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AC500 System data and system construction

The product family Advant Controller 500 control system is designed according to EN 61131-2 IEC 61131-2 standards. Data, different from IEC 61131, are caused by the higher requirements of Maritime Services.

System data

Operating and ambient conditions

Voltages, according to EN 61131-2		
24 V DC	process and supply voltage	24 V DC (-15 %, +20 % without ripple)
	absolute limits	19.2 V...30 V inclusive ripple (see remarks above)
	ripple	< 5 %
	protection against reverse polarity	10 s
120 V AC	line voltage	120 V AC (-15 %, +10 %)
	frequency	47 Hz..62.4 Hz / 50...60 Hz (-6 %, +4 %)
230 V AC	line voltage	230 V AC (-15 %, +10 %)
	frequency	47 Hz..62.4 Hz / 50...60 Hz (-6 %, +4 %)
120-240 V AC	wide-range supply	
	line voltage	102 V...264 V / 120 V...240 V (-15 %, +10 %)
	frequency	47 Hz..62.4 Hz / 50...60 Hz (-6 %, +4 %)
Allowed interruptions of power supply, according to EN 61131-2		
	DC supply	interruption < 10 ms, time between 2 interruptions > 1 s, PS2
	AC supply	Interruption < 0.5 periods, time between 2 interruptions > 1 s



Important: Exceeding the maximum power supply voltage (>30 V DC) for process or supply voltages could lead to unrecoverable damage of the system. The system could be destroyed.

Temperature		
	operating	0 °C...+55 °C (horizontal mounting of modules) 0 °C...+40 °C (vertical mounting of modules and output load reduced to 50 % per group)
	storage	-25 °C...+75 °C
	transport	-25 °C...+75 °C
Temperature of the Lithium battery		
	operating	0 °C...+55 °C
	storage	-20 °C...+60 °C
	transport	-20 °C...+60 °C
Humidity		
		50...95 %, without condensation
Air pressure		
	operating	> 800 hPa / < 2000 m
	storage	> 660 hPa / < 3500 m

Creepage distances and clearances

The creepage distances and clearances meet the overvoltage category II, pollution degree 2.

Insulation test voltages, routine test, according to EN 61131-2

230 V circuits against other circuitry	2500 V	surge 1.2/50 μ s
120 V circuits against other circuitry	1500 V	surge 1.2/50 μ s
120 V to 240 V circuits against other circuitry	2500 V	surge 1.2/50 μ s
24 V circuits (supply, 24 V inputs/outputs), if they are electrically isolated against other circuitry	500 V	surge 1.2/50 μ s
COM interfaces, electrically isolated	500 V	surge 1.2/50 μ s
FBP interface	500 V	surge 1.2/50 μ s
Ethernet	500 V	surge 1.2/50 μ s
ARCNET	500 V	surge 1.2/50 μ s
230 V circuits against other circuitry	1350 V	AC 2 s
120 V circuits against other circuitry	820 V	AC 2 s
120 V to 240 V circuits against other circuitry	1350 V	AC 2 s
24 V circuits (supply, 24 V inputs/outputs), if they are electrically isolated against other circuitry	350 V	AC 2 s
COM interfaces, electrically isolated	350 V	AC 2 s
FBP interface	350 V	AC 2 s
Ethernet	350 V	AC 2 s
ARCNET	350 V	AC 2 s

Power supply units

For the supply of the modules, power supply units according to PELV specifications must be used.

Electromagnetic compatibility

Immunity	
against electrostatic discharge (ESD)	according to EN 61000-4-2, zone B, criterion B
- electrostatic voltage in case of air discharge	8 kV
- electrostatic voltage in case of contact discharge	4 kV, in a closed switch-gear cabinet 6 kV ¹⁾
ESD with communication connectors	In order to prevent operating malfunctions, it is recommended, that the operating personnel discharge themselves prior to touching communication connectors or perform other suitable measures to reduce effects of electrostatic discharges.
ESD with connectors of Terminal Bases	The connectors between the Terminal Bases and CPUs or couplers must not be touched during operation. The same is valid for the I/O-Bus with all modules involved.
Immunity	
against the influence of radiated (CW radiated)	according to EN 61000-4-3, zone B, criterion A
- test field strength	10 V/m
Immunity	
against transient interference voltages (burst)	according to EN 61000-4-4, zone B, criterion B
- supply voltage units (AC, DC)	2 kV
- digital inputs/outputs (24 V DC)	1 kV
- digital inputs/outputs (120/230 V AC)	2 kV
- analog inputs/outputs	1 kV
- CS31 system bus	2 kV
- serial RS-485 interfaces (COM)	2 kV
- serial RS-232 interfaces (COM)	1 kV
- ARCNET	1 kV
- FBP	1 kV
- Ethernet	1 kV
- I/O supply, DC-out	1 kV
Immunity	
against the influence of line-conducted interferences (CW conducted)	according to EN 61000-4-6, zone B, criterion A
- test voltage	3V zone B, 10 V is also met.
High energy surges	
according to EN 61000-4-5, zone B, criterion B	
- power supply AC	2 kV CM* / 1 kV DM*
- power supply DC	1 kV CM* / 0.5 kV DM*
- AC I/O supply, add. AC-supply-out	2 kV CM* / 1 kV DM*
- DC I/O supply, add. DC-supply-out	0.5 kV CM* / 0.5 kV DM*
- Buses, shielded	1 kV CM*
- AC-I/O unshielded	2 kV CM* / 1 kV DM*
- I/O analog, I/O DC unshielded	1 kV CM* / 0.5 kV DM*
	* CM = Common Mode, * DM = Differential Mode
Radiation (radio disturbance)	according to EN 55011, group 1, class A

¹⁾ High requirement for shipping classes are achieved with additional specific measures (see specific documentation).

Mechanical data

Wiring method / terminals	
Mounting	horizontal
Degree of protection	IP 20
Housing	according to UL 94
Vibration resistance acc. to EN 61131-2	all three axes 2 Hz...15 Hz, continuous 3.5 mm 15 Hz...150 Hz, continuous 1 g (4 g in preparation)
Vibration resistance with SD Memory Card inserted	15 Hz...150 Hz, continuous 1 g
Shock test	all three axes 15 g, 11 ms, half-sinusoidal
Shipping specific requirements	
Mounting of the modules	
- DIN rail according to DIN EN 50022	35 mm, depth 7.5 mm or 15 mm
- mounting with screws	screws with a diameter of 4 mm
fastening torque	1.2 Nm

Mounting and disassembling the Terminal Bases, the CPUs and the couplers

Assembly on DIN rail

Step 1: Mount DIN rail 7.5 mm or 15 mm

Step 2: Mount Terminal Base (TB521, TB521, TB541)

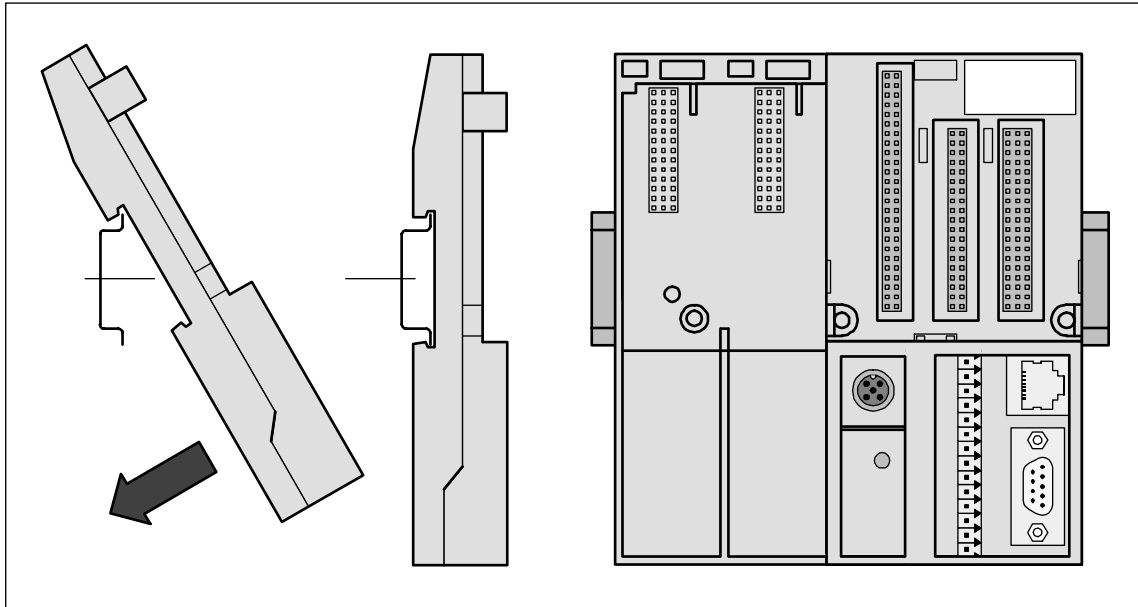


Figure: **Assembly** of the Terminal Base (TB511, TB521 or TB541)

The Terminal Base is put on the DIN rail above and then snapped-in below. The disassembly is carried out in a reversed order.

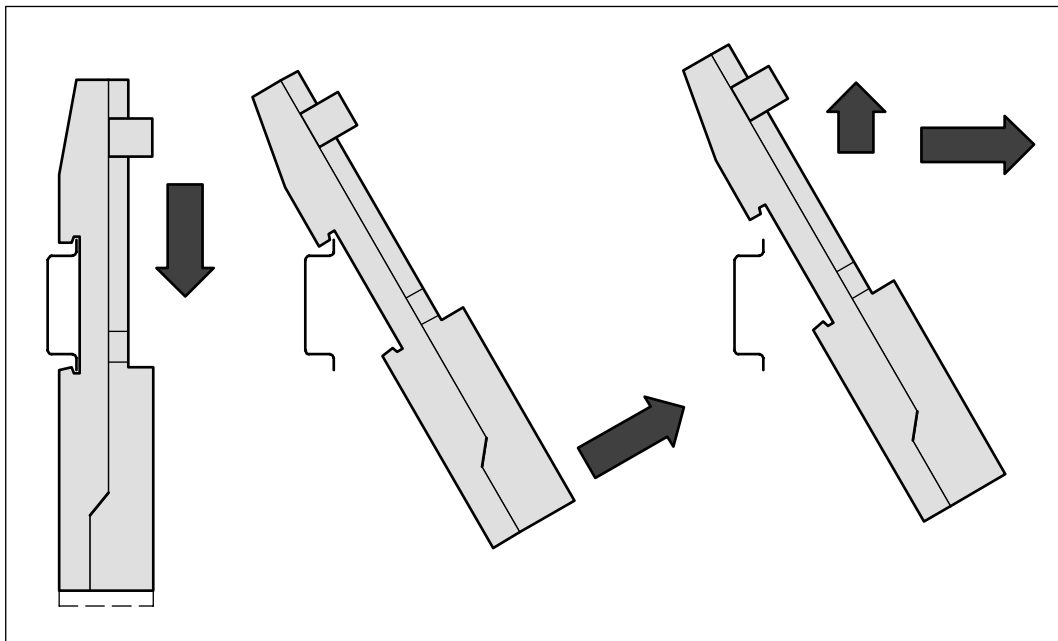


Figure: **Disassembly** of the Terminal Base (TB511, TB521 or TB541)

Step 3: Mount I/O Terminal Unit (TU515, TU516, TU531 or TU532)

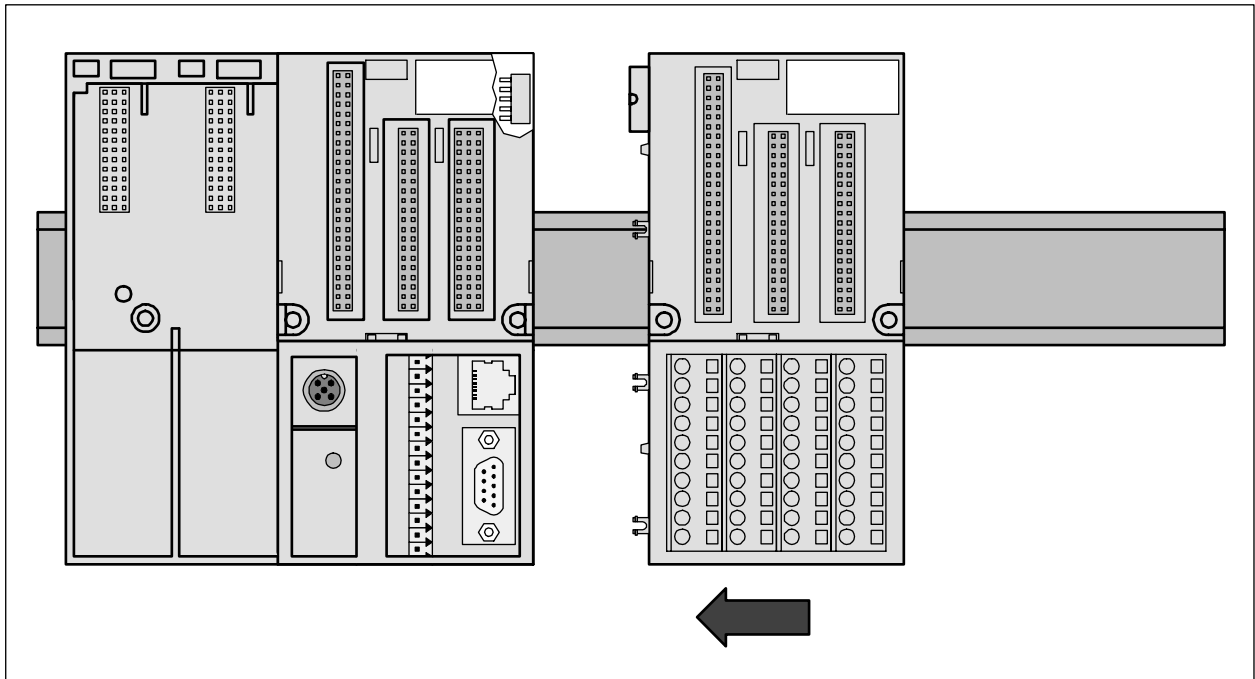


Figure: **Assembly** of the I/O Terminal Unit (TU515, TU516, TU531 oder TU532)

The I/O Terminal Unit is snapped into the DIN rail in the same way as the Terminal Base. Once secured to the DIN rail, slide the I/O unit to the left until it fully locks into place creating a solid mechanical and electrical connection.

Altogether 7 I/O Terminal Units can be combined with the Terminal Base.

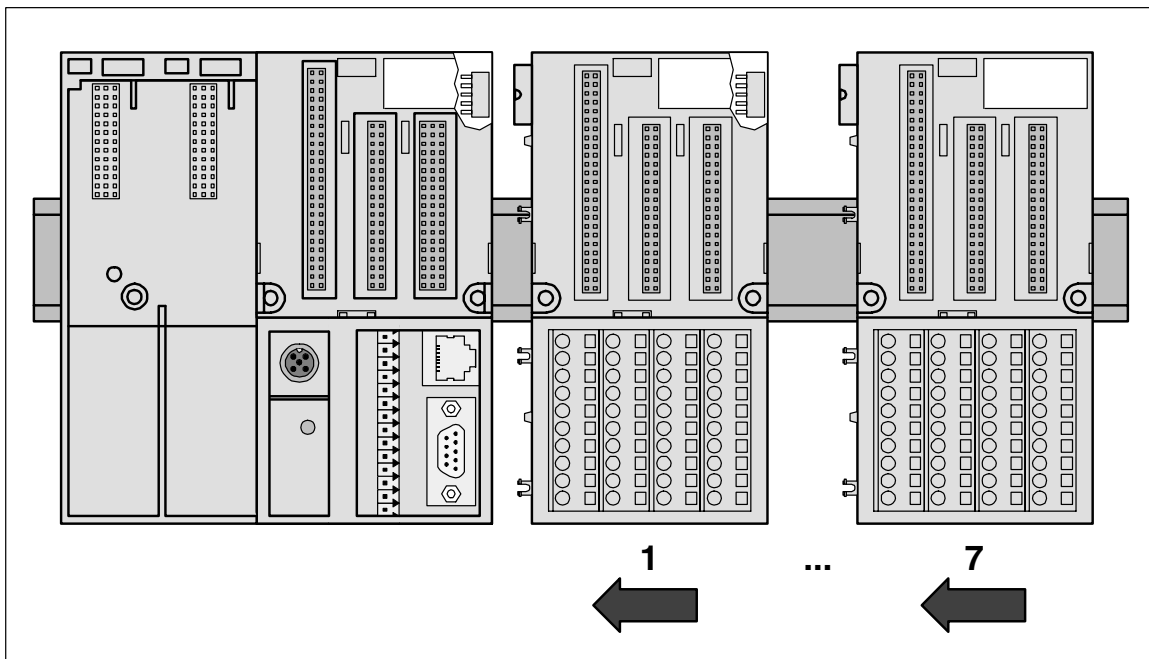


Figure: Maximum configuration (1 Terminal Base plus 7 I/O Terminal Units)

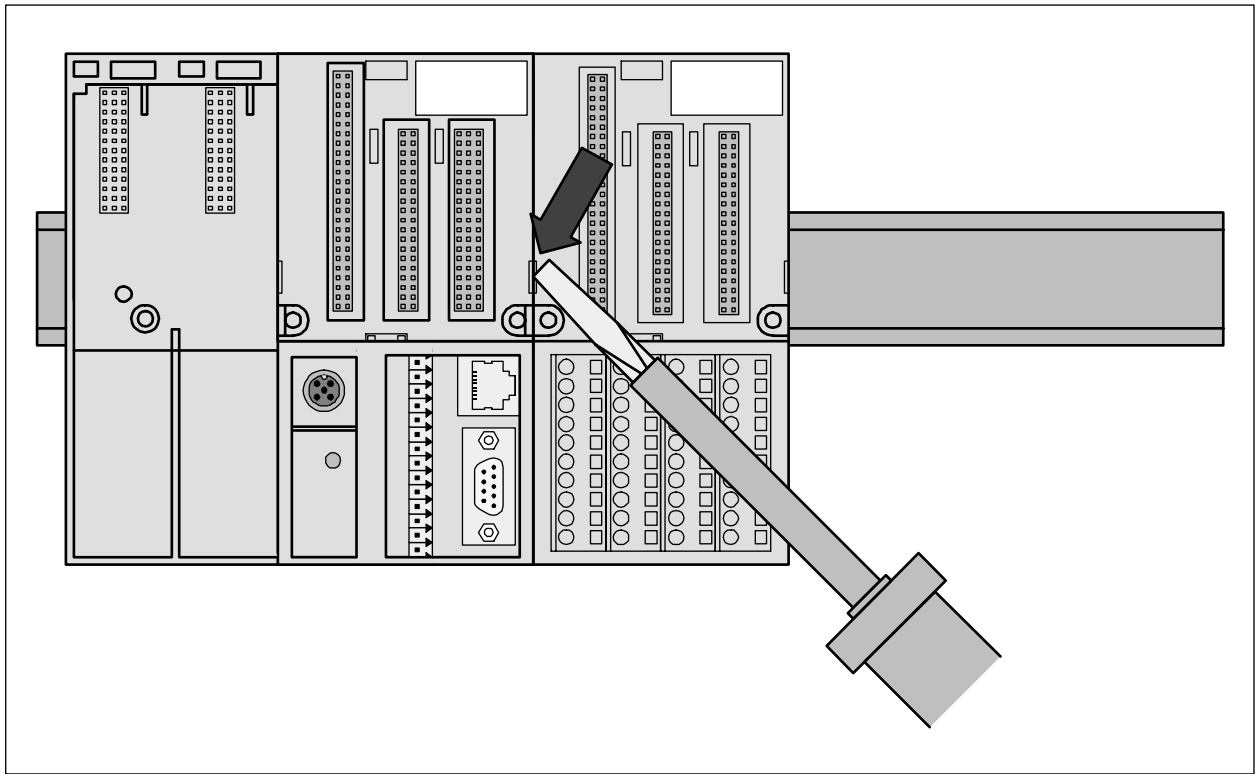


Figure: **Disassembly** of the I/O Terminal Unit (TU515, TU516, TU531 or TU532)

A screwdriver is inserted in the indicated place to separate the Terminal Units.

Step 4: Mount the CPU

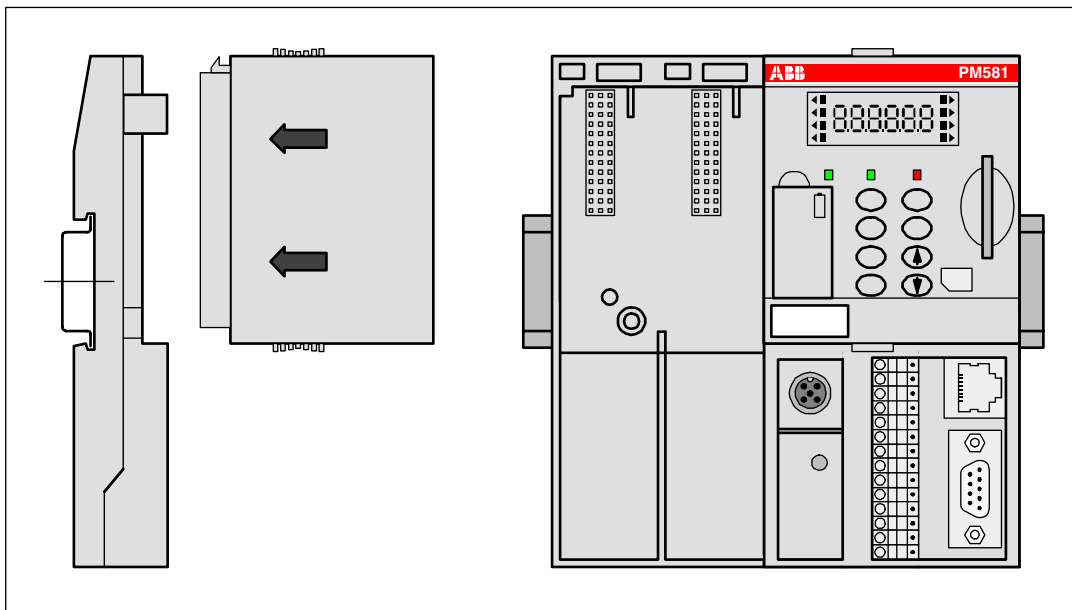


Figure: **Assembly** of the CPU

Press the CPU into the Terminal Base until it locks in place.

