PROGRAMMABLE LOGIC CONTROLLERS TECOMAT NS950

1998

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1. INTRODUCING THE PROGRAMMABLE LOGIC CONTROLLERS TECOMAT NS950

1.1 INTRODUCTION

What is the programmable logic controller?

Programmable logic controller (hereafter PLC) is a digital electronical system designed for process control in an industrial environment. It uses a programmable memory for inner storage of user-orientated instructions which serve to implementation of specific functions for the control of the various machine or process types via digital or analog inputs or outputs.

PLCs TECOMAT NS950 are freely programmable modular build-up systems, designed especially for logic control of work machinery, technological processes and equippment.

The principle of user programme performing

Control algorithm of programmable logic controller is entered as an instruction sequence in the memory of the user programme. Central unit reads the individual instructions from this memory step by step, performs the appropriate operations with data in note-pad memory and buffer; or, it performs transitions in instruction sequence if the instruction is from the group of organizing instructions. If all the instructions of required algorithm are performed, the central unit updates the output variables into output peripheral units and updates the states and conditions from input peripheral units into note-pad memory. This action repeats all the time and it is called the programme cycle. (fig. 1.1, fig. 1.2).

Cyclic performing of the user programme

Single update of input variable state eliminates during the whole programme cycle the possibilities of risky state development during the solution of control algorithm (change of input variables cannot occur during the calculation).

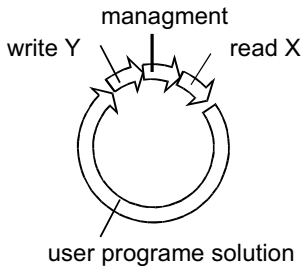


Fig.1.1 Cycle of user programme solution
read X - transcription of values from PLC input units into the area X in note-pad memory
write Y - transcription of values calculated by the programme from the area Y into PLC output units
management - preparation of PLC central unit for solution of other programme cycle

Input signal processing and output signal generation

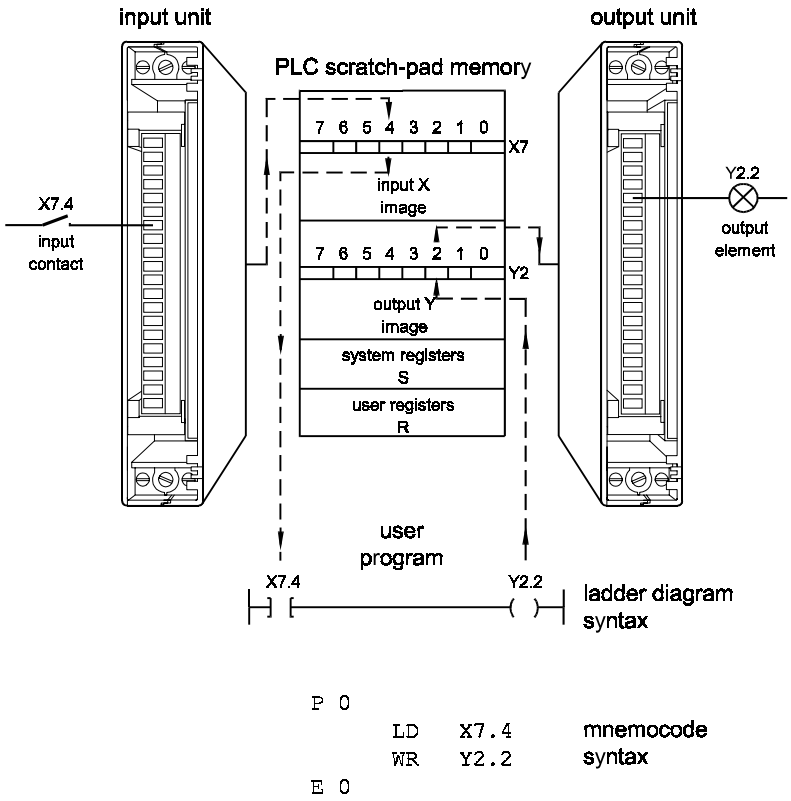


Fig.1.2 Scheme of signal processing by programmable logic controller

1.2 Property list of the systems TECOMAT NS950

Use of PLC TECOMAT NS950

Modular programmable logic controllers TECOMAT NS950 are designed for technology control in various areas of industry and other fields. The user selecting the system can choose from various types of peripheral units which can be combinated arbitrarily, there are power supply units for various voltage, various types of central units and last but not least various types of baseframes into which all the system components are installed. Consistent modularity allows a system design that ideally meets the requirements of the specific application, thus providing an optimal result for an optimal price.

Communication

The communication possibilities are the strong point of the system TECOMAT NS950. The need of communication is a characteristic feature of nowadays and the system fully meets the case. The communication is provided by the EPSNET industrial network. On a single level of EPSNET industrial network there may be up to 32 subscribers and the length of serial line up to 1200 m, while using the interface RS-485.

PLCs TECOMAT NS950 are supplied in several different modifications which differ from each other in the capacity and they are able to communicate over the serial channel. Serial channels in NS 950 system are equipped with a serial line interface according to the customer´s choice (RS-232, 20mA corrent loop, RS-485, RS-422).

Extensive system build-up

Thanks to serial communication, the individual parts of the whole system TECOMAT NS950 can be laid out decentralizated in such way that the high-duty parts are placed right at the controlled technology and the control parts can be concentrated in the control centre. The peripheral units are operated by the central unit in the basic module, in the extension modules they are operated by the expansion units, which take care of data transfer over the serial line from and into the central unit. The advantage of the serial connection is the possibility of periphery unit location up to hundreds meters from the central unit which in series of cases reduces the price of cabling.

Connection to PC

The whole system as well as its individual parts are able to communicate with the PC standard computers. An arbitrary serial interface is on the side of the PC adapted to the RS-232 interface by an interface adapter. Thus being located at a control desk or in a dispatching center the PC can be used as a monitor of the controlled process. The computer serves also as a programming tool for all types of PLCs.

The mutual communication is not restricted only to PLCs of the series TECOMAT NS950, but it applies to PC standard computers (using a serial interface adapter) as well as to other users meeting the requirements of the EPSNET network (another PCL TECOMAT, operator desks etc ...)

Distributed control systems

These facts allow a design of hierarchical or distributed control systems. Such systems can be built using the 'bottom-up' approach which means that an originally autonomous systems are interconnected and supplemented with an upper control layer or a central data monitoring and data acquisition. The lifetime of those 'bottom-up' designed systems is usually longer than the lifetime of systems designed in a 'top-down' way.

An advantage of distributed systems is the possibility of an autonomous control even in case of an outage of the control center. Also, such systems can be easily put into operation, tuned and supplemented with new parts. There is a considerable cut in the costs and quantity of work invested into cabling or switchboard.

Programming device

A PC computer can be used as a programming device (laptop would be a good choice). TECOMAT NS950 offers a number of system services that make the programming easy and user friendly. The services cover various indicators of time related information, display of the time and date, or a PLC switching-on system support.

High variability of PLC TECOMAT NS950

The frames of basic and expansion modules are delivered in several modifications with various number of positions for peripheral units so that they would meet the customer´s demands on the size of the system.

All systems of TECOMAT NS950 series use the same assortment of peripheral units. The units are closed in plastic protective cases. Because of that, the units can be manipulated without the risk of damaging the sensitive CMOS components. The basic technical data about the unit and instructions are printed on the sides of the cases. Thus, the basic information about the unit is available all the time.

1.3 TECOMAT NS950 RAPID

Class RAPID

TECOMAT NS950 RAPID is a PLC designed for medium and large applications.

CPU of series D

CPM-1D is a central unit of series D. It is designed for medium applications. It contains 32 KB CMOS RAM backup memory for user programmes, data and tables, 8 KB user registers, real time circuit and two serial channels. The unit can be arbitrarily set with EEPROM memory for the user programme backup and additional memory for Databox data archiving. The typical number of binary inputs and outputs 1024/1024 can be extended. Central units of series D contain an extended instruction file.

The central unit CPM-1D can be extended by other two serial channels, using the additional system unit SC-01.

CPU of series B

CPM-1B is a central unit of series B. It is designed for major applications or applications requiring high performance. It contains 64 KB CMOS RAM backup memory for user programmes, data and tables, 8 KB user registers, real time circuit and 4 serial channels. The unit is set with Flash EEPROM memory for the user programme stand-by and additional memory for Databox data archiving. The typical number of binary inputs and outputs 1024/1024 can be extended. The central units of series B contain an extended instruction file.

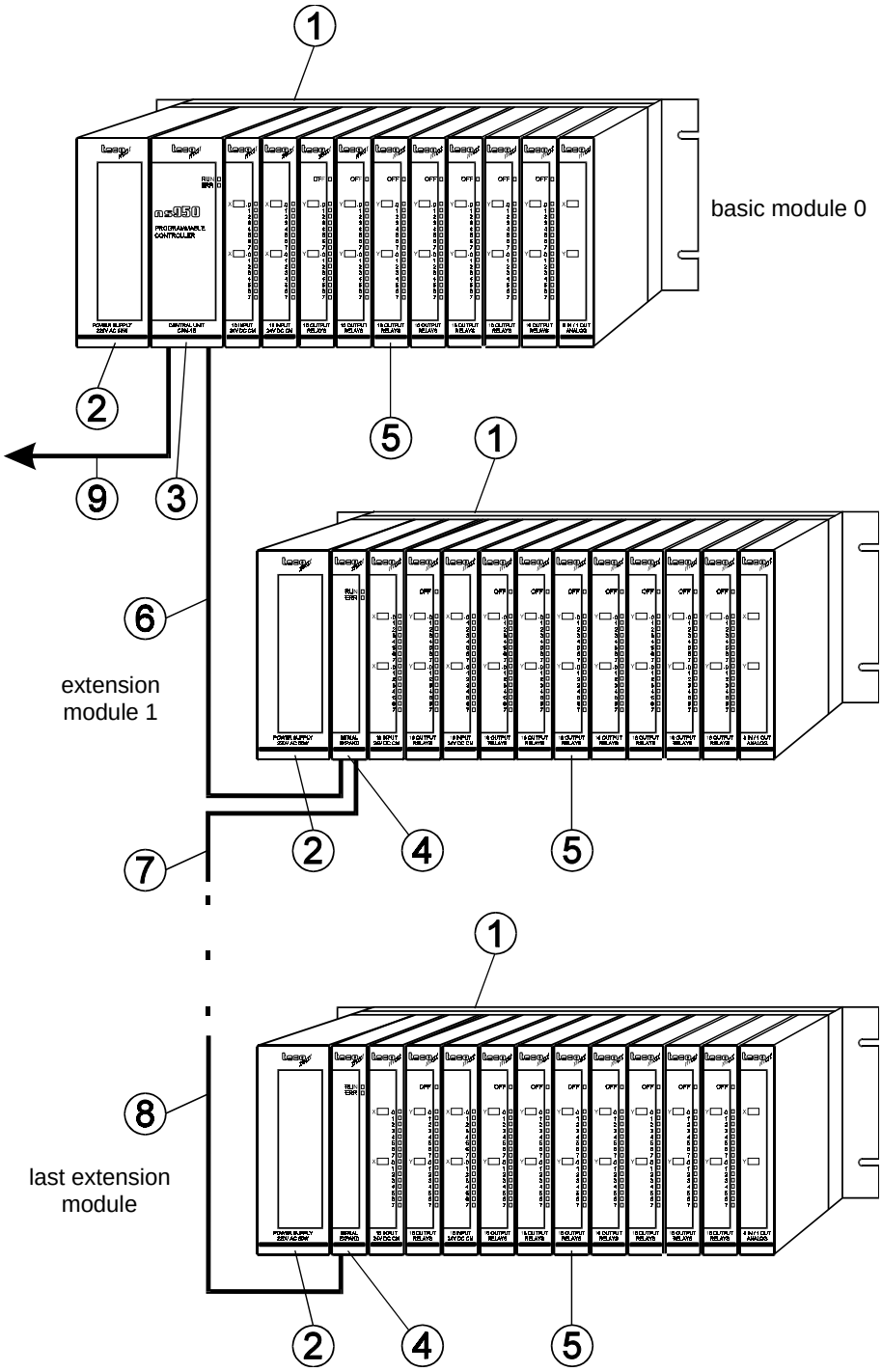


Fig.1.3 Setup of the PLC TECOMAT NS950 RAPID
1 - supporting frame RM-11, RM-13, RM-15 or RM-19
2 - power supply unit AC-60W or DC-60W
3 - central unit CPM-1B or CPM-1D
4 - expansion unit STM-3 (or STM-2 with a restriction - see the text)
5 - peripheral units
6 - interconnection cable CPM - STM
7 - interconnection cable STM - STM
8 - interconnection cable STM - last STM
9 - interconnection cable with superior system

The central unit CPM-1B can be extended by up to 8 additional serial channels, using the additional system units SC-01.

Build-up

The basic and extension PLC modules consist of a flat supporting frame and units placed in separate plastic cases, which are attached to the frame. Each case has a separate door which enables the access to withdrawable unit terminal board and to supply cable. The width of a single case is 30 or 60 mm according to the unit type.

Setup of series RAPID

The basic module PLC TECOMAT NS 950 RAPID is formed by the following setup /Fig. 1.3/:

- supporting frame RM-11, RM-13, RM-15 or RM-19
- power supply unit AC-60W or DC-60W
- central unit CPM-1D
- 4, 6, 8 or 11 positions for the peripheral units

  or
- supporting frame RM-11, RM-13, RM-15 or RM-19
- power supply unit AC-60W or DC-60W
- central unit CPM-1B (it takes up 2 positions on the frame - see the fig.1.3)
- 3, 5, 7 or 10 positions for the peripheral units

The additional system unit SC-01 which extends the central unit by other 2 serial channels takes up one position in the basic module.

The other peripheral units are placed into the extension modules RM950 formed by the following setup:

- supporting frame RM-11, RM-13, RM-15 or RM-19
- power supply unit AC-60W or DC-60W
- expansion unit STM-3 or STM-2 /only for CPM-1D/
- 4, 6, 8 or 11 positions for the peripheral units

Restriction of STM-2 expansion unit use

The expansion unit STM-2 can be used only for the setup with one extension module with the central unit CPM-1D in the basic module. If we want to connect more extension modules /max. 3/ to the unit CPM-1D, the expansion units STM-3 must be set in all of them. The central unit CPM-1B cooperates only with expansion units STM-3.

The order numbers of the setup components are stated clearly in the catalogue of the programmable logic controllers TECOMAT NS 950.

1.4 TECOMAT NS950 MINI

Class MINI

TECOMAT NS 950 MINI is a PLC designed for minor applications

CPU of series E

CPM-1E is a central unit of series E. It is designed for the least difficult applications and data collection. It contains 16 KB CMOS RAM backup memory for the user programmes, data and tables, 256 user registers and one serial channel. The typical number of binary inputs and outputs 128 / 128 can be extended further. Central units of series E contain reduced instruction file.

CPU of series M

CPM-1M is a central unit of series M. It is designed for minor application. It contains 16 KB CMOS RAM backup memory for the user programmes, data and tables, 256 user registers, real time circuit and one serial channel. The typical number of binary inputs and outputs 128 / 128 can be extended. The central units of series M contain standard instruction file.

CPU of series S

CPM-2S is a central unit of series S. It is designed for minor applications that require increased output. It contains 20 KB CMOS RAM backup memory for the user programme, data and tables, 512 user registers, real time circuit and two serial channels. The unit can be arbitrarily fitted with EEPROM memory for the user programme stand-by and with additional memory for Databox data archiving. The typical number of binary inputs and outputs 1024 /1024 can be extended. The central units of series S contain standard instruction file. Unit CPM-2S fully replaces the older unit CPM-1S.

Build-up

PLC module consists of supporting flat frame and units placed in a separate plastic cases, which are attached to the frame. Each case has a separate door which enables the access to the withdrawable unit terminal board

and to supply cables. The width of a single case is 30 or 60 mm according to the unit type.

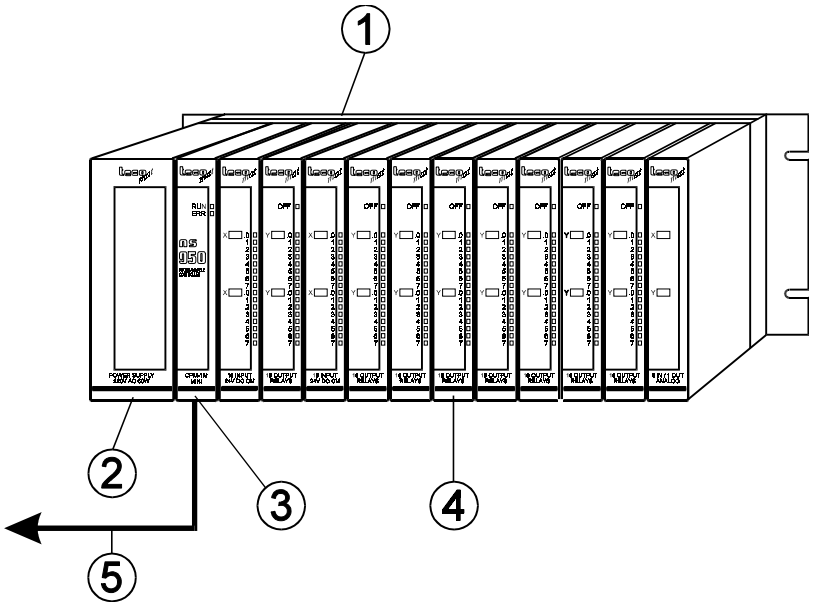


Fig. 1.4. Setup of the PLC TECOMAT NS950 MINI
1. supporting frame RM-11, RM-13, RM-15 or RM-19
2. power supply unit AD-60W or DC-60W
3. central unit CPM-1E, CPM-1Mor CPM-2S
4. peripheral units
5. interconnection cable with superior system

Setup of series MINI

Module PLC TECOMAT NS950 MINI is formed by the following setup (fig. 1.4.):

- supporting frame RM-11, RM-13, RM-15 or RM-19
- power supply unit AC-60W or DC-60W
- central unit CPM-1E, CPM-1M or CPM-2S
- 4, 6, 8 or 11 positions for the peripheral units

The order numbers of the composition components are clearly stated in the catalogue of the programmable logic controllers TECOMAT NS950.

1.5 TECOMAT NS950 PRIMA

Class prima

TECOMAT NS950 PRIMA is a PLC designed for the least minor applications.

CPU of series E, M,S

The used central units are identical with the class MINI (chapter 1.4), accordingly the units CPM-1E, CPM-1M and CPM-2S.

Build-up

Unlike the other classes, PLC PRIMA is formed by one compact case 90 mm wide. The case has common door which enables the access to withdrawable unit terminal board and to the supply cables. On the right side there are grips which enable the PLC installation into a small shallow cabinet

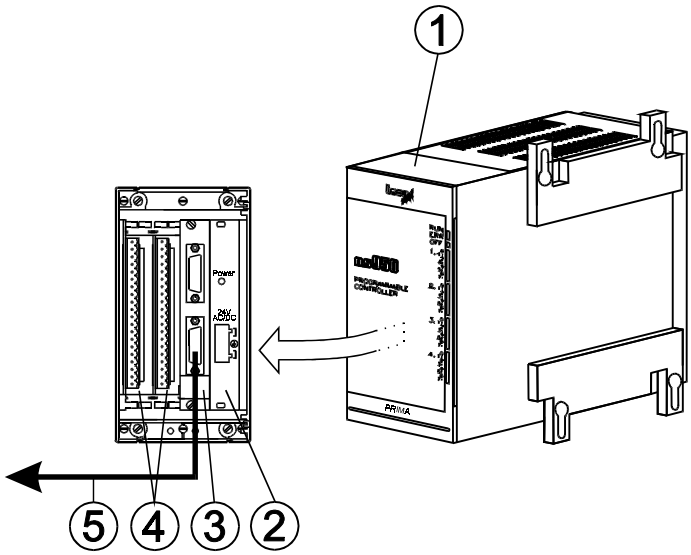


Fig. 1.5 Setup of the PLC TECOMAT NS950 PRIMA
1. protective case KM-02
2. power supply unit DCAC-17W
3. central unit CPM-1E, CPM-1M or CPM-2S
4. peripheral units
5. interconnection cable with superior system

Setup of class PRIMA

PLC TECOMAT NS950 PRIMA is formed by the following setup (fig. 1.5):

- protective case KM-02
- power supply unit DCAC-17W
- central unit CPM-1E, CPM-1M or CPM-2S
- 2 positions for the peripheral units

The order numbers of the setup components are clearly stated in the catalogue of the programmable logic controllers TECOMAT NS950.

1.6 PLC basic parameters

PLCs TECOMAT NS950 are constructionaly designed for the installation into cabinets and stands. They are designed for contamination degree 2. The installation must be carried out in such way, that the conditions for II. overstressed category are not exceeded.

PLC basic parameters are stated in the table 1.1 - 1.5. The parameters refering to the power supply and the system units are stated in the following tables:

Tab. 1.1 Basic parameters of the PLC TECOMAT NS950

Power supply	according to the type of the power supply unit
Type of device	built-in
Degree of cover	IP 20
Type of traffic	permanent
Lifetime	10 years

Tab. 1.2 Running conditions

Traffic environment	basic, without conductive dust, aggressive vapours and salts
Traffic temperature	0 °C - + 55 °C
Relative humidity	50 - 95 % without the vapour condensation
Vibration resistance	in zone 10 - 55 Hz with max. acceleration 2G

Tab. 1.3 Storage conditions

Storage environment	dry clean rooms without conductive dust, aggressive gases or acid vapours for the time which does not exceed the guarantee time
Storage temperature	-25 °C to +70 °C without sudden temperature variations
Relative humidity	max. 80 % without vapour condensation

Tab. 1.4 Transport conditions

Transport environment	covered conveyance, transport container must not be exposed to rain and snow conditions
Transport temperature	-25 °C - + 70 °C

Tab. 1.5 Characterization of the system

User programme execution • cyclic, multiloop control with the possibility of interruption from the outer events, time and error report
User programme memory • CMOS RAM, EEPROM
PLC regimes • RUN - user programme execution • HALT - user programme stop, PLC programming
Output lockout • by service input • by command on serial channel • automaticly after a serious system error
Hardware diagnostics • watchdog • supply voltage check (power fail), data protection by power fail • serial communication security • data transfer security on I/O bus
Software diagnostics • control of user programme validity • checking the time of user programme cycle • current control of user programme accuracy (non-existing jump aim, storage structure overflow, zerodivide, unknown instruction, etc.)
Communication • serial in EPSNET network • general serial asynchronous
The other functions • automatic recognition of peripheral unit configuration • EEPROM programming • communication support for data monitoring by superior system • possibility of user programme execution without connection of the peripheral units • additional memory for DataBox data archiving

2. Components of the basic PLC setup

2.1 SUPPORTING FRAMES AND CASES

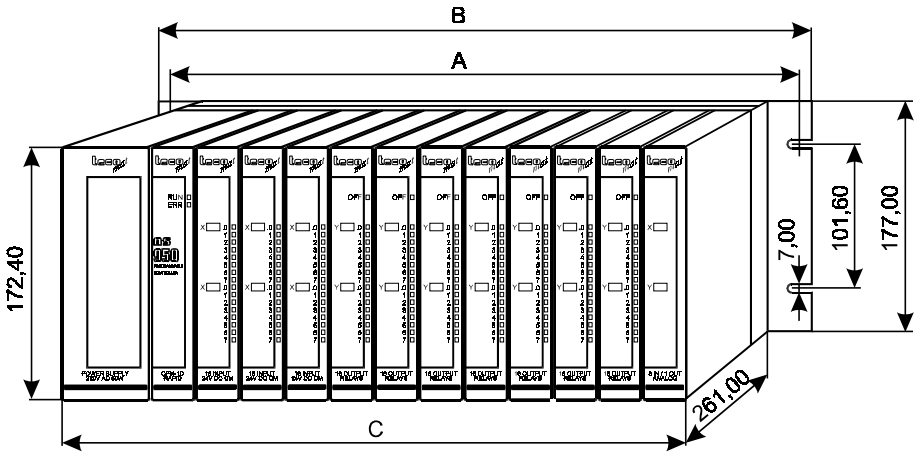
2.1.1 Supporting frames of classes RAPID and MINI

Supporting frames of classes RAPID and MINI

The supporting base of all PLC TECOMAT NS950RAPID and MINI modules is formed by a flat frame which can be delivered in several dimensional variants. IIOC-T bus with connectors for the peripheral units is part of the frame.

Installation sizes of the frame and their order numbers are on figure 2.1.

Mounting sizes of set frames



Type of the frame	A [mm]	B [mm]	C [mm]
RM-19 5XN 053 05.19	465,1	482,6	427,0
RM-15 5XN 053 05.15	373,7	391,2	335,7
RM-13 5XN 053 05.13	312,7	330,2	274,7
RM-11 5XN 053 05.11	251,2	269,3	213,8

Fig. 2.1. Mounting sizes of modules in PLCs RAPID and MINI

2.1.2 Supporting case of the class PRIMA

Supporting sizes of the class PRIMA

The supporting base of the PLC PRIMA is formed by a case, part of which is IIOC-T bus with connectors and positions for the feeder, central unit and two peripheral units.

Installation sizes of the case are stated on fig. 2.2.

The order number of the case is TXN 053 06.

