

## Mounting instructions

EMC cannot be achieved by the use of EMC filters alone. It must be considered as an integrated system and requires careful planning and preparations. Measures such as shielded motor leads, grounding and spatial separation are mandatory parts of such an integrated concept.

### Plan your EMC!

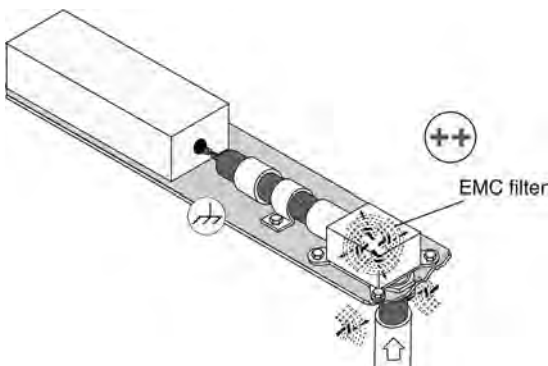
- Identify your interference sources (with interference emissions) and interference sinks (equipment or components with limited interference immunity).
- Assign interference sources and sink to specific zones (mounting sites) and separate them spatially from each other.
- Plan your cabling according to the corresponding categories for interference emissions and interference immunity.

**EMC is an indispensable quality feature.** The statutory protection requirements and technical risks must already be considered during the development phase of the system.

To ensure the electromagnetic compatibility of the total systems, the following points must be observed:<sup>1)</sup>

#### 1. The filter casing should be connected across a large area to ground and the other equipment.


For example, a bare metallic mounting plate should be provided jointly for filters and converters, well grounded and connected across a large area to the switching cabinet with a low-inductance connection. If necessary, use short ground straps and EMC gaskets (e.g. connection to switching cabinet doors).



<sup>1)</sup> The diagrams in the section "Assembly notes" were provided by Rittal GmbH Co. KG, Herborn and by Invensys Systems GmbH EUROTHERM, Limburg/ Lahn.

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2. Be sure to distinguish between:
  - The PE conductor connection of the EMC filter (see also the requirements on the PE connection in "General technical information", Section 8.4), which assures protection against hazardous body currents, and
  - the large-area grounding of the filter, which is required for the interference suppression function of the filter.

 At operating currents >250 A, we recommend not to run the PE connection between the supply (filter: Line) and output (filter: Load) via the PE pin in the filter housing. This is because of the limited area of the cable socket at the PE terminal to the filter housing. The PE conductor of the supply should preferentially be connected with the PE conductor of the outputs on a PE conductor busbar to which the PE terminals of the EMC filter are also connected. The number of necessary PE connections to the filter depend on the cross section and the required KU factor, which result from the magnitude of the leakage current (see also the safety notes in the "General technical information" Section 8.4). The PE conductor connections must satisfy the requirements of IEC 60364-5-54. At currents >1000 A and/or short circuit currents >25 kA, the PE conductor must not be "looped" via the filter housing.

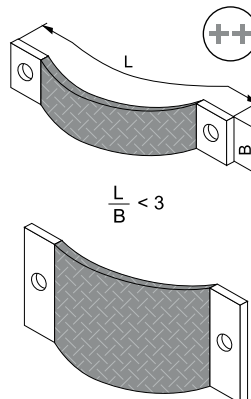
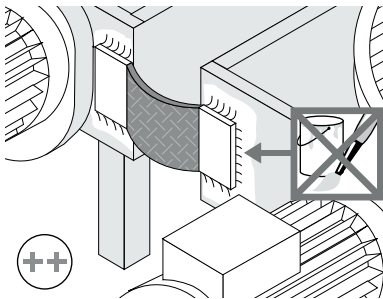
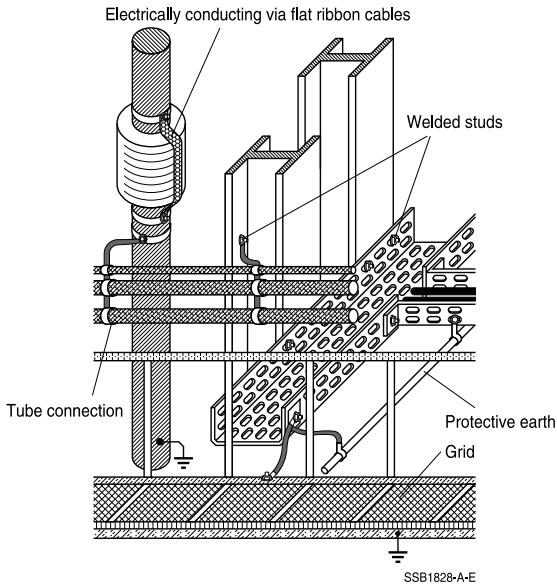
3. **Set up connections in your system with the same reference potential** in order to reduce electrically coupled interference. All metallic reference potentials of cases, machine and equipment parts should be connected via low-resistance connections suitable for high frequencies and should be interconnected as far as possible.

