MOELLER

EMC Engineering Guidelines For Automation Systems

PS 4
PS 416

04/97 AWB 27-1287-GB

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1 Fundamentals of Interference-Free Design

General comments

In order to meet EMC requirements the wiring of systems using the PS 4 and PS 416 must observe certain rules:

In particular a uniform reference potential must be created.

The reference potential is formed by the totality of all conductively interconnected, inactive metal structures:

- Control cabinet
- Cabinet door(s)
- Support bars
- Mounting plate
- Top-hat rail
- etc.

Here you should ensure that there is a low-impedance, conductive connection between all inactive metal structures.

The following sections will show you the right way to design your wiring systems.

The following rules must always be observed when installing cables :

- Cables should be grouped by function and then routed so that they are kept spatially separated.
- Cables with different functions should not be run in parallel.
- Power cables and signal or data lines should be kept at least 10 cm apart.

Low-impedance connection

A low-impedance connection is achieved in the following way:

A large-area, low-impedance metal-to-metal connection

The use of flexible earthing strips

Short connecting wires with a large surface area and contact surface

A conventional PE conductor with a small cross-section will not be adequate.

In the case of enamelled, anodized or insulated metal parts remove the insulating layer in the vicinity of the connecting point. Protect the connecting points against corrosion (for example, by greasing. Important: use only suitable lubricants).

The connections of the reference surfaces should comply with the pertinent regulations.

2 Construction of Reference Potential Surfaces

The construction of the reference potential surfaces is described below - from control cabinet design through to connecting up equipment.

Control cabinet design

The control cabinet housing is a part of the reference potential surface.

To be sure that you have an adequate reference potential surface you will need to observe the following rules:

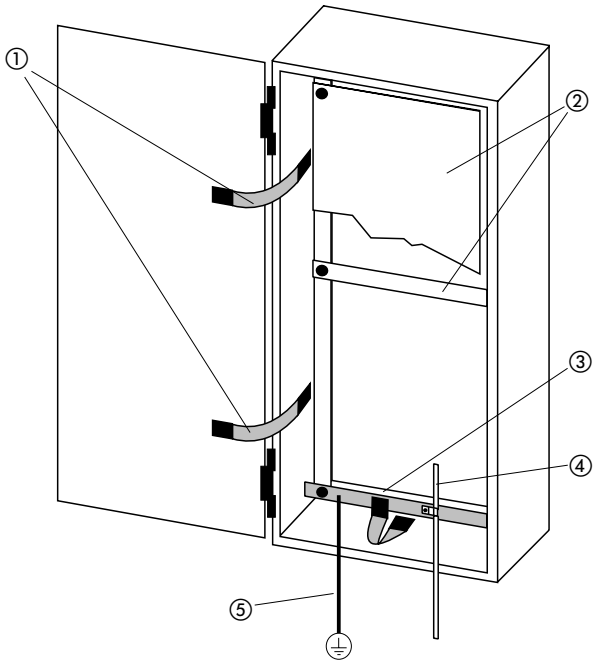

Figure 1: Installation

① Connect all inactive metal parts (cabinet doors, side parts and so on) to the reference potential surface ensuring you have a large area and low impedance connection.

② Connect mounting plates together so that they then form a common reference potential surface.

③ Make a large-area low-impedance connection between the protective conductor bar and the reference potential surface (cabinet housing).

④ Connect the guard screen of the screened cables to the reference potential surface using a suitable fastener (cable clip) and making sure the connection is large-area and low-impedance. The

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cable clip must sit snugly around the entire circumference of the cable screen.

⑤ Connect the external protective circuit (potential to earth) to the control cabinet reference potential (internal protective conductor bar) with a large-area and low-impedance connection.

Protect the all chassis earth connections against corrosion.

Mounting plates, CI distribution boards

You should use mounting plates as your base.

Connect the mounting plates to the control cabinet with a low-impedance connection.

Use mounting plates made of galvanized sheet steel (no enamelling).