Mounting sizes of PLC case

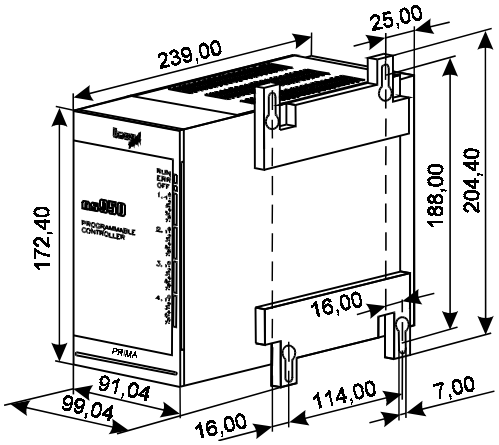


Fig. 2.2 Mounting sizes of the PLC PRIMA

2.2 Power supply units

Review of the power supply units

Tab. 2.1 Review of the power supply units with order numbers

Type of power supply	Modification	Order number
AC-60W/230	mains feeder 230 V AC for RAPID and MINI	5XN 053 10
AC-60W/115	mains feeder 115 V AC for RAPID and MINI	TXN 053 13
DC-60W/110	mains feeder 110 V DC for RAPID and MINI	TXN 053 16
DC-60W/24	mains feeder 24 V DC for RAPID and MINI	5XN 053 11
DCAC-17W/24	mains feeder 24 V DC/AC for PRIMA	TXK 070 14

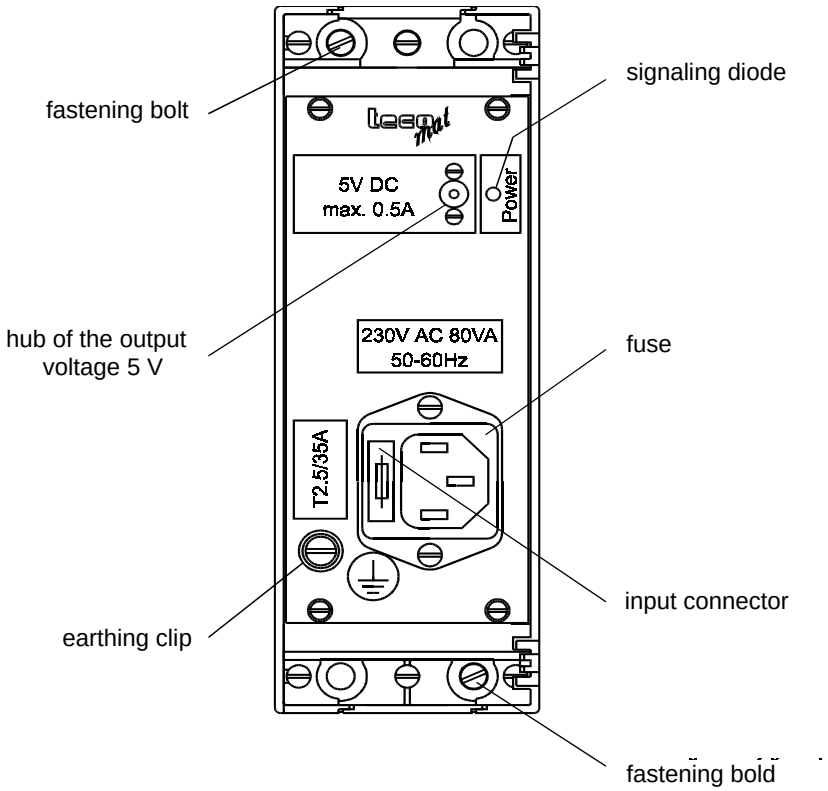


Fig.2.3 Front panel of the AC - 60W power supply unit

2.2.1 Supply units AC-60W

Power supply units of the PLC RAPID and MINI from the alternating network

Power supply units AC-60W are designed to supply the module types RAPID and MINI from network 230 V AC or 115 V AC at power output 60 W in 60 mm wide case. They are always placed in the first frame position from the left, set for the supply unit. The parameters are stated in table 2.2.

The power supply units have pulse regulation with four output levels at continuous output power 60 W (+5 V / 0,2 - 4 A, +12 V / 0 - 3,2 A, +15 V / 0 - 0,7 A, -15 V / 0 - 0,7 A). Supply units comply with the requirements for the safe voltage supply unit.

The power unit includes a module which alarms network voltage fall-out. All output levels are equipped with the surge progector components.

On the front panel (fig. 2.3) there is a combination of network fork and fuse holder. Inside there are two fuses - work fuse and stand-by fuse (T2,5 / 35 A). Furthermore, there is a fork jack 6,3 designed for the supply of external device, output indication +5 V and protective earthing clip.

Supply units AC-60W enable connection to TN-S and TN-C network and are marked ESČ.

Tab. 2.2 Parameters of supply units AC-60W

Type of supply unit	**AC-60W/230**	**AC-60W/115**
Input voltage		
nominal value	230 V AC	115 V AC
allowable span	187 - 235 V AC	95 - 131 V AC
frequency	50 - 60 HZ	50 - 60 Hz
Maximal power input	80 VA	
Prim. circuit safeguarding	fuse T2,5 / 35 A	
Output voltage	+5V / +12V / +15V / -15V DC	
Output current		
nominal value	4A / 3,2A / 0,5A / 0,5A	
allowable span	0,2 - 4 A; / 0 - 3,2A; / 0 - 0,7A; / 0 - 0,7 A	
Short-circuit protection	electronic	
Galvanic isolation	yes	
El. resistance of insulation		
input / output - 1 min.	3,75 kV AC	2,8 kV AC
input against ground	1850 V AC** (50Hz)	1750 V AC** (50 Hz)
Insulation resistance	> 10 MΩ** (500 V)	
Degree of live parts covering	IP 20	
Device of protection type	I	
Degree of interference elimination	class A	
Casing width	60 mm	

* Total power output from the supply may not exceed 58 W.

** It is valid for points galvan. connected with supply voltage against ground.

2.2.2 Supply units DC-60W

Power supply units of RAPID and MINI from the direct network

Power supply units DC-60W are for the supply of the module types RAPID and MINI from the network 110 V DC or 24 V DC at power output 60 W in 60 mm wide case. They are always placed in the first frame position from the left, set for the the supply unit. The parameters are described in table 2.3.

The function is similar to the one with types AC-60W, front panel is on figure 2.4.

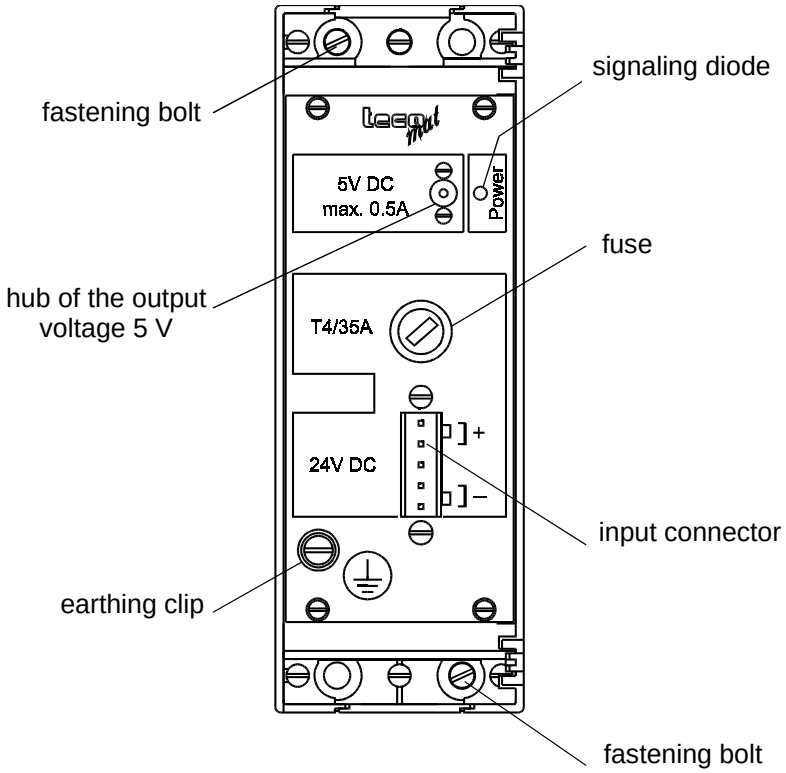


Fig. 2.4 Front panel of the supply unit DC-60W

Tab. 2.3 Parameters of the power supply units DC-60W

Type of power supply	DC-60W/110	DC-60W/24
Input voltage		
nominal value	110 V DC	24 V DC
allowable span	90 - 140 V DC	19 - 30 V DC
Maximal power input	80 W	80 W
Primary circuit safeguarding	fuse T 2,5 / 3,5 A	fuse T4 / 35 A
Output voltage	+5 V +12 V	+15 V -15 V DC
Output current		
nominal value	4 A 3,2 A	0,5 A 0,5 A
allowable span*	0,2 - 4 A 0 - 3,2 A	0-0,7 A 0-0,7 A
Short-circuit protection	electronic	
Galvanic isolation	yes	
Electr. resistance of insulation		
input/output - 1 min.	2,8 kV AC	350 V DC
input against ground	2500 V DC **	2500 V DC **
Insulation resistance	>10 MΩ** (500 V)	
Degree of live parts covering	IP 20	
Device of protection type	I	
Degree of interfer. elimination	class A	
Casing width	60 mm	

* Total power output from the power supply may not exceed 58 W.

** It is valid for points galvanicly connected with supply voltage against ground.

2.2.3 Power supply DCAC-17W

Power supply unit DCAC-17 W / 24 is for the supply of PLC PRIMA from mains 24 V AC or DC at overall power output 17 W. It is always set in the rightmost position of the case. Its parameners are described in table 2.4.

The power supply unit has four output levels at consistent overall output power 17 W (+5 V / 0,2 - 1,5 A, +12 V / 0 - 1A, +15 V / 0 - 0,2 A, -15 V /

0,02 A). The power supply complies with the requirements for safe voltage power supply. The power supply includes a module which alarms mains voltage fall-out. All output levels are equipped with the surge protector components.

On the front panel (fig. 2.5) there is a connector for connection of supply voltage 24V and output indication +5V.

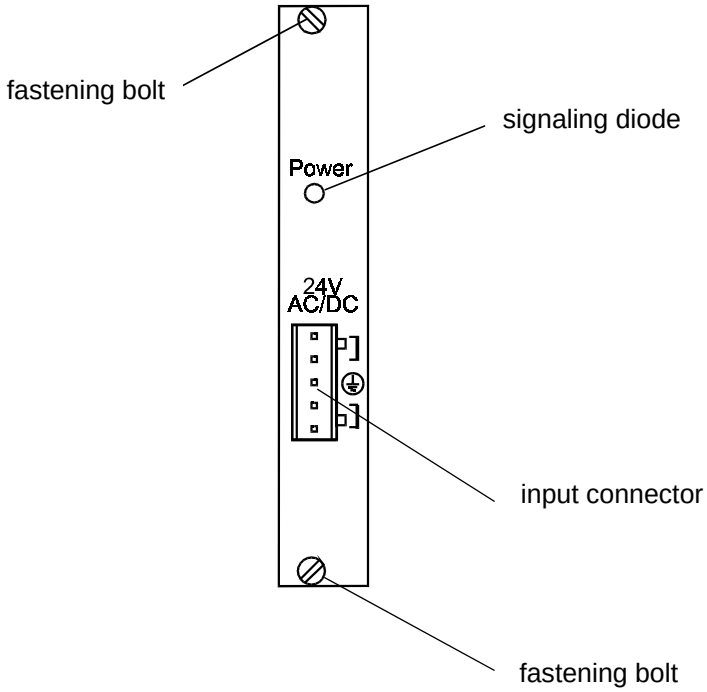


Fig. 2.5 Front panel of the supply unit DCAC-17W

Tab. 2.4 Parameters of the power supply DCAC-17W

Type of power supply	**DCAC-17W/24**
Input voltage	
nominal value	24 V DC / AC
allowable span	19 - 30 V DC / AC
frequency	-/ 50 - 60 Hz
Maximal power input	25 W / A
Primary circuit safeguarding	fuse T2,5L250V
Output voltage	+5 V + 12V +15V -15 V DC
Output current	
nominal value	1,5 A 0,6 A 0,1 A 0,1 A
allowable span*	0,2-1,5 A 0-1,0 A 0-0,2 A 0-0,2 A
Short-circuit protection	electronic
Galvanic isolation	yes
Electrical resistance of insulation	
input / output - 1 min.	350 V DC
input against ground	2500 V DC**
Insulation resistance	>10 MΩ**(500 V)
Degree of live parts covering	IP 20 (in PLC case of class PRIMA)
Device of protection type	I
Degree of interference elimination	class A

* Total power output from the power supply may not exceed 17 W.

** It is valid for points galvanicly connected with supply voltage against ground.

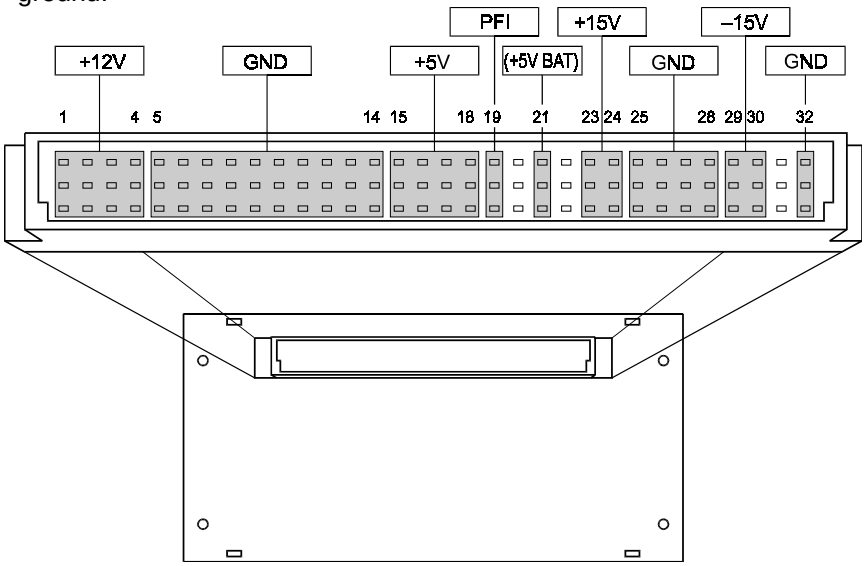


Fig. 2.6 Engagement of the tips on output connector of the supply units

2.3 System units

What are the system units?

The systems TECOMAT NS950 contain several types of the system units with different objectives. Generally, the system units can be divided into central units, expansion units and additional units.

Tab. 2.5 Outline of the system units with order numbers

Type of the unit	Modification	Order number
CPM - 1E	central unit for the class PRIMA	TXK 070 94.00*
		TXK 070 94.02**
	central unit for the class MINI	TXN 053 94.00*
		TXN 053 94.02**
CPM-1M	central unit for the class PRIMA	5XK 070 90.00*
		5XK 070 90.02**
	central unit for the class MINI	5XN 053 90.00*
		5XN 053 90.02**
CPM-2S	central unit for the class PRIMA	TXK 070 96*
	central unit for the class MINI	TXN 053 96*
CPM-1D	central unit for the class RAPID	TXN 053 93*
CPM-1B	central unit for the class RAPID	TXN 053 95*
STM-2	expansion unit for the class RAPID	TXN 053 84.00*
		TXN 053 84.04***
STM-3	expansion unit for the class RAPID	TXN 053 85.00*
		TXN 053 85.04***
SC-01	additional serial channels for the class RAPID	TXN 054 80*

* Replaceable piggybacks of the serial interface MR-xx have to be reordered separately.
** Serial channel is set with the interface RS-232 (piggyback MR-02)
*** Serial channel is set with the interface RS-485 (piggyback MR-04)

Central units

The central unit performs the actual user programme and it contains basic functions without which the PLC cannot exist. Therefore, the basic PLC module must contain the central unit. Each central unit is marked with a letter that determines the series. Each series of central units has its specific features which are important for the user programme compiler, such as mapping and size of the memory space, size of instruction file etc.

Series of central units

Expansion units

Expansion units transfer data between the central unit and extension modules and backup the operation of peripheral units in module. Therefore, each extension module RM950 must contain STM expansion unit.

Additional units

Additional units enable extension of the central unit by some other functions. The unit SC-01 extends the central units of series B and D by other two full-valuable serial channels. One additional unit SC-01 can be added to central units of series D, up to four additional units SC-01 can be added to central units of series B.

Stated in a separate manual Serial Communication of PLCs TECOMAT (order number TXV 001 06.01).

2.3.1 Central units

Central unit, type E - economic type for the basic bit signal proccessing and data agnisition

Central unit CPM-1E is designed for PLC MINI and PRIMA. It is placed in a case 30 wide (class MINI) and it is set into a frame in position next to the power supply. It contains:

- 16 KB CMOS RAM backup memory for the user programmes, data and tables
- 256 user registers
- 1 serial channel with optional interface which can be replaced with the help of the piggybacks (20 mA current loop, RS-232, RS-485, RS-422).

Central unit CPM-1E enables PLC build-up into the basic module and it contains reduced instruction file aimed mainly at data collection and logic bit data processing.

Serial channel is designed for PLC programming and communication with superior systems. The speed of serial communication is optional and it is adjusted together with the address by interconnectors on board. Serial channel is lead onto both connectors parallelly.

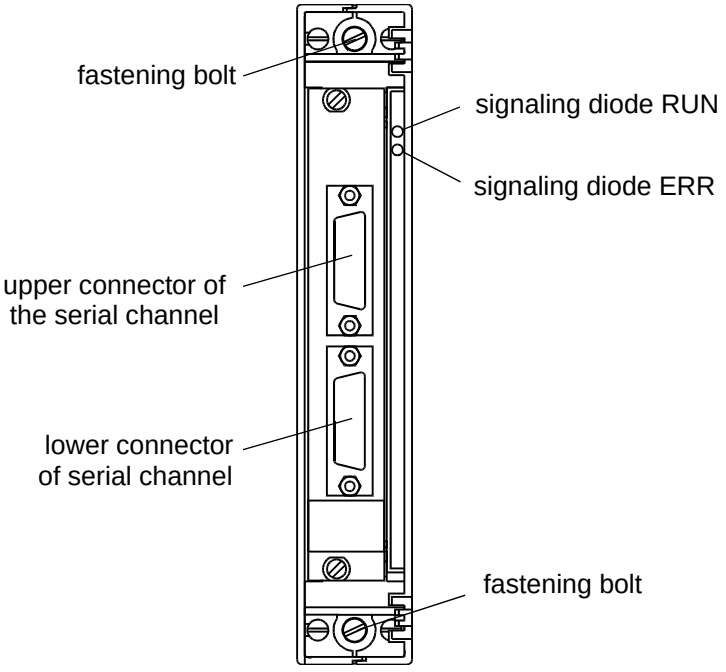


Fig. 2.7 Front panel of the central units CPM-1E, CPM-1M and expansion unit STM-2

Central unit CPM-1M

Central unit, type M - suitable for small applications

Central unit CPM-1M (tab. 2.6, fig. 2.7) is designed for PLC MINI and PRIMA. It is placed in a case 30 mm wide (class MINI) and it is set into a frame in position next to the power supply. It contains:

Central unit CPM-1M

- 16 KM CMOS RAM backup memory for user registers, data and tables
- 256 user registers
- real time circuit
- 1 serial channel with optional interface which can be replaced with the help the piggybacks (20 mA current loop, RS-232, RS-485, RS-422).

Central unit CPM-1M enables PLC build-up into the basic module and it contains standard instruction file.

Serial channel is designed to PLC programming and communication with superior systems. The speed of serial communication is optional and it is adjusted together with the address by the interconnectors on board. Serial channel is lead onto the both connectors parallelly.

Central unit CPM-2S

Central unit, type S - suitable for small applications where the enhanced power is regniered

Central unit CPM-2S (tab. 2.6, fig. 2.8) is designed for PLC MINI and PRIMA. It is placed in a case 30 mm wide (class MINI) and it is set into a frame in position next to the power supply. It contains:

- 20 KB CMOS RAM backup memory for the user programme, data and tables
- 20 KB EEPROM for the user programme stand-by (optional complement - order number TXK 080 11.02) (support of the version 6.3)
- 512 user registers
- real time circuit
- 2 serial channels with optional interface, the interface of both serial channels are replaceable with the help of the piggybacks (20 mA current loop, RS-232, RS-485, RS-422).

Central unit CPM-2S enables the PLC build-up into the basic module and it contains standard instruction file.

The speed of serial communication is optional and it is adjusted together with the address and the type of communication by the press buttons SET and MODE.

Communication possibilities of central unit CPM-2S

Serial channels enable the following types of communication:
channel CH1

- PLC programming and communication with superior systems

channel CH2

- **PC** regime - communication with the superior systems
- **PLC** regime - communic. between PLCs in EPSNET multimaster net work
- **MAS** regime - data collection from subordinate PLCs in EPSNET network
- **uni** regime - general channel with arbirary asynchron. communication

More detailed description of such communication types is stated in the manual Serial Communication of Programmable Logic Controllers TECOMAT (order number TXV 001 06.01).

Central unit CPM-1D

Central unit, type D - suitable for middle class applications

Central unit CPM-1D (tab. 2.6, fig. 2.8) is designed for PLC RAPID. It is placed in a case 30mm wide and it is set into a frame in position next to the power supply. It contains:

- 32 KB CMOS RAM backup memory for the user programme, data and tables
- 32 KB EEPROM memory for the user programme stand-by (optional complement - order number TXE 200 09)
- up to 0,5 MB additional memory for DataBox data archiving (optional complement - order number TXK 080 11.00, 256KB - order number TXK 080 11.01, 512 KB - order num. TXK 080 11.02) (supp. of the v. 6.5)
- 8192 user registers
- real time circuit

- 2 serial channels with optional interface, interface of both serial channel is replaceable with the help of piggybacks (200 mA current loop, RS-232, RS-485, RS-422)

Central unit CPM-1D enables the PLC build-up into basic module and one extension module RM950 with expansion unit STM-2 or three extension modules RM950 with expansion units STM-3.

Central unit CPM-1D contains an extended instruction file part of which are arithmetic operations with numbers in fixed point (size 32 bits) and in floating point, and instructions for PID controller.

Central unit can be extended by other two serial channels using the unit SC-01. The speed of serial communication is optional and it is set up together with the address and the type of communication by the press buttons SET and MODE on the central unit.

Communication possibilities of central unit CPM-1D

Serial channels enable the following types of communication:
channel CH1

- PLC programming and communication with superior systems

channel CH2

- **PC** regime - communication with superior systems
- **STM** regime - connection of extension modules using the expansion units
- **PLC** regime - communication between PLCs in EPSNET multimaster network
- **MAS** regime - data collection from subordinate PLCs in EPSNET network
- **uni** regime - general channel with arbitrary asynchr. communication

The other communication possibilities of central unit CPM-1D, extended by additional unit SC-01

channel CH3 and CH4 (on unit SC-01)

- **PC** regime - communication with superior systems
- **PLC** regime - communic. between PLCs in EPSNET multimaster network
- **MAS** regime - data collection from subordinate PLCs in EPSNET network
- **uni** regime - general channel with arbitrary asynchron. communication

More detailed description of these communication types is stated in the manual Serial Communication of Programmable Logic Controllers TECOMAT (order number TXV 001 06.01).

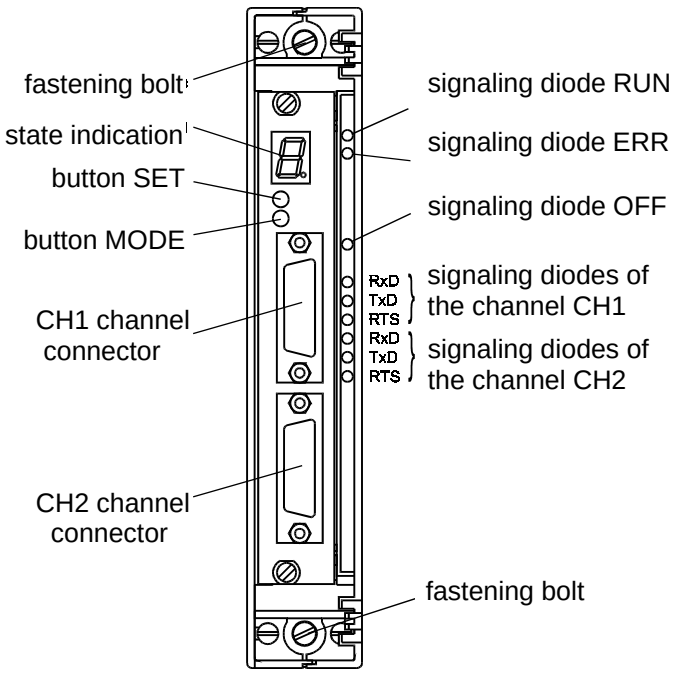


Fig. 2.8 Front panel of the central unit CPM-2S and CPM-1D after lifting the door

Central unit CPM-1B

Central units, type B - suitable for large applications

Central unit CPM-1B (tab. 2.6, fig. 2.9) is designed for PLC RAPID. It is placed in a 60 mm wide case and it is set into a frame in position next tothe power supply unit. It contains:

- 64 KB CMOS RAM backup memories for user programmes, data and tables
- 64 KB Flash EEPROM memories for the user programme stand-by
- 256 KB additional memories for Databox data archiving
- 8192 user registers
- real time circuit
- 4 serial channels with optional interface, interfaces of all serial channels are replaceable with the help of the piggybacks (20 mA current loop, RS-232, RS-485, RS-422)

Central unit CPM-1B enables the PLC build-up into a basic module and seven extension modules RM 950 with expansion units STM-3.