The disassembly is carried out in a reversed order.

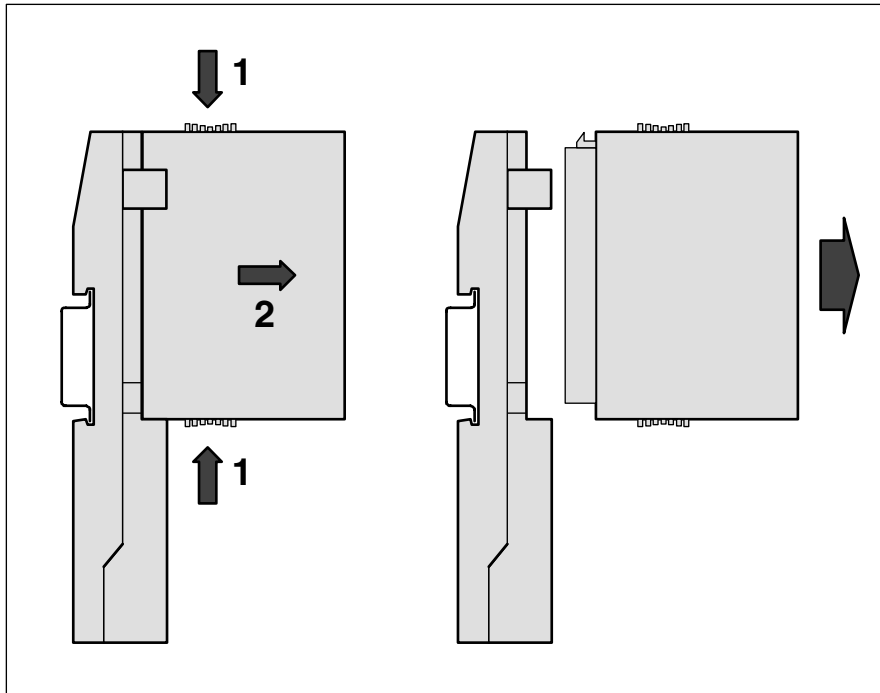


Figure: **Disassembly** of the CPU

Disassembly: Press above and below, then remove the CPU.

Step 5: Mount the coupler (communication module)

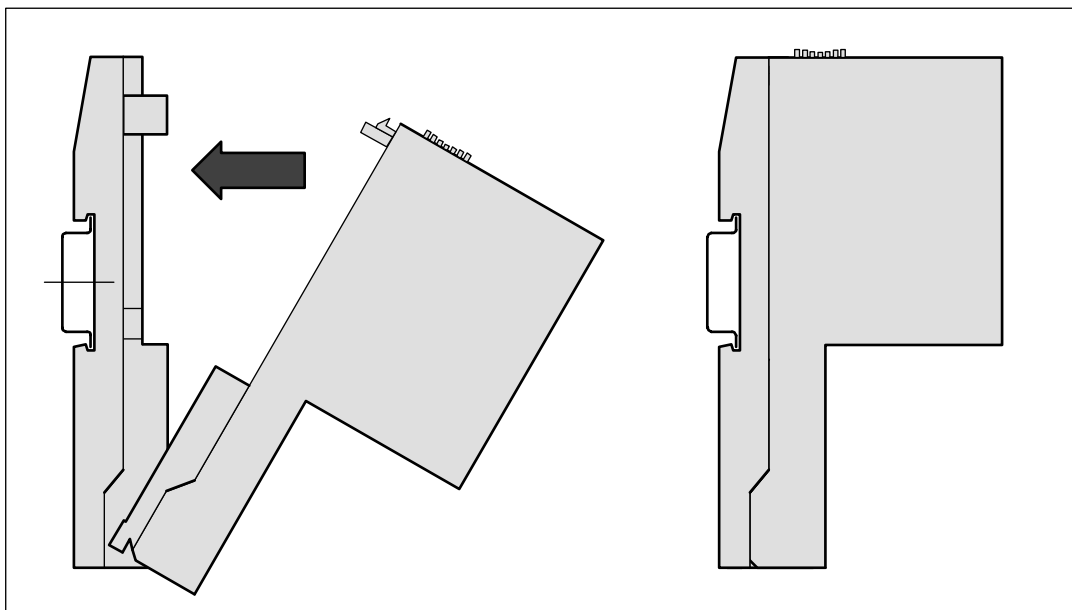


Figure: **Assembly** of a coupler

The coupler is first inserted below, then clicked-in above.

The disassembly is carried out in a reversed order.

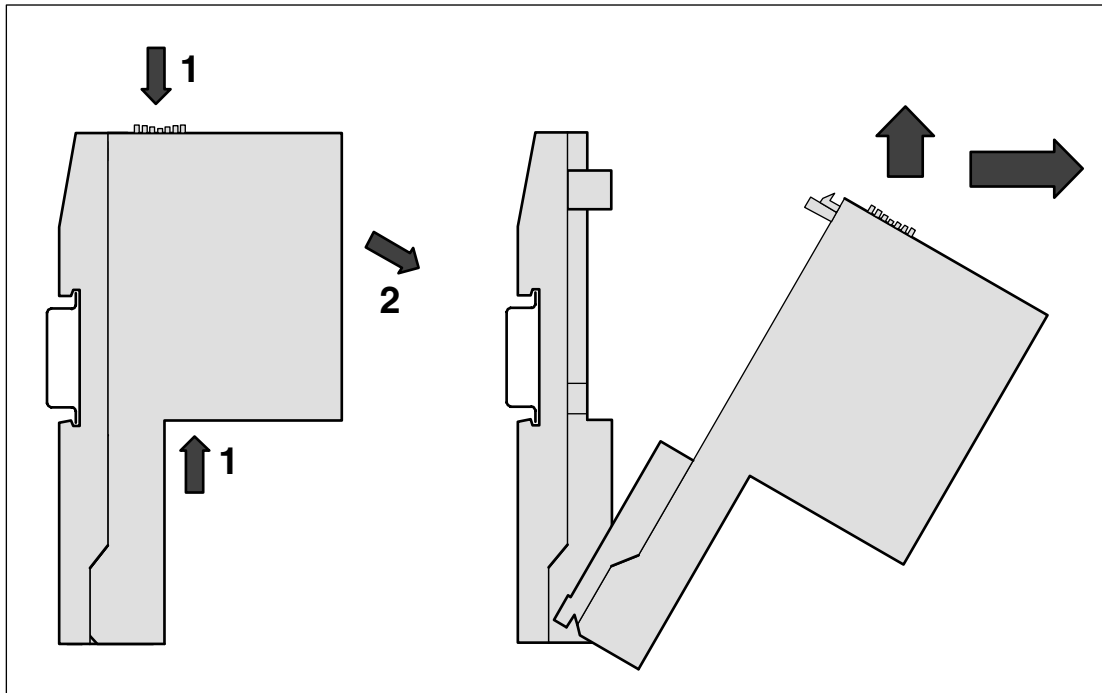
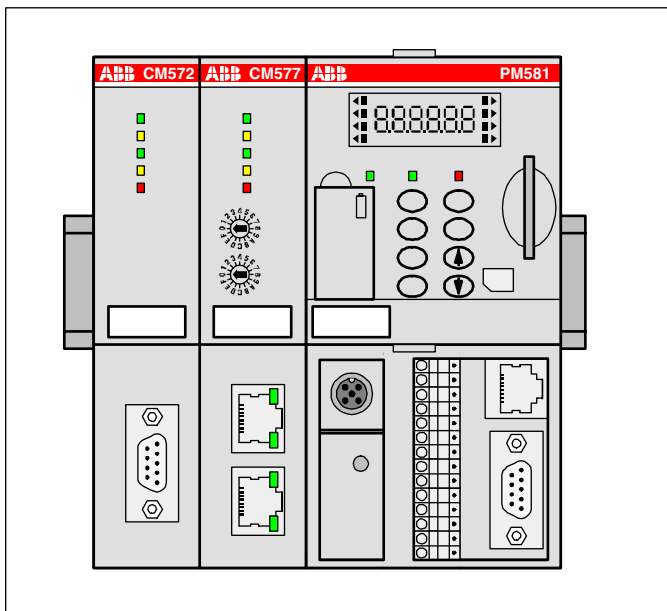


Figure: **Disassembly** of a coupler

Disassembly: Press above (and below), then swing out the coupler and remove it.

The following figure shows a Terminal Base with a CPU and two couplers inserted.



Assembly with screws

If the Terminal Base should be mounted with screws, Wall Mounting Accessories TA526 must be inserted at the rear side first. These plastic parts prevent bending of the Terminal Base while screwing on. TB511 needs one TA526, TB521 and TB541 need two TA526.

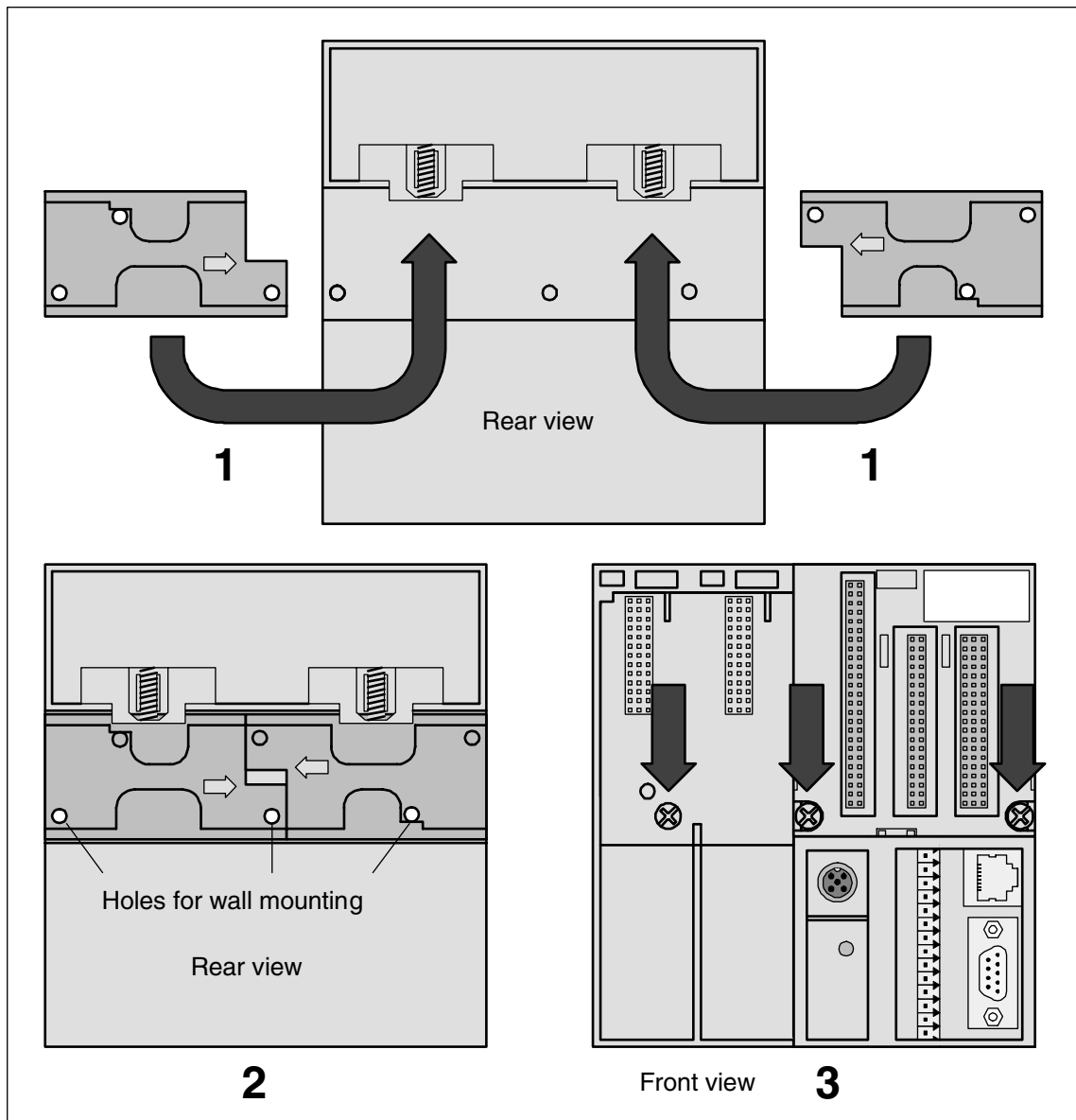


Figure: Fastening with screws of the Terminal Base TB521-ETH (as an example)

1 The two Wall Mounting Accessories TA526 are snapped on the rear side of the Terminal Unit like DIN rails. The arrows point to the middle of the Terminal Base. One TA526 is turned by 180°.

2 Two accessories for wall mounting inserted

3 Terminal Base, fastened with screws

By wall mounting, the Terminal Base is earthed through the screws. It is necessary that

- the screws have a conductive surface (e.g. steel zinc-plated or brass nickel-plated)
- the **mounting plate is earthed**
- the screws have a good electrical contact to the mounting plate

Mounting and disassembling the Terminal Units and the I/O modules

Assembly on DIN rail

Step 1: Mount DIN rail 7.5 mm or 15 mm

Step 2: Mount FBP Terminal Unit (TU505 or TU506)

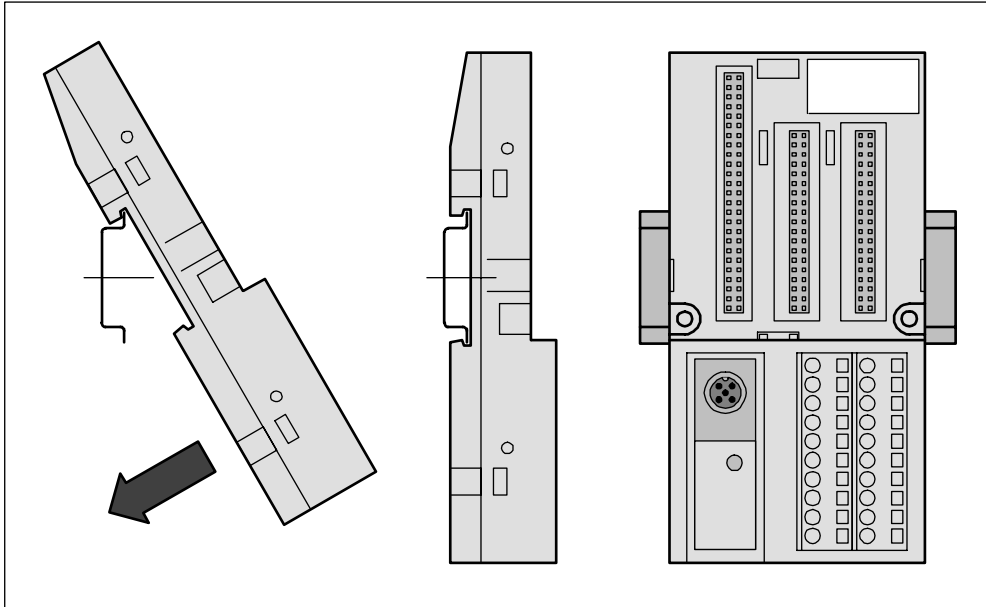


Figure: **Assembly** of the FBP Terminal Unit (TU505 or TU506)

The FBP Terminal Unit is put on the DIN rail above and then snapped-in below. The disassembly is carried out in a reversed order.

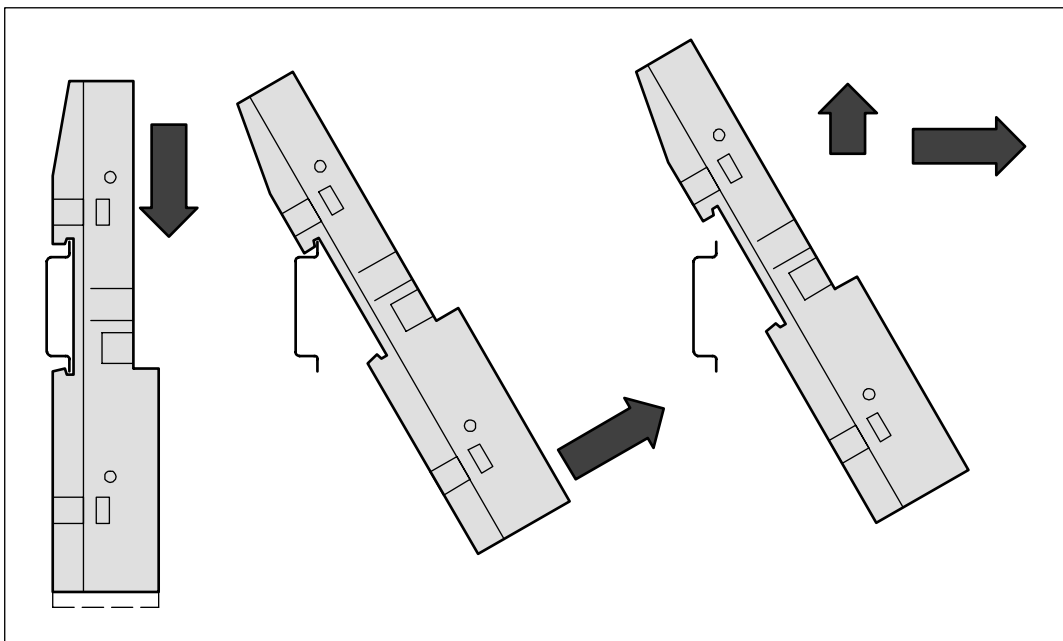


Figure: **Disassembly** of the FBP Terminal Unit (TU505 or TU506)

Step 3: Mount I/O Terminal Unit (TU515, TU516, TU531 or TU532)

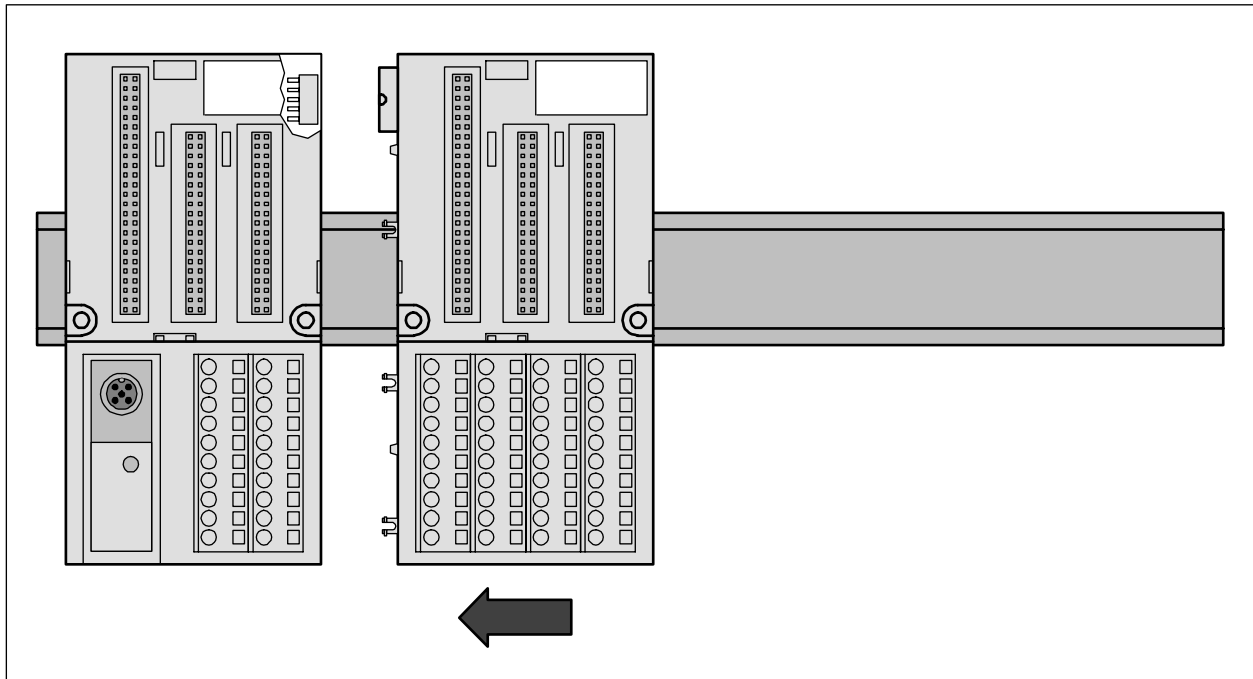


Figure: **Assembly** of the I/O Terminal Unit (TU515, TU516, TU531 or TU532)

The I/O Terminal Unit is installed on the DIN rail in the same way as the FBP Terminal Unit. Once secured on the DIN rail, slide the I/O unit to the left until it fully locks into place creating a solid mechanical and electrical connection.

Altogether 7 I/O Terminal Units can be combined with the FBP Terminal Unit.

