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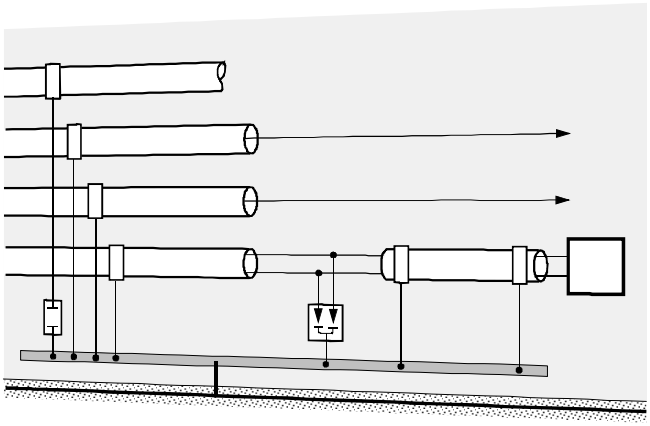

# Installation of Heating Plant in Compliance with EMC Directives

For architects, electrical consulting engineers, electrical contractors and control panel manufacturers

**As a general principle, all items of plant equipment must be installed according to the suppliers' instructions and as directed by national laws and standards. This document contains basic guidelines rather than specific requirements for the installation of Landis & Staefa products. Specific instructions to be observed during installation will be found only in the installation instructions for each product. In certain cases, this information may not accord with the statements given below.**

## Background

⚠ EMC problems and electrical interference mean unsatisfied customers and bothersome troubleshooting. For this reason, it is advisable to plan the installation of plant in compliance with EMC directives. The recommendations contained in this document are intended to help avoid or overcome such problems.

⚠ Every power cable can produce interference. Short-time voltage surges, so-called transients, are primarily caused by switching operations of inductive loads such as motors, contactors, pumps, magnetic valves, etc. These surges have a capacitive effect on neighboring signal or bus cables and lead to unexpected interference in plants or sections of plant. In practice, the level of interference depends on the way the plant is designed and installed. As a result, the risk of encountering EMC problems depends on a number of factors.

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Siemens Building Technologies
**Landis & Staefa Division**

There are 3 practical ways to fight EMC problems:

1. Prevent sparks on electrical contacts by using spark quenching devices.
   The main sources of electrical sparks are inductive loads, such as industrial relays, contactors, etc.
2. Reduce the looped areas between cables and between cables and the reference ground.
3. Use screened and twisted bus and signal cables.

## Terminology

**Grounding**
Electrically conductive connection of equipment with a reference ground.
This is the most important measure as screening and filtering can only work properly when the grounding is effective.

**Reference ground**
Within the scope of this document: grounding system that satisfies high frequency requirements, aimed at diverting interference currents to the ground. Cable ducts made of metal and equipotential bonding systems are part of the reference grounding system.

**Earth**
Electrical connection of one point of the operating circuit or of a metal component to the protective earth (PE).

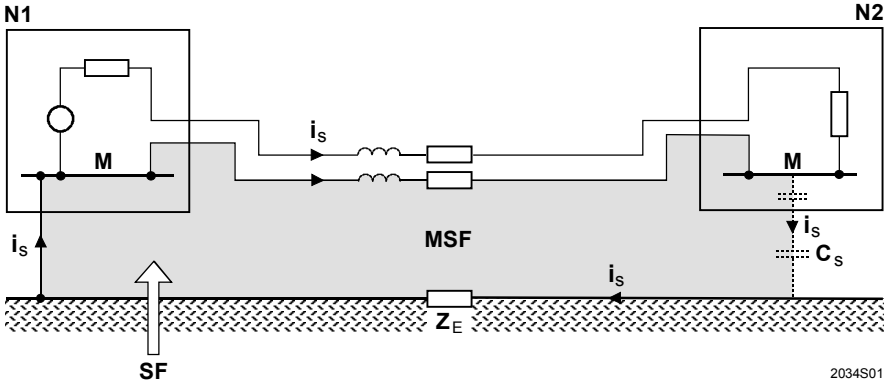
**Earthing**
The sum of all earthing measures.
Earthing protects the occupants of a building against electric shocks. It is normally accomplished by means of the protective earth wire, which is green / yellow.

**Looped area**
Area created between cables and the reference ground (common mode coupling) or between 2 cables (differential mode coupling).

