Drive Technology \ Drive Automation \ System Integration \ Services

Manual
Excerpt from Drive Engineering – Practical Implementation

EMC in Drive Engineering
- EMC-Compliant Installation in Practice

Edition 04/2013

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Contents

1 EMC-Compliant Installation in Practice

Electromagnetic compatibility (EMC) denotes the capability to operate several electrical and electronic components together and next to each other within a certain environment without any interference.

This manual will help you to optimize the EMC of your plant and to correct any existing EMC problems.

The notes in this chapter are no legal regulations; they are merely hints for improving the EMC of your plant. For unit-specific notes and instructions, refer to the operating instructions of the unit.

Observe the following guidelines and notes for electrical installation:

- General guidelines and instructions of the plant manufacturer
- General safety notes of the respective units
- Permitted conditions at the installation site
- Assembly notes and installation instructions of the respective units

Please do not hesitate to contact the author if you have any questions or suggestions.

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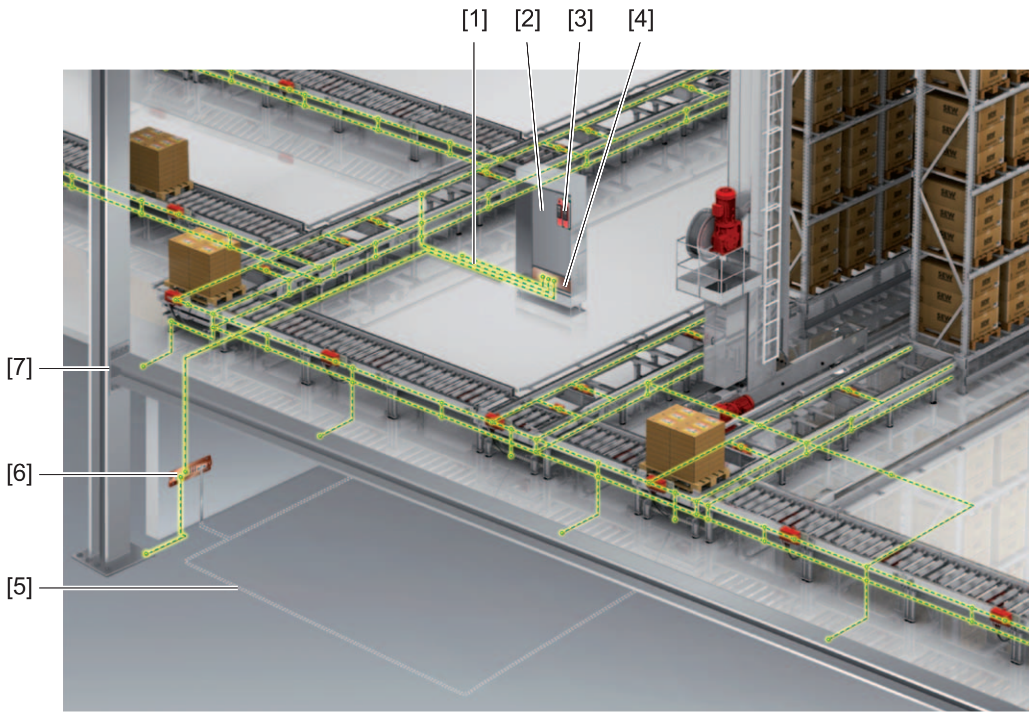
1.1 Grounding via interconnected EMC concept

Grounding is particularly important for fault-free operation of a plant.

Note the following:

- All components of the plant must be grounded via low resistance connections both in the low frequency (LF) and high frequency (HF) range. This is why the plant must have a grounding network with a consistent reference potential also for high frequencies.
- For electromagnetic interference mechanisms, the PE conductor represents a high HF impedance. Grounding cables are only effective in the HF range if they are **interconnected**. This **parallel connection** reduces the conductor resistance.

The following figure shows an example of the components of a plant that must be considered for grounding.



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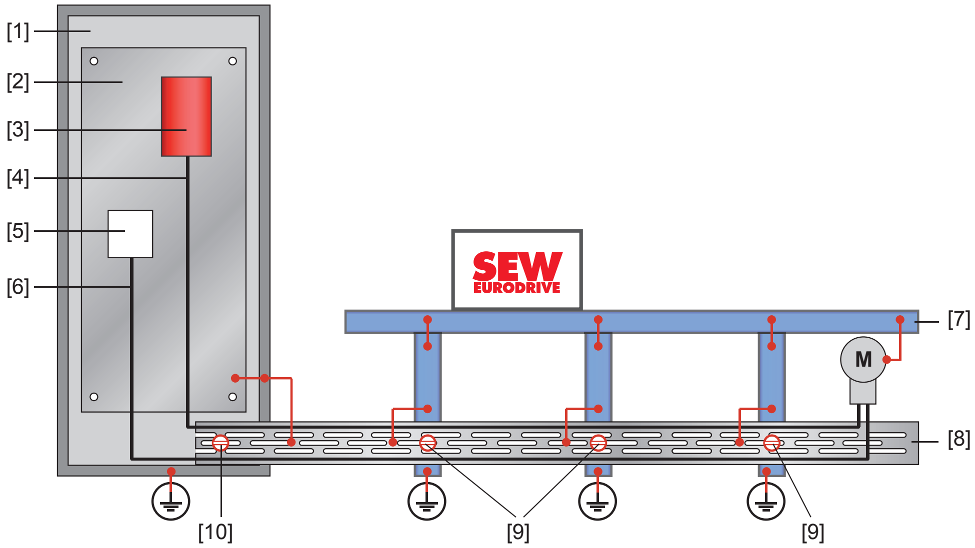
[1]	Sheet metal cable duct
[2]	Mounting plate in the control cabinet
[3]	Frequency inverter
[4]	Equipotential bonding bar (PE bar)
[5]	Foundation ground electrode
[6]	Equipotential bonding point
[7]	Steel frame

The following figure shows the equipotential bonding measures of a transportation system with one drive:



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[1]	Control cabinet
[2]	Mounting plate
[3]	Inverter
[4]	Motor cable
[5]	PLC
[6]	Signal cable
[7]	Metallic frame
[8]	Sheet metal cable duct
[9]	Sheet metal cable duct connected to the metallic machine frame over a large surface area
[10]	Sheet metal cable duct connected to the back wall of the control cabinet over a large surface area

1.1.1 Leakage currents

A controlled drive system always generates cable-conducted LF and HF interference. Suitable EMC measures reduce these interferences significantly, partly dissipating them as leakage currents to the ground potential.

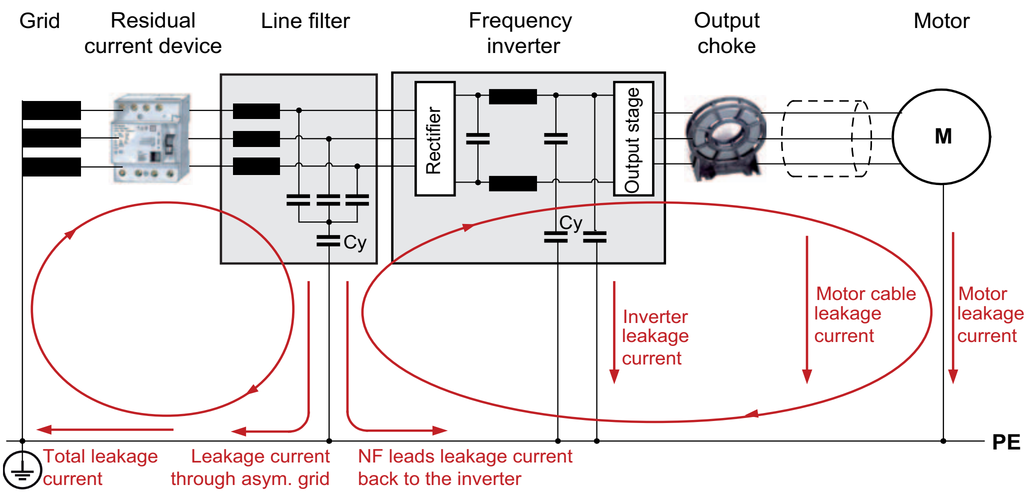
- The largest part of the leakage currents should flow back to the frequency inverter.

  This is why good, **low-resistance grounding** is particularly important. It prevents the leakage currents from taking another path and thus interfering with other units.

- The inductance of a **line filter** works against the leakage current in the kHz range and feeds a large part of the leakage current back to the frequency inverter via the Y capacitor.

  The line filter keeps back the leakage currents generated by the frequency inverter and the interference voltages from the power supply system and feeds them back to the frequency inverter (interference source).

The following figure shows the leakage currents of a controlled drive with suitable EMC measures.



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Conclusion

The largest part of the leakage currents should flow back to the frequency inverter to keep them from interfering with other units.

INFORMATION

Detailed information about leakage currents from frequency inverters are available from SEW-EURODRIVE on request.

1.2 Voltage supply

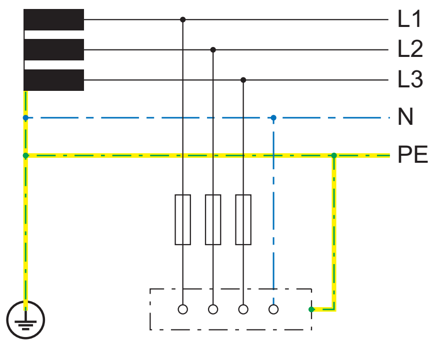
The equipment in a plant must be connected to the supply source in a star-type configuration. Sensitive equipment and equipment with high power ratings require separate supplies.

1.2.1 Supply system selection

Different supply systems are permitted for supplying the units. The supply system type has a significant influence on the EMC behavior of a plant.

The following figure shows the wiring diagrams of the supply system types.

TN-S network



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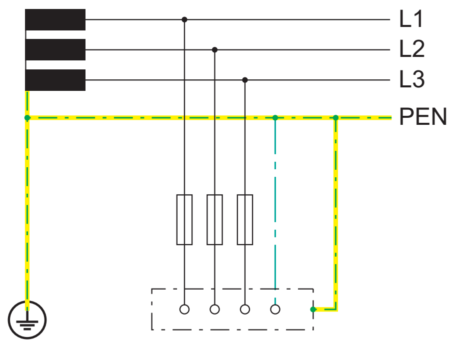
TN-C network



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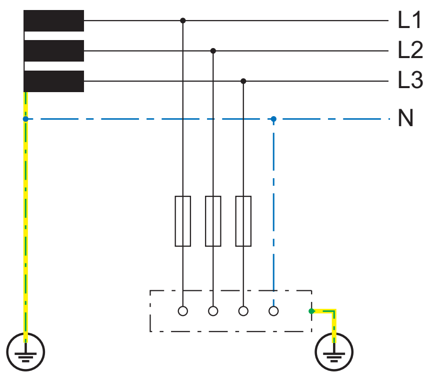
TT network



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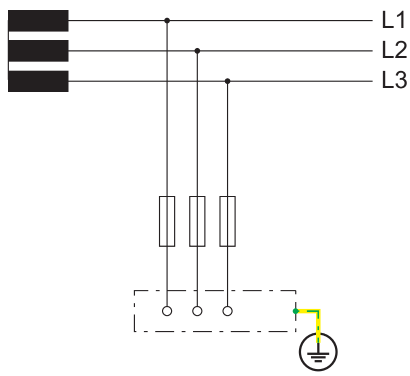
IT network



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The following table shows the EMC properties of the different supply systems.

Network configuration:	EMC characteristics
TN-S network	Very good
TT network	Good
TN-C network	Poor
IT network	Poor

The TN-S network with 5 conductors has the best EMC characteristics. The advantage of the TN-S network is the **separate routing of N and PE conductors**. Both conductors are only connected at a central point in the building. The PE conductor is usually only used for dissipating interference currents.

The isolated IT network has the poorest EMC characteristics.

1.2.2 Extra-low voltage

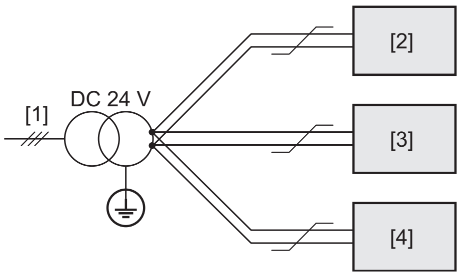
For extra-low voltages (e.g. 24 V), it is important that

- analog consumers (e.g. measuring sensors, proximity switches, etc.)
- and consumers with high power rating (e.g. contactors, brakes, etc.)

are connected to different power supply units or at least different lines. These lines must lead to the power supply unit in a star-type configuration.

Supply and return conductors must always be laid together.

The following figure shows a the supply concept for extra-low voltages.



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[1] Supply cable

[2] Power components with high power rating e.g. contactors, brakes

[3] Power components with small power rating, e.g. relays

[4] Extra-low voltage components, e.g. measuring sensors, proximity switches, etc.

1.2.3 24 V brake control

In motors with a DC 24 V brake that is not controlled by a brake control unit (BMV or BSG), burned relay contacts and EMI can occur in the 24 V supply.

SEW-EURODRIVE recommends to always use a BMV (in the control cabinet) or BSG (in the terminal box) brake control unit for 24 V brakes.

Brake with brake control unit (BMV or BSG)

The BMV and BSG brake control units are wear-free electronic switches. They prevent EMI coming from contact-breaking sparks when switching off the brake. The brake control unit protects the brake from overvoltages.

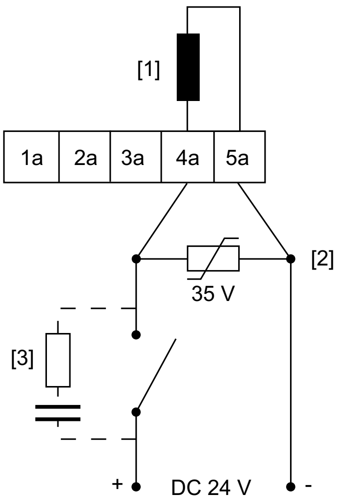
Brake without brake control unit

If the brake is not switched by a brake control unit (BMV or BSG), you must use a contactor or relay that is suitable for switching inductive DC loads. In this case, the 24 V brake needs a **35 V varistor** connected in parallel with the brake coil for overvoltage protection and for EMI suppression of the 24 V supply, see figure below.

For brakes with a DC supply higher than 24 V, use a 300 V varistor.

If EMI still occurs, you can additionally connect an RC element in parallel with the contactor.

The following figure shows a 24 V brake with EMI suppression:



[1] Brake coil
[2] Varistor (Example: SIOV S 10 K 35 => **35 V** from the company EPCOS)
[3] RC element (Example: RC BUG2/24-48V DC/DC from the company Murr)

Conclusion

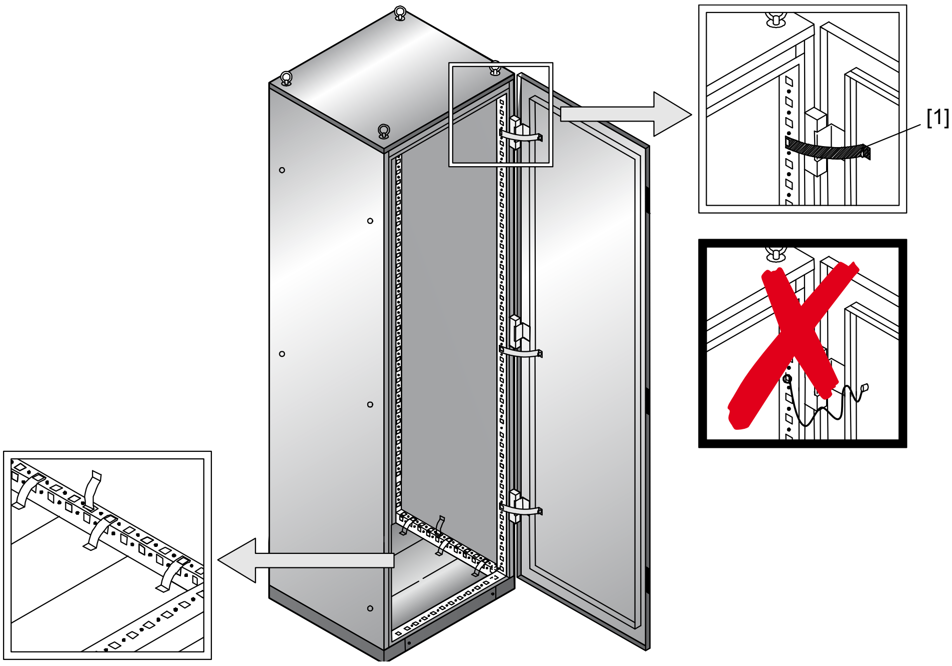
Compared with contactors or relays, the BMV and BSG brake control units offer the following advantages:

- Much higher system availability
- Much better EMC
- Much longer service life

1.3 EMC in the control cabinet

1.3.1 Sheet steel control cabinet

A control cabinet made of sheet steel is a good solution from an EMC viewpoint because it offers excellent shielding against magnetic interference fields.



