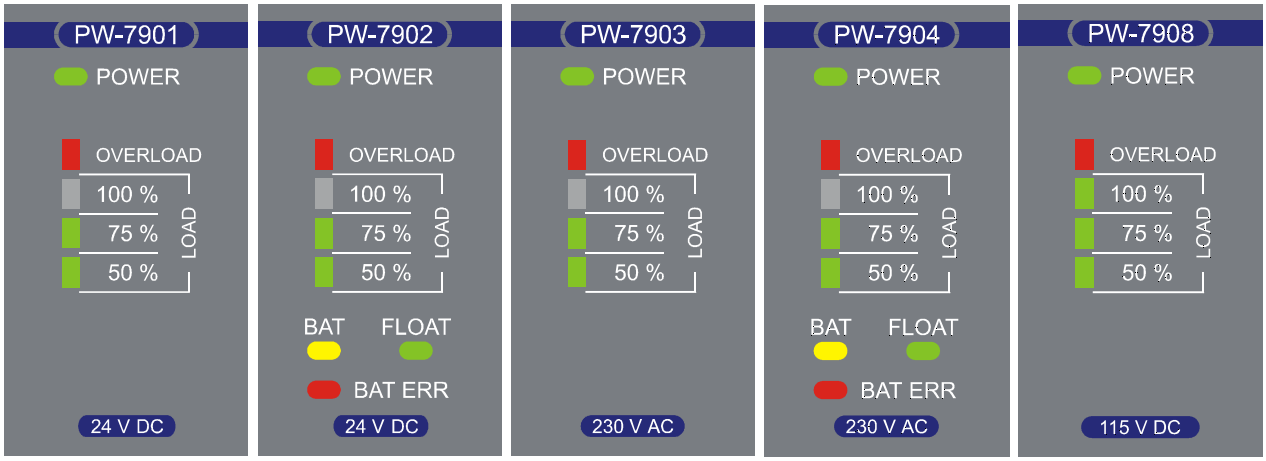


Fig. 2.8 Detail of supply modules indication

Table 2.9 Functions of indication LEDs of supply modules

Name	Colour	Behav.	Function
POWER	green	lighting	supply module is running
LOAD 50% 75% 100%	green	lighting	signalization of supply module load (bar diagram)
OVERLOAD	red	lighting	signalization of supply module overload (consumption exceeded 105%)
BAT	yellow	flashing	UPS battery is being charged
		lighting	PLC is fed from the battery (UPS running)
BAT ERR	red	flashing	UPS battery voltage dropped below the warning level (22 V)
		lighting	UPS battery voltage dropped below the critical level (21 V)
FLOAT	green	lighting	UPS battery is charged and the battery float mode is activated

2.2.7 Data obtained from supply modules

Supply modules PW-7901, PW-7902, PW-7903, PW-7904, PW-7908 provide information on the values of the voltage being supplied, current being drawn, total module load and in case of the supply modules with the UPS feature (PW-7902, PW-7904) also information on voltage and current of the UPS backup battery. The data structure becomes more clear from the panel *I/O Setting* in the Mosaic development environment (fig. 2.9) (icon IO). Supply modules PW-7906, PW-7907 provide no data.

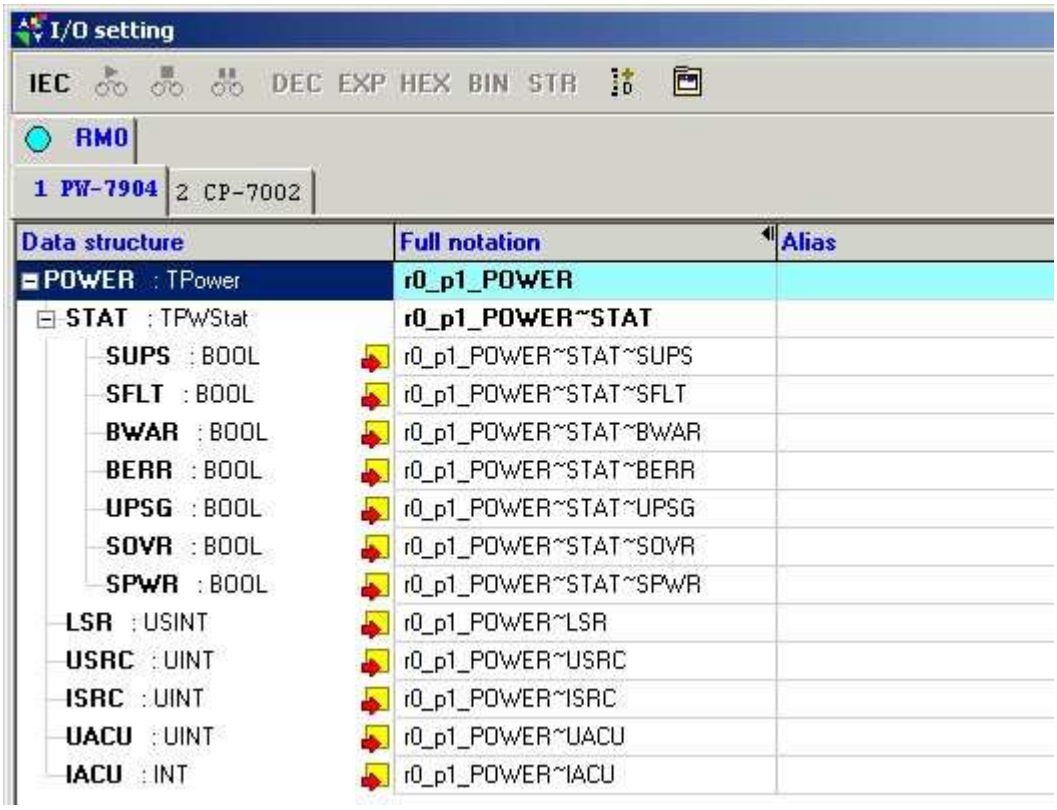


Fig. 2.9 Supply module data structure

Stat - information status (8 times type bool)

	0	SPWR	SOVR	UPSG	BERR	BWAR	SFLT	SUPS
bit	.7	.6	.5	.4	.3	.2	.1	.0

bits SUPS, SFLT, BWAR, BERR, UPSG work only at PW-7902, PW-7904

SUPS - UPS switch status
0 - UPS battery disconnected
1 - UPS battery connected

SFLT - „float“ status signalization (only when the battery is connected)
0 - the battery is being charged
1 - the battery is fully charged („float“ mode is running)

BWAR - warning status of the UPS battery
0 - battery O.K.
1 - the battery is nearly flat, voltage dropped below 22 V

BERR - critical status of the UPS battery
0 - battery O.K.
1 - the battery is flat, voltage dropped below 21 V

UPSG - UPS function signalization
0 - feeding from network
1 - feeding from UPS battery

SOVR - source overload
0 - source load in the permissible range
1 - source overloaded, overload exceeded 105%

SPWR - source status
0 - out of operation
1 - in operation (from network or UPS battery)

LSR - source load in % (type usint)

In the LSR variable, the source provides the value of the current load in %. In case of the sources with the UPS function, the load represents the sum of the UPS block consumption and consumptions of the peripheral modules in the racks.

USRC - output voltage supplied by the supply module in tenths of V (type uint)

ISRC - output current supplied by the supply module in mA (type uint)
In case of variables USRC and ISRC, the source provides the value of the output voltage and current supplied into the load. For the sources with the UPS function the load represents the sum of charging (maintaining) current of the UPS battery and the current supplied into the racks for peripheral modules. The charging current can be up to 400 mA.

UACU - UPS battery voltage in tenths of (type uint) (only for PW-7902, PW-7904)

IACU - UPS battery current in mA (type int) (only for PW-7902, PW-7904)
In variables UACU and IACU, the source provides the value of the current and voltage of the UPS battery. Positive values of the current represent consumption from the battery, negative values of the current represent charging of the battery.

2.2.8. Position and replacement of fuses

Supply modules PW-7901, PW-7902, PW-7903, PW-7904, PW-7908

The input circuits of supply from the network and from the UPS batteries are protected by miniature cylindrical cut out fuses that are accessible after taking off the door on the right side of the case. The door catch can be loosen by a screwdriver. Take out the blown fuse by pulling it out from the foot and replace with a new fuse. The position of the fuses can be seen on fig. 2.10.

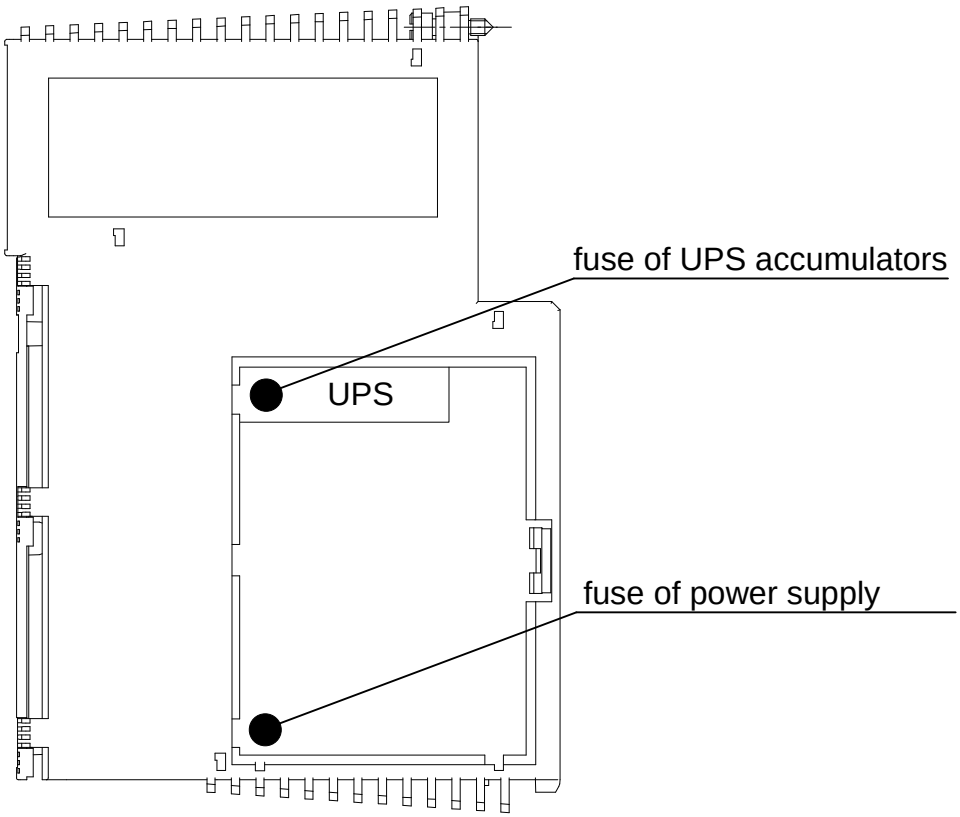


Fig. 2.10 Position of fuses in supply modules (the fuse of the UPS circuits can be found only in modules PW-7902 and PW-7904)

Supply modules PW-7906, PW-7907

The input circuits of supply from the network are protected by elektronic fuse.

2.3. CENTRAL MODULES

The central unit executes the user program and contains basic information necessary for the PLC function. As a result of this is that the PLC must have the current. Each central unit has been assigned a letter specifying its series. Each series of central units has its specific properties important for the compiler of the user program, such as mapping and size of memory space, instruction set size, etc.

Table 2.10 Overview of central units with order numbers

Module type	Modification	Order number
CP-7001	Central unit of series C	TXN 170 01*
CP-7002	Central unit of series C	TXN 170 02*
CP-7003	Central unit of series G	TXN 170 03*
CP-7004	Central unit of series K	TXN 170 04*
CP-7005	Central unit of series G for redundancy systems	TXN 170 05

* The plug-in modules of serial interfaces MR-01xx must be ordered separately.

Table 2.11 Parameters of central units

Central unit type	CP-7001	CP-7002	CP-7003	CP-7004	CP-7005
Real time circuit (RTC)	yes				
Redundancy support	no	no	no	no	yes
User program and table memory	64 + 64 KB	64 + 64 KB	128 + 64 KB	192 + 64 KB	128 + 64 KB
EEPROM backup memory of the program	yes	yes	yes	yes	yes
DataBox - data secondary memory					
min. (internal)	128 KB	128 KB	0 KB	512 KB	-
max. (submodule SX-7153) ***	-	3 MB	3 MB	3,5 MB	2,5 MB
Project archive memory	700 KB****	700 KB****	700 KB****	2 MB	700 KB****
SD / MMC card slot	no	no	no	yes	no
Backup of RAM and RTC *	20 000 h	20 000 h	20 000 h	20 000 h	20 000 h
Cycle time for 1k of log. instructions	0,9 ms	0,9 ms	0,9 ms	0,2 ms	0,9 ms
Number of user registers	40 KB	40 KB	40 KB	64 KB	40 KB
- number of remanent registers	16 KB	16 KB	16 KB	32 KB	16 KB
Max. number of IEC timers	2560	2560	2560	4096	2560
Max. number of IEC counters	5120	5120	5120	8192	5120
Binary inputs and outputs typ.	1920	3840	3840	3840	3840
Instruction length	2 ÷ 10 bytes				
Central unit class	C	C	G	K	G
Number of serial channels **	2 (+ 2)	2 (+ 8)	2 (+ 8)	2 (+ 8)	0 (+ 8)
Interface USB	1	1	1	1	1
Interface Ethernet	0 (+ 1)	1 (+ 1)	1 (+ 1)	1 (+ 1)	0 (+ 1)
Web server	no	no	no	yes	no
Max. demand from power supply module	3.6 W				
Case dimensions	137 x 30 x 198 mm				

* Valid for a central unit without feeding, when feeding is on, the battery is disconnected, backup time becomes longer. Moreover, the backup capacitor feeds the circuits for several days, the battery is connected after the capacitor is discharged (chapter 2.3.7). The backup capacitor allows replacing the battery without data loss.

** The serial are optional by means of plug-in submodules MR-01xx for RS-232, RS-485, RS-422, M-Bus, PROFIBUS DP, CAN.

*** Submodul SX-7153 s externí pamětí DataBox je volitelný pro centrální jednotky CP-7002, CP-7003 a CP-7004. Centrální jednotka CP-7005 je tímto submodulem standardně vybavena.
**** Centrální jednotky CP-7002, CP-7003 a CP-7005 obsahují paměť pro archivaci projektu až ve verzi hw 02.
****Submodul SX-7153 with external memory DataBox is a choice for central units CP-7002, CP-7003 and CP-7004. This submodule is a standard in central unit CP-7005.
****Central units CP-7002, CP-7003 and CP-7005 do not contain memory for project archivation.This memory begins with hw 02 version.

2.3.1. Central module CP-7001

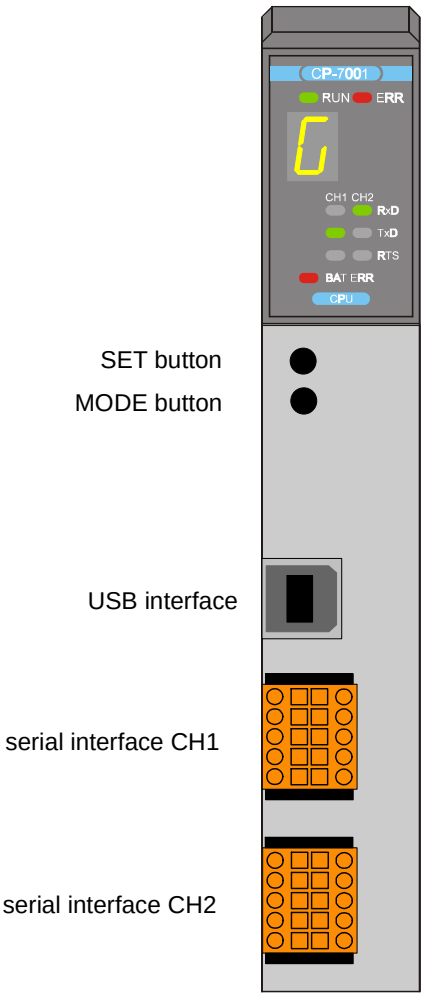


Fig. 2.11 Front panel of the CP-7001 central unit after opening the door

The CP-7001 central unit (table 2.11, fig. 2.11) is mounted in a case 30 mm wide and is fitted into the rack, usually on the position next to the supply source. The unit contains:

- 64 KB of CMOS RAM backup memory for user programs
- 64 KB of CMOS RAM backup memory for user tables
- 128 KB of Flash EEPROM memory for backup of user programs and tables
- 128 KB of DataBox secondary memory for data archiving
- 40 KB of user registers
- real time circuit (RTC)
- USB interface (according to USB 2.0 specifications) for debugging and servicing purposes
- 2 serial channels with optional interfaces, the interfaces of both serial channels are exchangeable by means of submodules (RS-232, RS-485, RS-422)

The CP-7001 central unit allows installation of PLC into four racks RM-7942. It is a unit of series C with instruction set, part of which are also arithmetic operations with numbers with fixed base point with the size of 32 bits with / without sign, with floating point single precision - 32 bits and double precision - 64 bits), PID controller instructions, operator panel support (TER instruction) and higher programming language support.

The mode and diagnostic messages are displayed on a seven-segment display. The connection of serial channels is done by screwless terminals, max. 1,0 mm^2 of conductor per a terminal. The USB interface has the standard USB B-connector. Detailed information, including signal assignment can be found in chapter 2.6.

By means of the SC-7101 communication module, the central unit can be expanded by another two serial channels.

By means of the SC-7102 communication module, the central unit can be expanded by another two serial channels and by the 10 Mb Ethernet interface.

Communication possibilities

USB channel

- mode **PC** - PLC programming and communication with superior systems

channels CH1 and CH2

- mode **PC** - communication with superior systems through EPSNET protocol
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through MODBUS protocol
- mode **UPD** - operation of special submodules
- mode **DPS** - PROFIBUS DP slave station realization (since sw version 2.6, hw version 02)
- mode **CAN** - connection of stations at CANopen bus (since sw version 2.7)
- mode **CAS** - CANopen station realization (since sw version 3.3)
- režim **CAB** - CAN bus connection with I82527 controller (since sw version 4.0)
- režim **CSJ** - CAN bus connection with SJA1000 controller (since sw version 5.4)

channels CH3 and CH4 (on module SC-7101, SC-7102)

- mode **PC** - communication with superior systems through EPSNET protocol (od verze sw 4.6 změna výměny dat, vyžaduje SC-710x s verzí sw 3.1 a vyšší) commencing sw version 4.6 data exchange, demands SC-710x with sw version 3.1 and higher.
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through MODBUS protocol

Ethernet ETH2 (on module SC-7102)

- mode **PC** - communication with superior systems through EPSNET UDP protocol in TCP/IP networks (od verze sw 4.6 změna výměny dat, vyžaduje SC-710x s verzí sw 3.1 a vyšší) commencing sw version 4.6 data exchange, demands SC-710x with sw version 3.1 and higher.
- mode **PLC** - data sharing among PLCs in TCP/IP network (since sw version 3.1)
- mode **UNI** - broadcasting and acceptance of arbitrary datas through UDP and TCP registers (since sw version 4.6)

The communication parameters are set at the MOSAIC development environment within the project, or by means of SET and MODE buttons on the central unit. The setting of the serial channels can be found both at the MOSAIC development environment and the keys on the central unit. If you press the SET button at the RUN mode, a text with the setup parameters of the CH1 serial channel rotates on the display. If you press the MODE button, a text with the setup parameters of the CH2 serial channel rotates on the display.

A more detailed description of these communications is given in the separate manual Serial communication of TECOMAT PLCs and TECOREG controllers - 32 bit model (order number TXV 004 03.01).

2.3.2. Central units CP-7002, CP-7003

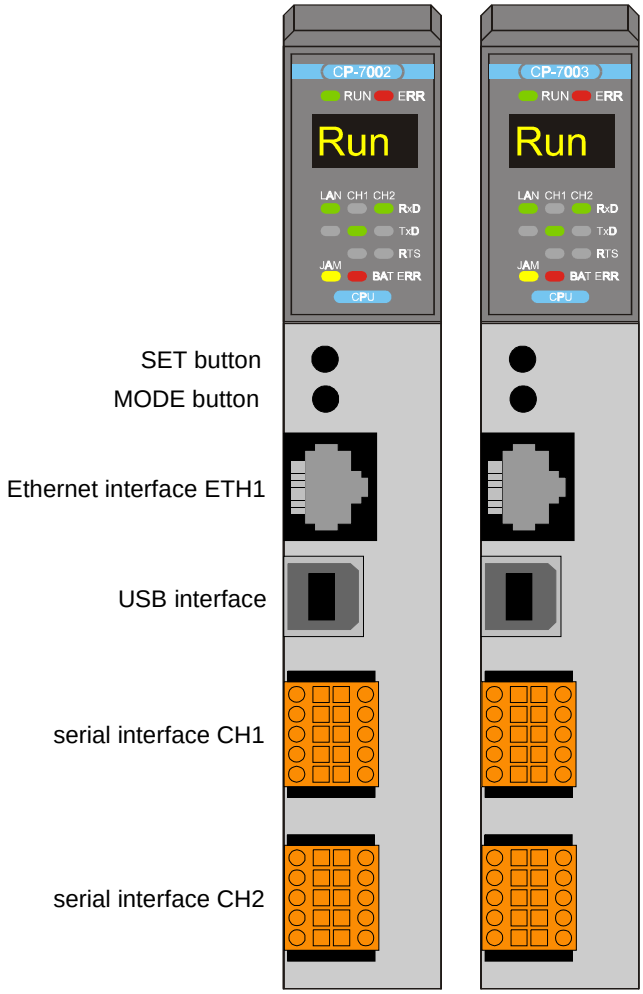


Fig. 2.12 Front panel of the CP-7002 and CP-7003 central units after opening the door

The CP-7002, CP-7003 central units (table 2.11, fig. 2.12) are mounted in a case 30 mm wide and are fitted into the rack on the position next to the supply source.

The CP-7002 central unit contains:

- 64 KB of CMOS RAM backup memory for user programs
- 64 KB of CMOS RAM backup memory for user tables
- 128 KB of Flash EEPROM memory for backup of user programs and tables
- 128 KB of DataBox secondary memory for data archiving, expandable to 3 MB (memory submodule SX-7153, order number TXN 171 53)

The CP-7003 central unit contains:

- 128 KB of CMOS RAM backup memory for user programs
- 64 KB of CMOS RAM backup memory for user tables
- 192 KB of Flash EEPROM memory for backup of user programs and tables
- up to 3 MB of DataBox secondary memory for data archiving (memory submodule SX-7153, order number TXN 171 53)

Otherwise both central units contain:

- 40 KB of user registers
- Real time circuit (RTC)
- USB interface (according to USB 2.0 specifications) for debugging and servicing purposes
- 2 serial channels with optional interfaces, the interfaces of both serial channels are exchangeable by means of submodules (RS-232, RS-485, RS-422)
- 10 Mb Ethernet interface

The CP-7002, CP-7003 central units allow installation into eight racks RM-7942. Four racks are operated by the central unit via the bus, another four racks have a bus interconnected with the CH2 serial channel of the central unit osazeným submodulem equipped by submodul MR-0154 (chapter 2.6.1.6.), nebo jsou připojeny pomocí systémových expanderů SE-713x, or are connected by system expanders SE-713x (chapter 2.5.).

The CP-7002 is a central unit of class C, the CP-7003 is a central unit of class G.

Both central units have instruction set, part of which are also arithmetic operations with numbers with fixed base point with the size of 32 bits with / without sign, with floating point single precision - 32 bits and double precision - 64 bits), PID controller instructions, operator panel support (TER instruction) and higher programming language support.

The mode and diagnostic messages are displayed on a four-digit matrix display.

The connection of serial channels is done by screwless terminals, max. 1.0 mm^2 of conductor per a terminal. The Ethernet interface has the RJ-45 connector. The USB interface has the standard USB B-connector. Detailed information, including signal assignment can be found in chapter 2.6.

By means of modules SC-7101 and SC-7102, the central unit can be expanded by another 8 serial channels. By means of the SC-7102 module, the central unit also can be added another one 10 Mb Ethernet interface.

Communication possibilities

USB channel

- mode **PC** - PLC programming and communication with superior systems

channel CH1

- mode **PC** - communication with superior systems through the EPSNET protocol
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through the MODBUS protocol
- mode **PFB** - connection of PROFIBUS DP slave stations (since sw version 2.5)
- mode **UPD** - operation of special submodules
- mode **DPS** - PROFIBUS DP slave station realization (since sw version 2.6, hw version 02)

- mode **CAN** - connection of stations at CANopen bus (since sw version 2.7)
- mode **CAS** - CANopen station realization (since sw version 3.3)
- režim **CAB** - CAN bus connection with I82527 controller (since sw version 4.0)
- režim **CSJ** - CAN bus connection with SJA1000 controller (since sw version 5.4)

channel CH2
- mode **EIO** - connection of another 4 peripheral racks (since sw version 2.5)
- mode **PC** - communication with superior systems through the EPSNET protocol
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through the MODBUS protocol
- mode **PFB** - connection of PROFIBUS DP slave stations (since sw version 2.5)
- mode **UPD** - operation of special submodules
- mode **DPS** - PROFIBUS DP slave station realization (since sw version 2.6, hw version 02)
- mode **CAN** - connection of stations at CANopen bus (since sw version 2.7)
- mode **CAS** - CANopen station realization (since sw version 3.3)
- režim **CAB** - CAN bus connection with I82527 controller (since sw version 4.0)
- režim **CSJ** - CAN bus connection with SJA1000 controller (since sw version 5.4)

channels CH3 to CH10 (on modules SC-7101, SC-7102)
- mode **PC** - communication with superior systems through the EPSNET protocol
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through the MODBUS protocol
- mode **PFB** - connection of PROFIBUS DP slave stations (since sw version 4.0)

Ethernet ETH1 (on central unit) and ETH2 (on module SC-7102)
- mode **PC** - communication with superior systems through EPSNET UDP protocol in TCP/IP networks
- mode **PLC** - data sharing among PLCs in TCP/IP network (since sw version 3.1)
- mode **UNI** - broadcasting and acceptance of arbitrary datas through UDP and TCP registers (since sw version 4.6)

The communication parameters are set at the MOSAIC development environment within the project, or by means of SET and MODE buttons on the central unit. The setting of the serial channels and Ethernet interface can be found both at the MOSAIC development environment and by the keys on the central unit. If you press the SET button at the RUN mode, a text with the setup parameters of the CH1 serial channel rotates on the display. If you press the MODE button, a text with the setup parameters of the CH2 serial channel rotates on the display. If we press both keys, a text with the setup parameters of the ETH1 Ethernet interface will rotate on the display.

A more detailed description of these communications is given in the separate manual Serial communication of TECOMAT PLCs and TECOREG controllers - 32 bit model (order number TXV 004 03.01).

2.3.3. Central unit CP-7004

The CP-7004 central unit (table 2.11, fig.2.13) is mounted in a case 30 mm wide and are fitted into the rack on the position next to the supply source. The unit contains:

- 192 KB of CMOS RAM backup memory for user programs
- 64 KB of CMOS RAM backup memory for user tables
- 256 KB of Flash EEPROM memory for backup of user programs and tables
- 512 KB of DataBox secondary memory for data archiving, expandable to 3,5 MB (memory submodule SX-7153, order number TXN 171 53)
- 64 KB of user registers
- Real time circuit (RTC)
- USB interface (according to USB 2.0 specifications) for debugging and servicing purposes
- 2 serial channels with optional interfaces, the interfaces of both serial channels are exchangeable by means of submodules (RS-232, RS-485, RS-422)
- 10/100 Mb Ethernet interface
- SD / MMC card slot
- Web server (chapter 4.7.)

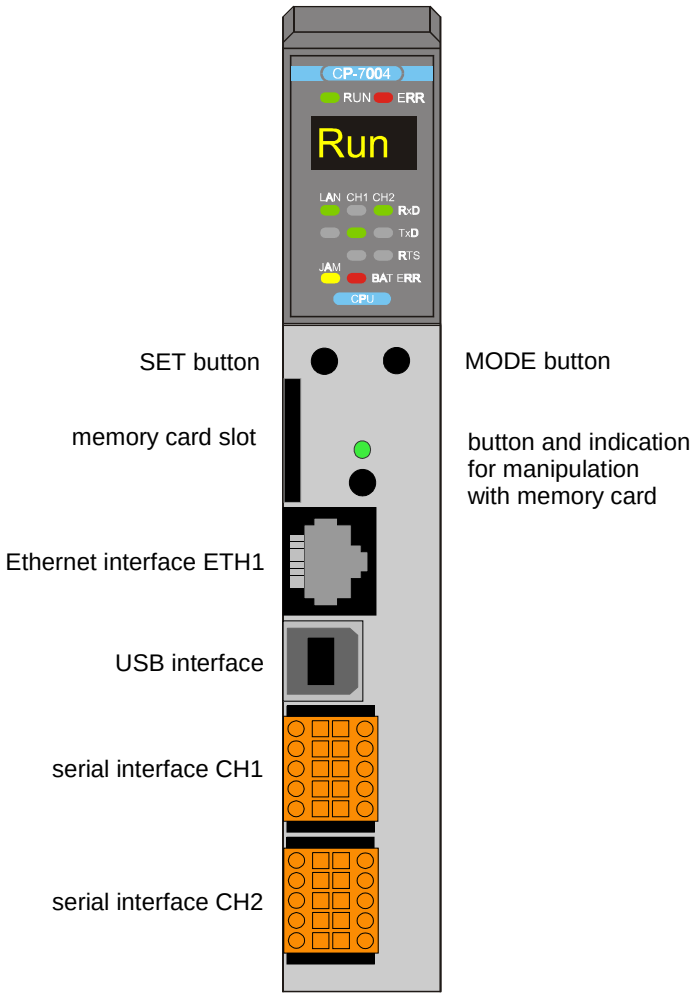


Fig.2.13 Front panel of the CP-7004 central unit after opening the door

The CP-7004 central unit allows installation into eight racks RM-7942. Four racks are operated by the central unit via the bus, another four racks have a bus interconnected with the CH2 serial channel of the central unit osazeným submodulem equipped by submodul MR-0157 (chapter 2.6.1.6.), nebo jsou připojeny pomocí systémových expanderů SE-713x, or are connected by system expanders SE-713x (chapter 2.5.).

The CP-7004 is a unit of class K with instruction set, part of which are also arithmetic operations with numbers with fixed base point with the size of 32 bits with / without sign, with floating point single precision - 32 bits and double precision - 64 bits), PID controller instructions, operator panel support (TER instruction) and higher programming language support.

Dále centrální jednotka CP-7004 obsahuje integrovaný Web server a slot na paměťové karty typu MMC a SD. Paměťovou kartu lze za chodu vyměňovat, pokud zrovna do ní systém neprovádí zápis. Centrální jednotka CP-7004 na paměťových kartách podoporuje souborové systémy ukládání dat FAT12, FAT16 a FAT32.

Further the central unit CP-7004 contains integrated Web server and slot for memory cards of type MMC and SD. It is possible to change memory card when system running except for when system is recording. Central unit CP-7004 supports file systems data storage of FAT12, FAT16 and FAT32 on memory cards.

The mode and diagnostic messages are displayed on a four-digit matrix display.

The connection of serial channels is done by screwless terminals, max. 1.0 mm^2 of conductor per a terminal. The Ethernet interface has the RJ-45 connector. The USB interface has the standard USB B-connector. Detailed information, including signal assignment can be found in chapter 2.6.

By means of modules SC-7101 and SC-7102, the central unit can be expanded by another 8 serial channels. By means of the SC-7102 module, the central unit also can be added another one 10 Mb Ethernet interface.

Communication possibilities

USB channel

- mode **PC** - PLC programming and communication with superior systems

channel CH1

- mode **PC** - communication with superior systems through the EPSNET protocol
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through the MODBUS protocol
- mode **PFB** - connection of PROFIBUS DP slave stations
- mode **UPD** - operation of special submodules
- mode **DPS** - PROFIBUS DP slave station realization (since sw version 3.5)
- režim **CSJ** - CAN bus connection with SJA1000 controller

channel CH2

- mode **EIO** - connection of another 4 peripheral racks (since sw version 5.0)
- mode **PC** - communication with superior systems through the EPSNET protocol
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through the MODBUS protocol
- mode **PFB** - connection of PROFIBUS DP slave stations
- mode **UPD** - operation of special submodules
- mode **DPS** - PROFIBUS DP slave station realization (since sw version 3.5)
- režim **CSJ** - CAN bus connection with SJA1000 controller

channels CH3 to CH10 (on modules SC-7101, SC-7102)

- mode **PC** - communication with superior systems through the EPSNET protocol
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through the MODBUS protocol
- mode **PFB** - connection of PROFIBUS DP slave stations

Ethernet ETH1 (on central unit)

- mode **PC** - communication with superior systems through EPSNET UDP protocol in TCP/IP networks
- mode **PLC** - data sharing among PLCs in TCP/IP network
- mode **UNI** - broadcasting and acceptance of arbitrary datas through UDP and TCP registers
- mode **MDB** - communication with superior systems through the MODBUS UDP and MODBUS TCP protocols (od verze sw 3.7)

Ethernet ETH2 (on module SC-7102)

- mode **PC** - communication with superior systems through EPSNET UDP protocol in TCP/IP networks (SC-710x with sw version 3.1 and higher is required)
- mode **PLC** - data sharing among PLCs in TCP/IP network
- mode **UNI** - broadcasting and acceptance of arbitrary datas through UDP and TCP registers

The communication parameters are set at the MOSAIC development environment within the project, or by means of SET and MODE buttons on the central unit. The setting of the serial channels and Ethernet interface can be found both at the MOSAIC development environment and by the keys on the central unit. If you press the SET button at the RUN mode, a text with the setup parameters of the CH1 serial channel rotates on the display. If you press the MODE button, a text with the setup parameters of the CH2 serial channel rotates on the display. If we press both keys, a text with the setup parameters of the ETH1 Ethernet interface will rotate on the display.

A more detailed description of these communications is given in the separate manual Serial communication of TECOMAT PLCs and TECOREG controllers - 32 bit model (order number TXV 004 03.01).

2.3.4. Central unit CP-7005

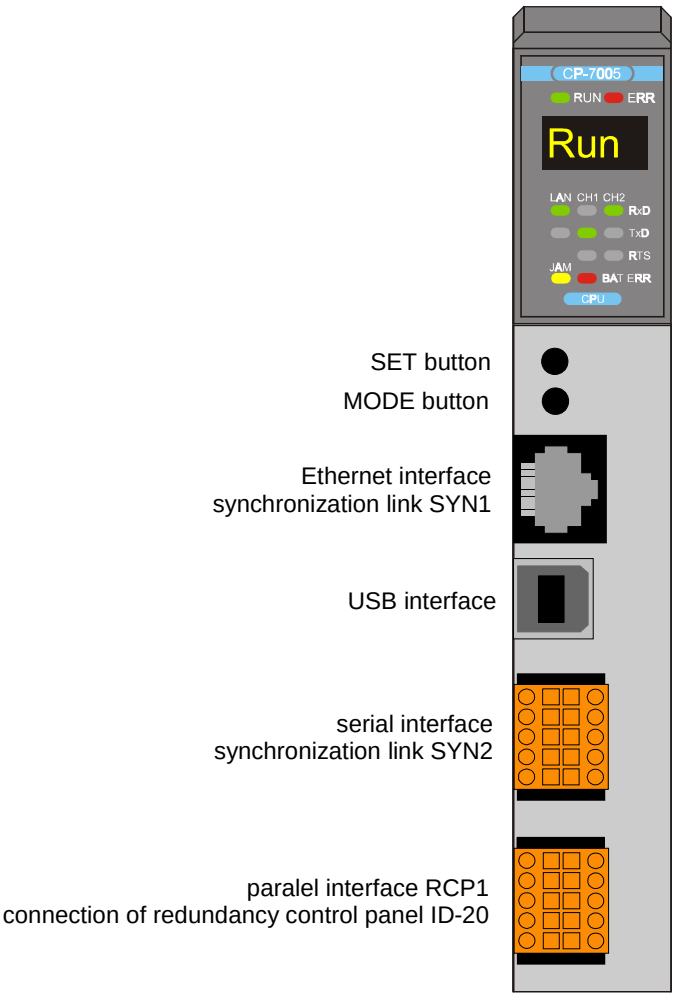


Fig.2.14 Front panel of the CP-7005 central unit after opening the door

The CP-7005 central unit (table 2.11, fig.2.14) is mounted in a case 30 mm wide and are fitted into the rack on the position next to the supply source. The unit contains:

- 128 KB of CMOS RAM backup memory for user programs
- 64 KB of CMOS RAM backup memory for user tables
- 192 KB of Flash EEPROM memory for backup of user programs and tables
- 2,5 MB of DataBox secondary memory for data archiving (standardně z výroby osazený production standard memory submodule SX-7153)
- 40 KB of user registers
- Real time circuit (RTC)
- USB interface (according to USB 2.0 specifications) for debugging and servicing purposes
- 2 sériové kanály a rozhraní Ethernet jsou trvale určené pro potřeby redundance, rozhraní obou sériových kanálů jsou již z výroby osazena potřebnými submoduly
- 2 serial chanels and Ethernet interface are determined for redundancy needs

The CP-7005 is a unit of class G with instruction set, part of which are also arithmetic operations with numbers with fixed base point with the size of 32 bits with / without sign, with floating point single precision - 32 bits and double precision - 64 bits), PID controller instructions, operator panel support (TER instruction) and higher programming language support.

The mode and diagnostic messages are displayed on a four-digit matrix display.

Centrální jednotka CP-7005 je určena pro výstavbu redundantního PLC (režim Hot-Standby) do osmi rámů RM-7942. Čtyři rámy jsou obsluhované centrální jednotkou po

sběrnici, další čtyři rámy mohou být připojeny pomocí systémových expanderů SE-713x (kap.2.5.). První čtyři rámy jsou redundantní (zdvojené), zatímco další čtyři rámy připojené přes expandery umožňují společnou obsluhu z obou redundantních centrálních jednotek.

Dvojice redundantních centrálních jednotek CP-7005 je navzájem propojena dvěma synchronizačními linkami. Synchronizační linka 1 (SYN1) je provozována na rozharní Ethernet a propojuje se kříženým UTP kabelem (Ethernet cat. 5). Synchronizační linka 2 (SYN2) je provozována na rozhraní RS-232. K paralelnímu rozhraní RCP1 se připojuje ovládací panel redundance ID-20.

Podrobnosti o propojení jednotlivých částí redundantního systému jsou uvedeny v kapitole 3.3.2.

Připojení linky SYN2 a rozhraní RCP1 je provedeno bezšroubovými svorkami, max. 1,0 mm^2 vodiče na svorku. Linka SYN1 na rozhraní Ethernet je vyvedena konektorem RJ-45. Rozhraní USB je vyvedeno standardním B - konektorem USB. Podrobnosti včetně rozmístění signálů jsou uvedeny v kap.2.6.

Centrální jednotka CP-7005 je již z výroby osazena submodulem MR-0104 na kanálu CH1 (linka SYN2) a submodulem PX-7812 na kanálu CH2 (rozhraní RCP1). Submoduly mohou být v případě poruchy vyměněny za jiné téhož typu.

Central unit CP-7005 is intended for redundancy PLC expansion výstavba (Hot-Standby regime) up to eight frames RM-7942. Four frames are served by central unit by collector, further four frames can be connected by system expanders SE-713x (chap. 2.5). First four frames are redundant (doubled), while other four frames connected through expanders allow mutual service from both redundant central units.

Couple of redundant central units CP-7005 is mutually connected with two synchro lines. Synchro line 1 (SYN1) runs at Ethernet interface and is interconnected by crossed UTP cabel (Ethernet cat. 5). Synchro line 2 (SYN2) runs at interface RS-232. Control redundancy panel ID-20 connects with paralel interface RCP1.

For details about interconnection of redundant system individual parts see chapter 3.3.2.

Connection of line SYN2 and interface RCP1 is done by screwless clamps, max. 1,0 mm^2 of conduct wire per clamp. Line SYN1 at Ethernet interface is brought out by connector RJ-45. USB interface is brought out by standard USB B – connector. For details including signals distribution see chap. 2.6.

Producer supplies central unit CP-7005 equipped by submodule MR-0104 on channel CH1 (line SYN2) and submodule PX-7812 on channel CH2 (interface RCP1). Submodules can be replaced by another of the same type in case of break down.

By means of modules SC-7101 and SC-7102, the central unit can be expanded by another 8 serial channels. By means of the SC-7102 module, the central unit also can be added another one 10 Mb Ethernet interface. Narozdíl od sériových kanálů a Ethernetu na centrální jednotce jsou tyto komunikační kanály k dispozici uživateli. On the opposite of serial channels and Ethernet these communication channels are at users disposal on central unit.