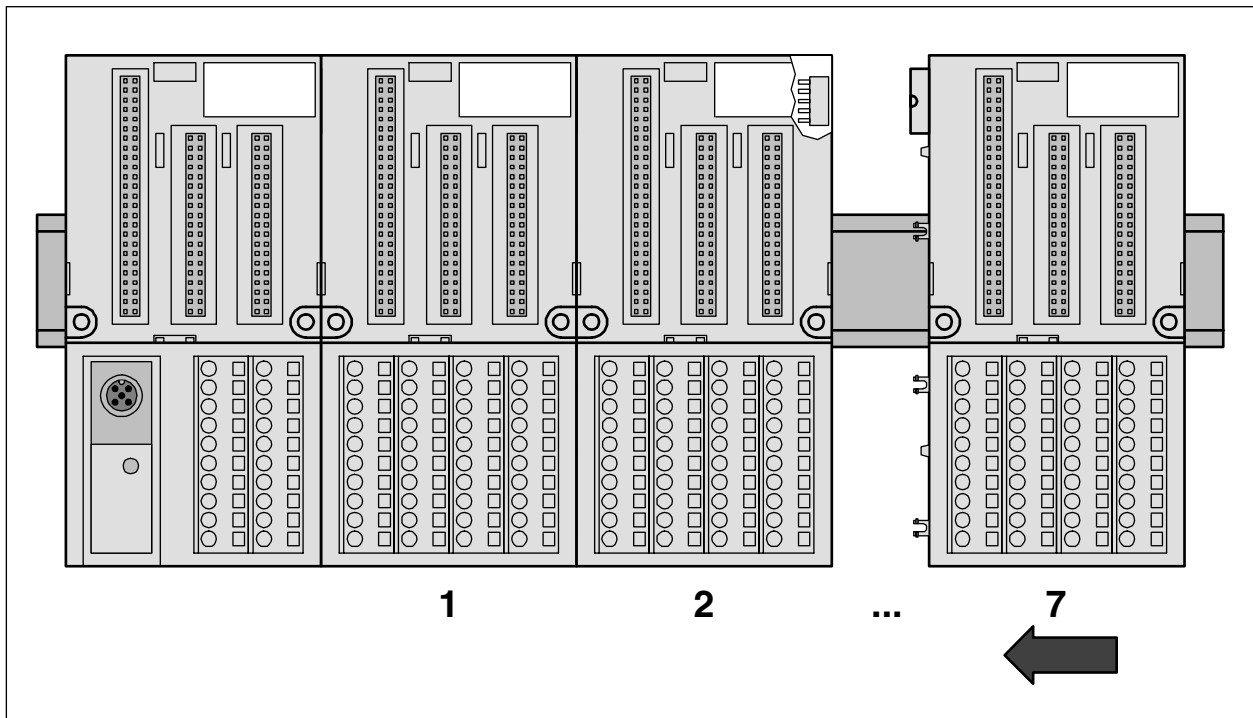


Figure: Maximum configuration (1 FBP Terminal Unit plus 7 I/O Terminal Units)

! **Important:** Up to 7 I/O modules can be used, of which up to 4 analog I/O modules are possible.

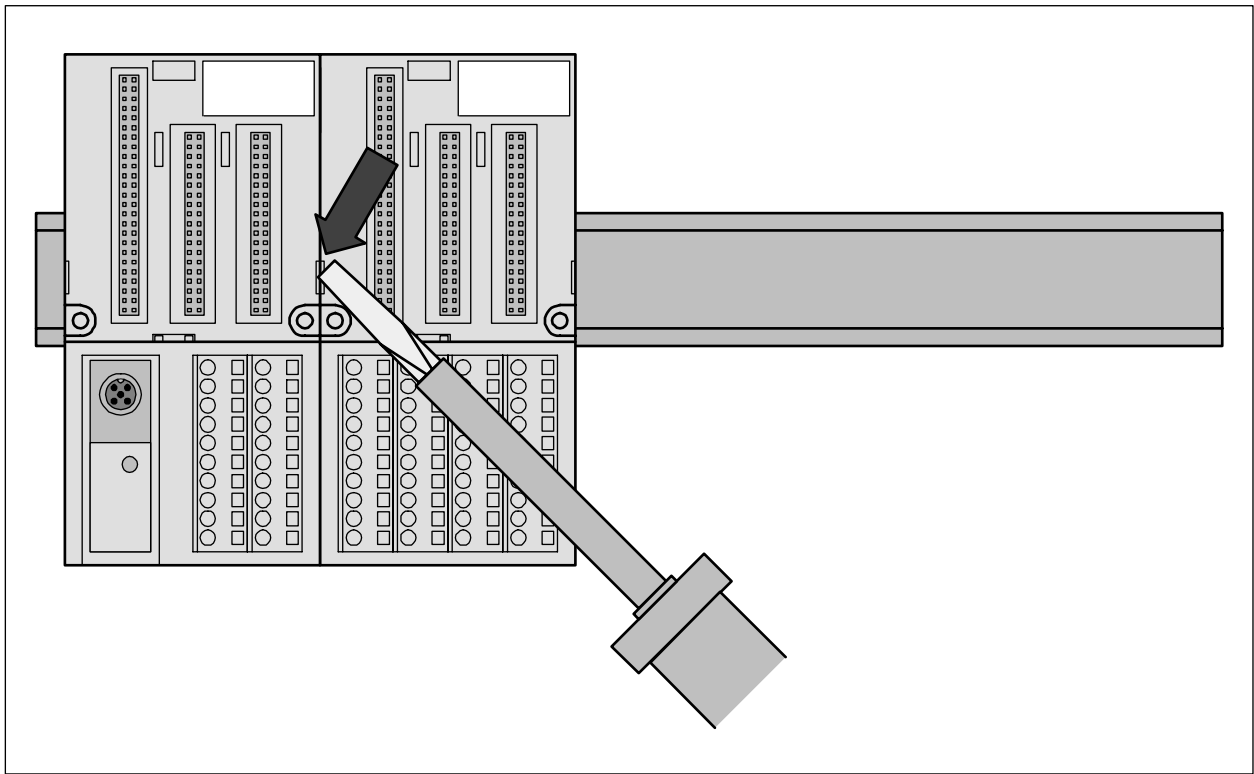


Figure: **Disassembly** of the I/O Terminal Unit (TU515, TU516, TU531 or TU532)

A screwdriver is inserted in the indicated place to separate the Terminal Units.

Step 4: Mount the modules

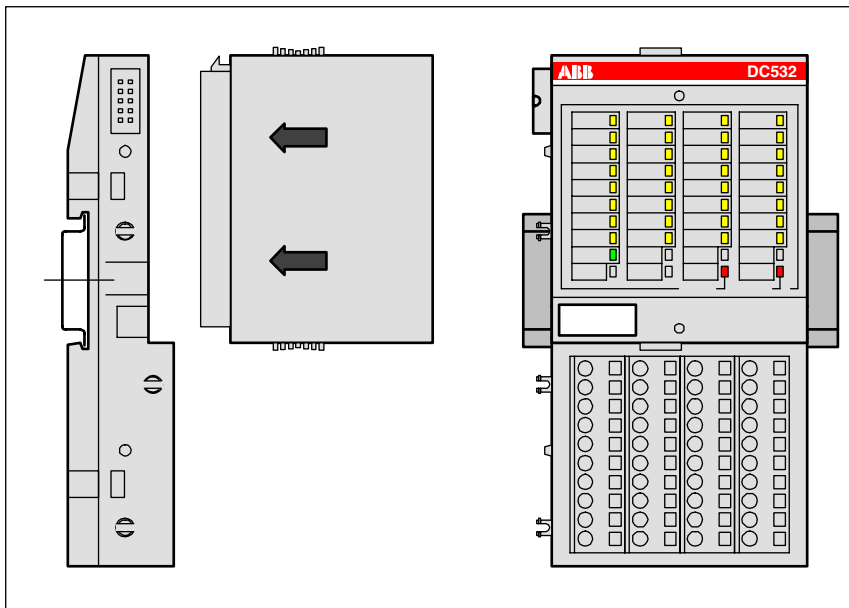


Figure: **Assembly** of the modules

Press the electronic module into the Terminal Unit until it locks in place.

The disassembly is carried out in a reversed order.

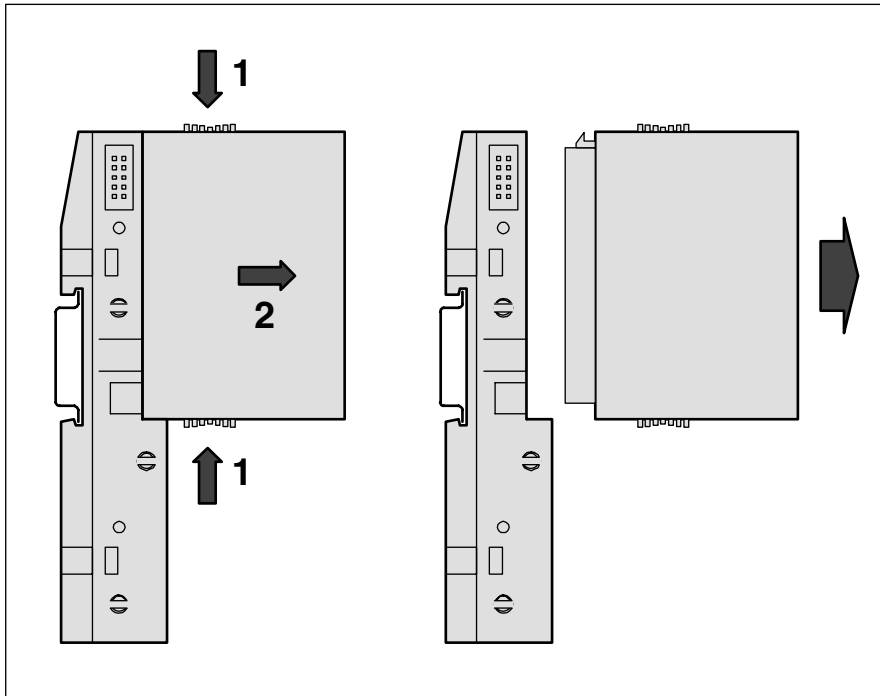


Figure: **Disassembly** of the modules

Disassembly: Press above and below, then remove the module.

Assembly with screws

If the Terminal Unit should be mounted with screws, a Wall Mounting Accessory TA526 must be inserted at the rear side first. This plastic part prevents bending of the Terminal Unit while screwing on.

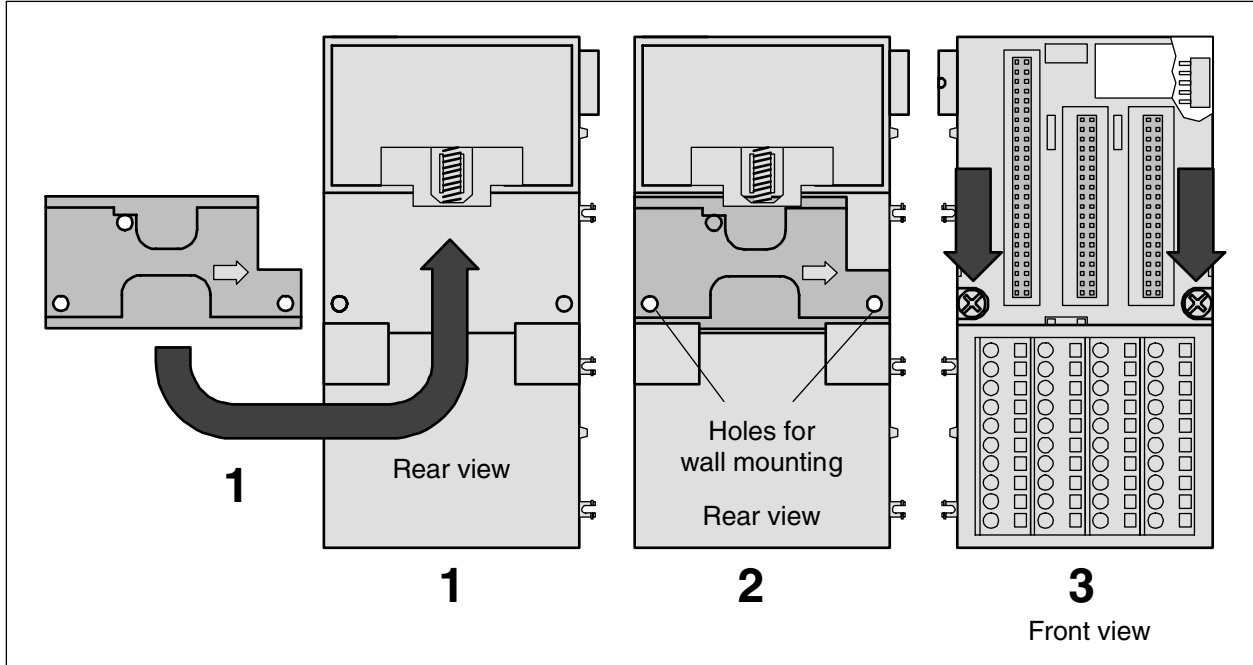


Figure: Fastening with screws of the Terminal Unit TU516 (as an example)

- 1 The Wall Mounting Accessory TA526 is snapped on the rear side of the Terminal Unit like a DIN rail. The arrow points to the right side.
- 2 Accessory for wall mounting inserted
- 3 Terminal Unit, fastened with screws

By wall mounting, the Terminal Unit is earthed through the screws. It is necessary that

- the screws have a conductive surface (e.g. steel zinc-plated or brass nickel-plated)
- the **mounting plate is earthed**
- the screws have a good electrical contact to the mounting plate

Mechanical dimensions AC500

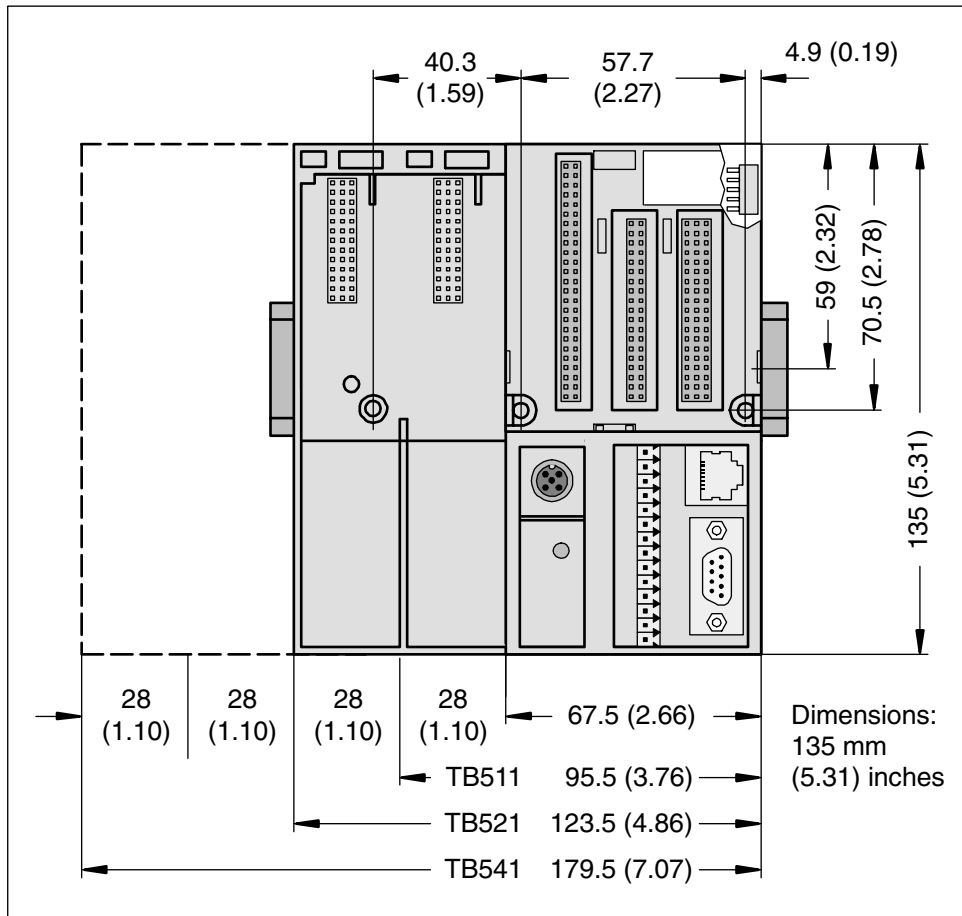


Figure: Dimensions of the AC500 CPU Terminal Bases TB511, TB521 and TB541

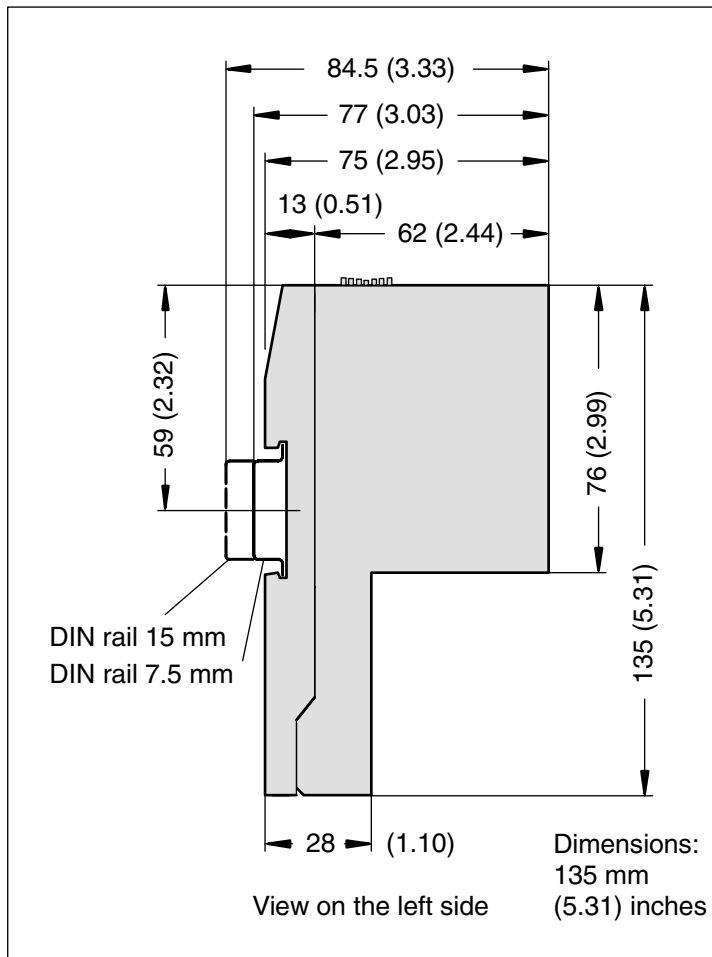


Figure: Terminal Base with coupler, view from the left side

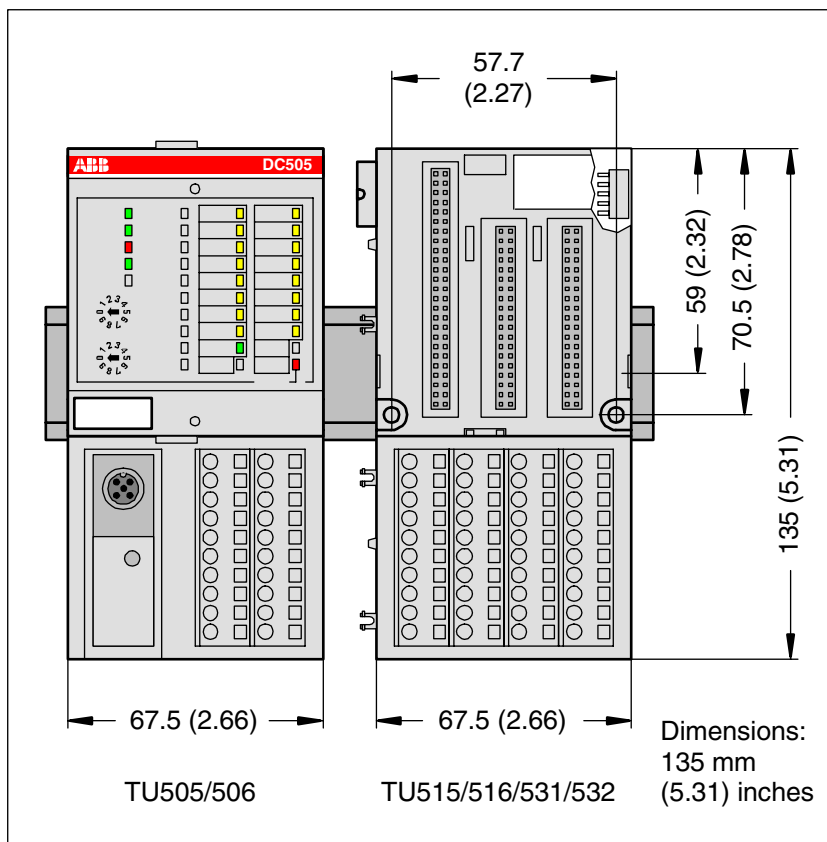


Figure: Dimensions of the S500 Terminal Units (front view)

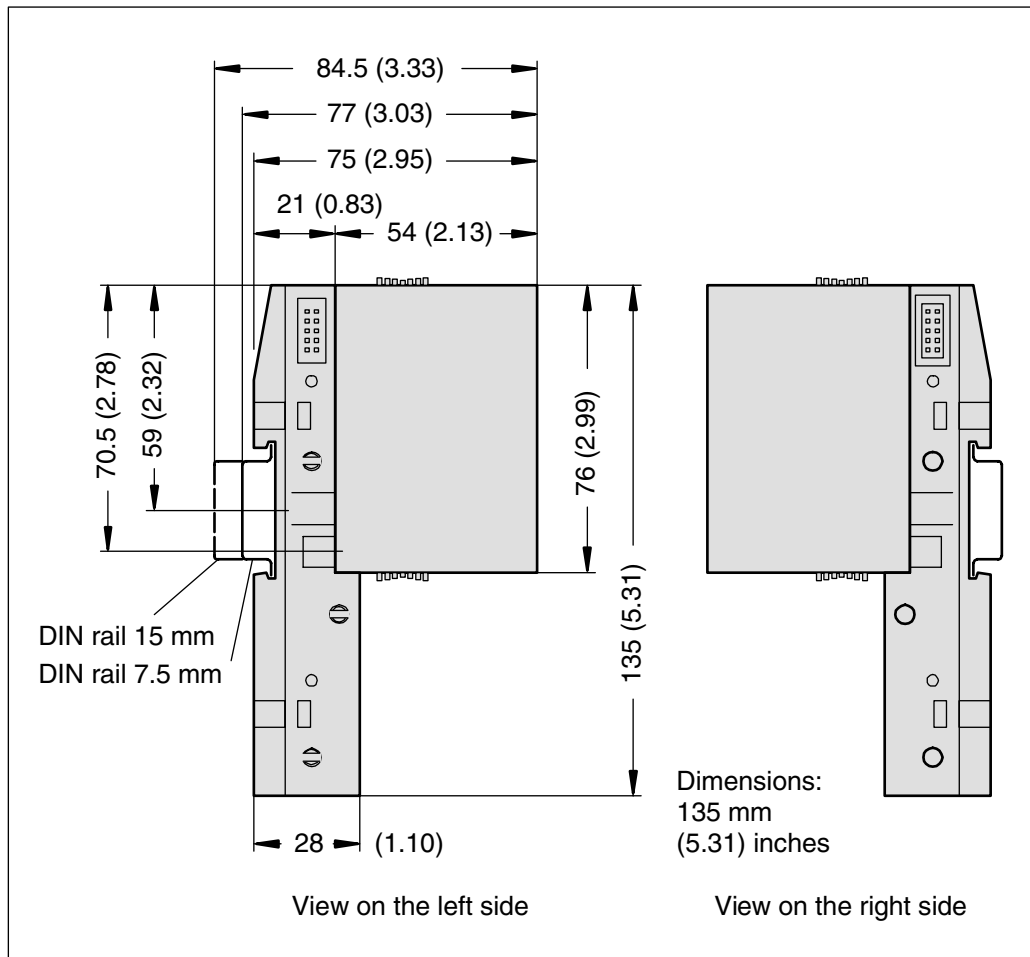


Figure: Dimensions of the S500 Terminal Units (view from the left and the right side)

Switch-gear cabinet assembly

Basically, it is recommended to mount the modules on an earthed mounting plate, independent of the mounting location.