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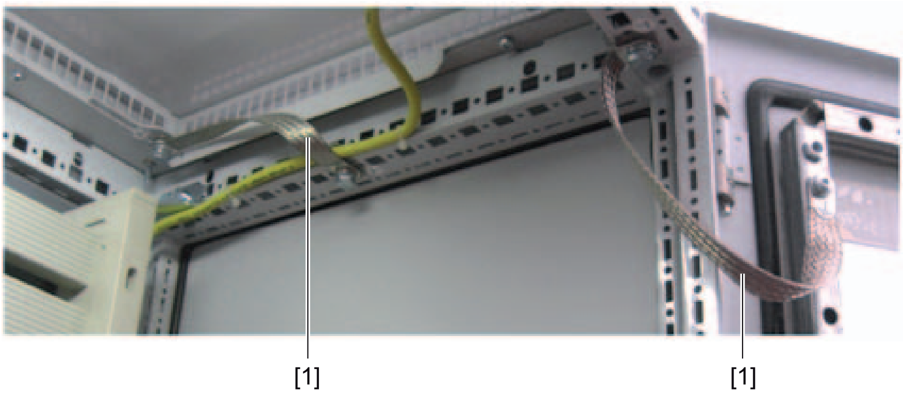
[1] HF braids

The following figure shows the HF equipotential bonding between doors, sheet metal, and the mounting plate:



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[1] HF equipotential bonding between doors, sheet metal, and mounting plate

The control cabinet helps to reduce radiation. Optimum equipotential bonding improves the shielding of the control cabinet. Integrating the doors and the cable ducts is important.

1.3.2 Mounting plate in the control cabinet

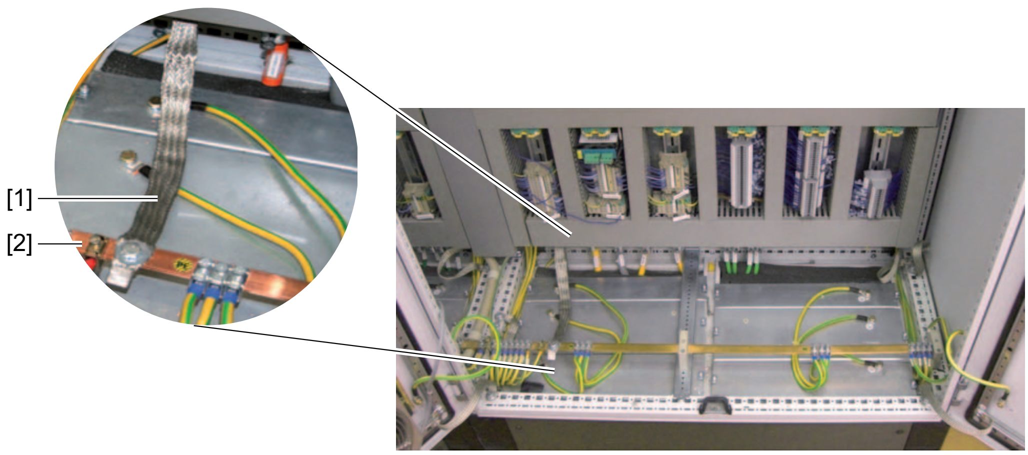
Apart from providing for an installation place for components, the control cabinet mounting plate is also used to ground components with metal housing over a wide area. Galvanized steel plates are most suitable for this purpose. The mounting plate must have a large-area connection with the machine hall construction. This connection is realized with an HF braid between the mounting plate and the PE busbar.

Nowadays, you can also use mounting systems instead of mounting plates. However, this offers disadvantages as the connections with the inverter housings are not over a wide area. If the grounding resistance increases with the use of a mounting system, this has a negative effect on EMC as well. This is why for mounting systems, all components such as frequency inverters, filters and shields must be connected over a wide area to a mounting plate integrated in the system.

1.3.3 PE busbar

The PE busbar is the central connection point for the PE conductors of the individual units in the control cabinet (star-type grounding). The PE conductor replaces neither HF grounding nor shielding. It is mandatory for protective earthing for safety reasons.

The following figure shows the PE busbar and the HF equipotential bonding between the mounting plate and the PE busbar in the control cabinet:



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[1] HF equipotential bonding between the mounting plate and the PE busbar
[2] PE busbar

Conclusion

From an electrical safety perspective, the PE busbar is the star point.

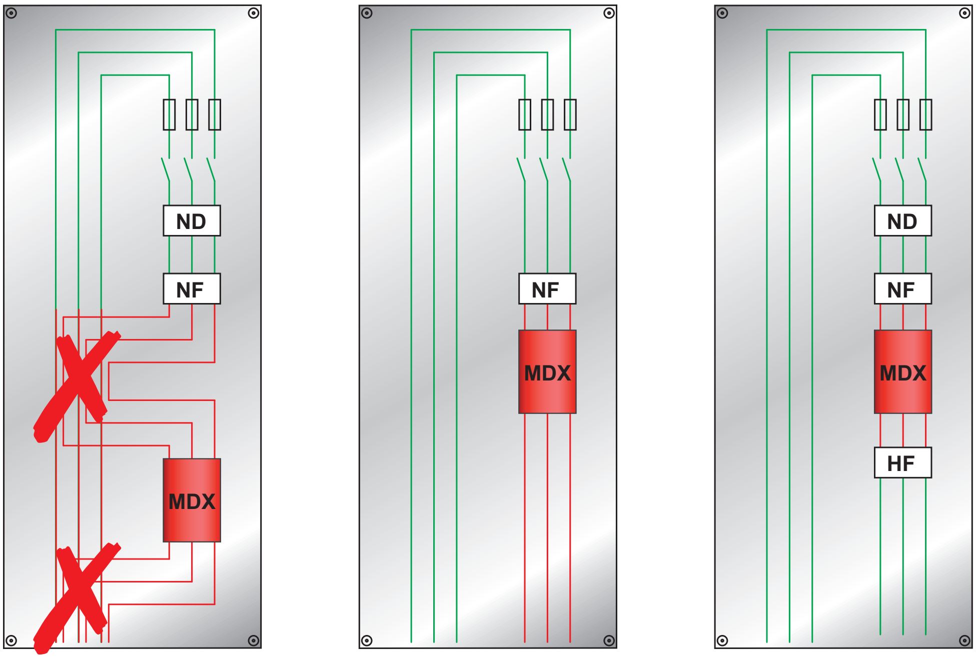
In terms of EMC, it is advantageous if the mounting plate is used as a star point with respect to HF equipotential bonding.

1.3.4 Arrangement of the EMC components

You can install EMC components to improve electromagnetic compatibility. **EMC components, such as line filters and output filters, require a large-area, metallic contact with the inverter via a shared mounting plate.**

They must be placed as close to the corresponding unit as possible in order to keep the lines short between the EMC component and the unit (max. 50 cm).

Stick to the following order of the components in the control cabinet:



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ND	Line choke	Green cable	= Cable without EMI
NF	Line filter	Red cable	= Cable with EMI
MDX	Inverter		
HF	Output filter		

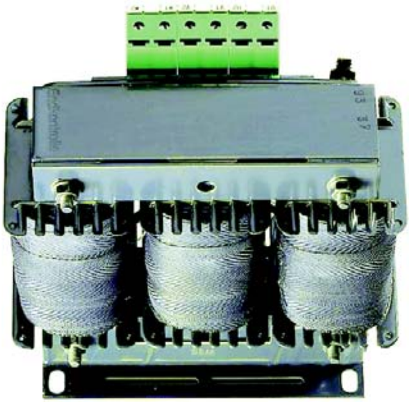
Make sure that the supply from the grid (before the line filter) does not run in parallel with the cable with EMI (after the line filter). Otherwise, the already filtered cable is exposed again to EMI.

If these requirements cannot be met, it makes sense to use shielded cables. To eliminate inductive coupling, you should not use single conductors for connection.

If you install EMC components on the base plate of the control cabinet due to their high weight (not ideal in terms of EMC), you must connect the base plate with the mounting plate using an HF braid.

1.3.5 Line choke

A line choke dampens voltage and current peaks. As a result, the line harmonics are also dampened.



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Power line harmonics

During operation, an inverter always generates line harmonics. An optimization of the inverter can limit or reduce these harmonics already when they are generated.

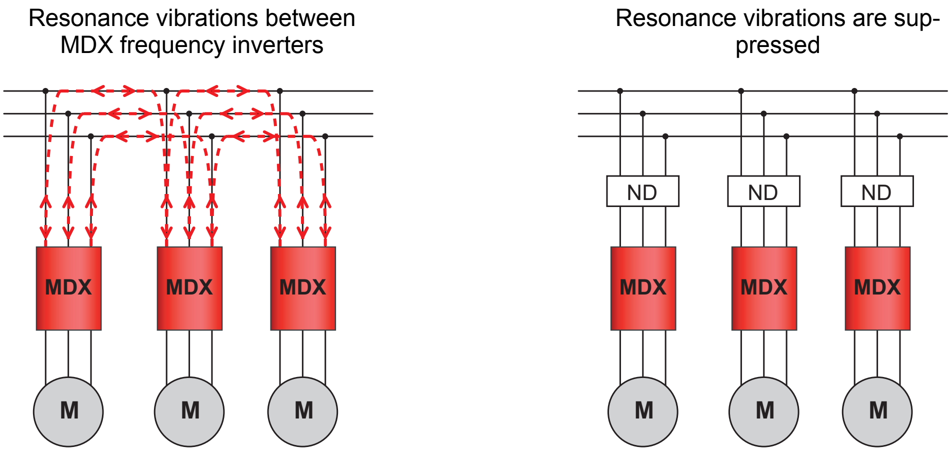
Line chokes are fitted ahead of inverters with high line current distortion. They smoothen the input current to an almost sinusoidal waveform, reducing the amplitude of the line harmonics.

SEW inverters

In modern frequency inverters with lean DC link (e.g. inverters from SEW-EURODRIVE), the harmonics are usually low enough so that a line choke is not necessary.

Resonance vibration

When several frequency inverters are installed next to each other and supplied via very short cables, resonance vibrations can occur between the inverters.



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The resonance vibrations can put a strain on the rectifiers at the inverter input and cause premature aging.

In such cases, a line choke must be connected before each frequency inverter. These line chokes dampen the harmful resonance vibrations.

Voltage spikes

Switching high power contactors causes voltage spikes in the supply system. These spikes can cause the inverter to shut down or even destroy it.

A line choke protects the inverter from these voltage spikes. In case of critical supply system conditions, in which voltage spikes are expected, SEW-EURODRIVE recommends using a line choke for inverter protection.

Inrush current spikes

When several frequency inverters are switched on at the same time, the total inrush current adds up. Especially in the case of small supply system contactors, too high an inrush current can lead to sticking or welding of the contacts.

Conclusion

If several frequency inverters are to be switched on simultaneously, you should connect a line choke before each frequency inverter.

1.3.6 Line filter

The line filter keeps back the interference voltages generated by the frequency inverter from the power supply system and feeds them back to the frequency inverter.

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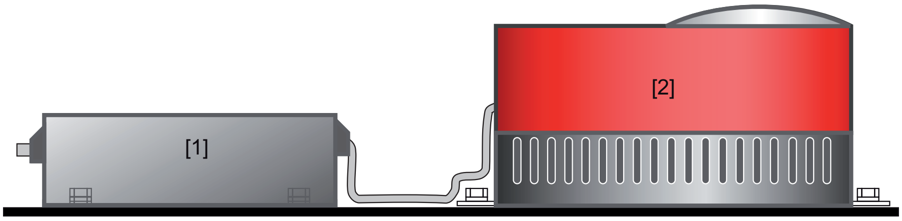
Note the following:

- The selection of the line filter depends on the inverter current and the line voltage of the frequency inverter.
- The line filter is selected according to the recommendation of the component manufacturer, who has proven compliance with the limit values in typical configurations. Proof for the variety of possible combinations of grid conditions, line filters, inverters, motor cables, and motors is not stipulated in the standards.

  It is <u>not</u> recommended to select line filters according to damping curves, because they only apply for idealized measurement conditions and can deviate considerably from that in specific applications.
- Install one line filter just before each frequency inverter.
- As an alternative, you can also use a shared line filter for the entire control cabinet. The common line filter is selected on the basis of the total current of all inverters.
- Do not install any switching element (e.g. contactor) between the line filter and the frequency inverter.

- Route the cable between the filter [1] and the frequency inverter [2] as closes as possible to the mounting plate.



Metallic contact over a large area at the common mounting plate.

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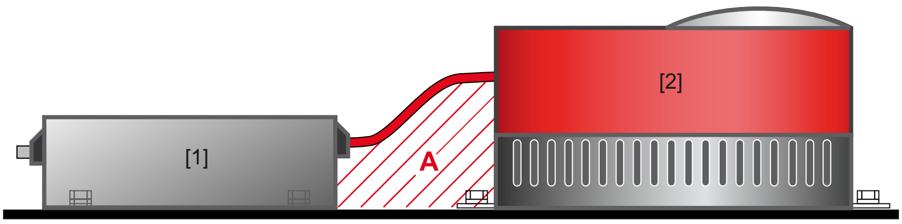
If you install the cable at a large distance from the mounting plate, the radiation area increases and so does EMI.



Radiation area between cable and mounting plate — Common mounting plate

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- For this reason, route the cables as close to the reference potential (mounting plate).

  Suspended cables act as active and passive antennas.

Use

The use of line filters is recommended for the following requirements:

- Reduced EMI via the line cable
- Compliance with limit values
- Reduced equipotential bonding currents
- Reduced leakage currents in case of long motor cables

1.3.7 Output choke (ferrite core choke)

An output choke is a cost-effective measure to reduce the EMI potential of the motor lead of the inverter.

The emission limits for radio interference suppression are met if the output choke is suitably sized.

SEW-EURODRIVE offers output chokes for different core cross sections (open variants HD001, HD002, HD003) and for inverter variants (HD012, HD004, HD005).

An output choke has the advantage that no additional voltage drop is caused at the inverter output. Usually, 3 – 5 turns around a toroidal core are sufficient.

Output chokes are usually used with unshielded motor cables.

Special case: Shielded motor cables with several plug connectors

INFORMATION

Plug connectors within a shielded motor line are not ideal with respect to EMC.

However, plug connectors are often a requirement in the automotive industry to avoid downtimes in case of failures.

If the shielded motor line has several plug connections, the shielding effect might deteriorate. In such cases, an output choke can also be used in combination with a motor cable shield. The leakage currents dissipated via the motor cable shield place an additional load on the output choke. This leads to a higher temperature.