Communication possibilities

USB channel

- mode **PC** - PLC programming and communication with superior systems

channel CH1 (synchronization link SYN2)

- mode **SYN** - synchronization channel for redundancy

channel CH2 (paralel interface RCP1)
- mode **UPD** - connection of redundancy control panel ID-20

channels CH3 to CH10 (on modules SC-7101, SC-7102)
- mode **PC** - communication with superior systems through the EPSNET protocol
- mode **PLC** - data sharing among PLCs in the EPSNET-F network
- mode **UNI** - common channel with arbitrary asynchronous communication
- mode **MPC** - data exchange with subordinated PLCs in the EPSNET multimaster network
- mode **MDB** - communication with superior systems through the MODBUS protocol
- mode **PFB** - connection of PROFIBUS DP slave stations

Ethernet ETH1 (on central unit - synchronization link SYN1)
- mode **SYN** - synchronization channel for redundancy

Ethernet ETH2 (on module SC-7102)
- mode **PC** - communication with superior systems through EPSNET UDP protocol in TCP/IP networks
- mode **PLC** - data sharing among PLCs in TCP/IP network
- mode **UNI** - broadcasting and acceptance of arbitrary datas through UDP and TCP registers

The communication parameters are set at the MOSAIC development environment within the project. The setting of the serial channels and Ethernet interface can be found both at the MOSAIC development environment.

A more detailed description of these communications is given in the separate manual Serial communication of TECOMAT PLCs and TECOREG controllers - 32 bit model (order number TXV 004 03.01).

2.3.5 Indication of central units

At the top of the front plate, there are indication LEDs (fig. 2.15, table 2.12).

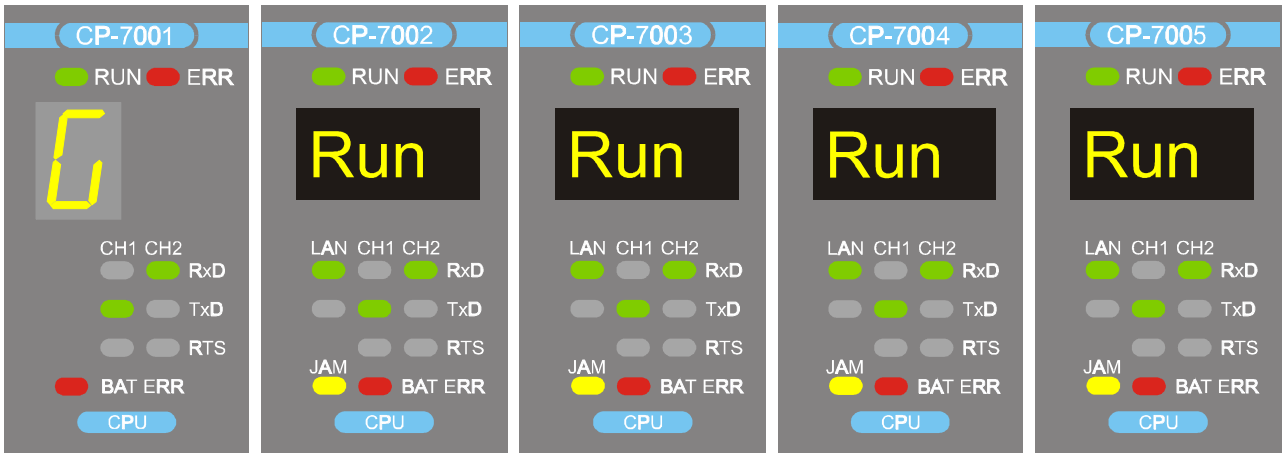


Fig. 2.15 Detail of indication of central units

Table 2.12 Functions of indication LEDs of central units

název	barva	chování	funkce
RUN	green	lighting	Central unit is working, user program not executed (HALT, PROG modes)
		flashing	Central unit is working, user program is executed (mode RUN, STB)
ERR	red	lighting	signalization of error reported by central unit
LAN			Ethernet ETH1 interface signalization
RxD	green	lighting	data receiving
TxD	green	lighting	data transmission
JAM	yellow	lighting	network collision state (does not mean a failure, but the more frequent this state is, the more the network is loaded)
CH1, CH2			signalization of CH1 and CH2 interfaces
RxD	green	lighting	data receiving
TxD	green	lighting	data transmission
RTS	green	lighting	RTS signal state
BAT ERR	red	lighting	battery voltage dropped bellow critical value (2.1 V)

2.3.6 Data obtained from central units

Central units provide data connected with serial communication (interface ETH1, USB, CH1, CH2, ...). Detailed information can be found in the manual Serial communication of PLC TECOMAT - 32 bit model (TXV 004 03.01).

2.3.7. Program memory supply and real time circuit backup

After switching off the PLC supply voltage the data in the program memory and in the remanent zone are backed up. In the central units the backup is ensured from two sources:

a) during the first 100 hours (minimum) the backup is ensured by the capacitor with a very high capacity
b) if supply is not restored during this period, the backup is taken over automatically by the Li-battery, life time of which is 5 years as minimum.

The energy of the backup capacitor is restored during supply switched on within minimally 30 minutes. As a result of this is that during one-shift working cycle the battery is not discharged, not even during the weekend. Moreover, when replacing the backup battery, which is in a holder, the program in the memory is backed up by the capacitor, so the program is not deleted.

Real time circuit (RTC) and calendars (RTC) are during power supply failure backed up in the same way as the user program memory.

The program memory requires a backup voltage of at least 2.1 V. This means that is the battery voltage drops below this value, secure backup of the program and data is not ensured after discharging of the backup capacitor. If we change the flat battery for a new one, the memory content will not be lost. The drop of the battery voltage below the value of 2.1 V is indicated by the BAT ERR LED on the front plate of the central unit and in the register S35.0.

The replacement of the backup battery (type CR2032 or similar, 3 V, ∅ 20 mm, thickness 3.2 mm) is recommended to be done every 2 to 3 years. The battery lifetime is usually 5 years.

The battery is slid in the holder mounted on the motherboard and is accessible after taking off the door on the right side of the case (fig. 2.16). Open the door with a screwdriver inserted behind the door catch on the right side of the module case. The old battery must be given for disposal to authorized companies.

ATTENTION!	**The modules contain parts sensitive to static charge, therefore, it is necessary to follow the safety rules when working with these circuits! Any handling must be done on the module taken out from the rack! For battery replacement do not use any metal tools (pincers, pliers, etc.) not to short-circuit the battery. Watch the correct polarity of the battery!**

2.3.8. Location of plug-in modules

The optional submodules MR-01xx of the serial interface are in the central units CP-7001, CP-7002, CP-7003 and CP-7004 fitted into positions marked on fig. 2.16. Centrální jednotka CP-7005 má potřebné submoduly osazené z výroby. Výměna se provádí pouze v případě jejich poruchy.

Central unit CP-7005 is equipped by producer with needed submodules. Exchange is done only in case of their break down.

The optional submodule SX-7153 of the DataBox memory is in the central units CP-7002, CP-7003, CP-7004 and CP-7005 fitted into the position marked on fig. 2.16.

When a submodule with the interface of the serial channel or the DataBox secondary memory should be fitted or changed, it is necessary to loosen the door catch and take out the door on the right side of the case. After taking off the door, you can access the plug-in modules.

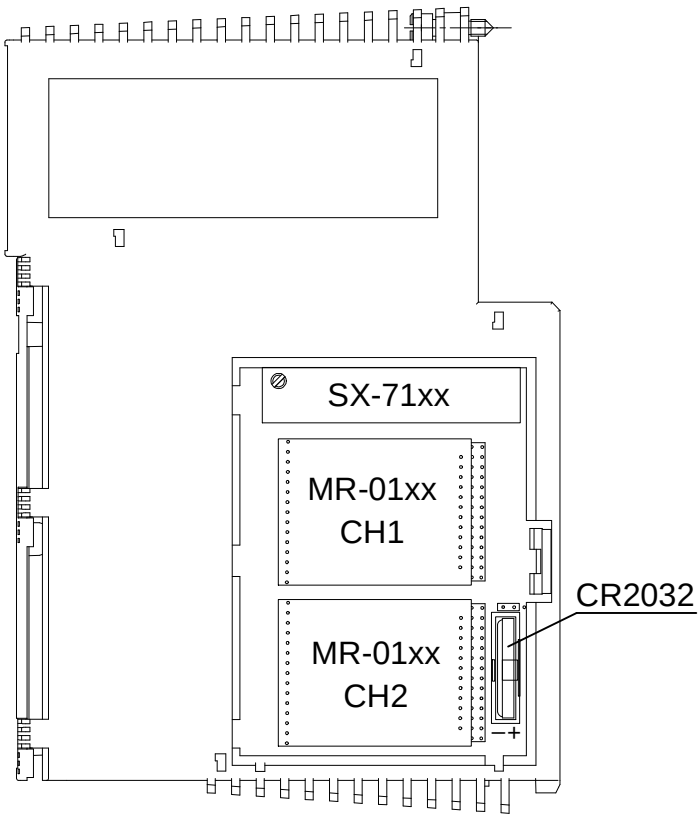


Fig. 2.16 Location of plug-in modules of serial interface and backup battery in central units after opening the door on the case side

ATTENTION!	**The modules contain parts sensitive to static charge, therefore, it is necessary to follow the safety rules when working with these circuits! Any handling must be done on the module taken out from the rack! When replacing submodules check the correctness of fitting of the submodule female headers against the tips of the motherboard. The female headers do not have any position coding and when incorrectly fitted, the submodule and/or motherboard can be damaged after switching power supply on!!!**

2.3.9. Parameter setting

For the central units, the parameters are set by means of SET and MODE buttons on the front panel (fig. 2.11, fig. 2.12, fig. 2.13 and 2.14) or from the MOSAIC development environment.

Displaying of parameters on the display

The central unit CP-7001 has a one-digit seven-segment display, while the central units CP-7002, CP-7003, CP-7004, CP-7005 have a four-digit matrix display. When we mention the display in the further text, we mean both type of them.

A text, which is longer than the number of characters that can be displayed on the display, rotates on the display from the right to the left. For example, number 123456 is displayed in such a way that digits 1, 2, 3, 4, 5, 6 follow each other on the display, followed by a rotational latency, and they rotate again. Each character is displayed for about 0.5 s and there is a short latency between the characters ensuring recognition of two identical characters following each other (e.g. displaying number 111). The same number is gradually displayed on the four-digit display as 1234, 2345, 3456, followed by a short latency and it rotates again. The shift takes place every 0.3 s.

Switching to parameter setup mode, ways of setup and mode termination

You can switch to parameter setup mode of the central unit by pressing the SET and MODE buttons at the same time when switching power supply on. The buttons SET and MODE are pressed, until "≡" appears on the display. Then, release both keys and you are in the mode for parameter setup. It can be said generally that by the SET button we change the parameter setup and by the MODE button we can list among the parameters. The parameter setup mode can be terminated at any time by pressing the SET and MODE buttons at the same time. The parameter setup mode termination is again indicated by the "≡" character.

The parameter state is saved at the EEPROM system memory, so that the central unit holds it even after power supply is off, even if the backup battery fails. The parameters of the serial channels set up in the user program are of priority before this setup! This setup becomes useful at such serial channels that are switched off in the user program (see the text below). After termination of the parameter setup, the central unit switches to the HALT mode (see chapter 4). Current setup of the serial channels CH1, CH2 and the Ethernet ETH1 interface can be in the RUN mode found also by means of keys. After pressing the SET button, CH1 channel setup is displayed, after pressing the MODE button, CH2 channel setup is displayed and when pressing both keys at the same time, Ethernet ETH1 interface setup is displayed.

Parameters setup

On the central units CP-7001, CP-7002, CP-7003 and CP-7004, parameters are set up according to the table 2.13. On the CP-7005 central unit, parameters are set up according to the table 2.14.

Sériové kanály CH3 až CH10 a rozhraní Ethernet ETH2 realizované pomocí systémových komunikačních modulů SC-7101 a SC-7102 se nastavují výhradně v prostředí Mosaic v rámci projektu.

Serial channels CH3 up to CH10 and Ethernet ETH2 interface that are realized by system communication modules SC-7101 and SC-7102 are being set only in Mosaic communication in the scope of project.

Table 2.13 Parameters that can be set up on the central units CP-7001, CP-7002, CP-7003 and CP-7004 (from the left to the right and by lines)

Object	Parameters to be set up						
	mode	**address**	**speed**	**response timeout**	**space between char.**	**CTS detection**	**mode parity**
serial channels CH1 and CH2	off	-	-	-	-	-	-
	PC	A	S	T	B	CTS	PAR
	MDB	A	S	T	-	CTS	PAR

	IP address				**IP mask**				**gateway IP address**			
Ethernet ETH1	IP1	IP2	IP3	IP4	IM1	IM2	IM3	IM4	GW1	GW2	GW3	GW4

	mode
EEPROM	off on

Table 2.14 Parameters that can be set up on the central unit CP-7005 (from the left to the right and by lines)

Object	Parameters to be set up	
	mode	**type**
serial channelCH1	**SYN**	TYP
serial channelCH2	**RCP**	-

	mode
EEPROM	off on

Pozn.: Režimy sériových kanálů jsou neměnné. Režim **RCP** znamená připojení řídicího panelu redundance ID-20 (redundancy control panel).

Note: Serial channels regimes are constant. RCP regime means connection of control pannel redundancy ID-20 (redundancy control panel).

Serial channel mode setup

The mode of the CH1 and CH2 serial channels is set only when we need to set up parameters independently of the user program. The condition is that the serial channel in question must be switched off in the user program. If not, the mode of the serial channel is during the restart of the PLC always set according to the user program without taking into account what we have set in the central unit by means of the keys. Information set up by the keys are saved, but until the serial channel is off in the user program, the information will not be accepted.

The modes requiring further initialization data contained in the user program (modes **PLC**, **MPC**, **UNI**, **PFB**, **UPD**, **DPS**, **CAN**, **CAS**, **CAB**, **CSJ**) cannot be set by means of the keys. The **EIO** mode is set automatically when MR-0154 submodule is fitted.

When setting the modes of the CH1 and CH2 serial channels, you can see the following on the display, for example:

C2-off

C - serial channel mode setup
2 - number of the channel being set up
off - mode set up

By means of the keys, the serial channels can be switched to the following modes:

off - the channel is off (no further channel parameter is being set up)

C2-off

PC - connection of superior system - a PC or an active operation panel via the EPSNET protocol (followed by setting up address, speed, response timeout, CTS and parity detection)

C2-PC

MDB - connection of superior system - a PC or an active operation panel via the MODBUS RTU protocol (followed by setting up address, speed, response timeout, CTS detection).

C2-MDB

By means of the SET button, we can change the mode being set up. By the MODE button, we save the mode that is set up and we go to set up the next parameter. The mode, which is not supported by the channel, is not offered when listing by the SET button. The USB channel has the **PC** mode fixed preset and cannot be changed. So, you do not set the mode for this channel, only the address.

V centrální jednotce CP-7005 je na sériovém kanálu CH1 pevně nastavený režim **SYN**.
Regime SYN is set constantly on serial channel CH1 in central unit CP-7005.

C1-SYN

V tomto režimu lze měnit parametr TYP, který určuje chování centrální jednotky v redundantním systému.

Parameter TYP can be changed in this regime. It determines behaviour of central unit in redundant system.

Typ1-None

Možnosti jsou následující:

None - chování není určeno
Prim - centrální jednotka se chová jako hlavní (primary) v redundantním systému
Back - centrální jednotka se chová jako záložní (backup) v redundantním systému

Sériový kanál CH2 je použit pro připojení řídicího panelu redundance ID-20. Tato skutečnost je znázorněna zkratkou **RCP**.

Possibilities are as follows:

None – behaviour is not set
Prim – central unit behaves as primary in redundant system
Back – central unit behaves as backup in redundant system

Serial channel CH2 is used in order to connect redundacy ID-20 control panel. This fact is showed by short form **RCP**.

C2-RCP

Serial channel address setup

When setting the address of the serial channel, you can see the following on the display, for example:

A2-0

A - serial channel address setup
2 - number of the channel being set up
0 - address set up

The address can assume values 0 to 99. By short pressing of the SET button, its value will be increased by one, by long pressing the SET button (approx. 1 second), its value will be increased by 10. By pressing the MODE button you can save the value and you can set up the next parameter. The address is set for the modes **PC** and **MDB**.

Serial channel communication speed setup

When setting the communication speed of the serial channel, you can see the following on the display, for example:

S2-19_2

S - serial channel speed setup
2 - number of the channel being set up
19_2 - set speed in kBd (the underline character replaces the decimal point)

The speed can assume predetermined values according to the table 2.15. The speed, which is not available for the given channel, is not offered when listing by means of the SET button. By pressing the MODE button you can save the value and you can set up the next parameter. The address is set for the modes **PC** and **MDB**.

Table 2.15 List of available communication speeds via serial channels

Speed	Channel mode	Speed	Channel mode
0,3 kBd	PC, MDB	19,2 kBd	PC, MDB
0,6 kBd	PC, MDB	28,8 kBd	PC, MDB
1,2 kBd	PC, MDB	38,4 kBd	PC, MDB
2,4 kBd	PC, MDB	57,6 kBd	PC, MDB
4,8 kBd	PC, MDB	76,8 kBd	PC, MDB
9,6 kBd	PC, MDB	115,2 kBd	PC, MDB
14,4 kBd	PC, MDB		

Response timeout setup

When setting the response timeout, you can see the following on the display, for example:

T2-10

T - response timeout setup
2 - number of the channel being set up
10 - set timeout in ms

By short pressing of the SET button, its value will be increased by one, by long pressing the SET button (approx. 1 second), its value will be increased by 10. By pressing the MODE button you can save the value and you can set up the next parameter.

The optional timeout is used in such cases, when the superior system transmitting a message or transmission devices on the way (modems, serial interface converters) do not manage to switch from transmitting to receiving on time, and thus they are not able to receive the PLC response. By making the timeout longer, the superior system has more time for preparations necessary to start receiving the response.

The timeout value is set in milliseconds and can assume values from 0 to 99 ms. The value of 0 means that the minimum timeout value will correspond to the time necessary to transmit 1 byte, thus, it depends on the speed set up. The values of 1 to 99 mean the timeout in milliseconds and they do not depend on the communication speed. The response timeout is set for the modes **PC** and **MDB**.

The space setup between received characters

Při nastavování mezery mezi přijímanými znaky se na displeji zobrazuje např.:
When space is set between received symbols the display shows for example:

B2 - 5

B - nastavení mezery mezi přijímanými znaky
2 - číslo nastavovaného kanálu
5 - nastavená mezera v ms

B - set up of space between received symbols
2 – number of set channel
5 – set space in ms

Krátkým stiskem tlačítka SET zvýšíme nastavovanou hodnotu o 1, dlouhým stiskem tlačítka SET (asi 1 s) zvýšíme nastavovanou hodnotu o 10. Stiskem tlačítka MODE uložíme nastavenou hodnotu a přejdeme na nastavení dalšího parametru.

When button SET is shortly pressed the set up value will be increased by 1. When butten SET is pressed a bit longer (about 1 s) the set up value will be increased by 10. When button MODE is pressed the set value will be saved and we can go on to set up other parameter.

The optional space between characters received is used for solution of events when the master system that sends the message out, or transmission device on the route (modems, serial interface converters), disturb the sending message in such a way that the maximum allowed space of 3 bytes between characters is not adhered. By setting this parameter to non-zero value, the PLC accepts a larger space in the middle of the receiving message up to the size set by the parameter.

Attention! As for security purposes, it is required that the heading of the message is received at full, i. e. **the first 8 characters of the message must not be interrupted**, only after then parameter **B** is accepted. This condition is usualy fullfiled by modems due to balancing buffers.

Value of the space between characters received is set in ms within the range from 1 to 255 and it does not depend on a communication speed. The 0 value means that this function is switched off and PLC requires the maximum space of 3 bytes between characters to be adhered.

Mezera mezi přijímanými znaky se nastavuje pro režim **PC**. Tento parametr obsahují centrální jednotky CP-7001, CP-7002, CP-7003 od verze sw 4.2. Centrální jednotky CP-7004 podporují tento parametr ve všech verzích sw.

Space between received characters is set up for regime PC. Central units C-7001, CP-7002, CP-7003 contain this parameter commencing sw version 4.2. Central units CP-7004 support this parameter in all sw versions.

CTS signal detection setup

When setting the CTS signal detection, you can see the following on the display, for example:

CTS2-on

CTS - CTS signal detection setup
2 - number of the channel being set up
on - detection is on

The CTS signal detection can be either off or on. By pressing the SET button we can change the setting, by pressing the MODE button we save the set up value and you can set up the next parameter. During the CTS signal detection on, the central unit tests the CTS signal state before transmitting the response after setting up the RTS signal. The response is transmitted 10 ms after the CTS signal has the same value as the RTS signal. This mode is useful for the communication through modems. Also at this mode, the response set up value is valid, so it is ensured that the central unit does not response earlier, even if the CTS signal is already set up.

With the CTS signal detection switched off, the central unit controls the RTS signal, but it does not take the CTS signal state in account. The CTS signal detection is set for the modes **PC** and **MDB**.

Parity mode setup

When setting the parity mode, you can see the following on the display, for example:

PAR2-on

PAR - parity mode setup
2 - number of the channel being set up
on - parity on

The parity can be either off or on. With the parity on, we always talk about the even parity. By pressing the SET button we can change the setting, by pressing the MODE button you can save the value and you can set up the next parameter.

Standardly, the parity is on. We switch it off only in the most urgent cases, when we need to communicate via modems that do not transmit the parity (in this case, the transmission without parity must be supported by the superior system, too). Switching the parity off reduces the security of data being transmitted (you can find more details in the manual Serial communication of PLC TECOMAT - 32 bit model (TXV 004 03.01). The parity mode is set for the modes **PC** and **MDB**.

Ethernet ETH1 interface IP address setup

When setting the Ethernet ETH1 interface IP address, you can see the following on the display, for example:

IP1-135

IP - IP address setup
1 - the order of the address part being set up
135 - set up part of the address

The IP address has the format of n.n.n.n, where n can assume values 0 to 255. Thus, the IP address is set up as a tetrad of parameters IP1 to IP4. By short pressing of the SET button, its value will be increased by one, by long pressing the SET button (approx. 1 second), its value will be increased by 10. By pressing the MODE button you can save the value and you can set up the next parameter.

Ethernet ETH1 interface IP mask setup

When setting the Ethernet ETH1 interface IP mask, you can see the following on the display, for example:

IM1-255

IM - IP mask setup
1 - order of the address part being set up
255 - set up part of the address

The IP mask has the format of n.n.n.n, where n assumes values 0 to 255. The IP mask is thus set as a tetrad of parameters IM1 to IM4. By short pressing of the SET button, its value will be increased by one, by long pressing the SET button (approx. 1 second), its value will be increased by 10. By pressing the MODE button you can save the value and you can set up the next parameter.

Ethernet ETH1 interface gateway IP address setup

Při nastavování IP adresy gateway rozhraní Ethernet ETH1 se na displeji zobrazuje např.:

At IP address gateway set up ethernet ETH1 interface display shows for example:

GW1-135

GW - nastavení IP adresy gateway
1 - pořadí nastavované části adresy
135 - nastavená část adresy

GW – set up gateway IP address
1 – sequence of address part being set up
135 – set up part of address

IP adresa má tvar n.n.n.n, kde n nabývá hodnot 0 až 255. IP adresa se tedy nastavuje jako čtveřice parametrů IP1 až IP4. Krátkým stiskem tlačítka SET zvýšíme hodnotu o 1, dlouhým stiskem tlačítka SET (asi 1 s) zvýšíme hodnotu o 10. Stiskem tlačítka MODE uložíme nastavenou hodnotu a přejdeme na nastavení dalšího parametru.

IP address form is n.n.n.n, where n gains values 0 to 255. IP address therefore sets up as four parameters IP1 to IP4. When SET button is shortly pressed value will increase by

1. When SET button is pressed a bit longer (about 1 s) value will increase by 10. When MODE button is pressed the set value is saved and we continue in further parameter set up.

Switching on the EEPROM backup user memory

When setting the EEPROM user memory, you can see the following on the display, for example:

EP-off

EP - EEPROM user memory setup
off - EEPROM memory off

The EEPROM memory can be either off or on. By pressing the SET button we can change the setting, by pressing the MODE button we save the set up value and we can change the next parameter. In all central units, the Flash EEPROM memory is standardly used.

Parameter setup via serial line

The information on setup of all parameters of the central unit is available at the MOSAIC development environment. Moreover, the central units allow downloading of the parameters directly from the MOSAIC environment, so time-consuming setup by means of keys is not necessary.

2.4. SYSTEM COMMUNICATION MODULES

System communication modules allow expanding of the central unit by several further functions, especially communication ones. More details on serial communications and their applications can be found in the separate manual Serial communication of PLC TECOMAT - 32 bit model (TXV 004 03.01)

Table 2.14 Overview of system communication modules with order numbers

Module type	Modification	Order number
SC-7101	System communication module	TXN 171 01*
SC-7102	System communication module	TXN 171 02*

* The plug-in submodules of the serial interfaces MR-01xx must be ordered separately.

By means of the system communication modules SC-7101 and SC-7102, the central units can be expanded by another communication interface, which automatically become part of the central unit. The communication parameters are set at the MOSAIC development environment within the project.

System communication modules must be always fitted in the same rack as the central unit is, primarily into the positions by the central unit. In the rack fitted with the CP-7001 central unit, only one system communication module SC-7101 or SC-7102 can be fitted. In the rack fitted with the CP-7002 or CP-7003 or CP-7004 or CP-7005 central unit, up to four system communication modules can be installed, one of them can be SC-7102, the other must be SC-7101. Pokud je v rámu osazen systémový expander SE-7131, který zabírá kanály CH9 a CH10, pak mohou být systémové komunikační moduly pouze tři.

Až čtyři systémové komunikační moduly SC-7101 mohou být obsluhovány i slave expanderem SE-7132. Musí být osazeny vždy ve stejném rámu, jako slave expander, nejlépe do pozic vedle něj.

In case system expander SE-7131 that occupies channels CH9 and CH10 is fixed in the frame then there can be only three system communication modules.

Up to four system communication modules SC-7101 can be served by slave expander SE-7132. They allways must be fixed in the same frame as slave expander in positions beside it at the best.

2.4.1. System communication modules SC-7101, SC-7102

The SC-7101 module (table 2.17, fig. 2.17) is positioned in a case 30 mm wide and has 2 serial channels with optional interfaces, the interfaces of both serial channels are changeable by means of submodules (RS-232, RS-485, RS-422).

The SC-7102 module (table 2.17, fig. 2.17) is placed in a 30 mm wide case and contains the 10 Mb Ethernet interface and 2 serial channels with optional interfaces, the interfaces of both serial channels are changeable by means of submodules (RS-232, RS-485, RS-422).

The connection of serial channels is done by screwless terminals, max. 1.0 mm^2 of conductor per a terminal. Detailed information, including signal assignment can be found in chapter 2.6.

Table 2.17 System communication modules parameters

Module type	SC-7101	SC-7102
Number of serial channels*	2	2
Interface Ethernet 10 Mb	-	1
Case dimensions	137 x 30 x 198 mm	137 x 30 x 198 mm
Consumption from internal source max.	3,6 W	3,6 W

* Serial interfaces are optional by means of plug-in modules MR-01xx for RS-232, RS-485 and RS-422.

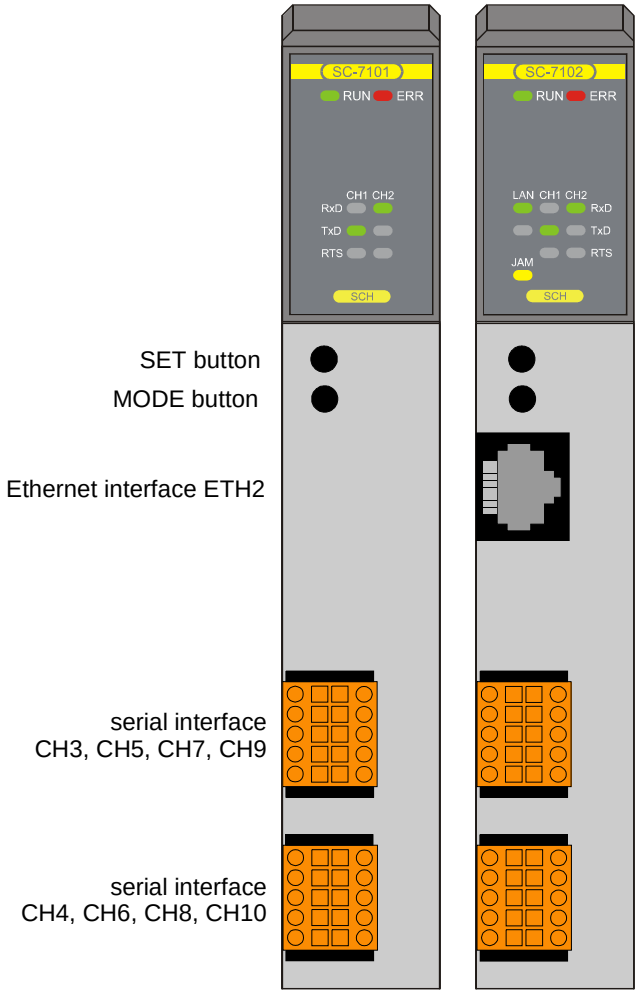


Fig. 2.17 Front panel of the SC-7101, SC.7102 system communication modules after opening the door

2.4.2 Indication of communication modules

At the top part of the front plate there are indication LEDs (fig. 2.18, table 2.18).

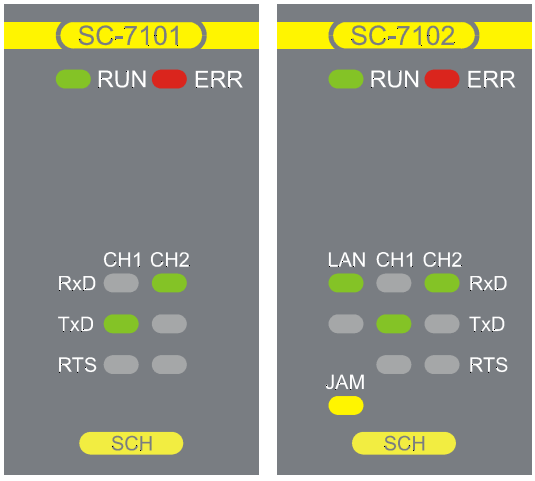


Fig. 2.18 Detail of indication of system communication modules

Table 2.18 List of functions of indication LEDs of the communication modules

Name	Colour	Behav.	Function
RUN	green	lighting	communication module is working, it is not operated by the user program (HALT mode)
		flashing	communication module is working, it is operated by the user program (RUN mode)
ERR	red	lighting	signalization of error reported by the central unit
LAN			signalization of the Ethernet ETH2 interface
RxD	green	lighting	data receiving
TxD	green	lighting	data transmission
JAM	yellow	lighting	network collision state (does not mean a failure, but the more frequent this state is, the more the network is loaded)
CH1, CH2			signalization of serial interfaces CHx
RxD	green	lighting	data receiving
TxD	green	lighting	data transmission
RTS	green	lighting	RTS signal state

2.4.3 Data obtained from communication modules

System communication modules provide data connected with serial communication (interface ETH2, CH3 to CH10). More details can be found in the manual Serial communication of PLC TECOMAT - 32 bit model (TXV 004 03.01)

2.4.4. Location of plug-in modules

The MR-01xx optional submodules of the serial interface are in the SC-7101 and SC-7102 communication modules fitted into the positions marked on fig. 2.19.

When fitting or replacing a submodule with serial channels interfaces, it is necessary to loosen the door catch and take out the door on the right side of the case. After taking off the door, you can access the plug-in modules.

ATTENTION!	**The modules contain parts sensitive to static charge, therefore, it is necessary to follow the safety rules when working with these circuits! When replacing submodules check the correctness of fitting of the submodule female headers against the tips of the motherboard. The female headers do not have any position coding and when incorrectly fitted, the submodule and/or motherboard can be damaged after switching power supply on!!!**

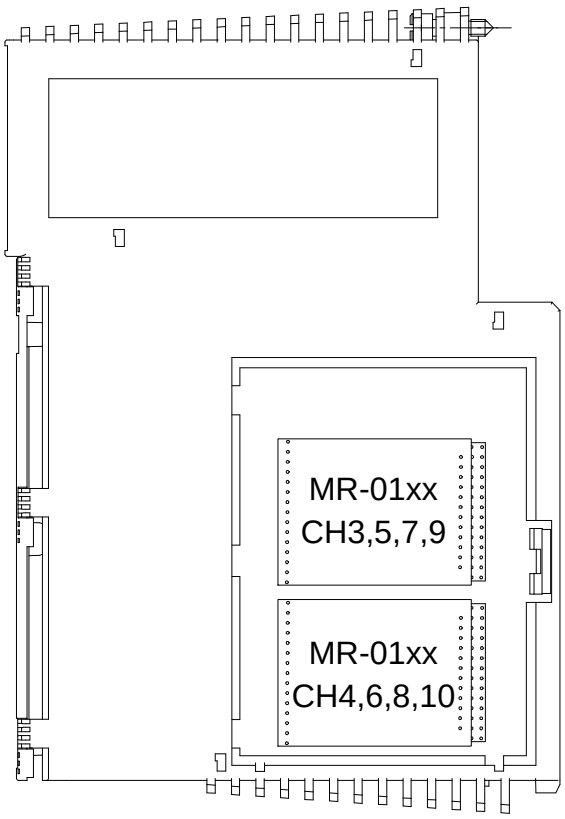


Fig. 2.19 Location of plug-in modules of serial interface in communication modules SC-7101 and SC-7102 after opening the door on the case side

2.5. SYSTEM EXPANDERS

Systémové expandery umožňují připojení vzdálených periferních rámů. K centrální jednotce se osazuje master expander SE-7131. Ten je propojen přes rozhraní Ethernet se slave expanderem SE-7132. Slave expander obsluhuje až čtyři rámy RM-7942, které jsou v centrální jednotce přístupné pod adresami 4, 5, 6 a 7.

Tab.2.19 Přehled systémových expanderů s objednacími čísly

Typ modulu	Modifikace	Objednací číslo
SE-7131	systémový expander - master	TXN 171 31
SE-7132	systémový expander - slave	TXN 171 32

2.5.1. System expanders SE-7131 and SE-7132

Systémové expandery SE-7131 a SE-7132 (tab.2.20, obr.2.20) jsou uloženy v pouzdře šířky 30 mm a obsahují rozhraní Ethernet, které je vyvedeno konektorem RJ-45. Sériové kanály nejsou pro uživatele dostupné a slouží pouze pro servisní účely.

Oba expandery master a slave jsou propojeny přes rozhraní Ethernet. Linka mezi oběma expandery nesmí být propojena do jiné sítě, protože její kapacita je plně využita.

Systémový expander master SE-7131 musí být osazen vždy ve stejném rámu jako centrální jednotka. Obsazuje sériové kanály CH9 a CH10. Tyto kanály tedy není možno použít pro komunikační modul SC-710x.

Pro systémový expander slave SE-7132 platí stejná pravidla jako pro centrální jednotku co se týče osazování v rámu. Expander může obsluhovat až čtyři systémové komunikační moduly SC-7101. Tyto sériové kanály jsou označeny jako CH43, CH44, ... CH49, CH4A.

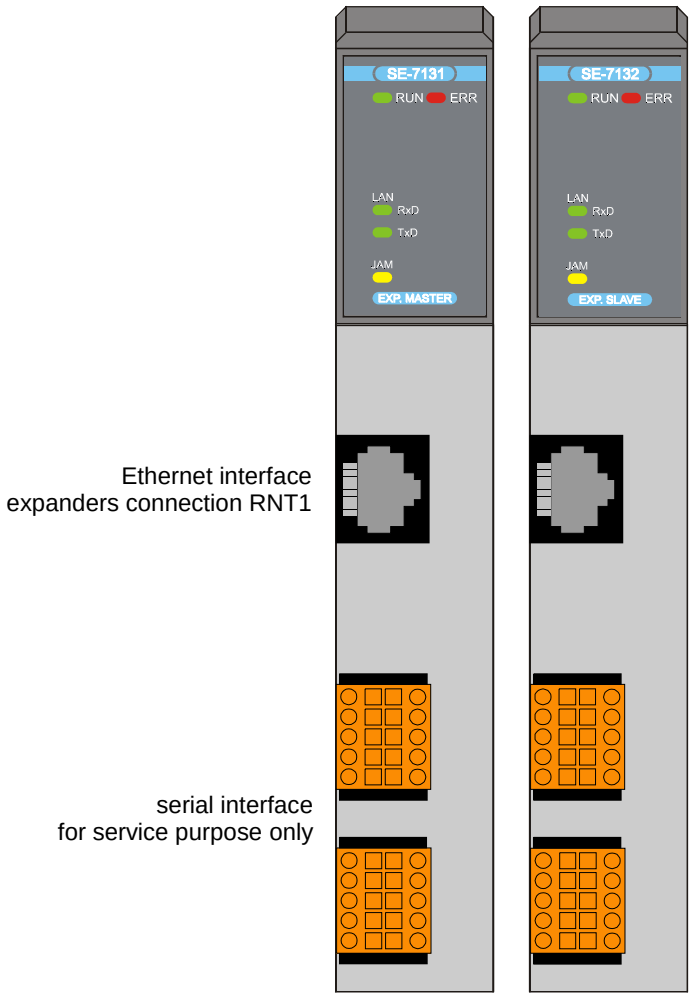


Fig.2.20 Front panel of the SE-7131, SE.7132 system expanders after opening the door

Systémové expandery podporují redundanci. Vzdálené periferní rámy jsou pak řízeny dvojicí slave expanderů, kde každý je propojen s jednou větví redundantního systému. Tímto způsobem se realizuje společný periferní systém pro redundantní centrální jednotky. Podrobnosti jsou uvedeny v chapter 3.3.2.

Table 2.20 System expanders parameters

Typ modulu	**SE-7131**	**SE-7132**
Expander type	master	slave
Redundancy support	yes	yes
Binary inputs and outputs typ.	-	1920
Number of serial channels *	-	0 (+ 8)
Interface Ethernet	1 for connection with SE-7132	1 for connection with SE-7131
Case dimensions	137 x 30 x 198 mm	137 x 30 x 198 mm
Consumption from internal source max.	3,6 W	3,6 W

* Včetně systémových komunikačních modulů SC-7101 obsluhovaných expanderem.

2.5.2 Indication of system expanders

At the top part of the front plate there are indication LEDs (fig. 2.21, table 2.21).

Fig.2.21 Detail of indication of system expanders

Table 2.21 List of functions of indication LEDs of the system expanders

název	barva	chování	funkce
RUN	green	lighting	expander is working, it is not operated by the user program (HALT, STB modes)
		flashing	expander is working, it is operated by the user program (RUN mode)
ERR	red	lighting	signalization of critical error
LAN RxD TxD JAM	 green green yellow	 lighting lighting lighting	signalization of the Ethernet interface data receiving data transmission network collision state (výměna dat je bezkolizní, neměl by nastat)

2.5.3 Data obtained from system expanders

System expanders provide no own data.

2.6. COMMUNICATION INTERFACE

2.6.1. Serial interface plug-in submodules

The serial channels on the central units and communication modules are necessary to be fitted with plug-in submodules of the serial interfaces. The submodules are equipped with identification codes that can be read at the MOSAIC development environment. So, we can find out fitting of the central unit as well as the communication modules with these submodules. If a mode is set on the serial channel, which is not supported by the plug-in module (see table 2.22), the serial channel is switched off (**OFF** mode).

Table.2.22 Order numbers of plug-in submodules

Typ	Modifikace	Ord. No.	Supported modes

MR-0104 MR-0114 MR-0124	RS-232 interface with galvanic isolation RS-485 interface with galvanic isolation RS-422 interface with galvanic isolation	TXN 101 04 TXN 101 14 TXN 101 24	PC, PLC, MPC, UNI, MDB, PFB
MR-0151	CAN controller (I82527)	TXN 101 51	CAN, CAS, CAB
MR-0152	PROFIBUS DP slave station	TXN 101 52	DPS
MR-0154	TC700 peripheral modules connection	TXN 101 54	EIO
MR-0155 MR-0156	FSK modem a rozbočovač FSK modem, rozbočovač a průběžný zesilovač	TXN 101 55 TXN 101 56	UNI
MR-0157	TC700 peripheral modules connection	TXN 101 57	EIO
MR-0158	M-Bus interface	TXN 101 58	UNI
MR-0160 MR-0161	two CAN controllers (SJA1000) CAN controller (SJA1000)	TXN 101 60 TXN 101 61	CSJ

Poznámka: Submoduly MR-0104, MR-0114 a MR-0124 plně nahrazují starší typy MR-0102, MR-0112 a MR-0122. Rozmístění signálů u jednotlivých rozhraní zůstává shodné.