The CI distribution board must be fitted with a galvanized mounting plate. The mounting plate of the CI distribution board forms the reference potential surface.

Total insulation is cancelled by implementing the provisions of “Reference potential surface”.

Make sure that connecting points are protected against corrosion.

Mounting plates must be connected not only to each other but also to the internal protective circuit with low-impedance and large-area connections so as to form one overall reference potential surface. Here you should connect the mounting plates, mounting sub-plates, metal device plates to the cabinet earthing system as often as possible.

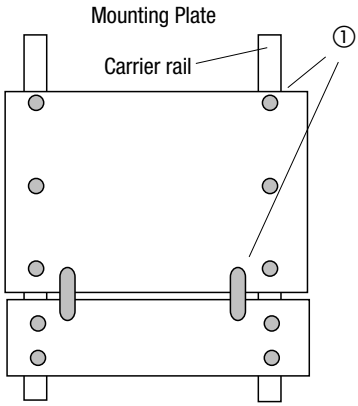

Figure 2: Large-area connections

① Divided mounting plates as a whole are inactive metal parts and thus form a constituent part of the reference surface. This is why they must also be connected together with low-impedance connections (for example, using galvanized earthing strips).

Fitting top-hat rails

Fasten the top-hat rail to the mounting plate with a large-area and low-impedance connection.

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Use commercially available top-hat rails that are corrosion-proofed.

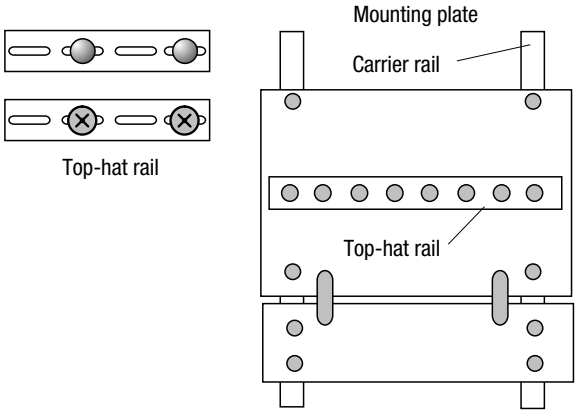

Figure 3: Fastening the top-hat rail

Use screws or rivets for a large-area and low-impedance connection of the top-hat rail with the support system.

In the case of enamelled, anodized or insulated metal parts remove the insulating layer in the vicinity of the connecting point. Protect the connecting points against corrosion (for example, by greasing. Important: use only suitable lubricants).

Use of screened cables

The following wires or cables must always be screened:

- Communications lines
- Analog lines
- Counter lines
- Inter-building data or signal lines (lightning protection) and so on.

The cable screen must be earthed as close as possible to the system's source of interference.

Always connect both ends of the cable screen to potential to earth. Do not forget here that the potential to earth may have different potentials at the earthing positions.

In this case you will need to install a supplementary equipotential bonding conductor with a cross-section of $\geq 10\ mm^2$.

Caution!
The cable screen must not be used for equipotential bonding.

The exposed ends of the cable should be kept as short as possible!

Incoming external screen cables

Connect the incoming screen cable to the local reference potential surface. Make this connection immediately after entry of the cable into the syste (control cabinet, frame, mounting plate).

The following contact paths are possible:

① Clamp strap → snap-on mounting → top-hat rail → reference potential surface

② Contact clamp → snap-on mounting → top-hat rail → reference potential surface

③ Contact clamp → screwed connection to the busbar → reference potential surface

④ Clamp strap → screwed connection to the busbar → reference potential surface

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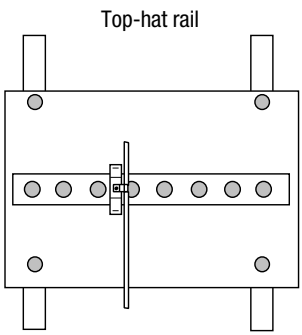