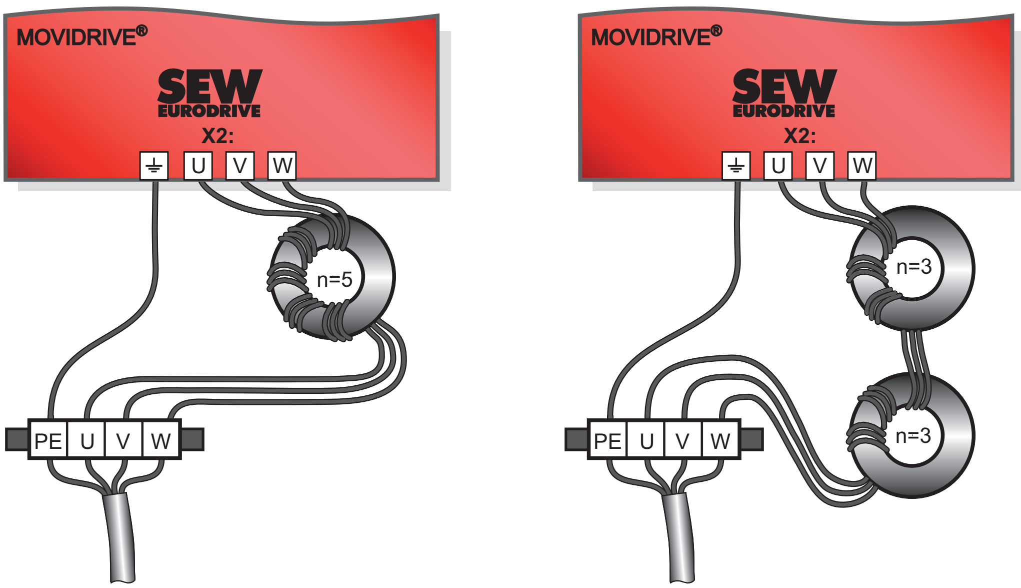
High operating temperature

The output choke can have high operating temperatures (above 100 °C) at the toroidal core. In open variants, a plastic guard protects the core insulation of the motor cables. If the application requires lower temperatures, the temperature can be reduced by using a second output choke.

When installing a second output choke, you must reduce the number of conductor windings on the ferrite core.

1 output choke with 5 windings

2 output choke with 3 windings



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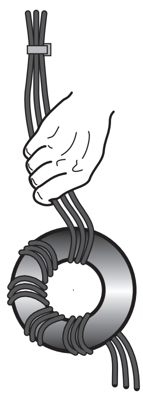
Installation

Always wind the motor conductors together on the output choke as follows:

1. Take the three conductors into one hand.
2. Secure the beginning of the three conductors with a cable tie.
3. Wind the three conductors together through the ring core five times.

Now all three conductors are routed in parallel around the ring core.



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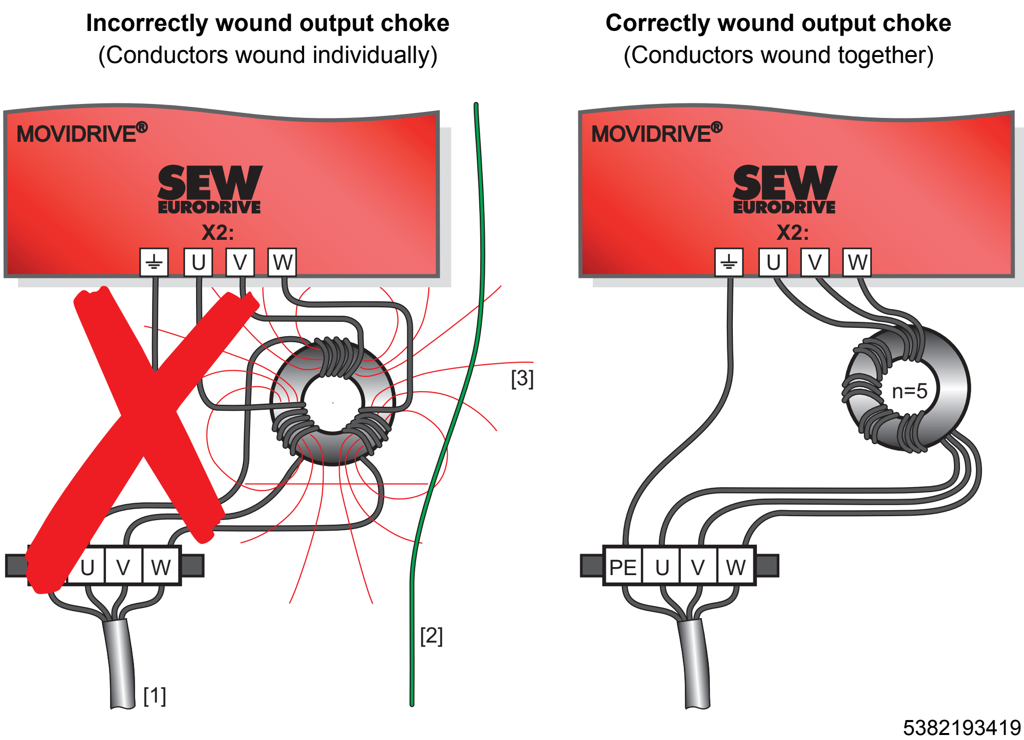
Note the following:

- Wind all three conductors in the same direction.
- Do not mix up the beginning and the end of the conductor. Otherwise this will cancel the effect of the choke.
- If you wind each conductor around the ring core individually, there is a risk that the winding direction or the beginning and end of the conductor are mixed up.

  There is also a risk of an increased stray field forming around the areas of the ring core that are not wound. This stray field can interfere with sensitive conductors.

The following figure shows how to connect the output choke:



[1] Motor cable
[2] Sensitive signal conductor
[3] Stray field

Use

An output choke suppresses interference at the inverter output.

An individual output choke is quickly overloaded by a group drive.

1.3.8 Output filter (sine filter)

The output voltage of an inverter is formed from square-wave pulses.

An output filter converts this square-wave output voltage to an almost sinusoidal voltage, see following figure.

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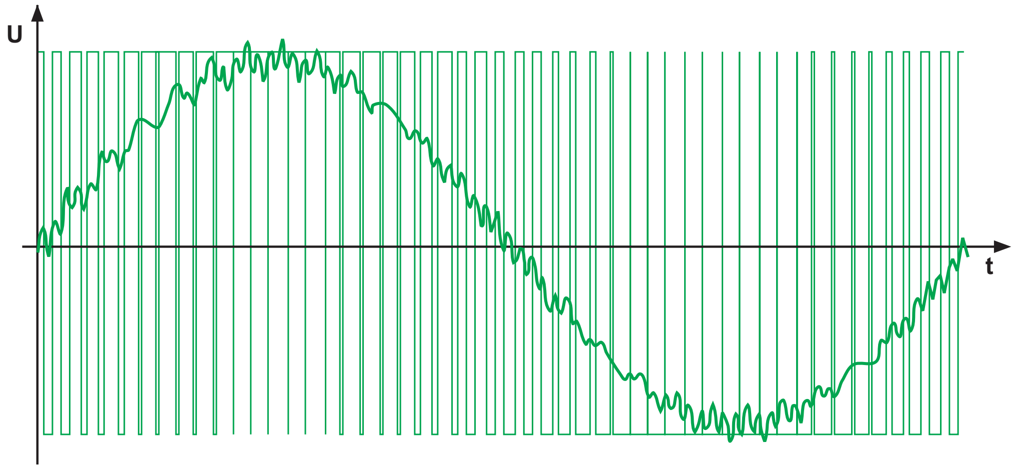

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Group drive

The square-wave output voltage of the inverter generates leakage current spikes in the parasitic capacitances of the motor cable and motor windings. In group drives, these leakage current spikes add up and can reach values that are not permitted for the inverter.

The leakage current spikes depend on:

- The number of motors connected in parallel,
- The type and length of the cable at the inverter output,
- And the size of the motors.

When using an output filter, these leakage current spikes are significantly reduced due to its sinusoidal output voltage. The output filter loads the inverter with a filter current component, which is independent of external factors such as number of motors, cable type, and cable length.

Motors that are not designed for inverter operation

The square-wave output voltage of the inverter can cause overvoltages in the motor, see chapter "Voltage load of the motor caused by inverter pulsing". In motors that are not designed for inverter operation, these overvoltages can destroy the winding insulation of the motor. Using an output filter solves this problem reliably. Thanks to the sinusoidal voltage after the output filter, the overvoltage is significantly reduced. This takes load off the insulation system of the motors. To avoid overvoltages caused by resonance against ground (e.g. in case of long cables), the output filter should also filter against ground. This is realized by feeding the signal back to the DC link (U_Z connection).

Noise filtering

The square-wave pulses of the inverter output cause audible noise in the motor. This noise in the range of the inverter pulse frequency can be very unpleasant. The output filter dampens this noise in the motor considerably. The filter itself creates noise in the range of the inverter pulse frequency.

Radio interference suppression

The use of an output filter enables operation without shielded motor cable also in applications that stipulate limit values.

Output filter without DC link connection

An output filter **without** DC link connection converts a pulsed inverter voltage to a sinusoidal voltage when connected phase-to-phase.

When connected phase-to-ground, it has a considerably reduced filter effect.

Output filter with DC link connection

An output filter **with** DC link connection converts a pulsed inverter voltage to a sinusoidal voltage when connected phase-to-phase and phase-to-ground.

When connecting the output filter to the DC link, you must increase the pulse frequency. With a pulse frequeny of 12 kHz, the inverter only delivers about 70% of its nominal power.

Dimensioning

The selection of the output filter depends on the nominal current and the nominal voltage of the inverter.

If the nominal current of the motor is smaller than the nominal current of the inverter, you select the output filter based on the motor current.

When operating several motors in parallel, select the output filter based on the total motor current.

Note the voltage drop at the output filter as specified under "Technical data". This voltage drop reduces the voltage that is available to the motor.

Motor cable

Only connect unshielded cables as motor cables to the output of the output filter.

Shielded cables can cause resonance vibrations between the shield capacitance and the capacitance of the output filter. These resonance vibrations can damage the output filter.

Use

The use of output filters is recommended for the following applications:

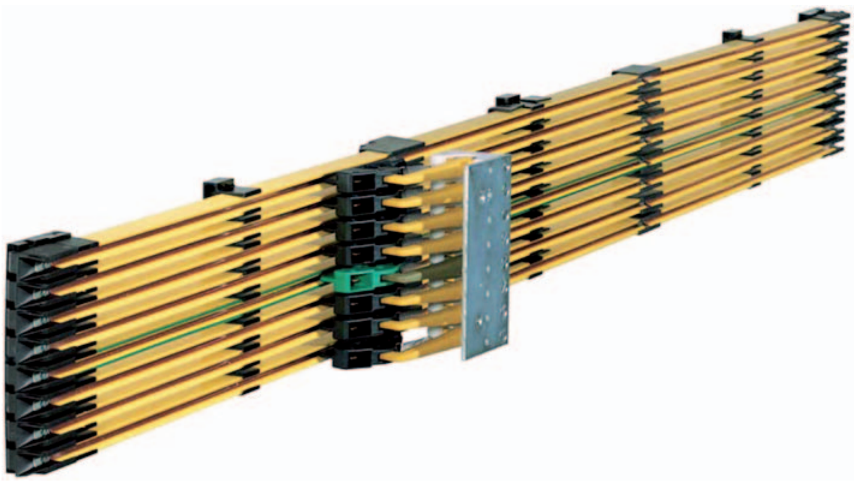
- Group drive (several motors connected to one inverter)
- Noise filtering
- Interference suppression with unshielded motor cables
- Protection from voltage spikes

Price

The purchase price, size, and energy loss of an output filter and an inverter are similarly high. This is why many project planners try to avoid using an output filter, even though the output filter is an almost ideal solution from an EMC perspective.

Conductor rail as motor supply

If you are using insulated conductor rails after a frequency inverter as a motor supply (e.g. from companies Wampfler or Vahle), SEW-EURODRIVE recommends using an output filter. A shielded cable is not possible in this case.



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The output filter offers protection from EMI. It also protects the output stage of the inverter in case of problems with the current collectors. The output filter acts like a buffer here.

Only use conductor rails with double current collectors (2 brushes in series).

For the PE conductor, use 2 current collectors with two separate holders.

1.4 Control cabinet components

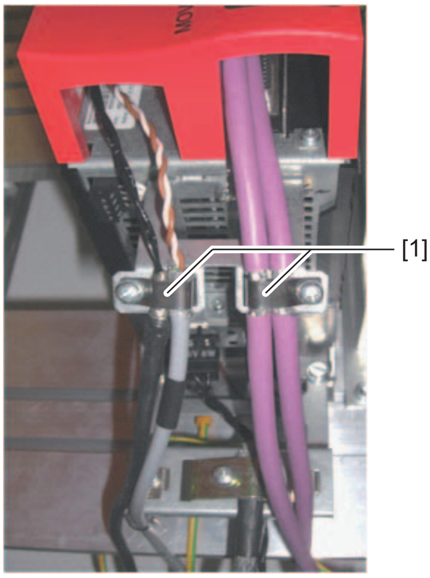
The following chapters exemplify equipotential bonding of the components in the SEW-EURODRIVE control cabinet.

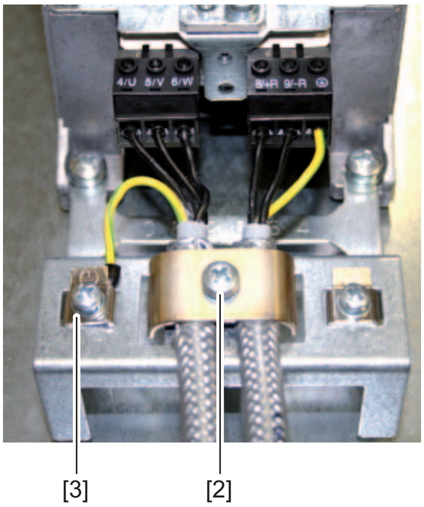
1.4.1 MOVIDRIVE® MDX

Connection of braided shield of MOVIDRIVE® size 1 and 2

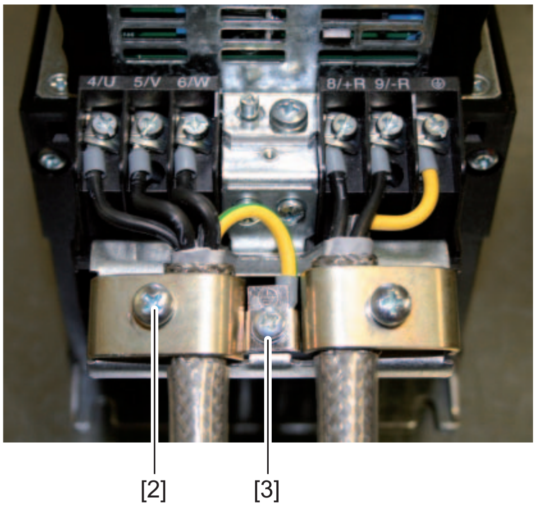
The following figures show the connection of braided shields to the MOVIDRIVE® MDX frequency inverter, size 1 and 2:

Control unit





Power section
Size 1



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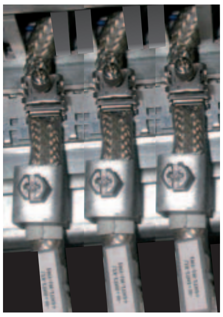
Power section
Size 2

[1] Connection of braided shield of signal cables (24 V cable, encoder cable and bus cable)
[2] Connection of braided shield of power cables (power section shield clamp)
[3] PE connection

Connection of braided shield of MOVIDRIVE® size 3 to 6

The following figure shows the connection of the braided shields of 3 MOVIDRIVE® MDX frequency inverter of size 3 – 6:

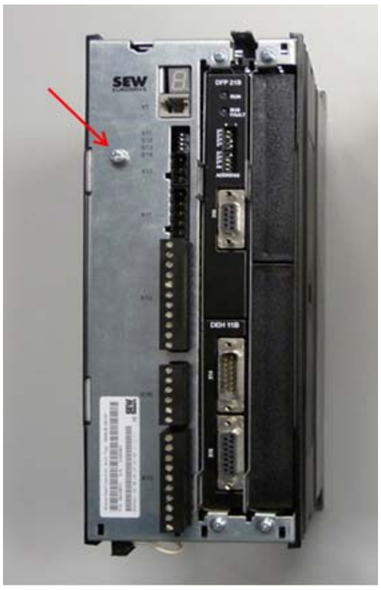
Connect the braided shield of the motor cable on the input side shield plate of the control cabintet according to the following figure:



9007203102443787

Increased encoder availability due to grounding screw of MOVIDRIVE® control unit

By using the grounding screw at the MOVIDRIVE® control unit, the reference potential of the 24 V supply can be separated from the PE conductor.