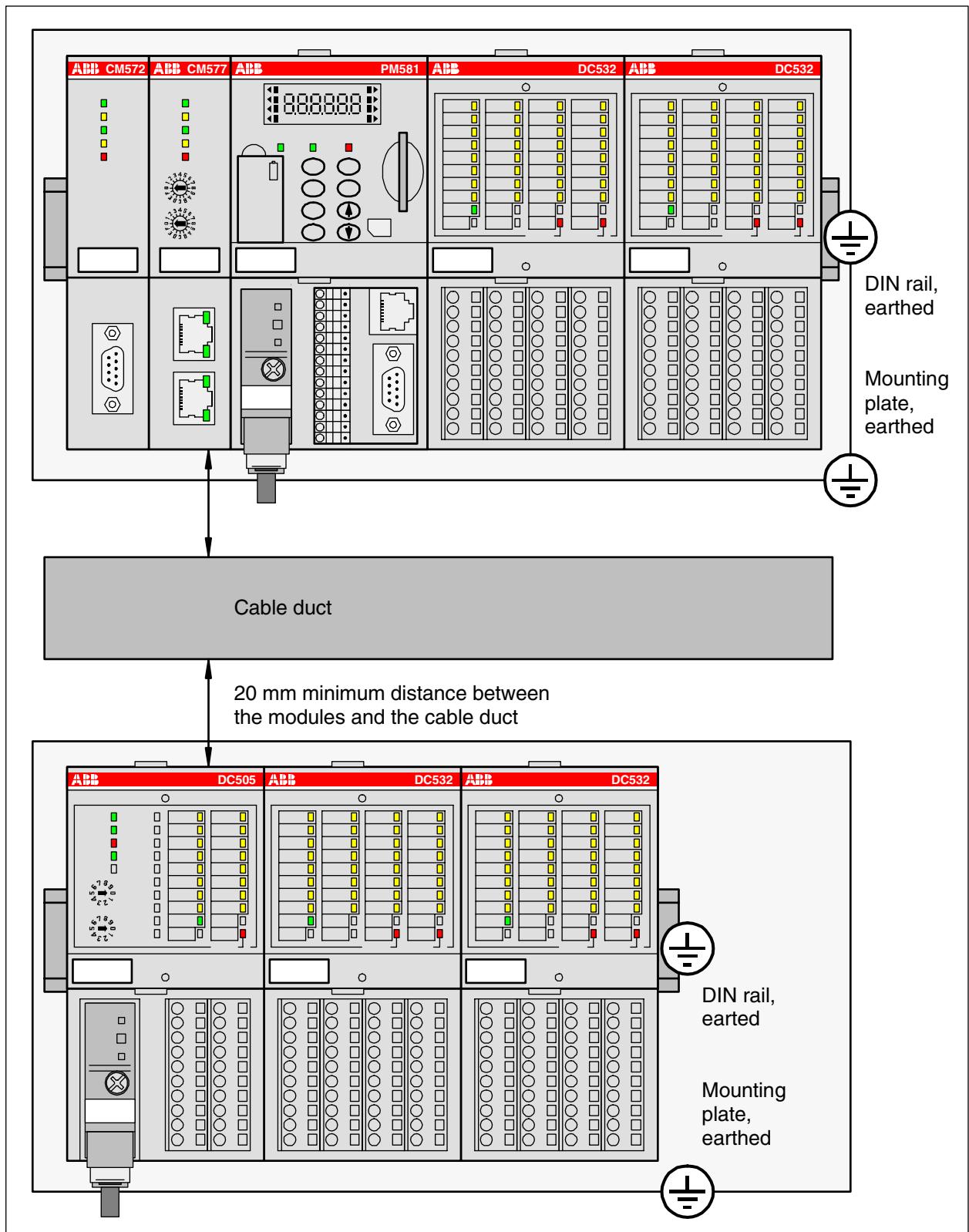


Figure: Installation of AC500/S500 modules in a switch-gear cabinet

⚠ Important: Horizontal mounting is highly recommended. Vertical mounting is possible, however, derating consideration should be made to avoid problems with poor air circulation and the potential for excessive temperatures (see also the AC500 system data, operating and ambient conditions, for reduction of ambient temperature).

👉 Note: By vertical mounting, always place an end-stop terminal block at the bottom and on the top of the module to properly secure the modules.

By high-vibration applications, we also recommend to place end-stop terminals at the right and the left side of the device to properly secure the modules:

e.g. type BADL, P/N: 1SNA 399 903 R0200

Insertion / replacement of the Lithium battery

AC500 CPUs are supplied without a Lithium battery. It therefore must be ordered separately. The TA521 Lithium Battery is used to save RAM contents of AC500 CPUs and back-up the real-time clock. Although the CPUs can work without a battery, its use is still recommended in order to avoid process data being lost.

The CPU monitors the battery status. A low battery error is output before the battery condition becomes critical (about 2 weeks before). After the error message appears, the battery should be replaced as soon as possible.

⚠ Attention: The TA521 Lithium Battery is the only one, which can be used with AC500 CPUs.

The following procedures describe the insertion / replacement of the Lithium battery.

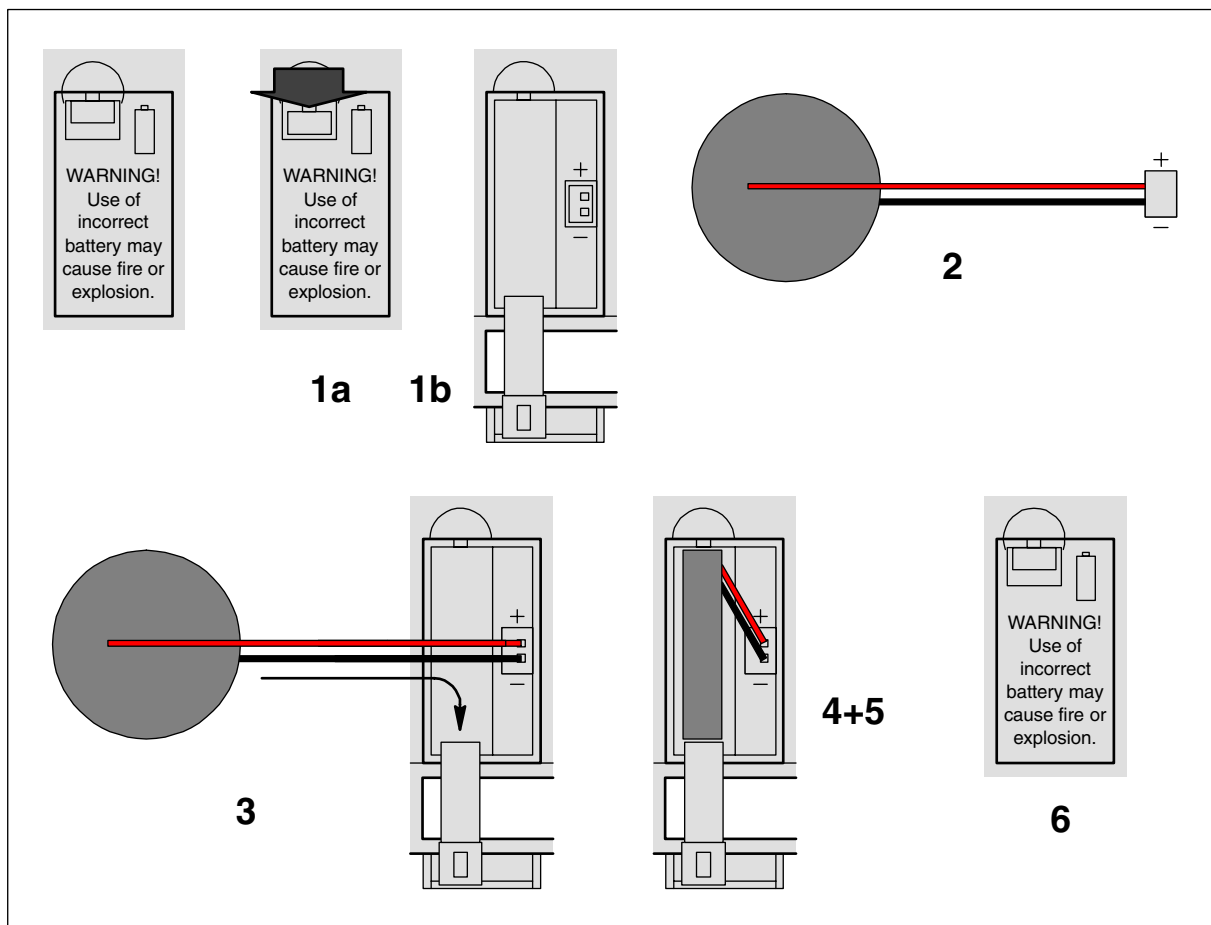


Figure: Insertion / replacement of the Lithium battery

Insertion of the battery:

1. Open the battery compartment by inserting a fingernail in the small locking mechanism, press it down and slip down the door. The door is attached to the front face of the CPU and cannot be removed.
2. Remove the TA521 battery from its package and hold it by the small cable.
3. Insert the battery connector into the small connector port of the compartment. The connector is keyed to find the correct polarity (red = plus-pole = above).
4. Insert first the cable and then the battery into the compartment, push it until it reaches the bottom of the compartment.
5. Arrange the cable in order not to inhibit the door to close.
6. Pull-up the door and press until the locking mechanism snaps.



Note: In order to prevent data losses or problems, the battery should be replaced after 3 years of utilisation or **at least** as soon as possible after receiving the "Low battery warning" indication. Do not use a battery older than 3 years for replacement, do not keep batteries too long in stock.

Replacement of the battery:



Attention: In order to avoid any data losses (if needed), the battery replacement should be done with the system under power. Without battery and power supply there is no data buffering possible.

1. Open the battery compartment by inserting a fingernail in the small locking mechanism, press it down and slip down the door. The door is attached to the front face of the CPU and cannot be removed.
2. Remove the old TA521 battery from the battery compartment by pulling it by the small cable. Remove then the small connector from the socket, do this best by lifting it out with a screwdriver (see photo).



3. Follow the previous instructions to insert a new battery.



Attention: Lithium batteries must not be re-charged, not be disassembled and not be disposed of in fire. They must be stored in a dry place. Exhausted batteries must be recycled to respect the environment.

The technical data sheet for the Lithium battery can be found in the chapter "Accessories / Lithium Battery TA521".

Insertion of the SD Memory Card

AC500 CPUs are supplied without an SD Memory Card. It therefore must be ordered separately. The SD Memory Card is used to back-up user data and store user programs as well as to update the internal CPU firmware. AC500 CPUs can be operated with and without SD Memory Cards.

The CPU uses a standard file system. This allows standard card readers to read the MC502 SD Memory Cards.

⚠ Attention: The use of memory cards other than the MC502 SD Memory Card is prohibited. ABB is not responsible nor liable for consequences resulting from the use of unapproved memory cards.

⚠ Attention: In operation, the plugged-in SD Memory Card withstands vibrations up to 1 g. Without using an SD Memory Card, the CPU itself withstands vibrations up to 4 g.

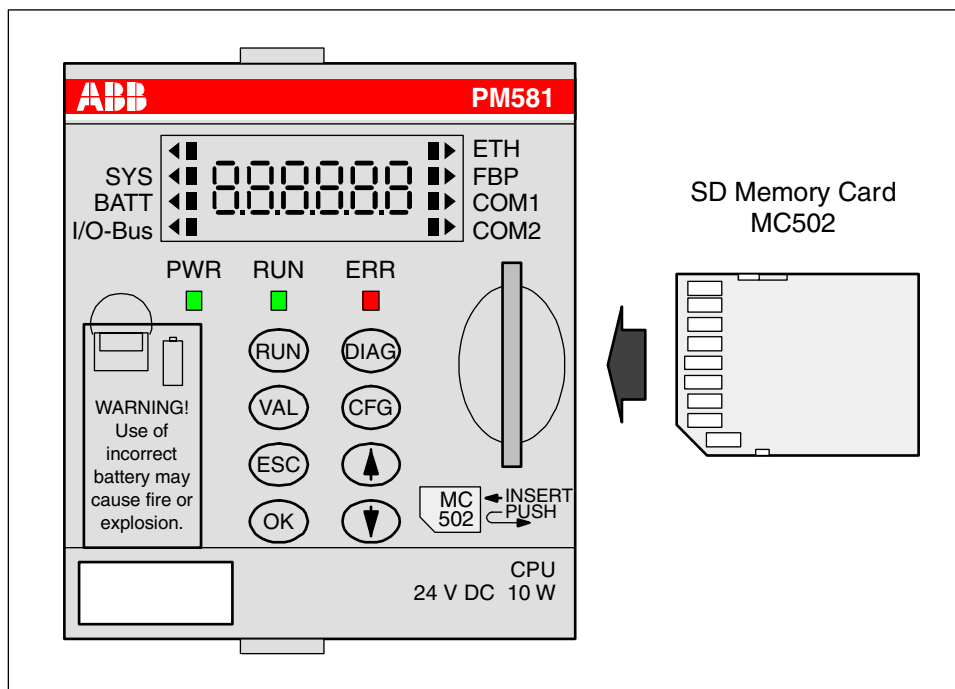


Figure: Insertion of the SD Memory Card

To insert the SD Memory Card, follow the procedure shown below.

1. Remove the SD Memory Card from its package.
2. Insert the memory card into the opening of the front face of the CPU with the memory aligned as shown above (contacts are visible on the left side, bevelled edge below).
3. Push on the card until it moves forward, then release your pressure, the SD card comes slightly backward and it locks into the card slot.

Removing the SD Memory Card

To remove the card, first push on the card until it moves forward (that unlocks the card), then release your pressure, the card will go forward out of the slot and can be easily removed.

The technical data sheet for the SD Memory Card can be found in the chapter "Accessories / SD Memory Card MC502".

Connection system

Terminals for power supply and the COM1 interface (CPU Terminal Base AC500)

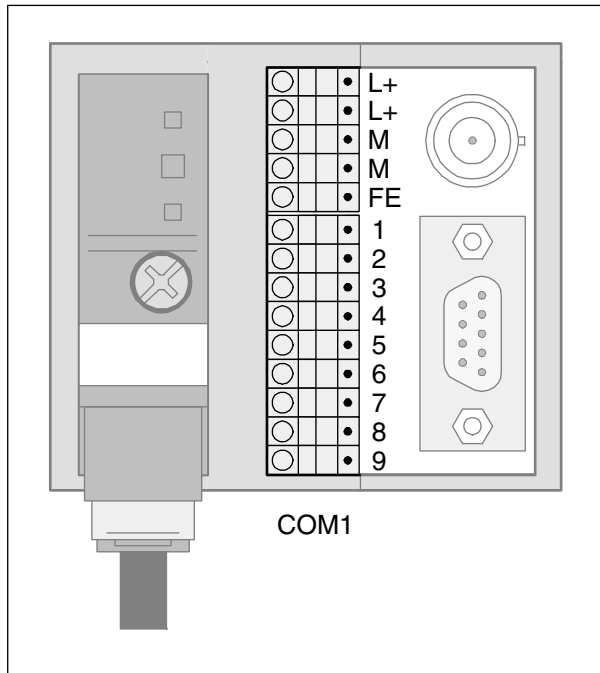


Figure: Terminals for power supply and the COM1 interface (CPU Terminal Base AC500)

Terminal type: **Screw-type terminal**

Number of cores per terminal	Conductor type	Cross section
1	solid	0.08 mm ² to 1.5 mm ²
1	flexible	0.08 mm ² to 1.5 mm ²
1 with wire end ferrule (without plastic sleeve)	flexible	0.25 mm ² to 1.5 mm ²
1 with wire end ferrule (with plastic sleeve)	flexible	0.25 mm ² to 0.5 mm ²
1 (TWIN wire end ferrule)	flexible	0.5 mm ²
2 (with the same cross section)	solid	0.08 mm ² to 0.5 mm ²
2 (with the same cross section)	flexible	0.08 mm ² to 0.75 mm ²
2 (with the same cross section) in wire end ferrule, without plastic sleeve	flexible	0.25 mm ² to 0.34 mm ²

Terminal type: **Spring terminal**

Number of cores per terminal	Conductor type	Cross section
1	solid	0.08 mm ² to 1.5 mm ²
1	flexible	0.08 mm ² to 1.5 mm ²
1 with wire end ferrule (without plastic sleeve)	flexible	0.25 mm ² to 1.5 mm ²
1 with wire end ferrule (with plastic sleeve)	flexible	0.25 mm ² to 0.5 mm ²
1 (TWIN wire end ferrule)	flexible	0.5 mm ²
2 (with the same cross section)	solid	0.08 mm ² to 0.5 mm ²
2 (with the same cross section)	flexible	0.08 mm ² to 0.75 mm ²
2 (with the same cross section) in wire end ferrule, without plastic sleeve	flexible	0.25 mm ² to 0.34 mm ²

Terminals at the Terminal Units (I/O, FBP)

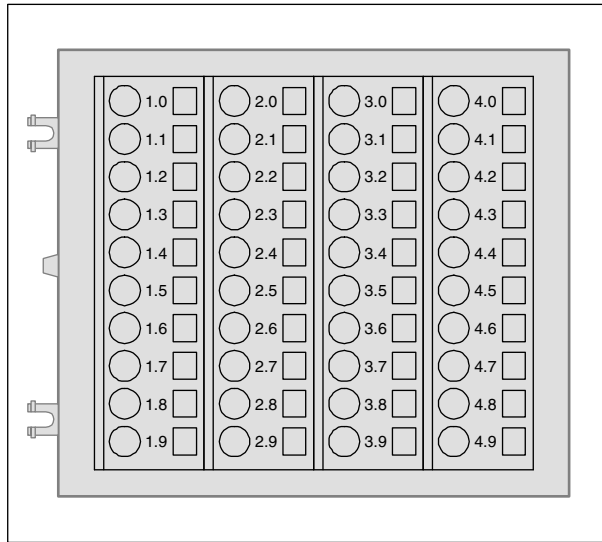


Figure: Terminals at the Terminal Units (I/O, FBP)

Terminal type: **Screw-type terminal**

Number of cores per terminal	Conductor type	Cross section
1	solid	0.08 mm ² to 2.5 mm ²
1	flexible	0.08 mm ² to 2.5 mm ²
1 with wire end ferrule	flexible	0.25 mm ² to 1.5 mm ²
TWIN wire end ferrule	flexible	2 x 0.25 mm ² or 2 x 0,5 mm ² or 2 x 0,75 mm ² , with square cross-section of the wire-end ferrule also 2 x 1.0 mm ²
2	solid	not intended
2	flexible	not intended

Terminal type: **Spring terminal**

Number of cores per terminal	Conductor type	Cross section
1	solid	0.08 mm ² to 2.5 mm ²
1	flexible	0.08 mm ² to 2.5 mm ²
1 with wire end ferrule	flexible	0.25 mm ² to 1.5 mm ²
TWIN wire end ferrule	flexible	2 x 0.25 mm ² or 2 x 0,5 mm ² or 2 x 0,75 mm ² , with square cross-section of the wire-end ferrule also 2 x 1.0 mm ²
2	solid	not intended
2	flexible	not intended

Connection of wires at the spring terminals

Connect the wire to the spring terminal

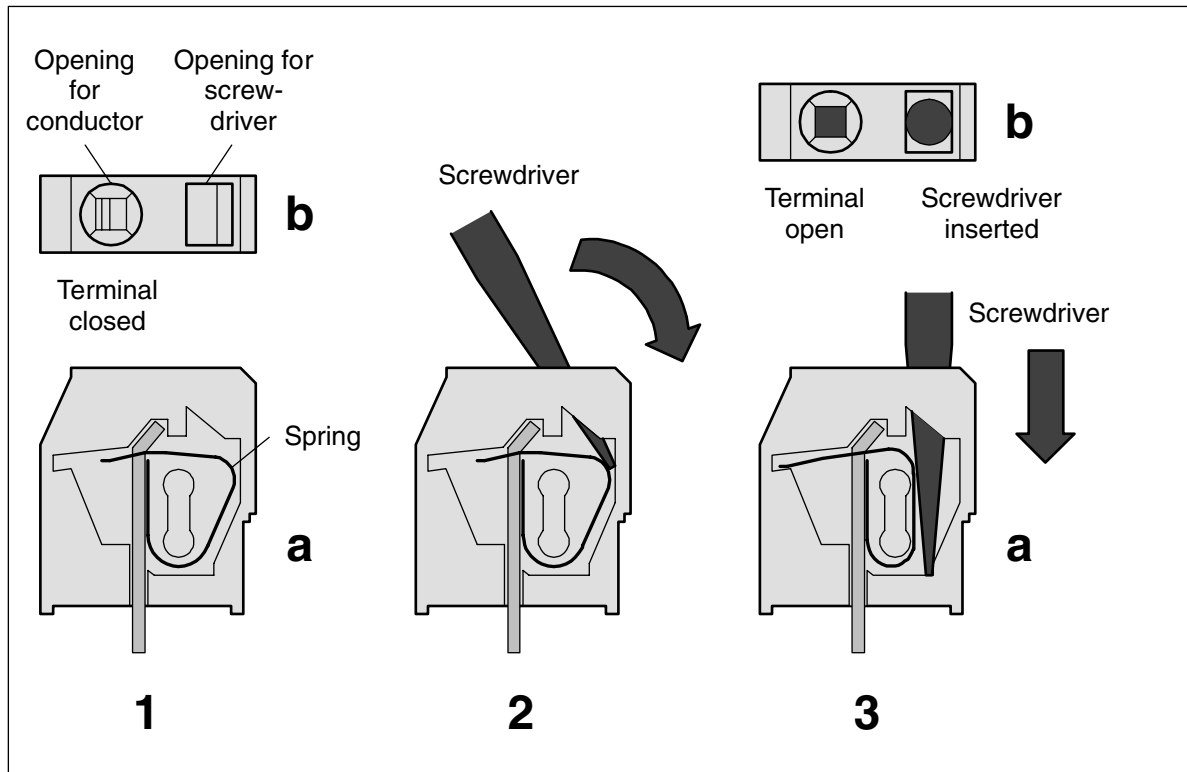


Figure: Connect the wire to the spring terminal (steps 1 to 3)