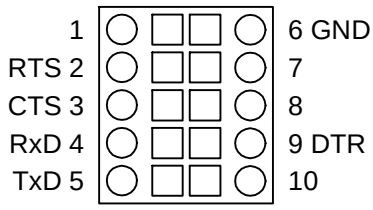
2.6.1.1. Interface RS-232

The MR-0104 submodule ensures the transfer of the TTL signals of the serial interface to the RS-232 interface, including galvanic isolation. This interface is designated only for interconnection of two participants, it cannot be used for the network (an exception is for example connection of ID-0x panels at the slave mode). It is suitable for example for the connection of the TECOMAT PLC and PC for short distances. The interconnection is done by the KB-0209 cable (order number TXN 102 09), terminated on the PC side by means of a nine-pole terminal Dsub.

Table 2.23 Technical specification of MR-0104 submodule

Galvanic isolation	yes
Galvanic isolation insulation voltage	1000 VDC
Max. transmission rate	200 kBd
Receiver input resistance	min. 7 kΩ
Output signal level	typ. ± 8 V
Max. length of transmission line	15 m

Table 2.24 Connection of serial channel connector with fitted MR-0104 submodule



RTS	request to send (for modem, adapter)
CTS	modem ready to send
RxD	received data
TxD	transmitted data
GND	signal ground
DTR	data ready for communication (steadily +5V)

2.6.1.2. Interface RS-485

The MR-0114 submodule ensures the transfer of the TTL signals of the serial interface to the RS-485 interface galvanically isolated. This type of interface is used to connect several participants through one line and for creation of communication networks.

For correct functioning, it is necessary to have correct termination of the communication line. This is done by interconnecting of TxRx+ with BT+ and TxRx– with BT– terminals.

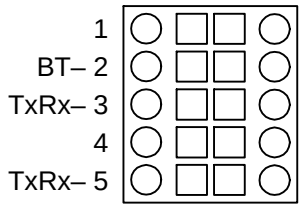
The galvanic isolation of the serial interface ensures the built-in converter and external power supply does not have to be used.

Table 2.25 Technical specification of MR-0114 submodule

Galvanic isolation	yes
Galvanic isolation insulation voltage	1000 VDC
Max. transmission rate	2 MBd
Receiver sensitivity	min. ± 200 mV
Output signal level	typ. 3.7 V
Max. length of transmission line	1200 m*

* Maximum length is valid for shielded twisted pair cable and transmission rate max. 120 kBd.

Table 2.26 Connection of serial channel connector with fitted MR-0114 submodule



BT–	– output of line termination RS-485
TxRx–	received and sent data (level –)
GND	signal ground
BT+	+ output of line termination RS-485
TxRx+	received and sent data (level +)

2.6.1.3. Interface RS-422

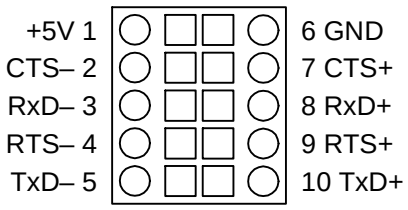
The MR-0124 submodule ensures the transfer of the TTL signals of the serial interface to the RS-422 interface galvanically isolated. The interface allows connecting of two cooperating devices, thus it cannot be used for networks (an exception is for example connection of two panels of ID-0x series).

Table 2.27 Technical specification of MR-0124 submodule

Galvanic isolation	yes
Galvanic isolation insulation voltage	1000 VDC
Max. transmission rate	2 MBd
Receiver sensitivity	min. ± 200 mV
Output signal level	typ. 3.7 V
Max. length of transmission line	1200 m*

* Maximum length is valid for shielded twisted pair cable and transmission rate max. 120 kBd.

Table 2.28 Connection of serial channel connector with fitted MR-0124 submodule



+5V	power supply output +5V
CTS–	modem ready to send (level –)
RxD–	received data (level –)
RTS–	request to send (level –)
TxD–	transmitted data (level –)
GND	signal ground
CTS+	modem ready to send (level +)
RxD+	received data (level +)
RTS+	request to send (level +)
TxD+	transmitted data (level +)

2.6.1.4. Connection of TC700 in the CAN bus

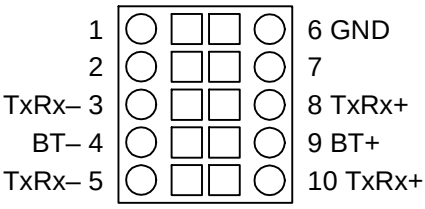
Submodule MR-0151 with I82527 controller allows connecting of PLC TECOMAT TC700 to the CAN bus with a transmission rate 500, 250, 125, 50, 20 or 10 kBd. It can be used in the **CAN**, **CAS**, **CAB** modes only.

Submodule MR-0151 is supported by the CP-7001, CP-7002, CP-7003 central units from sw version 2.7. This submodule isn‘t supported by the CP-7004 central unit.

Submodules MR-0160 with two SJA1000 controllers and MR-0161 with one SJA1000 controller allow connecting of PLC TECOMAT TC700 to the CAN bus with a transmission rate 1 MBd, 500, 250, 125, 50 or 20 kBd. It can be used in the **CSJ** mode only.

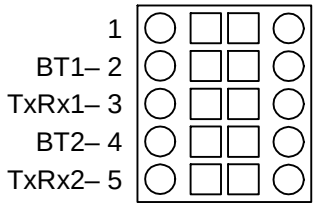
Submodules MR-0160 and MR-0161 are supported by the CP-7001, CP-7002, CP-7003 central units from sw version 5.4 and by CP-7004 central unit from sw version 3.0.

Table 2.29 Serial channel connector connection with fitted submodule MR-0151 or MR-0161



BT–	– output of CAN line termination
TxRx–	received and sent data (level –)
GND	signal ground
BT+	+ output of CAN line termination
TxRx+	received and sent data (level +)

Table 2.30 Serial channel connector connection with fitted submodule MR-0160

	BTn– TxRxn– GND BTn+ TxRxn+	– output of CANn line termination received and sent data (level –) on n line signal ground + output of CANn line termination received and sent data (level +) on n line

2.6.1.5. Connection of TC700 to the PROFIBUS DP network

Submodule MR-0152 allows connecting of PLC TECOMAT TC700 to the PROFIBUS DP network as a slave station with a transmission rate of up to 12 MBd. It can be used in the **DPS** mode only.

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 with the connection when fitting the MR-0114 submodule (see table 2.26), including termination possibility. Je třeba mít na paměti, že linka A sběrnice PROFIBUS má úroveň – (TxRx–) a linka B má úroveň + (TxRx+).

Submodule MR-0152 is supported by the CP-7001, CP-7002, CP-7003 central units from sw version 5.0. The hw version has to be 02.

The CP-7004 central unit supports submodule MR-0152 from sw version 3.0.

2.6.1.6. Connection of TC700 peripheral modules in EIO mode

The MR-0154 submodule allows connecting of another 64 peripheral modules. It can be used only with the CP-7002 and CP-7003 central units on the CH2 channel at the **EIO** mode. When the MR-0154 submodule is fitted, the **EIO** mode is set automatically at channel CH2 by central unit.

The MR-0154 submodule is supported by CP-7002 and CP-7003 central unit at channel CH2 since sw version 2.5.

Centrální jednotka CP-7004 používá k témuž účelu submodul MR-0157.

Since the physical interface of the bus corresponds to the RS-485 standard, the connection of the connector of the serial channel is identical with the connection when fitting the MR-0114 submodule (see table 2.26), including termination. Since the central unit will be usually connected at the end of the line, **we must not forget about bus termination!**

2.6.1.7. Connection of redundancy control panel ID-20

Připojení ovládacího panelu redundance ID-20 k centrální jednotce CP-7005 se provádí pomocí submodulu PX-7812 osazeného do pozice CH2 (rozhraní RCP1). Jedná se o galvanicky oddělené paralelní rozhraní pracující s napětím 24 V DC. Panel se připojuje kabelem KB-0213. Podrobnější údaje jsou uvedeny v chapter 3.3.2.

2.6.1.8. FSK modem

Submoduly MR-0155 a MR-0156 obsahují modem FSK (frequency shift keying - binární frekvenční modulace) s frekvenční modulací v pásmu nízkofrekvenčních signálů odpovída-

jící doporučením CCITT. Dále obsahují slučovací zařízení, které umožňuje sloučení více vysílaných signálů (kanálů) na jedno vedení, a rozbočovací zařízení, které umožňuje rozvedení přijímaných signálů (kanálů) z jednoho vedení na více modemů. Submodul MR-0156 navíc obsahuje průběžný zesilovač.

Pro přenos pomocí tohoto modemu se hodí všechny nízkofrekvenční telefonní spoje vedené kabely uloženými v zemi nebo vedenými vzduchem tak jako spoje TF- a PCM-provedené kabelem a radiově.

Systém může být nasazen v různých konfiguracích pro duplexní provoz ve čtyřvodičovém nebo dvouvodičovém provedení.

Podstatné funkce modemu FSK (oscilátory, směšovače, filtry, modulátory, detektory) jsou realizovány digitálně jako softwarové moduly signálového procesoru a jsou tedy nezávislé na teplotě a stárnutí. Veškeré cejchování analogových spojovacích okruhů odpadá. Všechny filtry jsou realizovány jako lineárně fázové filtry a mají tedy minimální vlastní zkreslení, což minimalizuje pravděpodobnosti chyb. Odstup více než 70 dB pro rušivé vysílané spektrum zaručuje vysokou spektrální čistotu vysílaného signálu. Průběžnou regulací úrovně příjmu je provedeno přizpůsobení na přijímanou úroveň, čímž je dosaženo vysoké selektivity.

Pomocí propojek může být měněn práh detekce, což umožňuje použití vedení s nízkou kvalitou při zřetelném snížení pravděpodobnosti chyb.

Celková systémová konfigurace (rychlost komunikace, vysílací kanál, přijímací kanál, nastavení logické úrovně, práh detekce, druh provozu, nastavení zesílení) je dána pozicemi konfiguračních propojek.

Po jednom vedení v nf pásmu je možné realizovat podle zvolené přenosové rychlosti více přenosových kanálů. Jejich frekvenční poměry jsou uvedeny v tab.2.31.

Tab.2.31 Frekvenční poměry a technické parametry submodulů MR-0155 a MR-0156

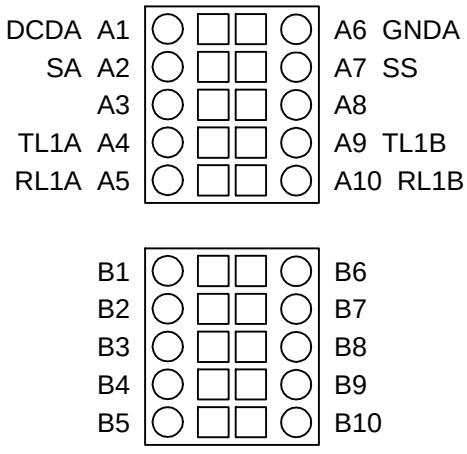
Rychlostní skupina	50 Bd	100 Bd	200 Bd	600 Bd	1200 Bd
Počet kanálů ve frekv. pásmu 300 až 3400 Hz	24	12	6	2	1
Odstup stř. frekv. kanálu	120 Hz	240 Hz	480 Hz	1440 Hz	-
Frekvenční zdvih	±30 Hz	±60 Hz	±120 Hz	±210 Hz	±400 Hz
Min. střední frekv. kanálu	420 Hz	480 Hz	600 Hz	1320 Hz	1700 Hz
Max. střední frekv. kanálu	3180 Hz	3120 Hz	3000 Hz	2760 Hz	1700 Hz
Max. odchylka frekvence	0,2 Hz	0,2 Hz	0,2 Hz	0,2 Hz	0,2 Hz
Vysílací úroveň jmen. / kanál P_s	–19,8 dBm	–16,8 dBm	–13,8 dBm	–9 dBm	–6 dBm
Vysílací úroveň	(0) –6 …. –18 dBm				
Max. rozdíl úrovně nejnižší / nejvyšší kanál	±0,3 dB	±0,3 dB	±0,3 dB	±0,3 dB	±0,3 dB
Min. přijímací úroveň vstupu AD-měnič P_{min}	–40 dBm	–38 dBm	–38 dBm	–34 dBm	–27 dBm
Stupně zesílení vstupu	0 / 6 / 10 / 14 / 26 dB				

Upozornění: Submoduly MR-0155 a MR-0156 obsazují pozice dvou sousedních sériových kanálů, přičemž vlastní komunikace probíhá po kanálu s nižším číslem. Kanál s vyšším číslem je nevyužit a zůstává vypnutý.

Zapojení konektorů je uvedeno v tab.2.32 (MR-0155) a tab.2.33 (MR-0156). Vysílací linka je připojena na svorky A4, A9, přijímací linka na svorky A5, A10. Svorky A2, A7 jsou určeny pro sčítání a rozbočení signálů z různých kanálů. Mezi svorkami A1 a A6 lze měřit signál indikující přítomnost dostatečné úrovně nosného signálu na přijímači modemu. Submodul MR-0156 má zabudovaný průběžný linkový zesilovač linkových signálů. Výstup zesíleného signálu je vyveden na svorky B4, B9. Vstup zesilovaného signálu se přivádí na svorky B5, B10.

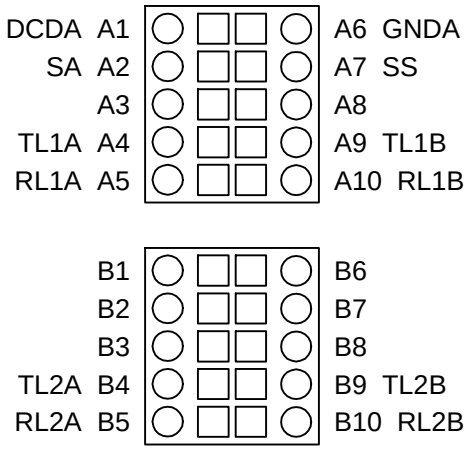
Konfigurace modemu FSK a nastavení propojek jsou popsány v dokumentaci dodávané s těmito submoduly (TXV 101 55.01).

Tab.2.32 Zapojení konektorů při osazeném submodulu MR-0155



DCDA	detekce nosné
SA	rozbočení signálů
TL1A	vysílaná data
RL1A	přijímaná data
GNDA	signálová zem
SS	sčítání signálů
TL1B	vysílaná data
RL1B	přijímaná data

Tab.2.33 Zapojení konektorů při osazeném submodulu MR-0156



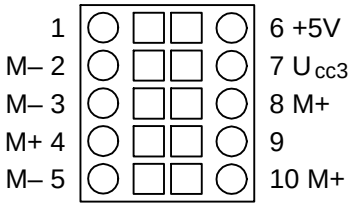
DCDA	detekce nosné
SA	rozbočení signálů
TL1A	vysílaná data (linka 1)
RL1A	přijímaná data (linka 1)
GNDA	signálová zem
SS	sčítání signálů
TL1B	vysílaná data (linka 1)
RL1B	přijímaná data (linka 1)
TL2A	vysílaná data (linka 2)
RL2A	přijímaná data (linka 2)
TL2B	vysílaná data (linka 2)
RL2B	přijímaná data (linka 2)

2.6.1.9. Connection of heat meters by M-Bus interface

Submodul MR-0158 umožňuje budit standardní M-Bus linku s šesti stanicemi slave (podřízenými). Napájecí napětí linky zajišťuje vnitřní zvyšující stabilizátor z oddělujícího měniče napájení strany TTL. Modulátor vysílače může být alternativně napájen vnějším napětím U_{cc3} (36 V / 50 mA), potom je možné připojit na linku až 20 stanic slave. Vyhodnocení proudu je dynamické, což umožňuje měnit počet připojených stanic bez jakékoli konfigurace.

Sériový kanál je nutné nastavit do režimu **UNI** a vlastní protokol realizovat uživatelským programem.

Tab.2.34 Zapojení konektoru sériového kanálu při osazeném submodulu MR-0158



+5V	výstup napájení +5V
M–	sběrnice M-Bus (úroveň –)
M+	sběrnice M-Bus (úroveň +)
U_{cc3}	vstup vnějšího napájení 36 V / 50 mA

2.6.2 Interface USB

For connection of the PC (programming, servicing) the central unit is always fitted with one USB interface according to the USB 2.0 specification. The USB interface allows connecting of two cooperating devices, it thus cannot be used for networks and it is designated for debugging, programming and servicing. The interface must not be used for permanent connection on the PC (for example for visualization of the technology being controlled). The USB interface is not galvanically isolated!

The connector on the central unit corresponds to the USB specification, "B"-device.

For connection of the PLC to the PC, the standard USB A-B cable can be used, with length of max. 5 m, twisted and shielded. The recommended KB-0208 cable is supplied under the order number TXN 102 08.

Table 2.35 Technical parameters of the USB interface

Maximum transmission rate	12 MBd
Maximum line length	5 m *

Galvanic isolation from PLC circuits	no

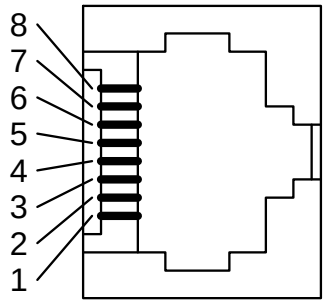
* The maximum length is valid for a twisted and shielded cable.

2.6.3 Interface Ethernet

The CP-7002, CP-7003, CP-7005 central units and the SC-7102 communication module are fitted with the Ethernet 10 Mbit interface. The CP-7004 central unit is fitted with the Ethernet 10 / 100 Mbit interface.

The Ethernet interface is fitted with the RJ-45 connector with standard signal assignment. The connector is ready to be used with common UTP patch cables.

Table 2.34 Ethernet interface connection (front view of the connector on PLC)



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

2.7. PERIPHERAL MODULES

All the peripheral modules are connected to the central units by means of a serial bus formed within one rack by a system of connectors interconnected by a printed circuit. The signal conductors have resistance dividers to reduce impedance of the line and to increase interference resistance. Individual peripheral modules are described in the documentation for each module. The latest list of the documentation for the peripheral modules is given in the catalogue of the TECOMAT TC700 PLC series.

2.8. MECHANICAL DESIGN

All the modules of the TECOMAT TC700 unit have a plastic protective case 30 mm or 60 mm wide.

Fixing the module in the rack

Fixing of the module in the rack is easy to do and is done by means of a screw at the top part of the case. When fixing the module in the rack, first put the module with the two teeth at the bottom part of the case into the openings at the bottom edge of the metal rack at required position, then press down the module by swinging movement onto the bus connector and secure it by the screw at the top side of the case. When loosing the module in the rack, loosen the screw at the top part of the case and by swinging movement tilt the module from the rack to you and take it our from the rack carefully.

Dismantling the case

The case can be dismantled only in reasoned situations, during dismantling the following instructions have to be observed:

- Take the module out of the rack.
- Open the front door.
- Press the door catch by the finger from inside under the indication and loosen the first lock of the left lid of the case cover.
- Put the case on the table, with the left lid up.
- Insert a flat screwdriver from top between the 2nd and the 3rd rib at the top of the case, where the bevelled catch is.
- Incline the screwdriver by approx. 60 degrees in the direction of the catch to loosen it.
- Insert the screwdriver from top between the 18th and 19th rib, where the bevelled catch is.

- By inclining the screwdriver by approx. 60 degrees in the direction of the catch bevel you loosen the catch (reverse direction than it was for the first catch)
- Proceed similarly for the 2nd and 3rd rib and the 12th and 13th rob at the bottom part of the case.
- By turning the screwdriver in the gap of the back edge you loosen the cover of the case.
- After taking out the printed circuit board, the position of the submodule memory becomes accessible.

Reinstallation:

- Insert the printed circuit board into the case and check the position of the ground spring
- Put on the left cover of the case.
- By slight pressing in the positions where the catches are close the case.

ATTENTION!	**The modules contain parts sensitive to static charge, therefore, it is necessary to follow the safety rules when working with these circuits! Any handling must be done on the module taken out from the rack!**

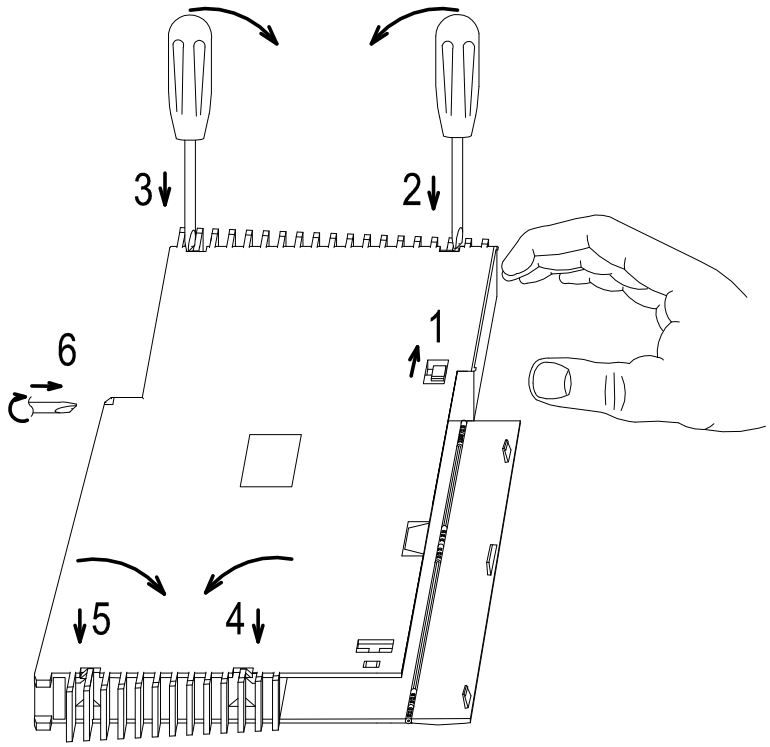


Fig. 2.22 Dismantling procedure for the module protective case

3. TRANSPORT, STORAGE AND INSTALLATION OF PLC

3.1. TRANSPORT AND STORAGE

The modules are packed according to internal packing instructions into cardboard boxes. Basic documentation is enclosed in the packaging. The external packaging is done according to the quantity and way of transportation into a shipping container being labelled and containing all the necessary data for transportation.

The goods is transported from the manufacture's facilities as agreed when placing an order. Transportation of the goods by the customer must be pursued by covered transport means and in the position as indicated on the packaging. The shipping container must be fixed in such a way to avoid accidental spontaneous movement and damage of the external container.

During transportation and storage, the product must not be exposed to direct influence of atmospheric actions. Transportation of the product is permitted within a temperature range of -25 ℃ to 70 ℃, relative humidity of 10 % to 95 % (without condensation).

The product must be stored only in clean spaces free from conductive dust, aggressive gases and vapours. The optimum storage temperature is 20 ℃. When storing the central unit for more than half a year, it is recommended to take out or isolate the battery to avoid its discharging.

3.2. PLC SUPPLY

Each component of the TECOMAT TC700 PLC is delivered in individual packagings. The assembly is carried out by the customer. On customer's request, the system can be assembled at our premises. System assembly is carried out according to the following chapter.

3.3. SYSTEM ASSEMBLY

3.3.1. Osazování rámů jednotlivými moduly

Assembly of individual modules

Connectors (slide in part) are usually packed separately. Should the module be fitted with optional submodules ordered separately (serial interfaces), then these submodules are also delivered in a separate packaging and the customer installs them according to the instructions in the documentation for these modules (central units - chapter 2.3.6., system communication modules - chapter 2.4.5.).

Principles of fitting the PLC with modules

When assembling the PLC or adding additional modules, it is necessary to observe the following instructions:

a) The power supply module is mounted on the left edge position of the rack, resp. na připojovací konektory sběrnice rámu (PW-7906, PW-7907)

b) If a second power supply module is used in the same rack, it is mounted in the position by the first power supply module.
c) The central unit is mounted in the position by the power supply module, if it is not mounted in this rack, the central unit is mounted in the left edge position of the rack.
d) Communication modules are mounted in the positions by the central unit
e) Peripheral modules are mounted in the remaining positions arbitrarily (if not specified otherwise in the documentation for the module in question).

Attention!	**Any physical handling with connecting cables between the rack can be carried out only with PLC power supply is off!**

Peripheral modules addressing

The addressing of the peripheral modules within one rack is carried out automatically by sliding in of the module in the position in the rack. Individual racks have to have the rack number set on the rotation switch under the interconnecting connectors, případně ještě na dalším přepínači číslo první pozice v rámu. The result address of the peripheral module consists of the position in the rack and the rack number.

The RM-7942 rack with 15 positions allows setting of a rack number 0, 1, 2 or 3. Its positions are numbered 0 to 14.

The RM-7941 rack with 8 positions allows setting of a rack number 0, 1, 2 or 3 in the blue or white field. To use the addresses fully, it is possible to set the same rack number of two RM-7941 racks, one in the blue field and one in the white field. The rack, the rack number switch of which is set into the blue field, has the positions numbered 0 to 7, the rack, the rack number switch of which is set in to the white field, has its positions numbered 8 to 15.

The RM-7946 rack with 4 positions allows setting of a rack number 0, 1, 2 or 3 and the first position address in the rack 0, 4, 8 or 12.

The RM-7944 rack with 2 positions allows setting of a rack number 0, 1, 2 or 3 and the first position address in the rack 0, 2, 4, 6, 8, 10, 12 or 14.

Při adresování rámů platí pravidlo, že rámy se stejným číslem nesmí obsazovat stejné pozice. Z toho plynou možné kombinace uvedené v tab.3.1.

Addressing of peripheral modules connected through the MR-0154 and MR-0157 submodules

The principles of the addressing of peripheral modules connected to the central unit through the MR-0154 or MR-0157 submodule are the same as described above. The only difference is that the central unit adds the value of 4 to the address of the rack set by the switch so that the racks will have the resultant addresses 4, 5, 6 and 7.

Addressing of peripheral modules connected through the expanders SE-7131 / SE-7132

The principles of the addressing of peripheral modules connected to the central unit through the expanders SE-7131 / SE-7132 are the same as described above. The only difference is that the central unit adds the value of 4 to the address of the rack set by the switch so that the racks will have the resultant addresses 4, 5, 6 and 7.

Table 3.1 Povolené kombinace rámů se stejným číslem rámu

	position of the rack															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	RM-7942															
2	RM-7941								RM-7941							
3	RM-7941								RM-7946				RM-7946			
4	RM-7941								RM-7946				RM-7944		RM-7944	
5	RM-7941								RM-7944		RM-7944		RM-7946			
6	RM-7941								RM-7944		RM-7944		RM-7944		RM-7944	
7	RM-7946				RM-7946				RM-7941							
8	RM-7946				RM-7946				RM-7946				RM-7946			
9	RM-7946				RM-7946				RM-7946				RM-7944		RM-7944	
10	RM-7946				RM-7946				RM-7944		RM-7944		RM-7946			
11	RM-7946				RM-7946				RM-7944		RM-7944		RM-7944		RM-7944	
12	RM-7946				RM-7944		RM-7944		RM-7941							
13	RM-7946				RM-7944		RM-7944		RM-7946				RM-7946			
14	RM-7946				RM-7944		RM-7944		RM-7946				RM-7944		RM-7944	
15	RM-7946				RM-7944		RM-7944		RM-7944		RM-7944		RM-7946			
16	RM-7946				RM-7944		RM-7944		RM-7944		RM-7944		RM-7944		RM-7944	
17	RM-7944		RM-7944		RM-7946				RM-7941							
18	RM-7944		RM-7944		RM-7946				RM-7946				RM-7946			
19	RM-7944		RM-7944		RM-7946				RM-7946				RM-7944		RM-7944	
20	RM-7944		RM-7944		RM-7946				RM-7944		RM-7944		RM-7946			
21	RM-7944		RM-7944		RM-7946				RM-7944		RM-7944		RM-7944		RM-7944	
22	RM-7944		RM-7944		RM-7944		RM-7944		RM-7941							
23	RM-7944		RM-7944		RM-7944		RM-7944		RM-7946				RM-7946			
24	RM-7944		RM-7944		RM-7944		RM-7944		RM-7946				RM-7944		RM-7944	
25	RM-7944		RM-7944		RM-7944		RM-7944		RM-7944		RM-7944		RM-7946			
26	RM-7944		RM-7944		RM-7944		RM-7944		RM-7944		RM-7944		RM-7944		RM-7944	

Pozn.: Kombinace uvedené v tabulce využívají vždy všechny dostupné pozice. Je samozřejmě možné využít menší počet pozic tak, že kterýkoli rám v uvedené kombinaci lze vynechat podle následujícího příkladu pro kombinaci č. 3:

	position of the rack															
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3	RM-7941								RM-7946				RM-7946			
3a	RM-7941								RM-7946				-			
3b	RM-7941								-				RM-7946			
3c	RM-7941								-				-			
3d	-								RM-7946				RM-7946			
3e	-								RM-7946				-			
3f	-								-				RM-7946			
3g	-								-				-			

3.3.2. Výstavba systému

3.3.2.1. Varianty konfigurace systému

Segment PLC

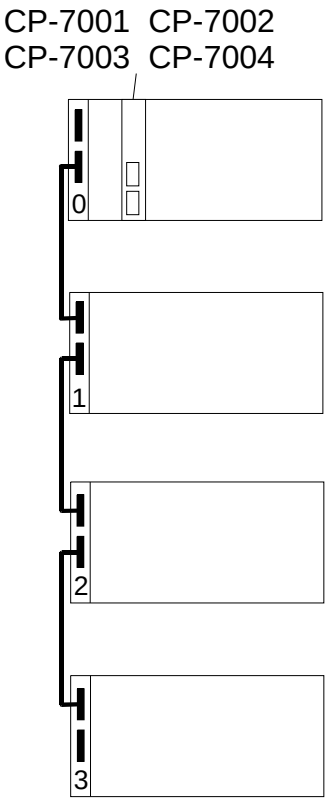
Pomocí sběrnicových kabelů lze navzájem propojit rámy s čísly 0 až 3 (například čtyři rámy RM-7942). Takto propojené rámy představují jeden segment. V jednom segmentu je k dispozici 64 pozic pro moduly.

Varianty konfigurace PLC

PLC TECOMAT TC700 lze vystavět do několika základních typů konfigurací s různými vlastnostmi.

- **základní sestava** (obr.3.1)

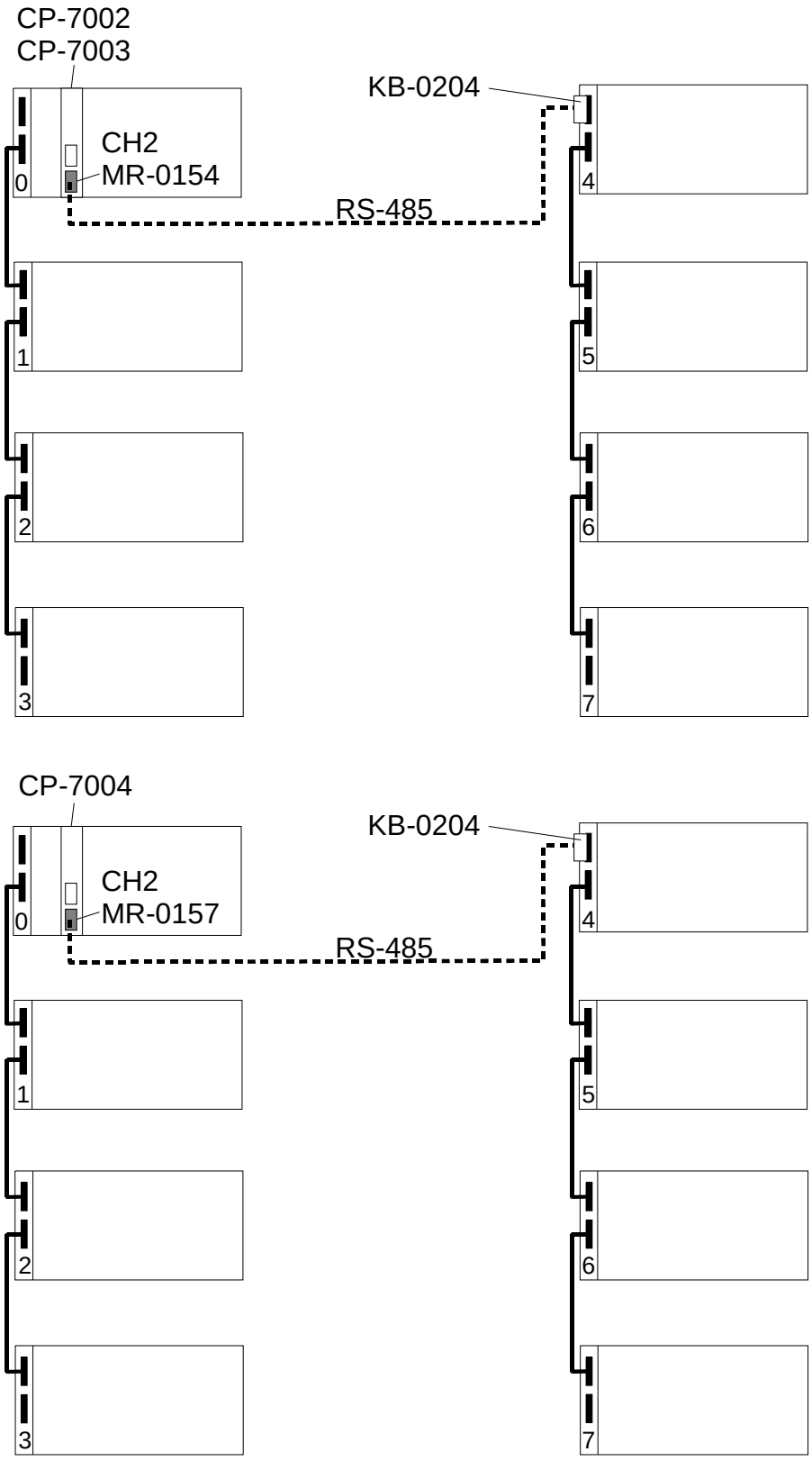
  Základní sestavu představují rámy s čísly 0 až 3 propojené sběrnicovými kabely. Jedná se tedy o jeden segment.
  Základní sestava má k dispozici 64 pozic pro moduly PLC. Tento typ konfigurace podporují centrální jednotky CP-7001, CP-7002, CP-7003 a CP-7004.



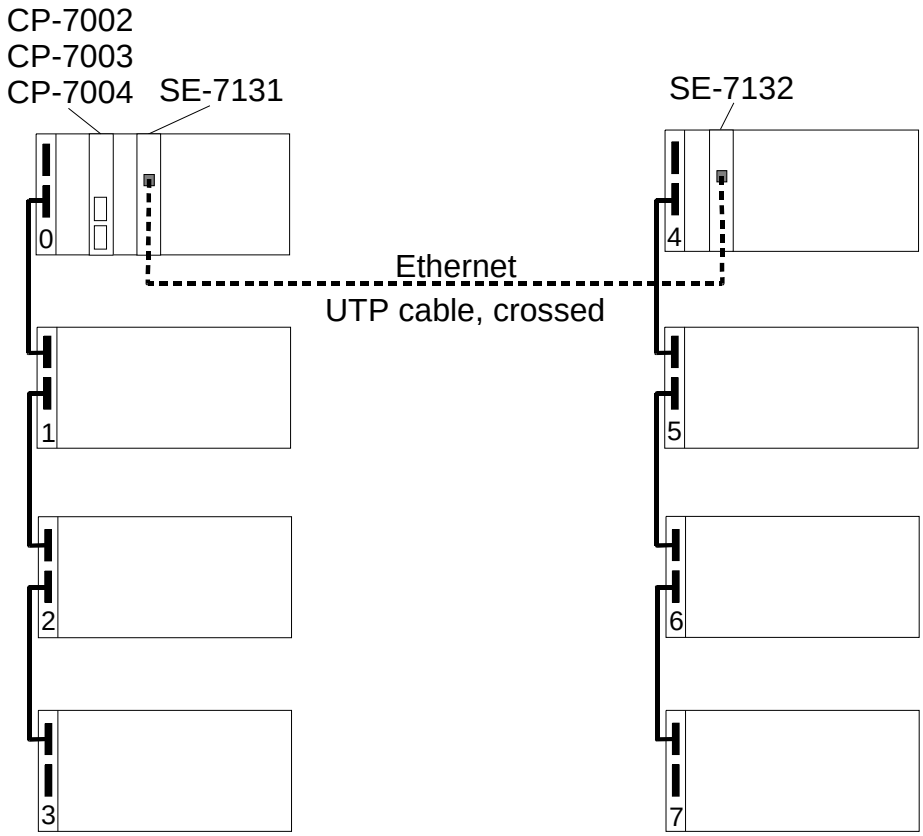
Obr.3.1 Základní sestava

- **rozšířená sestava** (obr.3.2, obr.3.3)

  Základní segment s rámy s čísly 0 až 3 propojenými sběrnicovými kabely je doplněn o další segment, který je připojen k centrální jednotce přes sériový kanál CH2 osazený submodulem MR-0154, resp. MR-0157 nebo pomocí expanderů SE-7131 a SE-7132. Rámy v druhém segmentu mají na přepínačích nastavena čísla 0 až 3, ale v centrální jednotce se objevují jako rámy čísel 4 až 7.
  Rozšířená sestava má k dispozici celkem 128 pozic pro moduly PLC. Tento typ konfigurace podporují centrální jednotky CP-7002, CP-7003 a CP-7004.



Obr.3.2 Rozšířená sestava se submodulem MR-0154 nebo MR-0157



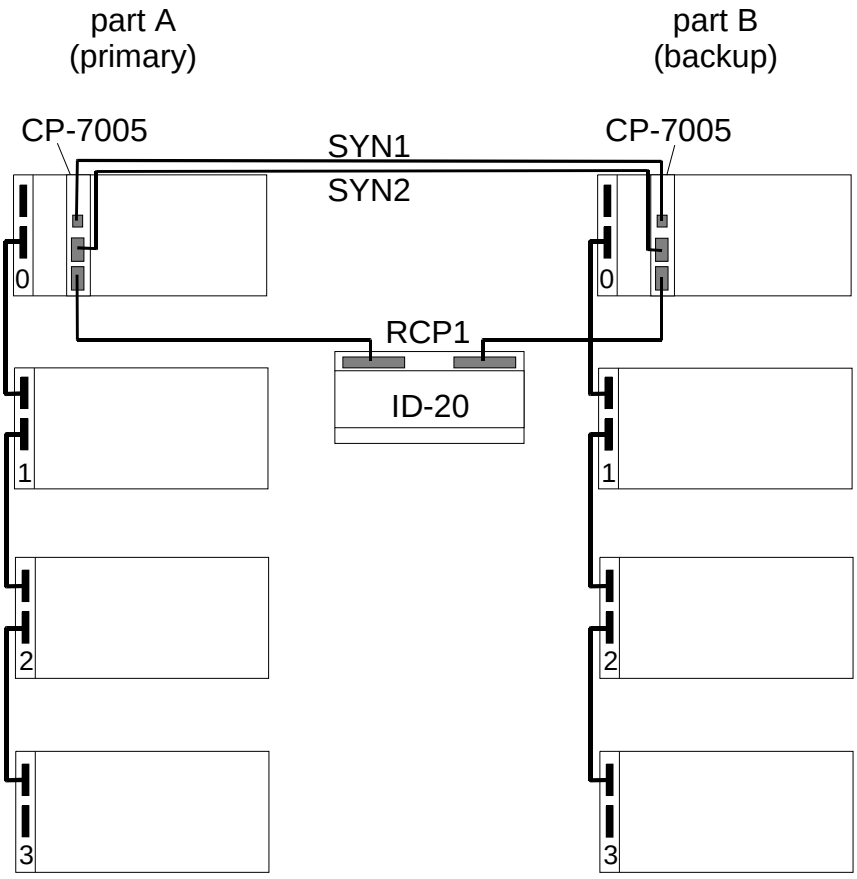
Obr.3.3 Rozšířená sestava s expandery SE-7131 a SE-7132

- **základní redundantní sestava** (obr.3.4)

  Základní redundantní sestavu představují dva systémy se zcela identickou základní sestavou rámů s čísly 0 až 3 propojených sběrnicovými kabely. Podstatou redundance je, že obě větve redundantního systému jsou zcela identické a navenek se tváří jako jeden PLC.