3847702795

- Grounding screw screwed in → direct connection with 0 V of 24 V supply

  DGND (X10, X12, X13, X16, X17) is connected with PE

  This means the MOVIDRIVE® inverter has increased protection against encoder errors.
- Without screw → high insulation resistance

  Removing the M4 grounding screw creates electrical isolation.

  Ground connection is now via 4 capacitors and a high resistance to ground.

Example: Insulation monitor in 24 V supply

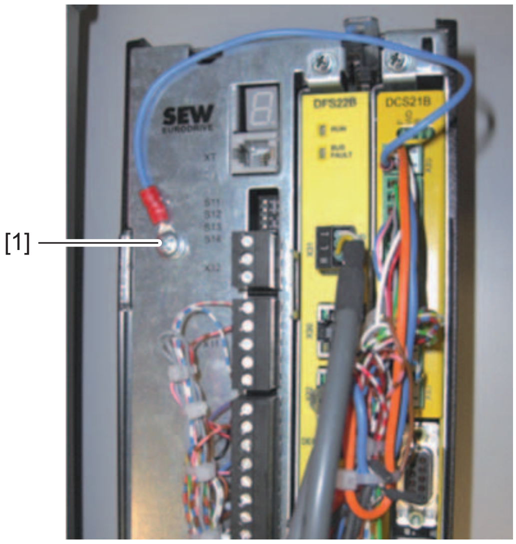
For additional operating reliability, the 24 V supply is partly monitored by an insulation monitor (e.g. in the chemical industry). This monitoring offers additional protection from malfunctions of the plant in case of faulty insulation in the 24 V control circuit.

If electrical isolation is not possible in a unit, you must provide a separate 24 V supply.

Equipotential bonding of the DCS21/31B option card

The following figure shows the equipotential bonding of the DCS21B/31B option card at the MOVIDRIVE® MDX frequency inverter of size 1 to 6:

MOVIDRIVE®
with grounding screw



3851412747

[1] Equipotential bonding of the option card using a grounding screw

INFORMATION

If you install the DCS21B/31B option in a MOVIDRIVE® MDX B frequency inverter without tapped hole, proper operation cannot be ensured.

SEW-EURODRIVE recommends to replace the MOVIDRIVE® MDX B frequency inverter without tapped hole by a MOVIDRIVE® MDX B frequency inverter with tapped hole.

1.4.2 Braking resistor

Braking resistor cables

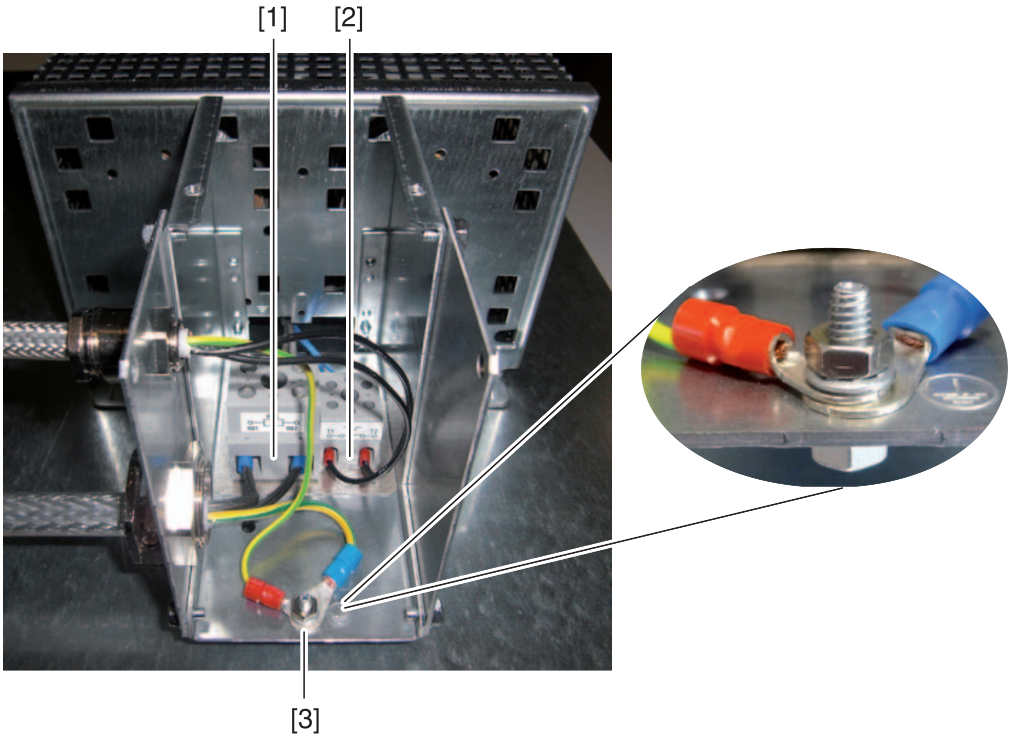
For connecting braking resistors to the inverter, use two closely twisted cores or a shielded power cable.

The nominal voltage of the braking resistor cable must be at least U_0 / U = 300 V / 500 V according to DIN VDE 0298.

Installation of steel-grid braking resistor

Install the braking resistor over a large, non-painted area, if possible. If this is not possible, you can also mount the braking resistor to the control cabinet panel using tooth lock washers.

The following figure shows the connection of a steel-grid braking resistor with temperature sensor or temperature switch:



3852709899

[1] Braking resistor connection
[2] Connection of TH temperature switch
[3] PE connection

1.5 Cables

1.5.1 Routing

Observe the following notes:

- Route the supply and return cables together.
- Avoid spare loops in all connection cables.
- Unused conductors must be grounded at both ends.
- Preferably route conductors emitting EMI in the corners of a metal cable duct or corner profile. This reduces the radiation of the conductor.

235879819

K Cable duct
E Corner profile
S Shielding effect

The shielding effect is improved significantly by using enclosed cable ducts.

Distance between conductors

The greater the distance between conductors, the smaller the parasitic capacitance and the smaller the interference current.

The parasitic capacitance (interference capacitance) increases

- with decreasing distance between conductors
- with increasing length of conductors routed in parallel

The interference current increases with increasing voltage in the interference-source cable.

Distance from the reference potential

Route the cables as close as possible to the reference potential, such as the mounting plate, metal cable duct, or grounded machine support.

Suspended cables act as active and passive antennas.

Cable groups

The interference source (e.g. motor cable) is usually coupled with the susceptible equipment (e.g. sensitive conductor, device) via the connected circuits. This is why cable routing and the type of cable play an important role in EMC.

For systematic cable routing, the cables are classified into groups according to the signals they transmit. This classification makes it possible to define general, practical rules for cable routing.

In practice, a classification into 4 cable groups has proven useful. The cable groups can be characterized as follows:

Cable group	Examples
Group 1 Very sensitive	Encoder cable Analog sensors Measuring line Capacitive proximity switches Bus cable
Group 2 Sensitive	Small signal cables Small signal supply (10 V, 24 V)
Group 3 Interference sources	Control cables for inductive loads (brakes, contactors, relays) Interference-suppressed power cables Power supply cables (unswitched)
Group 4 Strong interference sources	Power circuits Switched power cables (inductive loads, e.g. contactors) Pulsed power cables (inverter)

This group classification is the basis for the following rules of thumb for cable selection:

<table>
<tr><th>Cable group</th><th>In the control cabinet</th><th>Outside the control cabinet</th></tr>
<tr><td>Group 1</td><td colspan="2">Shielded, low-capacitance cable
Without interruptions up to the unit, if possible
Routed at some distance to groups 3 and 4</td></tr>
<tr><td>Group 2</td><td rowspan="2">Unshielded cable
Separate from groups 3 and 4</td><td rowspan="2">Cable
Routed at some distance to groups 3 and 4</td></tr>
<tr><td>Group 3</td></tr>
<tr><td>Group 4</td><td colspan="2">Shielded or filtered cable</td></tr>
</table>

Parallel, safe routing of cables from different groups is only possible with additional measures, such as shielding, filtering, or spacing.

In the control cabinet, power and signal cables must be branched off or split up several times. The cables are rather short. Radiation to the outside is reduced by the shielding effect of the control cabinet.

In the control cabinet, it is not always possible to route cables of groups 1 and 2 separately from cables of groups 3 and 4. However, parallel routing should be reduced to the necessary minimum.

- Motor cables in the control cabinet

  If you want to route an unshielded and unfiltered motor cable in the control cabinet, you have to twist the cores of the three phases and route them separately from sensitive conductors. However, this solution is only a compromise and should not be used in control cabinets with sensitive conductors.
- Braking resistor in the control cabinet

  Use only shielded cables or twisted-pair cables as braking resistor cables. Always route twisted-pair cables separately from sensitive conductors.

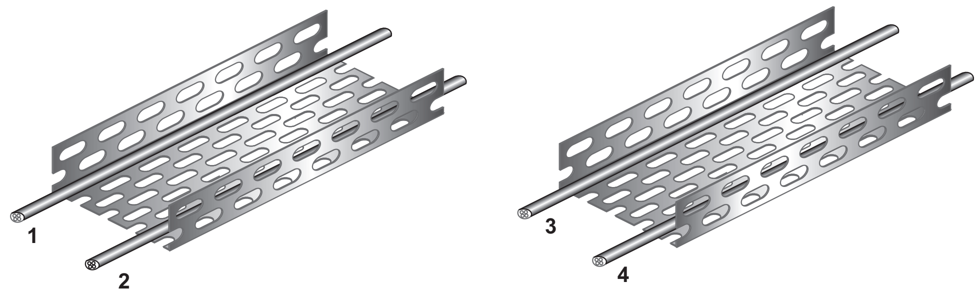
Outside the control cabinet, cables are often routed in parallel over long distances with little space in between. In case of non-EMC-compliant cable routing, this leads to increased coupling between the transmitted signals.

Outside the control cabinet, a distance of 20 cm between cables of group 1 or 2 and cables of group 3 or 4 is usually sufficient.

Installing cables from different groups

When installing cables from different groups, note the following:

- Always install cables of groups 1 and 2 as far from cables of groups 3 and 4 as possible, or separate them by means of a metallic partition.



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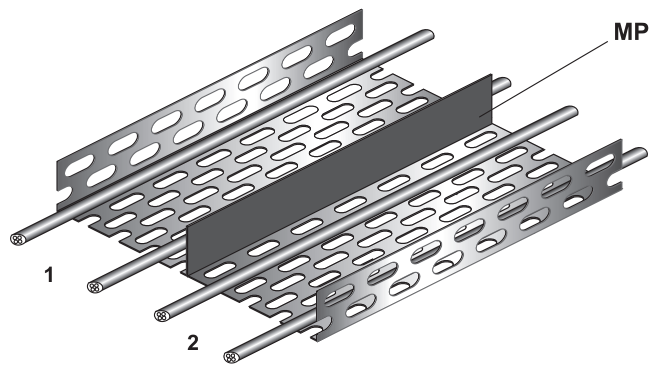
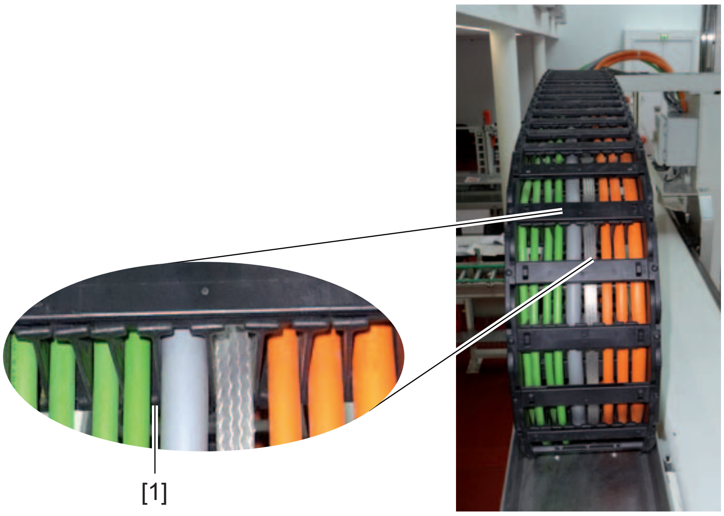


235452043

MP Metal partition

- The motor cables behind an output filter can be routed in the same cable duct as cables of other groups.

- Only use cable carriers with dividers [1].



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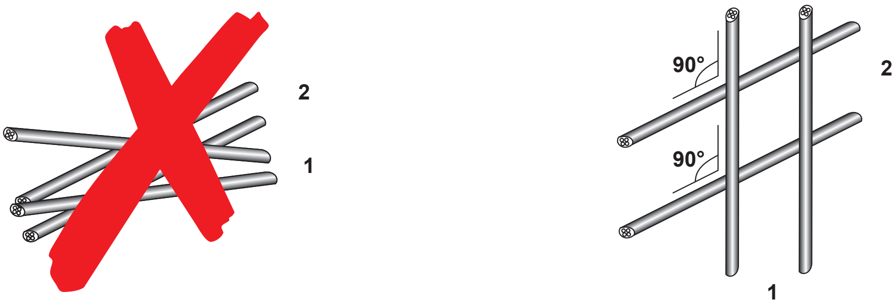
- Cross cables of groups 1 and 2 with cables of groups 3 and 4 at a right angle, if possible.



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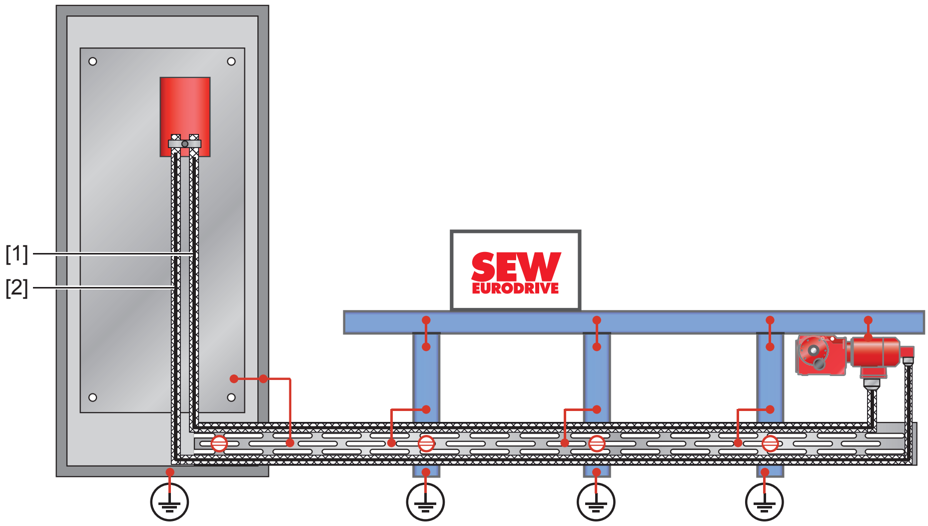
1.5.2 Shielding

Observe the following notes for shielding:

- Every conductor can emit or receive a magnetic field. This means that every conductor can act both as a transmitting and a receiving antenna.
- A single unshielded or unfiltered cable can nullify all the other measures taken.
- Single-sided shielding of a cable is only effective against capacitive coupling of parallel cables but not against magnetic fields.
- You always have to connect the shield on both ends against magnetic radiation. The shield should be made of copper.