## Cable routing

Signal and bus cables should always be segregated from mains cables while observing adequate distances.

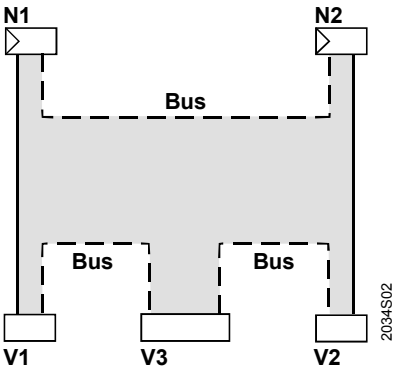
- The greatest possible distance seems desirable. Too great distances create too great looped areas, however, which in turn favor couplings from the field caused by lightning currents or mobile phones, for instance



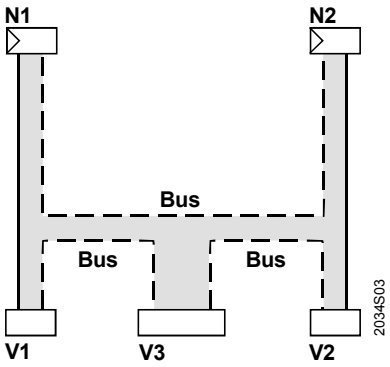

Principle of common mode coupling.
Interference field induces interference currents on the signal transmission line.

| | |
|---|---|
| N1 | Controller 1 |
| N2 | Controller 2 |
| $i_s$ | Interference current |
| $C_s$ | Stray capacitance |
| M | Ground |
| MSF | Decisive looped area for coupling from the field |
| SF | Electromagnetic interference field |
| $Z_E$ | Earth resistance |

Example: 2 controllers with bus connection located in the same building. The bus cable is laid far away from the mains cable, e.g. on the opposite side of the building. This results in a large looped area and, therefore, in considerable interference!




Unsuitable cable routing




Reduction of looped areas
Preferred cable routing

| | |
|---|---|
| N1 | Controller 1 |
| N2 | Controller 2 |
| V1 | Conduit box 1 |
| V2 | Conduit box 2 |
| V3 | Control panel |
| - - - | Bus cable |
| ——— | Mains power cable |
| | Looped area |

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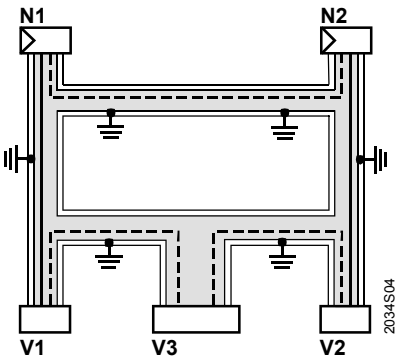
- Conclusion: lay cables together, but always observe a distance of 15 to 20 cm!
- Cables from controllers to pumps, burners, actuators, etc., are also considered to be mains cables causing interference
- Unfortunately, regulations for electrical building installations still allow signal and mains cables to be run in the same plastic duct, provided the insulation is in compliance with the safety requirements. From the EMC point of view, this is extremely unfavorable
- Wherever possible, lay the cables on the reference ground in metal cable ducts that are electrically properly interconnected, both between themselves and against the reference ground



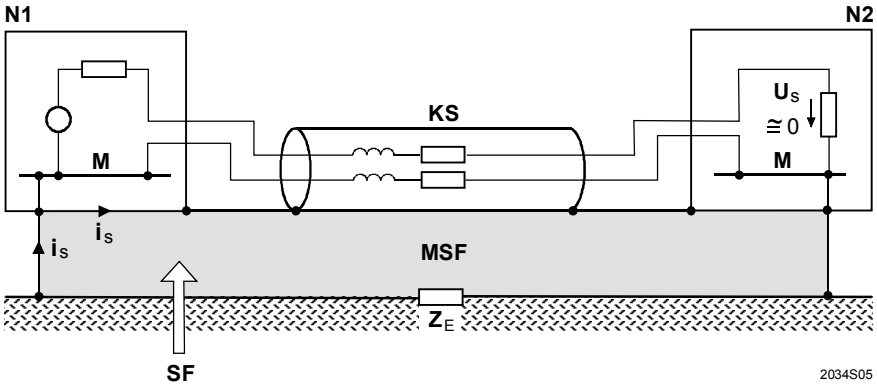

| | |
|---|---|
| N1 | Controller 1 |
| N2 | Controller 2 |
| V1 | Conduit box 1 |
| V2 | Conduit box 2 |
| V3 | Control panel |
| - - - | Bus cable |
| ——— | Mains cable |
| ═══ | Metal cable duct |
| | Looped area |

Reduction of looped areas
Optimum cable routing in metal cable ducts

Metal cable ducts reduce the looped area against the ground.