Central unit CPM-1B contains an extended instruction file, part of which are arithmetic operations with numbers in fixed point, size 32 bits, and in floating point and instructions of PID controller.

Central unit can be extended by other eight serial channels using the units SC-01. The speed of serial communication is optional and it is set up together with the address and the type of communication by the press buttons SET and MODE on the central unit.

Communication possibilities of central unit CPM-1D

Serial channels enable the following types of communication:

channel CH 1

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

channel CH 2

- **PC** regime - communication with superior systems
- **uni** regime - general channel with arbitrary asynchronous communication

channel CH3

- **PC** regime - communication with superior systems
- **STM** regime - connection of extension modules using the expansion units
- **PLC** regime - communication between PLC in EPSNET network multi-master
- **MAS** regime - data collection from subordinate PLCs in EPSNET network
- **uni** regime - general channel with arbitrary asynchronous communication

channel CH4

- **PC** regime - communication with superior systems
- **PLC** regime - data collection from subordinate PLCs in EPSNET network
- **MAS** regime - communication between PLC in EPSNET network multi-master
- **uni** regime - general channel with arbitrary asynchronous communication

channels CH5 to CH12 (on units SC-01)

The other communication possibilities of central unit CPM-1B, extended by additional units SC-01

- **PC** regime - communication with superior systems
- **PLC** regime - communication between PLC in EPSNET network multi-master
- **MAS** regime - data collection from subordinate PLCs in EPSNET network
- **uni** regime - general channel with arbitrary asynchron. communication

More detailed description of these communication types is stated in manual Serial Communication of Programmable Logic Controllers TECOMAT (TXV 001 06.01).

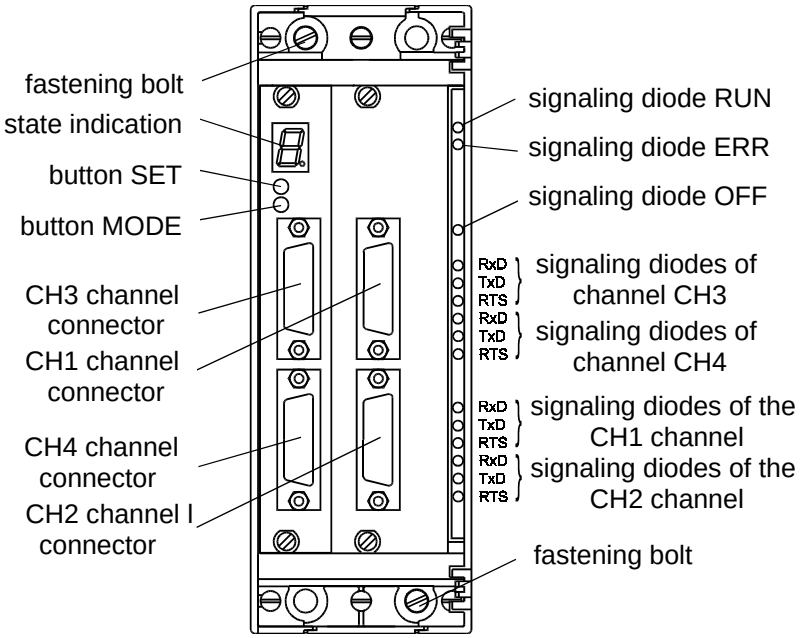


Fig. 2.9 Front panel of the central unit CPM-1B after lifting the door

Tab. 2.6 Parameters of the central units

Type of central unit	CPM-1E	CPM-1M	CPM-2S	CPM-1D	CPM-1B
Real time circuit	no	yes	yes	yes	yes
User programme memory	16 KB	16KB	20 KB	32 KB	64 KB
RAM and RTC stand-by*	20 000 h	20 000 h	20 000 h	20 000 h	20 000 h
Cycle time on 1k of logic instruc.	60 ms	60 ms	13 ms	13 ms	3 ms
Number of user registers	256	256	512	8192	8192
thereof remanent reg.	256	256	256	512	4096
Total num. of timers and counters	128	128	256	4096	4096
Timer range	65 536 x 10 ms ÷10 s with the possibility of cascading				
Counter range	65 536 with the possibility of cascading				
Binary inputs typ. **	128	128	1024	1024	1024
Binary outputs typ.**	128	128	1024	1024	1024
Instruction file	reduced	standard	standard	extended	extended
Instruction length	1 + 3 bytes	1 + 3 bytes	1 + 3 bytes	1 + 6 bytes	2 + 6 bytes
Number of serial channels***	1	1	2	2 + 2	4 + 8
Case width	30 mm	30 mm	30 mm	30 mm	60 mm

* It is effective for the unit without power supply, when the supply is on, the battery is disconnected and thus the stand-by time lengthens. Minimal battery lifetime is 5 years. By the central units CPM-2S, CPM-1D and CPM-1B the stand-by capacitor backs up for several days, the battery is connected only after its discharge (chapter 2.3.5). The stand-by capacitor enables battery replacement without data loss.

** User registers can be used without any restriction for the enhancement of connectable inputs and outputs of above said value.

*** Serial interface is selected with the help of the replaceable piggybacks MR-xx for RS-232, RS-485, RS-422 and current loop 20 mA.

2.3.2 Expansion units

Expansion unit STM-2

STM-2 expansion unit - economic version for the setup of basic module with CPM-1D and one extension module

STM-2 unit (tab. 2.7, fig. 2.7) is placed in a case 30 mm wide and it is set into a frame in position next to the power supply. It is designed to operate the peripheral units in extension module RM950 and for communication with central unit CPM-1D over the serial channel. The interface of serial channel is replaceable with the help of the piggyback (20 mA current loop, RS-232, RS-485, RS-422).

STM-2 unit detects the module setting by peripheral units and enables the both-way manipulation with data between these units and central units.

The speed of serial communication is optional and it is set together with the address by interconnectors on board. The serial channel is lead onto both connectors parallelly.

Unit STM-2 is designed only for the set up of one basic module with central unit CPM-1D and one extension module.

Expansion unit STM-3

STM-3 expansion unit

STM-3 unit (tab. 2.7, fig. 2.10) is placed in a case 30 mm wide and it is set into a frame in position next to the power supply. It is designed to operate the peripheral units in extension modules RM950 and for communcation with central unit over the serial channel. The interface of serial channel is replaceable with the help of the piggyback (20 mA current loop, RS-232, RS-485, RS-422).

STM-3 unit detects the module setting by peripheral units and enables both-way manipulation with data between these units and central unit. Unlike the STM-2 unit, it has an increased capacity and higher transmission speed, which reduces the time of PLC cycle markedly.

The speed of serial communication is optional and it is set up together with the address by the press buttons SET and MODE. Serial channel is lead onto both connectors parallelly.

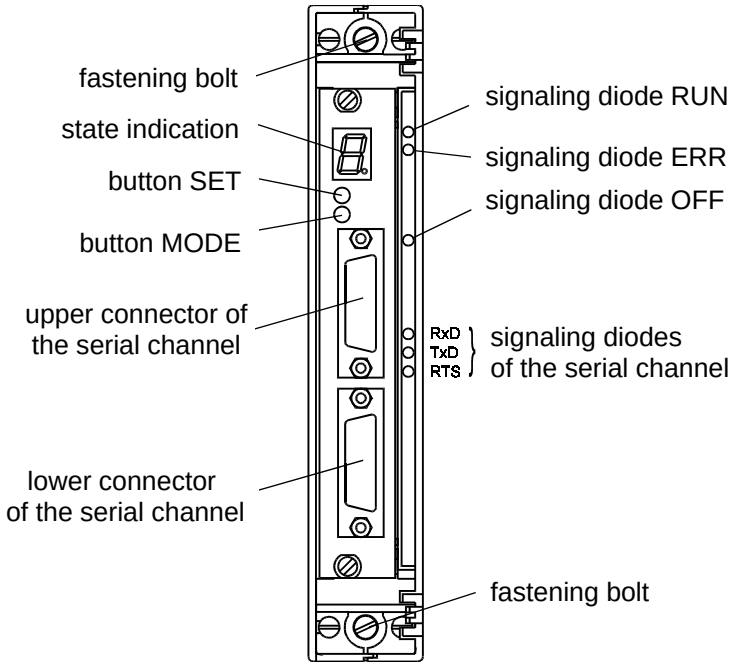


Fig. 2.10 Front panel of the expansion unit STM-3 after lifting the door

Tab. 2.7 Parameters of expansion units

Type of expansion unit	STM-2	STM-3
Number of serial channels*	1	1
Transmission speed	0,3 - 115,2 kBd	0,3 - 345,6 kBd
Case width	30 mm	30 mm

* Serial interface is selected with the help of the replaceable piggybacks MR-xx for RS-232, RS-425, RS-422 and current loop 20 mA.

2.3.3 ADDITIONAL UNITS

Additional unit of serial channels SC-01

SC-01 additional unit extends the central units of the series B and D by two serial channels

SC-01 unit (tab. 2.8, fig. 2.11) is placed in a case 30 mm wide and it is set into the basic module in position next to the central unit. There can be only one unit in the module fitted with central unit CPM-1D and up to four units SC-01 in the module fitted with central unit CPM-1B.

By means of the SC-01 units, the central units CPM-1D and CPM-1B can be extended by other two serial channels. The channels automaticly become part of the central unit as the channels CH3 and CH4 (CPM-1D), respectively CH5-CH12 (CPM-1B, the channel numbers are determined by the interconnector setup on the appropriate unit SC-01). The speed of serial communication, address and the type of communication are set up by the press buttons SET and MODE on the central unit.

Tab. 2.8 Parameters of the additional unit SC-01

Type of the additional unit	SC-01
Number of serial channels*	2
Case width	30 mm

* Serial inteface is selected with the help of replaceable piggyback MR-xx for RS-232, RS-485, RS-422 and current loop 20 mA.

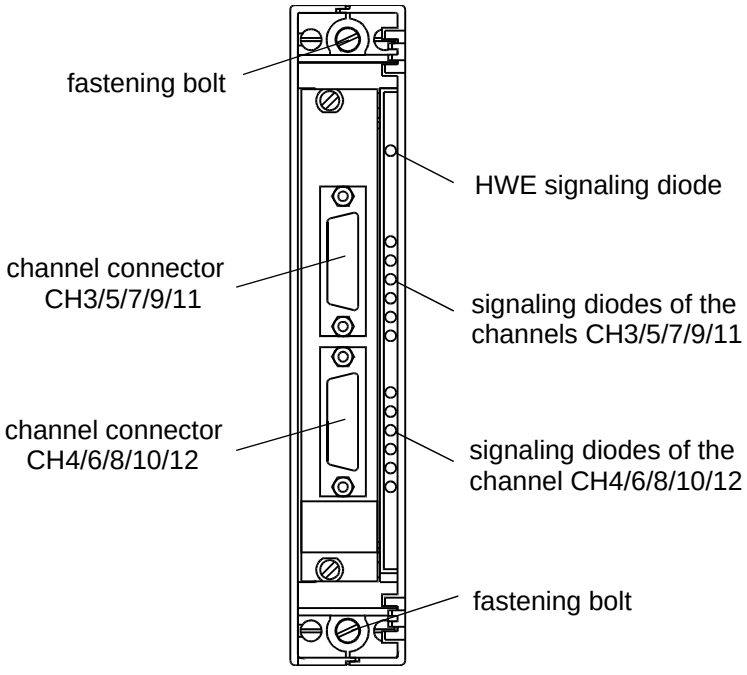


Fig. 2.11 Front panel of the additional unit SC-01 after lifting the door

2.3.4 Mechanical construction

Mechanical construction of the units of the clas. RAPID and MINI

All the units of the classes MINI and RAPID are equipped with protective plastic case 30 mm or 60 mm wide.

The unit can be easily attached onto the frame by two bolts which are accessible after the front door is opened. The fastening bolts are placed in upper and lower parts of the case. (fig. 2.7. - fig. 2.11).

Attachment of the unit to the frame

When attaching the unit onto the frame we proceed as follows:

- seat the unit with the help of the connector on the connector of the frame position and press
- open front door and tighten both bolts.

When releasing the unit, we proceed as follows:

- open front door and unscrew the bolts
- take out the unit carefully in order not to damage the connectors

Replacement of the piggyback

If there is a need to mount or replace the piggyback with serial channel interface, the right plastic side plate of the unit (with transparent window) has to be taken down. Open the door and unscrew two bolts in the corners on the right side of the case and take down the right plastic side plate. This is done in the following way: first, move it forwards and then take it off the metal frame. We proceed carefully in order not to damage the plastic lugs. There is no need to remove the board from the metal frame for it is well accessible and it is protected by the frame against mechanical damage.

When inserting the board into the case, we proceed the other way round. Seat the plastic side plate with the ends into the slots in the frame, push it in and insert the side plate towards the bus connector. Then tighten the bolts in the corners of the case.

Mechanical construction of the PLC - class PRIMA

PLC PRIMA has one common plastic case in which the central unit is set in the second position from the right, that means next to power supply.

If there is a need to set in or replace the piggyback with serial channel interface on the central units CPM-1E and CPM-1M we have to unscrew the bolts on both ends of the front card after the door is open and then take the unit with a holder and carefully slip it out of the case. If the unit is slipped out in the way that the tape cable is accessible to LED diodes, release the cable from the board on the side of the components. Then the whole board can be easily pulled out.

When inserting the unit into the case, we proceed the other way round. Insert the board into the guide-slots, push it half way in, connect the ribbon cable from the LEDs and push it all the way in carefully. Do not damage the bus connectors. Then fasten both bolts on the front tag.

The CPM-2S central unit can not be pulled out, it is necessary to disassemble the casing.

ATTENTION! The units contain components sensitive to electrostatic charge, therefore we observe the rules for working with these circuits!

Any manipulation with the board may be done only while the unit is pulled out of the frame!

2.3.5 Stand-by supplying of the programme memory and real time circuit

Stand by supplying of the programme memory

When the PLC supply voltage is turned off the data in programme memory and in the remanent zone of the note-pad are backed up. In central units CPM-1E and CPM-1M the backup is provided by lithium battery with lifetime at least 5 years. The backup in central units CPM-2S, CPM-1D and CPM-1B is provided by two sources:

a) the backup during the first 100 hours (at least) is provided by capacitor with high capacity
b) if the power supply has not been renewed by this time, the backup is automaticly taken over by lithium battery, whose lifetime is at least 5 years.

The energy in backup capacitor will be renewed again within 30 minutes after the power supply is turned on. Consequently, there is no battery discharge during the single-shift work cycle and not even during the weekend. Besides, during the change of stand-by battery (type CR 2032)

which is placed in a holder, the programme stays backed up in memory by the capacitor, so it cannot be erased as in case of CPM-1E and CPM-1M.

Stand by supplying of the real time circuit

Real time and calendar circuit (hereafter RTC) is backed up directly from the lithium battery if there is a power supply fall out. Therefore, with the change of battery the RTC content is rewritten to initial values (00:00:00 1.1.1996). The current time has to be set from the programme xPRO or EPOS, or by using the user instruction TIDA.

Detection of the stand-by battery condition

Supervisory circuits watch for voltage drop of the stand-by battery below the voltage 2,1 V and this state is presented in system register S35 by setting the bit S 35.0 on log.1. If the battery is not changed, RTC works as long as the battery voltage does not drop below 1 V. Then it comes to stop of RTC oscillator. In this case PLC stops and announces a serious err. 80 0C 00 00.

The programme memory requires stand-by voltage at least 2,1 V. This means that as long as the bit S 35.0 is set on log. 1, the programme and data backup is not guaranteed in central units CPM-1E and CPM-1M. In central units CPM-2S, CPM-1D and CPM-1B the programme memory looses the content only after the discharge of stand-by capacitor. If the discharged battery has been changed by this time, there is no loss of the memory content.

Central units CPM-2S, CPM-1D and CPM-1B enable emergency service with discharged stand-by battery. If PLC finds out after the power supply is turned on that the battery is discharged, it sets the bit S 35.0 on log. 1 and without any further continuous check of the battery it continues in normal activity. All PLC functions are without change. After the power supply is off the RTC is not backed up; the programme and data memory is backed up only by capacitor with high capacity for at least 100 hours.

Attention! If there is interconnector V27 on board of the central unit CPM-2S or CPM-1D set in position SC (chap. 2.3.6), not the battery condition but the condition of all stand-by power supplies including the stand-by capacitor is indicated in bit S 35.0. On the other hand there is no change of RTC content with the change of battery.

2.3.6 Setting up the parameters of the system units

Central units CPM-1E, CPM-1M
Expansion unit STM-2

Importance and setting of interconnectors in central units of series E and M and expansion unit STM-2

The parameters in central units CPM-1E, CPM-1M and expansion unit STM-2 are set by the interconnectors on board.

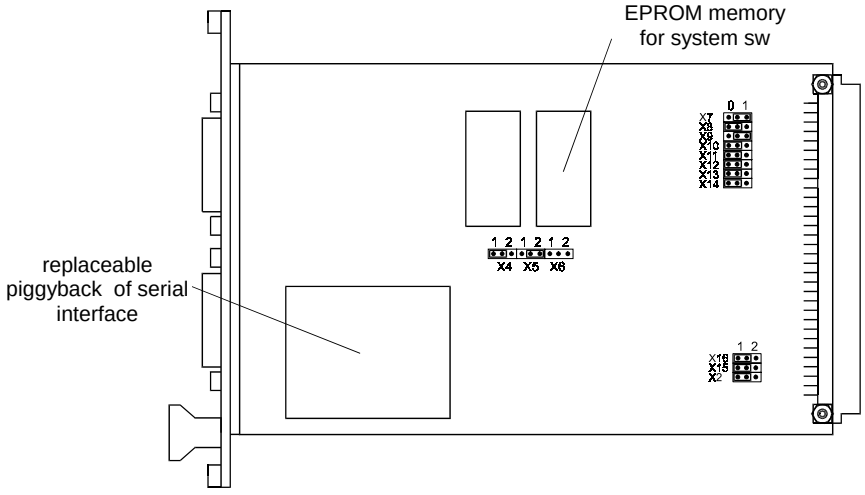


Fig.2.12 Location of replaceable components, code interconnectors and their standard setting on the board of unit STM-2.

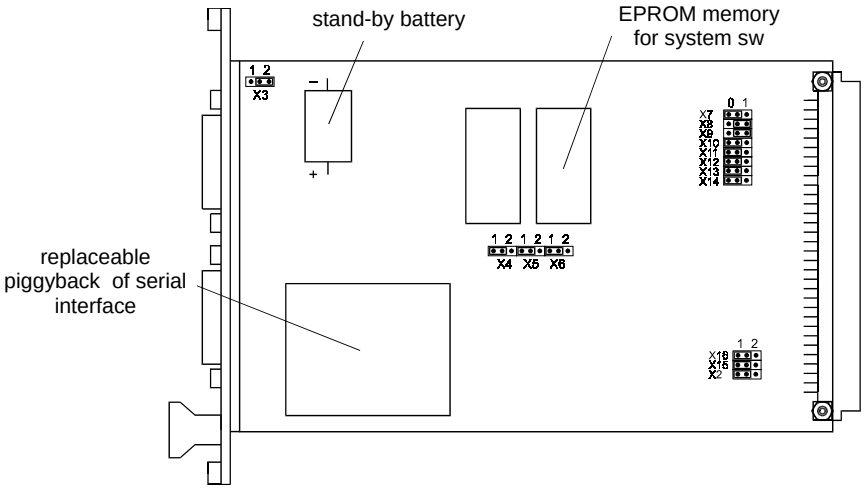


Fig.2.13 Location of replaceable components, code interconnectors and their standard setting on the board of unit STM-1E, CPM-1M

On fig. 2.12 and 2.13 there are the positions of interconnectors placed on board. Their setting is the following:

X2 - in position 1
X3 - disconnection of stand-by battery (only CPM-1E, CPM-1M)
1 - disconnected
2 - connected (preset)
X4 - in position 1
X5 - in position 1 (CPM-1E, CPM-1M)
- in position 2 (STM-2)
X6 - in position 1 (CPM-1E, CPM-1M)
- not set (STM-2)
X7-X10 - speed setting (see further)
X11-X14 - address setting (see further)
X15 - in position 1
X16 - in position 1

Setting of address and communication speed on serial channel

Eight interconnectors X7 - X17 for the address setting and communication speed of serial channel are visible in the inspection hole of the end cover and they are accessible by flat pliers or tweezers after the plexiglass cover card is pressed out. Any manipulation may be done only on unit taken off the module. It is inadmissible to manipulate the unit under voltage!

Serial channel address is set by 4 interconnectors X11 - X14 in range 0 -15 (0 -$0F), according to the table 2.9. The speed of serial communication is set by 4 interconnectors X7 - X10 according to the table 2.10. If the setting of interconnector combination differs from those in the table, LED diode ERR flashes.

Tab.2.9 Address setting for the serial channel

Setting of code interconnectors				Unit address
X11	X12	X13	X14	
0	0	0	0	0
0	0	0	1	1
0	0	1	0	2
0	0	1	1	3
0	1	0	0	4
0	1	0	1	5
0	1	1	0	6
0	1	1	1	7

Setting of code interconnectors				Unit address
X11	X12	X13	X14	
1	0	0	0	8
1	0	0	1	9
1	0	1	0	10
1	0	1	1	11
1	1	0	0	12
1	1	0	1	13
1	1	1	0	14
1	1	1	1	15

Tab.2.10 Setting of communication speed on serial channel

Setting of code interconnectors X7	X8	X9	X10	Communication speed
0	0	0	0	0,3 kBd
0	0	0	1	0,6 kBd
0	0	1	0	1,2 kBd
0	0	1	1	2,4 kBd
0	1	0	0	4,8 kBd
0	1	0	1	9,6 kBd
0	1	1	0	19,2 kBd
0	1	1	1	57,6 kBd*

Setting of code interconnectors X7	X8	X9	X10	Communication speed
1	0	0	0	-
1	0	0	1	-
1	0	1	0	38,4 kBd**
1	0	1	1	115,2 kBd**
1	1	0	0	-
1	1	0	1	-
1	1	1	0	-
1	1	1	1	-

* Speed 57,6 kBd only the units CPM-1E and CPM-1M

** Speed 38,4 and 115,2 kBd only the unit STM-2.

Central units CPM-2S, CPM-1D and CPM-1B
Expansion unit STM-3

In the central units of series B,D and S and in the STM-3 expansion unit the parameters are set with the help of buttons SET and MODE

The parameters in central units CPM-2S, CPM-1D, CPM-1B and expansion unit STM-3 are set by the press buttons SET and MODE on the front panel (fig. 2.8 - fig. 2.10). There is an interconnector for battery disconnection on board.

The position of the interconnector on board is on fig. 2.15 and 2.16. The setting is following:

V16/V6 - disconnection of stand-by battery (except STM-3)
OFF - disconnected
ON - connected (preset)

V27 - supply of RTC circuit (only CPM-1D, CPM-2S)
BT - only from battery (preset)
SC - from stand-by capacitor and battery
The state of RTC supply is indicated in bit 35.0, consequently, in position SC the battery fall out is not detected in time.

Piggyback of the DataBox memory

Optional piggyback IM-71 of the DataBox memory is set into the central units CPM-2S and CPM-1D on the positions of EEPROM memory (it is marked as dash rectangle on fig. 2.15). In that case, EEPROM memory can be set into free cap on this piggyback. In the central unit CPM-1B the DataBox memory is a part of the unit.

Attention! Piggyback IM-71 DataBox can be set in only by the producer!