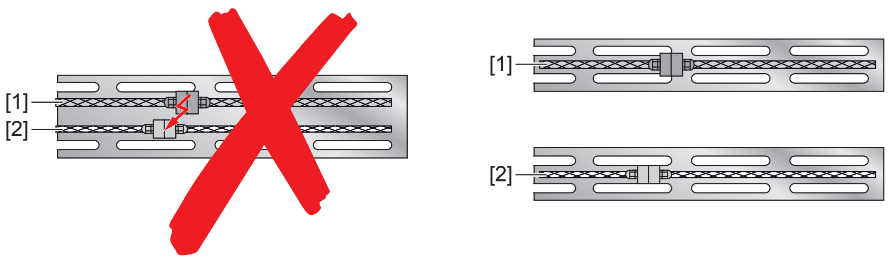
5558529931

[1] Motor cable (grounded on both ends)
[2] Encoder cable (grounded on both ends)

Exception:

- Routing the cable in a metal duct dampens radiation as well, but not as effectively as a copper shield.
- Metal pipes are good shields. Special attention must be paid to the connection of the shield at both pipe ends.
- Shielded cables from different groups that are grounded on both ends can be routed in the same cable duct.

  However, cables that have been extended with plug connectors must be routed in separate cable ducts. Otherwise, interference can be transmitted via the plug connectors.



5558536331

[1] Motor cable
[2] Encoder cable

Practical experience

- Often, non-EMC-compliant plug connectors are used for extended shielded encoder or motor cables.
- The plug connectors of extended cables are often not assembled in line with EMC requirements.

Use only prefabricated cables from SEW-EURODRIVE for extended encoder and motor cables.

Shield types

In practice, different shield types are used for electric conductors. The following table shows the characteristics of the different shield types:

Shield type	Characteristic
Foil shield	Foil shields are often used for signal cables. Their advantage is the high degree of shield coverage of 100%. As the conductive layer is very thin, the effectiveness of foil shields is limited, especially in case of: • Strong magnetic interference fields • Higher interference currents due to small cross sections Make sure that the shield foil is not damaged by bending.
Braided shield	Braided shields are usually used for power cables. The higher shield cross section of braided shields offers better protection from high interference currents and strong magnetic fields. Optical shield coverage is an important characteristic of this type of shield. For EMC purposes, it must be at least 85%. Cables with iron armoring are not suitable for EMC purposes.
Multi-shields	Multiple shield cables offer better shield damping compared with single-shield cables. The combination of foil and braided shields offers the advantages of both types. As the manufacturing of such cables is very complex, they are usually only used for transmitting sensitive signals.
Piping	A special type of shielding is routing cables in metallic pipes. Metal pipes offer a large shield cross section and a shield coverage of 100%. This is why metal pipes are well-suited for shielding purposes. Special attention must be paid to the connection of the shield at both pipe ends and to the coupling between cables that are routed together in the pipe.
Ferrite coating	For power cables, there are sheath materials available with integrated ferrite particles for dampening interference currents. These cables are not very significant in practice due to their length-dependent damping and effectiveness. Especially with respect to longer cable lengths and the complex manufacturing technique, these cables are not very common.

Encoder cables

Only use cables with the following characteristics as encoder cables:

- Low capacitance (capacitance between the cores $C_{core\text{-}core}$ ≤ 70 nF/km (70 pF/m))
- With braided shield
- Twisted pair

Recommendation:

Only use prefabricated encoder cables from SEW-EURODRIVE.

If you prepare the encoder cable yourself, note the following guide values:

Unit	Capacitance $C_{core\text{-}core}$ of the encoder cable
MOVIDRIVE® drive inverters	≤ 120 nF/km (up to 50 m cable length) ≤ 70 nF/km (more than 50 m cable length)
MOVISAFE® safety module (MOVIDRIVE® option)	≤ 70 nF/km
MOVIAXIS® servo inverter	≤ 70 nF/km

Example: Encoder cables from the company HELUKABEL®

HELUKABEL® type	Use
Li**9Y**CY	SEW-EURODRIVE uses this cable (70 nF/km) as standard low capacitance encoder cable.
Li**2Y**CY	This cable can also be used as encoder cable. $C_{core\text{-}core}$ = 70 nF/km
Li**Y**CY	This cable is also often used as encoder cable. This cable is not a low capacitance conductor. $C_{core\text{-}core}$ = 120 nF/km

Long, shielded cables

Observe the following notes for long shielded cables;

- The shielding effect decreases with increasing cable length. You can improve the shielding of longer cables by grounding the shield at regular intervals with several cable clamps.
- Each cable has a parasitic capacitance that drains off earth-leakage currents to ground. Shielding significantly increases this parasitic capacitance.
- In long shielded motor cables, the high leakage currents can cause considerable interference. Use output filters or ferrite cores instead of the shielded cable in such cases.

If the shield of an already installed shielded cable is not wanted, there is no need to replace this cable.

You can also disconnect and insulate the shield on both ends. Make sure that the insulation is sound, e.g. with shrinking tubing. In case of poor insulation, sparks can be created at the shield ends against ground or other conductive objects.

Disconnecting the shield can be necessary for the following reasons.

- Subsequent installation of an output filter
- Increased leakage current
- Capacitance of long cable is too high
- Group drives

No shielded cables in case of group drives

Group drives have increased leakage currents as the capacitance of the motor cables and motors increases with parallel connection. The leakage currents put an additional load on the output stage of the frequency inverter.

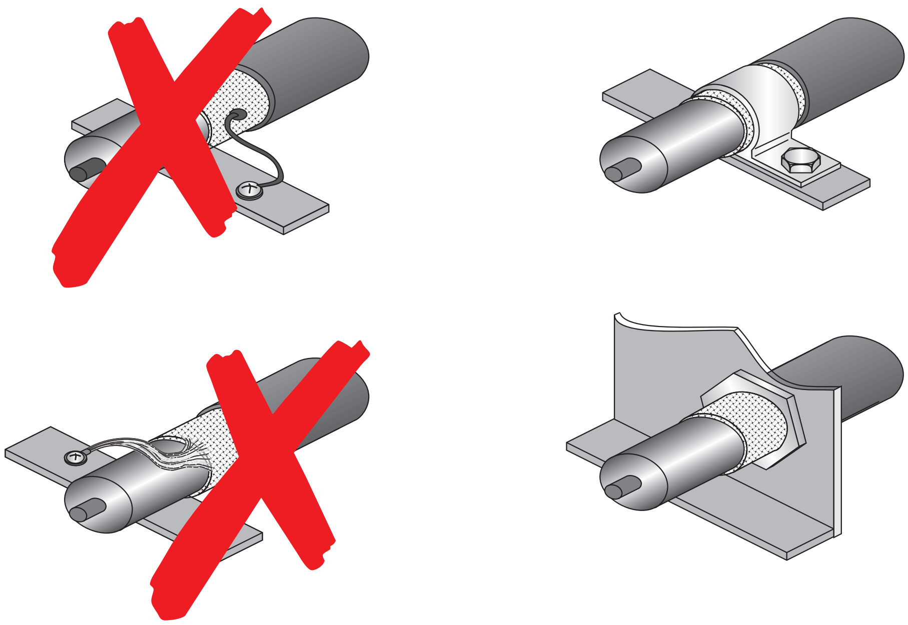
These leakage currents strongly increase when shielded motor cables are used. They can also trip the motor protection switch that is usually used in group drives. This is why you should preferably use unshielded cables for group drives. If the plant must meet EMC limit values, install an output filter instead.

Braided shield connection

Connect the braided shield over its entire circumference using grounding clamps or EMC cable glands.

Do <u>not</u> connect the shield via a twisted braid (so-called pigtail) or a wire extension. This can reduce the shielding effect by up to 90%.

The following figure shows the different options for connecting the shield:



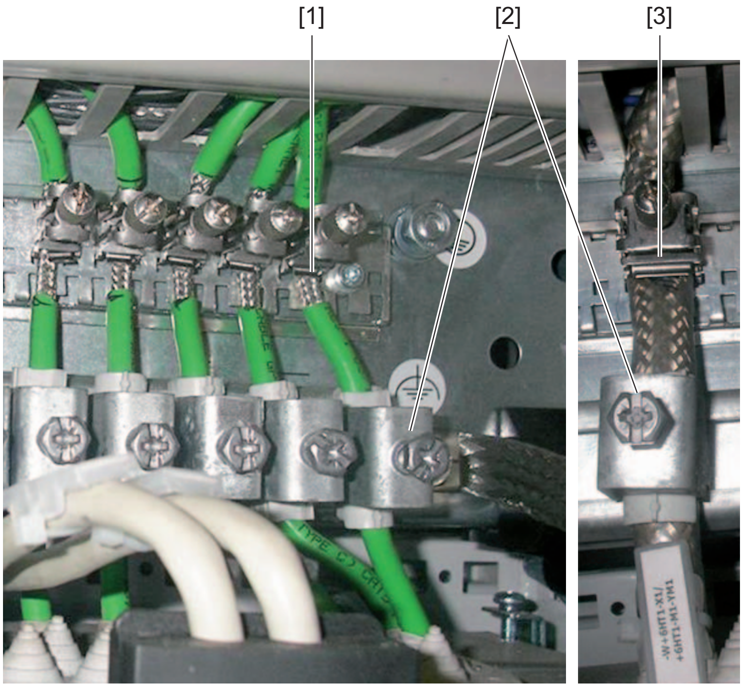
235857803

Incorrect shield connection
via wire extension
or twisted braiding

Correct shield connection
over entire circumference to housing
or grounded surface

Practice

The following figures show braided shield connections in practice:



3779830539

[1] Shield of encoder cable connected to shield plate of control components
[2] Mechanical cable relief
[3] Shield of motor cable connected to shield plate of power components

Note the following:

- Connect the braided shields of the encoder and bus cables to the shield plate of the control components [1].
- Connect the braided shield of the motor cable to the separate shield plate for power components [3].
- Fix the cables in position with mechanical cable reliefs [2].
- If the shield plate is not directly connected to the uncoated mounting plate, you have to establish an HF connection to the PE busbar in the control cabinet.
- The braided shield can also be connected directly at the frequency inverter.

EMC cable glands

Use an EMC cable gland of the following type for routing the cable into a housing:

3880956939

For example:

Manufacturer	Sales	Thread	Type
Jacob	Sonepar	Mxx	50.6xx M / EMC
		M20	50.620 M / EMC

You can also use EMC cable glands from the company Hummel:

HSK-M-EMV:	Type comparable with 50.6xx M / EMC from the company Jacob
HSK-MZ-EMV:	With integrated strain relief and bending protection
HSK-M-EMV-D:	For leading through the braided shield

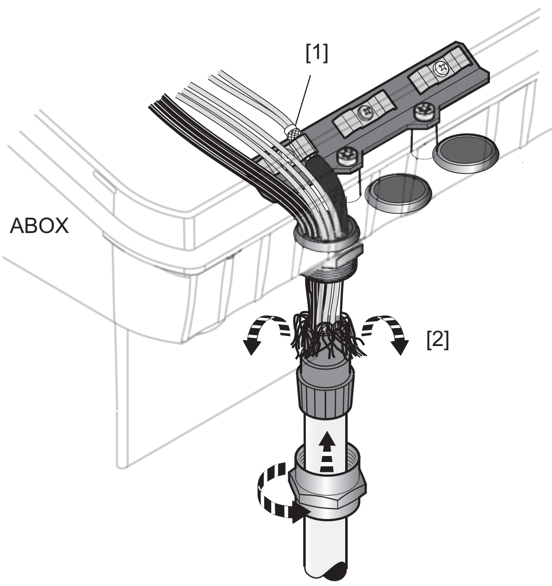
Shielding of hybrid cables

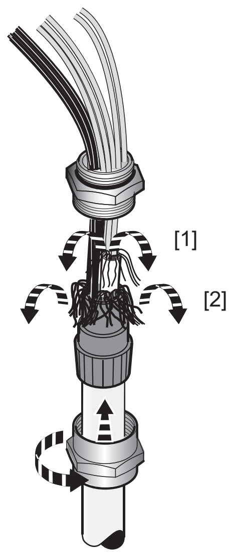
Each shield of a hybrid cable must be connected on both ends.

Example with MOVIFIT®

Connecting the 2nd braided shield of a hybrid cable to the shield plate

Connecting the 2nd braided shield of a hybrid cable with an EMC cable gland





3780284427

[1] Inner shield
[2] Outer shield

If there is no shield clamp for another braided shield of a hybrid cable, you must connect all braided shields to the EMC cable gland together.

Faulty prefabrication of hybrid cables

Prefabricated hybrid cables are often shortened on the motor end by customers or assembled by the customers themselves.

The following error is made often here:

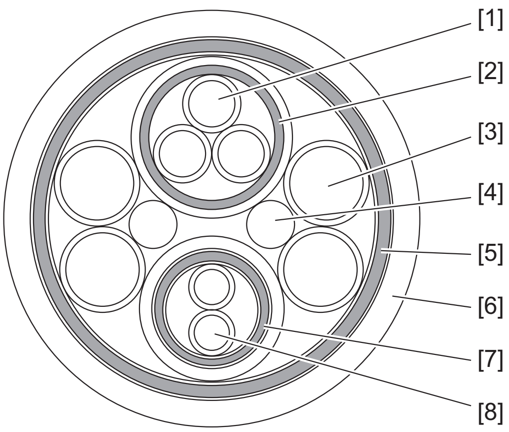
- The outer shield is connected correctly.
- The inner shield is connected correctly on the inverter end.
- **Error:** The inner shield is **not** connected correctly on the motor end.

Example of motor/brake cable:

If the brake cable of an hybrid cable is connected only on one end, the shielding effect is not sufficient.

In case of a pulsed motor cable with insufficient shielding, HF interference peaks are induced the brake cable. These HF interference peaks in the brake cable put an impermissibly high load on the brake rectifier, so that it ages more quickly.

The following figure shows the cross section of a hybrid cable (SEW-EURODRIVE, type D) with cores for connecting the motor [3], the brake [1], and the temperature sensor [8]:



3780763403

[1] Brake cable
[2] Brake cable shield
[3] Phase of motor cable
[4] Filling element
[5] Outer shield
[6] Outer cable sheath
[7] TF cable shield
[8] TF cable

- Connecting the inner shield of the brake cable in the hybrid cable on one end only can damage the brake rectifier and subsequently the brake coil in the long run.
- If the shield of a TF cable is not grounded on both ends, encoder errors can be triggered.

Connect each shield of the hybrid cable and TF cable <u>on both ends</u>.