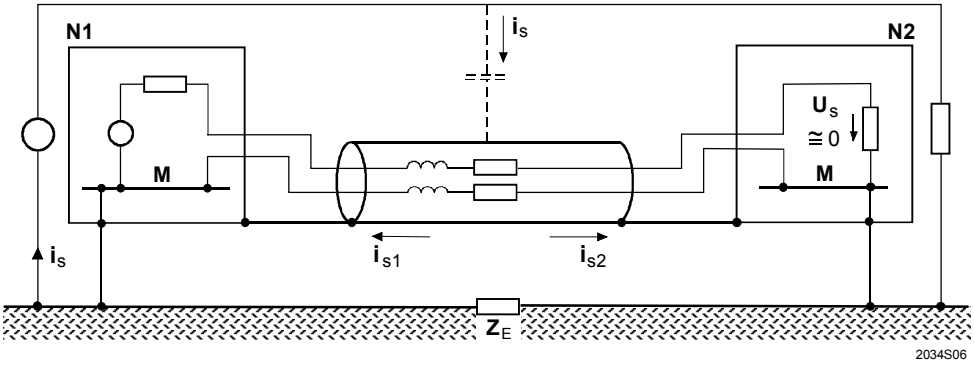
Screened cables offer very good protection.

- Braided screened cables with good coverage afford the best protection. Very important is the proper connection of the cable screen at both ends
- Foil screened cables should not be used. Foil screens are often plastic foils with a conductive coating on one side
- Twisted pairs of wires reduce differential mode coupling. Common mode interference currents (interference caused by inductive loads) are not reduced




Cable screen connected to the ground at both ends.
Immunity against **radiated and inductive coupling** is good.
The cable screen keeps the interference field away from the signal cable or diverts it to the ground.

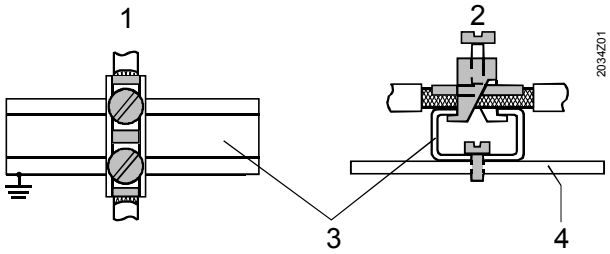
N1 Controller 1
N2 Controller 2
$i_s$ Interference current
$U_s$ Interference voltage
M Ground
MSF Decisive looped area for coupling from the field
KS Cable screen impedance ≅ 0 Ohm
SF Electromagnetic interference field
$Z_E$ Earth resistance




Cable screen connected to the ground at both ends.
Immunity against **capacitive coupling** is good.
The cable screen keeps capacitive coupling away from the signal cable or diverts it to the ground.

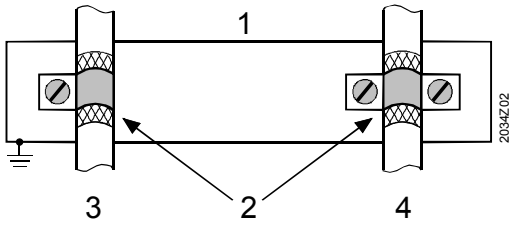
N1 Controller 1
N2 Controller 2
$i_s$ Interference current
$U_s$ Interference voltage
M Ground
$Z_E$ Earth resistance

- The whole circumference of the cable screen must be properly connected to the reference ground at both ends (equipotential bonding = building ground, control panel ground, etc.)
- It is recommended to connect the cable screens to the ground rail or to the metal mounting plate using suitable clamps