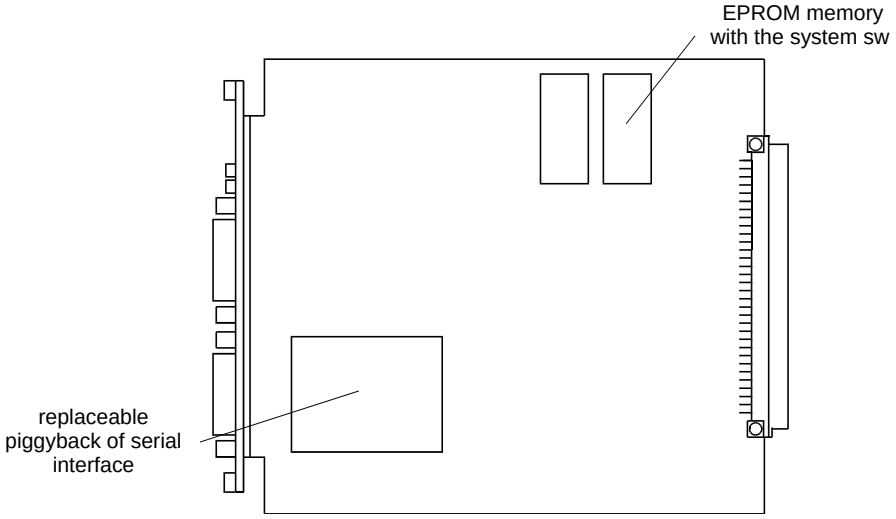


Fig.2.14 Location of replaceable components on board of the unit STM-3

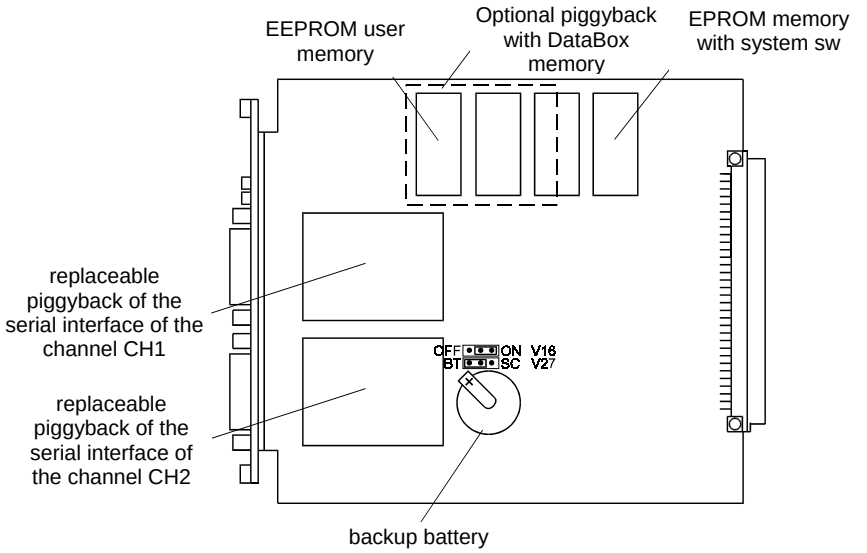


Fig.2.15 Location of replaceable components, code interconnectors and their standard setting on board of the units CPM-2S and CPM-1D (piggyback IM-71of DataBox memory is set in the position for EEPROM memory which can be set into the cap of the piggyback)

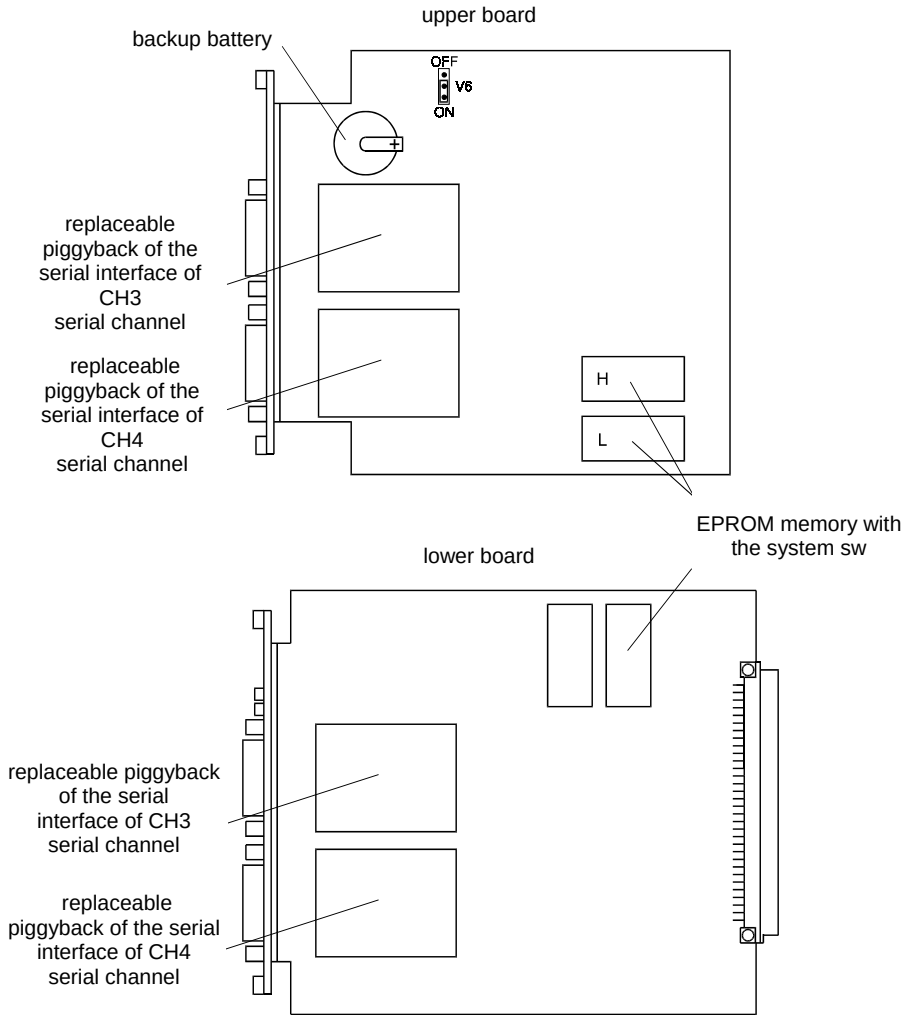


Fig.2.16 Location of replaceable components, code interconnectors and their standard setting on boards of the unit CPM-1B

Parameter display on the 7-segment unit

In the mode of unit parameter setting all data are displayed on 7-segment unit in the rotary way, that means the number 123 is displayed in such way that the digits 1, 2, 3 light gradually on the 7-segment unit, then there is a time-out and again all around. Each sign is displayed approximately for 0,5 s and between the signs there is a little pause which guarantees to distinguish two identical signs following one another (f. i. number 111).

Transfer into the mode of parameter setting, setting procedure and mode ending

To get into the mode of setting the unit parameters, press the buttons SET and MODE at the same time while the power supply is on. Hold the buttons SET and MODE until there is a triple dash ≡ on the 7-segment unit. Then, release both buttons and you are in the mode of parameter setting. In general, we change the parameter setting with the SET button and we list through the separate parameters with the MODE button. The press of the button is indicated by lightning of the decimal point on the 7-segment unit. The setting mode can be stopped anytime if the buttons SET and MODE are pressed at the same time. Parameter state is placed in EEPROM system memory, so the unit remembers the setting even after the power supply is turned off and also during stand-by battery breakdown.

The central unit always goes into the HALT mode after the parameter setting is finished (see chapter 4).

Set parameters

The address and communication speed on serial channel is set on the expansion unit STM-3. On the central units CPM-2S, CPM-1D and CPM-1B the parameters are set according to the table 2.11.

Tab.2.11 Adjustable parameters on central units (from the left to the right, and line by line)

Object to be set	Parameters to be set				
channel CH1	-	address	speed	time out.	CTS detection
channels CH2 to CH12 *	off	-	-	-	-
	STM mode	-	speed	-	-
	PC mode	address	speed	time out.	CTS detection
	PLC mode	address	speed	-	-
	MAS mode	-	speed	delay	CTS detection
	uni mode	-	-	-	-
EEPROM	activation of the set EEPROM memory				

* Channels CH3 and CH4 are part of the central unit CPM-1B and central unit CPM-1D with additional unit SC-01.
Channels Ch5 - CH12 are part of central unit CPM-1B with additional units SC-01

Setting of the serial channel regime

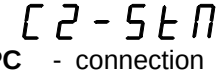
While setting the serial channel regime, you can read on the 7-segment unit for instance:

C - setting of the serial channel regime
2 -number of adjustable channel
off - set regime

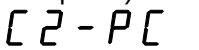
Serial channels can operate in the following regimes:

off - the channel is off (no other channel parameter is set)

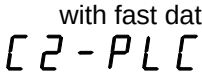
STM - connection of extension modules (only the speed is set)



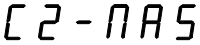
PC - connection of superior system (computer PC of active operating panel)



PLC - interconnection with other PLCs in the EPSNET multimaster network with fast data exchange (only the speed and address is set)



MAS - data collection from the subordinate PLCs in EPSNET network (the address is not set)



uni - general user channel for arbitrary use (no other channel parameter is set, all parameters are part of initialization in user channel)

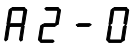
We list through the separate regimes with the button SET. Using the button MODE we store the set regime and go over to set the next parameter.

Channel CH1 has firmly set PC regime which cannot be changed. Therefore we do not set the regime in this channel.

Some channels do not enable the operation in all above mentioned regimes (according to the type of the unit - see chapter 2.3.1). Regime which is not supported by the channel is not offered during the listing with SET button.

Setting of the serial channel address

While setting the serial channel address, you can read on the 7-segment unit for instance:



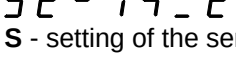
A - setting of the serial channel address
2 - number of adjustable channel
0 - set address

The address can take the values 0 to 99. Its value can be increased by 1 if the button SET is pressed for a short time, or it can be increased by 10 if the button SET is pressed longer (about 1s). Using the button MODE we store the set value and go over to set the next parameter.

The address is set only for the PC and PLC regimes. In uni regime the address setting is a part of initialization table in the user programme. In MAS regime, the address 63 is set automaticly.

Setting the communication speed of the serial channel

While setting the communication speed of serial channel, you can read on the 7-segment unit for instance:



S - setting of the serial channel speed
2 - number of adjustable channel
19_2 - set speed in kBd (decimal point is replaced by underlining dash)

The speed can take beforehand estimated values according to the table 2.12. The speed which is not accessible in the given regime and the given channel, is not offered during the listing with SET button. Using the button MODE we store the set value and go over to set the next parameter.

The speed is set only for regimes STM, PC, PLC and MAS. In uni regime the speed setting is a part of initialization table in the user programme.

Tab.2.12 List of available communication speed over serial channels

Speed	Channel regime	Speed	Channel regime
0,3 kBd	PC, MAS	28,8 kBd	STM, PC, PLC, MAS
0,6 kBd	PC, MAS	38,4 kBd**	STM, PC, PLC, MAS
1,2 kBd	PC, MAS	57,6 kBd	STM, PC, PLC, MAS
2,4 kBd	PC, MAS	76,8 kBd	STM, PLC
4,8 kBd	PC, MAS	115,2 kBd	STM, PLC
9,6 kBd	STM, PC, PLC, MAS	172,8 kBd*	STM, PLC
14,4 kBd	STM, PC, PLC, MAS	230,4 kBd*	STM, PLC
19,2 kBd	STM, PC, PLC, MAS	345,6 kBd	STM

* It cannot be set for the channels on units SC-01 (CH3, CH4/CH5 - CH12)
** It cannot be set on serial channels CH1 and CH2 on central unit CPM-1B

Setting of answer time out and transport delay

While setting the answer time out (PC), of the transport delay (**MAS**), you can read on the 7-segment unit for instance:

t - setting of the answer time out (**PC**) / transport delay (**MAS**)
2 - number of adjustable channel
10 -set time out in ms / transport delay in multiples of 100 ms

The adjustable value can be increased by 1 if the button SET is pressed for a short time, or it can be increased by 10 if the button SET is pressed longer (about 1s). Using the button MODE we store the set value and go over to set the next parameter.

Answer time out

Optional answer time out serves to solve the cases when the superior system that sends the message, or transmission equipment on route (modems, serial interface converter) do not manage to switch over from transmission to reception and they are not able to accept the PLC answer. By lengthening of the answer time out the superior system gains time needed for preparation which is necessary to initiate the answer reception.

The time out is set in milliseconds and it can take the values 0 to 99 ms. 0 value means that the minimal answer timeout will correspond to the time necessary for transmission of 1 byte, therefore, it depends on the set speed. Values 1 to 99 estimate the timeout in milliseconds and it does not depend on the communication speed.

Answer time out is set only for **PC** regime.

Transport delay

Optional transport delay serves to solve the cases in which PC as superior system waits for the answer from subordinate PLC longer than 0,5s because of the delay on transmission route caused by modems etc.

Transport delay is set in multiples of 100 ms and can take the values 0 to 6,0 s. Value 0 means that the superior PLC waits for the answer max. 0,5 s (maximal cycle time of subordinate PLC). Values 1 to 60 estimate the transport delay 0,1 to 6,0 s which is added to already mentioned value 0,5 s. Values 61 to 99 set the maximal transport delay of 6,0 s.

Transport delay is set only for the **MAS** regime.

Setting of CTS signal detection

While setting the CTS signal detection, you can read on the 7-segment unit for instance:

CTS - setting of CTS signal detection
2 - number of adjustable channel
on - detection is on

The signal detection can be either off or on. The setting can be changed if we press the button SET. Using the button MODE we store the set value and go over to set the next parameter.

When the CTS signal detection is on, the central unit tests the CTS signal condition before the answer is transmitted (after the RTS signal is set). The answer is transmitted only 10 ms after the CTS signal has the same value as RTS signal. This modem is suitable for the communication through modems. Even in this mode the set time out is in effect, so it is guaranteed that the central unit does not answer earlier even though the CTS signal is already set.

If the CTS signal detection is off the central unit controls RTS signal but it does not look at the CTS signal condition.

CTS signal detection is set only for regimes PC and MAS. It is possible to set the CTS signal detection in uni regime by the initialization table in the user programme.

Switching on the EEPROM stand-by user memory

While setting the EEPROM user memory, you can read on the 7-segment unit for instance:

EP - setting of EEPROM user memory
off - EEPROM memory is off

EEPROM memory can be either off or on. The setting can be changed with the press button SET. Using the button MODE we can store the value and go over to set the next parameter.

The size of EEPROM memory is 32 KB for the central units CPM-1D and CPM-2S. Teco a.s. supplies this kind of memory under the order number TXE 200 09. No other type can be used. Flash EEPROM 64 KB is set standardly in the central unit CPM-1B.

The information about the setting of all parameters is available in the environment xPRO through the options *Automat / HW configuration / Info.*

Additional unit SC-01

Only the code of particular channels is set on additional unit SC-01

There are four interconnectors on board (fig. 2.17), by which the code of the particular channels can be set according to tab. 2.13. If the unit SC-01set in compliance with this table is set into the system, other two serial channels appear in the parameter setting of the central unit CPM-1D and CPM-1B automaticly. No communication parameters are set directly on unit SC-01.

Tab.2.13 Setting of the appropriate channels on unit SC-01

Code interconnector setting V1 V2 V3 V4	Set channels for CPM-1D	Set channels for CPM-1B
0 0 0 0	CH3, CH4	CH5, CH6
0 0 0 1	CH3, CH4	CH7, CH8
0 0 1 0	CH3, CH4	CH9, CH10
0 0 1 1	CH3, CH4	CH11, CH12
other combinations	CH3, CH4	-

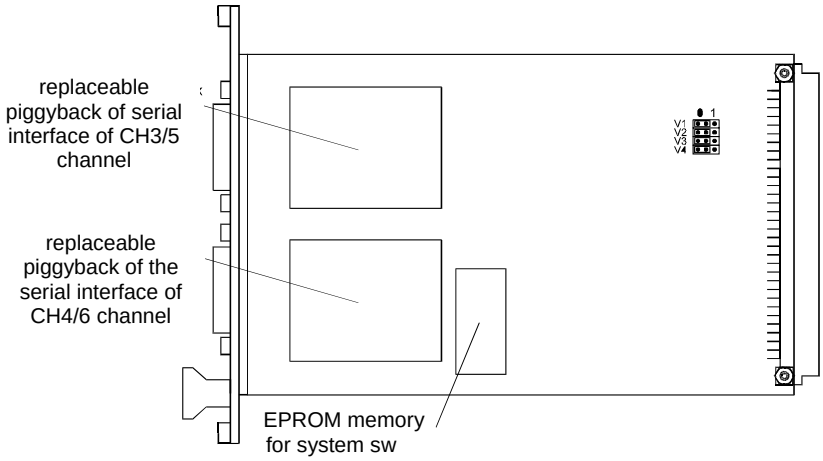


Fig.2.17 Location of the replaceable components, code interconnectors and their standard setting on board of the unit SC-01.

2.4 REPLACEABLE PIGGYBACKS OF SERIAL INTERFACE

Review of replaceable piggybacks with serial interface

Tab.2.14 Review and order num. of replaceable piggybacks with serial interf.

Type	Modification	Order num.
MR-01	20 mA current loop galvanicly isolated	5XK 068 90
MR-02	RS-232 without galvanic isolation	5XK 068 91
MR-03	RS-422 without galvanic isolation	5XK 068 92
MR-04	RS-485 without galvanic isolation	5XK 068 93
MR-05	RS-422 galvanicly isolated with ext. power supply	5XK 068 94
MR-06	RS-485 galvanicly isolated with ext. power supply	5XK 068 95
MR-09	RS-485 galvanicly isolated	TXK 085 03

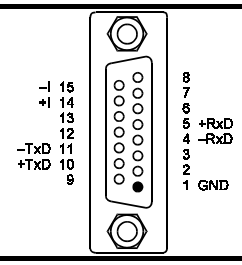
2.4.1 MR-01 - interface 20 mA current loop, galvanicly isolated

Interface 20 mA current loop galvanicly isolated

MR-01 board provides galvanicly isolated TTL signal conversion on interface of 20 mA loop used in industrial applications. It contains power supply which can be connected to the receiver or transmitter circuit. More network users can be connected to this interface. Recommended type of the cable is XAAB 4x0,75.

Tab.2.15 Technical parameters of MR-01 interface

Maximum transmission speed	19,2 kBd
Maximum length of the line	1000 m *
Output level	20 mA
(idle receiver and transmitter)	
Power supply	5 V / max. 50 mA



* The maximum transmission speed does not have to be reached at maximum length of line.

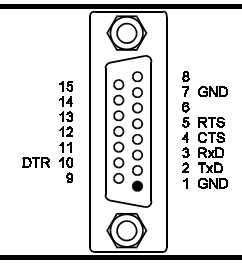
2.4.2 MR-02 interface RS-232, without galvanic isolation

RS-232 interface without galvanic isolation

MR-02 board provides conversion of TTL serial interface signals on RS-232 interface, without galvanic isolation. The conversion is realized by MAX232 circuit. This interface is designed only to connect two subscribers, therefore, it cannot be used for the network. It is suitable for instance for the connection of PLC TECOMAT NS950 and PC on short distance.

Tab.2.16 Technical parameters of MR-02 interface

Maximum transmission speed	57,6 kBd
Maximum length of line	15 m
Output level	12 V
Power supply	5 V / max. 50 mA



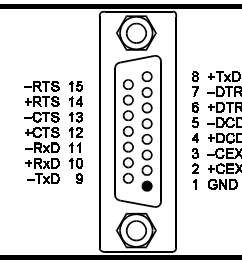
2.4.3 MR-03 interface RS-422, without galvanic isolation

RS-422 interface without galvanic isolation

MR-03 board provides conversion of TTL serial interface signals on RS-422 interface without galvanic isolation. RS-422 interface with output differential level ±6 V is able to resist the high level of electric interference better, with bigger reliability than the one offered by RS-232. Interface enables connection of two cooperating devices, therefore, it cannot be used for the network of extension modules. It is suitable for instance for connection of PLC TECOMAT NS950 and PC at higher interference level or bigger distance than 15 m (the adapter of serial interface RS-422/RS-232 is necessary on the PC side.)

Tab.2.17 Technical parameters of MR-03 interface

Maximum transmission speed	187,5 kBd
Maximum length of line	1000 m *
Output level	max. ±6 V
(difference levels)	
Power supply	5 V / max. 100 mA



* The maximum transmission speed does not have to be reached at maximum length of line.

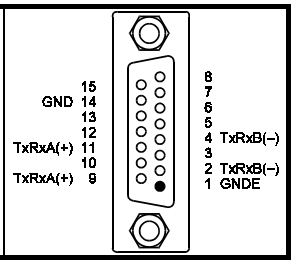
2.4.4 MR-04 interface RS-485, without galvanic isolation

RS-485 interface without galvanic isolation

MR-04 board provides the conversion of TTL serial interface signals on RS-485 interface without galvanic isolation. This type of interface is used as a drop data transmittor for several receivers and it is sometimes called multidrop interface. It is necessary to use termination resistor 120 Ω on each line end to ensure the proper function. In system TECOMAT NS950, the resistors are already part of the supplied cables (chapter 3.6). Maximum transmission speed depends on the delay of connected receiver.

Tab.2.18 Technical parameters of MR-04 interface

Maximum transmission speed	500 kBd
Maximum length of line	1200 m *
Output level (difference levels)	max. ±6 V
Power supply	5 V / max. 100 mA



* Maximum transmission speed does not have to be reached at maximum length of line.

Note: Cable screening is attached to the connector skeleton and the GND tip represents signal ground

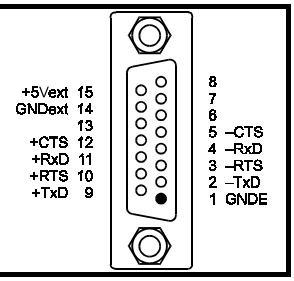
2.4.5 MR-05 interface RS-422, galvanicly isolated

RS-422 interface, galvanicly isolated with external power supply

MR-05 board provides the conversion of TTL serial interface signals on RS-422 interface with galvanic isolation. Galvanicly isolated interface RS-422 has higher resistance against electric interference than usual RS-422 interface. The interface enables connection of two cooperating devices, therefore it cannot be used for the network. It is suitable for instance for connection of PLC TECOMAT NS950 and PC at higher interference level or bigger distance than 15 m (Adapter of serial interface RS-422/RS-232 is necessary on the PC side).

Tab.2.19 Technical parameters of MR-05 interface

Maximum transmission speed	500 kBd
Maximum length of line	1200 m *
Output level (difference levels)	max. ±6 V
Internal power supply	5 V / max. 30 mA
External power supply	5 V / max. 100 mA
stability	±5%
ripple effect	100 mV
Insulating voltage TTL / RS	2 kV



* Max. transmission speed does not have to be reached at max. length of line

2.4.6 MR-06 interface RS-485, with galvanic isolation

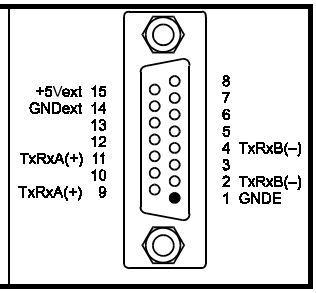
RS-485 interface, galvanicly isolated with external power supply

MR-06 board provides the conversion of TTL serial interface signals on RS-485 interface galvanicly isolated. This type of interface is more resistant to interference than the usual RS-485. It is used as drop data transmittor for several receivers and it is sometimes called multidrop interface. It is necessary to use termination resistor 120 Ω on each line end to ensure the proper function. In system TECOMAT NS950, the resistors are already a part of the supplied cables (chapter 3.6.). Maximum transmission speed will depend on the delay of connected receiver.

External power supply 5 V is distributed by communication cables. The subscriber has to secure only the lead-in from the power supply unit. Supply leads have to be outlet from any communication cable. If the system is so large that external supply voltage of serial interface does not meet the

requirements from table 2.20 in remote system parts, it is necessary to supply the system on more places.

Tab.2.20 Technical parameters of MR-06 interface

Maximum transmission speed	500 kBd	
Maximum length of line	1200 m *	
Output level (difference levels)	max. ±6 V	
Internal power supply	5 V / max. 30 mA	
External power supply	5 V / max. 80 mA	
stability	±5%	
ripple effect	100 mV	
Insulating voltage TTL / RS	2 kV	

* Maximum transmission speed does not have to be reached at maximum length of line.

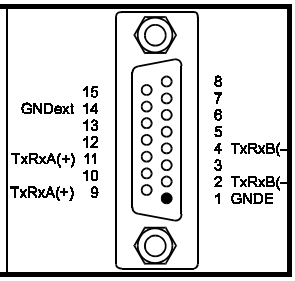
2.4.7 MR-09 interface RS-485, with galvanic isolation

RS-485 interface, galvanicly isolated without the need of external power supply

MR-09 board provides the conversion of TTL serial interface signals on RS-485 interface with galvanic isolation. This type of interface is used as drop data transmittor for several receivers and it is sometimes called multidrop interface. It is necessary to use termination resistor 120 Ω on each line end to ensure the proper function. In system TECOMAT NS950, the resistors are already part of the supplied cables (chapter 3.6.). Maximum transmission speed will depend on the delay of connected receiver.

Galvanic isolation of the serial interface is ensured by the built-in converter. The external power supply is not necessary.

Tab.2.21 Technical parameters of MR-09 interface

Maximum transmission speed	500 kBd	
Maximum length of line	1200 m *	
Output level (difference levels)	max. ±6 V	
Power supply	5 V / max. 100 mA	
Insulating voltage TTL / RS	2 kV	

* Maximum transmission speed does not have to be reached at maximum length of line.

Note: Cable screening is attached to the connector skeleton and the GND tip presents signal ground.

2.5. PERIPHERAL UNITS

Peripheral units

All units of the class MINI and RAPID are equipped with plastic protective case 30 mm or 60 mm wide.

PLC PRIMA has one common plastic case in which the central unit is set in the second position from the right, that means next to power supply.

Vacant positions has to be covered by the position cover

To cover the connector of vacant position on the frame in the module there is a connector cover 5XN 053 09 in PLC RAPID and MINI. In PLC PRIMA there is protecting label TXF 553 03. They protect the connector against dust, and the bus against involuntary short-circuit.

Serial-pararell bus

All peripheral units are connected to central and expansion units by series parallel 8-bit bus. The bus is formed by the system of connectors DIN 41 612 B interconnected by 64 conductor band cable. Signal wires are protected with resistance dividers to reduce the line impedance and increase the resistance against interference. Signal assignment to the connector tips is clearly stated in table 2.22.