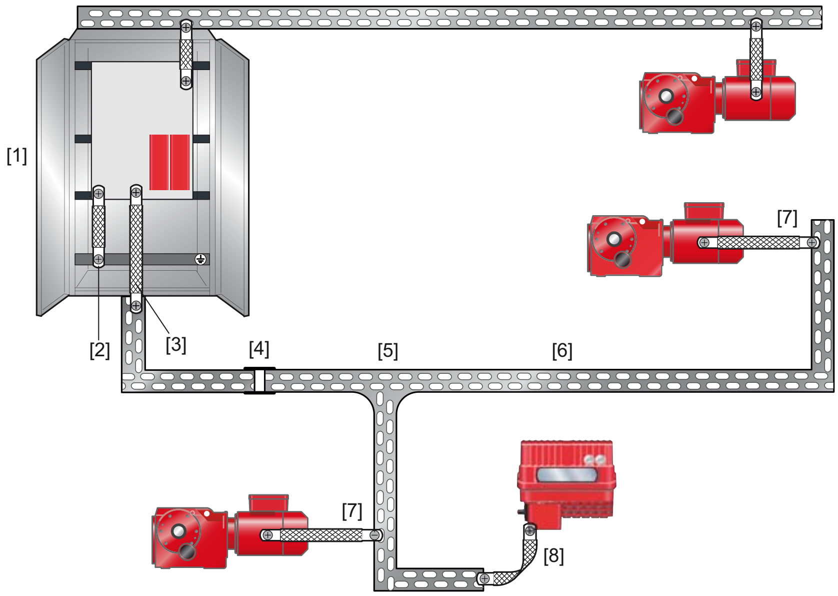
1.6 *Equipotential bonding in the plant*

1.6.1 Interlinked equipotential bonding

If you interlink several machines, you must provide for equipotential bonding between the control cabinet, conveyor elements, cable ducts, and resources.

- From an electrical safety perspective, the PE busbar is the star point.
- In terms of EMC, it is advantageous if the mounting plate is used as a star point with respect to HF equipotential bonding.

The following figure shows an example of interlinked equipotential bonding between several components:



3853533579

[1] Control cabinet with PE busbar
[2] Connection between the mounting plate and the PE busbar
[3] HF-capable connection of cable duct to PE busbar
[4] Connection between cable ducts over a large area
[5] Branches with extensive angles
[6] Cable duct made of sheet metal
[7] HF-capable equipotential bonding of the gearmotor to the cable duct
[8] HF-capable equipotential bonding of the MOVIFIT® unit to the cable duct

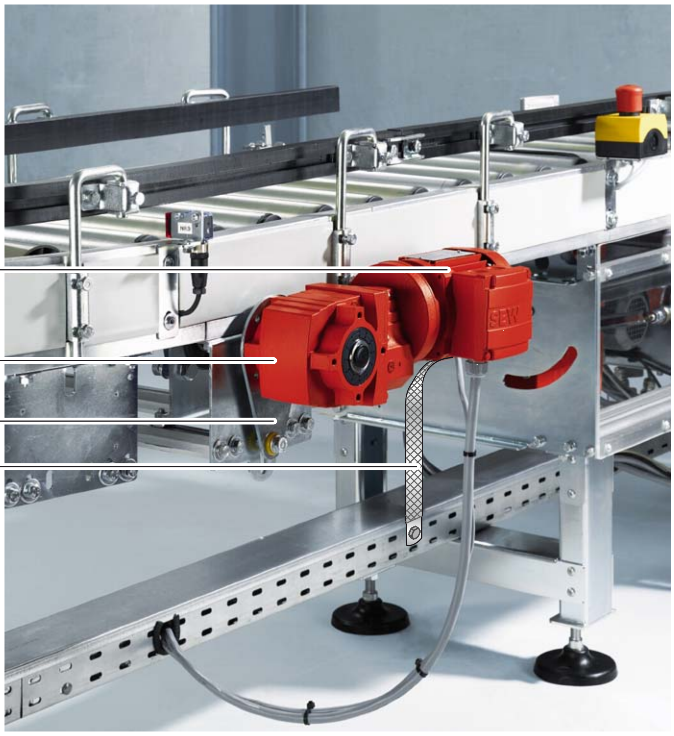
Observe the following notes when establishing equipotential bonding:

- Install the control cabinet with PE busbar according to the illustration above.
- Connect the cable duct to the control cabinet over a large area.
- Connect the cable duct with the mounting plate in the control cabinet [3] using an HF braid.
- Connect the PE busbar with the mounting plate [2] over a large area (HF connection).
- Connect the parts of the sheet metal cable duct with each other [4] over a large area.
- Connect cable ducts that branch off with large-area brackets [5] or with HF braids.
- Connect the PE connection of MOVIFIT® with the cable duct [8] using an HF braid.
- Connect the gearmotor with the cable duct [7] in the same way.

1.6.2 Example: Drive with shaft-mounted gear unit

Equipotential bonding for protection of the brake rectifier

A drive with shaft-mounted gear unit is mechanically connected to the plant only via the shaft and a torque arm.



5374678539

[1] Motor
[2] Shaft-mounted gear unit
[3] Torque arm with rubber bushing
[4] HF braid

The bearings of the gear unit offer no sufficient equipotential bonding for the drive. The torque arm is often equipped with an elastic rubber bushing that electrically isolates the drive from the plant. This means the drive has no HF-capable equipotential bonding.

Due to this insufficient equipotential bonding, some of the leakage currents from the motor flow back to the inverter in the control cabinet via the brake cable. This means the leakage currents flow through the brake rectifier, where they damage the electronic components of the brake rectifier. This can lead to accelerated aging and to an early failure of the brake rectifier.

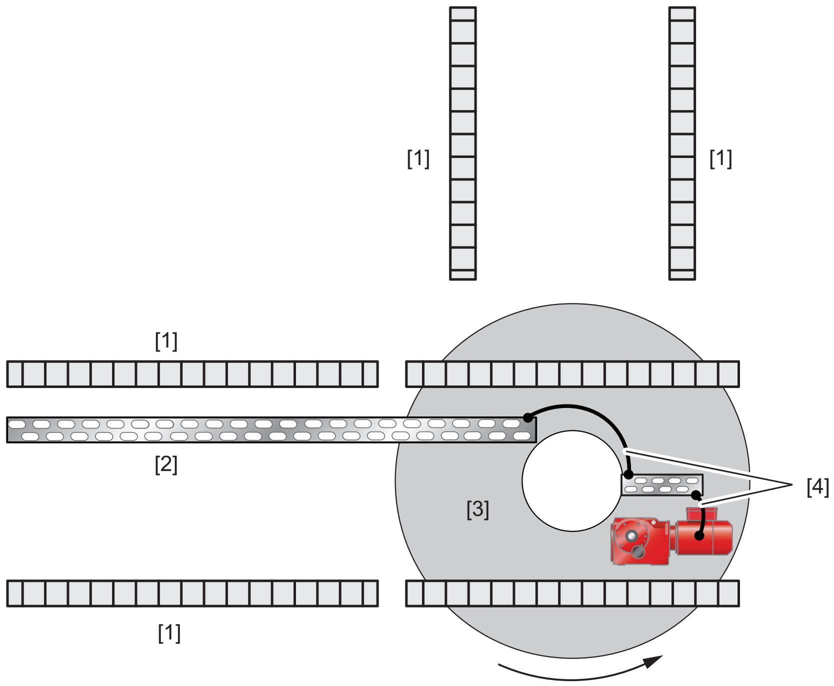
In hoists and rotary tables, the equipotential bonding of the mobile drive might also be unsuitable for HF. The insufficient equipotential bonding of mobile drives of hoists and rotary tables can also lead to an early failure of the brake rectifiers.

Conclusion

Always install an HF braid between the motor and the plant in case of shaft-mounted gear units, hoists, and rotary tables. The leakage currents then flow to ground via the HF braid.

1.6.3 Example: Rotary table

The following figure shows the equipotential bonding of a rotary table:



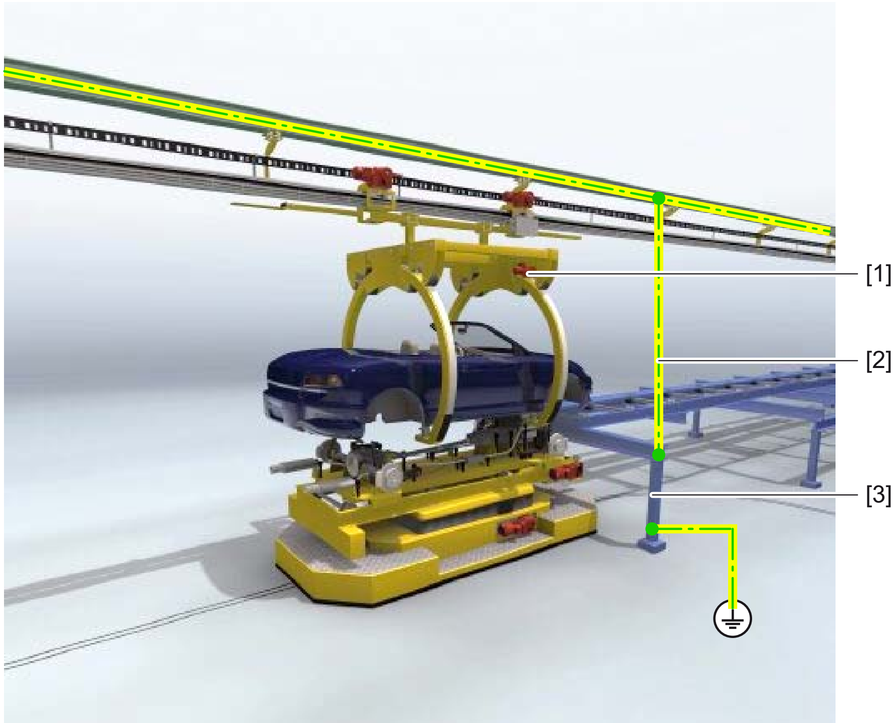
3854592267

[1] Chain of the chain conveyor
[2] Cable duct made of sheet metal
[3] Rotary table
[4] Equipotential bonding between stationary and mobile cable ducts and motor

Establish equipotential bonding between the stationary cable ducts, mobile cable ducts, and the motor as shown in the figure above [3].

1.6.4 Example: Electrified monorail system

The following figure shows the equipotential bonding at the docking station of an electrified monorail system:



3855975947

[1] Frequency inverter of the turning device with line filter
[2] Equipotential bonding of PE busbar to docking station
[3] Docking station

- Mobile drive on the electrified monorail unit

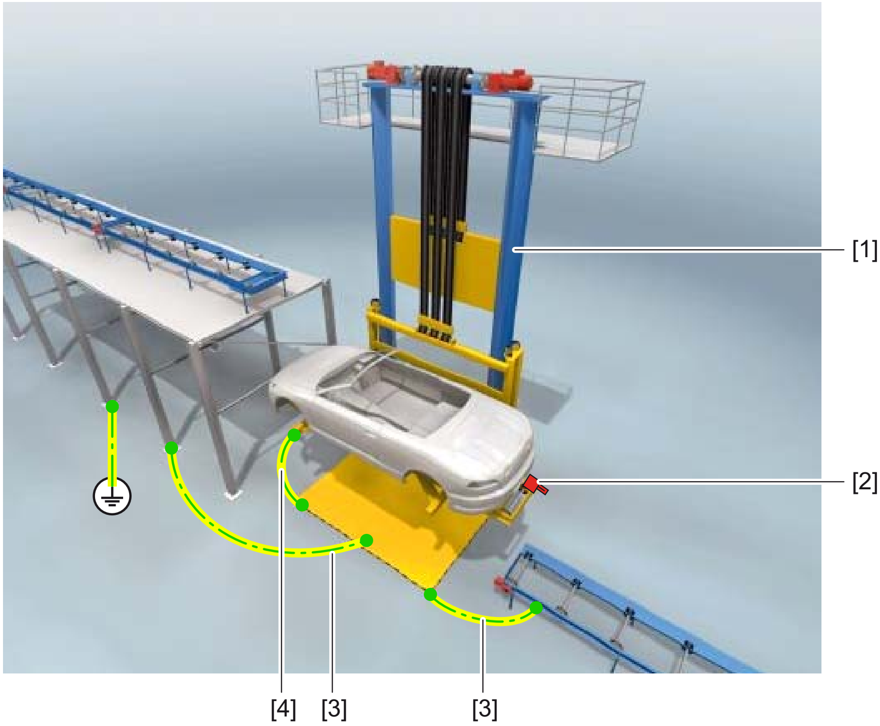
  If a controlled drive travels on an electrified monorail unit, the mobile drive must be equipped with a line filter. In smaller frame sizes, the line filter is already integrated. The line filter feeds the largest part of the leakage currents back to the frequency inverter. This reduces the risk of leakage currents dissipating via other components and interfering with equipment or communication.

- Equipotential bonding of the electrified monorail system at the docking station

  If an electrified monorail system is supplied with power via a conductor rail system, you must install an equipotential bonding cable between the PE busbar of the conductor rail system and the stopping point of the docking station. This ensures that no potential difference can occur between the electrified monorail system and the docking station. This prevents electrical hazards to persons.

1.6.5 Example: Hoist with integrated roller conveyor

The following figure shows the equipotential bonding of a hoist with integrated roller conveyor:



3857042187

[1] Hoist
[2] Mobile drive
[3] Equipotential bonding
[4] Equipotential bonding (traveling cable) of the fork

If a controlled drive [2] travels on a hoist, the mobile drive must be equipped with a line filter. In smaller frame sizes, the line filter is already integrated. The line filter feeds the largest part of the leakage currents back to the frequency inverter. This reduces the risk of leakage currents dissipating via other components and interfering with equipment or communication.

If the frequency inverter and the bus module of a roller conveyor drive are both installed on the fork of the hoist, correct equipotential bonding of the fork is especially important.

The following cables are suitable as traveling cables [4]:

- Round, tinned copper strip, e.g. RTCB from the company ERICO.

  This is the best solution with respect to EMC.
- Separate PE conductor with larger cable cross section, e.g. 16 mm^2.

1.6.6 ESD – electrostatic discharge

Electrostatic discharge (ESD) is a disruptive discharge or spark that is created by high potential differences in an electrically insulating material. ESD causes a very short, high electrical current impulse that strongly interferes with the components in the plant.

Cause

The cause for the high potential difference is usually continuous charging due to the triboelectric effect, e.g.:

- Walking on a rug with insulating shoes
- Handling plastic parts
- Pulling off plastic or paper webs from reels
- When using plastic rollers, e.g. in roller conveyors or hoists

Effects

- Interference with electronic equipment, especially in case of bus communication
- Damage to semiconductors, creeping defects
- Encoder malfunctions

Remedy

You can protect the plant from ESD by installing components for dissipating the charge at all points where insulating materials rub against each other.

The following measures are suitable for dissipating charges within the plant:

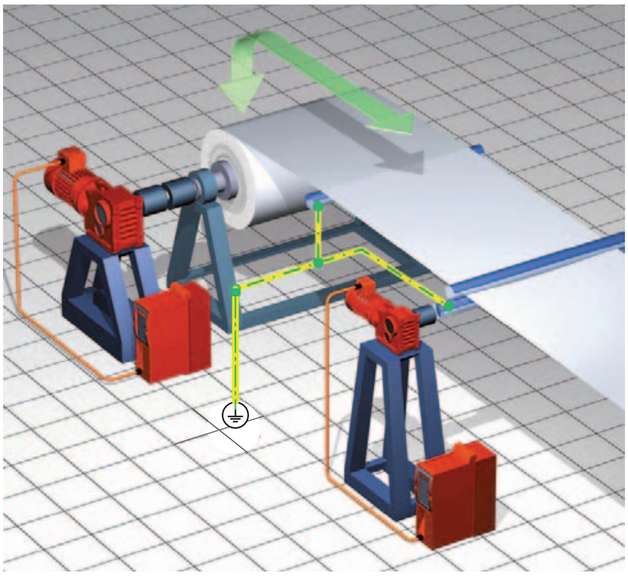
- Conductive combs
- Brushes, metal filaments
- Sliders, metal rollers, metal drums, etc.

These protective measures are especially important for the following applications:

- Conveyor belts
- Pulling off plastic or paper webs from reels.