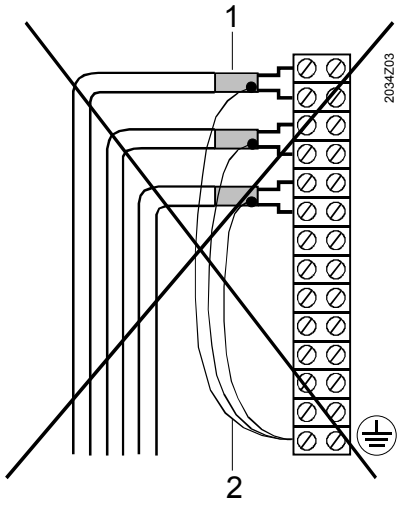

1 Protective earth terminal
2 Cable clamp
3 Rail
4 Metal plate

Connection of cable screen




1 Ground rail
2 Cable clamp
3 Good
4 Better

Connection of cable screen




1 Screening
2 “Pigtails“

Unsuitable connection of cable screen by so-called “pigtails“

Screened cables

- The distance required between correctly screened cables and parallel running mains cables may even be zero. It is better, however, to observe a distance of about 15 cm
- Screened cables to room units: in general, proper grounding at the room unit is not possible. For this reason, the cable screen is connected to the ground only at the controller

Unscreened cables

- Unscreened cables are much more susceptible to interference than screened cables. Both wires should be twisted
- If there are parallel running mains cables, a distance of 15 to 20 cm is mandatory
- It is recommended to rout mains and signal cables in metal cable ducts
- If plastic ducts are used, signal and mains cables must be laid in separate ducts observing a distance of 15 to 20 cm

### Mains cables

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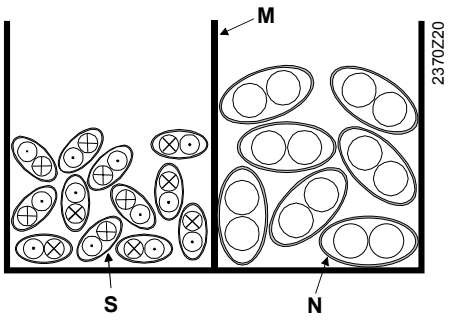
In situations that are difficult from the point of view of EMC, it is recommended to use screened power cables for motors, actuators, etc. In the case of power cables for frequency converters, screened cables are strongly recommended.

- Such cables are available in the form of mineral insulated copper-clad cables (MICC), for instance
- Naturally, the screening of such cables must be properly connected to the ground at both ends

### Cable ducts

Metal cable ducts afford very good immunity against interference because the signal cables or mains cables are laid on the reference ground.

- The looped area against the ground is thus reduced, provided the individual sections are electrically properly interconnected via large surfaces
- Cable ducts must be connected to the reference ground = equipotential bonding every 20 m, but at least once on every floor
- If mains and signal cables must be run in the same cable duct, the duct must be made of metal and be closed on 3 sides (see illustration below)
- The metal partition in the middle segregates the mains cables from the signal cables




S Signal lines
N Mains cables
M Metal duct with metal partition

### Surge protection with bus connections between buildings

Wherever a bus cable enters or leaves a building, the proper installation of a 3-step surge protector that ensures protection against lightning effects is mandatory.

⚠ Restrictions

The proposed surge protection does not offer protection against constant overvoltages (mains voltage) and surges that affect the terminal units via the building installation (water pipes or mains connection).

- The bus cable should enter the building at a location where the mains cable enters (single-point entry)
- Equipotential bonding system = reference ground must be fitted very close to the bus cable entry
- The surge protector must be mounted on a DIN rail which is to be connected to the equipotential bonding system using a short piece of copper (20 x 2 mm) to ensure good conductance

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- Note: the surge discharge current flows via the fixing of the surge protector to the DIN rail. Without this connection, there will be no protection!
- Each building requires a surge protector, such as the protector supplied by PHOENIX, consisting of plug-in unit UFBK-M 2-PE-48AC-ST (3-step surge protector) and basic unit UFBK BE (decoupling)
  Landis & Staefa has approved this type of surge protector for use with the LPB and M-bus

- The unprotected bus cable input must be connected to terminals 1 and 2 marked “IN”, the protected bus output to the controller to terminals 3 and 4 marked “OUT”
- Planning the bus topology: the capacitance of 2.3 nF per surge protector must be included in the permissible capacitive bus loading