Set up large-area metallic connections, use the potential equalization busbars and set up short connections via flat-ribbon grounding cables.

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The following should be ensured:

- Large-area conducting attachments
- Low-induction connections (a right-angled flat copper ribbon is to be preferred to circular conductors)
- Short connections (rule of thumb: length divided by width < 3)



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### 4. **Keep leads from the interference source as short as possible!**

Examples:

- A short connection from the converter to the EMC filter; ideally flange-mounted filters to avoid emissions.
- The connection leads between the converter output and the motor should be as short as possible (also to reduce asymmetrical currents caused by the parasitic capacitances of the cable shielding).

### 5. **Leads susceptible to interference must be shielded!**

Examples:

- Connection leads between the frequency converter and motor, if no corresponding output filter is used.
- Connection between the filter and converter on the line side, unless directly flange-mounted.
- Please note that the shielding effect of different cables differs greatly (foil-type shielding, shielding braid of various cover types, combinations).

### 6. **Connect shielded lines on both sides and across a large area with the reference potential, as far as possible directly or close to the entry and exit points of the housing.**

Use the following:

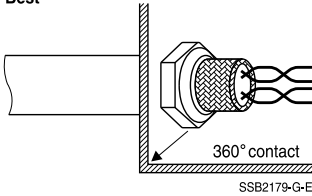
- EMC-compliant cable screw connections (all-round contact)
- EMC baseplates
- EMC shield bus with large-area contacting of the cable shielding with corresponding metal clamps.

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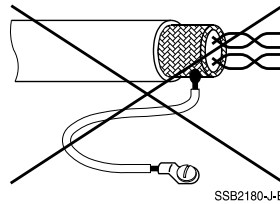
### Avoid shielding connections via stub lines (pigtaills)!

(twisted shielding braids; soldered cable sockets etc.)

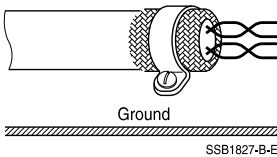
**Best**



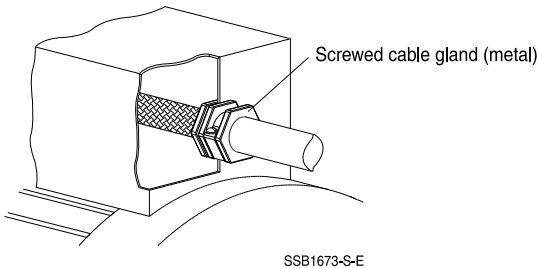
**No**



**Correct**



You should also ensure EMC-compliant cable screw connections at the motor terminal box. They must satisfy the protection type adapted to the respective location of use. The connection between the cable screws and the terminal box must be of the large-area type. When removing the lacquer, the corrosion protection must be reestablished where necessary.