  Centrální jednotky jsou navzájem propojeny dvěma synchronizačními linkami a navíc jsou připojeny na řídicí panel redundance ID-20 (obr.3.6).

  Základní redundantní sestava má k dispozici 64 redundantních pozic pro moduly PLC. Tento typ konfigurace podporuje centrální jednotka CP-7005.



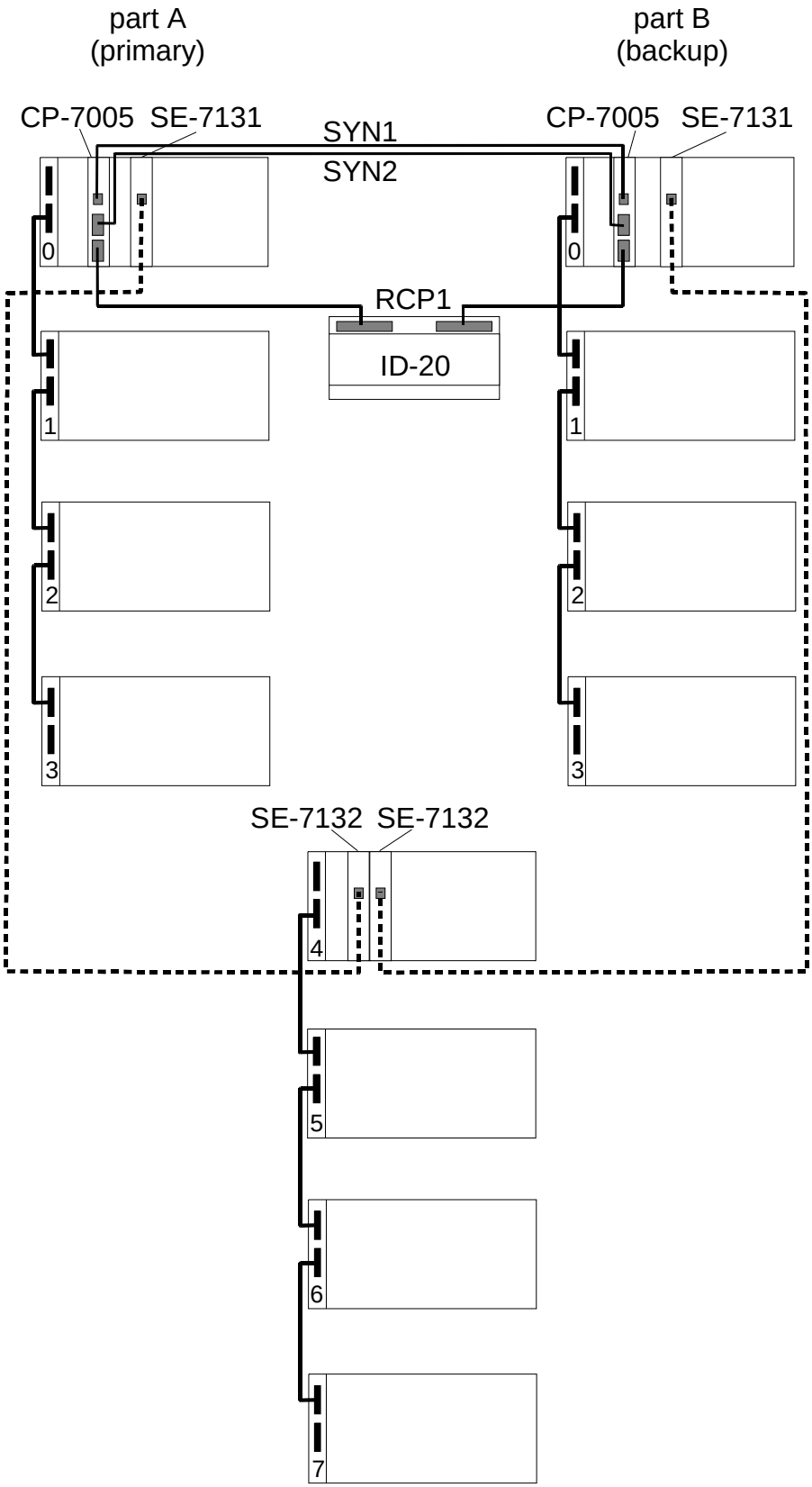
Obr.3.4 Základní redundantní sestava

- **redundantní sestava se společnými periferiemi** (obr.3.5)

  Základní redundantní sestava (dvě identické redundantní větve) je doplněna o další segment připojený k centrální jednotce pomocí expanderů SE-7131 a SE-7132. Rámy v tomto segmentu mají na přepínačích nastavena čísla 0 až 3, ale v centrální jednotce se objevují jako rámy čísel 4 až 7. Podstatným rozdílem oproti rámům 0 až 3 v redundantních segmentech je, že rámy 4 až 7 ve třetím segmentu nejsou redundantní, ale pomocí dvojice expanderů jsou ovládány z obou větví redundantního systému.

  Centrální jednotky jsou navzájem propojeny dvěma synchronizačními linkami a navíc jsou připojeny na řídicí panel redundance ID-20 (obr.3.6).

  Redundantní sestava se společnými periferiemi má k dispozici 64 redundantních + 64 neredundantních pozic pro moduly PLC. Tento typ konfigurace podporuje centrální jednotka CP-7005.



Obr.3.5 Redundantní sestava se společnými periferiemi

3.3.2.2. Řídicí panel redundance ID-20

Panel ID-20 je vestavný modul na DIN lištu určený pro řízení a indikaci režimu redundantního systému TC700 s centrálními jednotkami CP-7005. Panel je připojen k druhému sériovému kanálu CP-7005 (rozhraní RCP1) a ovládá napájení hlavního (primary) i záložního (backup) systému. Napájen je ze zdroje 24 V DC.

Panel je osazen pevnými svorkovnicemi a vyjímatelnými konektory A, B pro připojení centrální jednotky redundantního systému CP-7005. Napájení panelu se připojuje na svorkovnici M. Konektor A se připojí kabelem KB-0213 k rozhraní RCP1 CP-7005 (PLC A) a konektor B k rozhraní RCP1 CP-7005 (PLC B). Ovládání napájení hlavního a záložního PLC ovládají zdvojené rozpínací reléové kontakty (svorkovnice S pro PLC A, svorkovnice T pro PLC B). Zapojení konektorů a základní příklad zapojení je na obr.3.6.

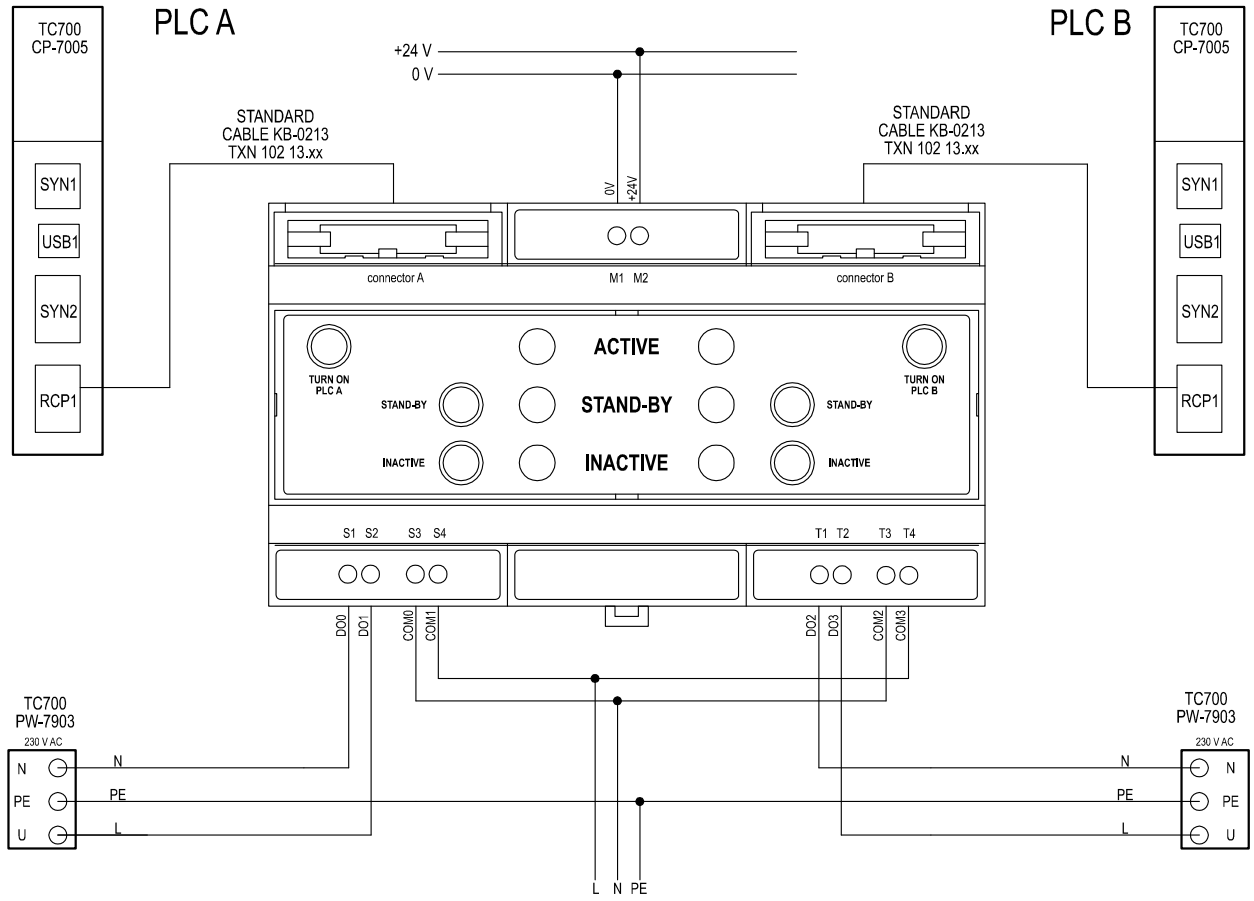


Fig.3.6 Connection of connectors of redundancy control panel ID-20

DOx break-type contact of output x
COMx second contact of output x
+ 24 V plus pole for the connection of internal circuits power supply of the panel and circuits of the connected interface RCP1 CP-7005
0 V minus pole for the connection of internal circuits power supply of the panel and circuits of the connected interface RCP1 CP-7005

Kabel KB-0213 (obr.3.7, tab.3.2, tab.3.3) je obecný kabel, který musíme pro připojení k panelu ID-20 upravit. Sejmeme dvouřadý konektor 20 pin a místo něho nasvorkujeme dvouřadý konektor 10 pinů, který je součástí dodávky centrální jednotky CP-7005. Propojení jednotlivých signálů je uvedeno na obr.3.7.

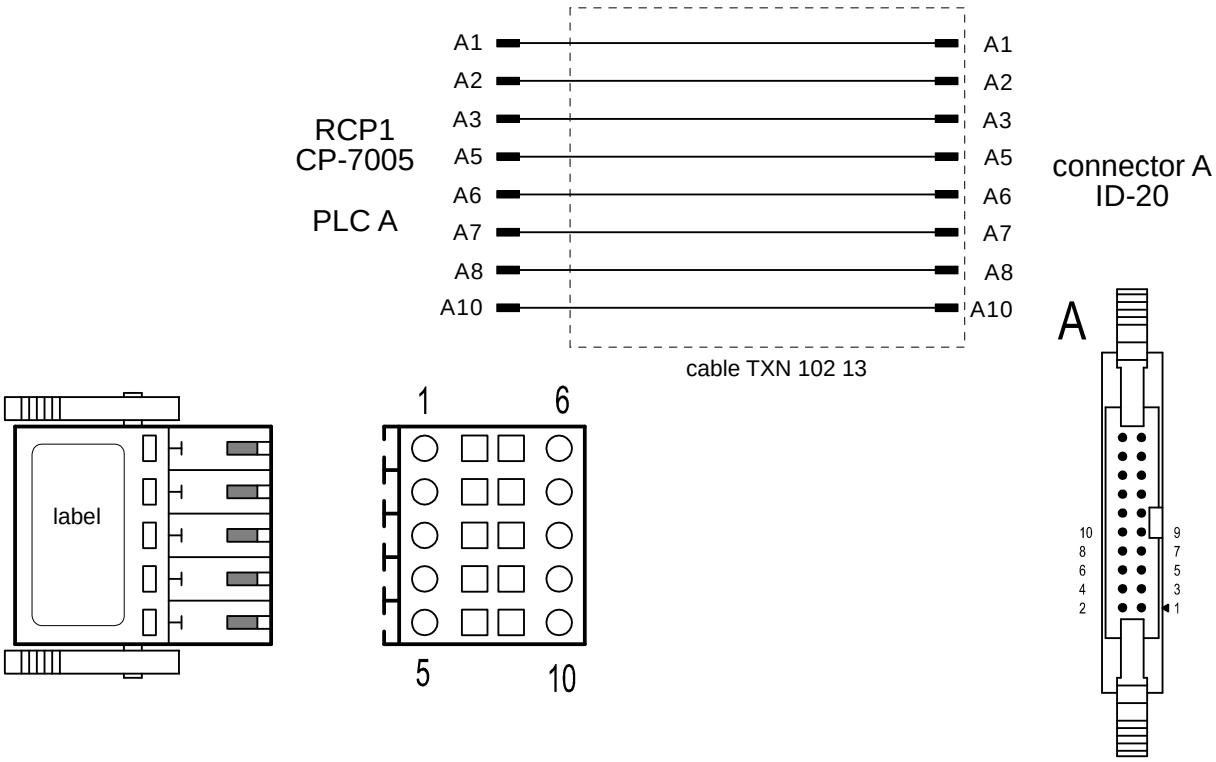


Fig.3.7 Connection of cable between CP-7005 and ID-20 - part A

3.3.2.3. Určení počtu napájecích modulů pro napájení sestavy s jednou centrální jednotkou

- **sestava s jedním rámem**
  V případě sestavy s jedním rámem (RM-7941 nebo RM-7942) vždy stačí pouze jeden napájecí modul, pokud nepožadujeme zálohování zdrojů.
- **vícerámová sestava s napájecím modulem v každém rámu**
  Jednotlivé rámy propojujeme kabely KB-0203 (propojení pouze komunikační sběrnice), nebo kabely KB-0202 (propojení včetně napájení - pak můžeme využít zálohování zdrojů). V případě větší vzdálenosti propojujeme pouze komunikační sběrnici pomocí připojovacích svorkovnic KB-0204 a KB-0220, nebo optickými kabely (moduly KB-0250 s kabelem KB-0260, moduly KB-0251 s kabelem KB-0260 či KB-0261, nebo moduly KB-0252 s kabelem se skleněným vláknem).
- **vícerámová sestava s napájecími moduly podle požadovaného příkonu**
  Jednotlivé rámy propojujeme kabely KB-0202 (propojení včetně napájení). Požadovaný počet napájecích modulů určíme podle celkového příkonu sestavy PLC. Napájecí moduly je vhodné rozložit podle možností rovnoměrně do jednotlivých rámů.

Uvedené způsoby napájení je možné kombinovat. Např. můžeme tři rámy propojené kabely KB-0202 napájet z jednoho zdroje a čtvrtý rám osadit samostatným napájecím zdrojem a propojit jej se zbytkem sestavy jen komunikační sběrnicí.

Možnosti a podmínky propojování rámů jsou uvedeny v následující kap.3.3.2.4.

3.3.2.4. Principles of rack interconnection

Všechny rámy v jednom segmentu musí mít propojenou komunikační sběrnici. Propojovací kabely nebo připojovací svorkovnice se zasouvají do konektorů na levém kraji rámu označených BUS EXTENSION. Propojení rámů musí být provedeno lineárně (tzn. že rámy jsou propojeny v sérii jeden za druhým, nelze realizovat odbočku). Volné konektory koncových rámů musí být osazeny zakončovacími členy KB-0201. Žádný propojovací konektor na rámu tedy nesmí zůstat neosazen.

Rámy můžeme propojit buď pomocí metalické sběrnice nebo pomocí optických kabelů. Celková délka spojité galvanicky oddělené metalické sběrnice bez opakovače může být max. 400 m. Pokud použijeme optické propojení, pak maximální délka optického kabelu (viz kap.3.3.2.5.) se uvažuje mezi sousedními rámy.

Pozor! Komunikační metalická sběrnice mezi rámy nesmí být vedena venkovním prostředím, ani mezi samostatnými budovami (bez ohledu na prostředí)!
Po blízkém úderu blesku je zde buď přímé ohrožení elektromagnetickým polem, nebo výrazně rozdílnými potenciály jednotlivých budov. V obou případech může dojít ke zničení všech součástí systému připojených ke sběrnici.
Zde musí být vždy použito optické propojení bez ohledu na délku sběrnice!

Způsoby propojení rámů můžeme rozdělit do následujících skupin:

- **metalické propojení včetně napájení**
  Dva sousední rámy jsou vzájemně propojeny kabelem KB-0202 a kromě komunikační sběrnice mají propojené i napájení. Maximální délka kabelu je 1 m.

- **metalické propojení bez galvanického oddělení**
  Dva sousední rámy jsou vzájemně propojeny kabelem KB-0203. V případě větší vzdálenosti použijeme svorkovnice KB-0204, které propojíme kabelem vhodným pro linku RS-485. Maximální délka celé metalické sběrnice (mezi oběma zakončovacími členy KB-0201) může být v tomto případě max. 300 m. Z důvodu nižší odolnosti vůči vnějším vlivům smí být takto propojeny rámy pouze v rámci jednoho rozvaděče.

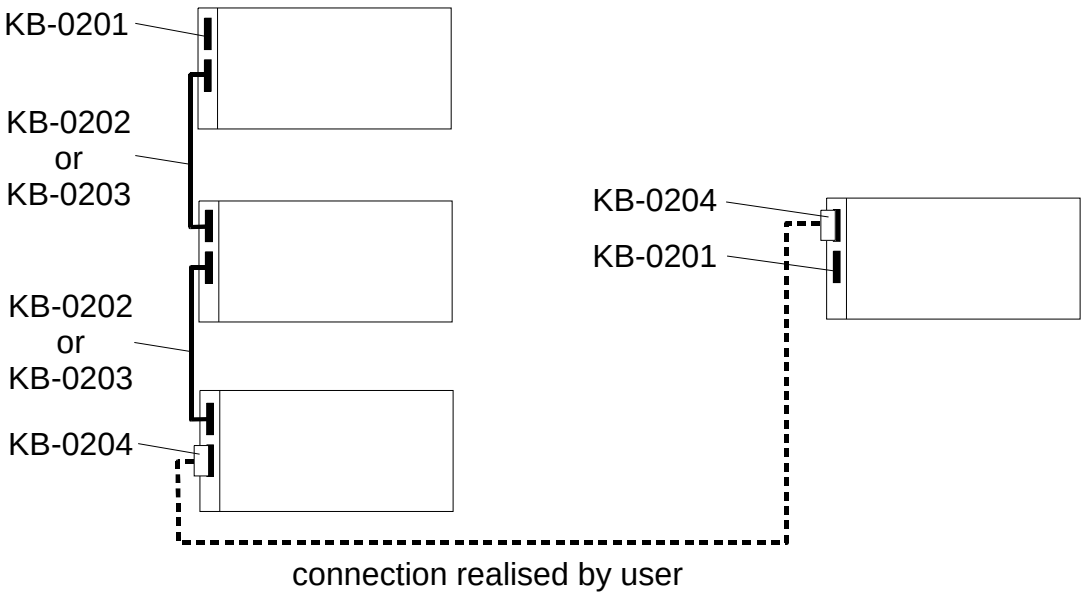
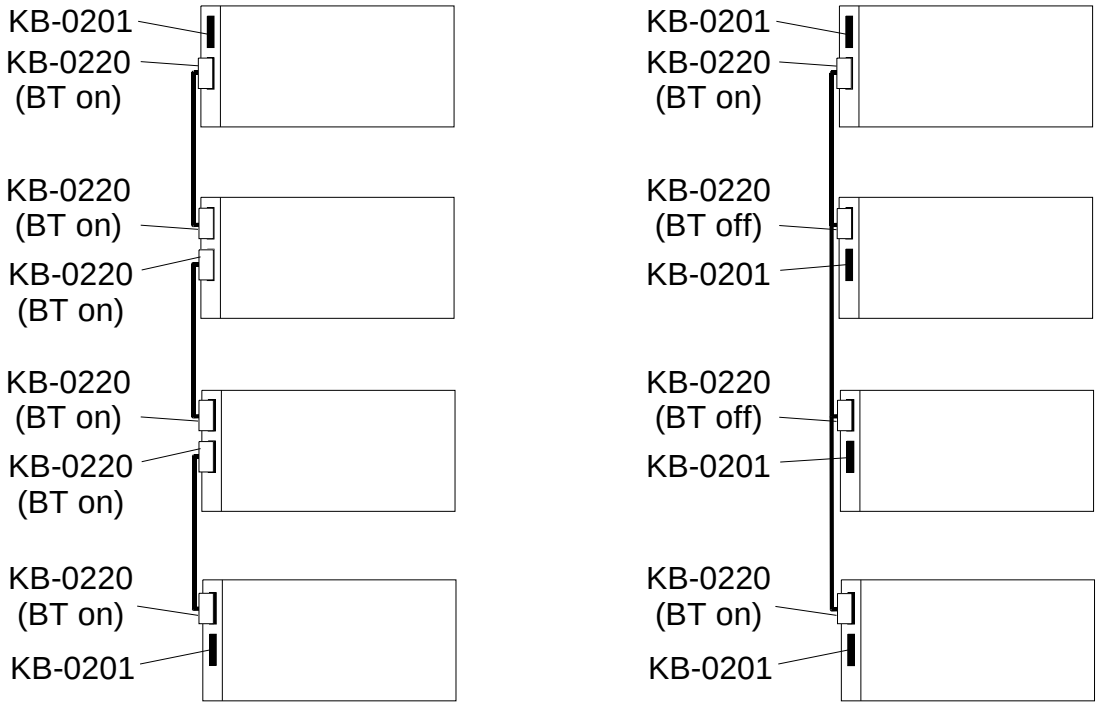


Fig.3.8 PLC rack interconnection via metallic cables without galvanic isolation

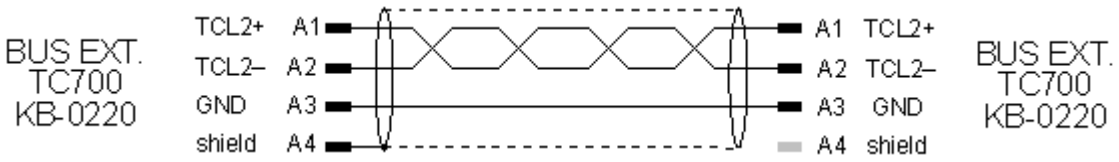
- **metalické propojení s galvanickým oddělením**

V tomto případě můžeme realizovat propojení dvěma způsoby.
Prvním způsobem je klasické spojení typu bod - bod. Rámy jsou osazeny adaptéry KB-0220, které vzájemně ve dvojících propojíme kabelem vhodným pro linku RS-485. Maximální délka každého propojení zvlášť může být 400 m. Všechny adaptéry KB-0220 musí mít připojené zakončení linky (spojené propojky BT+ a BT–). Výhodou tohoto způsobu je největší dosažitelná vzdálenost mezi rámy pomocí metalických kabelů.
Druhým způsobem je spojení typu sběrnice. Rámy jsou osazeny vždy jedním adaptérem KB-0220, které jsou všechny propojeny kabelem vhodným pro linku RS-485. Maximální délka celého propojení může být 400 m. Adaptéry KB-0220 na prvním a posledním rámu musí mít připojené zakončení linky (spojené propojky BT+ a BT–), adaptéry uvnitř realizované sběrnice naopak musí mít zakončení linky odpojené (rozpojené propojky BT+ a BT–). Všechny rámy pak na druhém připojovacím konektoru musí mít osazen zakončovací člen KB-0201 pro zakončení sběrnice rámu. Výhodou tohoto způsobu oproti předchozímu je nižší počet potřebných adaptérů KB-0220.



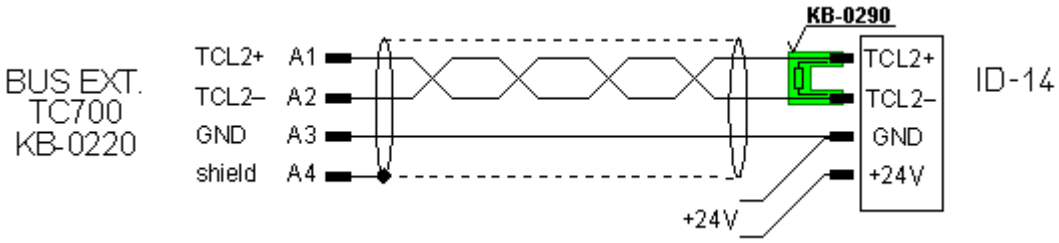
Obr.3.9 Propojení rámů v segmentu metalickými kabely s galvanickým oddělením - vlevo propojení typu bod- bod, vpravo propojení typu sběrnice (BT on - propojky BT+ a BT– spojeny, BT off - propojky BT+ a BT– rozpojeny)

Pomocí galvanicky odděleného metalického propojení můžeme realizovat propojení rámů v rámci jedné budovy. Izolační napětí galvanického oddělení je max. 1 kV. Propojovací kabel musí být stíněný, pro komunikaci (signály TCL2+, TCL2–) musí být kroucený pár (s výhodou lze použít kabelů STP pro strukturovanou kabeláž). Kabel je na obou koncích zapojen na šroubovací svorky adaptéru. Stínění kabelu musí být připojeno na kryt konektoru (svorka A4) pouze na jedné straně kabelu. Signálovou zem (GND) je nutné propojit, v případě využití kabelu s dvěma kroucenými páry lze zapojit oba vodiče do svorky GND (A3). Mechanicky lze kabel upevnit plastovým stahovacím páskem k výčnělku na desce plošného spoje. Zapojení kabelu je na obr 3.10, umístění svorek a propojek na adaptéru KB-0220 je na obr.3.12.

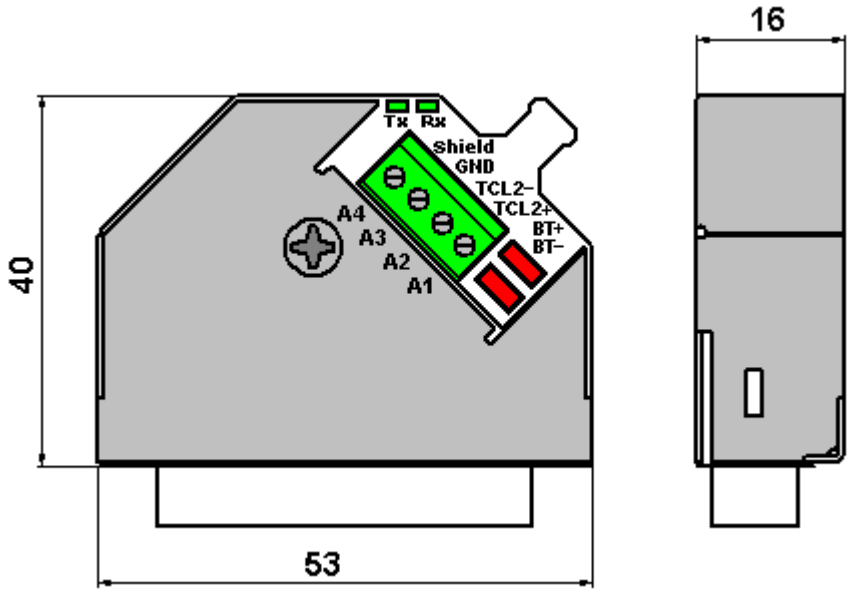


Obr.3.10 Zapojení kabelu mezi adaptéry KB-0220

Pro připojení textového panelu ID-14 je zapojení kabelu na obr 3.11. Je-li panel na konci vedení, musí se použít zakončovací člen KB-0290, který se zasune do svorek panelu spolu s vodiči kabelu.



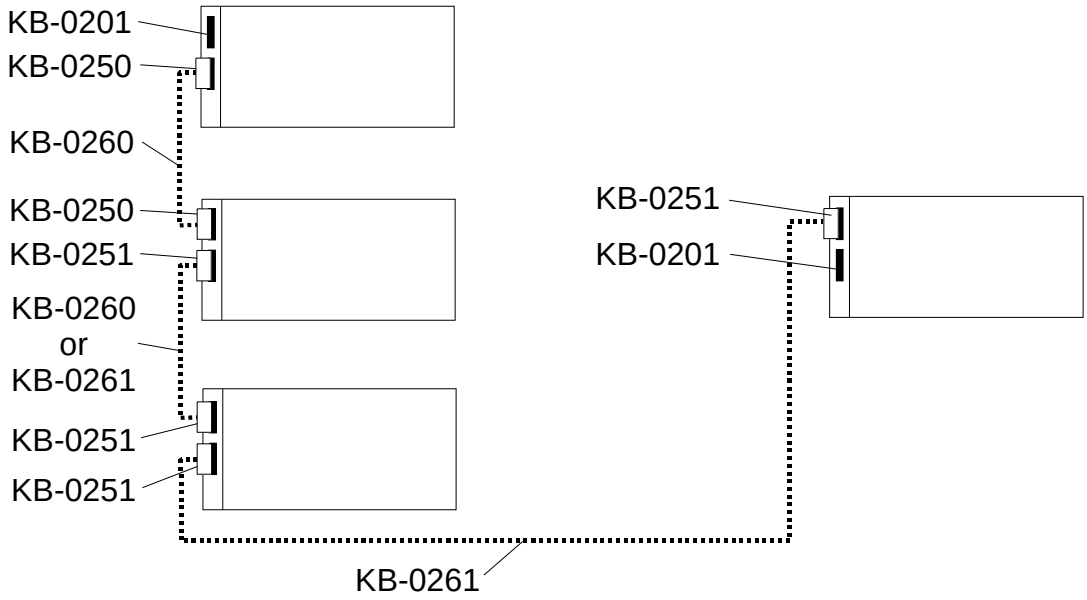
Obr.3.11 Připojení panelu ID-14



Obr.3.12 Umístění svorkovnice a propojek na adaptéru KB-0220

- **optické propojení**

  Rámy jsou osazeny převodníky KB-0250, KB-0251 nebo KB-0252, které jsou propojeny duplexním optickým kabelem KB-0260, KB-0261, nebo kabelem se skleněným vláknem.
  Optický kabel zaručuje galvanické oddělení a vysokou odolnost vůči vnějším vlivům. Proto je vhodný zejména k propojení rámů ve vnějším prostředí nebo mezi budovami, tedy tam, kde reálně hrozí riziko poškození systému důsledky úderu blesku ať už přímého nebo blízkého (ohrožení elektromagnetickým polem, nebo výrazně rozdílnými potenciály jednotlivých budov).
  Podrobnosti o optickém propojení jsou uvedeny v následující kap.3.3.2.5.



Obr.3.13 Propojení rámů v segmentu optickými kabely

Výše uvedené možnosti propojení rámů můžeme kombinovat.

V případě připojení druhého segmentu k centrální jednotce přes submodul MR-0154, resp. MR-0157 (rozšířená sestava - viz obr.3.2) se tento submodul zpravidla nachází na konci linky. V tomto případě nesmíme zapomenout na zakončení, které se realizuje propojením příslušných svorek konektoru (viz kap.2.6.1.4.). První rám druhého segmentu osadíme připojovací svorkovnicí KB-0204 a propojíme se svorkami příslušného komunikačního kanálu centrální jednotky.

Doporučené kabely jsou uvedeny v Příručce pro projektování programovatelných automatů TECOMAT TXV 001 08.01.

Table 3.2 Order numbers of connecting elements of PLC racks

Type	Modification	Order number
KB-0201	set of 2 pcs of termination elements	TXN 102 01
KB-0202	cable of bus interconnection including power supply	TXN 102 02.xx*
KB-0203	cable of bus interconnection without power supply	TXN 102 03.xx*
KB-0204	set of 2 pcs connecting terminal box without galvanic isolation	TXN 102 04
KB-0213	kabel propojení CP-7005 a ID-20	TXN 102 13.xx*
KB-0220	připojovací svorkovnice s galvanickým oddělením a opakovačem	TXN 102 20
KB-0250	sada 2 ks modulů pro připojení optického kabelu s vláknem POF 660 nm (kabel KB-0260)	TXN 102 50
KB-0251	sada 2 ks modulů pro připojení optického kabelu s vláknem POF nebo HCS 660 nm (kabely KB-0260 nebo KB-0261)	TXN 102 51
KB-0252	sada 2 ks modulů pro připojení optického kabelu se skleněným vláknem 820 nm a s konektorem ST	TXN 102 52
KB-0260	optický kabel s vláknem POF	TXN 102 60.xx*
KB-0261	optický kabel s vláknem HCS	TXN 102 61.xx*

* The xx specifies the cable length (table 3.3)

Tab.3.3 Objednací čísla kabelů podle délky

Length [m]	KB-0202	KB-0203	KB-0213	KB-0260	KB-0261
0,25	TXN 102 02.01	TXN 102 03.01	-	-	-
0,5	TXN 102 02.02	TXN 102 03.02	TXN 102 13.02	-	-
0,75	TXN 102 02.03	TXN 102 03.03	-	-	-
1	TXN 102 02.04	TXN 102 03.04	TXN 102 13.04	TXN 102 60.04	TXN 102 61.04
1,5	-	-	TXN 102 13.06	-	-
2	-	TXN 102 03.08	TXN 102 13.08	-	-
3	-	TXN 102 03.12	TXN 102 13.12	-	-
5	-	-	-	TXN 102 60.20	TXN 102 61.20
10	-	-	-	TXN 102 60.30	TXN 102 61.30
20	-	-	-	TXN 102 60.34	TXN 102 61.34
50	-	-	-	-	TXN 102 61.46
100	-	-	-	-	TXN 102 61.56

Poznámka: Jiné délky je možné dohodnout s obchodním oddělením.

3.3.2.5. Optické propojení rámů

Moduly optického propojení rámů

Moduly optického propojení sběrnice KB-0250 a KB-0251 jsou určené pro připojení optických kabelů s optickými konektory typu „Versatile Link“. Zajišťují korektní ukončení sběrnice (fyzicky odpovídající RS-485). Parametry jsou uvedeny v tab.3.4.

Moduly optického propojení sběrnice KB-0252 jsou určené pro připojení optických kabelů s optickými konektory typu „ST“. Zajišťují korektní ukončení sběrnice (fyzicky odpovídající RS-485). Moduly se propojují duplexním skleněným optickým kabelem 62.5/125 µm nebo 50/125 µm do vzdálenosti až 1750 m. Parametry modulů jsou uvedeny v tab.3.5.

Sady TXN 102 50, TXN 102 51 a TXN 102 52 obsahují vždy po dvou kusech příslušných modulů pro připojení duplexního optického kabelu. Moduly se osazují do konektorů BE1 nebo BE2 v levé části rámů RM-794x (resp. napájecích zdrojů PW-7906 a PW-7907).

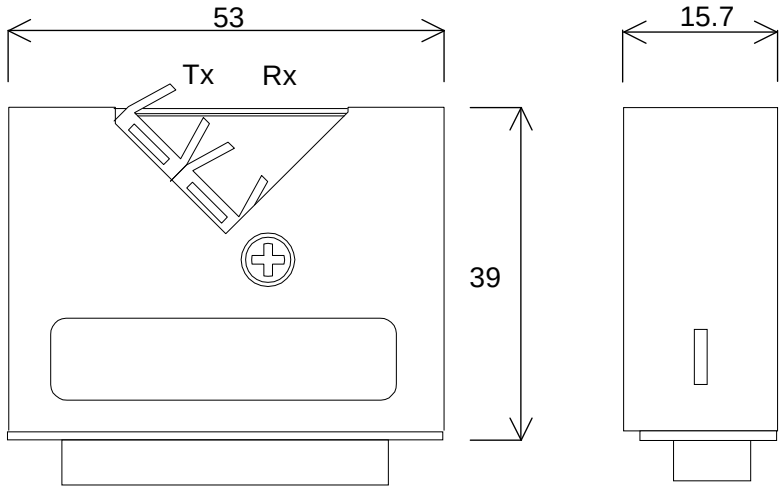


Fig.3.14 Dimensions of rack interconnection optical modules KB-0250 and KB-0251

Table 3.4 Basic parameters of optical interconnection modules KB-0250 and KB-0251

Module type			KB-0250			KB-0251		
Product standard			IEC EN 61131-2					
Protection class of electrical object ČSN 33 0600			III					
Connection			Connector D-sub 25					
			Duplex Versatile Link					
Power supply			24 V DC					
Power input			0.25 W					
Optical radiation wave length			660 nm					
Operating temperature			0℃ to +55 ℃			0℃ to +55 ℃		
Minimal budget attenuation for POF fiber			2.2 dB			13 dB		
Minimal budget attenuation for HCS fiber			-			5 dB		
Mean time of using at 55℃ operating temperature (– 3 dB power)			33 years					
Mean time of using at 40℃ operating temperature (– 3 dB power)			68 years					
Transmitter		**Symbol**	**min.**	**typ.**	**max.**	**min.**	**typ.**	**max.**
			[dBm]					
POF	Transmitter optical output –40 to +85℃	$P_{T\ (max)}$				–7.2		+1.3
POF	Transmitter optical output 0 to +70℃	$P_{T\ (max)}$	–17.8		–4.5	–6.9		+0.5
POF	Transmitter optical output at 25 ℃	$P_{T\ (max)}$	–15.5		–5.1	–6.0	–3.5	0
HCS	Transmitter optical output –40 to +85℃	$P_{T\ (max)}$	-	-	-	–17.3		–7.2
HCS	Transmitter optical output 0 to +70℃	$P_{T\ (max)}$	-	-	-	–17.0		–7.0
HCS	Transmitter optical output at 25 ℃	$P_{T\ (max)}$	-	-	-	–16.1	–12.5	–8.5
Temperature coefficient transmitter optical output		$\Delta P_T/\Delta T$	–0.85 %/℃ –0.05 dB/℃			–0.40 %/℃ –0.02 dB/℃		
Total optical output			0.355 mW			1.122 mW		
Receiver		**Symbol**	**min.**	**typ.**	**max.**	**min.**	**typ.**	**max.**
			[dBm]					
POF	Optical power input „log.0“ –40 to +85℃	$P_{RL(max)}$				–19.5		
POF	Optical power input „log.0“ 0 to +70℃	$P_{RL(max)}$	–19.0			–20.0		
POF	Optical power input „log.0“ at 25℃	$P_{RL(max)}$	–20.0			–21.0	–23.0	
POF	Optical power input „log.1“	P_{RH}			–43.0			–42.0
HCS	Optical power input „log.0“ –40 to +85℃	$P_{RL(max)}$	-	-	-	–21.5		
HCS	Optical power input „log.0“ 0 to +70℃	$P_{RL(max)}$	-	-	-	–22.0		
HCS	Optical power input „log.0“ 0 to +70℃	$P_{RL(max)}$	-	-	-	–23.0	–25.0	
HCS	Optical power input „log.1“	P_{RH}	-	-	-			–44.0

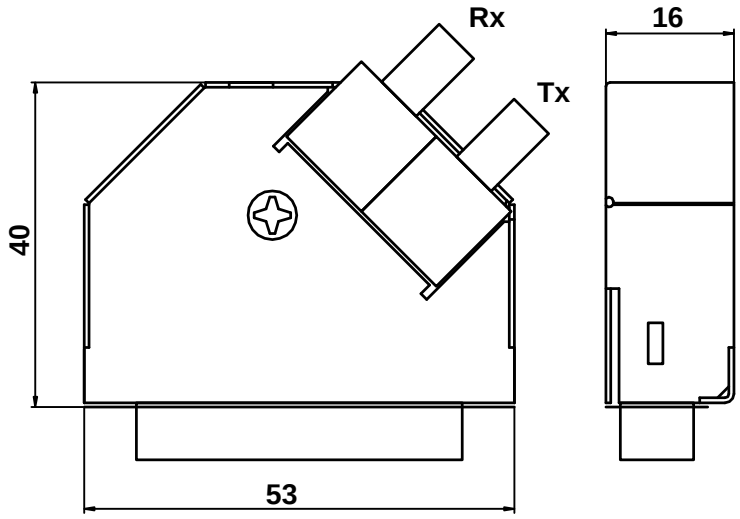


Fig.3.15 Dimensions of rack interconnection optical module KB-0252

Table 3.5 Basic parameters of optical interconnection moduleKB-0252

Module type		**KB-0252**		
Product standard		IEC EN 61131-2		
Protection class of electrical object ČSN 33 0600		III		
Connection		Connector D-sub 25		
		Duplex 2×ST		
Power supply		24 V DC		
Power input		0.25 W		
Optical radiation wave length		820 nm		
Operating temperature		0℃ to +55 ℃		
Budget attenuation		min. 8 dB, typ. 15 dB		
Mean time of using at 55℃ operating temperature (– 3 dB power)		33 years		
Mean time of using at 40℃ operating temperature (– 3 dB power)		68 years		
Transmitter	**Symbol**	**min.**	**typ.**	**max.**
		[dBm]		
Transmitter optical output at 25 ℃	$P_{T\ (max)}$	–15.0	–12.0	–10.0
Total optical output		0.355 mW		
Receiver	**Symbol**	**min.**	**typ.**	**max.**
		[dBm]		
Optical power input „log.0“ 0 to +70℃	$P_{RL(max)}$	–24.0		–10.0
Optical power input „log.0“ at 25℃	$P_{RL(max)}$	–25.4		–9.2
Optical power input „log.1“	P_{RH}			–40.0

Interconnection optical cables

The cable connection has to be carried out by this way: take out rubber anti-dust end caps pulling them from the interconnection module, then plug in the connector KB-0260 or KB-0261 with duplex optical cable under the angle 45° so that secure interlock will be outside of duplex optical connector. The duplex connector ensures cable orientation. In case of using of simplex fibers for interconnection, the transmitter (Tx) must be connected with receiver (Rx) of the opposite module (fig.3.14).