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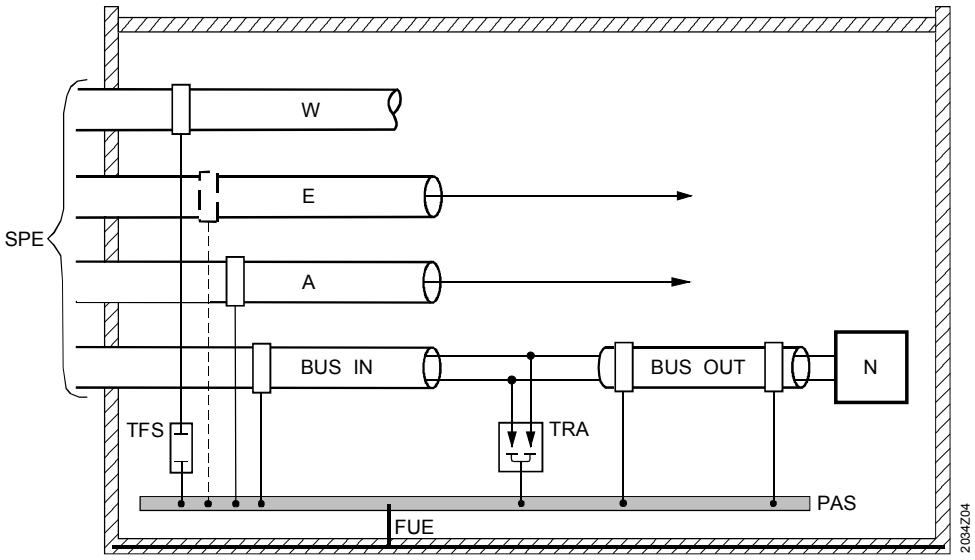
- At the point of entry to the building, the cable screen must be connected to the equipotential bonding system while ensuring good conductivity
- In normal situations, a TN-S mains network with separate protective and neutral conductors is now used. With buildings located in the same area, equipotential bonding is provided by the earth conductor
- Armoured mains supply lines must be properly connected to the equipotential bonding system where the supply lines enter the building
- In the case of long distance connections, equipotential bonding from one building to another is no longer ensured. In that case, only one side of the screen is to be earthed




Equipotential bonding and surge protection at the point of entry to the building (cellar)

| | |
|---|---|
| N | Controller |
| W | Water pipe |
| E | Power cable |
| A | Antenna cable |
| SPE | Single-point entry |
| TFS | Separate spark gap |
| FUE | Foundation earth |
| PAS | Equipotential bonding system |
| TRA | Surge protector |
| BUS IN | Unprotected |
| BUS OUT | Protected |

## Surge protection in plant with solar collector sensors

The surge protection device described below can never serve as a lightning conductor. It reduces the risk of damage to sensors and controllers.

In geographical areas with an average risk of damage, it is advisable to install one **surge protector (junction box with sensor protection device, type reference AGS2S200/109)** for each collector sensor.

- The junction box should be fitted as close as possible to the collector sensor
- The unprotected line input of the collector sensor must be connected to the terminal on the left marked “Input / Sensor / Fühler”, the protected output for the controller to the terminal on the right marked “Output / Controller / Regler”. Polarity is of no importance here

In geographical areas with a high risk of damage due to surges resulting from lightning effects, the best protection is offered by a correctly installed 3-step surge protector.

- A surge protector is required for each collector sensor line. It should be installed inside the building just after the cable entry point
- The surge protector must be mounted on a DIN rail that is to be connected to the closest building lightning grounding conductor using a short piece of copper (20 x 2 mm) to ensure good conductance
- If there is no proper building lightning protection, the local building insurance company should be contacted for the relevant regulations

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- Note: the surge discharge current flows via the fixing of the surge protector to the DIN rail. Without this connection, there will be no protection!
- Each collector sensor line requires a surge protector, such as the protector supplied by PHOENIX, consisting of plug-in unit UFBK-M2-PE-48AC-ST (3-step protector) and basic unit UFBK BE (decoupling).
  These surge protectors have been tested for use with sensor lines from Landis & Staefa
- The unprotected collector sensor line input must be connected to terminals 1 and 2 marked “IN”, the protected output to the controller to terminals 3 and 4 marked “OUT”

## Control panels

### Grounding

Metal mounting plates or the rear of control panels are the reference point for the cable screens and housings. They must be capable of isolating interference and of short-circuiting interference voltage.