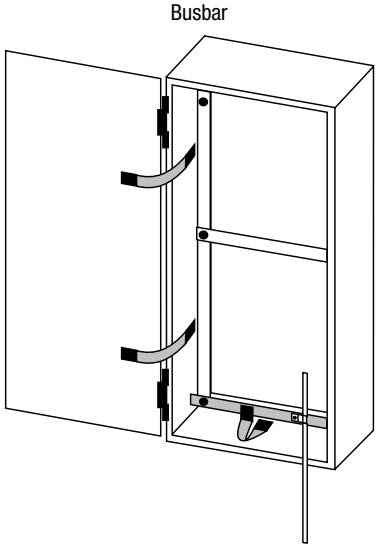

	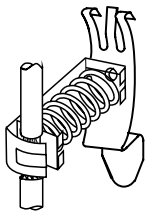	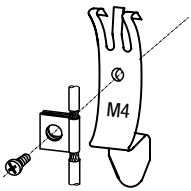	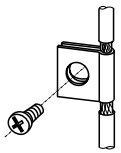	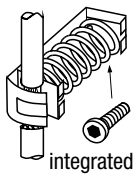
Top-hat rail	①	②		
Busbar			③	④

Remove the insulation of screened lines at the contact point. Make sure that the screen braid does not get broken or damaged.

It is important that the connection of the busbar with the reference potential surface is short and of low impedance (no insulated segments)!

▶ Make a new braided screen contact as close as possible to the device.

Inter-building wiring system: screening the line

For lightning protection in accordance with ENV 50 142 you should use a suitable surge arrester. Surge arresters manufactured by Messrs Dehn, for example, are suitable here.

All inter-building wires and cables must be screened. The screenscreen must not be used as a equipotential bonding conductor as it does not have the requisite current-carrying capacity.

For signal lines you should install suitable overvoltage protective devices.

These protectors should be fitted wherever possible at the point where the cable enters the building, but never later than the control cabinet.

Inter-building lines which are included in the equipotential bonding will need to be routed within metal conduits. These metal conduits must then be earthed at both ends.

The minimum cross-sections of the lighting protection equipotential bonding conductors specified by IEC 61 024-1 are as follows:

16 mm^2	copper
25 mm^2	aluminium
50 mm^2	iron

With this kind of installation it is not necessary to connect the screen to the equipotential bonding.

In addition, with the first consumer in each case following entry into the building you will need to connect a blue surge voltage protector clamp (secondary protector). Then earth the yellow and green terminal of this clamp at the next earthing position.

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3 Earthing Devices

PS 4 compact PLCs **Installation on top-hat rail**

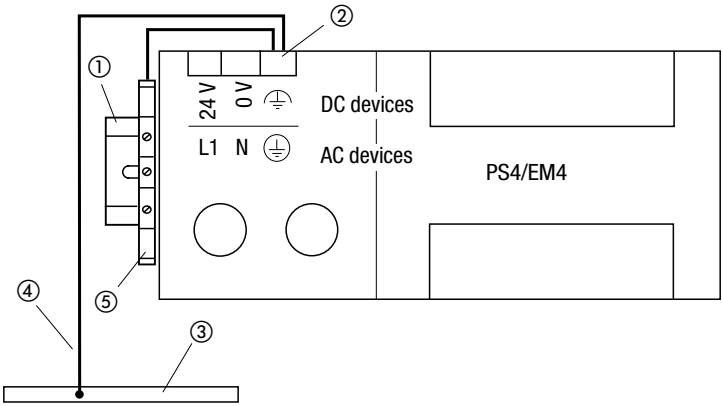

Figure 4: Device earthing when installing on top-hat rail

① Top-hat rail

② Functional earthing (with DC devices)
Protective and functional earthing (with AC devices)

③ Protective conductor bar

④ Connection only with AC devices

⑤ Protective conductor clamp

DC devices:
Connect the functional earthing to the reference potential surface as short as possible with a 2.5 mm^2 core cross-section via a protective conductor clamp and top-hat rail – for example, from Weidmüller or Phoenix.