S optickým kabelem ST postupujeme stejně. Při propojení vláken, musí být vždy propojen vysílač (Tx) s přijímačem (Rx) protějšího modulu (obr.3.15).

Table 3.6 Basic parameters of optical cables KB-0260 and KB-0261

Cable type		**KB-0260**			**KB-0261**		
Optical connector		Duplex Versatile Link			Duplex Versatile Link		
Optical radiation wave length		660 nm			660 nm		
Fiber type		POF diameter 1 mm			HCS® diameter 200 µm		
Operational temperature		–40℃ to +85 ℃			–40℃ to +85 ℃		
Installation temperature		0 ℃ to +70℃			0 ℃ to +70℃		
Receiver	**Symbol**	**min.**	**typ. (25℃)**	**max.**	**min.**	**typ. (25℃)**	**max.**
		[dBm]					
Attenuation of cable per 1 m length	α	0.19	0.22	0.27	0.005	0.007	0.012
Temperature coefficient of attenuation	$\Delta\alpha_T/\Delta T$	0.0067 dB/°C			0.000083 dB/°C		
Max. short-term tensile stress (< 30 min.)		100 N			202 N		
Delay given by propagation velocity		5 ns/m			4.8 ns/m		
Max. permanent tensile stress		1 N			21 N		
Max. permanent flexion radius		35 mm			15 mm		
Extrinsic diameter of one fiber coating (2x)		2.2 mm			2.2 mm		

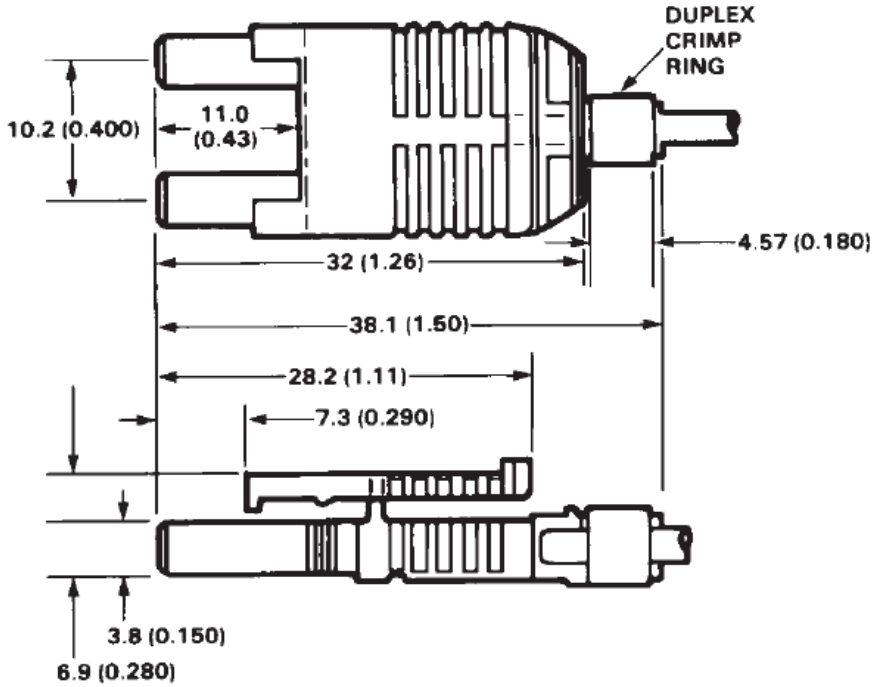
Tab.3.7 Základní parametry optických kabelů se skleněným vláknem

Optický konektor připojení		Duplex 2× ST
Vlnová délka optického záření		820 nm
Typ vlákna		sklo multimode 62.5/125 µm nebo 50/125 µm
Pracovní teplota		–40℃ až +85 ℃
Instalační teplota		0 ℃ až +70℃
Útlum kabelu na 1 km délky typ.	α	3,5 dBm
Max. krátkodobé namáhání v tahu (< 30 min.)		500 N
Zpoždění dané rychlostí šíření		5 ns/m
Max. trvalé namáhání v tahu		1 N
Max. trvalý poloměr ohybu		35 mm
Vnější průměr obalu jednoho vlákna (2x)		3 až 6 mm

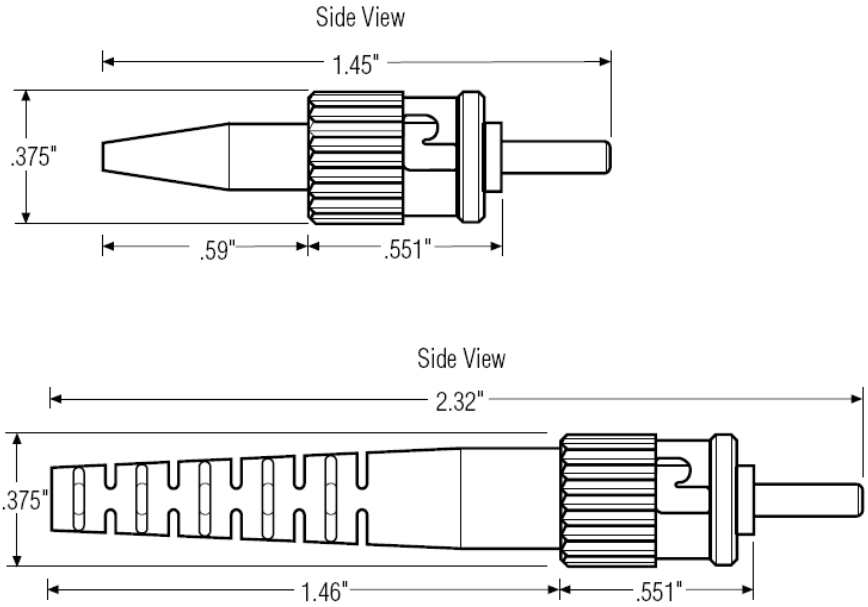
You should manipulate with modules only if the PLC power supply is switched off! Manipulation with power supply switched on may cause that the rack or modules fitted to the rack could be damaged!!!

You should always blank out optical transmitter and receiver by rubber end caps if you remove an optical connector. Otherwise they can be damaged by dust!

The product is a source of light radiation of CLASS 2 according to IEC 60825-1.
Do not stare into the emitter. It may injure your eyes!



Obr.3.16 Mechanické rozměry optických duplexních konektorů kabelů KB-026x



Obr.3.17 Mechanické rozměry optického ST konektoru

Maximální délka kabelu závisí na vysílaném optickém výkonu, citlivosti přijímače a útlumu použitého kabelu:

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

$L_{(max)}$ maximální délka
$P_{T\ (max)}$ nejmenší hodnota optického výkonu vysílače
$P_{RL(max)}$ největší hodnota vstupního optického výkonu pro „log.0“
α hodnota útlumu kabelu na 1 m délky

Výkon vysílače je také závislý na teplotě.

$P_{T\ (t)} = P_{T\ (25℃)} + \Delta P_T/\Delta T \times (t - 25℃)$

Útlum kabelu je také závislý na teplotě.

$\alpha_{(t)} = \alpha + \Delta\alpha_T/\Delta T \times (t - 25℃)$

Příklady orientačního výpočtu dosažitelné maximální délky optického kabelu

Použijeme moduly KB-0251 při maximální teplotě 50℃ a kabel KB-0261 (vlákno HCS) v prostředí s teplotami –40℃ až +80℃.

$P_{T\ (50℃)}$ = –17.0 dBm – 0.02 dB/℃ x (50℃ – 25℃) = –17.5 dB m
$\alpha_{(80)}$ = 0.007 dB/m + 0.000083 dB/℃ x (80℃ – 25℃) = 0. 0115 dB/m
$L_{(max)}$ = (–17.5 – (–22.0)) / 0.0115 = 391 m

Použijeme moduly KB-0251 při pokojové teplotě 25℃ a kabel KB-0261 (vlákno HCS) v prostředí s teplotou –40℃ až +80℃.

$\alpha_{(max)}$ = 0.012 dB/m
$L_{(max)}$ = (–16,1 – (–23.0)) / 0.012 = 575 m

Použijeme moduly KB-0251 při teplotě 40℃ a kabel KB-0260 (vlákno POF) v prostředí s teplotou 40℃.

$\alpha_{(40)}$ = 0.22 dB/m + 0.0067 dB/℃ x (40℃ – 25℃) = 0.32 dB/m
$L_{(max)}$ = (–6.9 – (–20.0)) / 0.32 = 40.9 m

Použijeme moduly KB-0250 při teplotě 40℃ a kabel KB-0260 (vlákno POF) v prostředí s teplotou 40℃.

$\alpha_{(40)}$ = 0.22 dB/m + 0.0067 dB/℃ x (40℃ - 25℃) = 0.3 2 dB/m
$L_{(max)}$ = (–17.8 – (–19.0)) / 0.32 = 3.75 m

3.4. PLC INSTALLATION

PLC installation into distributing frames

PLC TECOMAT TC700 are designed to be mounted into distributing frames. The mounting dimensions are given on fig. 2.1. The position of the mounting openings for mounting of the modules in distributing frames has to be in conformance with the data on fig. 3.18 (standard IEC EN 60297-1).

The PLCs are design for the pollution degree 2. The installation must be carried out in such a way so that the conditions of the overvoltage category II are not exceeded.

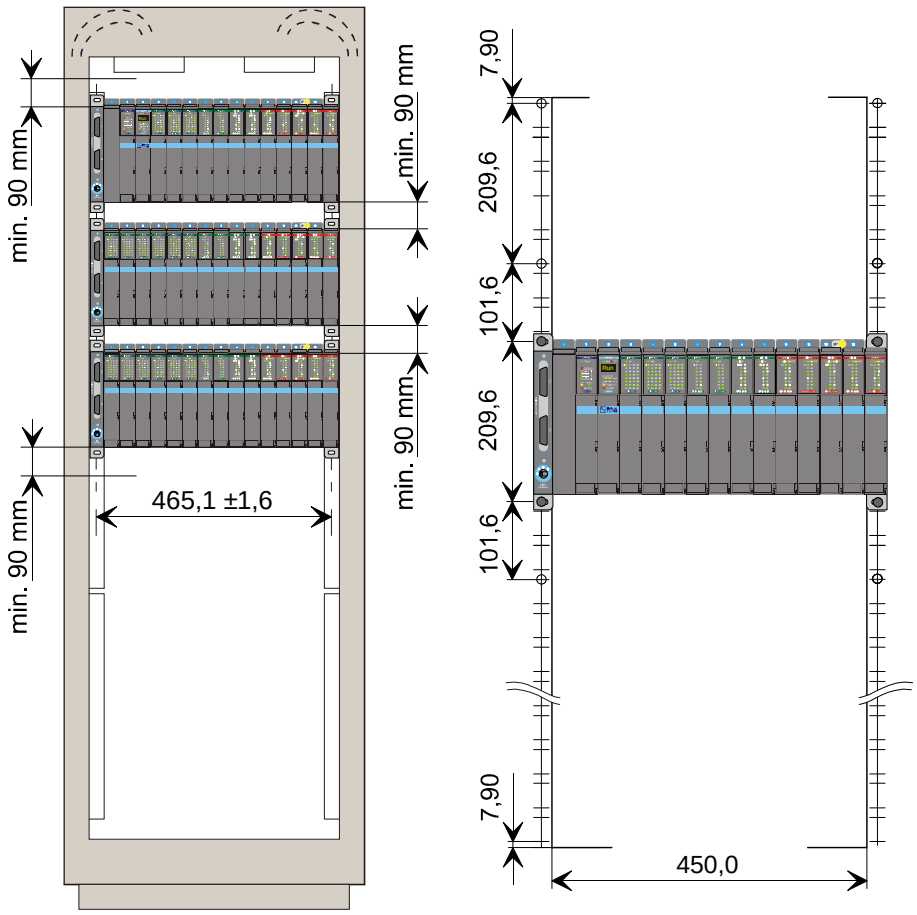


Fig. 3.18 PLC installation according to IEC EN 60297-1 (example for RM-7942)

Determination of dimensions and design of distributing frame

The dimensions and design of the distributing frame have to be considered with regard to the input power of installed devices and permissible operating temperature of the ambient environment of the PLC (chapter 1.5). Also the output losses arising on the inputs and outputs in active states have to be taken into account (this has to be based on the number of inputs and outputs activated at the same time, on the type and load of the particular outputs. The output losses on one PLC input / output in active state are given in table 3.8 and 3.9.

Table 3.8 Output loss on one input

Module type	Nominal voltage	Output loss per 1 input
IB-7302	24 V DC	0.09 W
IB-7303	24 V DC / AC	0.20 W
IB-7305	230 V AC	0.25 W
IB-7310, IB-7311	24 V DC	0.09 W
IS-7510	24 V DC	0.09 W
IR-7551	24 V DC	0.09 W

Table 3.9 Output loss on one output

Module type	Nominal voltage	Output current	Output loss per 1 output
OS-7401	24 V DC	2 A	0.35 W
OS-7402	24 V DC	0.5 A	0.10 W
OS-7405	115 - 230 V AC	0.25 A	0.30 W
OS-7410, OS-7411	24 V DC	0.05 A	0.10 W
IS-7510	24 V DC	0.05 A	0.10 W

Mounting of more racks in one distributing frame

The racks of the PLC can be positioned above each other, or alongside each other, as the case may be. When positioning the racks above each other, there has to be a minimum distance between the racks of 90 mm (top and bottom surface of the modules - see fig. 3.18) to create room for air circulation. In the distributing frames, where forced air circulation through the housing is not ensured, the installation has to be done in such a way so that the distance between the distributing frame ceiling and upper surface of the modules is at least 90 mm. Also the distance between the distributing frame bottom and bottom surface of the modules has to be at least 90 mm.

PLC Installation

The PLCs have to be fixed to the distributing frame rack by all the four fixing points. The protective terminals of the racks have to be connected by the shortest possible way with the main protective terminal of the distributing frame with a conductor with a cross-section of at least 2.5 mm^2 according to CSN 33 2000-5-54. The connection of PLC supply and its inputs and outputs has to be carried out in accordance with the requirements specified in the Manual for designing TXV 001 08.02.

Preventative protection against interference

To reduce the level of interference in the distributing frame with the installed PLC, all the inductive loads have to be treated with interference elimination elements. For this purpose, interference elimination sets are delivered (table 3.10, 3.11). The interference elimination set also serves to protect the binary DC and AC input PLC modules against voltage peaks arising primarily when controlling the inductive load.

Protection has to be carried out directly on the load due to maximum elimination of interference spread as a source of possible failures. As protective element we deliver varistors or RC-elements, the highest efficiency can be reached by combination of both protection types. The set can be used anywhere in controlled technologies to protect contacts or against interferences arising during control processes.

An example of connection is given on fig. 3.19. The principles of interference elimination in the position of its source as close as possible (load) have to be taken in account.

Table 3.10 Interference elimination sets

Interference elimination set content	For load	Set order number
8x varistor 24 V	24 V DC/AC	TXF 680 00
8x varistor 230 V	230 V AC	TXF 680 03
8x RC element - R = 10Ω, C = 0,47µF	24 - 48 V DC/AC	TXF 680 04
8x RC element - R = 47Ω, C = 0,1µF	115 - 230 V AC	TXF 680 05

Table 3.11 Parameters of varistors used in interference elimination sets

energy that can be captured by the varistor I^2t (t is for duration of the blanking pulse - in ms)	< 80 J
current through varistor I	< 25 A
mean value of output power loss P	< 0.6 W

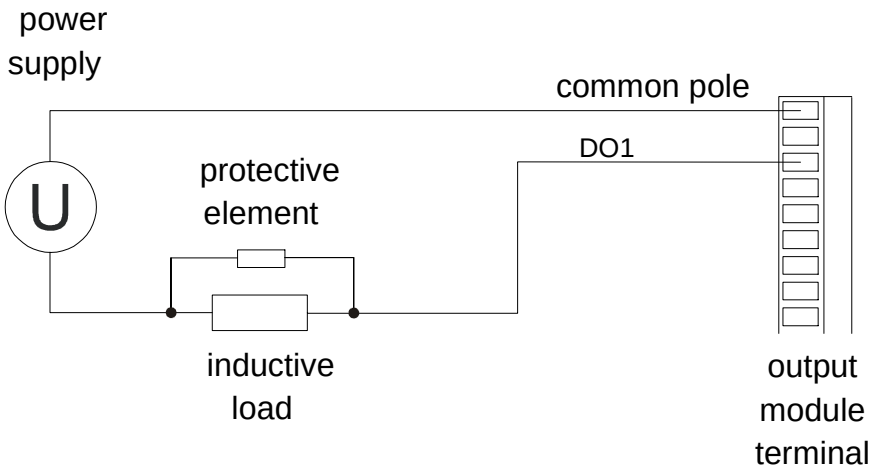


Fig. 3.19 Protective element connection parallel to the load

Further information on interference elimination can be found in the Manual for designing of TECOMAT PLCs TXV 001 08.01.

3.5. SUPPLY REQUIREMENTS

Further information on requirements for power supply and its realization can be found in the Manual for designing of TECOMAT PLCs TXV 001 08.02.

3.5.1. PLC supply

To reduce the interference effects, it is recommended to feed the supply modules from an auxiliary (isolating) transformer. Since the transformer will not supply energy to the resistance load, but to the input rectifier of the power supply source, it is necessary to have 1.2 multiple of the type output power of the isolating transformer according to the following formula:

$$P_T = 1{,}2 \cdot \sum_n P_Z \quad \text{[VA]}$$

P_T - result type power output of the isolating transformer
n - number of supply modules
P_Z - input power of n-th supply module

Between the primary and secondary winding of the isolating transformer has to be a shielding Cu-foil that has to be connected to the main protective terminal of the distributing frame, or, the secondary winding has to be wound on a separate coil so that the reciprocal capacity of the primary and secondary winding is minimized.

It is recommended to install a switch into the common PLC supply input (to have a possibility to switch the power supply off when debugging programs, for maintenance purposes, repairs, etc.). A shielded cable has to be used for power supply inputs. For power supply 230 V AC it is recommend to use a 3 x 0.75 mm^2 cable. Cable shielding has to be connected with the main protective terminal of the distributing frame only on the side of the transformer. The minimum cross-section of the conductors connected to the main protective terminal has to be 2.5 mm^2.

3.5.2. Use of supply module UPS circuits

When backing up of the PLC run is required, the UPS circuits can be used, these circuits are part of some power supply module types. For backing up, it is recommend to use encapsulated maintenance-free lead batteries that are used for example for security systems or as spare parts for commonly used UPS units. Batteries with a capacity of 1.3 Ah (the backup time under full load of one supply module and at full capacity of the batteries is approx. 15 minutes) to 12 Ah (the backup time under full load of one supply module and at full capacity of the batteries is approx. 3 hours). For one power supply module with UPS we always need two identical batteries, connected, if possible, by short conductors with a cross-section area of at least 0.75 mm^2. The batteries should be placed close to the PLC in such a way so that they are not warmed up by surrounding devices. An increased temperature of the batteries **significantly** reduces their life time.

3.5.3. Supply of input and output circuits

The alternating input and output PLC circuits have to be supplied from an isolating protective transformer. An RC element (R = 100 Ω / 2 W, C = 2 µF / 250 V_{ef}) has to be connected to the secondary winding, from which the output circuits switched by the alternating output units are supplied. The alternating input circuits have to be supplied from the separate secondary winding (no other appliances can be connected to the supply voltage of the input circuits).

For higher input power it is sensible to connect the supply isolating transformer with separate sources for the input and output circuits.

If this is necessary, one pole of the source can be connected to the plant frame. The permissible tolerance of the direct current supply voltages, including ripple effect for input and output circuits is 20 % from the nominal voltage value.

For program debugging purposes and putting the plant into operation, for maintenance and possible corrections it is sensible to connect the supply voltage of the input and output modules via switches.

3.6. SERIAL COMMUNICATION

The TECOMAT PLCs are connected to other systems by means of serial lines. For selecting an interface, MR-01xx plug-in submodules are used allowing connection by

means of interfaces RS-232, RS-485 or RS-422. Another possibility of connection to the other systems is the Ethernet interface.

For connection of the TECOMAT TC700 system components with other systems (a PC) via the serial line, any of the interfaces being offered can be used (chapter 2.6.). The interface is selected according to the type of interface contained in the system being connected. If this interface does not correspond with its parameters (longer distance, higher level of interference, low speed, connection of more participants at a time), a corresponding serial interface converter has to be used on the side of the system being connected.

For servicing and debugging purposes we can use the USB interface 2.0 for interconnection of the PC and TECOMAT PLC. For this purpose, a 3 m long KB-0208 cable is supplied. This interface is not galvanically isolated and must not be used for permanent connection within the normal operation of the application.

If there is no USB interface available on the PC, we can use the KB-0209 cable, which also serves primarily for servicing purposes and debugging. The cable has on the side of the PC the D-SUB 9 connector, on the side of the PLC 2x5 female connector, connected for the RS-232 interface and provided with a cover. The condition is that the serial channel used is fitted with a submodule realizing the interface RS-232 (MR-0104).

Table 3.12 Cable order numbers for connection of PLCs with other participants

Type	Modification	Order number
KB-0205	cable UTP Ethernet 10/100 Mb, standard (straight)	TXN 102 05.xx*
KB-0206	cable UTP Ethernet 10/100 Mb, crossed	TXN 102 06.xx*
KB-0207	cable for interconnection Ethernet 10/100 Mb HUB - HUB	TXN 102 07
KB-0208	cable USB A - B standard, 3 m	TXN 102 08
KB-0209	cable RS-232 PC - TC700, 3 m	TXN 102 09

* The "xx" specifies the length of the cable (table 3.13)

Table 3.13 Order numbers of cables according to their length

Length [m]	KB-0205	KB-0206
0.5	TXN 102 05.02	TXN 102 06.02
1	TXN 102 05.04	TXN 102 06.04
2	TXN 102 05.08	TXN 102 06.08
5	TXN 102 05.20	TXN 102 06.20

Note: You can arrange the order of cables of another length with business department.

Further information on realization of communication connections and networks can be found in the Manual for designing of TECOMAT PLCs TXV 001 08.01.

4. PLC OPERATION

4.1. INSTRUCTIONS FOR SAFE OPERATION

With PLC power supply on and with power supply on for input and output PLC circuits it is not permitted:

- to disconnect or connect the terminals to the input and output PLC modules
- to disconnect and connect the cables interconnecting individual PLC racks

When programming PLC control algorithms, a possibility of an error in the user program cannot be eliminated, which could result in an unexpected behaviour of the object being controlled, the consequence of which could be an emergency situation or hazardous for persons in the worst case. When operating the PLC, especially during trial runs and debugging of new user programs with the object being controlled, it is unconditionally necessary to pay high attention to this.

The object being controlled have to be made fit, so that zero values of the control signals (PLC without power supply) ensure stable and collision-free state of the controlled object!

4.2. PUTTING OF PLC INTO OPERATION

Procedure for putting the PLC into operation for the first time

When putting the PLC into operation for the first time, it is necessary to observe the following procedure:

a) Check the correctness of connection of supply module commercial power supply.
b) Check the interconnection of rack protective terminals with the main protective terminal of the distributing frame or switchgear.
c) Check the interconnection of the PLC racks.
d) Check, whether the PLC configuration and rack addressing corresponds to the given application.
e) Check the correctness of connection of the supply circuits of the input and output PLC modules (if the parameters of supply voltages are not kept, this could result in destruction of the input and/or output circuits).
f) Switch the power supply of the PLC supply modules on.
   Napájení všech rámů musí být zapnuta buď současně, nebo v následujícím pořadí:
   - nejdříve napájení rámů osazených pouze periferními moduly (v libovolném pořadí),
   - pak napájení rámů osazených slave expandery SE-7132,
   - nakonec napájení rámů osazených centrálními jednotkami CP-700x.
   Another procedure is not permissible.
   If the PLC or its part is fed by more supply modules mutually interconnected, it is then necessary that so many supply modules are switched on as it is necessary to supply the unit.
   If, for example, a PLC unit is fed by four supply modules being mutually interconnected (connecting cables among the racks transmit power supply, too) and for safe operation it is sufficient to have two supply modules working (another two modules are designated for power supply backup also e.g. from another network. Then, when putting this unit

into operation, at least two supply sources have to be switched on at the same time to avoid short-term insufficiency of power output.

Signalization of PLC activity after switching power supply on

The activity of the supply modules is signalized by the LED on the front panel of the module. The signalization of central units is described in chapter 4.4. After switching the PLC on, the outputs are locked. This is indicated by the OFF LEDs on the output modules. If on some input or output module the indication of closing of some inputs or outputs lights for a short period of time after switching power supply on, this is not a problem, since after switching power supply on, the system program ensures setting of the inputs and outputs to zero and the LEDs being on will go off after a while.

Outwardly, this intermediate state caused by supply voltage surge does not show up, since the outputs are always locked immediately after switching power supply on and they unlock after the PLC is switched to the RUN mode (if not set up otherwise by the user).

4.3. PLC SWITCHING SEQUENCE

Table 4.1 Switching sequence of central units

Unit activity OK - no error ER - error	**LED indication**	**Display**		
		CP-7001	**CP-7002 CP-7003 CP-7005**	**CP-7004**
1. Basic initialization and hw unit testing OK - transfer to next action	lighting RUN	sw version **v2_1**		
ER - switching sequence stop, PLC cannot be operated	lighting ERR	see table 4.2		
2. Initialization of system sw processor	lighting RUN	–	–	–
3. Power supply check OK - transfer to next action	lighting RUN	=	=	=
ER - signal from power supply expected, when it comes, transfer to next action	lighting RUN	o	off	off
4. Operating parameter setup (only when the SET and MODE keys are pressed)	lighting RUN	see chapter 2.3.9.		
5. SD / MMC card connection	lighting RUN			≡
6. Initialization of file system and Web server	lighting RUN			≣
7. Detection of system hw configuration - čekání na připravenost rozšiřovacích prvků sestavy (expanderů, apod.)	lighting RUN		Wait	Wait
OK - transfer to next action	lighting RUN	=	=	≣
ER - error is written to the error stack	lighting RUN and ERR	last error **E–80–09–0000**		
8. PLC initialization according to user program OK - transfer to next activity	lighting RUN	=	=	≣
ER - error is written to the error stack	lighting RUN and	last error		

	ERR	**E–80–09–0000**

Tab.4.1 Zapínací sekvence centrálních jednotek

Unit activity OK - no error ER - error	**LED indication**	**Display**		
		CP-7001	**CP-7002 CP-7003 CP-7005**	**CP-7004**
9. Activation of communication with superior system	lighting RUN	=	=	≡
8. PLC mode setup OK - switch to RUN mode and user program start	flashing RUN	**G**	**Run ***	**Run**
OK - when operating parameters were set, switch to HALT mode, user program is not started	lighting RUN	**H**	**Halt**	**Halt**
ER - if an error occurs during switching sequence, switch to HALT mode, user program is not started	lighting RUN and ERR	last error **E–80–09–0000**		

* Centrální jednotka CP-7005 prochází při spouštění uživatelského programu ještě dalšími stavy - viz tab.4.4

PLC activity after switching power supply on

Immediately after switching power supply on, the PLC performs the activities given in table 4.1. Further in the text, this state is called PLC switching sequence. The purpose of the switching sequence is to test the PLC hardware as well as software and PLC setup into the defined initial state. The table also explains the behaviour of the signalization LEDs and display during switching sequence.

The CP-7001 central unit is equipped with a one-digit seven-segment display, while the other central units contain a four-digit matrix display. If we mention the word "display" further in the text, we mean both types of these visual display units. The ways of text display is described in chapter 2.3.9.

Switching sequence interrupt

The switching sequence can be interrupted on two positions. The first one is power supply check, when the central unit expects a defined setup of signals from the supply module on the bus, which means the PLC power supply has parameters as required. If these signals are not set correctly, **o** or **off** starts flashing on the display, until the signals are set as required. A longer occurrence of this state usually means a PLC power supply failure.

The second position is operating parameters setup, if the user presses and keeps pressed the SET and MODE pushbuttons simultaneously, until "〓" appears on the display. Then it is proceed as described in chapter 2.3.9. After exiting the parameters setup mode, the switching sequence will proceed according to table 4.1.

Switching sequence termination

The switching sequence can be terminated by three possible ways. If everything is O.K., then after the switching sequence is terminated, the PLC starts executing of the user program and controlling the technology in question. Should the PLC diagnostics evaluate a critical error during the switching sequence, the PLC will stay at the HALT mode and signalize the error.

If new values of the operating parameters are set during the switching sequence (chapter 2.3.9.), the PLC will stay at the HALT mode, the user program is not executed, the PLC outputs stay locked and the PLC expects commands from the superior system. The user program can be initialised either by the superior system, or by switching the power supply off and on.

Table 4.2 Indication of error states of central units during the switching sequence

Central unit state	Display	
	CP-7001	CP-7002 CP-7003 CP-7004 CP-7005
Central unit initialization firmware error	?	
Central unit firmware error	E	
Configuration code error for Altera circuit	A	
Altera circuit cannot be programmed	P	
Power supply does not give signal of correct supply	o	off

4.4. PLC OPERATION MODES

PLC TECOMAT TC700 can be operated in some operating modes. These modes are RUN, STB, INA, HALT and PROG. Their indication is given in table 4.3.

At the any mode except PROG, it is possible to find out on the display of the central unit the setup parameters of the serial channels CH1 and CH2 and Ethernet ETH1. If you press and hold the top button (SET), parameters of the CH1 channel are displayed. If you press and hold the bottom button (MODE), parameters of the CH2 channel are displayed. If you press and hold both keys, parameters of the Ethernet ETH1 channel are displayed.

RUN mode

In the RUN mode, the PLC reads the values of the input signals from the input units, executes the instructions of the user program and writes the calculated values of output signals into the output units. The RUN mode is signalized by flashing of the RUN LED on the central unit. At the same time, the RUN LEDs on the peripheral modules are flashing, too, indicating data transmission is taking place among the central unit and peripheries. The ERR LEDs are off. On the seven-segment display letter **G** is on, on the four-digit display text **Run** is lighting.

If the analyzer is activated, which is part of the GraphMaker component at the MOSAIC development environment, letter **A** at the right bottom corner of the four-digit display is also on, simultaneously with text **Run**. On the seven-segment display, the analyzer operation is not indicated.

If the peripheral module signal fixation is active that is active at the MOSAIC development environment on the panel *I/O Setting*, letter **F** is on the seven-segment display, on the four-digit display letter **F** at the right top corner of the display is on, together with text **Run**.

STB mode

Režim STB (stand-by) existuje pouze u redundantních systémů (viz kap.4.4.5.), kdy centrální jednotka, která právě řídí technologii, je v režimu RUN, zatímco druhá centrální jednotka je ve funkci horké zálohy v režimu STB. Z toho plyne, že tato centrální jednotka pouze udržuje veškerá spojení v rámci systému, sdílí data s centrální jednotkou, která technologii právě řídí, ale sama žádnou řídicí činnost nevykonává. V případě jakéhokoli problému je připravena přejít do režimu RUN a převzít řízení technologie.

Na displeji centrální jednotky v tomto režimu svítí nápis **Stb**.

Pokud je spuštěn analyzátor, který je součástí komponenty GraphMaker ve vývojovém prostředí Mosaic, je současně s nápisem **Stb** rozsvíceno i písmeno **A** v pravém dolním rohu displeje.

Pokud je aktivní fixace signálů periferních modulů, která je přístupná v prostředí Mosaic v panelu *Nastavení V/V*, je současně s nápisem **Stb** rozsvíceno i písmeno **F** v pravém horním rohu displeje.

INA mode

Režim INA (inactive) existuje pouze u redundantních systémů (viz kap.4.4.5.), kdy centrální jednotka, která právě řídí technologii, je v režimu RUN, zatímco druhá centrální jednotka může pomocí řídicího panelu redundance ID-20 přejít do režimu INA například za účelem výměny některého periferního modulu. Tato centrální jednotka nevykonává žádnou řídicí činnost, její periferní systém je zastaven. V tomto režimu není připravena přejít do režimu RUN a převzít řízení technologie. Na povel z panelu ID-20 může centrální jednotka přejít opět do režimu STB.

Na displeji centrální jednotky v tomto režimu svítí nápis **InA**.

HALT mode

The HALT mode is mainly used for the activities connected with user program editing. At this mode, neither the user program nor data transmission between the central unit and peripheral units are executed. The green RUN LEDs on the central unit and peripheral modules are on permanently, the ERR LEDs are off. On the seven-segment display letter **H** is on, on the four-digit display text **Halt** is on.

PROG mode

The central units is in the PROG mode during user program saving to the backup EEPROM. In this mode, the program is not executed as well as data transmission among the central unit and peripheral units. The green RUN LEDs on the central unit and peripheral modules are on permanently, the ERR LEDs are off. On the seven-segment display letter **P** is on, on the four-digit display text **Prog** is on.

Behaviour of PLC during a critical error

An exception from the above mentioned is, if a critical error occurs in the PLC that inhibits control activities. In this case, a mechanism for critical error treatment is started and treats the critical error from the point of control security and **always** switches the PLC to the HALT mode. The green RUN LED stops flashing and the red ERR LED is on, indicating an error state. The code of the error that caused the PLC stop is displayed on the display. A detailed description of PLC behaviour when various errors occur, possible causes of the errors and troubleshooting is given in chapter 5.

Behaviour of PLC at power failure

In case of a power failure (intentional switching the power supply off, electric power supply failure or power supply module failure), the central unit is informed on power supply drop enough in advance and during the time left, it performs a defined system shutdown procedure, including ensuring the correct content of the user tables (in case some of the tables was being used when power supply failure occurred) and the remanent zone.

The central unit is then stopped and **O**, or text **OFF** appears on the display. The central unit detects on the bus the signals giving information on power supply state. If the power supply drop is short and was not completed (drop out), the power supply module gives a signal that the power supply is O.K. again.

After approx. 1.5 s, the central unit performs reset and the system passes through the switching sequence (see chapter 4.3). The indication of this state differs from a similar state in the switching sequence in the size of the characters on the display.

Table 4.3 Indication of operating mode of central units

Unit state	LED indication	Display		
		CP-7001	CP-7002 CP-7003 CP-7004	CP-7005
RUN mode	flashing RUN	**G**	**Run**	**Run**
RUN mode - analyser activated		**G**	**Run_A**	**Run_A**
RUN mode - active fixation of signals		**F**	**Run^F**	**Run^F**
RUN mode - active fixation of signals, analyzer running		**F**	**Run^F_A**	**Run^F_A**
STB mode	flashing RUN			**Stb**
STB mode - analyser activated				**Stb $_A$**

STB mode - active fixation of signals				**Stb ^{F}**
STB mode - active fixation of signals, analyzer running				**Stb $^{F}_{A}$**
INA mode	lighting RUN			**InA**
HALT mode	lighting RUN	**H**	**Halt**	**Halt**
HALT mode - PLC critical error	lighting RUN and ERR	last error **E–80–10–0000**		
PROG mode	lighting RUN	**P**	**Prog**	**Prog**
PLC switching off proceeding – power supply black-out	lighting RUN	**O**	**OFF**	**OFF**

4.4.1. Change of PLC operation modes

The change of the PLC modes can be done through a superior system (master computer) that is connected to the serial channel or USB interface or Ethernet interface.

Typically, a standard PC represents this superior system serving as a programming means, monitoring or visualization workplace for the operation of the object being controlled.

When changing the PLC operating modes, some activities are executed standardly and some are optional. It is possible to say in general that the change of the PLC operating mode is an activity requiring higher concentration of the operators, since in many cases it very significantly influences the state of the object being controlled. The change from the RUN to the HALT mode can be an example when the PLC stops executing the user program and the object connected is not controlled. Therefore we recommend to read the following text very carefully.

4.4.2. Standard activities during PLC mode change

Switching from HALT to RUN

When switching from the HALT to the RUN mode the following activities are executed:

- User program integrity test
- Software configuration test for the peripheral units stated in the user program (chapter 4.5.2.)
- User program start

Switching from RUN to HALT

When switching from the RUN the HALT mode the following activities are executed:

- the execution of the user program is stopped
- locking (disconnection) of PLC outputs

If during the change from one operating mode to the other one a critical error occurs, the PLC sets the HALT mode, indicates the error on the central unit display and waits for clearing the error cause.

Warning:	**Control stop through the HALT mode is designated only for PLC program debugging purposes. This feature does not replace the CENTRAL STOP feature in any way. The CENTRAL STOP circuits must be connected in such a way so that their function is independent of PLC work!**

4.4.3. Optional activities during PLC mode change

Options when switching from HALT to RUN

When switching from HALT to RUN, the following activities are optional:

- PLC error reset
- warm or cold restart
- output locking during user program execution

Options when switching from RUN to HALT

When switching from RUN to HALT**,** the following activities are optional:

- PLC error reset
- PLC output reset

When resetting the PLC error, the entire PLC error stack is reset, too, including error stacks of the peripheral modules. The request for output locking causes that the program will be solved with disconnected outputs, only the signalization of output states on the LEDs of the output modules will be active. Output locking is indicated by the OFF LEDs on the peripheral modules. During output reset all the PLC binary output units will be reset.

4.4.4. User program restarts

Restart is an activity of the PLC, the task of which is to prepare the PLC to execute the user program. Under normal conditions restart is executed at every change of user program.

The TECOMAT PLC systems differ two types of restart, warm and cold. The warm restart enables to holdback the values in the registers also when power supply is off (remanent zone - chapter 4.5.1.). The cold restart always performs full memory initialization.

Activities during restart

During restart, the following activities are performed:

- User program integrity test
- Reset of the entire PLC scratch pad
- Remanent zone reset (cold restart only)
- Setting of backed up registers (warm restart only)
- Initialization of system registers S
- Initialization and check of PLC peripheral system

User program start-up without restart

The user program is also possible to be run without restarting, in this case only the user program integrity test and PLC peripheral system check are performed.

User processes during restart

Dependent on the type of restart being executed functions also the scheduler of user processes P. If warm restart is executed within HALT → RUN switching, user process P62 is executed as the first one after switching into the RUN mode (if it is programmed). In case of cold restart, user process P63 is executed as the first one. If no restart during switching into the RUN mode is executed, process P0 is executed as the first one after switching.

4.4.5. Redundantní PLC

V případě požadavku na vysokou spolehlivost řídicího systému můžeme použít PLC TECOMAT v redundantní sestavě (kap.3.3.2.1., obr.3.4, obr.3.5). Principem redundance (nadbytečnost) je zdvojení těch prvků, jejichž případná, i když málo pravděpodobná porucha může způsobit kritický stav řízené technologie.

4.4.5.1. Zálohování napájení

Za základní stupeň redundance můžeme považovat i zálohování napájení PLC. Pokud použijeme zdroje PW-7902 nebo PW-7904 s integrovanou funkcí UPS, můžeme k nim připojit zálohovací akumulátor 24 V pro případ výpadku síťového napájení. Dále můžeme použít více zdrojů napájených z různých napájecích sítí. Pokud při výpadku některé napájecí sítě zůstává dostatek výkonu pro napájení celého systému, jde o redundantní zapojení napájení.