- Interior walls should not be painted
- Interior walls should be galvanized as standard (to ensure protection against corrosion)
- Grates and rails must be electrically conductive and may not be painted
- Screwed connections must be made directly on bare surfaces of the control panel
- Use flat bonding conductors made of copper or flat meshes
- Establish ground connections to control panel doors via flat bonding conductors made of copper (connection in addition to the normal protective earth, if required)

### Control panel conforming to EMC directives

When planning the control panel, strong emitters of interference must be separated from other devices. Particular care must be taken with the electrical connections between these 2 groups of devices.

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- Strong emitters of interference: contactors and magnetic valves
- Interference-susceptible equipment: controllers, PCs, electronic devices

**Basic rule**

Separation of interference emitters and interference-susceptible equipment:

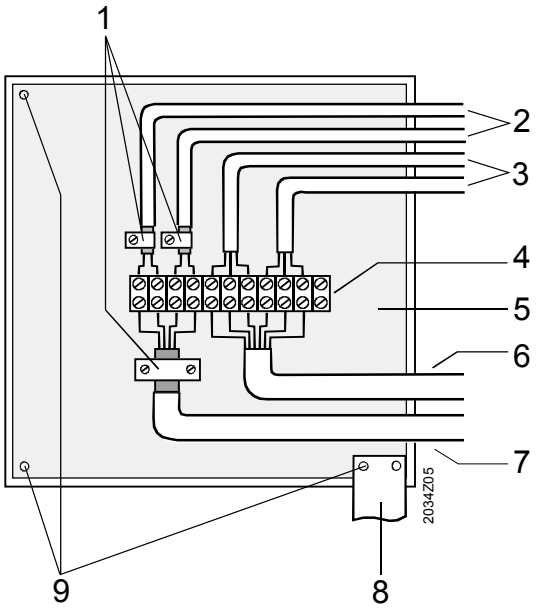
- Use separate control panels for strong interference emitters and interference-susceptible equipment
- If necessary, place strong sources of interference outside the control panel without infringing the safety regulations for the relevant devices
- Use a partition inside the control panel

**Connections conforming to EMC directives**

- Run interference-susceptible cables separately as close as possible to the reference ground (metal mounting plate or control panel)
- Single-point entry: all connections on the same side of the control panel (mains and control cables / inputs and outputs)
- Cable loops should be avoided
- Provide sufficient space for the connection of cable screens
- Integration of the control panel into the building's equipotential bonding system

**Connecting the cable screens**

Prerequisite for the proper connection of the cable screen is the availability of a reference ground. The reference ground is used to divert interference currents that flow through the cable screens.




1 Connection of cable screens with metal clamps
2 Screened sensor cables
3 Control cable from the process
4 Terminal strip
5 Metal baseplate
6 Unscreened primary cable
7 Screened primary cable
8 Connection to equipotential bonding system
**9** Grounding to the metal box

Correct mounting of the cable screens inside junction boxes

- The connection of cable screens must be circumferential and made directly to the reference ground, preferably with metal clamping devices, such as cable clamps
- "Pigtails" for the connection of cable screens are unsuitable, even if only a few cm long
- Cable screens must always be properly connected to the reference ground and, usually, at both ends (housing, control panel)

**Spark quenching**

Inductive plant components such as industrial relays, contactors, magnetic valves, etc., must be fitted with adequate spark quenching using an RC unit which is to be connected in parallel to the coil causing the interference.

- Suitable RC units are commercially available
- An alternative solution which causes practically no interference is the use of solid state relays
- Varistors (zink oxide resistors) ensure voltage limitations, but do not provide adequate spark quenching
- If, in spite of correct cable routing and the use of screened cables, interference occurs, it is advisable to make certain that all inductive loads contained in the building are in compliance with EMC directives. For spark quenching, all inductive loads, such as motors, contactors, fluorescent lamps, etc., must be used with an RC unit connected in parallel

Sources

"EMV-gerechte Gebäude- und Schaltschrankinstallation" (documentation provided by montena emc sa, CH-1728 Rossens)

"EMV von Gebäuden, Anlagen und Geräten"
Anton Kohling (editor)
VDE Verlag