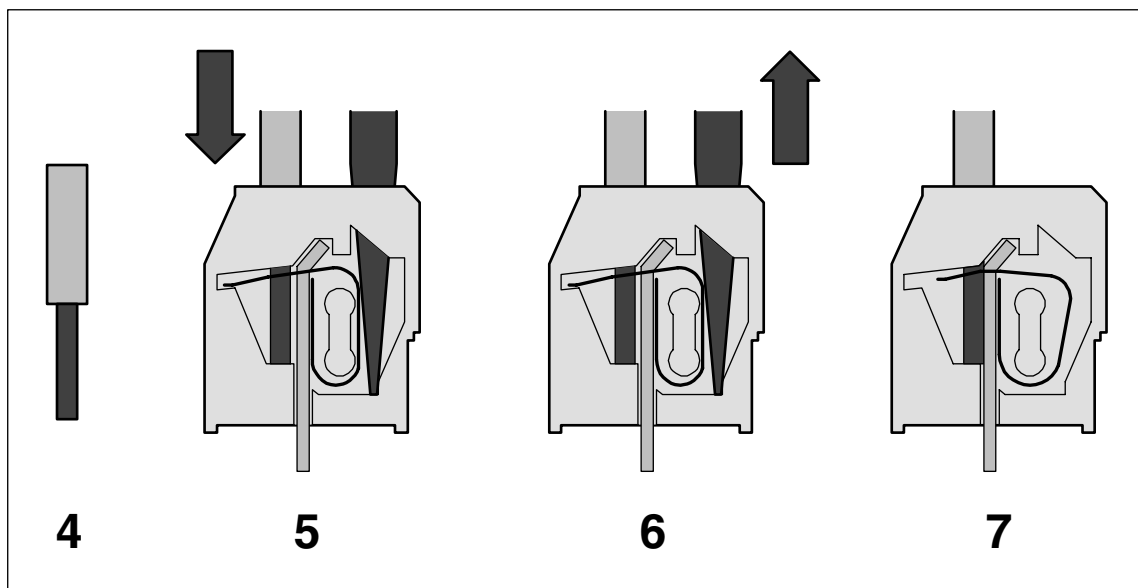


Figure: Connect the wire to the spring terminal (steps 4 to 7)

1 a	Side view (open terminal drawn for illustration)
1 b	The top view shows the openings for wire and screwdriver
2	Insert screwdriver (2.5 x 0.4 to 3.5 x 0.5 mm) at an angle, screwdriver must be at least 15 mm free of insulation at the tip
3 a	While erecting the screwdriver, insert it until the stop (requires a little strength)
3 b	Screwdriver inserted, terminal open
4	Strip the wire for 7 mm (and put on wire end ferrule)
5	Insert wire into the open terminal
6	Remove the screwdriver
7	Done

Disconnect wire from the spring terminal

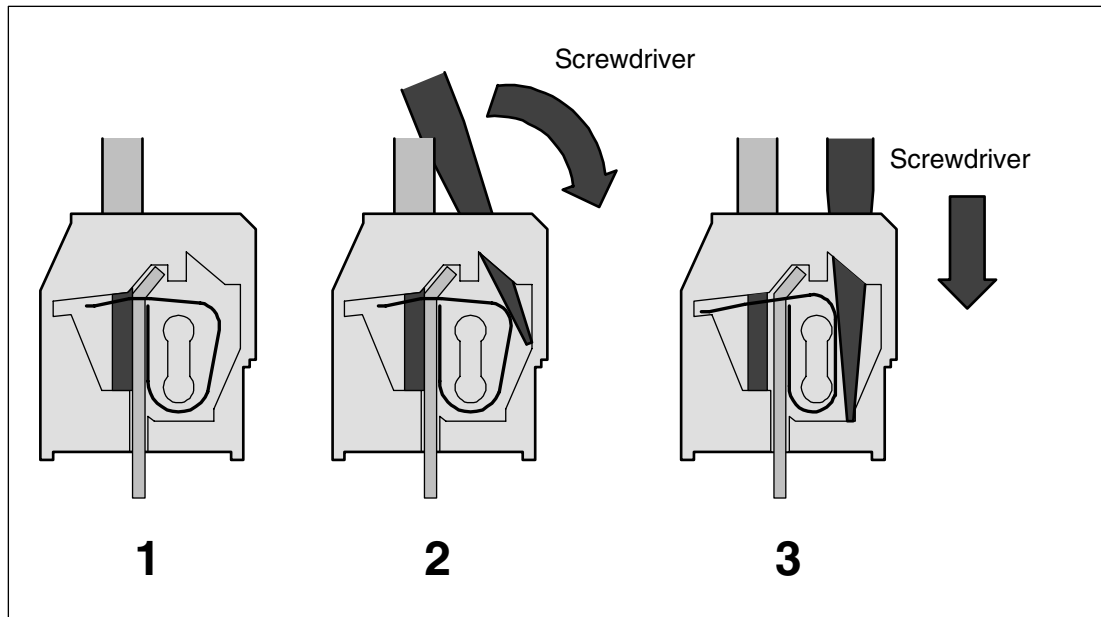


Figure: Disconnect wire from the spring terminal (steps 1 to 3)

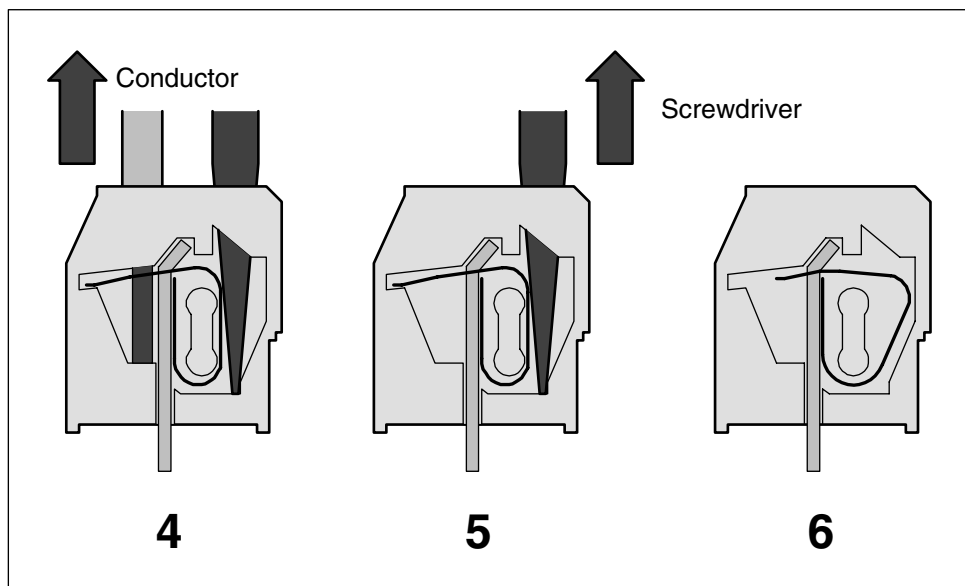


Figure: Disconnect wire from the spring terminal (steps 4 to 6)

1	Terminal with wire connected
2	Insert screwdriver (2.5 x 0.4 to 3.5 x 0.5 mm) at an angle, screwdriver must be at least 15 mm free of insulation at the tip
3	While erecting the screwdriver, insert it until the stop (requires a little strength), terminal is now open
4	Remove wire from the open terminal
5	Remove the screwdriver
6	Done

Mechanical encoding

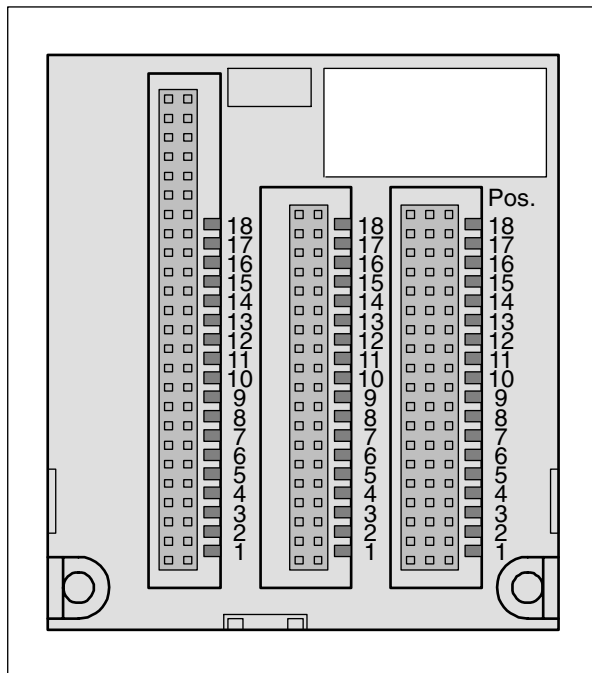


Figure: Possible positions for mechanical encoding (1 to 18)

Terminal Units (S500) and CPU Terminal Bases (AC500) have a mechanical coding which prevents that modules are inserted to wrong places. Otherwise

- dangerous parasitic voltages could occur or
- modules could be destroyed.

The coding either makes it impossible to insert the module to the wrong place or blocks its electrical function (outputs are not activated).

The following figure shows the 5 possible codings.

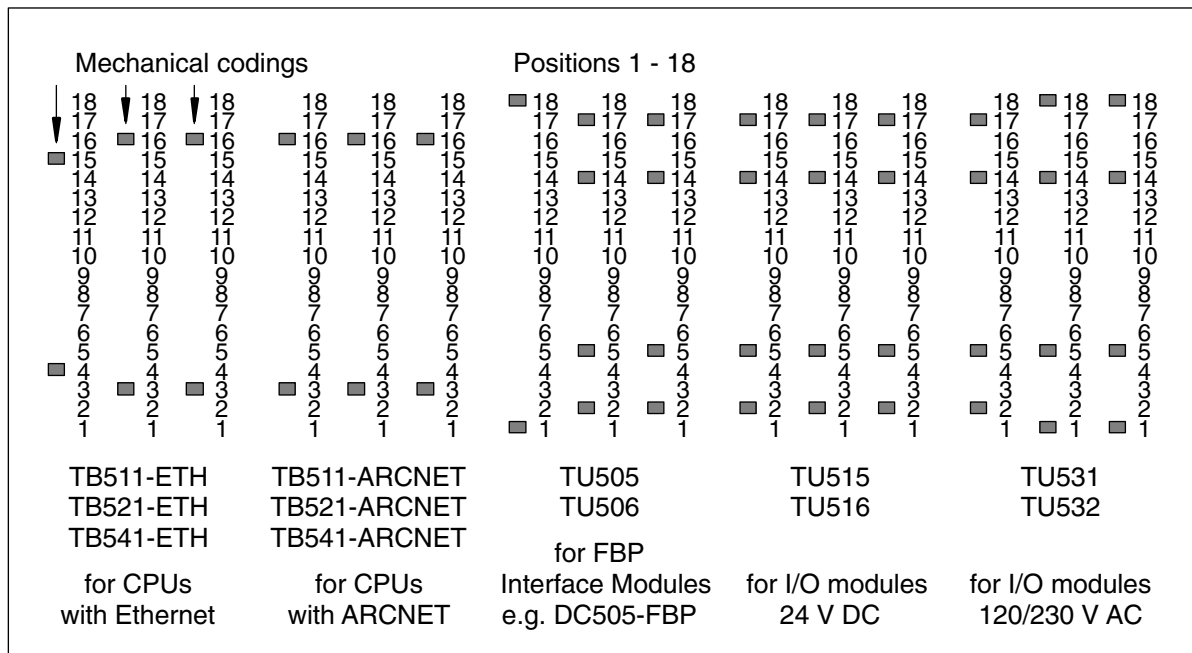



Figure: Mechanical coding


General wiring recommendations

Bad wiring on power supply terminals

 **Attention:** The product should be installed by trained people who have the knowledge of wiring electronic devices. In case of bad wiring, although the modules are protected against various errors (reverse polarity, short circuit, etc.), some problems could always happen:

- On the CPU Terminal Base, the terminals L+ and M are doubled. If the power supply is badly connected, a short circuit could happen and lead to a destruction of the power supply or its fuse. If no suitable fuse exists, the Terminal Base itself could be destroyed.
- The CPUs (Terminal Bases) and all electronic modules (and Terminal Units) are protected against reverse polarity.
- All necessary measures should be carried out to avoid damages to modules and wiring. Notice the wiring plans and connection examples.

Bad wiring on I/O terminals

 **Attention:** All I/O channels (digital and analog) are protected against reverse polarity, reverse supply, short circuit and continuous overvoltage up to 30 V DC.

Behaviour of the system in case of power supply interruptions and power recovering

AC500 system supply (terminals L+, M)

As soon as the CPU power supply is higher than 19.2 V DC, the power supply detection is activated and the CPU is started. When during operation the power supply is going down to lower than 19.2 V DC for more than 10 ms, the CPU is switched to safety mode (see System Technology of the CPUs).

A warm restart of the CPU only occurs by switching the power supply off and on again (see also the description of the function modes of the CPU in the "AC500 System Technology" chapters).

S500 system supply (is provided through the FBP plug)

AC500 or S500 process power supply (terminals UP and ZP)

I/O-Bus

General

The synchronized serial I/O-Bus connects the I/O expansion modules with the AC500 CPU or with the S500 FBP Interface Module.

The I/O-Bus provides the following signals:

- Supply voltage of 3.3 V DC for feeding the electronic interface components
- 3 data lines for the synchronized serial data exchange
- several control signals

With its fast data transmission, the I/O-Bus obtains very low reaction times. Up to 7 I/O expansion modules can be connected to a AC500 CPU or an FBP Interface Module.

General data:

Supply voltage, signal level	3.3 V DC \pm 10 %
Max. supply current	30 mA je Erweiterungsmodul
Max. number of I/O expansion modules (slaves on the I/O-Bus)	7 with the S500 FBP Interface Module with max. 4 analog modules (with up to 16 channels each), 7 with the AC500 CPU (digital or analog)
Type of the data interface	synchronized serial data exchange
Bus data transmission speed	2 Mb/s
Minimum bus cycle time	500 μ s ¹⁾
Electrical isolation	no isolation between the modules, but isolation against the process supply voltage and the I/O terminals
Protection against electrostatic discharge (ESD)	with an internal varistor
Max. bus length	1 m

¹⁾ Minimum bus cycle time: This value is valid for all module combinations (from 1 to 7 expansion modules)

Wiring (bus connection)

Bus connection	left-side and right-side connection from module to module via a 10-pole HE plug (male at the left side, female at the right side)
Mechanical connection	established by the Terminal Units
Max. bus length	1 m

Number of user data, bus cycle time and data security

See details before

Replacement of modules on the I/O bus

The I/O-Bus is not designed for plugging and unplugging modules while in operation. If a module is plugged or replaced while the bus is in operation, the following consequences are possible

- reset of the station or of the CPU
- system lockup



Caution: Removal of energized modules is not permitted. All power sources (supply and process voltages) must be switched off while working on any AC500 system.

Serial interfaces of the CPU Terminal Bases

Interface standards

The serial interfaces COM1 and COM2 are designed according to the standards EIA RS-232 and EIA RS-485. Both interfaces can be operated either in RS-232 or in RS-485 mode.

Technical data

Standard of the serial interfaces	EIA RS-232 or EIA RS-485
Interface connectors	COM1: 9-pole removable terminal block COM2: 9-pole Sub-D connector (female)
Electrical isolation	yes, against the CPU, 500 V DC
Serial interface parameters	configurable by the software
Operating modes	programming or data exchange
Supported protocols	Modbus or serial data exchange using special software function blocks

COM1 can be configured and terminated for either RS-232 or RS-485 (depending on used terminals). Please terminate according to the pin-out information for the COM1 port below and follow the appropriate rules and practices for RS-232 and RS-485 communication.

Serial interface COM1 of the CPU Terminal Bases

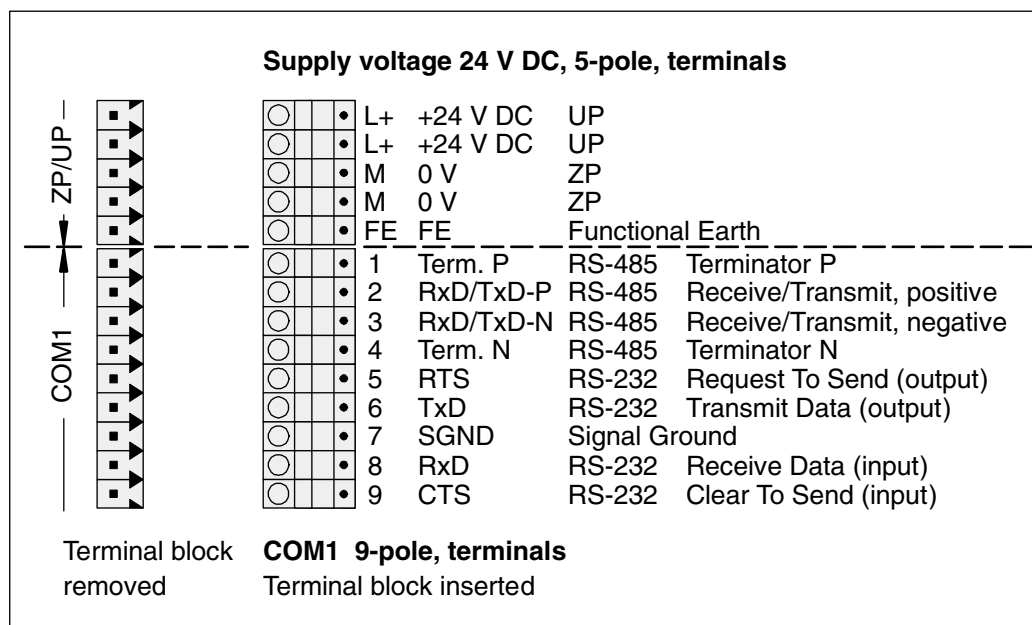


Figure: Serial interface COM1

The serial interface COM1 is connected via a removable 9-pole terminal block. It is configurable for RS-232 or RS-485 and can be used for

- an online access (RS-232 programming interface for PC/Control Builder)
- a free protocol (communication via the COMSND and COMREC function blocks)
- Modbus RTU, master and slave or
- a CS31 system bus (RS-485), as master only

If the RS-485 bus is used, each interconnected bus line (each bus segment) must be electrically terminated. The following is necessary:

- two resistors of 120 Ohms each at both line ends (to avoid signal reflections)

- in addition, a pull-up resistor at RxD/TxD-P and a pull-down resistor at RxD/TxD-N. These two resistors care for a defined high level on the bus, while there is no data exchange.

It is useful, to activate both the pull-up and the pull-down resistors, which only are necessary once on every bus line, at the bus master. For this reason, these two resistors are already integrated within the COM1 interface of the AC500 Terminal Bases. They can be activated by connecting the terminals 1-2 and 3-4 of COM1.

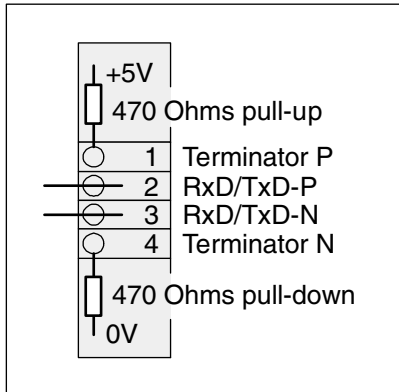


Figure: Integrated resistors (pull-up, pull-down) at COM1, can be activated by connections between 1-2 and 3-4

The following drawing shows an RS-485 bus with the bus master at one line end.

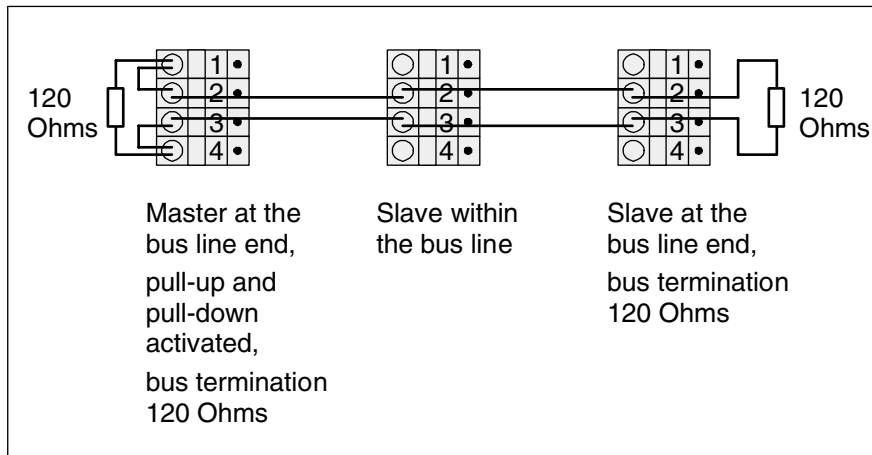


Figure: RS-485 bus with the master at one line end

If the master is located within the bus line, it does not need a terminating resistor. The pull-up and the pull-down resistors, however, must be activated (see the following drawing).