Tab.2.22 Bus signals on the tips of connector DIN 41 612 B

Series b			**Series a**		
system ground	GND	1	1	GND	system ground
		2	2	A15	address
		3	3	A14	address
		4	4	A13	address
		5	5	A12	address
additional	VXA	6	6	A11	address
system ground	GND	7	7	A10	address
system ground	GND	8	8	A9	address
system ground	GND	9	9	A8	address
system ground	GND	10	10	A7	address
system ground	GND	11	11	A6	address
power supply	+12 V	12	12	A5	address
power supply	+12 V	13	13	A4	address
power supply	+12 V	14	14	A3	address
power supply	+12 V	15	15	A2	address
output lockout	BLOK*	16	16	A1	address
hardware error	HWE*	17	17	A0	address
		18	18	R/W*	read / write
		19	19	D0*	data
interruption	IRQ*	20	20	D1*	data
power supply drop-out	PFI*	21	21	D2*	data
		22	22	D3*	data
		23	23	D4*	data
		24	24	D5*	data
data interception	DS*	25	25	D6*	data
data confirmation	DTACK*	26	26	D7*	data
bus clock	E*	27	27	RES*	system reset
basic address end	VMA	28	28	IRQS*	syst. interrupt
power supply	–15 V	29	29		
power supply	+15 V	30	30	–5 V	power supply
power supply	+5 V	31	31	+5 V	power supply
system ground	GND	32	32	GND	system ground

3. TRANSPORT, STORAGE AND INSTALLATION OF THE PLC

3.1 TRANSPORT AND STORAGE

Transport

PLC TECOMAT NS950 is transported in boxes which are marked with type mark of the product and the order number. There is a contents sheet on each transport box. It must be transported in a covered conveyance. The boxes must be placed on loading area in a position specified by the box label (max. in 3 layers) and they must be secured in such way so that they could not move spontaneously. Transport boxes and products may not be exposed to rain and snow conditions. The products may be transported at temperature from -25°C to +70°C.

Storage

PLC TECOMAT NS950 and the accessories may be stored only in dry and clean rooms with chemically non-agressive usual environment at temperature from -25 °C to +70 °C without sudden temperature changes and at relative humidity max. 80%.

During a long-time storage more than 6 months it is suitable to disconnect the interconnector at stand-by battery on the central units (chapter 2.3.6) so that there would not be any unnecessary battery discharge.

3.2 DELIVERY OF PLC

PLC supply according to the customer´s order

PLC TECOMAT NS950 is delivered by the producer in the setup which is specified in the customer´s order. The basic module and extension modules are set with peripheral units according to the scope of specification.

In the specification it is necessary to state what units shall be set into what kind of module because these modules can be far away from each other even hundreds of meters. Therefore, the customer should have an idea about the arrangement of PLC TECOMAT NS 950 system in controlled technology and about the equipment of individual centres.

In case the arrangement of peripheral units in individual modules of PLC build-up delivered by the producer does not comply with the particular user application or there are additional requirements to complete the build-up with other units, it is possible to rearrange the units or complete them according to the following chapter.

3.3 SETTING THE UNITS INTO THE SYSTEM

Rules for unit setting into PLC

When making the PLC specification or complementing the PLC with other units, it is necessary to follow the following rules:

a) CPM central unit is set into the first position of the basic module next to the power supply unit.
b) STM expansion unit is set into the first position of the extension module next to the power supply unit
c) SC-01 additional units are set into the positions next to the CPM-1D or CPM-1B central unit
d) peripheral unit addressing is performed according to the way stated in the description of these units
e) free position on the frame must be covered by 5XN 053 09 cover (class RAPID and MINI) or by TXF 553 03 card (class PRIMA)
f) any physical manipulation with units must be performed while the PLC power supply is off.

Peripheral unit addressing

General rules for peripheral unit addressing are the following:

- the same address must not be occupied by more units
- unit addressing always takes place in terms of 1 module
- it is not necessary for the addressing to be continuous, that means the address space of the following unit does not have to link up the address space of the preceeding unit.

The recommended way to address the units in the TECOMAT systems is the following. On address interconnectors of each peripheral unit we set the number of its position in module regardless of its type. This way, all conditions for correct addressing are always guaranteed. The peripheral units in the systems TECOMAT NS950 dispatched by the producer are addressed in this way.

Expansion unit addressing

General rules for STM expansion unit addressing in the network of extension modules are the following.

- the same address must not be occupied by more units
- expansion unit addressing must be continuous and it starts from 1, that means the addresses of expansion units are 1, 2, 3, ...

Automatic detection of the configuration

The central unit itself detects the module setup with peripheral units after the power supply is turned on and it compares it with the configuration ordered by the user in user programme by the *#unit* directives (programming software xPRO). Information about module setup can be found out in the programming software xPRO, this information can be also used for automatic generation of *#unit* directive file according to the set units.

Disconnection of the peripheral unit operation

The operation of any peripheral unit can be disconnected without taking it out of the module by mere entry of semicolon before the appropriate *#unit* directive in the user programme (active line becomes mere comment which can be activated again when the semicolon is erased).

3.4 PLC INSTALLATION

PLC installation into the cabinets and stands

PLCs TECOMAT are structurally designed for installation into the cabinets and stands. Installation sizes of individual types are stated on fig. 2.1 and fig. 2.2. The placement of installation holes for the module attachment in cabinets and stands must correspond with data on fig. 3.1 (standard DIN 41 496).

They are designed for contamination degree 2. The installation must be carried out in such way, that the conditions for II. overstressed category are not exceeded.

Determination of the cabinet sizes and the types

Cabinet sizes and types must be selected with regard for power input of installed devices and for allowable operating temperature of PLC surroundings (chapter 1.6). We have to consider also the power loss which developes on inputs and outputs which are set into the active state (it is necessary to proceed from the number of simultaneously activated inputs and outputs, and from the type and load of individual outputs). Output loss on one PLC input or output in active state is stated in table 3.1 and table 3.2.

Placement of more PLCs into one cabinet

PLCs can be placed above each other or even next to each other in the cabinet. If they are placed above each other, there must be a distance at least 90 mm between the modules so that there was a space for air flow. In cabinets which do not have guaranteed forced air circulation through the shell, the module installation must be carried out in such way, so that the distance between the cabinet ceiling and the upper surface of the module at least 90 mm. As well as the distance between cabinet bottom and the module must be at least 90 mm.

PLC installation

PLC modules must be attached to the cabinet frame through insulating bushes and pads which are supplied with modules. Protective clips of the module frames must be connected to main protective cabinet clip in the shortest possible way by a wire with the cross-section at least 2,5 mm^2 according to ČSN 33 2000-5-54. Connection of the module power supply must comply with the requirements specified in chapter 3.5. Connection of

PLC inputs and outputs must be carried out according to the corresponding documentation which is supplied with the units.

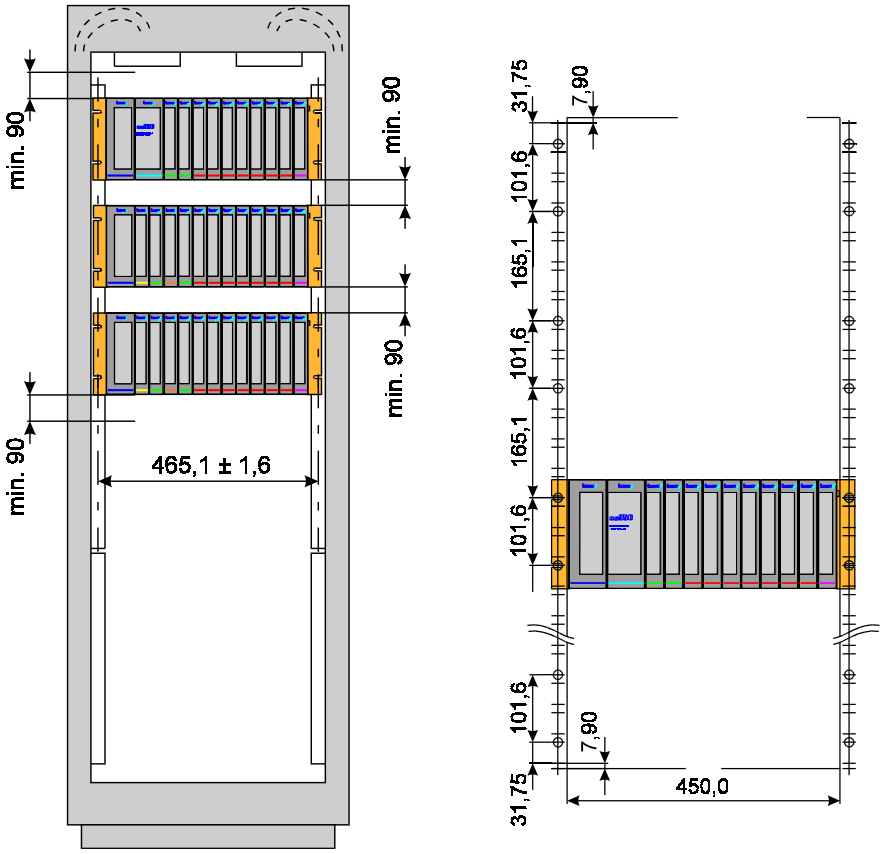


Fig.3.1 Location of instal. holes in cabinets and stands for PLC installation according to the standard DIN 41 496 (an example for RM-19)

Power loss on PLC inputs and outputs influences the selection of cabinet type with regard to the final temperature inside the cabinet

Tab.3.1 Power loss on one input

Unit type	Nominal voltage	Power loss on 1 input
IB-36, IB-40	5 V DC	0,03 W
IB-37, IB-41	12 V DC	0,12 W
IB-38, IB-42	24 V DC	0,25 W
IB-39, IB-43	48 V DC	0,25 W
IB-44	24 V AC	0,25 W
IB-45	48 V AC	0,25 W
IB-46	115 V AC	0,25 W
IB-47	230 V AC	0,25 W
IB-48, IB-49	24 V DC	0,12 W
IB-50	24 V DC	negligible
XH-04	24 V DC	0,25 W

Tab.3.2 Power loss on one output

Unit type	Nominal voltage	Output current	Power loss on 1 output
OS-26, OS-27	24 - 48 V DC	0,5 A	0,20 W
OS-28, OS-29	115 - 230 V AC	0,2 A	0,35 W
OS-30	24 V DC	2 A	0,40 W
OS-31	48 V DC	2 A	0,80 W
OS-32, OS-33	24 - 48 V AC	2 A	2,50 W
OS-34, OS-35	115 - 230 V AC	2 A	2,50 W
XH-04	24 V DC	0,5 A	0,10 W

Precautionary protection against the interference

Because of reducing the interference level in the cabinet where the PLC is installed, all inductive loads must be handled by anti-interference

elements. The anti-interference setups are supplied for this purpose (tab. 3.3, tab. 3.4).

Tab.3.3 Anti-interference setup

Content of an anti-interfer. setup	For a load of	Order num.
8x varistor 24 V	24 V DC/AC	TXF 680 00
8x varistor 48 V	48 V DC/AC	TXF 680 01
8x varistor 115 V	115 V AC	TXF 680 02
8x varistor 230 V	230 V AC	TXF 680 03
8x RC elem. - R = 10 W, C = 0,47 µF	24 - 48 V DC/AC	TXF 680 04
8x RC element - R = 47 W, C = 0,1 µF	115 - 230 V AC	TXF 680 05

Tab.3.4 Varistor parameters used in the anti-interference setup

energy interceptable by I^2t varistor (t is duration time of an extinction impuls in ms)	< 80
current in I varistor	< 25 A
medium value of the P power loss	< 0,6 W

Use of anti-interference setup

The anti-interference setup also serves to protection of binary direct and alternating PLC output units against voltage tips that originate mainly at inductive load control. Although this protection is performed on board by some units, we recommend to perform it especially directly on load. We supply varistors or RC elements as protective elements and the highest effectiveness can be reached by combination of both protection types. Certainly, the setup can be used anywhere in controlled technology for contact protection or for protection against interference which develops during the control process.

The possibilities of protective element connection and their comparison

The examples of protective element connection are illustrated on fig. 3.2 and fig. 3.3. In case of RC element the both possibilities are equal, nevertheless, we have to consider the rule of suppressing the interference to the place of origin as near as possible, that means the load or power supply. Therefore we prefer the connection on fig. 3.2.

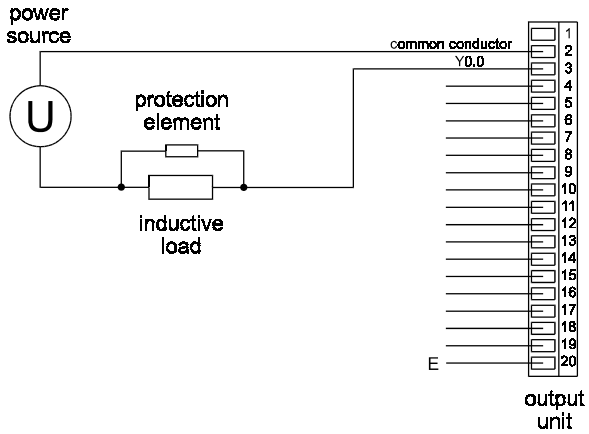


Fig.3.2 Connection of the protective element parallelly to the load
E - clip for contingent connection of screening of the input/output wires (only in highly interfered environment)

In the case of varistor the situation is a bit more difficult. If the varistor is already set on the unit (triac output units), it is no use to connect another varistor parallely to the load, because the varistor on the unit works earlier. Therefore it is necessary to connect the varistor parallely to the switching contact of PLC output unit. The varistor on the unit is selected with a little higher limiting voltage than the outer varistor which also has higher rating. Varistor on the unit serves then as a protection of unit switching element. If there is no varistor on the unit (reley and transistor units), both possibilities of connection can be used, but the connection of varistor parallely to the contact of the output unit is more suitable considering the better suppression

of voltage induced on load. Certainly, there is a rule again to suppress the interference as near the place of origin as possible.

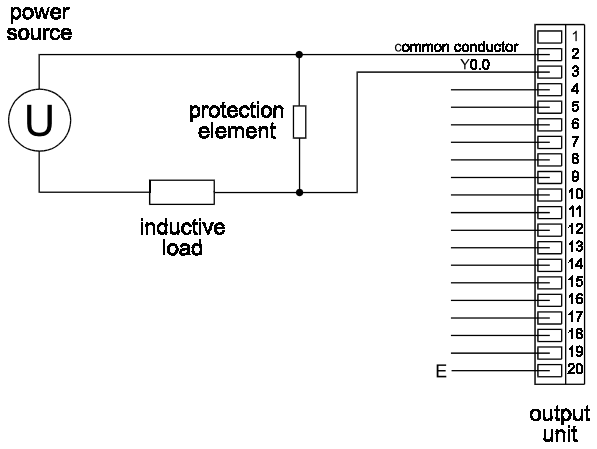


Fig.3.3 Connection of a protective element parallely to the switch. contact E - clip for contingent connection of screening of the input/output wires (only in a highly interfered environment)

3.5 REQUIREMENTS FOR POWER SUPPLY

3.5.1 PLC supplying

Connection and installation of mains power supply circuits

An example of how to connect and install the mains feeding circuits of PLC modules, inputs and outputs is illustrated on fig. 3.4., 3.5. and fig. 3.6.

We recommend to supply the module power supply units from a secondary (separating) TR1 transformer. Considering the fact that secondary transformer will not work into resistive load but into the input power supply rectifier, double type power of the secondary transformer is necessary, according to the following pattern:

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

P_T - final type power of separating transformer
n - number of power supply units
P_Z - input of n-th power supply unit

Between the primary and secondary winding of the TR1 transformer there must be a screen Cu foil which has to be attached to main protective clip of the cabinet, or the secondary winding must be winded up on a separate coil in such way so that the mutual capacity of the primary and secondary winding is minimized. It is useful to dimension the socket for input of approximately 100 W because of the possibility to connect the solder.

We recommend to insert a switch into the common inlet of module supply (because of the possibility to turn off the power supply during the programme debugging, maintenance, repair work etc.) The inlets of module power supply must be lead through a screened cable. The recommended cable type is 3 x 0,75 mm^2. Cable screening must be connected with the main protective clip of the cabinet only on the side of the transformer. The modules must be installed isolated in switchboard. The minimum cross-section of wires interconnected to the main protective clip must be 2,5 mm^2.

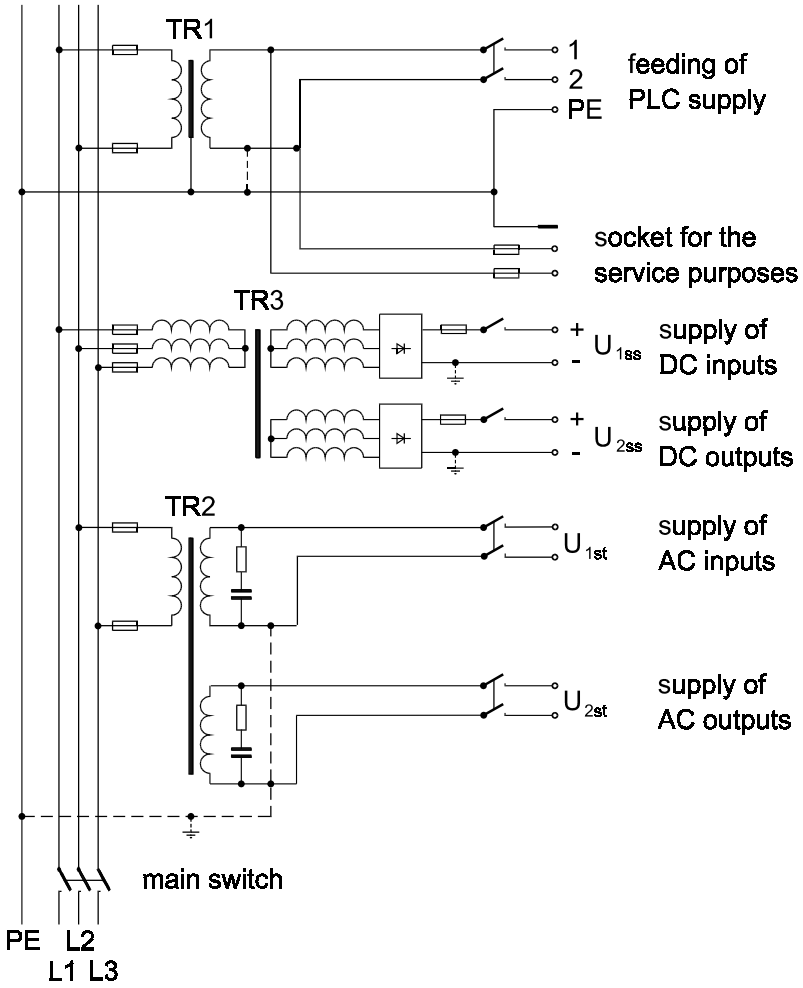


Fig.3.4 Example of PLC supply

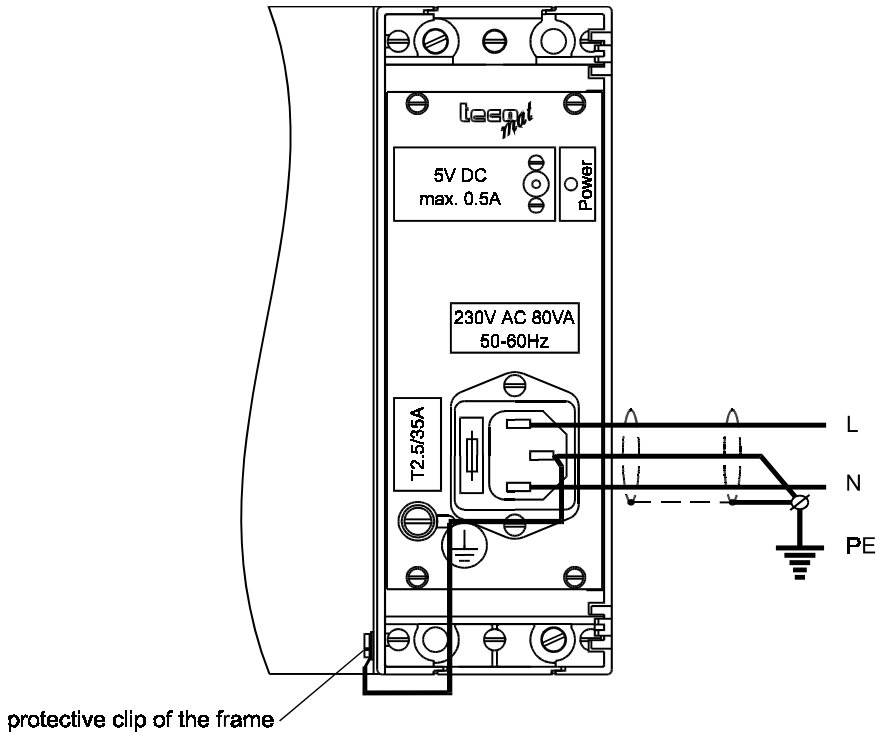


Fig.3.5 Connection of the protective wire to the PLC power supply

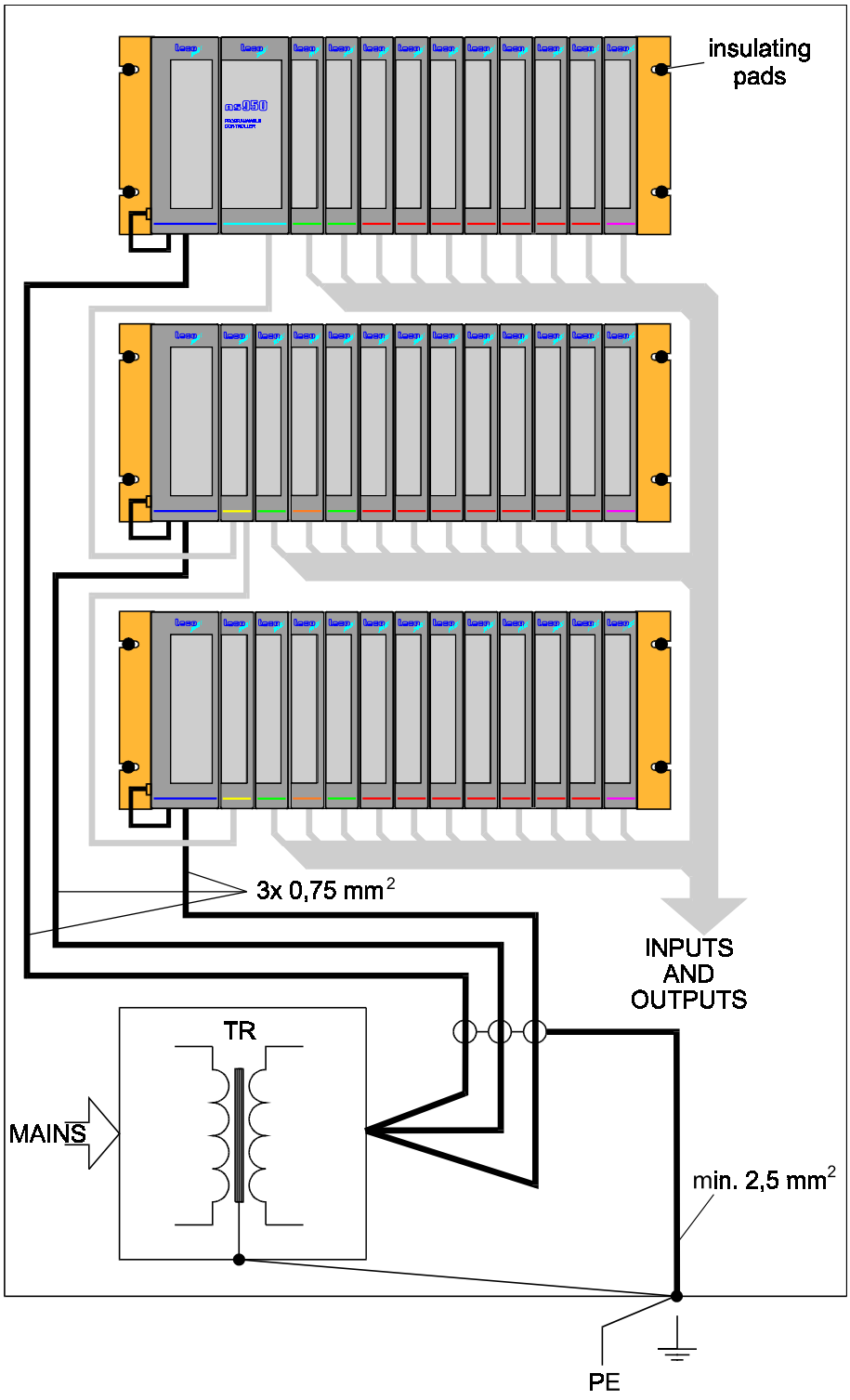


Fig.3.6 An example of the protective wire interconnection during the PLC installation

3.5.2 Power supply of input and output circuits

Supply of the PLC input and output circuits

Alternating input and output PLC circuits must be supplied from the separating protective transformer (fig. 3.4). RC element (R = 100 W / 2 W, C = 2 µF / 250 V_{ef}) must be connected to the secondary winding, out of which the output circuits switched by alternating output units are supplied. Alternating input circuits must be supplied from separate secondary winding (no other appliances may be connected on supply voltage of input circuits). If it is necessary, one end of the secondary winding can be connected to PE clip.

Power supply units PW-40W a PW-60W

Direct-current input and output circuits are supplied from the direct-current power supply. No other appliances may be connected to the power supply unit. For this purpose we can use the power supply units PW-40W (order number 5XN 053 15) or PW-60W (order number TXN 053 17) which serve for supply of DC circuits at voltage 24 V and input up to 40 W or as the case may be 60 W (fig. 3.7, tab. 3.5). Power supply PW-40W is supplied from the mains 230 V AC, power supply PW-60W is supplied from the mains of 110 V DC. Both power supply units are built in a case 60 mm wide and they can be mounted both on the PLC frame and outside the frame.

For higher inputs it is useful to connect the supply separating transformer with separate supply units for the input and output circuits according to the fig. 3.4. If it is necessary, one pole of power supply can be connected to the device skeleton. The allowable tolerance of DC supply voltage including the winding for input and output circuits is 20% from nominal voltage value.

If there is a need to debug a programme and put the device into operation, or for the needs of maintenance and contingent repair work it is useful to connect the supply voltage of input and output units through the switches.