In large moving objects (e.g. winders), the charges can become so high that ESD protection is necessary for reasons of operator protection alone.

The following figure shows ESD protection of a winding machine:



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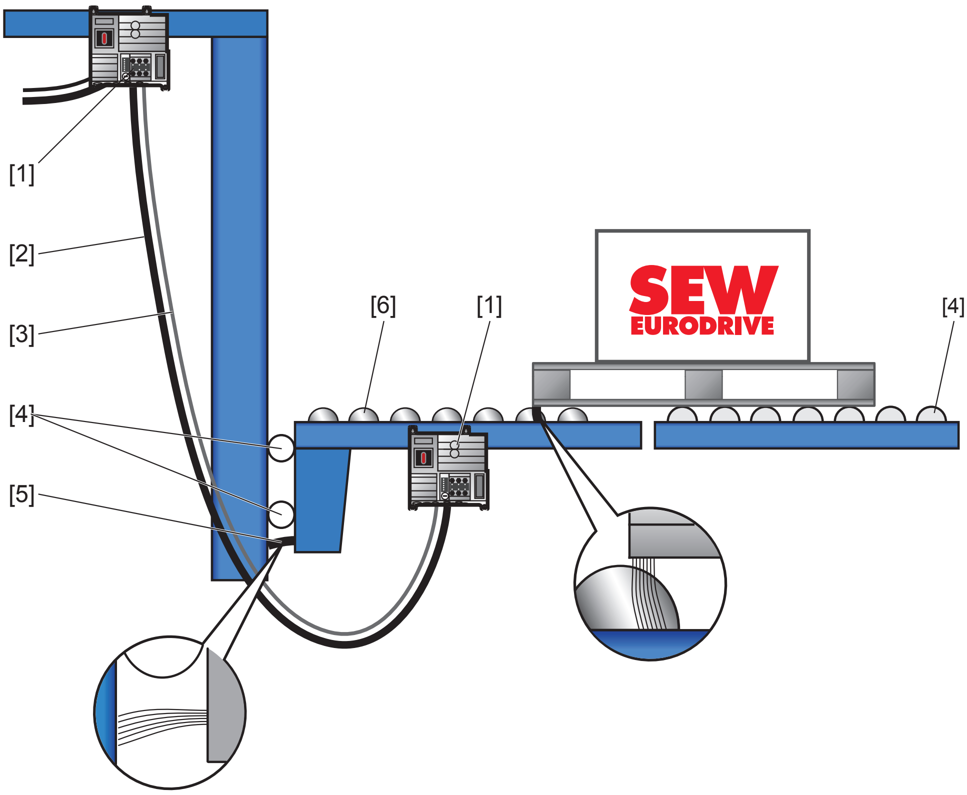
The following figure shows ESD protection of a hoist and a roller conveyor with metal and plastic rollers:



301406603

[1] Susceptible field distributor with inverter
[2] Hybrid cable (power, bus communication)
[3] EMC-compliant equipotential bonding conductor
[4] Plastic rollers (made of PVC)
[5] Metal comb
[6] Metal rollers

The charges of the mobile part are dissipated continuously via the metal comb to the frame of the hoist. This prevents electrostatic charging of the transported goods.

Conclusion

Plants that are vulnerable to ESD need ESD protection measures in addition to EMC-compliant equipotential bonding.

The following measures are required:

- EMC-compliant **equipotential bonding** against EMI
- **ESD protection** as unit protection

  In case of large, moving objects, ESD protection is necessary also for operator safety reasons.

1.6.7 Low-resistance ground reference

For optimized equipotential bonding in the HF range, a low-resistance ground reference is obligatory.

The following connection elements ensure low-resistance ground reference:

235057163

A Connection over a wide area (1:3 < X:Y < 3:1)
e.g. for connecting sheet metal ducts
B HF braid

Connection over a wide area

To connect individual machine parts or sheet metal ducts, you can use a wide metal plate [A].

Connect it to the reference potential at both ends over a large area.

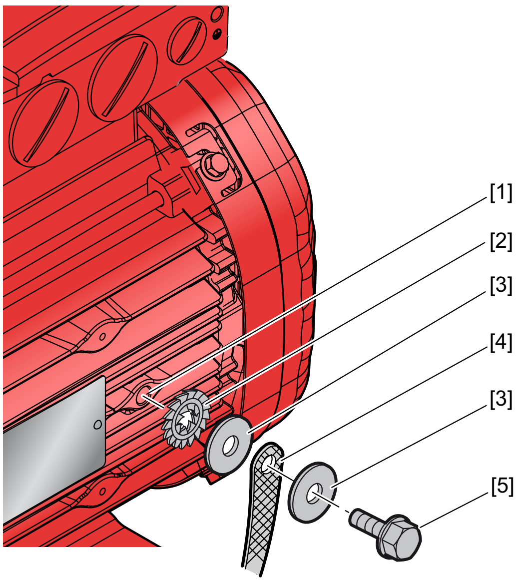
HF braids

If it is not possible to use metal plate connections, you can also use flexible HF braids [B].

According to **EN 60204-1**, chapter 13.2.2 from 2006, HF braids may also be used as PE conductor if the connection points are marked with the ground symbol.

Protect the HF braid with 2 washers to avoid damage to it from the screws or vibrations. Note the structure of the screw connection below.

The following figure shows an example of how the HF braid is installed to a DR.100M motor:



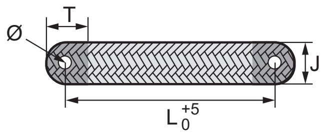
9007204735364875

[1] Hole
[2] Serrated lock washer
[3] Washer for protecting the HF braid
[4] HF braid
[5] Self-tapping screw

SEW-EURODRIVE recommends the following HF braids from the company ERICO for equipotential bonding:

- For the standard equipotential bonding connection of SEW components such as motors and decentralized controllers, use an HF braid with a hole diameter of 6.5 mm.
- For the "Improved grounding" option for DR motors (see chapter "DR motors" (page 59), use an HF braid with a hole diameter of 8.5 mm.

The following figure shows the HF braid from the company ERICO:



3566927115

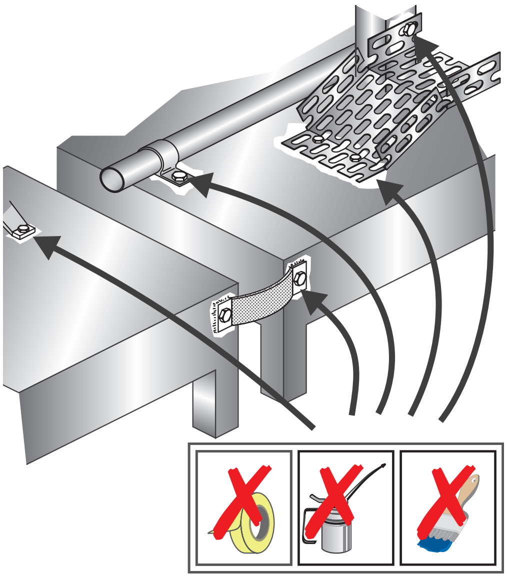
The following table shows the technical data of the HF braids:

	SEW standard connection for equipotential bonding	"Improved grounding" option
Item number (ERICO)	556610	556660
Type	MBJ 10-300-6	MBJ 16-300-8
[L] length	300 mm	300 mm
[J] Width	12 mm	15 mm
[Ø] Hole diameter	6.5 mm	8.5 mm
[T] Minimum contact length	22 mm	25 mm
Current carrying capacity	Max. 75 A	Max. 120 A
Cable cross section	10 mm^2	16 mm^2

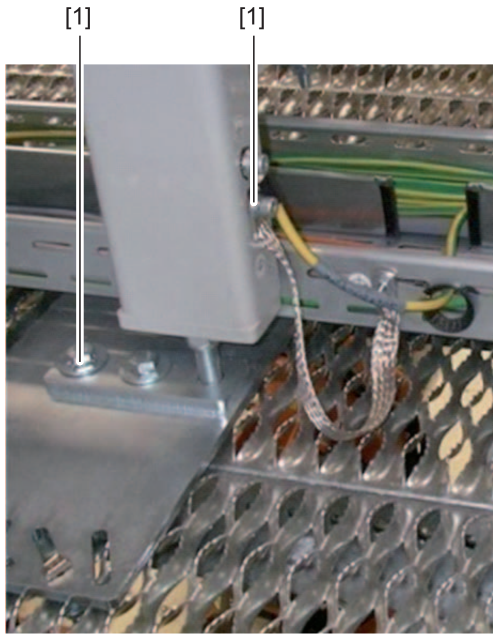
1.6.8 Contact

The contacts of the grounding connections have a significant influence on the quality of the grounding connection. The effectiveness of the best ground conductor can be nullified by careless or unsuitable contacts.

The following figures show examples of suitable contact options:



235062283



3879515275

[1] Contact options

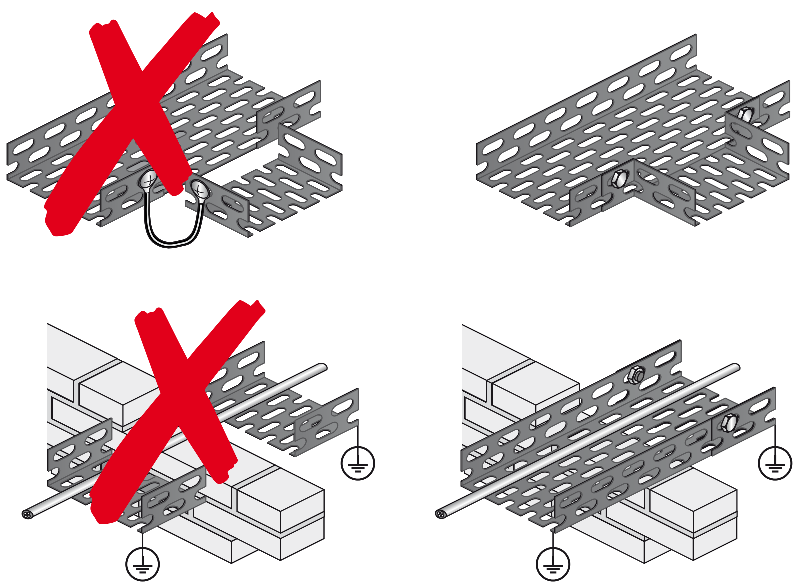
1.6.9 Cable duct connections

Observe the following notes for the installation of cable ducts:

- Ensure connection over a large area by using metal brackets for the cable ducts.
- A continuous ground reference surface (sheet metal duct) must exist between two plant components.
- Route all cables along the ground reference surface.
- Make sure that the contact points pose no tripping hazard.

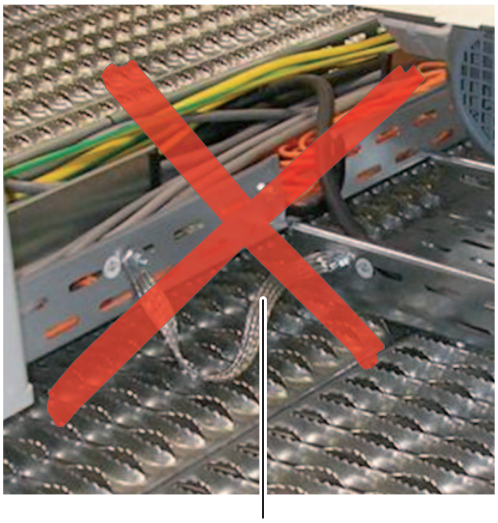
The following figures show examples of suitable contact options:

Non-recommended connections	**Recommended connections**



235092491

The following figures show negative examples of contact options:



[1] [1]

[1] Connection poses a tripping hazard

Do **not** establish connections [1] as shown in the pictures above, as they do not offer contact over a large area and pose a tripping hazard.

1.7 Equipotential bonding of decentralized components

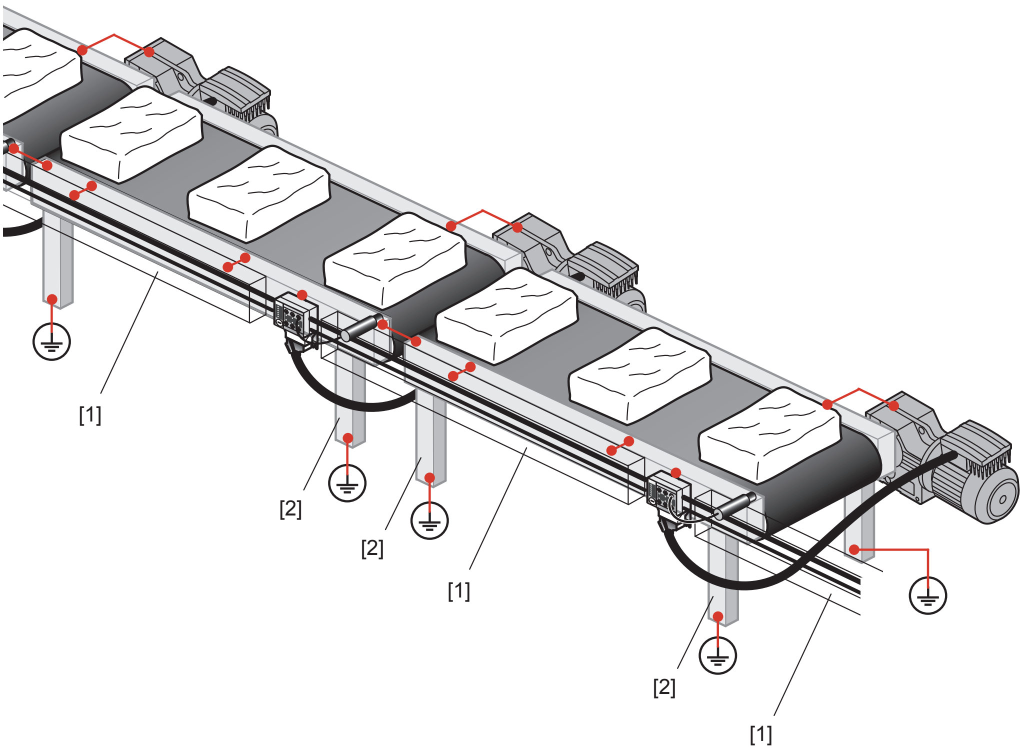
In decentralized applications, bus communication is distributed in the field. This is why HF-capable equipotential bonding is particularly important.

In addition to the PE connection, you must install low-resistance, HF-capable equipotential bonding (e.g. HF braid).

The following chapters exemplify equipotential bonding of the decentralized components from SEW-EURODRIVE.

1.7.1 MOVIMOT® with field distributor

The following figure shows the equipotential bonding measures of a transportation system with several MOVIMOT® drives: Signal transmission and supply is via field distributors:



462884107

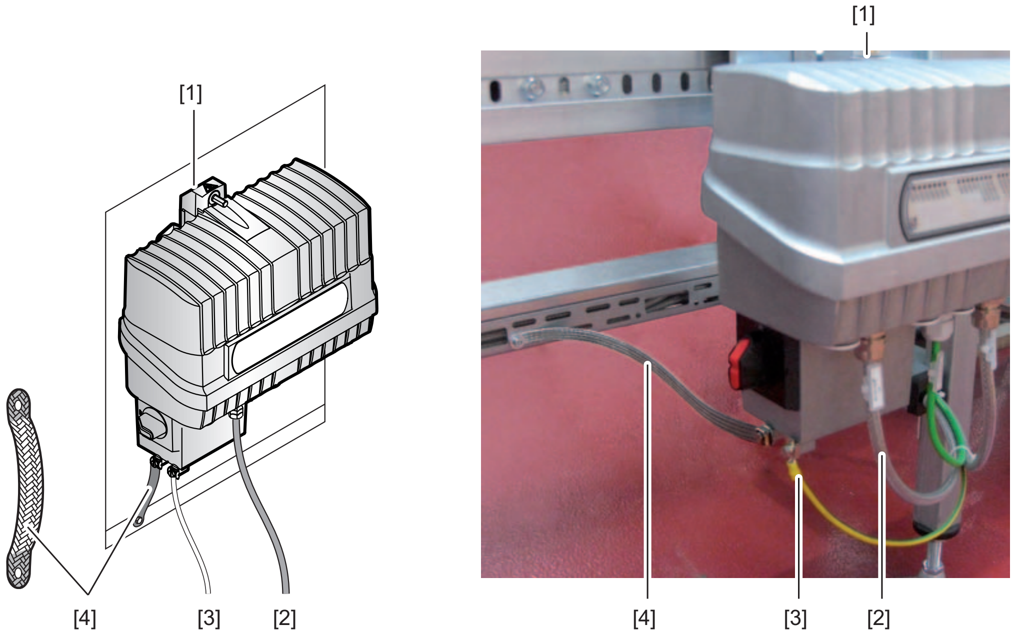
[1] Cable duct
[2] Metallic frame

The cables for fieldbus systems and rotary and position encoders transmit sensitive signals, and due to the decentralized principle, they are routed in parallel with power cables, e.g. from frequency inverter to the motor.