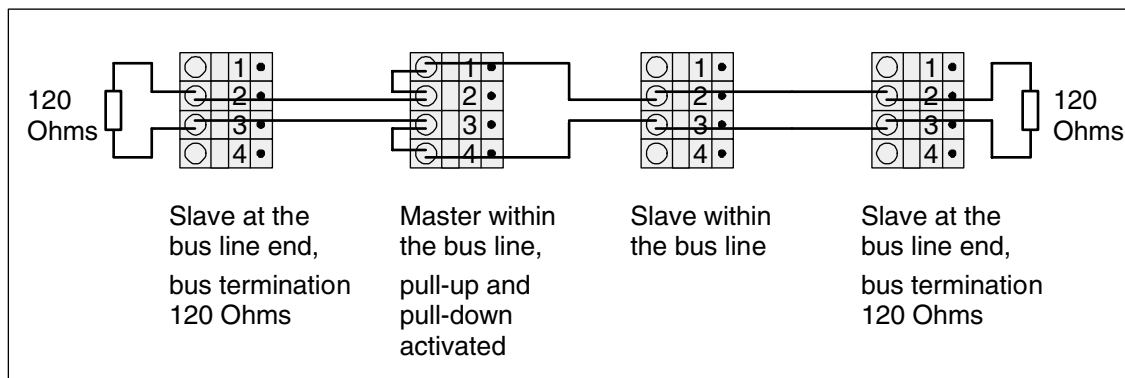


Figure: RS-485 bus with the master within the bus line

The following photo shows a wiring example "master within the bus line".

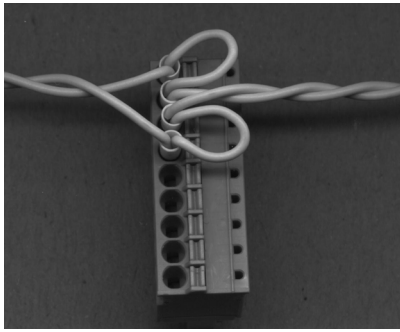


Figure: "Master within the bus line", wired at the COM1 bus connector of the Terminal Base

⚠ Attention: If the bus is operated with several masters, the pull-up and pull-down resistors may only be activated at one master.

The earthing of the cable shields of the bus lines are described in the chapter "CS31 system bus" of the AC500 system data.

CS31 system bus

Connection of the AC500 CPU to the CS31 system bus using COM1 of the Terminal Base

The AC500 CPU can be used as a CS31 bus master. The connection is performed via the serial interface COM1 used as a CS31 system bus. The following drawing shows the connection of the bus signals BUS1 and BUS2.

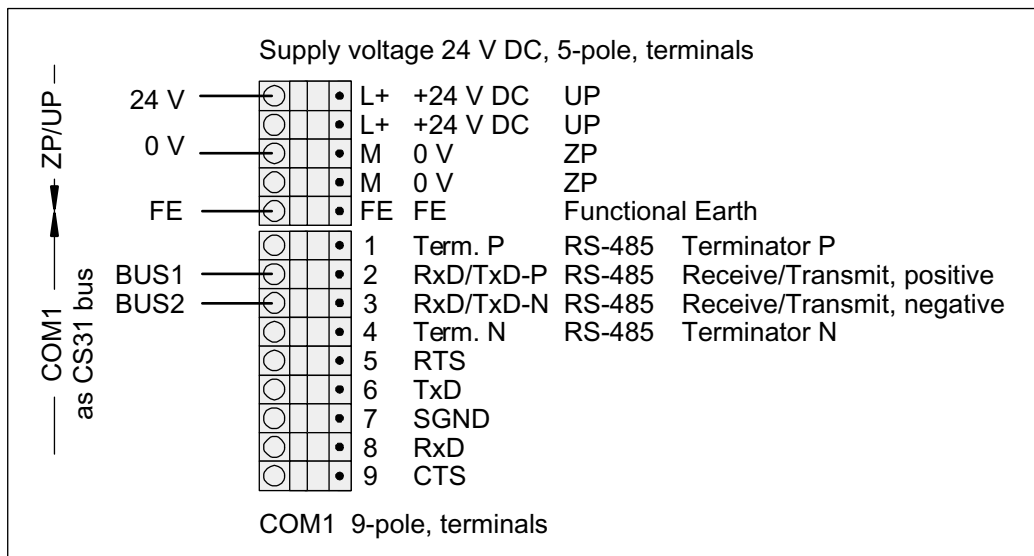


Figure: AC500 CPU connected to the CS31 system bus via the serial interface COM1

With connecting the terminals 1-2 and 3-4, a pull-up and a pull-down resistor can be activated (see chapter "Serial interface COM1" for details).

Wiring

Bus line	
Construction	2 cores, twisted, with common shield
Conductor cross section	$\geq 0.22 \text{ mm}^2$ (24 AWG)
- recommendation	0.5 mm^2 corresponds to $\varnothing 0.8 \text{ mm}$
Twisting rate	> 10 per meter (symmetrically twisted)
Core insulation	Polyethylene (PE)
Resistance per core	$< 100 \text{ } \Omega/\text{km}$
Characteristic impedance	ca. $120 \text{ } \Omega$ ($100\dots 150 \text{ } \Omega$)
Capacitance between the cores	$< 55 \text{ nF/km}$ (if higher, the max. bus length must be reduced)
Terminating resistors	$120 \text{ } \Omega \frac{1}{4} \text{ W}$ at both line ends
Remarks	Commonly used telephone cables with PE insulation and a core diameter of $\geq 0.8 \text{ mm}$ are normally good.
	Cables with PVC core insulation and a core diameter of 0.8 mm can be used up to a length of ca. 250 m . In this case, the bus terminating resistor is ca. $100 \text{ } \Omega$.

Bus topology

A CS31 system bus always contains only one bus master (CPU or coupler) which controls all actions on the bus. Up to 31 slaves can be connected to the bus, e.g. remote modules or slave-configured CPUs. Besides the wiring instructions shown below, the wiring and earthing instructions provided with the descriptions of the modules are valid additionally.

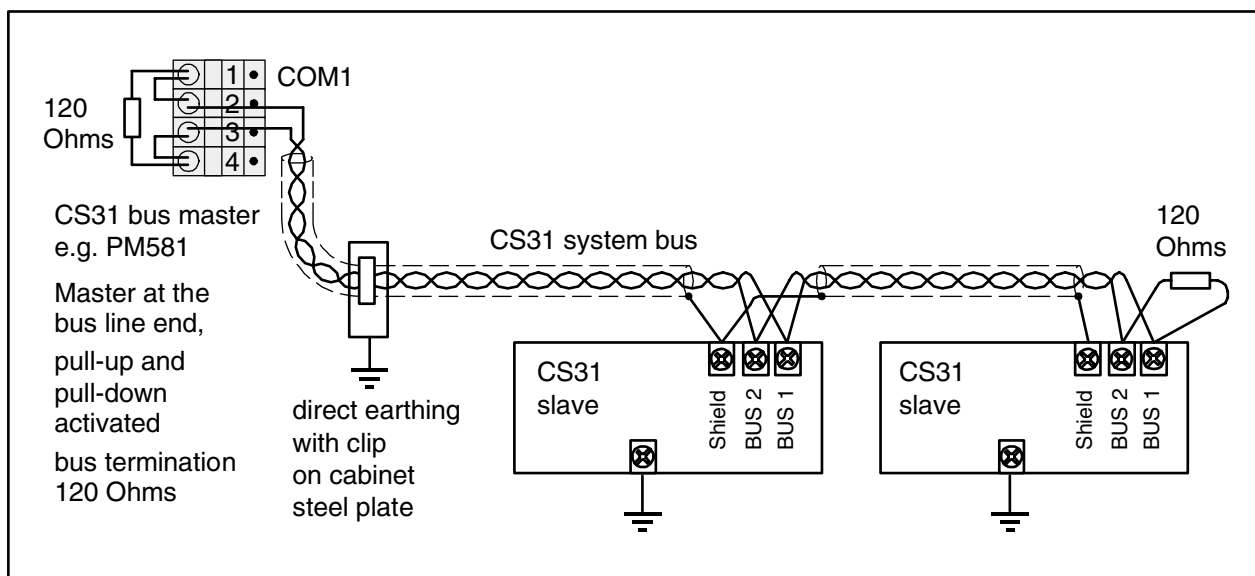


Figure: Bus topology for a CS31 system bus at COM1 (bus master at one end of the bus line)

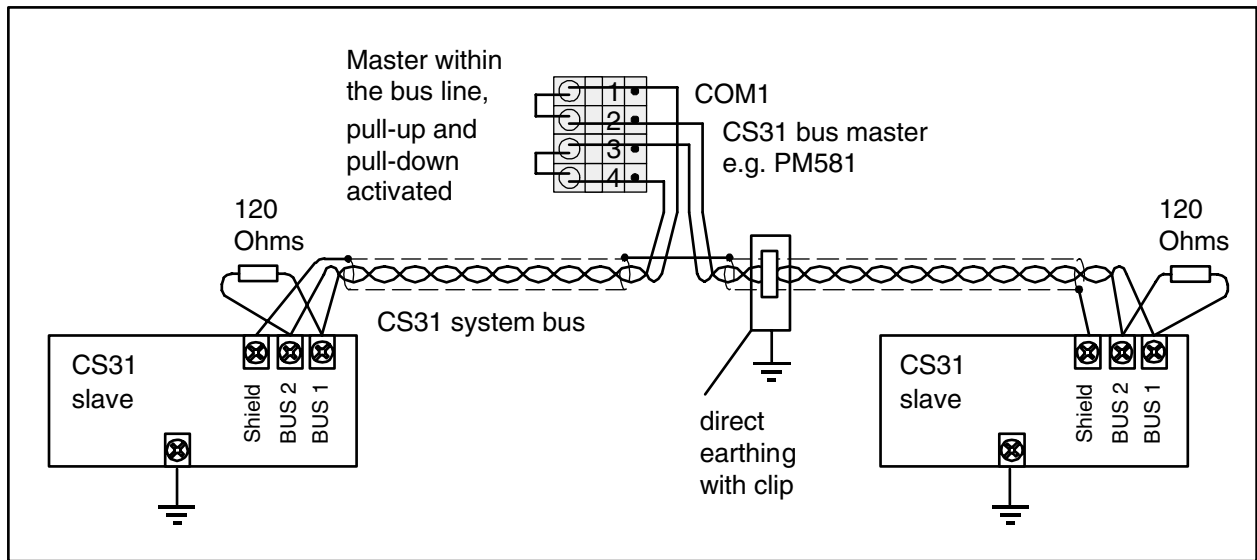


Figure: Bus topology for a CS31 system bus at COM1 (bus master within the bus line)

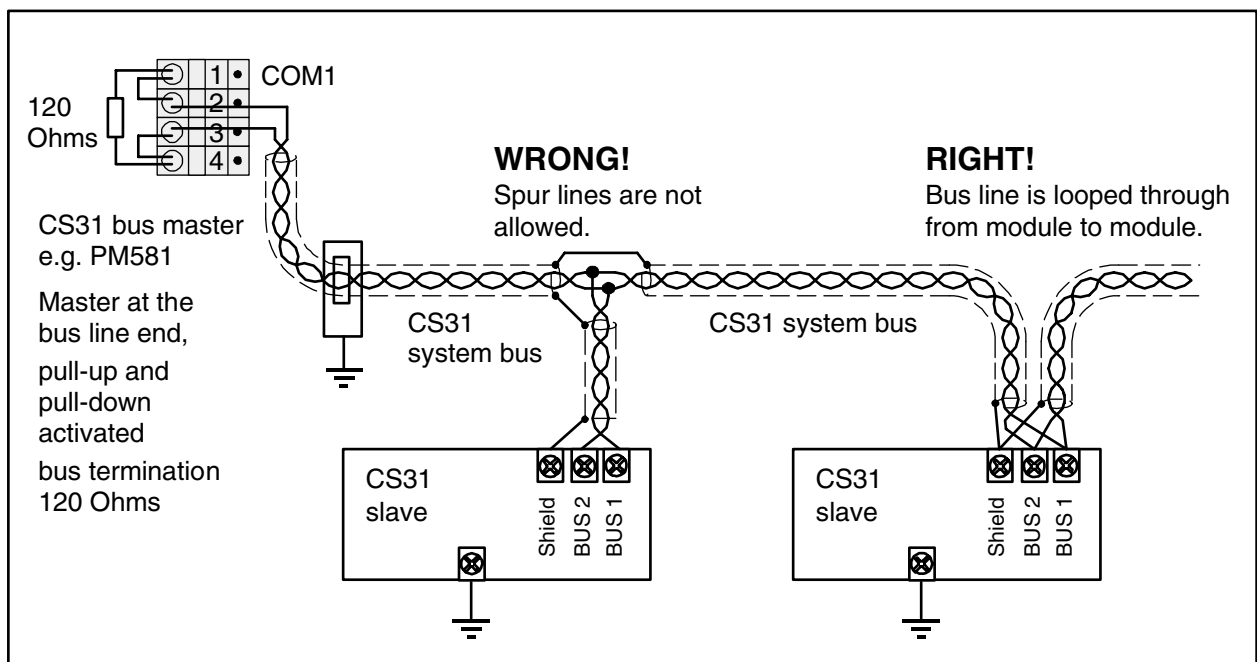


Figure: Wiring with spur lines is not allowed

Earthing

In order to avoid disturbance, the cable shields must be earthed directly.

Case a:

Multiple switch-gear cabinets: If it can be guaranteed that no potential differences can occur between the switch-gear cabinets by means of current-carrying metal connections (earthing bars, steel constructions etc.), the direct earthing is chosen.

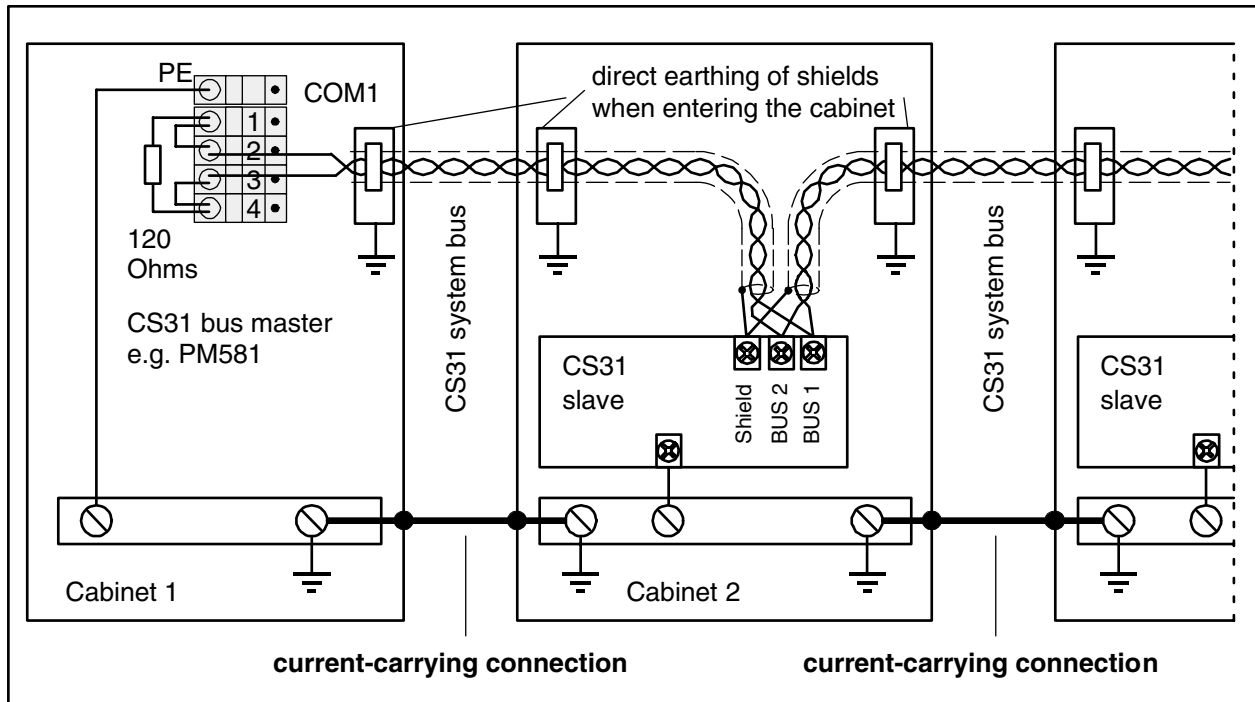


Figure: Direct earthing

Case b:

Multiple switch-gear cabinets: If potential differences can occur between the switch-gear cabinets, the capacitive earthing method is chosen in order to avoid circulating currents on the cable shields.

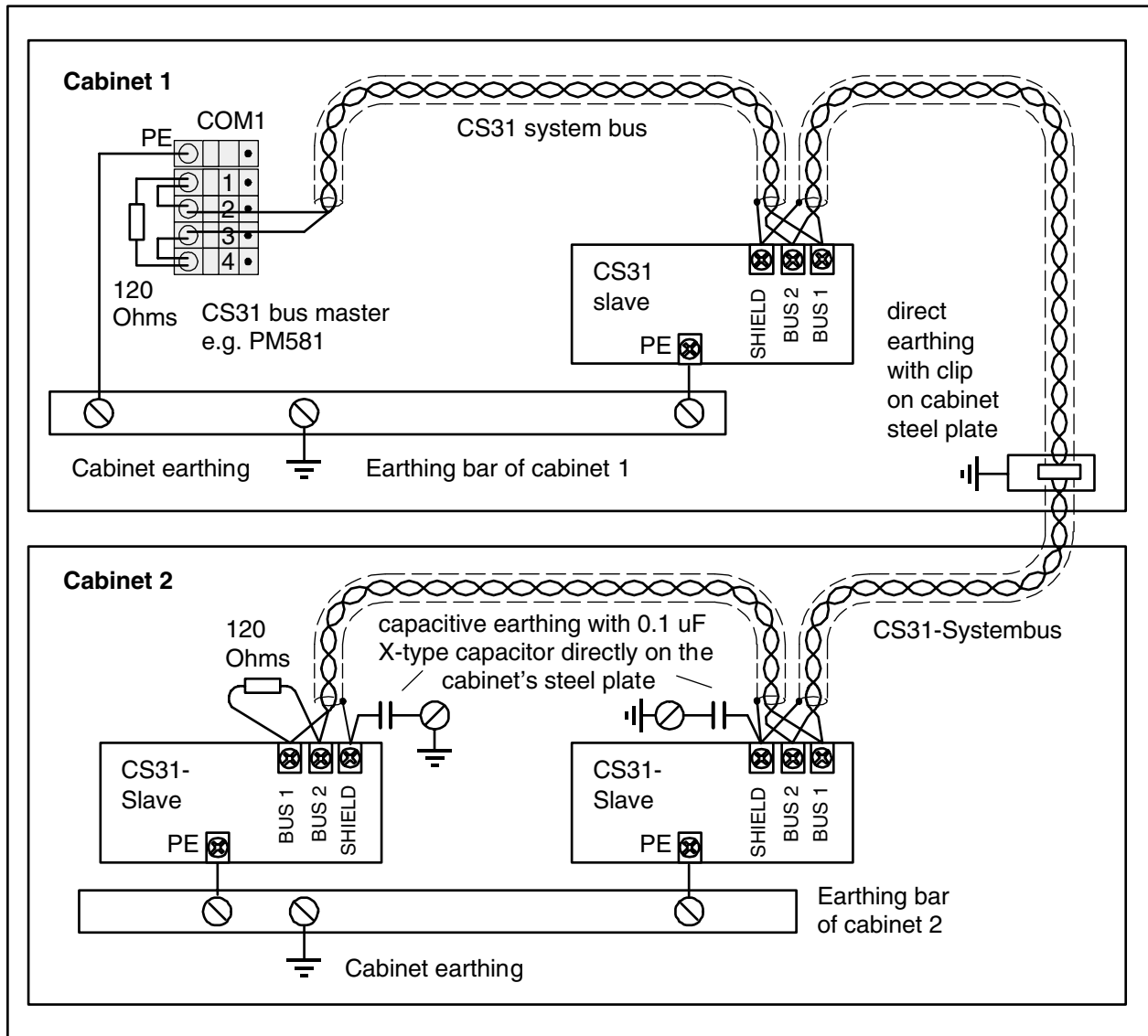


Figure: Earthing concept with several switch-gear cabinets: direct earthing of cable shields when cables enter the first switch-gear cabinet (containing the master), and capacitive earthing at the modules

Everywhere is valid: The total length of the earthing connections between the shield of the Terminal Base and the earthing bar must be as short as possible (max. 25 cm). The conductor cross section must be at least 2.5 mm².

VDE 0160 requires, that the shield must be earthed directly at least once per system.

Number of user data, bus cycle time and data security

See the relevant chapters in the user handbook.

Replacement of modules on the CS31 system bus

Serial interface COM2 of the CPU Terminal Bases

The serial interface COM2 is connected via a 9-pole SUB-D plug. It is configurable for RS-232 or RS-485 and can be used for

- an online access (RS-232 programming interface for PC/Control Builder)
- a free protocol (communication via the COMSND and COMREC function blocks)
- Modbus RTU, master and slave

It is not intended to use COM2 to establish a CS31 system bus.

If the RS-485 bus is used, each interconnected bus line (each bus segment) must be electrically terminated. The following is necessary:

- two resistors of 120 Ohms each at both line ends (to avoid signal reflections)
- in addition, a pull-up resistor at RxD/TxD-P and a pull-down resistor at RxD/TxD-N. These two resistors care for a defined high level on the bus, while there is no data exchange.

It is useful, to activate both the pull-up and the pull-down resistors, which only are necessary once on every bus line, at the bus master.