AC devices:
Connect the protective and functional earthing to the reference potential surface as short as possible with a 1.5 mm^2 core cross-section via a protective conductor clamp and top-hat rail – for example, from Weidmüller or Phoenix. In addition the protective

earth should be connected as short as possible to the protective conductor bar with a 1.5 m ^{2} core cross-section.

Installation on mounting plates

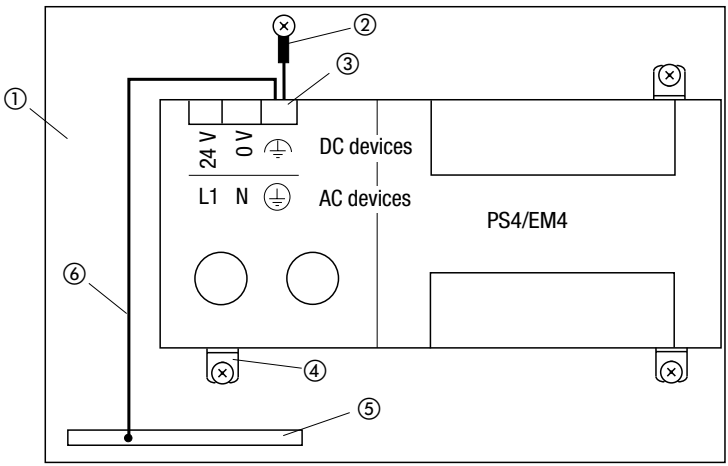

Figure 5: Device earthing when installing on mounting plates

① Mounting plate
② Cable lug
③ Functional earthing (with DC devices)
Protective and functional earthing (with AC devices)
④ Fixing feet
⑤ Protective conductor bar
⑥ Additional connection with AC devices, core cross-section 1.5 mm^2

DC devices:
Connect the functional earthing to the mounting plate (reference potential surface) as short as possible and with a 2.5 mm^2 core cross-section.

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The conductor is connected to the mounting plate via a highly conductive connection which should be as flat as possible; for example, a cable lug.

Connect the fixing feet to the mounting plate with a low-impedance connection.

AC devices:
Connect the protective and functional earthing to the mounting plate (reference potential surface) as short as possible and with a 1.5 mm^2 core cross-section. The protective earth should also be connected as short as possible to the protective conductor bar with a 1.5 mm^2 core cross-section.

The conductor is connected to the mounting plate via a low-impedance connection which should be as flat as possible; for example, a cable lug.

Connect the fixing feet to the mounting plate with a low-impedance connection.

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PS 416 series of modular PLCs

Rack

You should connect the rack to the carrier system (mounting plate, rack frame, hinged frame and so on) with a low-impedance connection of maximum area.

Connect the rack to the protective conductor bar. The protective earthing cable used here must have a cross-section of $\geq 6\ mm^2$.

The side panels of the rack have been designed to include a connection for the protective earthing cable.

Fix the protective earthing cable to the side panel using a punched cable lug (of the correct size!) .