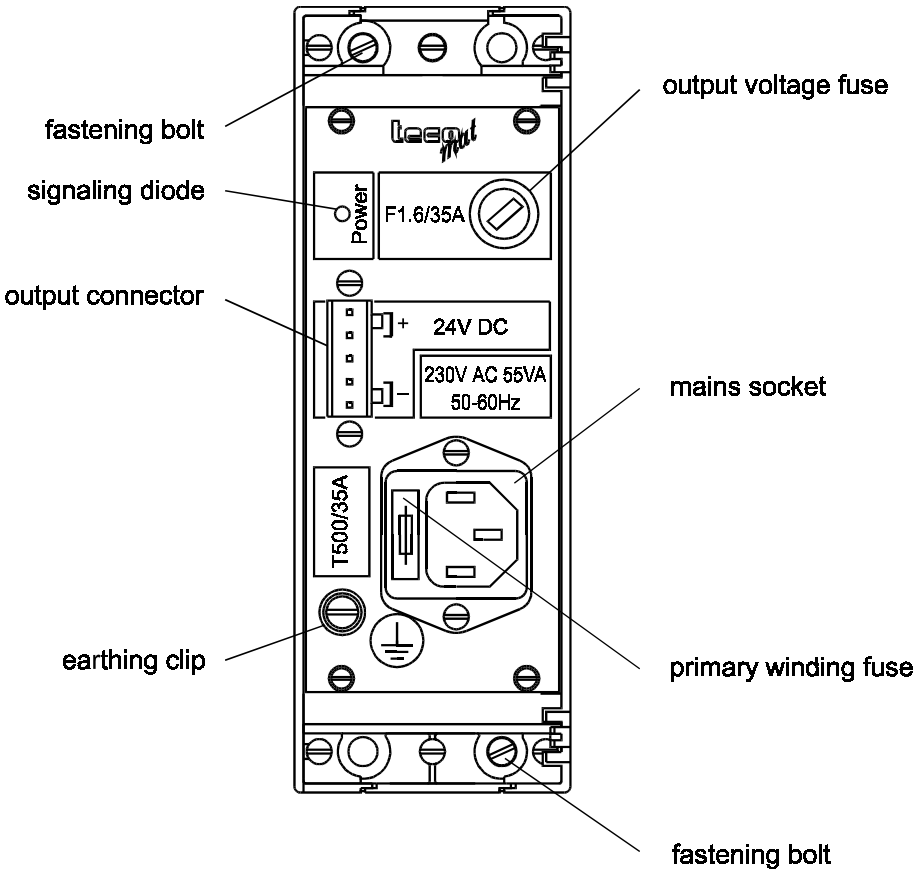


Fig.3.7 The front panel of the PW-40W power supply

Tab.3.5 Parameters of the power supply units PW-40W and PW-60W

Power supply units	PW-40W	PW-60W
Input voltage		
nominal value	230 V AC	110 V DC
allowable span	199 - 253 V AC	90 - 140 V DC
frequency	50 Hz	-
Maximum power input	55 VA	80 W
Primary circuit safeguarding	fuse T500L250V	fuse T2,5L250V
Output voltage	24 V DC ±20%	24 V DC ±20%
Output current	0 - 1,6 A	0 - 2,5 A
Short-circuit protection	fast blow	electronic
Galvanic isolation	yes	yes
El. resistance of insulation		
input / output - 1 min.	3,75 kV AC	2,8 kV AC
input against ground	1750 V AC* (50 Hz)	2500 V DC*
Insulating resistance	>10 MW* (500 V)	>10 MW* (500 V)
Degree of live parts covering	IP 20	IP 20
Device of protection type	I	I
Degree of interference elimination EN 55022	class A	class A
Case width	60 mm	60 mm

* It is valid for points galvan. connected with supply voltage against ground

3.6 COMMUNICATION NETWORK BUILD UP AND REQUIREMENTS

Selection of serial interface

PLC TECOMAT is connected to other systems by means of serial lines. Replaceable boards, type MR-xx, produced in the forms of piggyback serve for selection of the interface. They enable the connection by means of interface RS-232, RS-485, RS-422 or 20 mA current loop.

To connect the elements of the system TECOMAT NS950 with other systems (f. i. with PC computer) we can use any from the offered interfaces (chapter 2.4). We select the interface according to the type of interface contained in the connected system. If this interface does not suit with its parameters (longer distance, higher interference, low speed, connection of more subscribers at the same time), we have to use the appropriate serial interface converter on the side of the connected system.

The cables for the connection of PC and PLC on RS-232 interface

For the connection of PC computer to the PLC central unit on RS-232 interface we supply 2 types of cables. The cable 5XK 645 68.-- is designed for computers with serial interface connector Cannon 9, the cable 5XK 645 69.-- is designed for the computers with serial interface connector Cannon 25 (fig. 3.8). End number of the cables specifies their length (tab. 3.7)

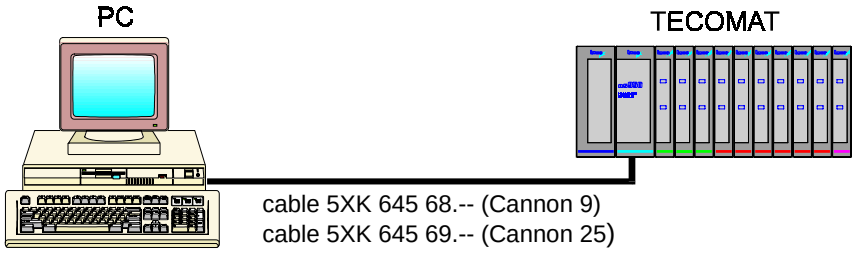


Fig.3.8 Connection of the PLC to superior system on RS-232 interface

Connection of PC and PLC on a longer distance

If we want to connect PC computer on a distance longer than 15 m we cannot use the RS-232 interface, but we have to use some other interface (mostly RS-485) and we have to connect the computer to this line through the serial interface convertor, which transforms the signals of the used type of interface into the signals of RS-232 interface (fig. 3.9).

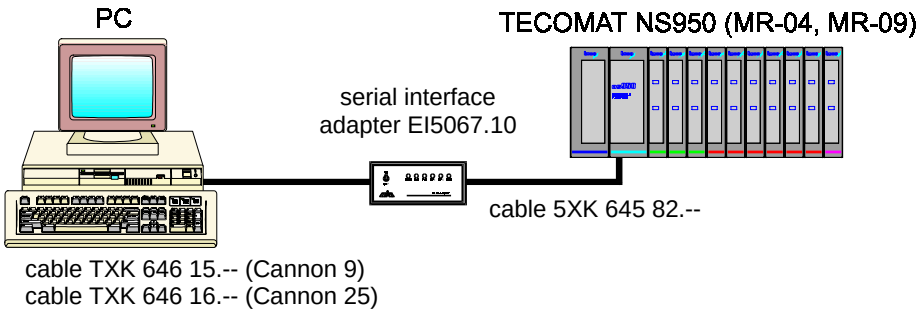


Fig.3.9 Connection of PLC to the superior system on RS-485 interface

RS-485 interface for the network build-up

We use RS-485 interface for interconnection of individual elements of the system TECOMAT and their connection to other systems. This interface is designed especially for networks with up to 32 users. It uses half-duplex operation, which means the wire savings in cable, it is interference-resistant, it enables to build the serial line up to 1,2 km long (without the use of repeater). It is necessary to ensure the terminate resistors 120 Ω on each cable end to ensure the correct function of this interface.

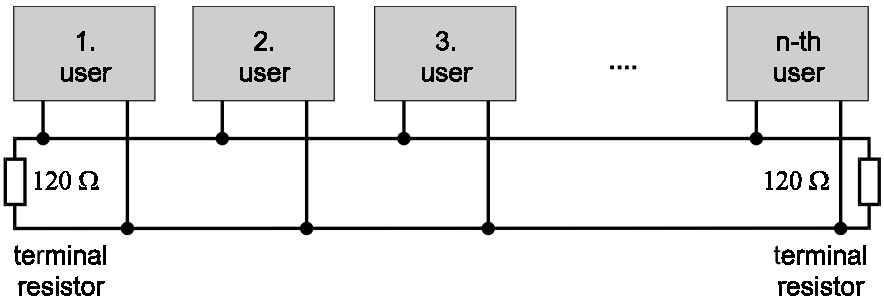


Fig.3.10 Handling the RS-485 interface line

Cables for the network build-up

This requirement is solved in systems TECOMAT by special cables which include the terminate resistor 120 Ω in one or both connectors (tab. 3.6). Connector with terminate resistor is marked with coloured sleeving on the cable. With the help of these cables we can interconnect the elements of one system and even more systems together. For easier realization of extensive networks there are point deviders which are interconnected by cables whose ends will be connected into screw clips of point deviders (suitable for cable channels where the cable with end connector cannot be pulled through). On the point devider XL-41 there is a network branch line lead onto the connector Cannon 15 where we connect the PLC. There is a condition that the connecting cable to PLC must be much shorter than the remaining part of the line, therefore, the tree structure or beam structure of the network cannot be carried out (fig. 3.11).

Tab.3.6 Cables for the RS-485 interface

Cables RS-485 Cannon 15 - Cannon 15	order number
- without impedance termination 120 W	5XK 645 80.-- *
- with impedance termination 120 W on one side	5XK 645 81.-- *
- with impedance termination 120 W on both sides	5XK 645 82.-- *
Nothing but connector with impedan. termination 120 W	5XK 645 83

* The end number specifies the cable length according to the tab. 3.7

Connection of extension modules

RS-485 interface can be used for connection of CPM central unit with STM expansion units. Terminal resistor 120 Ω is placed in cable which connects the PLC central unit with the first STM expansion unit, in the connector on the side of central unit (cable 5XK 645 81.--). We protect the second line end by using the same cable with terminal resistor 120 Ω on the side of last expansion unit. The connector with the terminal resistor is

marked by colourful sleeving on the cable. The other expansion units are interconnected by cables 5XK 645 80.-- without terminal resistor.

If we have only one extension module we use the cable 5XK 645 82.-- with the ending on both sides to interconnect the central and expansion units.

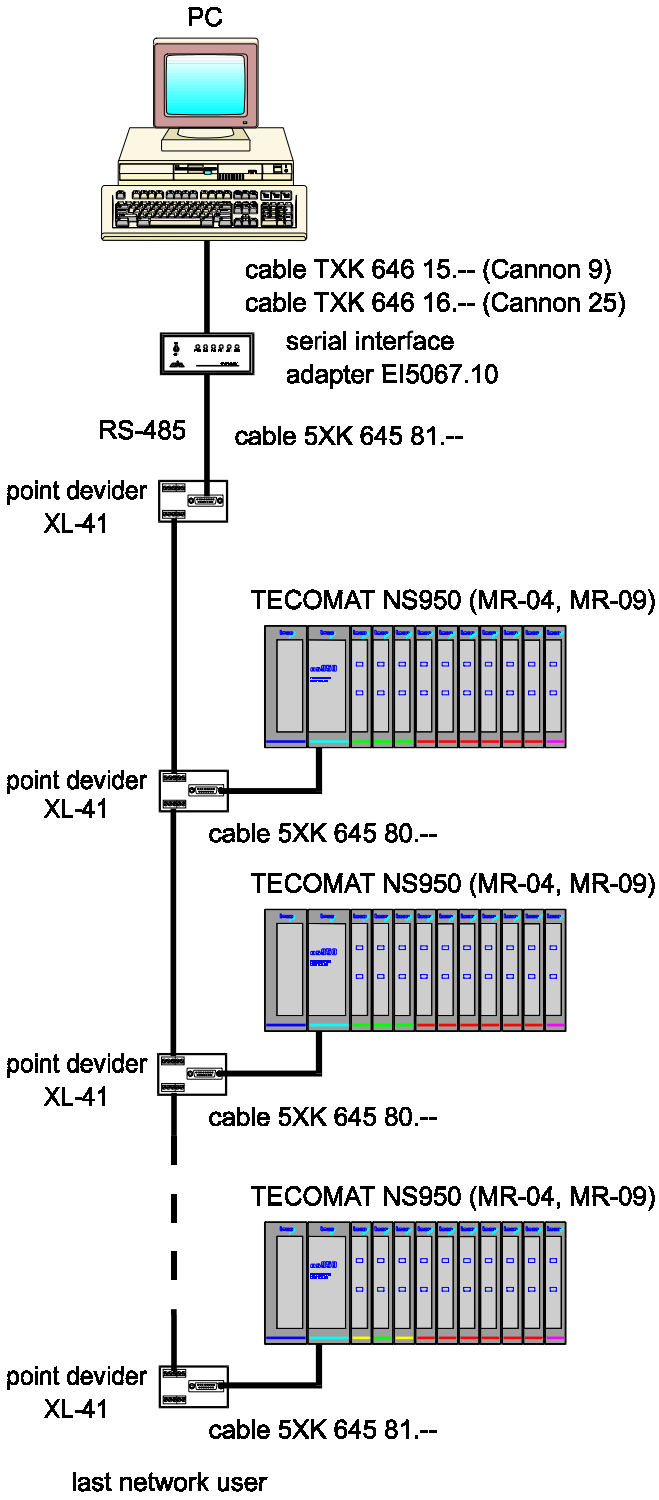


Fig. 3.11 Connection of more PLCs to a superior system on RS-485 interface

Tab.3.7 Length of the cable according to the end number

end number	length [m]	end number	length [m]	end number	length [m]
.01	0,25	.32	15	.56	100
.02	0,5	.33	17,5	.57	110
.03	0,75	.34	20	.58	120
.04	1	.36	25	.59	130
.06	1,5	.38	30	.60	140
.08	2	.40	35	.61	150
.10	2,5	.42	40	.62	160
.12	3	.44	45	.63	170
.16	4	.46	50	.64	180
.20	5	.48	60	.65	190
.25	7,5	.50	70	.66	200
.30	10	.52	80		
.31	12,5	.54	90		

System extension

If the user assumes the further system extension, he will use for the connection of last but one and the last STM expansion units the cable without the impedance ending 5XK 645 80.-- and he will insert the connector with terminal resistor 120 Ω (order number is 5XK 645 83) into the free hub of the last STM expansion unit. In the case of system extension he will take out the connector, then he will connect the new added units to the established network with the help of cables 5XK 645 80.-- and he will insert the connector again to the free hub of the last STM expansion unit. This procedure is convenient because it does not require any intervention into the cabling of the established network.

Expansion unit addressing

STM expansion units are addressed continuously starting with address 1 (address 0 is reserved for marking the basic module in configuration). That means that the address of expansion unit in the first extension module is 1, in the second extension module it is 2 etc. The examples of setups with extension modules are illustrated on fig. 3.12 and 3.13.

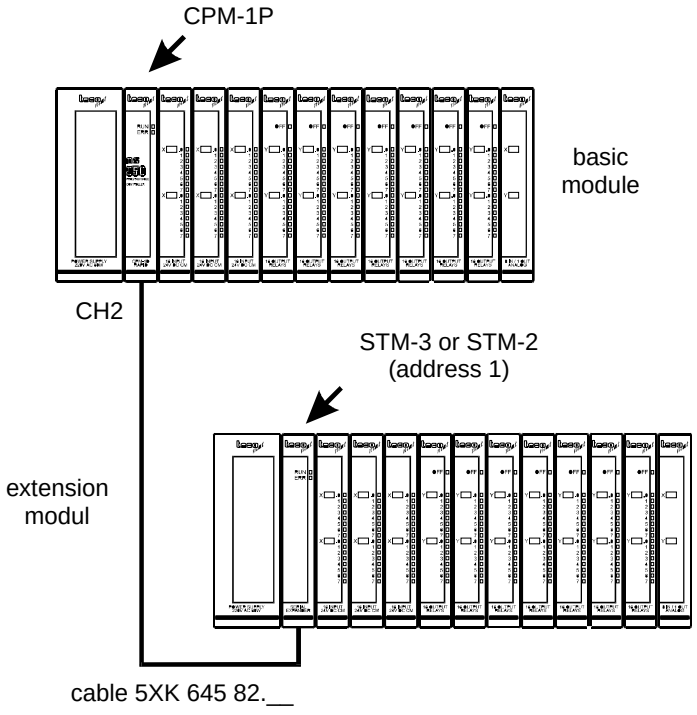


Fig.3.12 An example of the TECOMAT NS950 RAPID setup with the CPM-1D central unit and one extension module

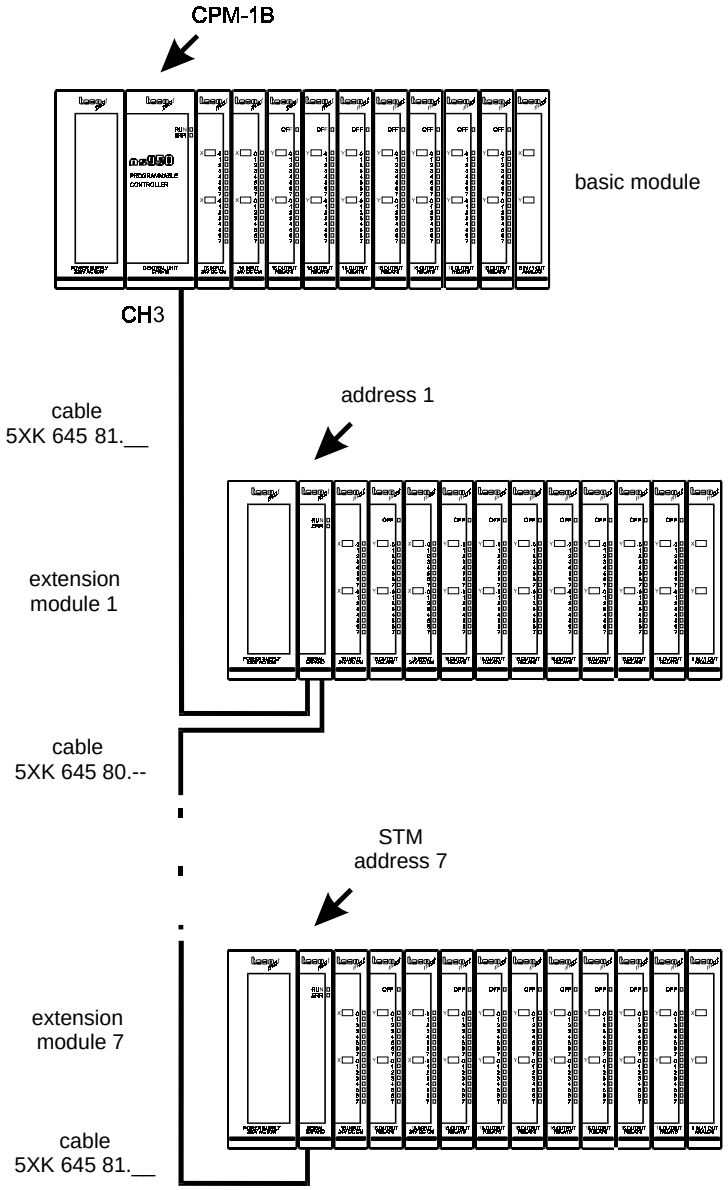


Fig.3.13 An example of the TECOMAT NS950 RAPID setup with the CPM-1B central unit and seven extension modules

4. PLC ATTENDANCE

4.1 INSTRUCTIONS FOR SAFE ATTENDANCE

Instructions for safety

While the PLC supply and the supply of input and output PLC circuits are turned on, it is not allowed:

- to insert the units into the frame of basic and extension modules
- to take the units out of the frame of basic and extension modules
- to disconnect or connect terminal board to input and output PLC units
- to disconnect or connect cables which interconnect the basic module and extension modules

During the programming of the PLC control algorithms we cannot exclude the possibility of error in user programme which can result in an unexpected behaviour of the controlled object. This can result in a crash situation and in extreme case also in danger for people. While attending the PLC, and especially in time of trying and debugging new user programmes with controlled object, it is necessary to be cautious.

Controlled object must be adjusted in such way so that the zero values of the control signals (PLC without power supply) ensure safe and free-of-collision condition of the controlled object!

4.2 PUTTING THE PLC INTO OPERATION

How to proceed while putting the PLC into operation for the first time

When we put the PLC into operation for the first time, it is necessary to proceed in the following way:

a) Check if the mains feed of the module supply in PLC is connected correctly.
b) Check the interconnection of the module protective clips with the main protective clip of the switchboard or cabinet
c) Check the communication interconnection of PLC modules
d) Check if the PLC configuration and addressing of the peripheral units and modules correspond to the given application
e) Check if the supply circuits of input and output PLC units are connected correctly (if the parameters of supply voltage are not kept, the input or output circuits of the unit may be damaged).
f) Turn on the power supply of PLC modules. Supply voltage of the basic module supply unit and of the extension module supply units must be turned on either at the same time, or first turn on the power supply of extension modules (in arbitrary order) and then the power supply of the basic module. Another procedure is not allowed.

Signaling of power supply activity and the operation of the system units after the power supply is on

LED diode signals the activity of power supply units on front panel of the supplied unit and this can be visible only after lifting the door. Its check is necessary only when none of the operating LED diodes in the rest of the module units does not light.

The signaling of the LED diodes in central and expansion units is described in chapter 4.4.

After the PLC is on, the outputs are locked. This fact is indicated by the LED diodes OFF on output units. If there is an indication on a central unit after the power supply is on that some outputs are switched, it is not a hindrance, the system programme secures the output reset after the power supply is on, and the lighting LED diodes go out in a moment. This intermediate state caused by the impact of supply voltage does not become outwardly evident, because the outputs are always locked immediately after the power supply is on and they get unlocked during the PLC transfer into the RUN mode (unless the user sets it up otherwise).

4.3 STARTING SEQUENCE OF THE PLC

PLC operation after the power supply is on

Immediately after the power supply is on, PLC performs the operations for individual types of units according to the table 4.1 to 4.4. This state is hereafter called PLC starting sequence. The starting sequence serves for testing PLC sw and hw and setting the PLC into defined initial state. At the same time, the tables explain the behaviour of signal LED diodes and 7-segment unit during the starting sequence.

In system units CPM-2S, CPM-1D, CPM-1B and STM-3 the 7-segment unit is accessible after the door is opened. It serves for closer estimation of the PLC state, for display of system errors and for setup of operating parameters. The version of the system unit sw is displayed here during the starting sequence (separating point is replaced by underlining dash - see tab. 4.2 and tab. 4.4).

Termination of starting sequence

The starting sequence can be finished in three possible ways. If everything is all right PLC starts to perform the user programme and thus controls the connected technology after the starting sequence is finished. If the PLC diagnostics evaluates a critical error during the starting sequence, PLC stays in the HALT mode and it signals an error.

If new values of operating parameters were set during the starting sequence (chap. 2.3), PLC stays in the HALT mode in which the user programme is not performed, the PLC outputs stay locked and the PLC waits for orders from the superior system. User programme can be started either by means of superior system or by switching off and on the power supply.

Operation review and their indication during the starting sequence

Tab.4.1 Starting sequence of central units CPM-1E, CPM-1M

Unit operation OK - without errors ER - error	**LED indication**
1. Basic initialization and hw unit tests OK - transfer to the next operation	RUN lights
ER - starting sequence suspension, PLC cannot be operated	RUN does not light, ERR flashes according to the tab.4.5
2. Initialization of the system sw processor	RUN lights
3. Finding of the system hw configuration OK - transfer to the next operation	RUN lights
ER - error is entered in the error buffer	RUN a ERR light
4. PLC initialization according to the user programme OK - transfer to the next operation	RUN lights
ER - error is entered in the error buffer	RUN a ERR light
5. Activation of communication with superior system	RUN lights
6. PLC mode setup OK - transfer into the RUN mode and start of the user programme	RUN flashes
ER - If an error occurs during the starting sequence, then transfer into the HALT mode, user programme is not initiated	RUN a ERR light

Tab.4.2 Starting sequence of the central units CPM-2S, CPM-1D, CPM-1B

Unit operation OK - without errors ER - error	**LED indication**	**Indication by the 7-segment unit**
1. Basic initialization and hw unit tests OK - transfer to the next operation	RUN lights	–
ER - starting sequence suspension, PLC cannot be operated	RUN and ERR light	according to tab. 4.5
2. Initialization of system sw processor	RUN lights	–
3. Operating parameter setup (only if the buttons SET and MODE are pressed)	RUN lights	see chapter 2.3
4. Finding of the system hw configuration OK - transfer to the next operation	RUN lights	sw version 4_0
ER - error is entered in the error buffer	RUN and ERR light	last error E-80-09-00-00
5. PLC initialization according to the user programme OK - transfer to the next operation	RUN lights	sw version 4_0
ER - error is entered in the error buffer	RUN and ERR light	last error E-80-09-00-00
6. Activation of the communication with superior system	RUN lights	sw version 4_0
7. PLC mode setup OK - transfer into the RUN mode and start of the user programme	RUN flashes	G
OK - if the operating parameters were set, then transfer into the HALT mode, the user programme is not initiated	RUN lights	H
ER - if an error occurs during the starting sequence, then transfer into the HALT mode, the user programme is not initiated	RUN and ERR light	last error E-80-09-00-00

Tab.4.3 Starting sequence of the STM-2 expansion unit

Unit operation OK - without errors ER - error	**LED indication**
1. Basic initialization and hw unit tests OK - transfer to the next operation	RUN flashes
ER - starting sequence suspension, PLC cannot be operated	RUN does not light, ERR flashes according to table 4.5
2. Initialization of the system sw processor	RUN flashes
3. Finding of the system hw configuration OK - transfer to the next operation	RUN flashes
ER - error is entered in the error buffer	RUN and ERR light
4. Activation of the communication with central unit OK - after the communication is established, the next operation is controlled by the central unit	RUN lights
ER - if an error occured during the starting sequence, it is passed to the central unit	RUN and ERR light

Tab.4.4 Starting sequence of the STM-3 expansion unit

Unit operation OK - without errors ER - error	**LED indication**	**Indication by the 7-segment unit**
1. Basic initialization and hw unit tests OK -transfer to the next operation	RUN lights	–
ER - starting sequence suspension, PLC cannot be operated	RUN and ERR light	according to table 4.5
2. Initialization of the system sw processor	RUN lights	–
3. Operating parameter setup (only if the buttons SET and MODE are pressed)	RUN lights	see chapter 2.3
4. Finding of the system hw configuration OK - transfer to the next operation	RUN lights	sw version 1_0
ER - error is entered in the error buffer	RUN and ERR light	last error E-40_91
5. Activation of the communication with central unit OK - after the communication is established, next operation is controlled by the central unit	RUN flashes	G
ER - if an error occured during the starting sequence, it is passed on the central unit	RUN and ERR light	last error E-40_91

Tab.4.5 Indication of hardware unit failure
LED indication is effective for the units CPM-1E, CPM-1M, STM-2
the indication by the 7-segment unit is effective for the units CPM-2S, CPM-1D, CPM-1B, STM-3

Unit condition	**LED indication**	**Indication by the 7-segment unit**
Connection of stand-by RAM was not successful	ERR flashes in series of 4 flashes	t
Invalid EPROM system	ERR flashes in series of 5 flashes	E
Invalid speed setup by the inter-connectors	ERR flashes in series of 6 flashes	no error occurs

4.4 PLC WORKING MODES

PLC TECOMAT NS950 can work in two basic modes. These modes are called RUN and HALT.