Všechny tyto funkce jsou dostupné ve všech konfiguracích PLC TECOMAT.

4.4.5.2. Redundance centrální jednotky

Centrální jednotky CP-7005 jsou určeny pro redundantní provoz v režimu Hot-Standby. Obě centrální jednotky (CPU) obsahují identický uživatelský program. Zatímco technologii řídí primární CPU, druhá ve funkci zálohy kontroluje její chod a je připravena okamžitě převzít řízení v případě zastavení nebo výpadku primární CPU.

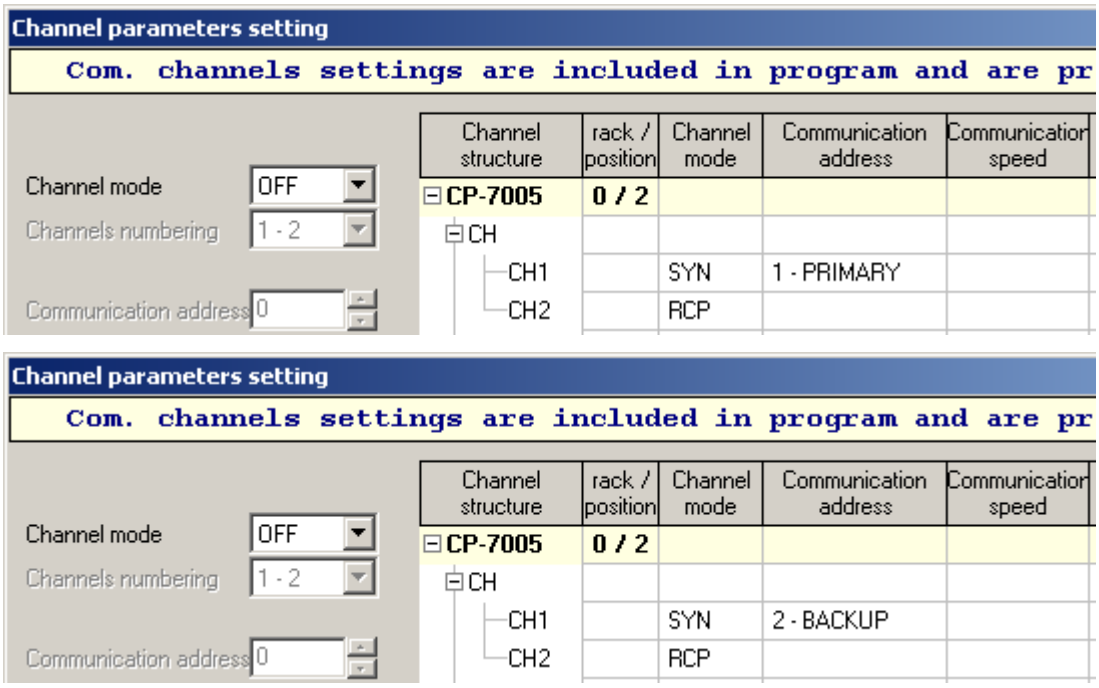
Aby převzetí řízení bylo „beznárazové“, předává primární CPU do zálohovací všechna data nezbytná pro zachování kontinuity řízení. K tomu slouží synchronizační linka na rozhraní Ethernet. Tato linka také zajišťuje jednotné programování a ladění celé sestavy. Díky tomu se celý systém navenek chová jako běžný PLC s jednou centrální jednotkou a programátor není zatěžován nutností zavádět stejný uživatelský program do obou centrálních jednotek zvlášť.

Jak vyplývá z obr.3.4, každá centrální jednotka je osazena do samostatného rámu. Protože obě zpracovávají stejný uživatelský program, je zřejmé, že se vlastně jedná o dvě zcela identické sestavy PLC, kde všechny moduly musí být shodného typu a na stejných pozicích.

Redundantní PLC TECOMAT TC700 je postaven tak, že toleruje výskyt jedné závažné chyby v redundantní části. To znamená, že po výskytu závažné chyby je tato chyba vyhlášena, centrální jednotka, která chybu zjistila, se zastaví a technologii řídí centrální jednotka, která chybu nemá. To dovoluje obsluze chybu odstranit za chodu technologie a opravenou část systému znovu spustit.

Proto jsou centrální jednotky propojeny dvěma synchronizačními linkami. Kromě linky SYN1 na rozhraní Ethernet slouží jako záložní linka SYN2. Pokud dojde k poruše linky SYN1, nejsou synchronizována data, ale centrální jednotky nadále mají přehled o svém stavu. Převzetí řízení však již není „beznárazové“, protože centrální jednotka přebírající řízení nemá aktuální provozní data.

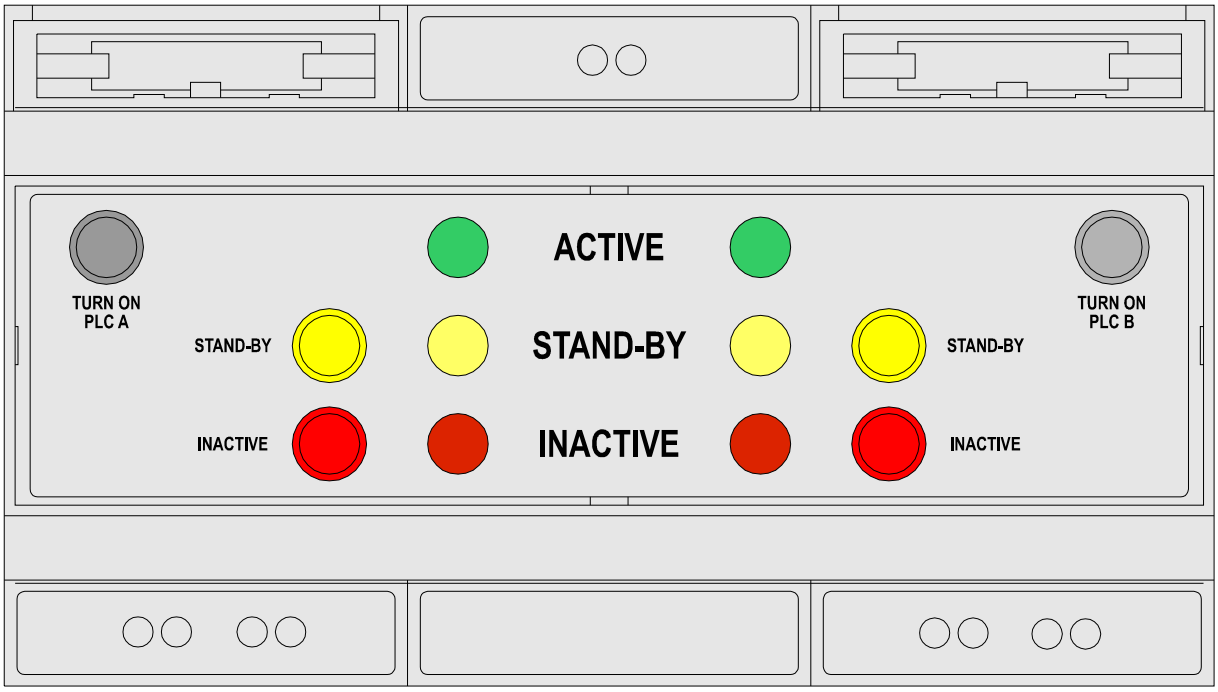
O tom, která centrální jednotka je primární a která zálohovací, rozhoduje nastavení adresy na záložní synchronizační lince SYN2 na kanálu CH1, které lze provést ve vývojovém prostředí Mosaic (obr.4.1), nebo pomocí tlačítek na centrální jednotce v nastavovacím režimu po zapnutí napájení (kap.2.3.8.).



Obr.4.1 Nastavení primární (PRIMARY) a zálohovací (BACKUP) centrální jednotky

Nedílnou součástí redundantního systému je řídicí panel redundance ID-20 (obr.4.2). Panel obsahuje trojici tlačítek a trojici indikačních LED diod pro každou centrální jednotku. LED diody indikují stav příslušné centrální jednotky a pomocí tlačítek lze ovládat ručně přechod centrálních jednotek do požadovaných stavů.

Podrobnosti o přípojení panelu ID-20 k oběma centrálním jednotkám jsou uvedeny v kap.3.3.2.2.



Obr.4.2 Řídicí panel redundance ID-20

4.4.5.3. Stavy redundantního systému

Redundantní PLC se chová obdobně jako standardní PLC. Rozdíl spočívá v tom, že zatímco standardní PLC lze provozovat pouze v režimu RUN, redundantní systém má provozních stavů několik (tab. 4.4).

NOT CONFIG - stav bezprostředně po předchodu z režimu HALT do některého provozního stavu. Systém ještě není zkonfigurován. Po splnění podmínek přechází systém do stavu INITIAL.

INITIAL - probíhá inicializace systému včetně všech periferií. Po splnění podmínek přechází systém do některého provozního stavu. Za normálních okolností (obě větve redundantního systému byly spuštěny současně) přechází primární CPU do stavu ACTIVE (režim RUN) a záložní CPU do stavu STAND-BY (režim STB). Pokud primární CPU přechází do provozního stavu v době, kdy záložní CPU už je ve stavu ACTIVE (řídí technologii), primární CPU přejde do stavu STAND-BY. Nebude se tedy snažit převzít zpět řízení. To může udělat obsluha ručně přes panel ID-20.

ACTIVE - provozní stav, centrální jednotka je v režimu RUN a řídí technologii.
Pokud dojde k závažné chybě, přechází CPU do stavu NOT CONFIG a do režimu HALT. Druhá CPU přejde do stavu ACTIVE, pokud byla ve stavu STAND-BY.
Pokud obsluha stiskne na panelu ID-20 tlačítko STAND-BY příslušné této CPU, přechází do stavu STAND-BY. Druhá CPU přejde do stavu ACTIVE. Pokud druhá CPU nebyla ve stavu STAND-BY, nebo v něm byla

dobu kratší než 5 sekund (bliká LED dioda STAND-BY), CPU, která je ve stavu ACTIVE, na stisk tlačítka nereaguje.

STAND-BY - provozní stav, centrální jednotka je v režimu STB a funguje jako horká záloha připravená kdykoli okamžitě přejít do stavu ACTIVE.
Pokud dojde k závažné chybě, přechází CPU do stavu NOT CONFIG a do režimu HALT. Druhá CPU zůstává ve stavu ACTIVE a na tlačítka na panelu ID-20 nereaguje.
Pokud dojde k závažné chybě druhé CPU, přechází tato CPU do stavu ACTIVE a na tlačítka na panelu ID-20 nereaguje, dokud druhá CPU nebude ve stavu STAND-BY.
Stav STAND-BY je prvních 5 sekund blokován, aby nebyla častým přepínáním narušena stabilita systému. Tento stav je indikován blikáním LED diody STAND-BY. Po tuto dobu ani jedna z CPU nereaguje na tlačítka panelu ID-20.
Pokud obsluha stiskne na panelu ID-20 tlačítko INACTIVE příslušné této CPU, přechází do stavu INACTIVE. Druhá CPU zůstává ve stavu ACTIVE. Pokud tato CPU nebyla ve stavu STAND-BY, nebo v něm byla dobu kratší než 5 sekund (bliká LED dioda STAND-BY), na stisk tlačítka nereaguje.

INACTIVE - provozní stav, centrální jednotka je v režimu INA a nevykonává žádnou řídicí činnost, ani není schopna se jí okamžitě ujmout. Periferie nejsou obsluhovány a jsou uvedeny do bezpečného stavu (zablokovány výstupy). V tomto stavu je možné vyměnit periferní moduly v redundantní části periferního systému. Nelze měnit uživatelský program, protože druhá centrální jednotka řídí technologii a stav, kdy je v každé centrální jednotce jiný uživatelský program, je nepřípustný. Chceme-li změnit uživatelský program, musíme celý systém převést do režimu HALT, nebo použít on-line změnu.
Pokud obsluha stiskne na panelu ID-20 tlačítko STAND-BY příslušné této CPU, přechází přes stavy NOT CONFIG a INITIAL do stavu STAND-BY. Druhá CPU zůstává ve stavu ACTIVE a po 5 sekundách umožní předání řízení pomocí panelu ID-20.

Tab.4.4 Indikace stavů redundance na centrálních jednotkách a řídicím panelu

Stav redundance	**CP-7005**		**ID-20**
	Indikace LED	**Displej**	**Indikace LED**
Režim HALT	svítí RUN	**Halt**	nesvítí žádná
Systém nezkonfigurován - stav NOT CONFIG	bliká RUN	**NCf**	nesvítí žádná
Inicializace systému - stav INITIAL	bliká RUN	**Ini**	svítí všechny
Režim INA - stav INACTIVE	bliká RUN	**InA**	svítí INACTIVE
Režim STB - stav STAND-BY	bliká RUN	**Stb**	svítí STAND-BY*
Režim RUN - stav ACTIVE, spojení s druhou CPU je platné (synchronizační linky SYN)	bliká RUN	**Run**	svítí ACTIVE
Režim RUN - stav ACTIVE, odpojeno napájení druhé větve z důvodu ztráty spojení s její CPU	bliká RUN	**Run**	svítí ACTIVE, bliká INACTIVE

* Stav STAND-BY je prvních 5 sekund blokován, aby nebyla častým přepínáním narušena stabilita systému. Tato skutečnost je indikována blikáním LED diody STAND-BY.

O svém stavu se centrální jednotky navzájem informují na synchronizačních linkách SYN1 (rozhraní Ethernet) a SYN2 (kanál CH1). Pokud dojde k poruše jedné linky, centrální jednotky mají stále dostatek informací. Pokud dojde k poruše obou linek nebo se jedna centrální jednotka z nějakého důvodu odmlčí, pak centrální jednotka, která je ve stavu STAND-BY, přejde do stavu ACTIVE, převezme řízení a pomocí panelu ID-20 odpojí napájení druhé větve systému, aby nemohlo dojít ke stavu, kdy se snaží řídit technologii obě centrální jednotky. Tento stav je indikován blikáním LED diody INACTIVE na panelu ID-20 na straně aktivní CPU při současném trvalém svitu LED diody ACTIVE.

Po opravení závady musíme stisknout tlačítko TURN ON na panelu ID-20 na straně vypnuté centrální jednotky a tím obnovíme napájení vypnuté větve systému.

4.4.5.4. Redundance periferních modulů

Plně redundantní systém

Jak už bylo řečeno v předchozích kapitolách, plně redundantní systém představuje dvojice identických systémů, tedy včetně všech periferních modulů.

Vstupní signály se rozvedou identicky k odpovídajícím vstupním modulům v obou větvích, nebo můžeme pro každou větev použít samostatná čidla. V případě samostatných čidel jde o jejich redundanci pouze v případě, že jsme schopni uživatelským programem rozpoznat jejich poruchu a na základě toho vyvoláme předání řízení sousední větvi.

Výstupní signály z odpovídajících výstupních modulů v obou větvích je potřeba „sečíst“ pomocí hardwaru v řízené technologii.

Komunikační moduly SC-710x se v režimech MPC, PLC a UNI chovají tak, že v režimu STB (stav STAND-BY) se odpojují od linky a přestávají komunikovat. Díky tomu je možné při použití rozhraní RS-485 odpovídající sériové kanály v obou větvích propojit. Data do sériových linek vysílají pouze komunikační moduly ve větvi, která řídí technologii.

Neredundantní periferní moduly v redundantním systému

Zvláště u rozsáhlejších technologií lze ušetřit nemalé prostředky kombinací redundantního systému a neredundantních periferií obsluhovaných pomocí expanderů SE-7131 a SE-7132 (kap.3.3.2.1., obr.3.5).

Periferní moduly, které nechceme mít redundantní, osadíme do rámů obsluhovaných dvojicí slave expanderů SE-7132. Tyto slave expandery jsou rozhraním Ethernet připojeny každý k jednomu master expanderu osazenému v redundantní části systému v rámu, kde je osazena centrální jednotka. Tak je zajištěno spojení s oběma větvemi redundantního systému. Oba slave expandery spolu komunikují po sběrnici a je tak zajištěno, že periferní moduly v neredundantní části systému budou obsluhovány vždy jen jedním z nich.

Na sběrnici je aktivní vždy ten slave expander SE-7132, který má spojení s větví, jejíž centrální jednotka je ve stavu ACTIVE. Tento stav expanderu je indikován blikající zelenou LED diodou RUN na čelním panelu modulu. V ostatních stavech tato LED dioda trvale svítí (tab.4.5).

Naproti tomu indikace master expanderů SE-7131 v redundantní části systému se chová tak, že zelená LED dioda RUN bliká ve stavech STAND-BY a ACTIVE i během přechodů do těchto stavů (tab.4.5), pokud nedojde k závažné chybě.

Tab.4.5 Indikace stavů redundance na expanderech

Stav redundance	SE-7131 Indikace LED	SE-7132 Indikace LED
Režim HALT	svítí RUN	svítí RUN
Systém nezkonfigurován - stav NOT CONFIG	bliká RUN	svítí RUN
Inicializace systému - stav INITIAL	bliká RUN	svítí RUN
Režim INA - stav INACTIVE	svítí RUN	svítí RUN
Režim STB - stav STAND-BY	bliká RUN	svítí RUN
Režim RUN - stav ACTIVE	bliká RUN	bliká RUN

Závažné chyby vzniklé na expanderech jsou indikované červenou LED diodou ERR na těchto modulech. Chyba je následně předána příslušné centrální jednotce, která přejde do režimu HALT a chybu zobrazí na displeji. Pokud chyba vznikne pouze v jedné větvi systému, řízení převezme druhá větev. Pokud vznikne chyba v neredundantní části systému, do režimu HALT přejde celý systém.

Pozor! Je třeba si uvědomit, že závažná chyba v neredundantní části systému má za následek okamžité zastavení celého systému.
Je zakázáno za chodu vyjímat a zasouvat kterýkoli z obou slave expanderů SE-7132, i když zrovna neobsluhuje sběrnici.
Je nutné zabezpečit, aby při uvádění systému do provozu bylo napájení neredundantní části systému zapnuto dříve nebo nejpozději ve stejnou dobu jako napájení redundantní části systému, aby došlo ke správnému navázání komunikace mezi master a slave expandery.

4.4.6. Module hot-swap procedure

This feature is supported by the central units CP-7001, CP-7002, CP-7003 and CP-7005 from software version 2.5. The CP-7004 central unit supports this feature in all software versions.

Under normal circumstances, a critical error is reported when communication between the central unit and the peripheral module is lost and the PLC switches to the HALT mode. But there are also cases, when it is required to replace the peripheral module for another one in case of a failure under PLC run, this is to say the PLC stays permanently in the RUN mode.

The possibility of removing the peripheral module under run is allowed for each module individually in the Mosaic development environment. Select the required module in the project manager in folder *Hw* | *HW Configuration* and, in panel *Settings* (icon on the corresponding line) select the option *Modul can be removed under run*.

Selecting this option causes suppression of error messages related to this module. To keep the user program working only with valid data from this module, it is necessary to condition data processing by the DATA bit in the status register related to this module. The status register is part of the status zone of the peripheral system located in registers S100 - S227 and releases the current state of the corresponding peripheral module (see chapter 5.5.).

Attention! **It is not allowed to remove or plug in a switched on supply module into the system!** When handling a supply module**, it has to be off!**
The system can be switched on provided it is supplied from another supply module.

4.4.7. Change of the program while the PLC is in operation

Program on-line change

The Mosaic development environment enables a so called online program change which is a change of the user program undertaken while the PLC is in operation that can be performed with central units CP-7001, CP-7002, CP-7003 and CP-7005 commencing sw version 4.1 and with central unit CP-7004 in all sw versions. The support for on-lin change is integrated in th Mosaic development environment commencing version 1.5.10. This can be tried out on the PLC simulator in the Mosaic development environment.

The on-line change of the program is a feature of the central unit which allows performing changes to the user program without stopping the technology under the control, i.e. without a necessity to shut down the technology controlled, when modifying the PLC program. This feature gives the programmer using the TECOMAT TC700 system a possibility to make changes to the PLC program while the PLC is running. It is, of course, the programmer who is responsible for the correctness of modifications being made on-line. The PLC central unit together with the Mosaic development environment ensures safe execution of these changes at one time so, that the continuity of control is not threatened.

To explain the basic principle let us use the following example. Let us assume that the TECOMAT PLC controls a technology which shut down would mean a very high economic loss, e.g. a calciner, and the programmer was ordered to make changes to the PLC program used. It is not important at this moment, whether it is a correction of an incorrect control algorithm or addition of a new function (e.g. baking of a new product). It is necessary to make changes to the PLC program and the calciner working must not be stopped. The on-line change of the program can be a solution to this situation. The programmer performs the corresponding changes of the PLC program and the central unit ensures swapping from the old program to the new one in such a way that the n-th cycle of computation is fully executed according to the original program and the following cycle will be performed according to the new program. The central unit also ensures necessary activities connected with the changes of variables in such a way that the continuity of control is not affected.

The on-line change of the program can be enabled in the Mosaic development environment in the *Project manager* in the folder *Environment / PLC Control* where we enable the option *Enable 'On-line changes'*. If the central unit does not support the on-line changes, this mode cannot be activated in the Mosaic development environment.

The enabled support of the on-line changes is signalized in the Mosaic development environment on the menu bar by the flower symbol  . If the icon is coloured, the support of the on-line changes is on. If the flower icon is grey, the on-line changes are off and each change to the program will result in stopping of the control when loading the new program to the PLC.

Detailed information on the on-line changes can be found in the Help of the Mosaic development environment.

Possibilities of on-line changes

When using the on-line change, the programmer can modify the following parts of the program:

- Program code, i.e. any modifications of all parts of the program;
- Modifications of variables, i.e. insertion and deleting of all types of variables such as modification of the field size;
- Modifications of data types, e.g. changes to structures, adding of new data types and deleting data types not being used;

- Modifications of the size of the remnant zone.

The following modifications cannot be performed within the on-line change of the program:

- Changes to hw configuration of the system, such as addition of I/O modules or changes to I/O module types;
- Changes to I/O modules settings;
- Changes to settings of communication parameters for serial channels;
- Changes to PLC network.

4.5. PLC PROGRAMMING AND DEBUGGING

PLC programming

Programming of control algorithms and testing of the program correctness for the TECOMAT TC700 PLCs is carried out on a standard PC. For connection with the PLC, a common serial channel of these computers or the USB interface or the Ethernet interfaces is used. For each PLC, a CD ROM with the installation of the MOSAIC development environment with the version Mosaic Lite is supplied.

The MOSAIC development environment

The Mosaic development environment is a complex development tool for programming PLC TECOMAT applications and TECOREG controllers that provides a user-friendly application for program creation and debugging. It is a product running under Windows 2000 / XP platforms where a great number of modern technologies are employed. The modular structure of the Mosaic development environment allows the users to create such an environment from its parts that he will need. The following versions are available:

Mosaic Lite non-keyed version with a possibility to program a PLC with two peripheral units
Mosaic Compact allows programming compact TECOMAT PLCs of series TC400, TC500, TC600 and TECOREG controllers without limitations
Mosaic Profi designated for all systems of company Teco without limitations

The basic environment contains the components necessary for creation of a program or such components the user usually will be using: text editor, xPRO mnemocode compiler, debugger, a module for communication with the PLC, a PLC simulator, a PLC configuration module and help. A simulator of operation panels ID-07 / ID-08 and built-in TC500 panel are part of the basic environment.

The expansion of the environment is done by means of plug-ins - modules that are initialised in connection with the basic environment, so the Mosaic development environment can be expanded to have a possibility of further programming - structured text according to standard EN 61131 (Mosaic ST plugin), language of relay diagrams (Mosaic LD plugin) or function blocks (Mosaic FBD plugin) and other support tools for designing operator panel screens (PanelMaker), a tool for working with PID controllers (PIDMaker), graphic on-line analysis of variables being monitored or off-line analysis of archived data (GraphMaker).

4.5.1. Configuration constants in the user program

Configuration constants are generated automatically during the compilation of the user program and are integral part of it. They carry information on the requested PLC mode and its use. The constants can be set up by means of the menus of the MOSAIC development environment before compilation is performed (Project manager, folder *Sw* | *Cpm*) (fig. 4.1).

Default values are set up after pressing the button *Default.*

Configuration constants contain the following items:

- *PLC restart* - type of restart after switching PLC power supply on. It specifies, whether warm or cold restart will be performed (chapter 4.4.4.). By default, cold restart is preset.
- *Protected tables* - specification of user program backup range at EEPROM. It is defined here, whether the entire user program including T-tables or without T-tables is backed up and T-tables remain original at backed up RAM (if the option is enabled - useful in

such cases when the tables are modified by the user program). By default, the entire user program is backed up (option disabled).

- *First warning* - time of warning that the maximum permissible cycle time could be exceeded.
  If the cycle time of user program processing is longer than the period of time defined by this constant, PLC system services set the bit S2.7 as a flag that the time set is exceeded during program processing at this cycle. At the same time, the code of the soft error is set in the system register S34. By default, the value is 150 ms.

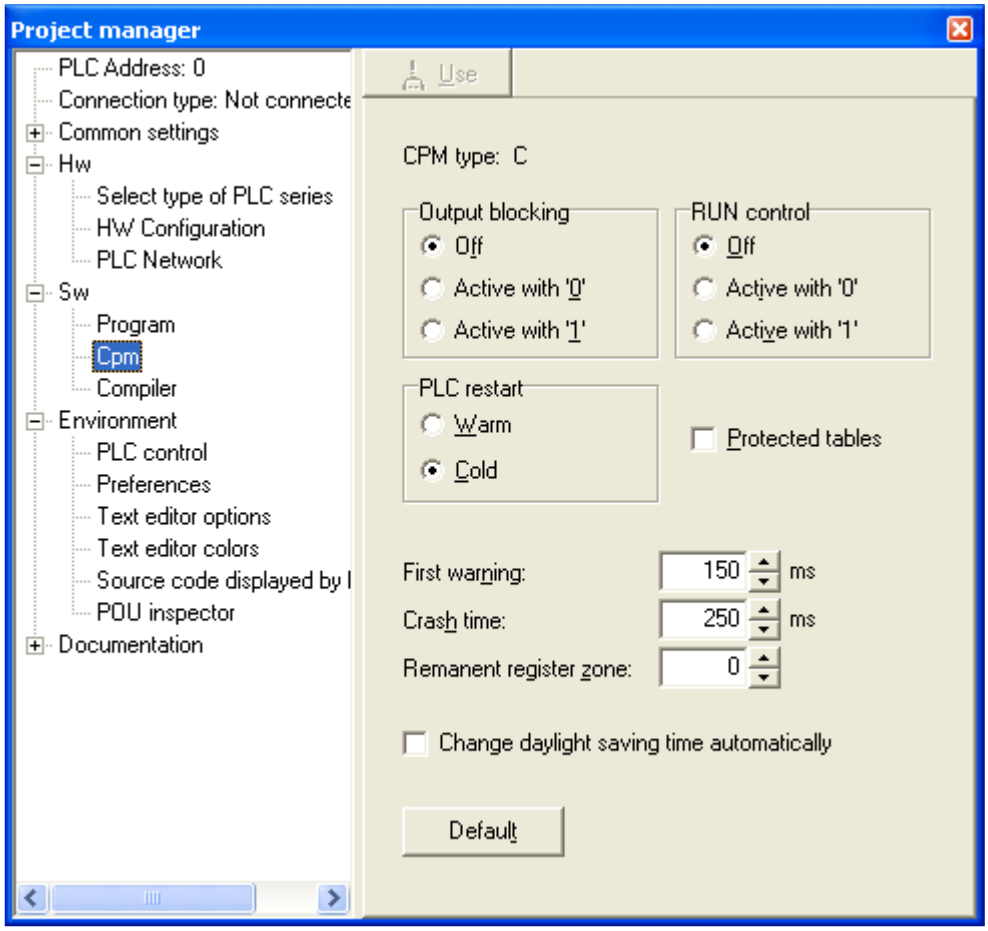


Fig. 4.1 Configuration constant setup

- *Crash time* - time of monitoring of the maximum permissible cycle time
  If the user program processing cycle is longer than the maximum permissible period of time, the PLC reports the critical error of cycle time exceeding, locks the outputs and interrupts the cyclic execution of the user program. This constant defines the longest permissible period of time, at which the controlled object can be without any intervention. The default value is 250 ms, the recommended maximum value is 500 ms.
- *Remanent register zone* - number of backed up registers R (remanent zone). Setting of the number of backed up registers R, values of which will be saved during PLC power supply failure, protected by a check character and will be restored in case of warm restart of the PLC. The registers are saved beginning with register R0, the state of the registers is backed up after the last fully completed cycle of the user program. The default value is 0.

- *Change daylight saving time automatically*
  The setup causes that the system will switch the system time automatically to daylight saving time at the time from the last March Sunday from 2 o'clock a.m. till the last October Sunday till 3 o'clock a.m. Time indication is accessible on the bit S35.6 (0 - regular time, 1 - daylight saving time). The bit S35.7 indicates the function activity (1 - on).
  By default, this function is off.

4.5.2. PLC configuration

The configuration of the peripheral units describes the PLC unit and is integral part of the user program. This description is compared with the reality found during the PLC switching sequence before the initialization of the user program execution. At the MOSAIC development environment, the configuration is entered by filling in of the forms and based on them, the environment generates directives *#module*. It can be said in general that these directives contain the following information on each operated PLC peripheral module.

- rack address, where the module is fitted
- position of the module in the rack
- information on assignment of the serial channel number CHn for a particular communication module, for example
- number of transmitted input and output bytes of the modules
- position in the PLC scratchpad, where the read data / sent data from / to the module are (start of the continuous zone in the area X, Y)
- reference to T-table containing initialization data

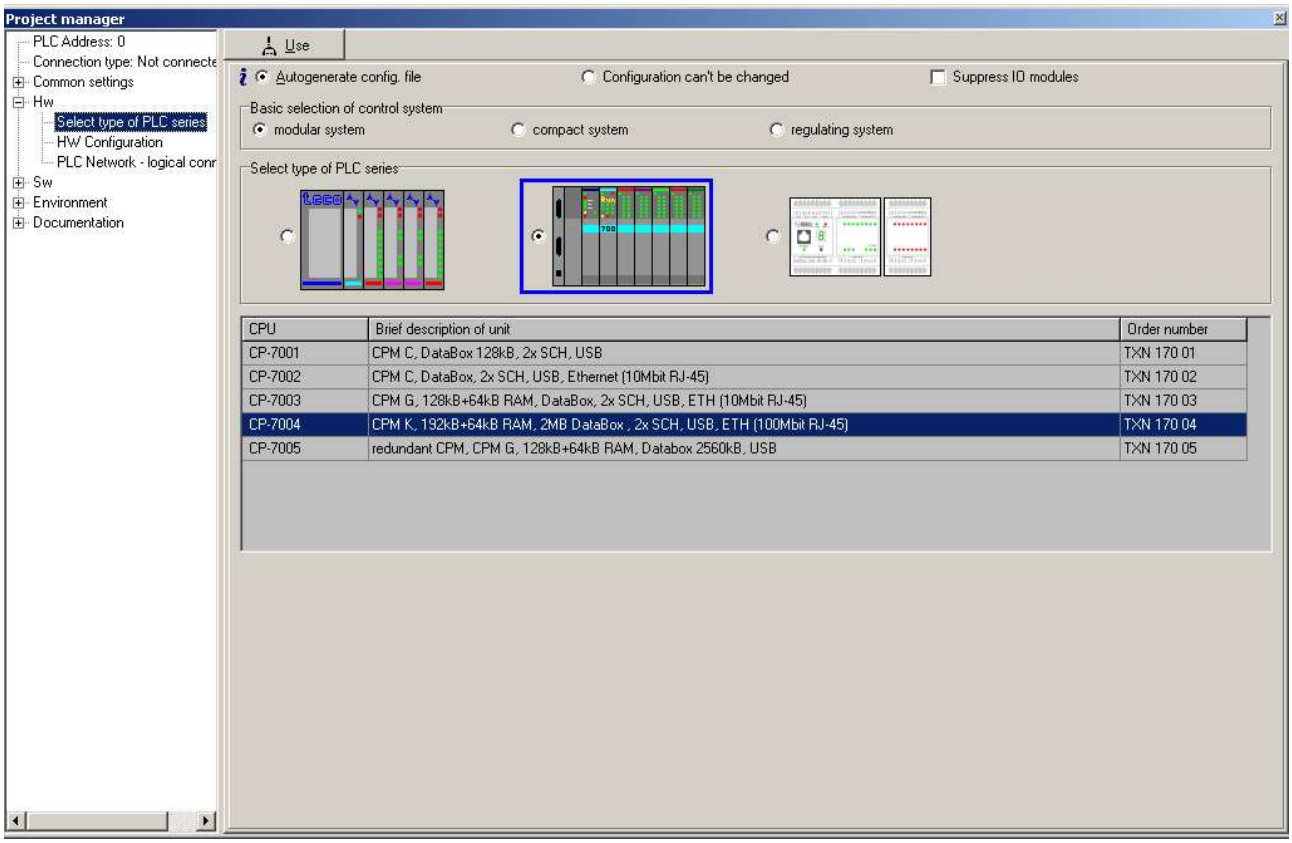


Fig. 4.2 PLC series selection

This information allows to check readiness of the entire PLC to be controlled, before program initialization. The MOSAIC development environment allows manual as well as automatic TECOMAT TC700 PLC configuration.

First, in the Project manager select the TC700 modular system in the folder *Hw / Select type of PLC series* and select the central unit, which is the PLC fitted with (fig. 4.2). Then, we can configure the PLC (fig. 4.3.) in the folder *Hw / HW configuration* of the Project manager.

Manual configuration of PLC

You can configure the PLC manually when the concrete PLC unit is not physically available. In this case, we set the number of racks and the size of each rack (number of positions). At the selected position of the form (fig. 4.3.) we then right-click at the column *Module type*. In the menu we select the module required. Its name appears at the required position of the form. By clicking the left mouse button on the icon a panel opens, allowing to configure the concrete module. Detailed information on the possibilities of configuration can be found in corresponding manuals.

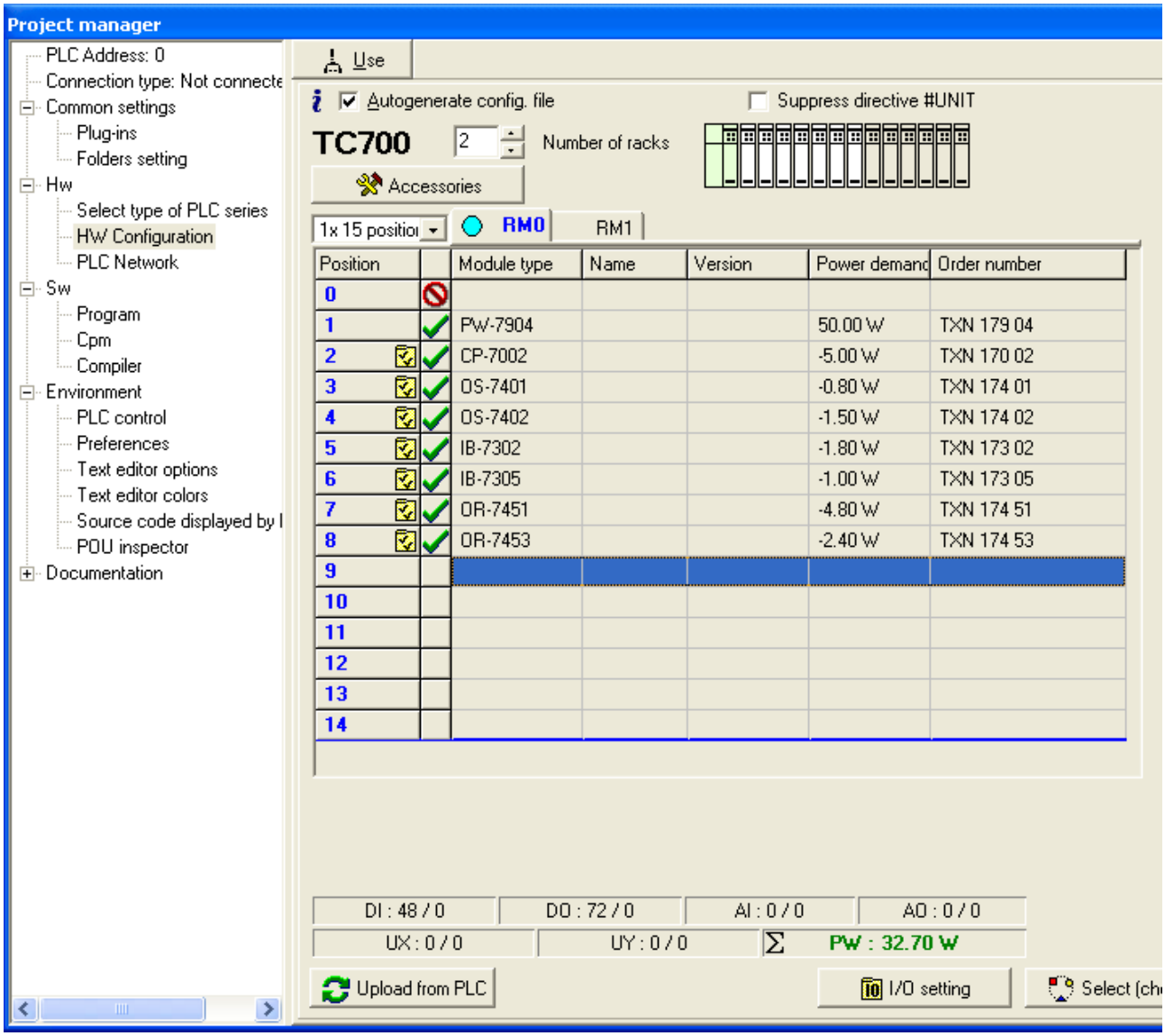


Fig. 4.3 TC700 configuration setup

Automatic configuration of PLC

If the PLC unit is physically available, which we want to configure, switch the PLC power supply on and establish communication with the PLC. Go back to the folder *Hw / HW configuration* and press the button *Upload from PLC* (fig. 4.3). Based on the data in the central unit, a list of found modules is produced (fig. 4.4.). The option *Keep original module setup for imported modules* allows correcting of the configuration or adding to it without loosing the original setting. If the option is active (enabled), then the modules that have been configured already and found at the same positions, will keep their settings. The other modules newly found or modified (another type at the same position) have their configuration set to their initial values. If this option is not active (disabled), all the modules will have their configuration set to their initial values. Thus, their possible presetting will be lost. If you do not want some of the found modules to be included in the configuration, click on the check mark on the left edge of the line with the name of this module. By pressing the button *Apply* the list offered will be accepted. Consecutively, individual configuration dialogues for all modules are automatically offered. After finishing this, the object is ready for debugging purposes with the concrete PLC unit, which is available.

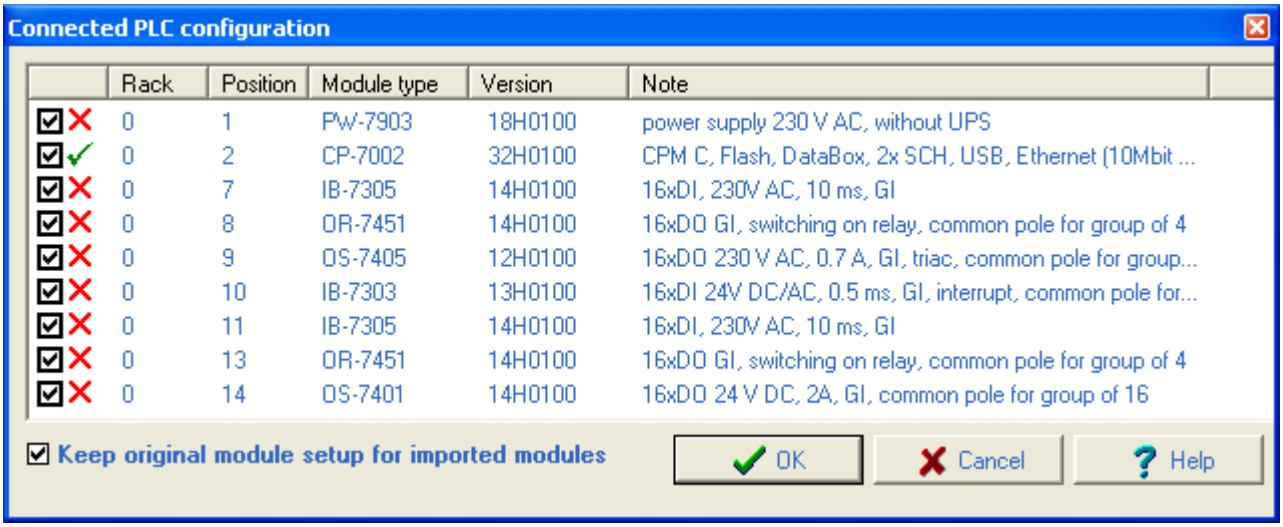


Fig. 4.4 Configuration upload from PLC

As it can be understood from the above mentioned text, the automatically set up PLC configuration can be modified manually at any time and vice versa.