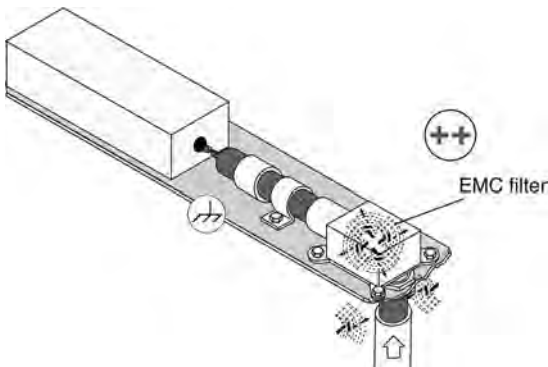


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### 7. Placing EMC filters directly at the entry and exit points of the casing wherever possible.

Examples:

- The power terminal side of the filter extends beyond the corresponding opening of the filter housing (Assure protection against contact!)
- Use an appropriate EMC filter.
- Use appropriate housing adapters to obtain the required shielding attenuation (upon request).



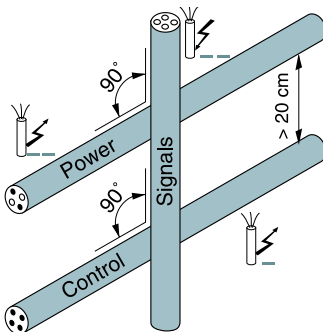
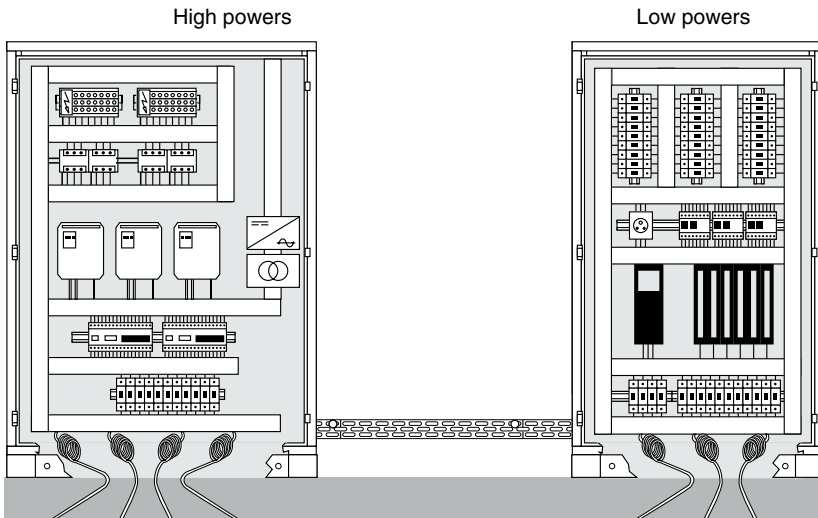
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8. **Ensure spatial separation** between leads susceptible to interference and "clean" leads (the first category includes leads between converters and filters, whereas "clean" leads typically run between the power connection and the filter).

Avoid running leads in parallel (to reduce coupled interference).

Ensure spatial separation between signal and power cables in order to avoid coupling (minimum recommended spacing = 20 cm). If necessary, use separating plates and ground them across a wide area.

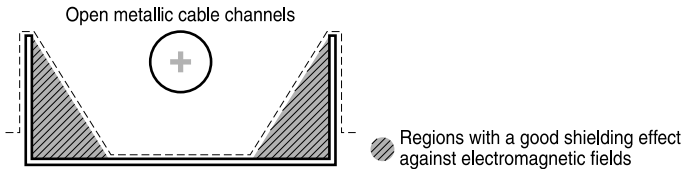
Run crossed lines at right angles and at a distance as far as possible.



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9. To reduce interference coupling, run **leads as far as possible to sheet metal parts** which are connected to the reference potential (mounting plates, switching cabinets, etc.)  
Current-carrying leads should also be run as close as possible to the reference potential (to reduce inductively coupled interference).

Preference should be given to cable ducts, cable troughs and installation pipes made of metal rather than plastic in order to improve the electromagnetic compatibility.