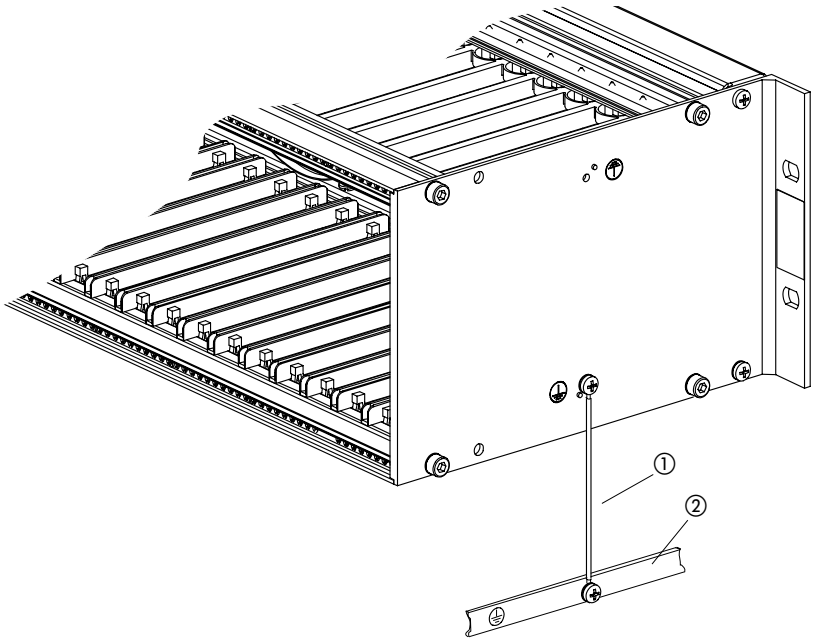

Figure 6: Earthing the rack

① Protective earthing cable
② Protective conductor bar

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Avoiding RF interference signals, ferrite ring

If RF interference signals are to be avoided, when installing the assemblies you will need to fit the data lines – and possibly also the supply lines – with ferrite rings.

Card	Ferrite ring for supply lin	Ferrite ring for data line
Power supply card PS 416-POW-400	×	
Power supply card PS 416-POW-420	×	
Digital output card PS 416-OUT-400	×	
Digital output card PS 416-OUT-410	×	
Counter card PS 416-CNT-200	×	×
Communications card PS 416-NET-210		×
Communications card PS 416-NET-220		×
Communications card PS 416-NET-230		×
Communications card PS 416-MOD-200		×
Communications card PS 416-COM-200		×

Fit the ferrite ring directly below the potential equalisation bar. If it is to function correctly the ferrite ring must fit the cable snugly.

Use two cable ties at the cable to hold the ferrite ring.

After the ferrite ring there should not be any onward runs to other devices.

The ferrite ring is not included in the scope of supply of the cards.

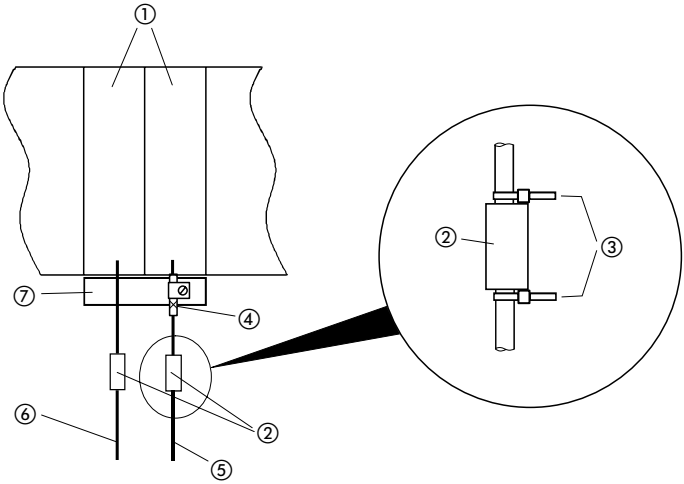

Figure 7: Fitting the ferrite ring

① Cards
② Ferrite ring P S416-ZBX-405
③ Cable ties
④ Screen connection
⑤ Screened data line
⑥ Supply line
⑦ Potential equalisation bar

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4 Installing a Screen Line Inside a Control C abinet