Peripheral module operation disconnection

The operation of any of the peripheral modules can be disconnected without its taking out of the rack, at the MOSAIC development environment by double-clicking on the field immediately before the name of the module in the Project manager in the folder *Hw / HW configuration*. The green mark indicates that the module will be operated, the red cross says, the module will not be operated.

User program execution with disconnected peripheral modules

If there is no sw configuration entered in the user program, the program will be solved only above the PLC scratch pad memory and the PLC inputs and outputs will not be operated. The output modules will be locked in this case.

We can achieve the same result if we select the option *Suppress IO modules operation* in the *Hw / HW configuration* folder in the Project manager. The translator will then ignore the set configuration and the program will be, after the compilation and launching, executed above the notepad memory only.

Monitoring of data provided by peripheral module

By pressing the button *I/O Setting* a panel with data structure provided by the specified module is called, with its symbolic name generated that can be changed arbitrarily, and with current values of the data. A description of the content of this panel is always given within the description of each concrete module.

4.5.3. Project archivation in the PLC

CP-7001, CP-7002, CP-7003, CP-7005 with version hw 02 and higher and all CPUs CP-7004 enable to archive user projects directly into the central unit. This feature is useful when servicing the system and connected technologies when we have access to the source files of the user program which the central unit works with. In this manner we can avoid problems when after several years application source files cannot be found or it is not obvious which version is uploaded in the central unit.

The whole project is saved in the central unit as a zip file protected with a password. The complete process of archivation and restoring is done in the Mosaic environment.

Project archivation

Choose the item *File* | *Archivation* | *Archivation of the project to the PLC* in the menu in the Mosaic environment which will open the panel *Archive project group into the PLC)* (Fig.4.7).

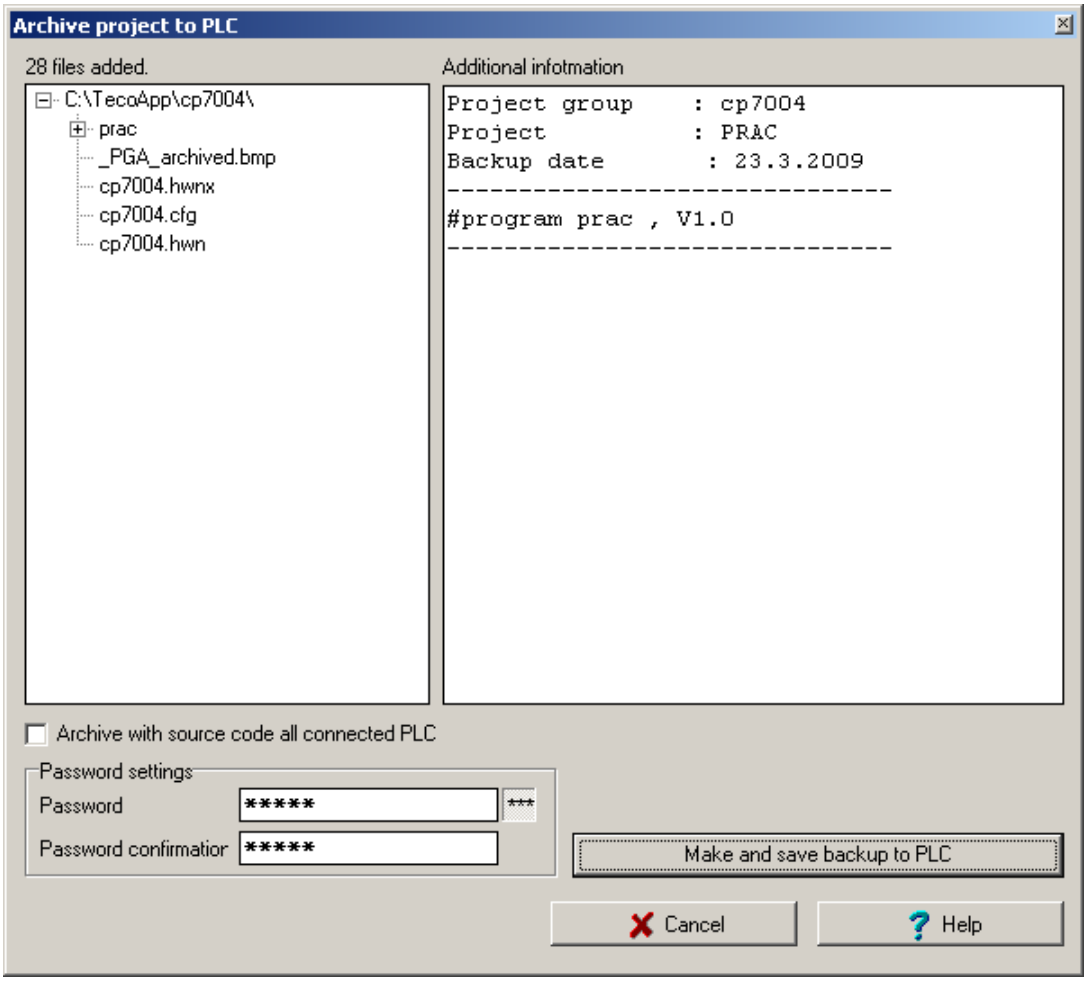


Fig. 4.7 Archive project to PLC

The left field shows a tree of archived files. We can enter a random text into the right field to describe the archived project.

All files of the actual project are saved in the central unit. If we select the option *Archive including source codes of connected PLCs,* then, besides the relevant project, also projects from all other PLCs from the project group which are in any way connected to this PLC *will be saved, too. (*in the project manager in the folder *Hw|PLC network - logic interconnection)*.

Input a password into the field *Password* and input the same password into *Password check*. If we want to see what we are writing, we can switch off the character masking by pressing the button ***. By pressing it again the masking will be renewed. The maximum password length is 20 characters.

Then press the button *Create and save the backup to the PLC* and Mosaic will create an archive and save it to the central unit. If another project has been already saved into the central unit, then a window will appear stating its name and time of archivation and will ask you to confirm the overwriting of the former project.

Project restoration

In the Mosaic environment choose from the menu *File | Archiving|Restore the project from the PLC* and the panel *Project group restoration from the PLC* (Fig.5.7) will appear.

The description of the saved project that we entered during its archivation will appear in the right field.

Input the password into the field *Password*. If you want to see what you are writing, you can switch off the character masking by pressing the button ***. By pressing it again the masking will be renewed. After pressing the button *Download from the PLC,* the PLC archive is downloaded to the computer.

In the part *New project group* we enter, to the field *Name of new project group,* the name under which the project group containing the archived projects will be created. After pressing the button *Create and open* the project group will be created and opened according to the name entered and it will contain all projects that were downloaded from the PLC archive.

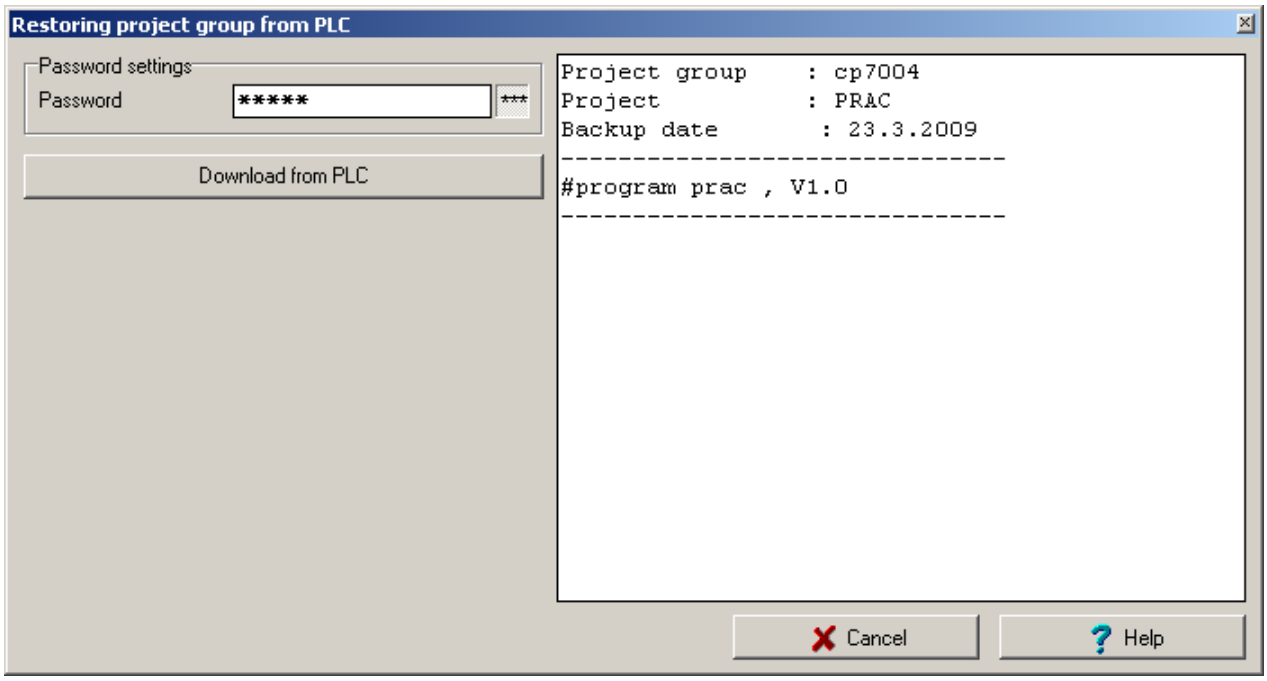


Fig.4.8 Restoring project group from PLC

4.6. TESTING OF I/O SIGNALS CONNECTED TO THE PLC

For basic testing of the input and output signals connected to the PLC, it is sufficient to create an empty program containing only sw configuration of the PLC being tested and instructions P 0 and E 0, which create an empty basic process. By means of the debugging means of the MOSAIC development environment, we then can monitor the states of the connected inputs and set any values on the PLC outputs. This very easy but very effective way is recommended to be used before user program debugging, since the entire path from the input elements (limit switches, ...) through the input units to the PLC scratch pad memory and back from the scratch pad memory through the output units to the action elements will be tested. By doing this, errors arisen when connecting the PLC to the object to be controlled will be cleared. Finding of such errors is significantly more difficult at the stage of control program debugging. Testing of the input and output signals can also be carried out by means of so called "fixation", which is accessible at the MOSAIC development environment on the panel *I/O Setting*. This procedure is applicable any time at the stage of user program debugging and later when servicing connected technologies. The fixed value keeps its set value regardless of the user program as well as serial communication. The state of fixation is indicated on the display of the central unit (see table 4.3).

4.7. FILE SYSTEM AND WEB SERVER

The central unit CP-7004 contains a slot for a memory card of the MMC and SD types. Individual files on cards can be saved in file systems FAT12, FAT16 or FAT32.

Cards must be formatted beforehand (the card cannot be formatted in the PLC) and if possible clear (the card can be also used for archivation of other files connected with the application but with the increasing number of files, the access to the card is slowed down). It is also important to take into consideration the card´s lifetime which is round 100 000 entries.

Memory card application

The Mosaic enables the entry of files to the memory card inserted in the central unit via the option *PLC* | *File system PLC*. All files transferred via the Mosaic are saved on the card into the directory (folder) ROOT. Within this folder other directories can be created by the user alone. Files saved on the card outside of the directory ROOT are not visible in the Mosaic environment.

Furthermore, the memory card is used by the Webmaker by the help of which web pages for the display of the PLC user program variables can be created. These files are saved in the folder ROOT / WWW.

Library FileLib functions used in the PLC user program enable data transfer between the memory card and the PLC notepad in both directions and other file operation. The library is supplied as a part of the Mosaic environment installation from the version 2.6.0.

Directories structure

The root directory for file operations within the PLC is called ROOT. The PLC programmer can work with those files and directories only that are located in the ROOT directory. Other files and directories are not accessible from the user program. Consequently, the ROOT directory is for the PLC programmer the current directory.

File names

The file system support file names in the convention DOS 8.3. The file name consists of the file name itself (max. 8 characters) and of the file name extension (max. 3 characters). These two parts are separated by a dot. No punctuation symbols, spaces and symbols *, ? can be used in file names. Characters of national alphabets are not supported in names. Capital and small letters are not distinguished. Substituting characters (e.g. *.*) are not supported.

File path

The file path determines the file location on the disc in relation to the ROOT directory. Consequently, the file path contains names of directories where the file is saved. Same rules apply to the directory names as apply to file names. Individual directory names in the path are separated by the / (slash). The PLC file system supports absolute paths only. Relative paths or even current directory change are not supported.

Maximum file name length including the path is limited to 65 characters.

4.7.1. Memory card handling

Memory card insertion to the switched off system

After the memory card is inserted to the slot of switched off system, its automatic connection will take place immediately after the system power switch-on. Připojení karty je indikováno rozsvícenou LED diodou ENABLED umístěnou vedle slotu (obr.2.13). Blikání této LED diody pak indikuje probíhající zápis dat na kartu (otevřený soubor).

Memory card insertion during system run

Paměťovou kartu lze také vkládat za chodu systému. K tomu slouží tlačítko ON/OFF umístěné vedle slotu pod indikační LED diodou (obr.2.13)..

Paměťovou kartu zasuneme do slotu a stiskneme tlačítko ON/OFF. Centrální jednotka připojí paměťovou kartu a rozsvítí LED diodu ENABLED. Paměťová karta je připojena.

Memory card removal from the shut down system

The memory card can be removed from the shut down system only when we are sure that **no entry on the card was in action during the system power switch-off** Pokud dojde k výpadku napájení během zápisu na kartu, právě otevřený soubor se neuzavře a souborový systém je porušen. Po zapnutí napájení centrální jednotka tento problém zdetekuje a opraví bez následků. Pokud ale kartu s takto narušeným obsahem vyjmeme ze systému a zkusíme přečíst v jiném zařízení, může dojít až ke ztrátě všech dat na kartě.

Memory card removal under system run

Bezpečnější je vyjmout paměťovou kartu za chodu systému. Pokud je karta připojená, svítí LED dioda ENABLED vedle slotu. Stiskneme tlačítko ON/OFF. Pokud LED dioda trvale zhasne, můžeme kartu bez obav vyjmout. Pokud LED dioda bliká, znamená to, že probíhá zápis na kartu (je otevřen soubor). Karta bude odpojena bezprostředně po zavření souboru.

Pokud převedeme centrální jednotku do stavu HALT (např. z vývojového prostředí Mosaic). Centrální jednotka zastaví vykonávání uživatelského programu a uzavře všechny otevřené soubory na paměťové kartě.

IF LED diode ENABLED is flashing or lighting, do not handle with the memory card. If you do it, the file system on the card can be damaged!

4.7.2. Web server

The central unit contains a Web server that enables the technology state viewing via the common internet browsers as is for example Internet Explorer, Firefox, etc. Individual pages are created in the XML language.

In Mosaic the Webmaker is used for pages creation that contains graphic editor allowing the insertion of pictures, texts and PLC user program variables.

Files created are saved on the memory card in the folder ROOT / WWW. As a consequence, the **memory card must be inserted** in the central unit to ensure the functioning of the Web server.

Files for the Web server are part of the PLC project. If we send the user program from Mosaic to the PLC, then after the program is loaded, the check of files for the Web server on the memory card in the PLC is undertaken and if any change in comparison with files saved on the PC is detected, PLC files will be updated. This automatic check can be switched off in the Project manager in the node *SW* | *File sending to the PLC* where we disable the option *Send newer files to the PLC automatically.*

4.8. INSTRUCTION SET

The TECOMAT TC700 central units of series C, G and K have a stack with the width of 32 bits. They contain an instruction set, which is when following certain conditions, compatible with another TECOMAT PLCs. .

The instruction set contains the following items:

- Data load and write instructions with direct as well as indirect addressing
- Logical operations with operands of 1, 8, 16 and 32 bits width
- Operation of counters, timers, shift registers
- Arithmetic instructions, conversions and comparison of 8, 16 and 32 bit operands with / without sign
- Limit functions, value shift
- Operating instructions and transfer in programs
- Conditional jumps according to comparison flags
- Table instructions above tables in the user memory, which allow optimum realizing of complicated combinational and sequential functional blocks, decoders, time and sequential controllers, sequential generators, and they also facilitate realization of diagnostic functions, recognition of error states, sequential record of events, process protocols, diagnostic reports of type „black box“.
- Table instructions above the variable space allows operating with index variables, realizing of delay line, long shift registers, conversions into code "1 of n", variable selection, step sequencers, event records and various stack structures
- Table instructions with structured access
- Sequential controller instructions
- The system contains 8 user stacks and instructions for their switching - useful for passing of more parameters between functions that do not follow immediately after each other, saving of immediate state of the stack, etc.

- A useful toll is the set of system variables, in which system time, system time units and their edges, communication variables, flag and command variables, system messages are realized.
- To reduce the response time and to facilitate programming, so called multiprogramming (multi-loop control), including interrupt processes is used.
- Complex tasks (special communication, control, time-critical user tasks) are optimally realized USI user instructions (on the level of microprocessor instructions)..
- Arithmetic instructions with floating point with single precision as well as double precision.
- PID controller instructions
- Operator panel operation instructions.

A detailed description of the instruction set is given in the manual Instruction set for PLC TECOMAT - 32 bit model, order number TXV 004 01.02.

The system can also be programmed in ST, IL, LD and FBD languages in accordance with the international standard IEC 61131. The language description can be found in the manual *Programming of TECOMAT systems in accordance to IEC 61131-3,* order number TXV 003 21.02.

5. ERROR DIAGNOSIS AND TROUBLESHOOTING

PLC diagnostic system

PLC TECOMAT TC700 diagnostic system is part of the PLC software and hardware, the main task of which is to ensure trouble-free and exactly defined PLC function in any situation. In case of a PLC fault the diagnostic system has to avoid in the first instance the possibility of emergency situation in the technology connected to the PLC. A further task of the diagnostic system is to facilitate to service people or users to clear the faults arisen. The diagnostic system is active from switching of the PLC power supply on and works independently from the user.

It is possible to say in general that the diagnostic system continuously monitors all the essential parts and functions of the PLC and at the moment of a fault it ensures that the error state is treated and provides information on the fault, so control safety is ensured and quick corrective actions can be taken, if a PLC fault occurs. Another function of the diagnostic system is to inform the user on possible mishandling or procedures when operating the PLC, so that working with PLCs is easier and more efficient.

5.1. CONDITIONS FOR TROUBLE-FREE FUNCTION OF PLC DIAGNOSTICS

Check for correct function of the supply source

Correct function of the supply modules of the TECOMAT TC700 systems is the essential condition for error-free function of PLCs and for correct function of their diagnostics. The check can be done by means of the indication panel of the supply module (chapter 2.2.3.) and data provided by the supply module (chapter 2.2.4).

System unit function check

After switching the power supply on, the unit performs the basic hw check (see table 4.5). If a hardware error is reported, we recommend the repair to be done by a specialist.

5.2. ERROR INDICATION

The central unit has the main error stack containing 8 last errors reported by the diagnostics of the entire PLC. All the peripheral modules have a local stack containing 8 last errors reported by the diagnostics of these modules. The error in the main error stack have the length of 4 bytes, the errors in the local error stack have the length of 2 bytes.

Error indication

All these stacks can be read by the MOSAIC development environment. The last critical error that stopped PLC running is displayed on the display of the central unit in the following form:

E–80–09–0000

E– - followed by error code in hexadecimal form (digits 0 to F)
80-09-0000 - error code

Centrální jednotky, které mají prostor pro kód uživatelského programu větší než 64 KB (řady G a K), indikují u chyb začínajících číslicí 9 delší chybový kód o dvě číslice.

E–95–00–014212

Chyby v chybovém zásobníku se zpravidla týkají programování PLC a stavu periferních modulů. Stavy centrální jednotky indikované během zapínací sekvence jsou uvedeny v kap.4.3. Indikace operačních režimů je uvedena v kap.4.4.

Error division by severity

Errors that can occur in PLCs, can be divided according to their severity into two groups:

a) Critical errors making error-free control impossible
The ERR and RUN LEDs are on, the PLC switches to the HALT mode and lock the outputs, the last error is displayed.

b) Other errors not affecting significantly the control itself
The ERR LED is not on, the RUN LED is flashing, the PLC at the RUN mode, the error code is written to registers S48 to S51 and is available fro processing by the user program, the interrupt process P43 called by this error can also be used.

5.3. FATAL ERRORS

In cases that a fatal error occurs, the diagnostic system locks the outputs first, interrupts the user program execution and identifies the fault. The information on the fault can be displayed on the seven-segment display of the central unit (last fault only) or it can be found by reading of the error stack to the superior system (PC).

The indication of the error can be cancelled by the command from the superior system or by switching the PLC power supply off and on.

5.3.1. User program and central unit hardware errors

The errors are reported by the central unit.
The user program map is the main control structure generated by compiler.
The numerical codes are in hexadecimal form, thus as they are displayed.

User program saving errors

80 01 0000 invalid map length of user program at EEPROM
80 02 0000 invalid protection character (CRC) of the user program map at EEPROM
80 03 0000 invalid protection character (CRC) of entire program at EEPROM
80 04 0000 no user program at EEPROM

There is a fault at EEPROM or the user program is designated for another series of central units or it was not loaded into EEPROM at all. It is necessary to load a new user program into EEPROM, or disconnect the EEPROM memory and load the user program into RAM.

80 05 0000 invalid map length of user program at RAM
80 06 0000 invalid protection character (CRC) of the user program map at RAM
80 07 0000 invalid protection character (CRC) of entire program at RAM

There is a memory fault or the user program is designated for another series of central units. It is necessary to load a new user program into RAM.

80 08 0000 editing intervention into the user program with EEPROM connected

If the EEPROM memory is connected, its content is loaded into the RAM memory of the central unit after switching the system on. The central unit

checks the integrity of the program copy from EEPROM. In case of editing intervention, the error is reported at the moment of switching of the PLC into the RUN mode. If the editing intervention is wanted, the EEPROM memory has to be disconnected or reprogrammed. If the editing intervention is not required, it is sufficient to switch the PLC off and on again, the original program will be downloaded from EEPROM.

80 09 0000 program is compiled for another series of central units

The compiler was set for another series of central units, it is necessary to select the correct series of the central unit in the compiler menu and compile the user program again. When the compiler was set correctly, this compiler is designated for a higher version of system software than the version fitted in the central unit of your PLC. This has to be cleared either by using of an older compiler version or by replacing of the system software in the central unit.

80 0A 0000 trial to program non-existing EEPROM

The EEPROM backup memory is disconnected.

80 0B 0000 EEPROM programming failed

Data saved at the EEPROM backup memory do not comply with the data being written. An EEPROM fault could be a possible cause of this problem.

Central unit hardware errors

80 0C 0000 RTC error

Real time circuit (RTC) does not work, which results in a failure of all PLC time functions. It means more than likely that the backup battery is flat and has to be replaced. If the backup battery is not flat, than the central unit has to be repaired by a specialist.

80 44 0001 identification error - the record cannot be read
80 44 0002 identification error - no record
80 44 0003 identification error - invalid record length
80 44 0004 identification error - invalid record data

Reading of the identification record failed. A repair by a specialist is necessary.

Programming errors

pc - instruction address, where the error occurred (program counter)

80 10 pcpc return address stack overflow

The maximum number of subroutine nesting is exceeded. By nesting we mean calling of a next subroutine within the subroutine being already executed.

80 11 pcpc return address stack underflow

A subroutine (CAL, CAD, CAC, CAI) was not called before a return instruction (RET, RED, REC).

80 12 pcpc non-zero stack of return addresses after process termination

There is a different number of instructions for subroutine call (CAL, CAD, CAC, CAI) in the user program than the number of return instructions from the subroutine (RET, RED, REC).

80 13 pcpc label not declared

A jump or call instruction with a label number is used, which is not anywhere in the user program.

80 14 pcpc label number is greater than the maximum value

The instruction label number for call or jump is greater than the greatest number of the label used in the user program.

80 15 pcpc T-table not declared

The T-table used in this instruction is not entered into the user program, it has to be added.

80 16 pcpc unknown instruction code

The instruction used is not implemented in this central unit.

80 17 pcpc non-regular user instruction USI

The user instruction is designated for another series of central units or its structure is broken.

80 18 pcpc required user instruction USI does not exist

The USI user instruction required is not connected to the user program.

80 19 pcpc BP instruction nesting error

The BP instruction cannot be used in processes P50 to P57 (call of P5n debugging process in another process P5m).

80 1A pcpc the process for BP operation is not programmed

The P5n debugging process called by the BP instruction is not programmed. It has to be added into the user program.

80 1B t t t t invalid T-table configuration (t t t t is for table number)

The check sum of the values of the T-table used by this instructions does not correspond. The user program has to be reloaded.

80 1C pcpc Array / string overrange

During indirect addressing in the ST language, the value of the index calculated by the user program exceeded the array or string size, to which the index is directed.

80 1D pcpc překročení rozsahu zápisníku při nepřímém adresování

Při nepřímém adresování pomocí instrukcí LDIB, LDI, LDIW, LDIL, LDIQ, WRIB, WRI, WRIW, WRIL a WRIQ byl překročen rozsah zápisníku.

80 20 pcpc user program fault during continuous check found

Internal system error

80 21 pcpc	nelze nastavit DP - překročen rozsah zápisníku
80 22 pcpc	nelze nastavit SP - překročen rozsah systémového stacku
80 23 pcpc	nelze nastavit FP - překročen rozsah systémového stacku

Důvodem chyby může být rekurzivní volání téže funkce v jazyce ST, nebo nekorektní operace se systémovým stackem přes instrukce PSHB, PSHW, PSHL, PSHQ a POPB, POPW, POPL, POPQ. Podobné následky může mít i nechtěný zápis do systémových registrů S, které nejsou přímo určeny k uživatelskému použití.

80 30 pcpc	maximum cycle time not exceeded

The cycle time is longer than the set value.

80 31 pcpc maximum time of interrupt process exceeded

The interrupt process execution time exceeded 5 ms, or, the cycle time was exceeded during the interrupt process execution (see error 80 30 0000).

Následující skupina chyb je hlášena centrálními jednotkami, které mají prostor pro kód uživatelského programu větší než 64 KB (řady G a K).

90 00 pcpcpc return address stack overflow

The maximum number of subroutine nesting is exceeded. By nesting we mean calling of a next subroutine within the subroutine being already executed.

90 40 pcpcpc return address stack underflow

A subroutine (CAL, CAD, CAC, CAI) was not called before a return instruction (RET, RED, REC).

90 80 pcpcpc non-zero stack of return addresses after process termination

There is a different number of instructions for subroutine call (CAL, CAD, CAC, CAI) in the user program than the number of return instructions from the subroutine (RET, RED, REC).

91 00 pcpcpc label not declared

A jump or call instruction with a label number is used, which is not anywhere in the user program.

91 40 pcpcpc label number is greater than the maximum value

The instruction label number for call or jump is greater than the greatest number of the label used in the user program.

91 80 pcpcpc T-table not declared

The T-table used in this instruction is not entered into the user program, it has to be added.

91 C0 pcpcpc unknown instruction code

The instruction used is not implemented in this central unit.

92 00 pcpcpc Array / string overrange

During indirect addressing in the ST language, the value of the index calculated by the user program exceeded the array or string size, to which the index is directed.

92 40 pcpcpc stack range exceeding during indirect addressing

During the indirect addressing by means of instructions LDIB, LDI, LDIW, LDIL, LDIQ, WRIB, WRI, WRIW, WRIL and WRIQ, the stack range was exceeded.

92 80 pcpcpc BP instruction nesting error

The BP instruction cannot be used in processes P50 to P57 (call of P5n debugging process in another process P5m).

92 C0 pcpcpc the process for BP operation is not programmed

The P5n debugging process called by the BP instruction is not programmed. It has to be added into the user program.

93 00 pcpcpc user program fault during continuous check found

Internal system error

93 40 pcpcpc DP cannot be set - stack range exceeded
93 80 pcpcpc SP cannot be set - system stack range exceeded
93 C0 pcpcpc FP cannot be set - system stack range exceeded

The reason of this error can be the recursive calling of the same function in the ST language, or incorrect operation with the system stack via instructions PSHB, PSHW, PSHL, PSHQ and POPB, POPW, POPL,

POPQ. Podobné následky může mít i nechtěný zápis do systémových registrů S, které nejsou přímo určeny k uživatelskému použití.

94 80 pcpcpc unsupported functional block

The programmed functional block is not supported by the central unit.

95 00 pcpcpc maximum cycle time not exceeded

The cycle time is longer than the set value.

95 40 pcpcpc maximum time of interrupt process exceeded

The interrupt process execution time exceeded 5 ms, or, the cycle time was exceeded during the interrupt process execution (see error 95 00 pcpcpc).

5.3.2. Serial channel operation errors

The errors are reported by the central unit.
The numerical codes are in hexadecimal form.
The character cc stands for serial channel numbers (01 to 10 - CH1 to CH10, D1 - USB, E1 and E2 - Ethernet 1 and Ethernet 2).

83 cc 3701 serial channel initialization table length is invalid

The initialization table is either broken or designated for another channel mode or for another type of module or another version of module.
Usually, the reason of this error is that the serial channels does not allow setting of the required mode and sets itself to the **off** mode, thus, it switches off. Vznikne tak situace, kdy komunikační kanál je v jiném režimu, než pro který je inicializační tabulka určena.
Dvojí inicializace komunikačního kanálu může vzniknout v případě, kdy použijeme pro nastavení komunikačního kanálu knihovní prvek, zdrojový text, nebo jiný způsob mimo standardní konfigurační nástroj v prostředí Mosaic (v manažeru projektu ve složce *Hw / Konfigurace HW*). Pokud pak v manažeru projektu není příslušný komunikační kanál vypnut (režim **OFF**), dojde k této chybě.
Special submodules requiring special operation are identified by the central unit automatically and only such modes can then be set on the serial channel that are permitted for the given module. On the contrary, if this submodule is not identified, then it is not possible to set the mode required by this submodule, too.

83 cc 3702 non-existing auxiliary table

The auxiliary table, the initialization table adverts to, does not exist. The table must be declared, a new compilation must be made and the corrected user program must be loaded into the PLC again. Auxiliary tables are used in the for example **PFB** mode.

83 cc 3801 invalid speed in initialization table of serial channel

This communication speed cannot be used in the given mode of the serial channel.

83 cc 3802 station address is invalid

At the **MPC** or **PFB** modes there is a subordinated station entered with the same address as the address of the superior station is. One of these addresses has to be changed.
At the **CAN** or **PFB** modes there is a station entered with address out of permitted range.

83 cc 3803 invalid number of network participants at the mode **MPC**, **PLC**or **PFB**, invalid number of data block at the mode **UPD**

The maximum permissible number of network participants was exceeded at the mode **MPC**, **PLC**or **PFB**.
The maximum number of data blocks offered by the submodule was exceeded in the **UPD** mode. In the initialization, the number of the data blocks must be harmonized with the type of the submodule. Also an incorrect or illegible configuration record in the submodule can be a cause of this problem.

83 cc 3804 number of network participants at the mode **MPC**, **PLC**or **PFB** exceeds the number of lines

The information on the number of participants does not correspond with the following data in the initialization table. This error is generated also by the number of network participants 1 or 0.
Check the correctness of the content of the initialization table or use configuration by means of the MOSAIC development environment.

83 cc 3810 non-permissible number of the local port

The number of the local port was set within the range 61680 – 61699 via the Ethernet interface in the **UNI** mode. These values are reserved for system use of in-built protocols. It is necessary to use a number outside this range.

83 cc 3811 unknown Ethernet interface protocol

An unknown protocol (UDP, TCP, etc.) was set via the Ethernet interface in the **UNI** mode. It is necessary to set the correct protocol or to update the software version of the relevant communication module.

83 cc 3815 false connection

The false connection index was set via the Ethernet interface in the **UNI** mode. It is necessary to check the maximum possible number of connections within the relevant communication module. This error occurs even in case when the number of connections was increased in the newer firmware version only, than in the one loaded in this communication module. The module firmware must be re-loaded.

83 cc 4204 serial channel is not in the required mode

The serial channels is set to another mode that initialization is designated for. Usually, the reason for this error is that the serial channels does not allow setting of the required mode and sets itself to the **OFF** mode, thus it switches off.
Special submodules requiring special operation are identified by the central unit automatically and only such modes can then be set on the serial channel that are permissible for the given module. On the contrary, if this module is not identified, it is not possible to set a mode required by this submodule.

83 cc 4206 maximum volume of transmitted data within network or for participant exceeded

The specified volume of the transmitted data in the network at the mode **MPC** and **PLC**exceeded the maximum value. One network allows transmitting of data with a total volume of approx. 32 kB. A second reason of this fault can be that the specified volume of transmitted data with one participant exceeded the maximum value.
For another modes, the specified volume of transmitted data exceeded the maximum size, which the communication submodule is able to transmit in some of data areas.

83 cc 4207 serial channel cannot be assigned – permanently occupied by another module

The number we want to assign to the serial channel, is already occupied. This error occurs for example when we use SE-7131 expander that occupies serila channels CH9 and CH10. These channels then cannot be assigned to another communication module SC-710x.

83 cc 4208 non-permissible mode of the communication channel

The required mode cannot be set on this communication channel. The reasons can be as follows:
- the selected communication channel does not support the required mode;
- the selected communication channel is fitted with a submodule that does not support the required mode;
- the selected communication channel is not fitted with a submodule supporting the required mode.

Please check the correctness of the submodule fitted in the channel or select another mode or use another communication channel.

5.3.3. Chyby komunikace s periferními moduly přes expander

Chyby vyhlašuje centrální jednotka obsluhující expandery, kde chyba vznikla.
Číselné kódy jsou uvedeny v hexadecimálním tvaru.
Znak rr zastupuje číslo slave expanderu (číslo rámu, kde je expander osazen - tj. hodnota nastavená na přepínači + 4).

84 r r 50ss	expander neodpověděl na komunikační službu ss
	Slave expander neodpověděl na komunikační službu ve stanoveném čase. Příčinou je závada na propojení expanderů rozhraním Ethernet, nebo na slave expanderu, který neodpověděl.
84 00 5101	inicializace expanderů nedokončena
	Probíhající inicializace slave expanderu nebyla dokončena.

84 r r 52ss sběrnice nevrátila reakci na komunikační službu ss
84 r r 54ss expander odpověděl chybnými daty na komunikační službu ss

Expander slave neodpověděl na komunikační službu ve stanoveném čase. Příčinou je závada na propojení expanderů rozhraním Ethernet, nebo na slave expanderu, který neodpověděl.

84 r r 6001 expander nedostává data

Slave expander je vybaven kontrolním časovačem, který v režimu RUN sleduje četnost výměny dat s centrálním jednotkou. Pokud není během cyklu provedena výměna dat mezi expanderem a centrální jednotkou, je komunikace prohlášena za přerušenou a expander provede samostatně přechod do režimu HALT.
Příčinou je závada na propojení expanderů rozhraním Ethernet, nebo na master expanderu, který data distribuuje mezi centrální jednotkou a slave expanderem, nebo došlo k chybě v centrální jednotce, která přestala data dodávat.

84 r r 6502 expander nepřešel do stavu INITIAL
84 r r 6504 expander nepřešel do stavu STANDBY
84 r r 6505 expander nepřešel do stavu ACTIVE

Slave expander v redundantním systému nepřešel ve vymezeném čase do požadovaného stavu.

5.3.4. Peripheral system errors

The errors are reported by the central unit operating the peripheral module where the error occurred. The numerical codes are in hexadecimal form. The whole four-byte codes are reported by the central unit in the main error stack. In the list of hardware configuration there is available the local stack of errors reported by this module in the description of each peripheral module. These errors are two-byte ones and are derived from the four-byte ones in such a way they do not contain the first two bytes specifying the address of the peripheral module.

The r character represents the rack number (0 to 7), the pp character represents the number of position in the rack (0 to 15). When pp has a value 7F, it means that communication service was designated for all modules together.

Ar pp 1200 address error
Ar pp 15hh error of service byte hh
Ar pp 16ss invalid parameters of communication service ss
Ar pp 1705 received zone overflow
Ar pp 1809 protection error

Data exchange error via the system bus. The reason for this is a high level of interference, missing or non-functional bus termination or a PLC fault.

Ar pp 3100 initialization not executed

Data exchange error via the system bus. The reason for this is a high level of interference, missing or non-functional bus termination or a PLC fault.

Ar pp 3101 initialization table is missing

The initialization table necessary for the operation of all peripheral modules is missing. It is necessary to verify the correctness of configuration setup of the corresponding peripheral module, make a new compilation and load the corrected user program into the PLC again.

Ar pp 3401 maximum size of variable exceeded

The maximum size of variable of field type exceeded for the data exchanged with the peripheral module. It is necessary to verify the correctness of configuration setup of the corresponding peripheral module, make a new compilation and load the corrected user program into the PLC again.

Ar pp 3402 incorrect notepad address

Exceeded notepad range in the declaration of peripheral modules controlled by the expander.

Ar pp 3700 invalid length of received initialization table in the module
Ar pp 3701 invalid length of declared initialization table in the module

The initialization table is either broken or designated for another type of module or another version of module. It is necessary to verify the correctness of configuration setup of the particular serial channel, make a new compilation and load the corrected user program into the PLC again.

Ar pp 3805 communication channel invalid number

Trial to initialize the communication channel, which is not available in this central unit. Check the correctness of communication channel configuration.

Ar pp 3806 invalid mode of communication channel

Attempt to initialise the communication channel in the mode, which is not available in this central unit.
Check the configuration of the communication channels for correctness.

Ar pp 3807 invalid combination of activated variables

The peripheral module indicates an invalid combination of required data. For example some data cannot be transmitted at the same time, or the total volume of the data is limited or on the contrary it is necessary to transmit an undivided data set. It is necessary to check the setting of the configuration of the relevant peripheral module for correctness, to perform a new compilation and to load the corrected user program to the PLC again.

Ar pp 3808 invalid length of activated variable

The peripheral module indicates a wrong length of a variable. The absolute majority of variables has its fixed size, which is given by the type of the variable. If the variable represents an array with a variable length (a typical example are the data zones of communication modules, e.g. CD-7252), then a too small or too big value for the length of such variable was specified. It is necessary to check the setting of the configuration of the relevant peripheral module for correctness, to perform a new compilation and to load the corrected user program to the PLC again.

Ar pp 3809 unsupported type of analog channel

Required type of analog channel is not supported by the peripheral module. It is necessary to check up if the peripheral module is configured properly, to perform compilation and to upload user program to PLC again. The error is occurred in case that the required function was add to the newer firmware version then the version used in this peripheral module, too.

Ar pp 3813 unsupported data conversion type

The requested data conversion type is not supported by the central unit. The data conversion, during which the error occurred, is undertaken during the information exchange with the peripheral module address of which is a part of the error code. This error occurs when the requested data conversion type was included only in the new firmware version that was not uploaded into the central unit. It is necessary to update the central unit firmware.

Ar pp 3901 interrupt from the module cannot be activated

The option *Module can initiate interrupt* is enable din the initialization module, but the module is not at the same rack as the central unit, which is a necessary condition. In this case, arrange the PLC unit in such a way that the module that could cause the interrupt is at the same rack as the central unit, or disable the option *Module can initiate interrupt*.

Ar pp 4201 serial channel for communication with the rack is not assigned
Ar pp 4202 serial channel for communication with the rack is not on
Ar pp 4203 serial channel is not at the **EIO** mode

If we want to connect more racks with peripheral modules to the central unit than the system bus allows, we have to use the CH2 serial channel with the applicable submodule set to the **EIO** mode.
The CP-7002 and CP-7003 central units require submodule MR-0154, the CP-7004 central unit requires submodule MR-0157.
The CP-7001 central unit does not have this possibility.

Ar pp 4301 non-existing module

In the hardware configuration such module operation is set that does not exist in a real unit. Set the configuration to correspond with reality either manually or by loading the data from the PLC.

Ar pp 4302 non-conforming module type - initialization for another type

In the hardware configuration such module operation is set that does not exist in a real unit. Set the configuration to correspond with reality either manually or by loading the data from the PLC.