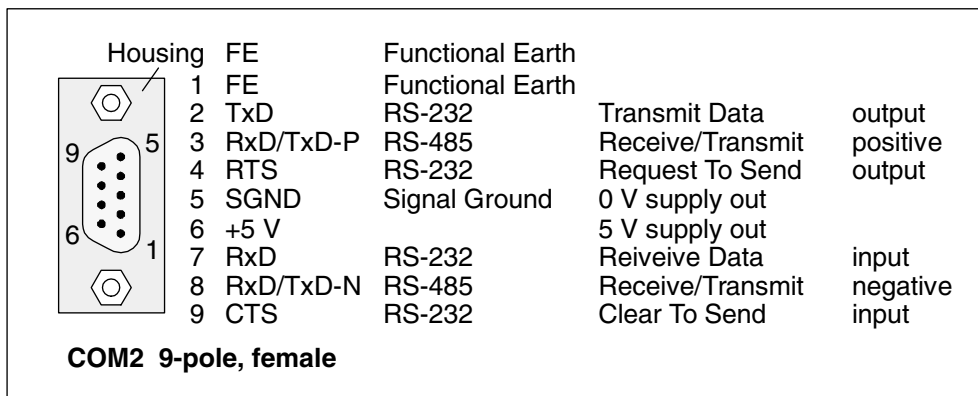


Figure: Pin assignment of the serial interface COM2

The following drawing shows an RS485 bus with the bus master at the line end.

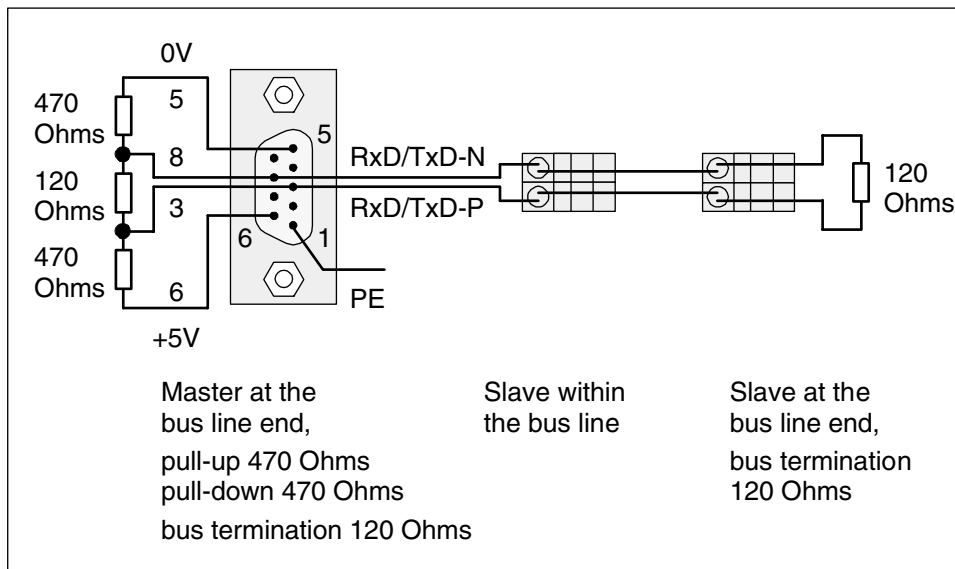


Figure: RS-485 bus, master at a line end

If the master is located within the bus line, it does not need a terminating resistor. The pull-up and the pull-down resistors, however, are necessary (see the following drawing).

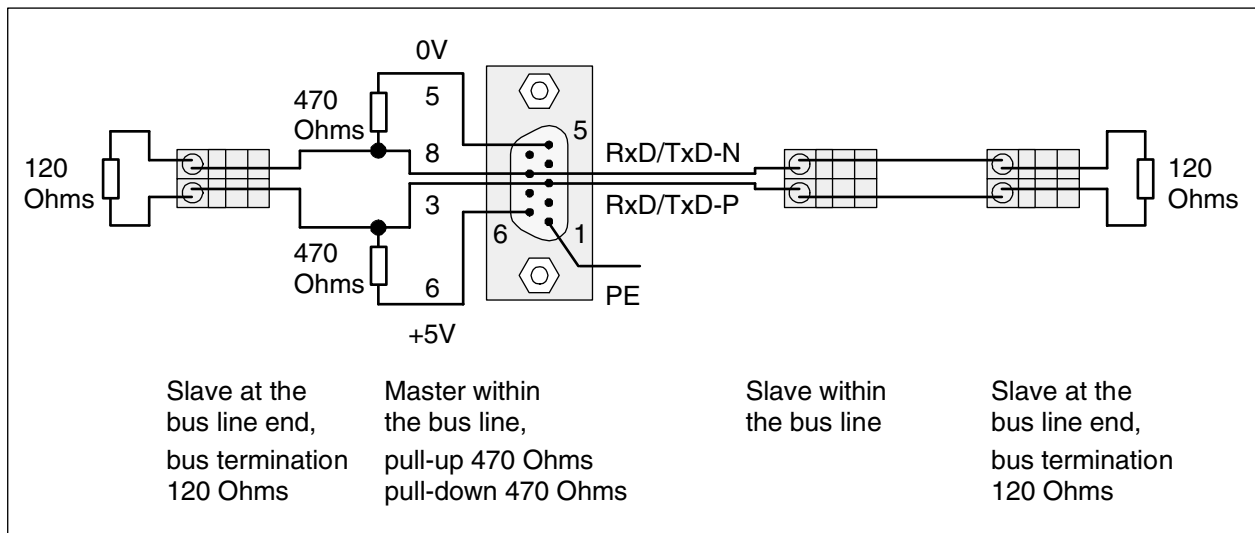


Figure: RS-485 bus, master within the bus line



Attention: If the bus is operated with several masters, the pull-up and pull-down resistors may only be installed at one master.

The cable shields must be earthed (refer to the chapter "CS31 system bus" of the AC500 system data).

FieldBusPlug / FBP

Wiring

For example, refer to description of the PROFIBUS DP FBP, documentation 2CDC 192 001 D010x.PDF

Bus topology

For example, refer to description of the PROFIBUS DP FBP, documentation 2CDC 192 001 D010x.PDF

Modbus

General

The Modbus protocol is used all over the world. The MODICON Modbus® RTU protocol is integrated in the AC500 CPUs.

Numerous automation devices, such as PLC installations, displays, variable-frequency inverters or monitoring systems, for instance, have a Modbus® RTU interface by default or as an option and can therefore communicate with the AC500 CPUs without any problems via the serial interfaces COM1 and COM2 (RS-232 or RS-485).

Modbus® is a master-slave protocol. The master sends a request to the slave and receives its response.

Both interfaces COM1 and COM2 can work as Modbus® interfaces simultaneously.

The Modbus® operating mode of an interface is set with several function blocks.

Bus topology

Point-to-point with RS-232 or bus topology with RS-485. Modbus® is a master-slave protocol..

Technical data

Supported standards	EIA RS-232 or EIA RS-485
Number of connection points	1 master max. 1 slave with RS-232 interface max. 32 slaves with RS-485 interface
Protocol	Modbus® (master/slave)
Check sum	CRC 16
Data transmission rate	up to 19200 baud
Character frame	1 start bit, 8 data bits, 1 parity bit, even or odd (optional) 1 or 2 stop bit(s)
Maximum cable length	for RS-485: 1200 m with 19200 Baud

Number of user data, bus cycle time and data security

See relevant chapters in the operating manual

PROFIBUS

ISO/OSI model

At the moment, PROFIBUS DP is the Field bus most frequently used worldwide for industrial applications. It is standardized under IEC 61158 together with other field bus protocols.

The definition of the PROFIBUS is based on the experience concerning data transmission collected during long years.

One base is the ISO/OSI model (Open Systems Interconnection Reference Model). It is an open layer model with 7 layers for the communication in information processing systems. The model describes uniformed procedures and rules for the exchange of data.

Fieldbus systems normally use only three of the 7 layers:

ISO/OSI	Transmitting CPU		Receiving CPU		
Layer 7	Application layer		Application layer	=	Interface to the application program (CPU) with application oriented commands (read, write)
...		
Layer 2	Data-link layer		Data-link layer	=	Access control (to the line), telegram (start, length,..), data security (e.g. CRC=Cyclic Redundancy Code)
Layer 1	Physical layer		Physical layer	=	Definition of the medium (Twinax, optical fiber, ..), coding ("1"=-4V), transmission speed (baud rate)..
Transmission medium (physical)					

As a result of the ISO/OSI layer model, each layer can be defined separately and (nearly) independent of the other layers.

Indeed, it is possible and common to use conventional cables, but also optical fibers as physical layer for the PROFIBUS DP or have a mixture of both in a single bus configuration.

For the application layer, there are also different versions possible, e.g. PROFIBUS DP-V0, PROFIBUS DP-V1 but also others that are not regarded here.

Typical Field Bus Topologies

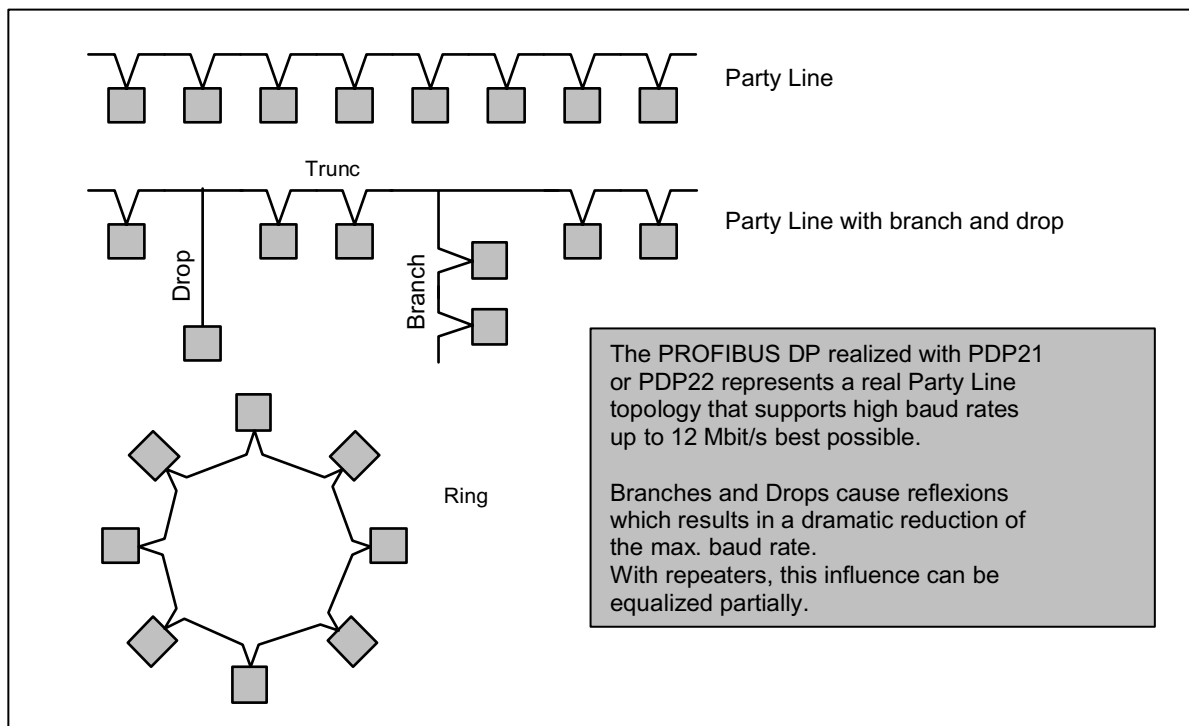
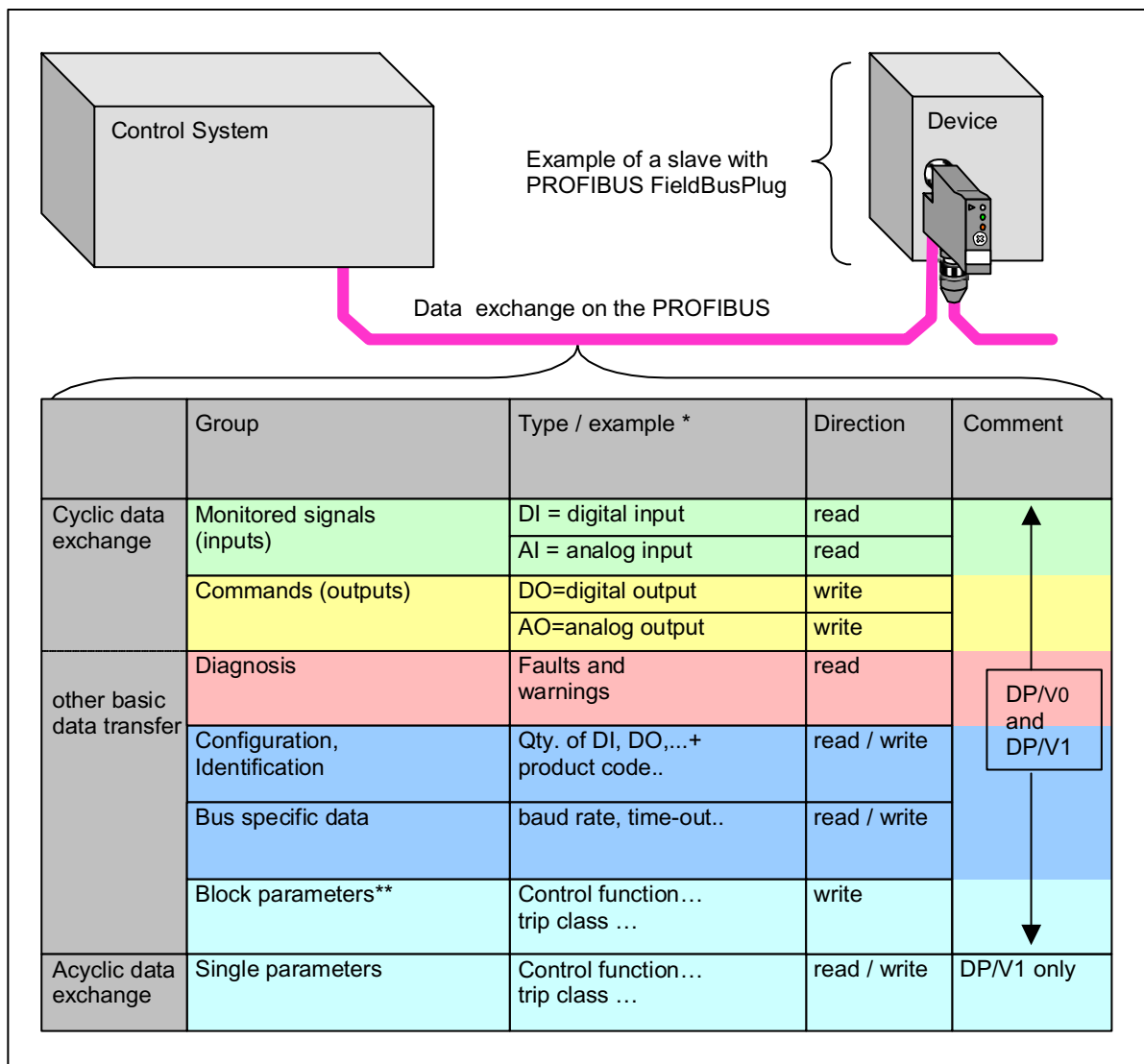


Figure: Typical field bus topologies

Overview of transferred data



* The quantities of bytes/words are defined by the connected device.

** Block parameters are transferred during power-up.

The PDP22 (PROFIBUS DP-V1) allows to suppress the block parameter transfer (executed e.g. during power-up) setting the appropriate parameter. This parameter is not sent to the device and cannot be set via the device.

In the Control Builder AC500 used for the CPU AC500, the parameter is 'Ignore Block Parameters' or 'Use Block Parameters' respectively in the PDP22 parameter part.

Figure: Overview of transferred data

PROFIBUS DP-V0 <---> PROFIBUS DP-V1

Commands and monitoring signals

The transfer of commands and monitoring signals is the essential task of the field bus and the connected units. They control and inform mainly about the process, e.g. start a motor and inform if it runs correctly, and are the same for DP-V0 and DP-V1.

Command and monitoring telegrams represent the cyclic data transfer.

Diagnosis

The diagnosis telegram provides detailed information if there is any problem, particularly in the process. A trip caused by overload of a motor is an example. Diagnosis data are automatically read by the PROFIBUS DP master if it gets a general fault info within a monitoring telegram.

Complete diagnosis telegram:

PROFIBUS DP		PROFIBUS DP with PDP21, PDP22	
6 bytes	Standard diagnosis data	6 bytes	Standard diagnosis data
x bytes	User-specific diagnosis data	1 byte + 1 byte	PDP21, PDP22 itself + length of slave diagnosis
		n bytes	Device-specific

Remark: Diagnosis function blocks provide additional 3 bytes diagnosis data that are created by the bus master.

Configuration, Identification and other data

Configuration, identification and other data are necessary to start the operation and communication with the PROFIBUS DP slave. These data is created during configuring/selecting the bus line including the slaves/devices and is sent to the FieldBusPlugs directly after power-up.

All slaves compare the expected configuration with their real configuration and confirm if they agree as a supposition to start the data exchange.

Additionally some general data such as baud rate and time-out are transferred.

Parameters

Parameters are necessary to adapt the device to the process.

E.g., for the device UMC22 the parameter "Set current" that has to be set correctly to enable the UMC22 to protect the connected motor perfectly against overload.

Parameters can also include service-oriented data such as "Operation hours".

The main difference between the PROFIBUS DP versions DP-V0 and DP-V1 is:

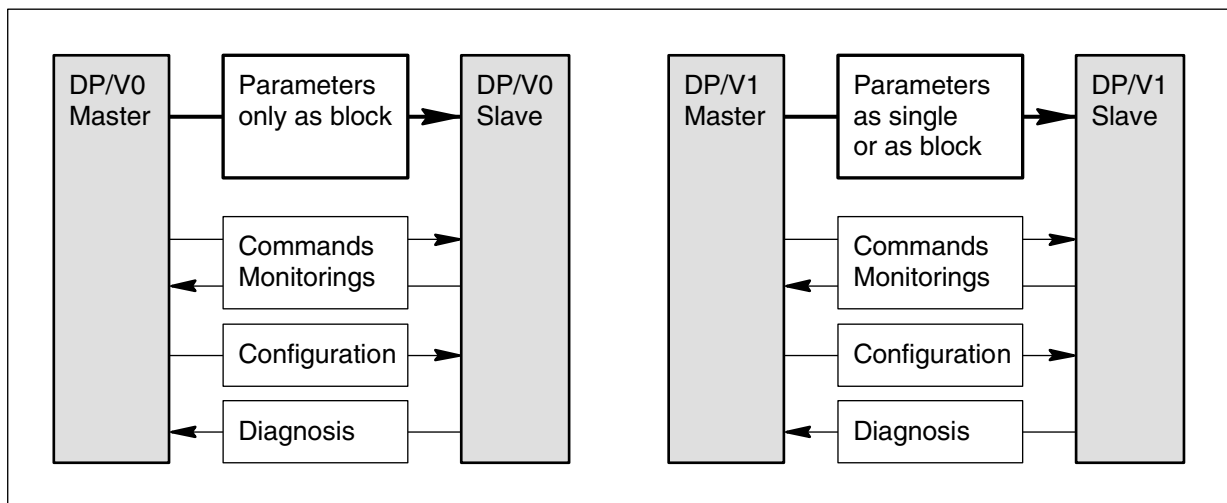


Figure: Parameters DP-V0 and DP-V1

DP-V0 only allows to write the complete parameter set in one block.

The bus master sends the parameter block to the slave during power-up of the slave/device. Some control systems also allow to send the parameter block during normal operation.

DP-V1 offers reading and writing single parameters.

The possibility to read single parameters is an important advantage: If e.g. during commissioning the "Set current" for a motor is modified locally by the electrician, then the control system must be able to read this value to back it up into its data base.

The PDP22 (PROFIBUS DP-V1) also allows to suppress the block parameter transfer. This avoids that the parameters are overwritten during power-up of the slave / device.

The appropriate parameter is evaluated in the PDP21 / PDP22 and is not sent to the device and cannot be set via the device.

The appropriate parameter is "Ignore V0 Parameters" or "Use V0 Parameters" respectively and is available in the .GSD file for DP-V1.

In former times a separate master class 2 was needed to read and write single parameters. Currently, most of the control systems offer a class 1 master capable to perform acyclic DP-V1 services to read and write all data types.

Note: In all cases only the bus master can start the data exchange on the PROFIBUS DP bus.