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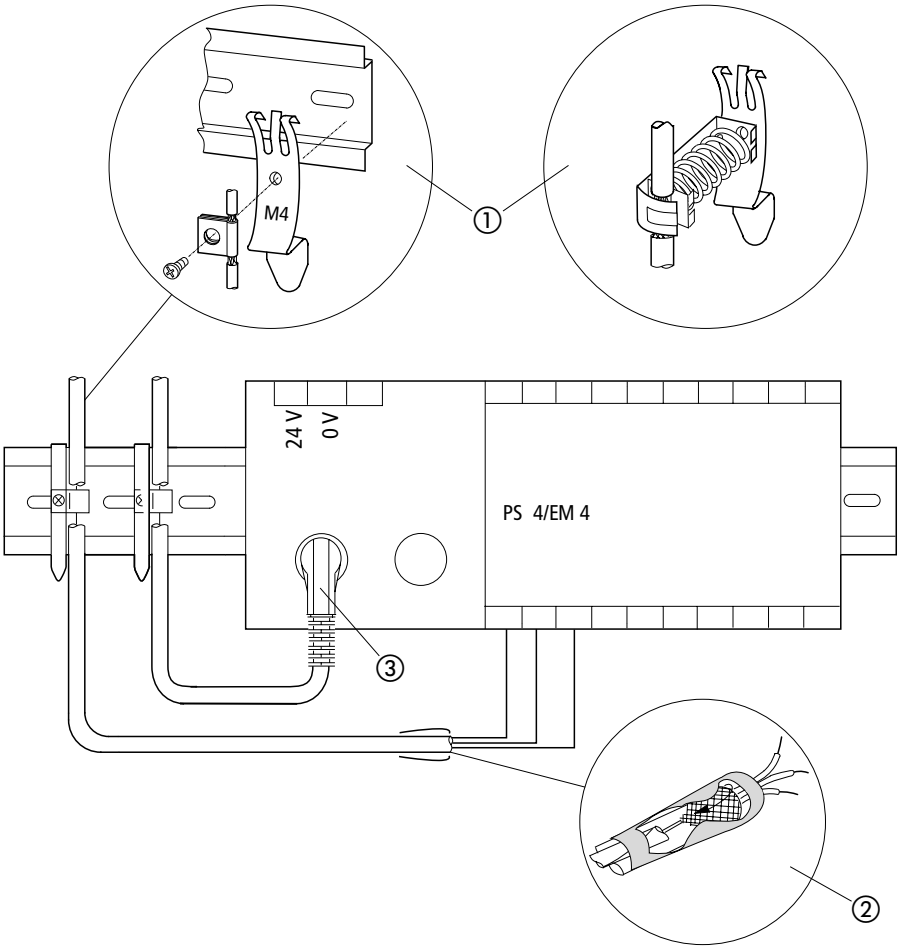

Figure 8: Screen connection to reference potential surface

① Route the screen wire on the left or right in the device using the shortest path.

② If a DIN connector is used, connect the braided screen with the metal sleeve of the plug.

③ Insulate the end of the braided screen as close as possible to the point where the signal line enters the device.

PS 416 modular PLCs

A suitable potential equalisation bar for connecting the cable screens can be ordered. The strip is not included in the scope of supply of the racks.

The strip is fitted to the bottom front edge of the rack. For this purpose three screws are enclosed with the strip. When attached in this way the strip forms part of the overall reference potential surface.

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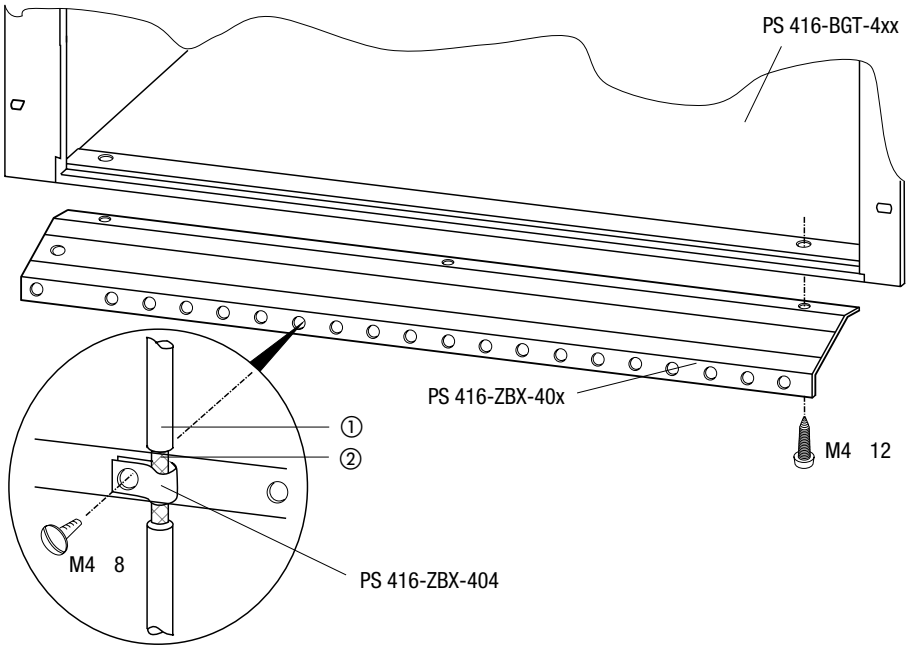
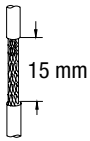