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10. Use twisted two-wire leads for unshielded signal lines (in both directions) in order to minimize the area between them (to avoid magnetic coupling). The same applies to avoiding conductor loops.
11. Switched inductors (such as contactors, relays, and magnetic valves) should be connected close to the interference source with corresponding suppression circuits.
12. For control signals in the environment of high interference levels use appropriate switching technology, e.g. symmetrical transmission systems with twisted lead pairs in conjunction with data line chokes (see also Data Book "Inductors"), the transmission of digital signals to the RS-422 standard, or in extreme cases use optical fibers to traverse the interference region.
13. ⚠ Note the mounting position of the filters! Natural convection must never be impaired. This means taking due care of the ventilation slits in the filter casing and maintaining a sufficient distance to other assemblies. Upside-down mounting is prohibited. In particular mounting situations, the thermal conditions may need to be checked in coordination with EPCOS.
14. Minimizing noise  
Chokes with very diverse core materials represent a significant filter component. AC voltage applications will always involve electro-acoustic effects. The materials and processing technologies used generate noise levels appropriate for use in industrial applications with observation of the harmonic content to EN 50160. However, these can increase significantly with higher harmonic content. In sensitive applications, such as office environments, the advice of EPCOS should be sought.

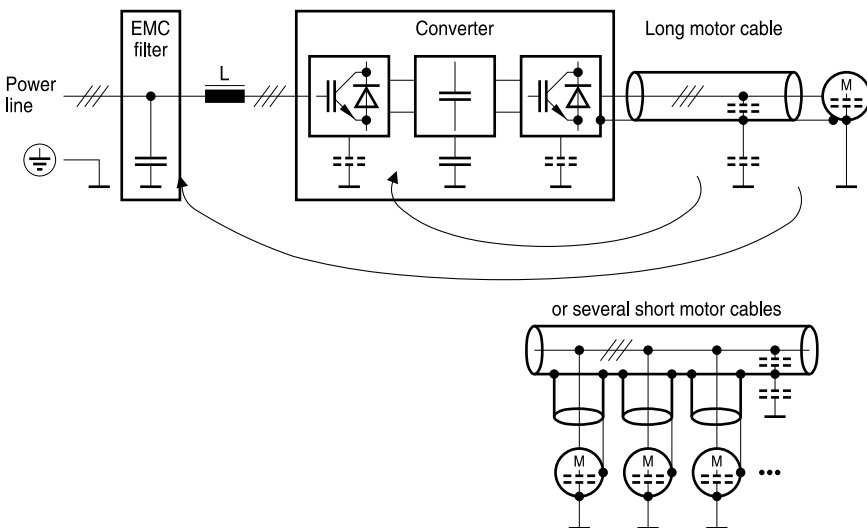


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### 15. Motor leads and motor types

In converter applications, output voltages are generated with almost square waveforms. They are characterized essentially by the  $dv/dt$  value (rate of voltage rise) and the switching frequency of the converter. The cables and motors in the converter output circuit with their inductive and capacitive components significantly determine the EMC properties of the system. Thus resonances from the combination of cables and motors in many cases appear as a resonance of the noise voltage measurement at the converter input.

- ⚠ The parasitic capacitances of the cables and motors must be carefully considered. Whereas the parasitic capacitances of the motors depend on their design, in cable they depend on the insulating material, the cable structure, the type of shielding and especially on their length. Depending on the switching frequency, the  $dv/dt$  value and the level of parasitic capacitances, a higher frequency current flows through the grounded parts of the equipment.
- ⚠ The following effects may then occur:
  - As the parasitic currents flow through the ground connections of the equipment, the sum of the input currents into the filter is no longer zero. From a specific level of parasitic currents, this can lead to the saturation of the current-compensated chokes contained in the filter and hence to the permissible noise level being exceeded. The noise voltage of the installed equipment must therefore be measured.
  - The parasitic currents also flow via the filter casing and the capacitors in the filter to the noise source. Impermissibly high currents can lead to overload of the capacitors and thus risk damaging them!



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