PROFIBUS DP Master Class 1, PROFIBUS DP Master class 2

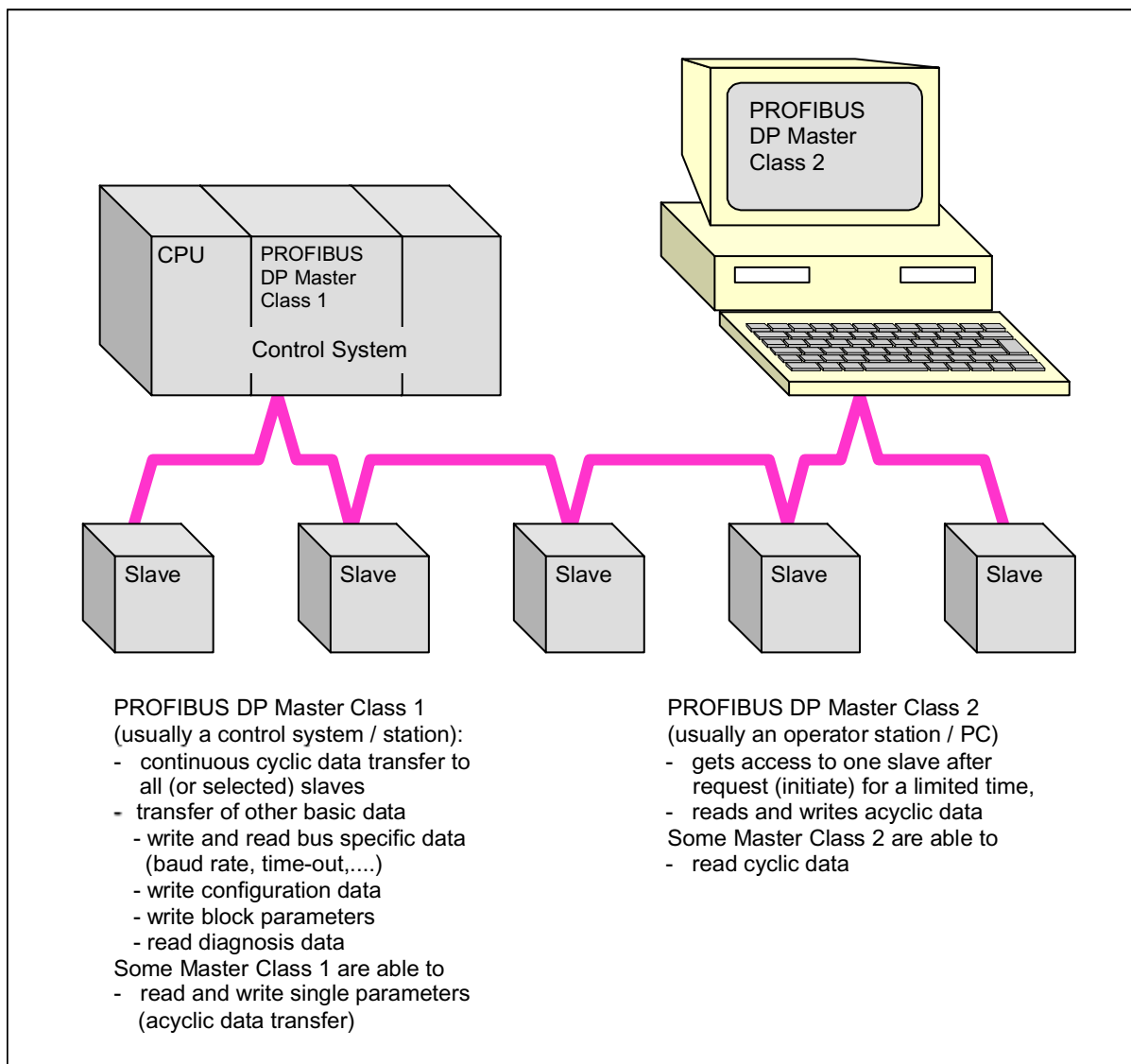


Figure: PROFIBUS DP Master, class 1 and class 2

Wiring

Bus line

Type	twisted wires (2 cores, shielded)
Characteristic impedance	135...165 Ω
Cable capacitance	< 30 pF/m
Diameter of the cores (copper)	≥ 0.64 mm
Conductor cross section of the cores	≥ 0.34 mm ²
Wire resistance per core	≤ 55 Ω /km
Loop resistance (resistance of two cores)	≤ 110 Ω /km

Cable lengths

Within one segment, the maximum possible cable length of a PROFIBUS subnet depends on the transmission speed.

Baud rate	Max. cable length
9.6 kbaud to 187.5 kbaud	1000 m
500 kbaud	400 m
1.5 Mbaud	200 m
3 Mbaud to 12 Mbaud	100 m

Table: Maximum cable length of a segment within a PROFIBUS subnet

The cable ends of the bus segments must be equipped with terminating resistors according to the following drawing. The terminating resistors are commonly integrated into the bus connectors.

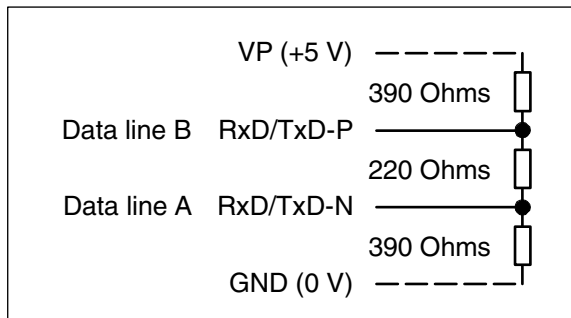


Figure: Configuration of the terminating resistors

Ethernet

Wiring

Bus line

Parameter	100Base-TX [100 MHz]
Attenuation [dB/100 m]	23.2
NEXT [dB/100 m]	24
ACR [dB/100 m]	4
Return Loss [db/100 m]	10
Characteristic impedance [Ω]	100
Category	5
Class	D or higher

Cable length restrictions

For the maximum possible cable lengths within an Ethernet network various factors have to be taken into account. So, for twisted pair cables (for transmission rates of 10 Mbit/s and 100 Mbit/s) the maximum length of a segment which is the maximum distance between two network components is restricted to 100 m due to the electric properties of the cable.

Furthermore the length restriction for one collision domain has to be observed. A collision domain is the area within a network which can be affected by a possibly occurring collision (i.e. the area the collision can propagate over). This, however, only applies if the components operate in half duplex mode since the CSMA/CD access method is only used in this mode. If the components operate in full duplex mode, no collisions can occur.

Reliable operation of the collision detection method is important which means that it has to be able to detect possible collisions even for the smallest possible frame size of 64 bytes (512 bits). But this is only guaranteed if the first bit of the frame arrives at the most distant subscriber within the collision domain before the last bit has left the transmitting station. Furthermore the collision must be able to propagate to both directions within the same time. Therefore, the maximum distance between two ends must not be longer than the distance corresponding to the half signal propagation time of 512 bits. Thus, the resulting maximum possible length of the collision domain is 2000 m for a transmission rate of 10 Mbit/s and 200 m for 100 Mbit/s. In addition, the bit delay times caused by the passed network components have also to be considered.

ARCNET

The ARCNET system (Attached Resource Computer Network)

- ARCNET is a system for data transmission in local networks.
- The ARCNET protocol is based on the Token Passing principle.
- By passing an identifier (token) from station to station it is guaranteed, that only one station can start a data transmission (transmission without collision).
- The order of sequence, in which the stations are accessed, is automatically adapted by the existing conditions in the network, i.e. that the network is reconfigured automatically each time a station is added to the network or switched off.

ARCNET bus topology

The networking possibilities of Linear ARCNET

- The Linear ARCNET connects the individual stations directly to each other, i.e. without using any distribution units.
- Each station is connected to the network by using a T connector.
- Both cable ends must be terminated by termination resistors.
- A maximum of 8 stations can be connected to one Linear ARCNET.
- The maximum cable length of the network is 300 m.
- An additional segment can be connected at the end of the wired segment via an Active Hub (active distribution unit), see next but one drawing.

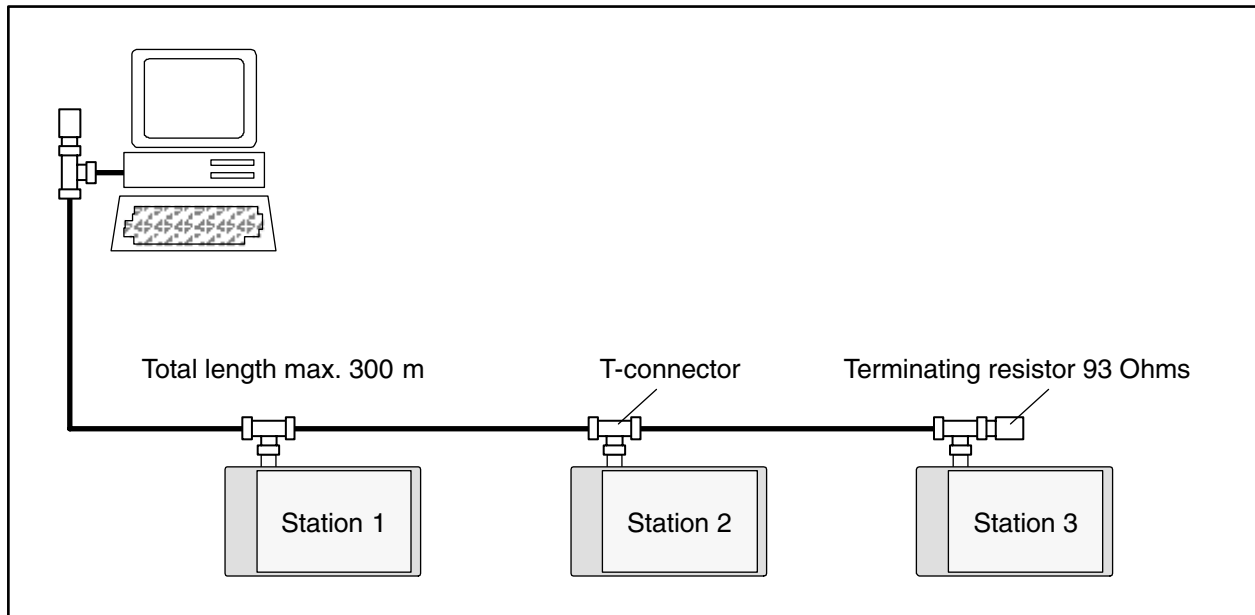


Figure: Linear ARCNET

Linear ARCNET, expanded by active distribution units (Active Hubs)

Active Hubs amplify the arriving signals. So they stabilize the network configuration and allow especially for high distances. The Active Hub decouples the station connectors from each other. Therefore, the entire network does not fail when one of the connections fails.

The maximum length of the network is 6 km.

A maximum of 255 stations can be used.

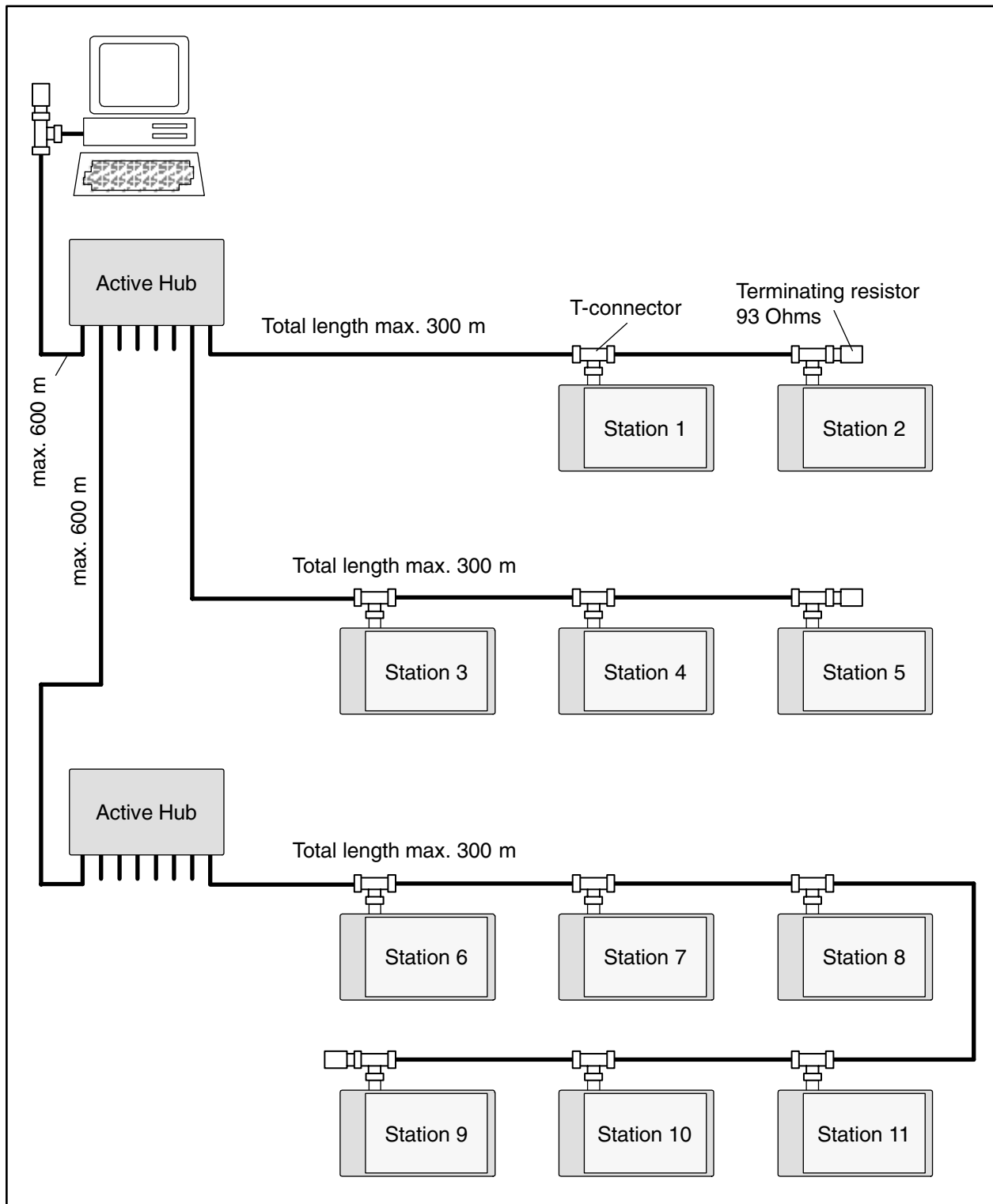


Figure: Linear ARCNET, expanded by active distribution units (Active Hubs)

Wiring

Bus cable:

Cable RG 62 A/U:
e.g. Lapp Kabel, Stuttgart
Telephone: 0711/7838-0

Plugs for bus cable:

BNC plugs 75 Ω : Order No. B-9005
BNC T plug 75 Ω : OrderNo. B-9083
BNC termination 93 Ω : Order No. B-9093
Rufenach Vertriebs-GmbH, Heidelberg
Telephon: +49 6221/8443-0
Telefax: +49 6221/8443-99

General considerations for EMC-conforming assembly and construction

Electric and electrical devices have to work correctly on site. This is also valid when electro-magnetic influences affect them in defined and/or expected strength. The devices themselves must not emit electro-magnetic noises.

Advant Controller components are developed and constructed so that they have a very high noise immunity. When the wiring and earthing instructions under "System data and system configuration" are met, an error-free operation is given.

However, there are applications where high electro-magnetic noises must be taken into due consideration already during the planning phase: e.g. when frequency converters, compressors, small-power pumps (high inductance) or mediumvoltage switchgear are mounted nearby. An EMC-compatible earthing concept will also guarantee an error-free operation here.

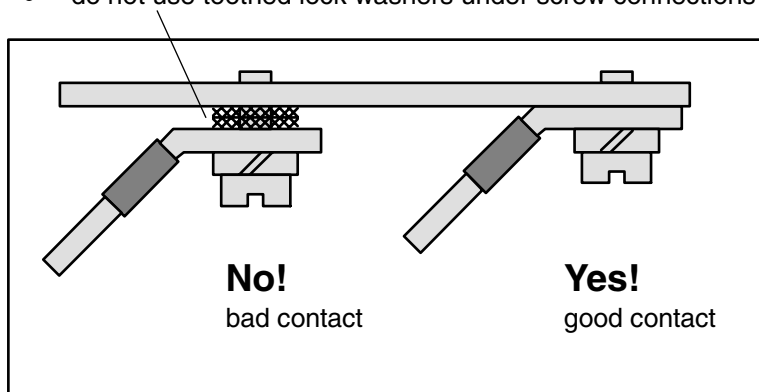
General principles

There are three important principles to be especially considered:

- Keep all connections as short as possible (in particular the earthing conductors)
- Use large conductor cross sections (in particular for the earthing conductors)
- Create low-impedance, i.e. good and large-sized contacts (in particular for the earthing conductors)

In particular:

- vibration-resistant connections
- clean metallic contact areas (remove paint, clean surfaces)
- if possible, do not use aluminium parts (they oxidize)
- solid plug and screw-type connections
- earth cable shields with clips on a well-grounded metallic surface
- do not use sheath wires
- do not use toothed lock washers under screw connections



Make a connection between the DIN rails and PE (Protective Earth). For this, use an earthing wire with a minimum conductor cross section of 10 mm². The wire is connected to the DIN rail with an M6 screw according to the drawing above. A large-area contact of the DIN rail with the metallic mounting plate improves the EMC behaviour significantly, as the disturbances can be discharged more effectively.

Cable routing

- Route cables meeting the standards.
- Sort the cables into cable groups (power current cables, power supply cables, signal cables and data cables)
- Rout signal cables and data cables separately from the power cables, i.e. in separate cable ducts or cable bundles. The distance should be 20 cm or greater.
- Lay signal and data cables close to earthed surfaces.

Cable shields

- Only use shielded data cables. The shield should be earthed at both ends. Make sure that no parasitic currents can flow through the cable shields. This can be done by installing current-carrying equipotential bondings.
- A cable shield only earthed at one end can only protect from capacitively coupled interference and low-frequency disturbances (50 Hz hum).
- Use only cables with braided shields. Foil shields are not robust enough, cannot be contacted well and have poor HF properties.
- Only use metallic or metal-plated plugs for shielded data cables.
- For analog signals, only use shielded cables. Earth the shield only at one end for small signals.
- Earth the cable shield directly with a clip when entering the switch-gear cabinet. Do not cut the shield until the cable reaches the module connected.
- The connection between the PE bar and the shield bar must have a low impedance.

Switch-gear cabinet

- The connections between the switch-gear cabinet, the mounting plates, the PE bar and the shield bar must have a low impedance.
- Earth the switch-gear cabinet doors with short and highly flexible conductors.
- For illumination of the switch-gear cabinet, only use filament lamps (bulbs) or fluorescent tubes with interference suppression to prevent the control system being disturbed.
- For supplying the PC, use the mains socket which is located inside the switch-gear cabinet. In this way, all earthing measures are performed with short conductors and no parasitic currents can flow even in case of non-isolated interfaces.

Reference potential

- Provide a uniform reference potential in the entire installation and earth all electrical appliances if possible.
- Route your earthing conductors in a star configuration so that no earth loops can occur.

Equipotential bonding

- Install sufficiently dimensioned equipotential bondings, if potential differences are present or have to be expected in your application between different parts of the installation.
- The impedance of a equipotential bonding must be equal or lower than 10 % of the shield impedance of the shielded signal cables between the same points.
- The conductor cross section of a equipotential bonding must be able to withstand the maximum possible compensating current. By experience, a conductor cross section of 16 mm² has proven to be sufficient.
- Equipotential bondings and shielded signal cables should be laid close to each other. This prevents coming up inductive loops in which disturbances could be induced.
- Equipotential bondings must be connected to PE with low impedance.

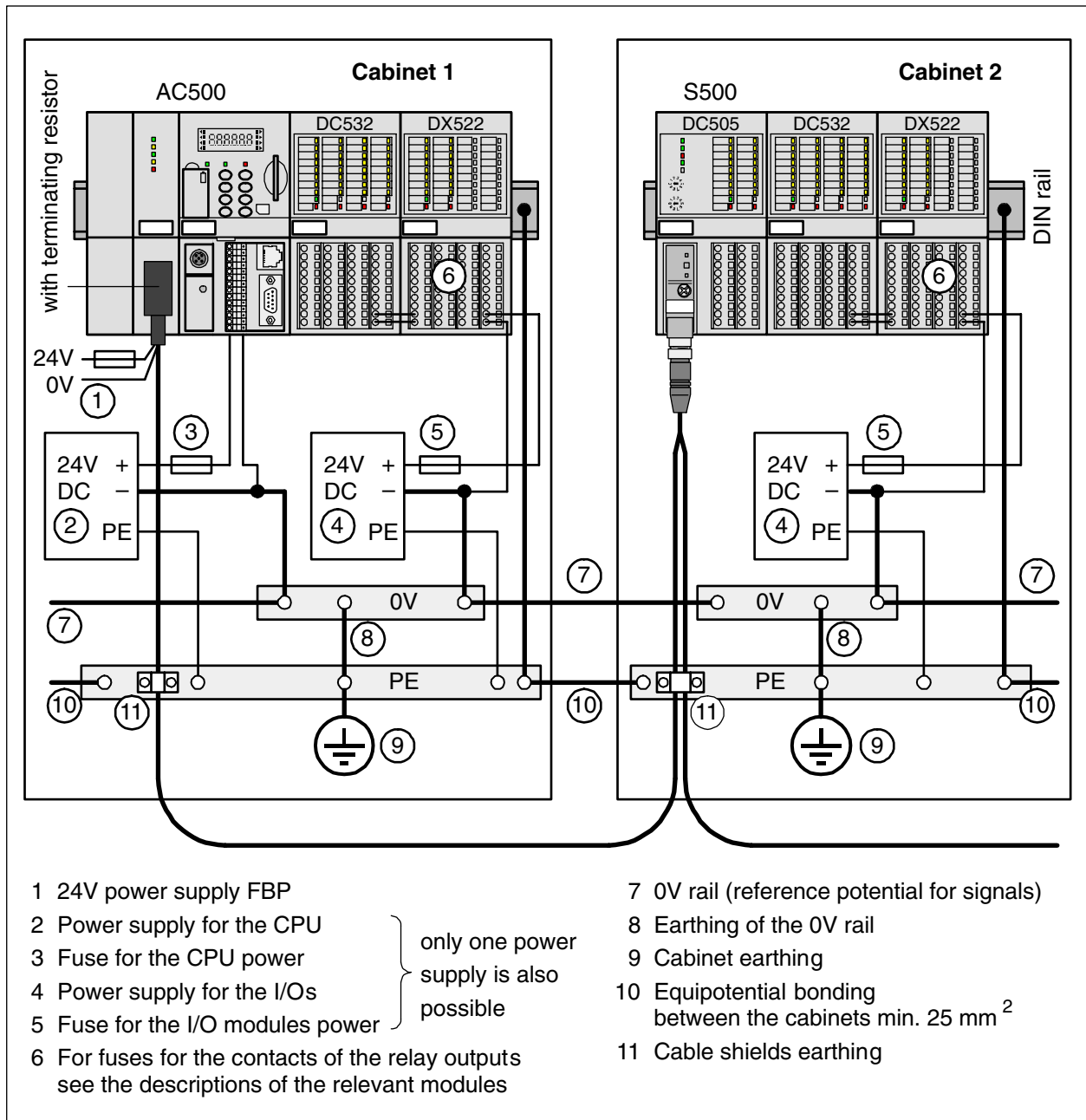


Figure: AC500, equipotential bondings