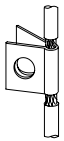
Figure 9: Connecting the cable screens

① Cable
② Screen

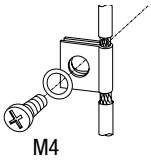
Use a cable clip to connect the cable screen to the potential equalisation bar with a large-area and low-impedance connection. The cable clip must sit snugly around the entire circumference of the cable screen.



Strip back the cable insulation 15 mm.



Bend the cable clip on. Place the clip over the cut-back part of the cable.



Pinch the clip together and screw it tightly onto the potential equalisation bar.

Caution!
The potential equalisation bar must not be used for relieving strain on the signal lines or cables.

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5 ESD Measures

In order to protect the PS 4 and PS 416 programmable controllers against electrostatic discharge, before touching control elements, interfaces and / or data connectors and so on the operator must earth himself (discharge static electricity) by touching a earthed surface.

Make sure when using the programmable controllers under normal operation (operating mode 'Run') that

- the front panels are closed,
- the front covers are inserted or fitted in place.

6 Lightning Protection

Lightning protection is divided into internal and external lightning protection.

By external lightning protection is meant the diversion of the lightning stroke current outside buildings directly into the earthing system.

Internal lightning protection limits the effects of the lightning stroke current – for example, electromagnetic fields and overvoltages – on the electrical equipment downstream.

The upstream surge arrester does not form part of the scope of supply of automation equipment.

The following illustration shows an example of an upstream surge arrester.

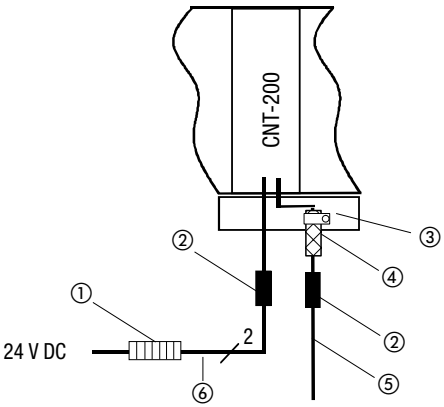

Figure 10: Use of an upstream surge arrester

① Lightning protector
② Ferrite ring
③ Potential equalisation bar
④ Screen
⑤ Data line
⑥ Supply line

7 Accessories for Interference-free Design

Snap-on mounting for the top-hat rail	for example, Weidmülle	FM4 / TS35	Order number: 068790
Screen earth kit	Klöckner-Moelle	ZB 4-102-KS1	
Clamp strap for snap-on mounting	for example, Weidmülle	KLBü 3-8 SC	Order number: 169226
Protective conductor clamp for the top-hat rail	for example, Weidmüller, Phoenix Wago		
Earthing strip, tinned	for example, Schlemmer GmbH, Postfach 1309, 85582 Poing, Germany Cross-section $\geq$ 16 mm^2		Item number Schlemmer: 7697536
Ferrite rin	Klöckner-Moelle	PS 416-ZBX-40	Order number: 025519
Potential equalisation bar for rack PS 416-BGT-420/421 PS 416-BGT-410 PS 416-BGT-400	Klöckner-Moelle	 PS 416-ZBX-40 PS 416-ZBX-40 PS 416-ZBX-40	Order number: 054124 054125 054126
Upstream surge arreste	Equipment from, for example, Messrs. Dehn		

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