RUN mode

In the RUN mode, PLC counts the input signal values from the input units, it solves the user programme instructions and writes the calculated values of the output signals into the output units. RUN mode is signaled by flashing of LED diode RUN on the central unit. RUN diodes on expansion units flash at the same time and thus signal that the data transfer between central unit and periphery is in progress.LED diodes ERR are off. There is a letter **G** on the 7-segment unit.

HALT mode

HALT mode serves especially for the operations connected with user programme edition. The programme is not performed in this mode and not even the data transfer between the central unit and periphery is performed. Green LED diodes RUN on the central unit and on the expansion units light constantly, ERR diodes are off. There is a letter **H** on the 7-segment unit.

PLC behaviour during a critical error

Exceptions from the stated rules are situations when there is a critical error in PLC, which prevents continuation of controls. In this case, the mechanism of critical error handling in PLC is started, it performs the error handling from the standpoint of control safety and it turns the PLC always into the HALT mode. Green LED diode RUN stops flashing and red LED diode ERR turns on and signals the error state. On the display unit there is a code of the error which caused the PLC to stop. More detailed description of PLC during the errors and the instructions for error removal are stated in chapter 5.

Note: In central units CPM-1E, CPM-1M and expansion unit STM-2 the LED diode RUN may go out for a while during reading from the unit with EEPROM memory (IM-61). This fact is not a hindrance and it does not mean an error.

4.4.1 Change of PLC working modes

Change of working modes

The change of PLC working modes can be performed with the help of superior system (computer), which is connected to the serial channel CH1, or with the help of service inputs. Typical superior system is PC computer which works in function of programming device or monitoring, as the case may be, visual work site for the handling of the controlled object.

During the change of PLC working modes some operations are performed in standard way and some of them may be performed facultatively. In general, the change of PLC working mode is an operation requiring an increased attendant´s attention because in many cases it has an influence on condition of the controlled object. As an example may serve the transfer from the RUN mode into the HALT mode, when the PLC stops solving the user programme and the connected object is not controlled any more. Therefore, we recommend a detailed study of the following text.

If the change of PLC mode is performed with the help of programming sw for PLC, the optional operations during the change of mode are part of offers in the intergrated programming software.

Use of service signals to external output lockout and suspension of user programme solution

Central units of all types enable the external output lockout and suspension of user programme solving with the help of MS and SP service signals.

MS service signal enables to lock out the PLC outputs externally. This function must be allowed in programming sw in which at the same time, it is possible to select on what signal level the outputs are going to be blocked. The signal is connected to output declared as X0.1.

SP service signal enables to suspend the user programme solving externally. The programme solving is suspended after the proceeding cycle is finished. The programme suspension does not cause output lockout. After the PLC power supply is on, the PLC will stop in case of active SP signal after it has performed the starting sequence, that means before the first user programme cycle is performed. This fact can be used for instance to synchronize the start of more control systems independently on the moment when the power supply is turned on. This function must be allowed in programming sw, in which we can also select on what signal level the programme is going to be suspended. Signal is connected on the input declared as X0.0.

If no unit is declared on input image X0, the signals are not active!

An example of service signal connection is on the fig. 4.1.

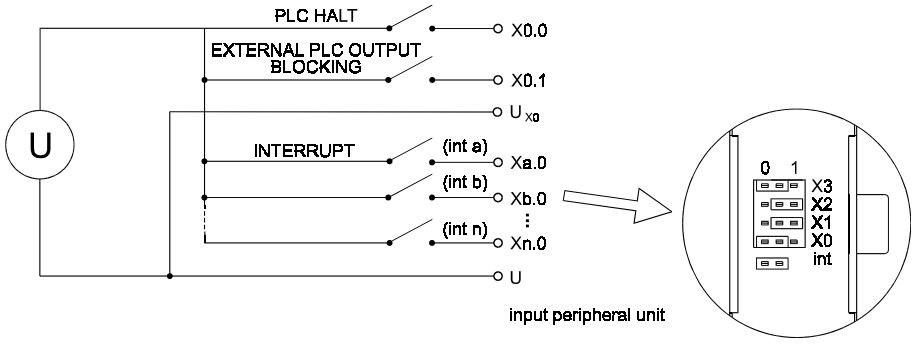


Fig.4.1 *An example of possible PLC service signal connection (in the case of user interruption it is necessary to connect the interconnector int, which is placed at the address interconnectors).*

4.4.2 Standard performed operations during the change of PLC mode

Transfer from HALT into RUN

During the transfer from the HALT mode into the RUN mode it is performed:

- test of user programme integrity
- check of periphery units software configuration stated in user programme (chapter 4.5.2)
- initiation of user programme solution

Transfer from RUN into HALT

During the transfer from the RUN mode into the HALT mode it is performed:

- suspension of user programme solution
- PLC output lockout (disconnection)

If a critical error occurs during the operations performed during the transfer between the modes, the PLC sets the HALT mode, it indicates an error with the help of 7-segment unit on the central unit and it waits for the error removal.

Notice: Control suspension with the help of the HALT mode is determined only for the purpose of PLC programme debugging. This function by no means replaces the CENTRAL STOP function. CENTRAL STOP circuits must be connected in such way so that their function is independent of PLC working.

4.4.3 Optional performed operations during the change of PLC mode

Options during the transfer from HALT into RUN

During the transfer from HALT mode into the RUN mode it is possible to perform:

- PLC error clearing
- warm or cold restart
- output lockout during the use programme solution

Options during the transfer from RUN into HALT

During the transfer from the RUN mode into the HALT mode is is possible to perform:

- PLC error clearing
- PLC output reset

The whole PLC error buffer including the error buffers in STM expansion units is cleared down during the PLC error clearing.

The requirement for PLC output lockout will cause that the programme will be solved with disconnected binary outputs, only the signaling of output states on LED diodes of output units will be active. Output lockout is indicated by LED diodes OFF on peripheral units.

All binary PLC output units will be cleared down during the output reset.

4.4.4 User programme restarts

User programme restart

Restart is a kind of PLC operations whose task is to prepare the PLC for user programme solving. Restart is performed under normal circumstances during each change of the user programme.

Systems TECOMAT NS950 distinguish two restart types, warm and cold. Warm restart enables the holding of values in registers even when the power supply is off (remanent zone - chapter 4.5.1). Cold restart performs always full memory initialization.

Operations during the restart

During the restart it is performed:

- test of user programme integrity
- clearing of the whole PLC buffer
- remanent zone reset (only cold restart)
- setup of the stand-by registers (only warm restart)
- initialization of the S system registers
- initialization and check of the PLC peripheral system

Starting the user programme without restart

The user programme can be also started without restart, in this case only the test of user programme integrity and the check of the PLC peripheral system (not at all initialization) are performed.

User processes during the restart

It is also the scheduler of P user processes that works dependent on the performed restart. If warm restart was performed during the transfer HALT → RUN, the P62 user process (in case it is programmed) is solved as the first after the transfer into RUN. If there was a cold restart, it is the P63 user process which is solved as the first after the transfer into RUN. If the restart is not performed during the transfer into RUN, it is P0 process which is solved as the first after the transfer.

Change of programme during PLC run

Programming sw xPRO enables also the change of programme while the PLC is running. We have to remember that during the time of new programme recording the programme solution is suspended without output lockout. This state may last even for several seconds!

4.5 PLC PROGRAMMING AND DEBUGGING

PLC programming

Programming of control algorithms and the test of the accuracy of writen programmes for PLC TECOMAT NS950 are performed on computers PC. We use ordinary serial channel of these computers for the connection with PLC.

For each PLC we supply a diskette with examples and programming software xPRO in version xPRO Lite and xPROm.

Examples of PLC programmes contain instructions for operation of various PLC units and declarations made exactly for the particular PLC setup, with which the diskette is supplied. These declarations may be arbitrarily used for the new programmes.

sw xPRO programming

Special programming software xPRO is outlined as an integrated developmental environment. The following versions are available:

xPRO - full version with hw key for professional work
xPRO Lite - freely circulating version of xPRO programme without hw key
xPROm - freely circulating version of xPRO programme designed for control of technology run, the possibility of intervention into the PLC user programme is eliminated

xPRO programme has the following properties:

- Turbo Vision integrated environment including the editor
- possibility to work with several files at the same time, each in its own window
- compiler into the machine code of a processor (all series)

- symbolic names of labels and operands
- automatic variable allocation
- generation of table with symbols and cross references
- formation of macroinstructions
- reverse programme translation
- built-in PLC TECOMAT simulator
- technologic panel simulation
- full use of PLC debugging means
- automatic generation of configuration according to the connected PLC
- contact plan (reley line schemas) with lighting of connecting paths in the debugging mode
- integrated sensitive clue system which contains the whole programmer manual
- control with the help of mouse or keyboard with the possibility to use both programme offers (pull down menu) and direct option by pressing the key combination (hot keys)

4.5.1 Configuration constants in user programme

Configuration constants for setting of services provided during the PLC run

Configuration constants are automaticly generated during the user programme translation and they are part and parcel of this programme. They carry information about the required PLC mode and its usage. The constants can be set with the help of offers from integrated invironment of xPRO compiler before the actual translation.

Configuration constants contain the following services:

- type of the restart after the PLC power supply is on.
- It determines if warm or cold restart will be performed after the power supply is on (chapter 4.4.4). Warm restart is set implicitly.
- meaning of MS and SP service signals (external lockout and external permission of RUN - see chapter 4.4.1)
- This constant influences if the service signals are active, and the signal level at which the signals are active. Both signals are implicitly set as not active, that means they do not influence the PLC behaviour.
- time of warning issue that the exceeding of maximum allowable cycle time is imminent
- If the cycle of user programme processing lasts longer than the time defined by this constant, PLC system services set the S2.7 bit as a flag that the set time has been exceeded during the programme processing in this cycle; at the same time there is a code of soft error set in the S34 system register. Implicitly set value is 150ms.
- time of watching the maximum allowed cycle time
- If the cycle of user programme processing lasts longer than maximum allowed cycle time, PC announces a critical error that the cycle time has been exceeded, it blocks the outputs and interrupts the processing of the user programme. This constant defines the longest possible time during which the controlled object can be without action intervention. The implicitly set value is 250ms, recommended maximum is 500ms.
- estimating the range of user programme backup in EEPROM
- The definition, if the whole user programme including T tables is backed up or if the user programme is backed up without T tables, and T tables stay original in stand-by RAM (suitable in the case of table modification by the user programme). The whole user programme is backed up implicitly.
- number of stand-by registers R (remanent zone)
- Setting the number of stand-by registers R, whose values will be stored during the PLC supply fall-out, secured by a check character and renewed in case of PLC warm restart. The registers are stored starting

with register R0, the state of registers is backed up after the last fully completed cycle of user programme solution. The implicitly set value is 0.

4.5.2 Concept of software configuration

Software and hardware configuration

The software configuration of peripheral units describes the PLC setup and it is part and parcel of the user programme. This description is compared before starting the user programme solution with the reality detected during the PLC starting sequence (so called hardware configuration). In xPRO programme the sw configuration is set by means of the directive *#unit*. Generally spoken, it contains the following information about each PLC peripheral unit:

- number of the module in which the unit is set (it corresponds to address set on the appropriate STM expansion unit, the basic module has number 0)
- address of unit in module (address set by means of address interconnectors)
- unit type or class (for instance 8, 16, 32 binary inputs, 8, 16, 32 binary outputs, IT-04, XH-04, ...)
- number of input and output unit bytes
- space in PLC record memory where the data scanned into /transmitted from/ the unit are mapped down (the beginning of contiguous zone in the area X, Y or R)
- input and output activation
- reference to T table containing the initialization data (number of T initialization table, necessary f. i. for virtual units, analogue units etc).

This information enables proper check of the whole PLC ready to controlling before starting the programme. At the same time, the user has a possibility to assign the unit image location in zones X, Y, R almost arbitrarily, regardless of the physical unit location in individual modules.

Automatic generation of sw configuration

xPRO programme contains also the function for automatic generation of sw configuration according to the connected PLC and its other editing. This gives a possibility to the user to create sw configuration directly according to the real hardware, or possibly to modify it in phase of user programme debugging (f. i. temporarily disable the peripheral unit services which connect the parts of technology that have not been debugged yet, with the help of commenting the appropriate line with semicolon)

Virtual units

Another possibility is declaration of so called PLC virtual units, as f. i. input multiplex (see the manual Digital units 5XV 001 34.01). These units use classic binary inputs and outputs, but their handling requires more difficult buildup algorithms. In case of virtual units, these service algorithms are realized by the central unit, or by the STM expansion units, therefore, the handling of these units by user programme stays very easy.

Solution of user programme with disconnected peripheral units

If no sw configuration is set in user programme, the programme will be solved only above the PLC note-pad memory and the PLC inputs and outputs will not be operated. Output units will stay blocked in this case.

4.6 TESTING THE I/O SIGNALS CONNECTED TO THE PLC

The method how to test if the input and output signals were connected correctly

To test the input and output signals connected to PLC, we create an empty programme containing only the sw configuration of the tested PLC and P0 and E0 instructions that form an empty basic process. Then, with the help of debugging tools of programming software, we can monitor the states of connected inputs and set arbitrary values on PLC outputs. This easy but effective method is recommended to use before debugging the actual user programme, because in this way we check the whole way from input elements (terminal switch, ...) via input units up to the PLC note-pad

memory and all the way around from the note-pad memory via output units up to the action elements. This way, the errors originated during the PLC connection to controlled object are removed - their retrieval in phase of control programme debugging is much more difficult.

4.7 SET OF INSTRUCTIONS

The set of instructions and system services of the systems TECOMAT NS950 is compatible with other PLCs TECOMAT. Central units of the given series contain a set of instructions of various range according to the central unit performance.

Reduced set of instructions

Central unit of series E contain reduced set of instructions, part of which are:

- bit logic operations
- basic operations of counters and timers
- basic organizing instructions and transfers in programme
- matching in the range of word
- uniloop control

Standard set of intructions

Central units of series M and S contain standard set of instructions, part of which are (in addition to the reduced set):

- logic operations in the range of byte and word
- extended operations of counters, timers and shift registers
- arithmetic instructions, conversions and matching in the range of word
- extended organizing instructions, transfers in programmes
- table instructions above tables in user memory, which allow to realize optimally also very complicated combinatorial and sequential function blocks, decoders, time and sequential controllers, sequential generators; furthermore they make easier the implementation of diagnostic functions, recognition or error state, sequential event recording, process log, diagnostic report of type „black box“
- table instructions above the variable area allow to operate with subscripted variables, realize the delay line, long shift registers, conversions into code „1 from n“, variable selection, step controllers, event recording and various stack structures
- instructions of sequential controller
- instructions realizing the logic operation file, including counting of 1-bits in operand, type word - the majority and general threshold functions, parity functions (MOD 2) and arbitrary symetric functions can be realized this way easily
- the system contains 8 user stacks and instructions for their switching - suitable for dispatching of more parameters among the functions, which do not follow each other immediately, storing of momentary stack state, etc.
- automatic conversion of the operand length and of the intermediate results at combination of bit, byte and word instructions or logic instructions with arithmetic instructions is convenient
- convenient aid is the system variable file where the system time, system time unit and their edges, communication variables, flag and command variables, system reports are realized
- so called multiprogramming (multiloop control), including the interrupting processes, contributes to reduction of response time and to easier programming
- the user instructions USI realize in optimal way (on level of microprocessor) difficult tasks (special communications, regulations, time-critical user tasks)

Extended set of instructions

Central units of series D and B contain extended set of instructions, part of which are (in addition to the standard set):

- logic operations in the range of long
- arithmetic instructions, conversions and matching in the range of long
- conditional jump according to the matching flag
- arithmetic instructions in form with floating point
- extended table instructions with tables of large range
- table instructions with structured approach
- PID controller instructions

Detailed description of the instuction set is stated in the manual Instructions and system services TECOMAT, the order number TXV 001 05.01.

5. ERROR DIAGNOSTICS AND REMOVAL

PLC diagnostic system

Diagnostic system of PLC TECOMAT NS950 is a part of standard sw and hw PLC equipment, whose main task is to secure the fault-free and directly defined PLC function in any situation. If there is a fault of PLC, the diagnostic system has to prevent the possibility of crash state developement in technology which is connected to PLC. Another task of diagnostic system it to make the removal of developed fault easier for the service workers or the user. Diagnostic system operates after the PLC power supply is on and it operates independently of the user.

In general, the diagnostic system monitors the essential PLC parts and functions continuously and in the moment of fault developement it secures the appropriate fault handling and informs about the fault. This way the control safety, and at the same time the possibility of fast repair are secured. The other function of diagnostic system is to draw the user´s attention to possible incorrect manipulations or procedures during the PLC attendance, and this way the work with PLC becomes easier and more effective.

5.1 CONDITIONS FOR CORRECT FUNCTION OF PLC DIAGNOSTICS

Checking the correct function of the power supply unit

The basic condition for fault-free function of the PLC and the correct functioning of its diagnostics is the correct function of module power supply in system TECOMAT NS950. Correct levels, tolerance and supply voltage ripple effect is stated in table 5.1. In the table there are connector tips of IIOC-T bus (bus for peripheral units), on which it is possible to measure the supply voltage.

Tab.5.1 Levels, tolerance and voltage ripple effect of power supply units

Voltage	Tolerance	Ripple effect	Connector tip of IIOC-T bus
+5 V*	+4,9 V to +5,3 V	0,15 V	31a, 31b
+12 V	+10,0 V to +13,2 V	0,50 V	12b, 13b, 14b, 15b
+15 V	+14,25 V to +15,75 V	0,30 V	30b
–15 V	–14,25 V to –15,75 V	0,30 V	29b
0 V	-	-	1a, 1b, 32a, 32b

* Level +5 V must be charged with consumption at least 0,2 A.

Check of system unit function

After the power supply is on, the unit performs the basic check of hw (see tab. 4.5). If there is an error of system EPROM, it is necessary to change the EPROM. The error of RAM connection to the system is probably caused by stand-by battery failure. We recommend the professional repair.

5.2 ERROR INDICATION

Error buffers of the system units

The central unit has the main error buffer which contains last 8 errors announced by the diagnostics of the whole PLC, and the local buffer which contains last 8 errors announced by the diagnostics of the peripheral unit services and communication on serial channels. Also the STM expansion units are equipped with the local error buffers.

The errors in the main error buffer have a length of 4 bytes, the errors in the local error buffers have a length of 2 bytes.

Error indication

All these buffers can be read with the help of programming sw xPRO. The units equipped with the display unit enable to detect the developed error even without the use of superior system. From the moment of error developement there are number codes of the error flashing in the following form on the 7-segment unit:

E-80-09-00-00

E– - error code follows in the hexadecimal form (digits 0 to F)
80 - basic error code, it determines the group of errors
09 - more detailed error determination
00 00- additional information

The error code in local buffers is shorter:

E-40_91

E– - the error code follows in hexadecimal form (digits 0 to F)
40 - basic error code, it determines the group of errors
91 - more detailed error determination

Division of the errors according to their importance

The errors which may develop in PLC can be divided into two groups from the standpoint of their importance:

a) serious errors which make the fault-free control impossible
   LED diodes ERR and RUN light, PLC goes into the HALT mode and blocks the outputs
   There is the last developed error on the 7-segment unit
b) other errors which do not essentialy influence the actual control
   LED diode ERR does not light, LED diode RUN flashes, PLC stays in the RUN mode, the basic error code is entered in the S34 register and it is at disposal for the processing by the user programme
   also the P43 interrupting process recalled by the developement of such error can be used

5.3 SERIOUS ERRORS

PLC behaviour during the serious error

If some of the serious errors developes, the diagnositc system blocks the outputs first, interrupts the user programme processing and then indentifies the developed error. The information about the error can be announced either on the 7-segment unit of the central unit (only the last developed error), or by mapping the error buffer into the superior system (PC).

This error flag may be cancelled by the command from the superior system or by turning the PLC supply off and on.

Used symbols:

PC - instruction address where the error developed (programme counter)
RM - module number (the address of appropriate STM expansion unit, basic module has number 0)
AM - module number (the address of appropriate STM expansion unit, basic module nas number 0) and activations of unit inputs and outputs where the error developed

	AO	AI	N5	N4	N3	N2	N1	N0
bit	7	6	5	4	3	2	1	0

AO - activation of peripheral unit outputs
  0 - the outputs are not operated
  1 - the outputs are operated
AI - activation of peripheral unit inputs
  0 - inputs are not operated
  1 - inputs are operated
N5-N0 - module number

AJ - upper byte of unit physical address, where the error developed (it is formed by unit type and unit position)

	T3	T2	T1	T0	P3	P2	P1	P0
bit	7	6	5	4	3	2	1	0

T3-T0 - type of peripheral unit
  0000 (0) - reserve

0001 (1) - serial channels on central units CPM-2S, CPM-1D a CPM-1B
0010 (2) - reserve
0011 (3) - reserve
0100 (4) - virtual unit - input multiplex
0101 (5) - virtual unit - serial display (LCD-5)
0110 (6) - reserve
0111 (7) - physical addresses of additional units (SC-01)
1000 (8) - 8 inputs or outputs (OR-14, OS-28, OS-32, OS-34, XH-04)
1001 (9) - 16 inputs or outputs (IB-36 až IB-47, OR-15, OS-29, OS-30, OS-31, OS-33, OS-35)
1010 (A) - 32 inputs or outputs (IB-48, IB-49, OS-26, OS-27, UX-52)
1011 (B) - 64 inputs or outputs
1100 (C) - connection of incremental scanners (IC-04)
1101 (D) - analogue units without own processor (IT-04, IT-12, IT-15, OT-04)
1110 (E) - reserve
1111 (F) - units with own processor (IT-06, OT-05, IC-12, IC-13, IC-14, GT-40, SC-11, CD-01, CD-02, CD-03, CD-04, UP-01, UP-02)

P3-P0 -unit position in frame set by interconnectors (see the manuals about these units)

5.3.1 Errors in user programme

The errors are announced by the central unit.
The main control structure is the user programme map.
Number codes are stated in hexadecimal form.

Errors of the user programme storage

80 01 00 00 wrong length of user programme map in EEPROM

80 02 00 00 wrong guard character (CRC) of user programme map in EEPROM

80 03 00 00 wrong guard character (CRC) of the whole programme in EEPROM

80 04 00 00 there is no user programme in EEPROM

There is an error in EEPROM memory, or the user programme is designed for different series of central units, or it was not recorded into the EEPROM at all. It is necessary to record new user programme into the EEPROM or to disconnect EEPROM memory and record the user programme into RAM.

80 05 00 00 wrong length of user programme map in RAM

80 06 00 00 wrong guard character (CRC) of user programme map in RAM

80 07 00 00 wrong guard character (CRC) of the whole programme in RAM

There was a error in memory or the user programme is designed for different series of central unit. It is necessary to record a new user programme into RAM.

80 08 00 00 editorial intervention into the user programme during the connected EEPROM memory

If the EEPROM memory is connected, its content is recorded into the RAM memory of the central unit after the system is switched on. The central unit checks the integrity of the programme copy from EEPROM. In case of editorial intervention it announces the error in the moment of PLC start into RUN. If it is a wanted editorial intervention, it is necessary to disconnect the EEPROM memory or reprogramme it. If the editorial intervention was not wanted, we can just switch the PLC on

and off, and thus the original programme is recorded from EEPROM.

80 09 00 00 programme is compiled for different series of central units

The compiler was set for different series of central units, it is necessary to choose the correct series of central unit in the compiler offer (the series is marked by capital letter in the name of central unit) and compile the user programme again. If the compiler was set correctly, it is designed for higher version of system sw, than the version set in the central unit of your PC. This discord has to be removed either by use of older version of compiler or by change of system sw in CPM.

80 0A 00 00 attempt to programme non-existing EEPROM

The memory is not set or it is disconnected.