Ar pp 4303 invalid rack address, higher than the maximum possible

In the hardware configuration the operations of a rack with a higher number is set than the central module is able to operate (at an address higher than 15, the address r = F is displayed). Set the configuration to correspond with reality either manually or by loading the data from the PLC.

Ar pp 4304 module with unknown operation

In hw configuration, operation of a module is set, with which the central unit is not able to communicate. Please harmonize the configuration with real state either manually or by loading data from the PLC.

Ar pp 4401 module identification read error - the record cannot be read
Ar pp 4402 module identification read error - no record

Ar pp 4403 module identification read error - invalid record length
Ar pp 4404 module identification read error - invalid record data

Reading of the identification record of the peripheral module failed. A repair to be done by a specialist is necessary to do.

Ar pp 4502 hw module configuration error - no data for configuration
Ar pp 4503 hw module configuration error - invalid data on configuration
Ar pp 4504 hw module configuration error - invalid configuration data

Configuration of the peripheral module hardware failed. A repair to be done by a specialist is necessary to do.

Ar pp 50ss the module did not reply to communication service ss

The peripheral module did not respond to communication service with specified period of time. The reason for this is a high level of interference, missing or non-functional bus termination or a PLC fault.

Ar pp 5103 initialization not finished

Running initialization of the peripheral module was not finished.

Ar pp 52ss the bus did not react to communication service ss
Ar pp 53ss bus is not free after communication service ss
Ar pp 54ss the module responded to communication service ss with invalid data

The peripheral module did not respond to communication service with specified period of time. The reason for this is a high level of interference, missing or non-functional bus termination or a PLC fault.

Ar pp 5501 unknown mode of data exchange

The peripheral module requires an operation mode which is not supported by the central module. It is necessary to update the firmware of CPU.

Ar pp 6000 communication interrupt with central unit

Peripheral modules are equipped with a check timer monitoring the bus at the RUN mode. The central unit sets the timer to a period of time a little bit longer than the maximum permissible PLC cycle time is. If there is no communication with any of the network participants detected on the serial line during this period of time, the communication is declared interrupted and the peripheral module switches to the HALT mode independently.
The reason for this is a high level of interference, missing or non-functional bus termination or a PLC fault.

Ar pp 6001 peripheral module does not receive data

Peripheral modules are equipped with a check timer monitoring the frequency of data exchange with the central unit at the RUN mode. If there is no data exchange between the peripheral module and central unit within the cycle time, the communication is declared interrupted and the peripheral module switches to the HALT mode independently.
The reason for this is a high level of interference, missing or non-functional bus termination or a PLC fault.

Ar pp 6201 data cannot be transmitted at the HALT mode

The peripheral module, which is at the HALT mode, cannot perform data exchange with the central unit. The reason, why the module did not switch to the run as commanded by the central unit, is that the initialization of the peripheral modules failed, or a high level of interference, missing or non-functional bus termination or a PLC fault. The failed initialization is usually reported by a more specified error message.

Ar pp 6202 non-available bus service
Ar pp 6203 non-available bus service - hw module failure
Ar pp 6204 unknown bus service

Data exchange via system bus errors. The reason is a high level of disturbance, missing or non-functional termination of the bus or a PLC fault. Another reason can be an older version of the software of the central unit or of the corresponding module.

Ar pp 6401 Incorrect software of peripheral module

The peripheral module does not support the required function. The firmware version of this module must be changed.

Ar pp kkkk Another errors reported by the peripheral module are described in the documentation for this module.

5.3.5. System errors

FF kk kkkk central unit system error (kk - any number specifying error type)

Central unit malfunction, please contact the manufacturer.

5.4. OTHER ERRORS

If another error occurs that does not influence the control itself significantly, the diagnostic system only identifies the error and process control goes on. The information on the error is released in the register S34 (the first byte) and in registers S48 - S51 (full code), which can be used for user-treatment of these errors. The error can also be found by reading of the error stack into the superior system (PC).

5.4.1. System errors

These errors can be treated as needed by the user program by means of registers S48 to S51, where the last error is saved.

pc - instruction address, where the error occurred (program counter)
cc - communication channel (F1, F2 - system bus)

02 cc 1200 address error
02 cc 15hh error of service byte hh
02 cc 16ss invalid parameters of communication service ss
02 cc 1809 protection error

Data exchange via the system bus errors. The reason is a high level of interference, missing or non-functional bus termination or a PLC fault. These errors do not cause an immediate PLC suspension, however, their occurrence means a problem that could result in a critical bus error which then causes the PLC suspension.

07 00 0000 remanent zone check error

Backed up part of the scratchpad, so called "remanent zone", the check sum is not correct. The zone will be deleted and cold restart performed. The cause of this problem is a fault in RAM user memory backup on the central unit, more than likely on the backup battery.

08 00 0000 exceeding of the first limit of cycle time monitoring

The cycle time was longer than the preset value for warning.

20 00 pcpc user program fault during continuous check found

Internal system error.

5.4.2. User program errors

These errors can be treated as needed in the user program either by elimination of the cause by checking the input parameters before the execution of the particular instruction, or by treating of the consequence by means of the registers S48 to S51, where the last error is saved.

10 00 0000 division by zero

In the instruction the divisor was 0.

13 00 0000 table instruction above the scratchpad exceeded its range

The table defined by the table instruction above the scratchpad exceeded its range, the instruction will not be executed.

14 00 0000 data source block defined out of range

The data source block for the transfer instruction was defined out of range of the scratchpad, data or table. The instruction will not be executed.

15 00 0000 data destination block defined out of range

The target source block for the transfer instruction was defined out of range of the scratchpad or table. The instruction will not be executed.

5.4.3. Errors during the on-line change

These errors are reported during the on-line change of the user program. If some of these errors occur, the new user program is denied by the central unit and the technology is hereafter controlled without an interruption according to the original program.

The rr character represents the rack number (0 to 7), the pp character represents the number of position in the rack (0 to 15).

The character cc stands for serial channel numbers (01 to 10 - CH1 to CH10, D1 - USB, E1 and E2 - Ethernet 1 and Ethernet 2).

70 05 0000 invalid map length of user program at RAM
70 06 0000 invalid protection character (CRC) of the user program map at RAM
70 07 0000 invalid protection character (CRC) of entire program at RAM

There is a memory fault or the user program is designated for another series of central units. It is necessary to load a new user program into RAM.

70 09 0000 program is compiled for another series of central units

The compiler was set for another series of central units, it is necessary to select the correct series of the central unit in the compiler menu and compile the user program again. When the compiler was set correctly, this compiler is designated for a higher version of system software than the version fitted in the central unit of your PLC. This has to be cleared either by using of an older compiler version or by replacing of the system software in the central unit.

70 0B 0000 EEPROM programming failed

Data saved at the EEPROM backup memory do not comply with the data being written.

70 24 0000 list of on-line changes missing
70 25 0000 list of on-line changes has invalid CRC

An error of the new user program entry to EEPROM of the central unit occurred. It is necessary to repeat the process.

70 31 r r pp initialization table is missing

The initialization table necessary for the operation of all peripheral modules is missing. It is necessary to verify the correctness of

configuration setup of the corresponding peripheral module, make a new compilation and load the corrected user program into the PLC again.

70 34 r r pp maximum size of variable exceeded

The maximum size of variable of field type exceeded for the data exchanged with the peripheral module. It is necessary to verify the correctness of configuration setup of the corresponding peripheral module, make a new compilation and load the corrected user program into the PLC again.

70 43 r r pp invalid rack address, higher than the maximum possible

In the hardware configuration the operations of a rack with a higher number is set than the central module is able to operate (at an address higher than 15, the address rr = 0F is displayed). Set the configuration to correspond with reality either manually or by loading the data from the PLC.

70 51 r r pp initialization not finished

Running initialization of the peripheral module was not finished.

70 64 r r pp invalid software of peripheral module

The peripheral module does not support required function. The firmware version of this module must be changed.

70 A1 r r pp non-existing module

In the hardware configuration such module operation is set that does not exist in a real unit. Set the configuration to correspond with reality either manually or by loading the data from the PLC.

70 A2 r r pp non-conforming module type - initialization for another type

In the hardware configuration such module operation is set that does not exist in a real unit. Set the configuration to correspond with reality either manually or by loading the data from the PLC.

70 A3 r r pp module does not support this type of on-line change

The module does not enable to change required parameters in running. This situation can be, generally, superseded by the module firmware update. (chapter7.1.2.).

70 C5 r r pp communication channel invalid number

Trial to initialize the communication channel, which is not available in this central unit. Check the correctness of communication channel configuration.

70 C6 r r pp invalid mode of communication channel

Attempt to initialise the communication channel in the mode, which is not available in this central unit.
Check the configuration of the communication channels for correctness.

73 cc 3701 invalid length of declared initialization table in the module

The initialization table is either broken or designated for another type of module or another version of module. It is necessary to verify the correctness of configuration setup of the particular serial channel, make a new compilation and load the corrected user program into the PLC again.

73 cc 3702 non-existing auxiliary table

The auxiliary table that the initialization table refers to, does not exist. The table must be declared, a new compilation must be made and the corrected user program must be loaded to the PLC again. Auxiliary tables are used, for example, in the **PFB** mode.

73 cc 3801 invalid speed in initialization table of serial channel

This communication speed cannot be used in the given mode of the serial channel.

73 cc 3802 station address is invalid

At the **MPC** or **PFB** modes there is a subordinated station entered with the same address as the address of the superior station is. One of these addresses has to be changed.
At the **CAN** or **PFB** modes there is a station entered with address out of permitted range.

73 cc 3803 invalid number of network participants at the mode **MPC**, **PLC**or **PFB**, invalid number of data block at the mode **UPD**

The maximum permissible number of network participants was exceeded at the mode **MPC**, **PLC**or **PFB**.
The maximum number of data blocks offered by the submodule was exceeded in the **UPD** mode. In the initialization, the number of the data blocks must correspond to the type of submodule. Also an invalid or illegible configuration record in the submodule can be a cause of this problem.

73 cc 3804 number of network participants at the mode **MPC**, **PLC**or **PFB** exceeds the number of lines

The information on the number of participants does not correspond with the following data in the initialization table. This error is generated also by the number of network participants 1 or 0.
Check the correctness of the content of the initialization table or use configuration by means of the MOSAIC development environment.

73 cc 3810 non-permissible number of the local port

In the **UNI** mode via the Ethernet interface, there was set the number of the local port in the range 61680 - 61699. These values are reserved for the system use by in-built protocols. It is necessary to use a number out of this range.

73 cc 3811 unknown protocol of Ethernet interface

In the **UNI** mode via the Ethernet interface, there was the unknown protocol set (UDP, TCP, etc.). It is necessary to set the correct protocol or

to update the software version of the correspondent communication channel.

73 cc 3815 error connection

In the **UNI** mode via the Ethernet interface, there was an error index of the connection set. It is necessary to check the maximum possible number of connections within the relevant communication channel. This error occurs also when the number of connections was increased in the newer version of the firmware than the one loaded in this communication module. The module firmware must be re-loaded.

73 cc 4204 serial channel is not in the required mode

The serial channels is set to another mode that initialization is designated for. Usually, the reason for this error is that the serial channels does not allow setting of the required mode and sets itself to the **OFF** mode, thus it switches off.
Special submodules requiring special operation are identified by the central unit automatically and only such modes can then be set on the serial channel that are permissible for the given module. On the contrary, if this module is not identified, it is not possible to set a mode required by this submodule.

73 cc 4206 maximum volume of transmitted data within network or for participant exceeded

The specified volume of the transmitted data in the network at the mode **MPC** and **PLC**exceeded the maximum value. One network allows transmitting of data with a total volume of approx. 32 kB. A second reason of this fault can be that the specified volume of transmitted data with one participant exceeded the maximum value.
For another modes, the specified volume of transmitted data exceeded the maximum size, which the communication submodule is able to transmit in some of data areas.

73 cc 4207 serial channel cannot be assigned – permanently occupied by another module

The number of the serial channel that we want to assign to the serial channel is already occupied. This error occurs for example when we use SE-7131 expander that occupies serial channels CH9 and CH10. These channels then cannot be assigned to the other communication module SC-710x.

73 cc 4208 non-permissible mode of communication channel

The required mode cannot be set on this communication channel. The reasons can be as follows:
- the required communication channel does not support the required mode;
- the selected communication channel is fitted with a submodule that does not support the required mode;
- the required communication channel is not fitted with a submodule supporting the required mode.

Please check the correctness of the submodule fitted in the channel or select another mode or use another communication channel.

5.5. PERIPHERAL SYSTEM STATE ZONE

This function have central units CP-7001, CP-7002, CP-7003 and CP-7005 from software version 2.5. The CP-7004 central unit has this function in all software version.

Registers S100 to S227 contain the status zone of the peripheral system providing information on the immediate state of each peripheral module.

This is important especially in such a case, when the removal of the peripheral module under run is allowed and the user program requires a piece of information, whether the data read from the module are valid. In other respects, this zone can be used for a detailed PLC diagnostics realized by a superior system.

To each position in the rack corresponds one register, the index of which can be deduced from the following formula:

$$n = (r * 16) + p + 100$$

where n stands for register resultant index
r stands for rack number
p stands for rack position number

As the result of this is that the module fitted in rack 0 on position 0 has assigned register S100, module on position 1 register S101, ..., module in rack 1 on position 0 register S116, etc. All the registers of the status zone have the following structure:

Sn.7	Sn.6	Sn.5	Sn.4	Sn.3	Sn.2	Sn.1	Sn.0
POS	OTH	DEC	ERR	0	0	DATA	ECOM

Sn.0 (ECOM) - communication status with module
0 - communication OK
1 - module stopped communicating
Sn.1 (DATA) - validity of transmitted data
0 - data in scratchpad are not current, no data exchange
1 - current data in scratchpad, data exchange takes place
Sn.4 (ERR) - an error reported by module
0 - module is without error
1 - module reports a serious error not allowing data exchange
Sn.5 (DEC) - module operation is declared
0 - module is not operated by the user program
1 - module is operated by the user program
Sn.6 (OTH) - wrong module type
0 - in position fitted module required by declaration
1 - module type fitted in position is different than required
Sn.7 (POS) - position occupied
0 - position is not occupied
1 - module found on position

The content of the status register of the module selected is also released in the Mosaic development environment in the top part of panel *I/O Setting* or after selecting *PLC* | *HW Configuration* in tag *Additional Information*.

Examples of states of peripheral module operation

The most frequent states of peripheral module operation and their signalisation in the status zone are given in Table 5.1.

Table 5.1 The most frequent states of peripheral modules operation

Value of status register Sn	State of peripheral module operation
$00	Empty position, operation off
$21	The module being operated does not communicate, data is not valid - module hot-swap procedure status.
$31	The module being operated stopped communicating, critical error reported, data is not valid - module hot-swap procedure status.
$80	Position occupied, operation off
$90	Module information detection error
$A0	Module operation is being performed, data is temporarily invalid, communication performed OK - short-term status when plugging in the module under run, when module initialisation is performed.
$A2	Module operation is being performed, data is valid - normal status
$B0, $B1	The module reported a critical error, which caused that the execution of the user program has been stopped.
$E1	Another type of module was plugged in into the position during the module hot-swap procedure than declared by the user program.

5.6. PROBLEM SOLVING OF COMMUNICATION WITH SUPERIOR SYSTEM

Connection of the PLC to the superior system, usually a PC is necessary, since each PLC has to be programmed. If there are problems in communication between the PLC and PC, proceed according to the following instructions:

PLC check

1. Is power supply led into the PLC?
   No Make corrections.
   Yes Proceed as specified in point 2.

2. Is the POWER LED on the indication panel of the power supply module on?
   No The power supply lead has no electricity, or voltage is out of source tolerance, or the power supply module is defective.
   Yes Proceed as specified in point 3.

3. Is the OVERLOAD LED on the indication panel of the power supply module on?
   No Proceed as specified in point 4.
   Yes The power supply module is overloaded by too high consumption. Make corrections immediately.

4. Was the switching sequence of the central unit completed and is the unit at the RUN or HALT mode (see chapter 4.3.)?
   No The central unit reports a hardware error (see table 4.2), communication is not possible.
   Yes Proceed as specified in point 5.

5. *For serial channels:*
   Are the LEDs of the particular channel flashing on the central unit or communication module during communication?
   No LED is flashing
   a) The submodule of the interface MR-01xx on the particular channel is not fitted, or a submodule for another interface is fitted.
   b) The error is in the PC, cable or adapter of the serial interface (RS-485).
   If you use the adapter, proceed as specified in point 11.
   If you do not use the adapter, proceed as specified in point 21.
   Flashing only RxD
   The channel parameters of the central unit are set incorrectly (mode, speed, address, CTS detection - see chapter 2.3.9.).
   Flashing alternately RxD and TxD with RTS
   Communication in direction PC → PLC is in order. Proceed as specified in point 6.
   Another state
   More than likely, a submodule for another interface is fitted, or the cable is connected incorrectly.

   For Ethernet
   Are the Ethenet LEDs flashing on the central unit or communication module during communication?
   No LED flashing
   The error is in the PC or the cabling (including used hub or switch type devices).
   Flashing only RxD
   Wrong setting of the IP address and the IP mask of the central unit or PC. Generally the principle is that the IP addresses of both participants of

communication have to be identical in the positions where the IP mask has a no-zero value. The IP mask should be identical for both participants.
For example:

PC		PLC	
IP address:	192.168.1.1	IP address:	192.168.1.2
IP mask :	255.255.255.0	IP mask :	255.255.255.0

or:

PC		PLC	
IP address:	192.168.12.1	IP address:	192.168.25.8
IP mask :	255.255.0.0	IP mask :	255.255.0.0

Flashing alternately RxD and TxD

Communication in direction PC → PLC is in order. Proceed as specified in point 6.

Flashing JAM

The more frequently the JAM LED flashes, the more frequently the message collision on the Ethernet network take place. A frequent occurrence of this status indicates network capacity overload and it is desirable to resolve the problem.

For USB

The error is in the PC (e.g. incorrect or lack driver for communication via USB) or in the cable. If not, proceed as specified in point 6.

6. Do you want to program the PLC by means of the MOSAIC development environment?
   Yes Proceed as specified in point 7.
   No, this is communication with visualization software, etc.
   If you use the adapter, proceed as specified in point 11.
   If you do not use the adapter, proceed as specified in point 21.

7. Is the MOSAIC development environment or another software using PLC system services already connected through any interface?
   No If you use the adapter, proceed as specified in point 11.
   If you do not use the adapter, proceed as specified in point 21.
   Yes At the same time, PLC system services cannot be used through more interfaces. Terminate the communication of all other software using the system services, wait 5 seconds and retry to established the required communication.

Serial interface adapter check

11. Are the channel LEDs flashing on the adapter of the serial interface(RS-232 / RS-485) during communication?
    The adapter is not equipped with indication
    Consider the below mentioned possibilities.
    No LED is flashing
    a) Adapter power supply not working or defective adapter.
    b) The fault is in the PC or cable between the PC and adapter.
    Proceed as specified in point 8.
    Flashing only TxD, RTS lighting permanently or not at all
    The fault is either in the RTS signal between the PC and adapter, or in the software in the PC does not support RTS signal control necessary for the RS-485 interface (for RS-232 not necessary).

If the software in the PC does not support the RTS signal, the adapter has to be set to the mode of automatic switching of communication direction and a sufficient response timeout has to be set on the central unit (chapter 2.3.9. - parameter **T**). The MOSAIC development environment and some visualizations support the RTS signal.

Flashing only TxD with RTS

The fault is at the output part of the adapter or in the cable between the adapter and PLC.

Flashing alternately TxD with RTS and RxD

Communication is in order, the problem is in the cable between the adapter and PC or in the PC. Proceed as specified in point 21.

Cable check

21. Is the cable in the PC in the right COM port, or USB or Ethernet as the case may be?
    - **No** Make corrections.
    - **Yes** Proceed as specified in point 22.

22. Are correct cables used?
    - **No** Make corrections.
    - **Yes** If possible, use another cable of the same type. Proceed as specified in point 31.

PC check

31. Are there some more drivers (mouse driver, IR port driver, etc.) installed on the serial port COM, which you are using?
    - **Yes** There is a collision of drivers also when a device requiring this driver is not connected. Communication through another COM port has to be used or the driver has to be uninstalled.
    - **No** Some programs at Windows do not manage to switch quickly enough from transmission to receiving. This problem can be easily solved by setting a sufficiently long response timeout of the PLC central unit (chapter 2.3.9. - parameter **T**) or by reducing of communication speed (chapter 2.3.9. - parameter **S**).

6. PLC MAINTENANCE

According to this chapter, PLC maintenance is carried out during its operation. The person doing the maintenance has to be trained at least and have required electrical competences.

Check of correct connection of inputs and outputs

Check fastening of the terminal screws and conductor insulation integrity. Also check fastening of cables.

Check of input and output power supply

The level of supply voltage for input and output units is checked by a voltmeter. Corresponding voltages and permissible tolerances are given in the documentation of units used.

Earthing terminal interconnection check

By means of an accurate meter of small resistances, the resistance between any permissible metal frame part of the PLC and the main earthing terminal of the distributing frame is measured, where the PLC is located. The measured resistance has to always be less than 0.1 Ω.

PLC cleaning

If the units are covered by dust, they have to be taken out of the frame and cleaned by air or by a paintbrush. This has to be done very carefully not to switch the switches or damage the units. After reassembling of the PLC we recommend to check the connection of cables (possibility of confusion!).

Recommended measuring devices

1. Voltmeter for alternating voltage measurement, accuracy class 1,5 or better
2. Voltmeter for direct current voltage measurement, accuracy class 1 or better
3. Meter of small resistances OMEGA III or similar

Change of backup battery

The backup battery is accessible after taking of the door on the right side of the case. The backup functions and the procedure for battery replacement are described in chapter 2.3.7. After battery replacement, hand over the old battery for disposal to an authorized company.

In the central units a battery of type CR2032 with a minimum life time of 5 years is used. The battery is placed in a holder.

ATTENTION!	**The modules contain parts sensitive to static charge, therefore, it is necessary to follow the safety rules when working with these circuits! Any handling must be done on the module taken out from the rack! For battery replacement do not use any metal tools (pincers, pliers, etc.) not to short-circuit the battery. Watch the correct polarity of the battery!**

6.1. FIRMWARE CHANGE

The CP-700x CPUs, SC-710x, CD-725x communication modules and SE-713x expanders enable the firmware change of all processors without the necessity of removal. The upgrading programs needed and individual firmwares are accessible on the Internet - www.tecomat.com.

6.1.1. Central unit firmware change

For the firmware change (company system software) in central units of the TECOMAT TC700 system, the program Firmup1c.exe is used. The change can be undertaken via the serial line, USB interface or the Ethernet.

The Firmup1c.exe program is a consol application that can be run under Windows 2000 and Windows XP operation systems. This program requires for the functioning the SimplePlcCom.dll library which must be located in the same folder as the program Firmup1c.exe is.

The central unit firmware consists of several files whereas some can be changed by the Teco maintenance workers only. In case of the TECOMAT TC700 system, the user can change the firmware of the central unit itself and the content of Altera gate array.

Table.6.1 The list of files for CPU firmware change

Module	Processor firmware file	Altera circuit content file
CP-7001	teco7001.tfw	acex7001.tfw
CP-7002	teco7002.tfw	acex7002.tfw
CP-7003	teco7003.tfw	acex7003.tfw
CP-7004	teco7004.tfw	cyclone7004.tfw
CP-7005	teco7005.tfw	acex7005.tfw

Firmup1c.exe program parameters

The Firmup1c.exe program is run via the command line (e.g. *Start* | *Run*) and it requires for its functioning the following parameters to be set:

```
FIRMUP1C.EXE P1 P2 P3 P4 [P5] [P6] [P7] [Px] [Py] [Pz]
```

P1	- 1, 2, 3, 4	number of COM port, serial communication
	- E	communication via Ethernet
	- U	communication via USB
P2	- 600, 1200, ..., 38400	serial communication speed
	- xxx.xxx.xxx.xxx	IP address PLC, communication via Ethernet
P3	- 0, ..., 99	address for communication
P4 / P5 / P6 / P7	- *.tfw	names of files with firmware
Px	- /V	display current versions of firmwares in the processor
Py	- /P	program, even if the current versions of firmware is the same or higher
Pz	- /C or /E	language (Czech or English)

The Firmup1c.exe program can also be run from the batch file (*.bat).

If we run the Firmup1c.exe without a parameter /C or /E, the following query will be displayed:

```
!!! Select language / Vyberte jazyk
    English (E) / Cesky (C)  :
```

By pressing the key E or C we select the language which the following dialogues will be displayed in.

Launching of the program Firmup1c.exe examples

Load the new firmware via COM2 at a speed of 38400 kBd to CP-7004 with the address 0, after the communication establishment display actual firmware versions in the processor, program dialogues will be in English

```
Firmup1c.exe 2 38400 0 teco7004.tfw cyclone7004.tfw /V /E
```

Load the new firmware via Ethernet to CP-7004 with the address 192.168.33.160, after the communication establishment display actual firmware versions in the processor, program dialogues will be in English

```
Firmup1c.exe E 192.168.33.160 0 teco7004.tfw cyclone7004.tfw /V /E
```

The procedure of a new firmware version upload

1. Switch the PLC power supply on and wait till it switches to the RUN or ERR mode.
2. Connect the communication cable (serial communication cable, USB cable or Ethernet cable).
3. The current communication parameters setting can be detected by the button stroke on the front panel of the central unit (SET - channel CH1, MODE - channel CH2, SET + MODE - Ethernet).
4. Terminate all other communications with the central unit before running the Firmup1c.exe program (esp. communication with the Mosaic). If we did not do so, the Firmup1c.exe program will notify that it is not possible to establish contact with the central unit. Communication can be terminated, for example, by disconnection of all other communication cables from the central unit.
5. Run the Firmup1c.exe program on the PC with corresponding parameters or the prepared batch. In the window that will open during the run, there is information on the central unit connected and on the type of connection displayed:

```
Firmware Upgrade Utility for TECOMAT systems
  version 2.7 (c) 2002,...,2007 Teco a.s.

System address               : 192.168.33.160
Communication pc channel     : Ethernet 10M
Identification string        : 700 CP7004K V2.4

Current version FW           : Switch 7004 v1.7
                             : Testy CP-7004 v1.4
                             : Boot CP7004 v1.9
                             : CP-7004 v2.4
                             : Cyclone CP-7004 v1.2

!!! System SW runs !!! Run BOOT (Y/N) ??? :
```

If we press the key N, the Firmup1c.exe program will be terminated and no changes to the firmware will be done. Hereby, versions of all firmware parts of the central unit can be detected. By pressing the key Y, we initiate the process of the firmware re-loading. Then we must answer the following query:

```
!!! Program with verification (Y/N) ??? :
```

If we press the key N, the firmware programming will be undertaken without an additional verification of programmed blocks. The time needed for programming will be shorter than in case of pressing the key Y when apart from the positive acknowledgement after the programming of each block, the block will be loaded from the PLC back to the PC and compared with the file programmed.
The programming progress will be displayed as follows:

```
Identification string                : 700  BOOT C 1.9

Upgrade of FW processor initiated    : 11:32:39

File programming in progress         : teco7004.tfw
File version in Flash                : v2.4
Programmed file version              : v2.5
Approx. file size                    :  756.8 [KB]
                                        342.8 [KB] programmed
```

After the programming is finished, the following report will appear:

```
Upgrade of FW processor finished : 11:34:18

The new firmware is programmed in the system
After the termination of the FirmUp1C program, the firmware will
be run !

     ... Press any key ...
```

By pressing any key, the firmware upgrade will be terminated. The central unit will reset and run again under the new firmware version that is displayed during the switching sequence on the central unit indication.

6.1.2. Změna firmwaru komunikačních modulů a expanderů

Pro změnu firmwaru v komunikačních modulech a expanderech systému TECOMAT TC700 se používá program Firmup1c.exe, tedy stejný jako pro centrální jednotky. Změnu je možné provádět pouze přes sériovou linku na horním sériovém kanálu modulu. Rychlost přenosu je vždy 38,4 kBd, adresa stanice je 0.

Firmware těchto modulů se skládá z několika souborů, přičemž některé mohou být změněny pouze servisními pracovníky firmy Teco. V případě systému TECOMAT TC700 může uživatel měnit vlastní firmware modulu a obsah hradlového pole Altera.

Tab.6.2 Seznam souborů pro změnu firmwaru komunikačních modulů a expanderů

Modul	soubor s firmwarem procesoru	soubor s obsahem obvodu Altera
SC-7101	teco7101.tfw	acex7101.tfw
SC-7102	teco7102.tfw	acex7102.tfw
SE-7131	teco7131.tfw	acex7131.tfw
SE-7132	teco7132.tfw	acex7132.tfw
CD-7251	teco7251.tfw	acex7251.tfw
CD-7252	teco7252.tfw	acex7252.tfw

Parametry programu Firmup1c.exe jsou podrobně popsány v kap.6.1.1.

Příklady spuštění programu Firmup1c.exe

Nahrát nový firmware přes COM2 rychlostí 38400 kBd do SC-7101 s adresou 0, po navázání komunikace zobrazit aktuální verze firmwaru v procesoru, dialogy programu budou v češtině

```
Firmup1c.exe 2 38400 0 teco7101.tfw acex7101.tfw /V /C
```

Postup pro nahrání nové verze firmwaru

1. Před před manipulací ukončíme všechny komunikace s centrální jednotkou, zejména pak ty, které vedou přes modul, který chceme přehrávat. Pokud bychom tak neučinili, může při přehrávání firmwaru dojít k nepředvídatelným následkům. Komunikace lze ukončit například odpojením všech komunikačních kabelů od přehrávaného modulu.
2. Horní sériový kanál modulu musíme osadit submodulem s vhodným sériovým rozhraním (RS-232, RS-485 nebo RS-422).
3. Ze sestavy PLC vyjmeme centrální jednotku CP-700x, nebo expander SE-7132 (pokud nepřehráváme právě tento modul). Tím zajistíme potřebný klid na systémové sběrnici.
4. Připojíme komunikační kabel pro sériovou komunikaci.
5. Zapneme napájení PLC a počkáme cca 30 s. Když po tuto dobu trvá klid na systémové sběrnici (který jsme zajistili vytažením centrální jednotky, resp. slave expanderu), modul odemkne na horním sériovém kanálu komunikaci umožňující změnu firmwaru.
6. Na počítači PC spustíme program Firmup1c.exe s příslušnými parametry nebo připravenou dávku (komunikujeme vždy rychlostí 38400 Bd a s adresou 0). V okně, které se při spuštění otevře, budou zobrazeny informace o připojeném modulu a typu připojení. Ovládání programu Firmup1c.exe je podrobně popsáno v kap.6.1.1. Po zahájení programování modul přejde do režimu BOOT, který je indikován střídavým blikáním zelené a červené LED diody RUN a ERR.
7. Po ukončení programování je modul restartován. Pokud trvale svítí pouze zelená LED dioda RUN, je nahraný firmware v pořádku. Pokud trvale svítí pouze červená LED dioda ERR, došlo k chybě firmwaru. V případě chyby vypneme a zapneme napájení rámu. Modul detekuje chybu firmwaru a pokusí se sám přejít do režimu BOOT (střídavé blikání zelené a červené LED diody). V tom případě můžeme zkusit nahrát firmware znova. Pokud modul není schopen do režimu BOOT přejít a trvale svítí pouze červená LED dioda, nebo modul nereaguje ani na žádnou komunikaci ze strany centrální jednotky nebo PC, je nutné modul odeslat výrobci.
8. V případě úspěšného naprogramování firmwaru vypneme napájení rámu PLC, vrátíme do něj centrální jednotku, resp. expander, a můžeme PLC opět zapnout.

APPENDIX

List of errors saved in the main error stack of the central unit

Symbols used:

cc - serial channel number
kk - error code
pc - instruction address, where the error occurred (program counter)
pp - number of position in the rack
r - rack number
t t - T-table number

The numerical codes are in hexadecimal form.

Error code	Error specification
02 cc 1200	address error
02 cc 15hh	error of service byte hh
02 cc 16ss	invalid parameters of communication service ss
02 cc 1809	protection error
07 00 0000	remanent zone check error
08 00 0000	exceeding of the first limit of cycle time monitoring
10 00 0000	division by zero
13 00 0000	table instruction above the scratchpad exceeded its range
14 00 0000	data source block defined out of range
15 00 0000	data destination block defined out of range
20 00 pcpc	user program fault during continuous check found
70 05 0000	invalid map length of user program at RAM
70 06 0000	invalid protection character (CRC) of the user program map at RAM
70 07 0000	invalid protection character (CRC) of entire program at RAM
70 09 0000	program is compiled for another series of central units
70 0B 0000	EEPROM programming failed
70 24 0000	list of on-line changes missing
70 25 0000	list of on-line changes has incorrect CRC
70 31 r r pp	initialization table is missing
70 34 r r pp	maximum size of variable exceeded
70 43 r r pp	invalid rack address, higher than the maximum possible
70 51 r r pp	initialization not finished
70 64 r r pp	invalid software of peripheral module
70 A1 r r pp	non-existing module
70 A2 r r pp	non-corresponding module type - initialization is designated for another type
70 A3 r r pp	module does not support these on-line changes
70 C5 r r pp	communication channel invalid number
70 C6 r r pp	invalid mode of communication channel
73 cc 3701	serial channel initialization table length is invalid
73 cc 3702	pomocná tabulka neexistuje
73 cc 3801	invalid speed in initialization table of serial channel
73 cc 3802	station address is invalid
73 cc 3803	invalid number of network participants
73 cc 3804	number of network participants exceeds the number of lines
73 cc 3810	non-permissible number of the local port
73 cc 3811	unknown protocol of the Ethernet interface
73 cc 3815	error connection
73 cc 4204	serial channel is not in the required mode
73 cc 4206	maximum volume of transmitted data within network or for participant exceeded
73 cc 4207	serial channel cannot be assigned - permanently occupied by another module
73 cc 4208	non-permissible mode of communication channel

Error code	Error specification
80 01 0000	invalid map length of user program at EEPROM
80 02 0000	invalid protection character (CRC) of the user program map at EEPROM
80 03 0000	invalid protection character (CRC) of entire program at EEPROM
80 04 0000	no user program at EEPROM
80 05 0000	invalid map length of user program at RAM
80 06 0000	invalid protection character (CRC) of the user program map at RAM
80 07 0000	invalid protection character (CRC) of entire program at RAM
80 08 0000	editing intervention into the user program with EEPROM memory connected
80 09 0000	program is compiled for another series of central units
80 0A 0000	attempt to program EEPROM that is off
80 0B 0000	EEPROM programming failed
80 0C 0000	RTC error
80 10 pcpc	return address stack overflow
80 11 pcpc	return address stack underflow
80 12 pcpc	non-zero stack of return addresses after process termination
80 13 pcpc	label not declared
80 14 pcpc	label number is greater than the maximum value
80 15 pcpc	T-table is not declared
80 16 pcpc	unknown instruction code
80 17 pcpc	non-regular user instruction USI
80 18 pcpc	required user instruction USI does not exist
80 19 pcpc	BP instruction nesting error
80 1A pcpc	the process for BP operation is not programmed
80 1B t t t t	invalid T-table configuration
80 1C pcpc	array / string overrange
80 1D pcpc	překročení rozsahu zápisníku při nepřímém adresování
80 20 pcpc	user program fault during continuous check found
80 21 pcpc	nelze nastavit DP - překročen rozsah zápisníku
80 22 pcpc	nelze nastavit SP - překročen rozsah systémového stacku
80 23 pcpc	nelze nastavit FP - překročen rozsah systémového stacku
80 30 pcpc	maximum cycle time not exceeded
80 31 pcpc	maximum time of interrupt process exceeded
80 44 0001	identification error - the record cannot be read
80 44 0002	identification error - no record
80 44 0003	identification error - invalid record length
80 44 0004	identification error - invalid record data
83 cc 3701	serial channel initialization table length is invalid
83 cc 3702	non-existing auxiliary table
83 cc 3801	invalid speed in initialization table of serial channel
83 cc 3802	station address is invalid
83 cc 3803	invalid number of network participants
83 cc 3804	number of network participants exceeds the number of lines
83 cc 3810	non-permissible number of local port
83 cc 3811	unknown Ethernet interface protocol
83 cc 3815	fault connection
83 cc 4204	serial channel is not in the required mode
83 cc 4206	maximum volume of transmitted data within network or for participant exceeded
83 cc 4207	nelze přidělit sériový kanál - trvale obsazen jiným modulem
83 cc 4208	nepřípustný režim komunikačního kanálu
84 r r 50ss	expander neodpověděl na komunikační službu ss
84 00 5101	inicializace expanderů nedokončena
84 r r 52ss	sběrnice nevrátila reakci na komunikační službu ss
84 r r 54ss	expander odpověděl chybnými daty na komunikační službu ss
84 r r 6001	expander nedostává data
84 r r 6502	expander nepřešel do stavu INITIAL
84 r r 6504	expander nepřešel do stavu STANDBY
84 r r 6505	expander nepřešel do stavu ACTIVE
90 00 pcpcpc	return address stack overflow
90 40 pcpcpc	return address stack underflow
90 80 pcpcpc	non-zero stack of return addresses after process termination
91 00 pcpcpc	label not declared

Kód chyby	Specifikace chyby
91 40 pcpcpc	label number is greater than the maximum value
91 80 pcpcpc	T-table is not declared
91 C0 pcpcpc	unknown instruction code
92 00 pcpcpc	array / string overrange
92 40 pcpcpc	stack range exceeding with indirect addressing
92 80 pcpcpc	BP instruction nesting error
92 C0 pcpcpc	the process for BP operation is not programmed
93 00 pcpcpc	user program fault during continuous check found
93 40 pcpcpc	DP cannot be set - stack range exceeded
93 80 pcpcpc	SP cannot be set - system stack range exceeded
93 C0 pcpcpc	FP cannot be set - system stack range exceeded
94 80 pcpcpc	unsupported function block
95 00 pcpcpc	maximum cycle time not exceeded
95 40 pcpcpc	maximum time of interrupt process exceeded
Ar pp 1200	address error
Ar pp 15hh	error of service byte hh
Ar pp 16ss	invalid parameters of communication service ss
Ar pp 1705	received zone overflow
Ar pp 1809	protection error
Ar pp 3100	initialization not executed
Ar pp 3101	initialization table is missing
Ar pp 3401	maximum size of variable exceeded
Ar pp 3402	invalid address in working memory
Ar pp 3700	invalid length of received initialization table in the module
Ar pp 3701	invalid length of declared initialization table of the module
Ar pp 3805	communication channel invalid number
Ar pp 3806	invalid mode of communication channel
Ar pp 3807	invalid combination of activated variables
Ar pp 3808	invalid length of activated variable
Ar pp 3809	unsupported type of analog channel
Ar pp 3813	nepodporovaný typ konverze dat
Ar pp 3901	interrupt from the module cannot be activated
Ar pp 4201	serial channel for communication with the rack is not assigned
Ar pp 4202	serial channel for communication with the rack is not on
Ar pp 4203	serial channel is not at the EIO mode
Ar pp 4301	non-existing module
Ar pp 4302	non-corresponding module type - initialization is designated for another type
Ar pp 4303	invalid rack address, higher than the maximum possible
Ar pp 4304	module with unknown operation
Ar pp 4401	module identification read error - the record cannot be read
Ar pp 4402	module identification read error - no record
Ar pp 4403	module identification read error - invalid record length
Ar pp 4404	module identification read error - invalid record
Ar pp 4502	hw module configuration error - no data for configuration
Ar pp 4503	hw module configuration error - invalid data on configuration
Ar pp 4504	hw module configuration error - invalid configuration data
Ar pp 50ss	the module did not reply to communication service ss
Ar pp 5103	initialization not finished
Ar pp 52ss	the bus did not react to communication service ss
Ar pp 53ss	bus is not free after communication service ss
Ar pp 54ss	the module responded to communication service ss with invalid data
Ar pp 5501	unknown mode of data exchange
Ar pp 6000	communication interrupt with central unit
Ar pp 6001	peripheral module does not receive data
Ar pp 6201	data cannot be transmitted at the HALT mode
Ar pp 6202	nedostupná služba sběrnice
Ar pp 6203	nedostupná služba sběrnice - závada na hw modulu
Ar pp 6204	neznámá služba sběrnice
Ar pp 6401	chybný sw periferního modulu
Ar pp kkkk	another errors reported by the peripheral module
FF kk kkkk	central unit system error (kk - any number specifying error type)

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