80 0B 00 00 the programming of EEPROM was not successful

Data stored in EEPROM do not correspond to the entered data.
In central units CPM-2S, CPM-1D and CPM-1B it was probably caused by wrong setting of the used EEPROM capacity. EEPROM programming algorithms (EEPROMs with various capacities) are different. If the capacity is set correctly, it is an error in EEPROM memory.
In central units CPM-1E and CPM-1M it is probable that if the external EEPROM memory has been used in IM-61 unit, there is an error in IM-61 unit or directly in the EEPROM memory.

80 0C 00 00 error of RTC real time circuit

The real time circuit does not work which results in failure of all PLC time functions. The most probable error is the stand-by battery discharge, which has to be exchanged. If the stand-by battery is not discharged, it is necessary to repair the central unit professionally.

80 0D 00 02 wrong regime of CH2 serial channel

The units in expansion modules are declared in the user programme, but the CH2 serial channel is not set into the STM regime. It is necessary to set it.

Errors of the programming

80 10 PC PC buffer overflow of return addresses

Maximum number of subprogramme insertion was exceeded. Under insertion we undestand call of another subprogramme within the bounds of subprogramme which is already being executed.

80 11 PC PC buffer underflow of return addresses

Instruction of return from the subprogramme (RET, RED, REC) was not preceeded by subprogramme call (CAL, CAD, CAC, CAI)

80 12 PC PC non-null buffer of return addresses after the process is finished

In the user programme there is a different number of subprogramme call instructions (CAL, CAD, CAC, CAI) than the instructions of return from subprogramme (RET, RED, REC)

80 13 PC PC the label is not declared

There was an instruction of jump or call with the label number, which is not used in user programme.

80 14 PC PC label number is bigger than the maximum value

The number of jump or call instruction label is bigger than the biggest label number used in the user programme

80 15 PC PC T table is not declared

T table used in this instruction was not assigned in the user programme. It is necessary to complete it.

80 16 PC PC unknown instruction code

The used instruction is not implemented in this central unit

80 17 PC PC uncorrect USI user instruction

User instruction is designed for different series of central units or it has a disturbed structure

80 18 PC PC there is no required USI user instruction

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

80 19 PC PC error of BP instruction insertion

The BP instruction can not be used in the processes P50 to P57 (call of debugging process P5n in different process P5m)

80 1A PC PC Process for the BP operation is not programmed

Debugging process P5n called by BP instruction is not programmed. It is necessary to add it into the user programme.

80 1B PC PC wrong T table configuration

The check sum of the T table values used by this instruction differs. it is necessary to record the user programme again.

80 30 00 00 exceeding of the maximum cycle time

The cycle time was longer than the set value.

80 31 00 00 exceeding of maximum interrupting process time

The time of execution of interrupting process exceeded 5 ms, or during the execution of interrupting process there was an extension of the cycle time (see error 80 30 00 00).

5.3.2 Errors in peripheral system

The errors are announced by the central unit and expansion unit of the module, where the error developed.

Number codes are stated in hexadecimal form. 4-byte codes are announced by central unit, 2-byte codes are announced by the appropriate expansion unit or the local central unit buffer.

Sw configuration errors

81 RM 30 AJ
30 AJ the number of bytes on the unit was exceeded

In sw configuration in user programme, bigger number of bytes was assigned than the unit actually occupies. It is necessary to correct this statement and record the corrected programme into the PLC again

81 RM 31 AJ
31 AJ there is no initialization t able

In user programme there is no initialization table necessary for the operation of some units (f.i. virtual units, analogue units and most of the units with own processor). It is necessary to complete this table into the user programme and record the corrected programme into the PLC again.

81 RM 32 AJ
32 AJ unknown operation

Central, respectively expansion unit cannot operate this unit. It is necessary to replace the system software of the appropriate

unit with newer version (the version number can be found out either in the programme xPRO or it is possible to read it on the 7-segment unit after the power supply is on.

81 RM 33 AJ
33 AJ odd number of bytes for the analogue unit

In sw configuration in user programme odd number of bytes was assigned for the analogue unit, which is inadmissible, because one channel of the analogue unit takes two bytes. It is necessary to correct this statement and record the corrected programme into the PLC again.

81 RM 34 AJ
34 AJ wrong number of bytes in initialization table

The initialization table has different number of bytes from the one required by the operation of the initiated unit

81 RM 35 AJ
35 AJ initialization zone overflow

The part of memory in the central or expansion unit reserved for the initialization data of the given unit type was overflown.

81 RM 36 AJ
36 AJ the number of initialization table is bigger than the maximum value

The number of initialization table is bigger than the central unit allows (series E and M max. 256 tables). It is necessary to correct the number of table and record the corrected programme into the PLC again.

81 RM 37 AJ
37 AJ wrong configuration of the initialization table

The control sum of the initialization table values for this unit is different. It is necessary to record the user programme again.

81 RM 38 AJ
38 AJ wrong information in initialization table

There is an information in the initialization table, that is incorrect. As for virtual units it is usually incorrectly assigned physical address of the unit above which the virtual unit is formed. As for the units with own processor, this unit refused to accept the table because the table content is not correct or because there is an error in the unit. During the serial channel initialization it is usually exceeding the maximum allowed values of some parameter (f.i. the length of transmitted data).

Errors of peripheral units during PLC run

81 RM 40 AJ
40 AJ the input unit did not report

The input unit stopped reporting. The probable cause is an error on the address decoder of this unit

81 RM 41 AJ
41 AJ the output unit did not report

The output unit stopped reporting. The probable cause is an error on the address decoder of this unit.

81 RM 43 AJ
43 AJ start of a non-existing unit

Non-existing unit operation was started. The most probable error is in the functioning of the programming software of the superior PC and the PLC central unit.

Errors of data transmission between central and extention unit

60 00 communication failure with the central unit

STM expansion units are equipped with the control timer which monitors the serial channel activity. The central unit sets it for the time a little longer than the longest allowed PLC cycle time. If there is no communication with any network subscriber found during this time on the serial line, the communication is announced as interrupted and the STM unit blocks the outputs and stops the peripheral unit operations on its own.
An exception is the HALT regime during which the control timers of STM units are stopped.

hw configuration errors

81 RM 61 00
61 00 overflow of the zone for input configuration
81 RM 61 01
61 01 overflow of the zone for output configuration

These errors are caused by too large number of units entered in sw configuration in user programme. Maximum numbers are 16 input units and 16 output units including the virtual units for one module.

81 RM 61 02
61 02 overflow of the expansion unit communication zone for the data transmission

The error is caused by excessively great number of required data from the expansion unit. The number of the transmitted data between the central unit and one extension module is limited to 246 input bytes and 246 output bytes. The error can be eliminated by reducing the byte number in sw configuration of the units in module, or by physical relocation of some units into the less loaded module.
In the basic module which is operated directly by the central unit, this restriction is not valid.

70 AJ incorrectly addressed one-byte input unit
71 AJ incorrectly addressed one-byte output unit
72 AJ incorrectly addressed two-byte input unit
73 AJ incorrectly addressed two-byte output unit
74 AJ incorrectly addressed four-byte input unit
75 AJ incorrectly addressed four-byte output unit
76 AJ incorrectly addressed eight-byte input unit
77 AJ incorrectly addressed eight-byte output unit
8Y AJ wrong number of occupied bytes of input unit
9Y AJ wrong number of occupied bytes of output unit
(Y states the detected number of occupied bytes)

Error on the address decoder of the peripheral unit, the unit takes up a different number of bytes than it really should, or two units have the same address.

5.3.3 Errors of communication with extension modules

The errors are announced by the central unit.
The number codes are stated in hexadecimal form.

Errors of communication with expansion units and errors of configuration control

82 03 00 RM there is no answer from the extension module

STM expansion unit in the module did no answer the question from the central unit. The cause is the interrupted serial line, high interference, interrupted supply of the questioned module or the error in the questioned module which makes the funtion of the expansion unit impossible.

82 06 AM AJ configuration control error

AJ unit in the M module was not found. Either the unit is not set in the module or it has an error on the address decoder. Other possibility is that M module did not report during the establishment of the communication at all (AJ address is the address of the unit from this module stated in the sw configuration in user programme as the first). The turned-off power supply of the module, an error in the module which makes the function of the expansion unit impossible, interrupted or highly interfered serial line can also be a cause.

82 07 AM AJ error during the unit initialization from the initialization table

The initialization data could not be sent into the appropriate module. This error is usually accompanied by the communication error 82 03 00 RM, or by some other error of the group 81.

82 08 00 RM there are no data from the extension module

There was sw overload of the appropriate STM expansion unit, which does not manage to prepare new data for each user programme cycle. It is necessary to take out units from the module (analogue units, virtual units) or to extend the PLC cycle time.

82 09 00 RM required function is not implemented in the expansion unit

STM expansion unit does not know the required communication function. It is necessary to replace the system software of the expansion unit with a newer version (version number can be found out either in the xPRO programme or it is possible to read it on the 7-segment unit on the unit after the power supply is on).

5.4 OTHER ERRORS

If there are some other errors which do not influence the actual control radically, the diagnostic system only indentifies the developed error and the process control is in progress. The information about the error is stated in the S34 register (the first byte), which can be used to user handling of these errors. The error can be detected also by scanning the error buffer into the superior system (PC).

5.4.1 Errors of serial communication

This group of errors is entered only in the local buffer without the possibility of evaluation by the user programme.

Errors of the serial communication protocol

10 05	wrong delimiter start
11 05	bad parity SD
11 06	bad parity LE at SD2
11 07	bad parity LER at SD2
11 09	bad parity DA at SD2
11 0A	bad parity SA at SD2
11 0B	bad parity FC at SD2
11 0C	bad parity RB at SD2
11 0D	bad parity DAT at SD2
11 0E	bad parity CHS at SD2
11 0F	bad parity ED at SD2
11 10	bad parity DA at SD1
11 11	bad parity SA at SD1
11 12	bad parity FC at SD1
11 13	bad parity CHS at SD1
11 14	bad parity ED at SD1

12 07 different value LE and LER - SD2
13 08 different value SD and SDR - SD2
14 0A extended address SA - it cannot process - SD2
14 11 extended address SA - it cannot process - SD1
15 0B error of reception flag FCF in check byte FC - SD2
15 12 error of reception flag FCF in check byte FC - SD1
18 0E wrong check sum CHS - SD2
18 13 wrong check sum CHS - SD1
19 0F wrong terminal character ED - SD2
19 14 wrong terminal character ED - SD1

These errors are caused by excessive interference of the serial communication. They cause the message loss and their frequent occurence results in communication interruption.
Error 10 05 or some of the errors in group 11 can occur unrepeatedly during the communication establishment with the superior system in the middle of the message transmitted by this system. If the errors do not occur any more during the subsequent communication, everything is all right.
Errors starting from the CH2 serial channel have an increased value of the second byte by 20 (f.i. error 10 25 etc.), starting from CH3 by 40, etc.

20 FC wrong check byte in combination with global address
2X RB unknown communication function (X is a value of control byte FC-3, 4, 5, 6, 9, C, D, E, F)

The unit does not know the required communication function. It is necessary to replace the unit system software with newer version (the version number can be found out either in xPRO programme or it is possible to read it on the 7-segment unit on the unit after the power supply is on.)

5.4.2 System errors

These errors can be handled by the user programme with the help of the S34 register, where the first byte of the error is stored.

System errors

07 00 00 00 Error in the remanent zone control

The backed up part of the buffer, so called remanent zone, has a wrong check sum. Cold restart will be performed. The cause is the fault in back up of the RAM user memory on the central unit, probably the fault in the stand-by battery.

08 00 00 00 the first limit of monitoring the cycle time was exceeded.

Cycle time was longer than the set value for warning.

09 00 00 00 wrong system time of the RTC circuit

It is necessary to write in the actual time from the superior system.

5.4.3 Errors in the user programme

These errors can be handled in the user programme either by elimination of the cause by means of input parameter control before the given instruction is performed, or by handling the consequence with the help of the S34 register, where the first byte of the error is stored.

Errors of programming

10 00 00 00 zerodivide

In the division instruction the divisor was equal to zero.

11 00 00 00 the initial index for the WMS instruction is out of the T table

WMS instruction has a wrong parameter and therefore it will not be performed

12 00 00 00 the initial index for the LMS instruction is out of the T table

LMS instruction has a wrong parameter and therefore it will not be performed.

13 00 00 00 table instruction above the buffer exceeded its space

The table defined by the table instruction above the buffer exceeded its space, the instruction will be not performed.

14 00 00 00 data source block was defined outside the space

Data source block for the transfer instruction was defined outside the space of the buffer, data or table. Instruction will not be performed.

15 00 00 00 data target block was defined outside the space

Data target block for transfer instruction was defined outside the space of the buffer or table. Instruction will be not performed.

5.5 SOLUTION TO COMMUNICATION PROBLEMS WITH THE SUPERIOR SYSTEM

How to proceed while solving the problems with non-functioning communication

PLC connection to the superior system, usually PC computer, is necessary because each PLC has to be programmed. If you have troubles with communication between PLC and PC, proceed according to the following lines:

The communication between PLC and PC cannot be established

PLC control

1. Is there a power supply inlet to PLC?
   NO Set it right.
   YES Continue with the point 2.
2. Does the LED diode Power light on the source after lifting the door ?
   NO Power supply inlet is without electricity, or the voltage is out of the source tolerance, or the source is defective.
   YES Continue with the point 3.
3. Did the central unit go through the starting sequence and is it in the RUN or HALT regime (see chapter 4.3)?
   NO Central unit announces the hardware error (see chapter 4.5), it is not possible to communicate.
   YES Continue with the point 4.
4. Do the LED diodes of the appropriate channel flash on the central unit during the communication?

   Central unit is not equipped with indication

   Consider all the following possibilities. If you use serial interface adapter equipped with the channel indication, continue with the point 6.

   Not a single one flashes

   a) MR-xx piggyback is not set on the appropriate channel, or there is a piggyback for different interface.
   b) The error is in PC, cable or adapater of serial interface (RS-485).
   If you use an adapter, continue with the point 6.
   If you do not use an adapter, continue with the point 7.

   Only RxD flashes

   The channel parameters (regime, speed, address, CTS detection - see chapter 2.3.6.) in the central unit are set incorrectly.

   RxD and TxD with RTS flash alternately

   The communication in the direction PC → PLC is all right. Continue with the point 5.

   Another state

   There is probably a piggyback for different interface, or the cable is connected incorrectly.

5. Do you want to programme the PLC with the help of sw xPRO or EPOS?
   Yes, on channel CH1
   If you use an adapter, continue with the point 6.
   If you do not use an adapter, continue with the point 7.
   Yes, on channels CH2 to CH 12
   It is not possible, PLC can be programmed only through channel CH1.
   No, it is a communication with visual sw, etc.
   If you use an adapter, continue with the point 6.
   If you do not use an adapter, continue with the point 7.

Check of the serial interface adapter

6. Do the channel LED diodes flash on the adapter of serial interface (RS-232 / RS-485) during the communication?

   Adapter is not equipped with the indication
   Consider all the following possibilities.
   Not a single one flashes
   a) The power supply of the adapter is not working or the adapter is faulty.
   b) The error is in PC or the cable between PC and the adapter.
   Continue with the point 7.
   Only TxD flashes, RTS lights permanently or does not light at all.
   There is either a fault in RTS signal between PC and adapter, or the software on PC does not support the control of RTS signal which is necessary for RS-485 interface (it is not necessary for the RS-232 interface).
   xPRO and EPOS programme and some visualisations support the RTS signal.
   If the software in PC does not support the RTS signal, it is necessary to set the adapter into the regime of automatic communication direction switching and set the adaquate reply timeout on the central unit (chapter 2.3.6 - **t** parameter.).

Only TxD with RTS flashes

The error is in the output part of the adapter or in the cable between the adapter and PLC. If the central unit is not equipped with channel indication, there can also be a problem there (see point 4).

TxD with RTS and RxD flash alternately

The communication is all right, the problem is in the cable between the adapter and PC or in PC. Continue with the point 7.

Check of the cable

7. Is the cable in PC connected to the right COM socket?
   NO Set it right.
   YES Continue with the point 8.
8. Are the right cables used?
   NO Set it right.
   YES If it is possible, use another cable of the same type.
   Continue with the point 9.

Check of the PC

9. On which COM channel is the mouse installed and on which channel do you communicate?

On the same one

There is a clash of controllers even if the mouse is not connected. It is necessary to communicate through a different COM, or disconnect the mouse controller.

Mouse on COM1, communication on COM3
Mouse on COM2, communication on COM4
Mouse on COM3, communication on COM1
Mouse on COM4, communication on COM2

Some programmes (f. i. xPRO) cannot communicate through the channel, which shares the same interrupt vector as the mouse controller. Therefore, it is necessary to use a different combination than those mentioned above. In the xPRO programme a different interrupt vector can be set in the communication options. However, such experiments are for experienced PC users.

Other combinations

Read the following problem.

Communication drop-out

The whole route is all right, but the PC does not accept an answer, or the communication often falls out.

The problem occurs in programmes working in extended regime (protected mode) or under the operation systems with graphic interface (Windows).

In xPRO programme which works in the extended regime from 2.1 version, it is necessary to have a serial channel equipped with an equivalent of 16550 circuit with the buffers. In communication options in xPRO programme we tick off the *UART 16550A* option and choose *Interruption - standard*. With the start of operation system Windows 95 all new computers are equipped with these circuits standardly. Older computers can be equipped with the additional board with serial channels (in that case xPRO communicates also on PC with the 386SX processor), or we can choose *Interruption - standard* or *Interruption - without interruption* and reduce the communication speed little by little (speed has to be reduced also on the PLC central unit). The option *UART 16550A* must not be ticked off. This procedure has some purpose at PC which is equipped with the processor 486 DX or 486DX2 and higher.

Some programmes in the Windows environment do not manage to switch over from transmission to reception adequately fast. This problem can be solved easily by setting an adequate answer timeout of the PLC central unit (chapter 2.3.6. - **t** parameter).

6. PLC MAINTENANCE

PLC maintenance

The PLC maintenance is performed during the operation according to this chapter. The worker performing the maintenance has to be at least trained.

6.1 CHECK OF THE CORRECT INPUT AND OUTPUT CONNECTION

Check of the terminal boards and cables

We check if the screws of the terminal board are tightened and if the wire insulation is not damaged. At the same time we have to check the cable fastening.

6.2 CHECK OF THE VOLTAGE FOR INPUT AND OUTPUT POWER SUPPLY

Check of the power supply

We check the level of supply voltage for input and output units with the voltmeter. The correct size and allowed tolerance are stated in the documentation of the used units.

6.3 CHECK OF THE EARTHING CLIP INTERCONNECTION

Check of the earthing

With the help of accurate indicator of small resistance we measure the resistance between any accessible part of the peripheral module and the main earthing clip of the cabinet where the peripheral system is placed. The measured resistance has to be always smaller than 0,1 Ω.

6.4 CLEANING OF THE PLC

Cleaning of the PLC

If the units are covered with dust, it is necessary to take them out of the frame and clean them by air blowing, possibly by a brush. We have to proceed carefully, so that we would not switch the switches or damage the units.

After the PLC is set up again, we recommend to check the cable connection (watch out - do not exchange them).

6.5 RECOMMENDED MEASURING INSTRUMENTS

Measuring instruments

1. voltmetr for measurement of alternating voltage, the accuracy class 1,5 or better
2. voltmetr for measurement of direct-current voltage, the accuracy class 1 or better
3. small resistance meter OMEGA III or some other similar type

SUPPLEMENT

Review of the errors stored in the main error buffer of the central unit.

Used symbols:

PC - Address of the instruction where the error developed (the programme counter)
RM - Module number (the address of the appropriate STM expansion unit, basic module has number 0)
AM - Module number (the address of the appropriate STM expansion unit, basic module has number 0) and activation of the unit inputs and outputs in which the error developed
AJ - the upper byte of the physical unit address, where the error developed (it consists of unit type and unit position)

Number codes are stated in hexadecimal form:

Error code	Error specification
07 00 00 00	error during the remanent zone check
08 00 00 00	the first limit of the cycle time monitoring was exceeded
09 00 00 00	wrong system time of the RTC circuit
10 00 00 00	zerodivide
11 00 00 00	initial index for the WMS instruction is outside the T table
12 00 00 00	initial index for the LMS instruction is outside the T table
13 00 00 00	table instruction above the buffer exceeded its size
14 00 00 00	data source block was defined outside the span
15 00 00 00	data target block was defined outside the span
80 01 00 00	wrong length of user programme map in EEPROM
80 02 00 00	wrong guard character (CRC) of the user programme map in EEPROM
80 03 00 00	wrong guard character (CRC) of the whole programme in EEPROM
80 04 00 00	there is no user programme in EEPROM
80 05 00 00	wrong length of user programme map in RAM
80 06 00 00	wrong guard character (CRC) of the user programme map in RAM
80 07 00 00	wrong guard character (CRC) of the whole programme in RAM
80 08 00 00	editing intervention into the user programme at connected EEPROM memory
80 09 00 00	the programme is compiled for different series of central units
80 0A 00 00	attempt to programme a non-existing EEPROM
80 0B 00 00	EEPROM could not be programmed
80 0C 00 00	error in the RTC real time circuit
80 0D 00 02	wrong regime of the CH2 serial channel
80 10 PC PC	overflow of the buffer with return addresses
80 11 PC PC	underflow of the buffer with return addresses
80 12 PC PC	non-zero buffer of return addresses after the process is finished
80 13 PC PC	label is not declared
80 14 PC PC	label number is bigger than the maximum value
80 15 PC PC	T table is not declared
80 16 PC PC	unknown instruction code
80 17 PC PC	wrong USI user instruction
80 18 PC PC	the required USI user instruction does not exist
80 19 PC PC	error of BP instruction insertion
80 1A PC PC	process for BP operation is not programmed
80 1B PC PC	wrong configuration of the T table
80 30 00 00	the maximum cycle time was exceeded
80 31 00 00	the maximum time of interrupt process was exceeded
81 RM 30 AJ	the byte number on unit was exceeded
81 RM 31 AJ	there is no initialization table
81 RM 32 AJ	unknown operation
81 RM 33 AJ	odd number of bytes for the analogue unit
81 RM 34 AJ	wrong number bytes of the initialization table
81 RM 35 AJ	initialization zone overflow
81 RM 36 AJ	the number of initialization table is bigger than the maximum value
81 RM 37 AJ	wron configuration of the initialization table
81 RM 38 AJ	wrong data in initialization table
81 RM 40 AJ	the input unit did not report
81 RM 41 AJ	the output unit did not report
81 RM 43 AJ	start of non-existing unit
81 RM 61 00	zone overflow for input configuration
81 RM 61 01	zone overflow for output configuration
81 RM 61 02	overflow of the expansion unit communication zone for data transfer
82 03 00 RM	there was no reply from the extension module
82 06 AM AJ	error of the configuratio n check
82 07 AM AJ	error during the unit initialization from the initialization table
82 08 00 RM	there are no data from the extension module
82 09 00 RM	the required function is not implemented in expansion unit

Review of errors stored in local error buffer of the central and expansion unit

Used symbols:
AJ - upper byte of the unit physical address, where the error developed (it consists of unit type and unit position)

Number codes are stated in the hexadecimal form.

Error code	Error specification
10 05	wrong delimiter start
11 05	bad parity SD
11 06	bad parity LE at SD2
11 07	bad parity LER at SD2
11 09	bad parity DA at SD2
11 0A	bad parity SA at SD2
11 0B	bad parity FC at SD2
11 0C	bad parity RB at SD2
11 0D	bad parity DAT at SD2
11 0E	bad parity CHS at SD2
11 0F	bad parity ED at SD2
11 10	bad parity DA at SD1
11 11	bad parity SA at SD1
11 12	bad parity FC at SD1
11 13	bad parity CHS at SD1
11 14	bad parity ED at SD1
12 07	different value LE and LER - SD2
13 08	different value SD and SDR - SD2
14 0A	extended address SA - it cannot process - SD2
14 11	extended address SA - it cannot process - SD1
15 0B	error of the reception flag FCF in control byte FC - SD2
15 12	error of the reception flag FCF in control byte FC - SD1
18 0E	wrong check sum CHS - SD2
18 13	wrong check sum CHS - SD1
19 0F	wrong terminal character ED - SD2
19 14	wrong terminal character ED - SD1
20 FC	wrong check byte FC in combination with global address
2X RB	unknown communication function (X is a value of the check byte FC - 3, 4, 5, 6, 9, C, D, E, F)
30 AJ	the number of bytes on the unit was exceeded
31 AJ	there is no initialization table
32 AJ	unknown operation
33 AJ	odd number of bytes for analogue unit
34 AJ	wrong number of bytes of the initialization table
35 AJ	initialization zone overflow
36 AJ	the number of initialization table is bigger than the maximum value
37 AJ	wrong configuration of the initialization table
38 AJ	wrong data in the initialization table
40 AJ	the input unit did not report
41 AJ	the output unit did not report
43 AJ	start of non-existing unit
60 00	communication fall-out with the central unit
61 00	zone overflow for the input configuration
61 01	zone overflow for the output configuration
61 02	overflow of the expansion unit communication zone for data transfer
70 AJ	incorrectly addressed one-byte input unit
71 AJ	incorrectly addressed one-byte output unit
72 AJ	incorrectly addressed two-byte input unit
73 AJ	incorrectly addressed two-byte output unit
74 AJ	incorrectly addressed four-byte input unit
75 AJ	incorrectly addressed four-byte output unit
76 AJ	incorrectly addressed eight-byte input unit
77 AJ	incorrectly addressed eight-byte output unit
8Y AJ	wrong number of occupied bytes in input unit (Y states the detected number of occupied bytes)
9Y AJ	wrong number of occupied bytes in output unit (Y states the detected number of occupied bytes)