To ensure the necessary protection from HF interference, these systems are equipped with high-quality HF shields. In such systems, equipotential bonding via cable ducts and the metal structure of the machine is especially important. Otherwise, different potentials are mainly equalized via the signal cables, which causes interference.

1.7.2 MOVIFIT®

The following figure shows the PE conductors and EMC-compliant equipotential bonding of MOVIFIT® units:



3880956939

[1] Conductive connection over a large area between MOVIFIT® and the mounting rail
[2] PE conductor in the supply cable
[3] 2. PE conductor via separate terminals
(double safety for leakage currents > 3.5 mA according to EN 61800-5-1)
[4] EMC-compliant equipotential bonding via HF braid

INFORMATION

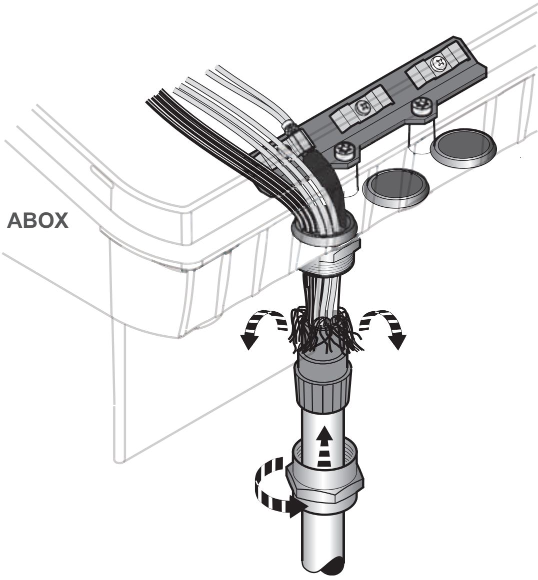
- **Metallic cable ducts may not be used as PE conductors** for electrical safety reasons.
- However, **from an EMC perspective**, a low-resistance connection between the control cabinet, the metal cable duct, and the motor for equipotential bonding **offers the following advantages**:
  - The metal cable duct is always installed in parallel with the cables.
  - It can easily be checked for interruptions.

Observe the following notes when establishing equipotential bonding for MOVIFIT® units:

- Establish a large-area connection between the MOVIFIT® unit and the grounding point of the plant.
- To do so, connect an HF braid between the MOVIFIT® unit and the grounding point of the plant.

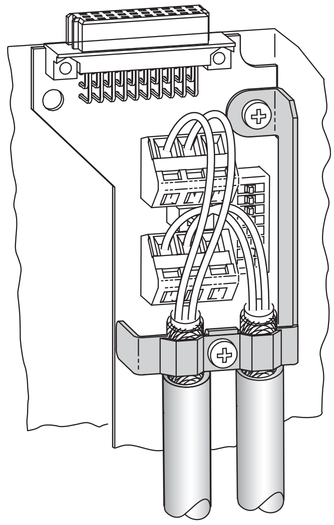
The following figures show the braided shield connection of hybrid and PROFIBUS cables at MOVIFIT® units:

Connection of hybrid cable



5461694475

Connection of PROFIBUS



5449603851

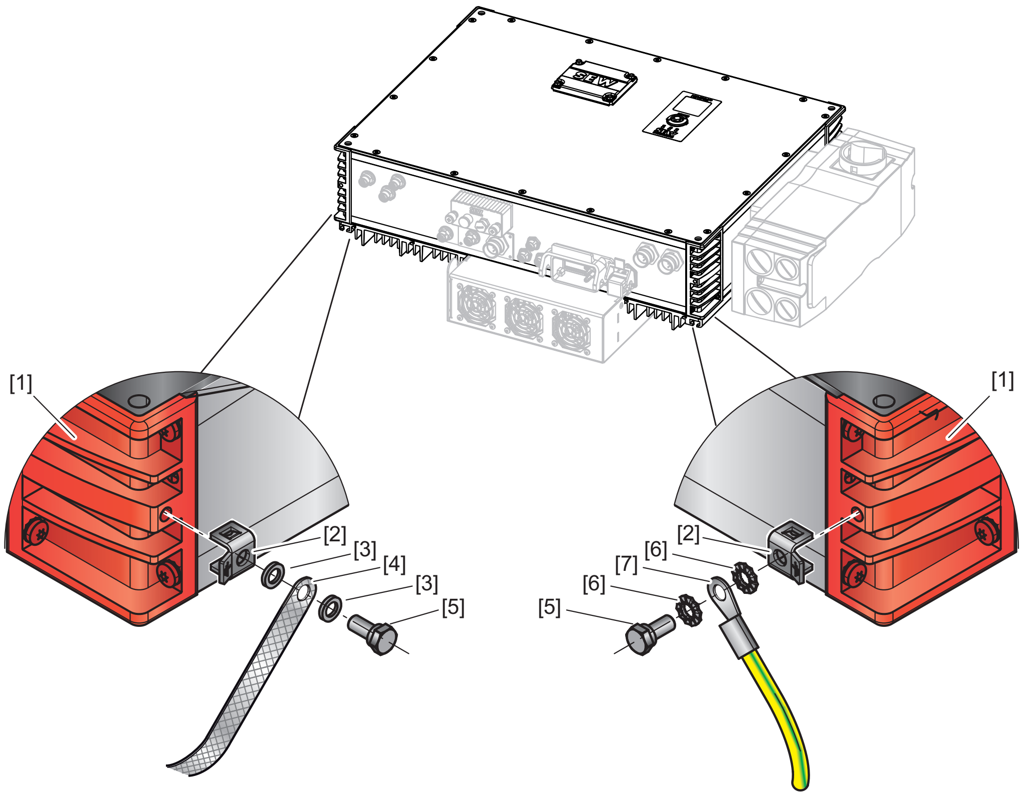
Use only EMC cable glands for connecting the hybrid cable to the MOVIFIT® unit, see chapter "EMC cable glands" (page 39).

1.7.3 MOVIPRO®

Grounding kit

The scope of delivery of MOVIPRO® includes two grounding kits.

The following figure shows the positions of the connection points and the sequence in which to install the individual parts:

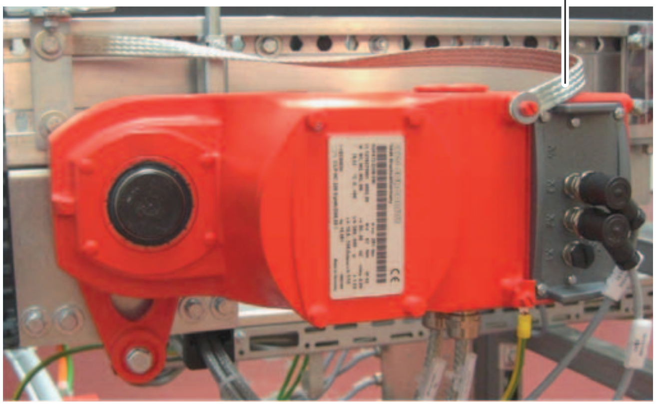


5462396939

[1] Housing corner
[2] Terminal clip
[3] Washer for M5
[4] HF braid
[5] M5 screw, self-tapping
[6] Tooth lock washer
[5] Ring cable lug for PE copper conductor

1.7.4 MOVIGEAR®

The following figure shows the equipotential bonding of MOVIGEAR® drive units:



3882314891

[1] Equipotential bonding of MOVIGEAR® drive unit

Observe the following notes when establishing equipotential bonding for MOVIGEAR® drive units:

- Establish a large-area connection between the MOVIGEAR® drive unit and the grounding point of the plant.
- To do so, connect an HF braid between the MOVIFIT® unit and the grounding point of the plant.

1.8 Equipotential bonding of AC motors

1.8.1 Connection of options

Temperature sensor connection

Route the cable of the TF temperature sensor separately from other power cables.

Keep a minimum distance of 200 mm.

The cables can only be routed together if either the TF cable or the power cable is shielded.

Brake connection

Route the brake cable separately from other power cables.

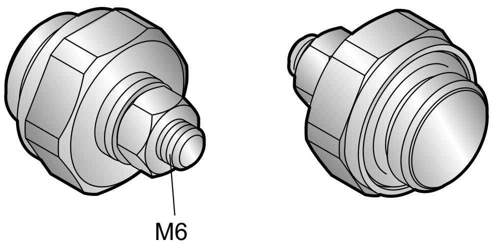
Keep a minimum distance of 200 mm.

The cables can only be routed together if either the brake cable or the power cable is shielded.

Use varistors for connections in the DC circuit of disk brakes. The varistors prevent harmful overvoltages. Brake control systems from SEW-EURODRIVE are equipped with varistors as standard.

1.8.2 Equipotential bonding / HF grounding at the connection box

Another option for HF-capable equipotential bonding at a connection box is the following cable gland with M6 threaded bolt.



3884960907

	Part number
M16 cable gland with M6 threaded bolt	0 818 923 4
M25 cable gland with M6 threaded bolt	0 819 268 5

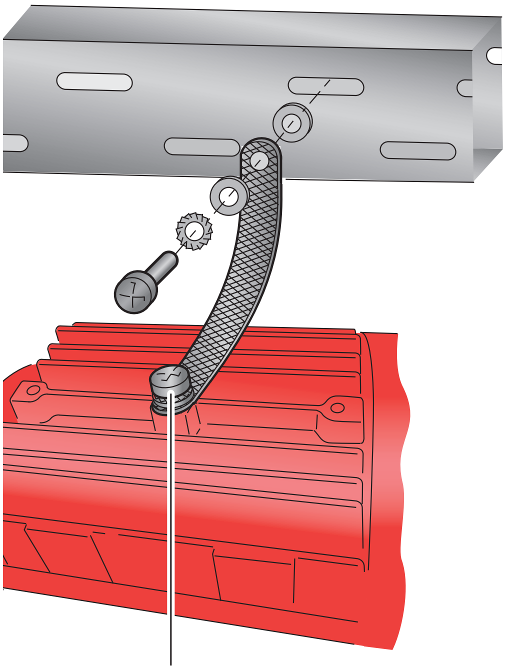
You can install this cable gland at a connection box that still has a free cable entry hole of size M16 or M25.

Screw the cable gland into the free hole and install the grounding cable (with ring cable lug) or the HF brand at the M6 threaded bolt.

1.8.3 DT/DV motors

Size DT71 – DV132

The following figure shows the equipotential bonding connection with suitable screws and serrated lock washers:



3884799499

[1] Self-tapping screw and 2 serrated lock washers

Use the following screws and serrated lock washers for equipotential bonding for the respective size:

- **Size DT71 – DV132S:**

  1 self-tapping screw M5 x 10 and 2 serrated lock washers [1]

- **Size DV112M – DV280:**

DV112 / DV132S:	M8 screw	+ 2 serrated lock washers
DV132M – DV180L:	M12 screw	+ 2 serrated lock washers
DV200 – DV280:	M16 screw	+ 2 serrated lock washers

1.8.4 DR motors, exterior LF grounding

In addition to the interior PE connection, a LF (low frequency) grounding cable can be attached to the outside of the terminal box. LF grounding is not installed as standard.

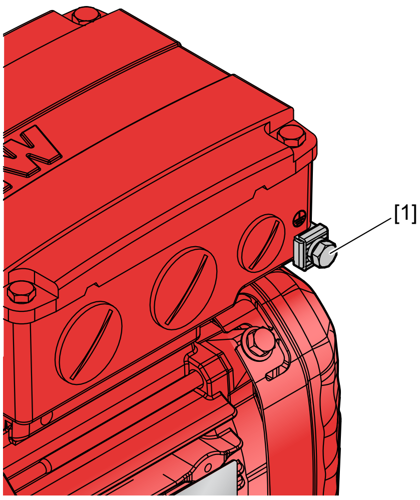
LF grounding can be ordered as completely pre-installed at the factory. For DR.71 – 132 motors, this requires a brake or gray-cast terminal box. For DR.160 – 225 motors, this option can be combined with all terminal box types.

The option can be combined with HF grounding.

INFORMATION

All parts of the LF grounding kit are made from stainless steel.

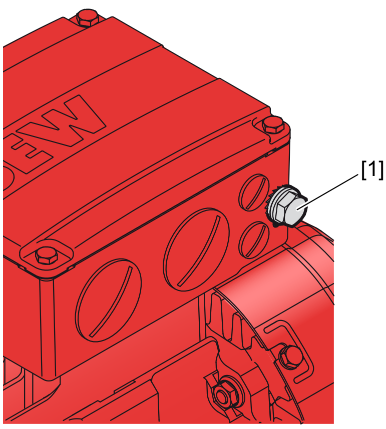
Size DR.71 – DR.132



9007204717158539

[1] LF grounding at the terminal box

Sizes DR.160 – DR.225



9007204718646539

[1] LF grounding at the terminal box

1.8.5 "Improved grounding" option (HF grounding) for DR motors

For improved, low-impedance grounding at high frequencies, we recommend using the following connections: SEW-EURODRIVE recommends to use corrosion-resistant connection elements.

HF grounding is not installed as standard.

The HF grounding option can be combined with LF grounding at the terminal box.

If you require LF grounding in addition to HF grounding, you can connect the conductor to the same point.

The HF grounding option can be ordered as follows:

- Completely pre-installed at the factory, or as
- "Grounding terminal" kit for customer installation; part numbers listed in the following table.

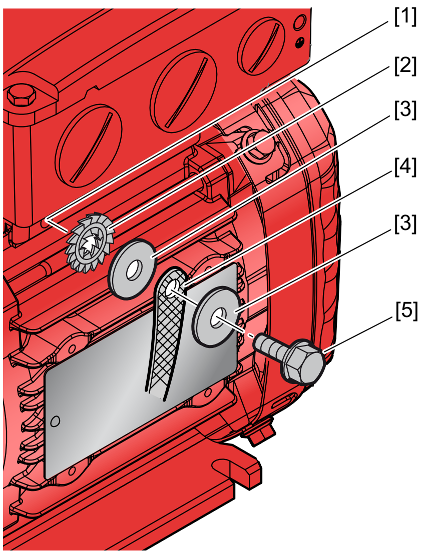
Motor size	Part number of "Grounding terminal" kit
DR.71S / M DR.80S / M	1363 3953
DR.90M / L	
DR.100M	
DR.100 L – DR.132 with aluminum terminal box	1363 3945
DR.160 – DR.225 with aluminum terminal box	

INFORMATION

All parts of the kit are made from stainless steel.

Size DR.71S / M and DR.80S / M

The following figure shows how the grounding kit is installed:



9007204719329675

[1] Use of the pre-cast bore at the stator housing

[2] Serrated lock washer

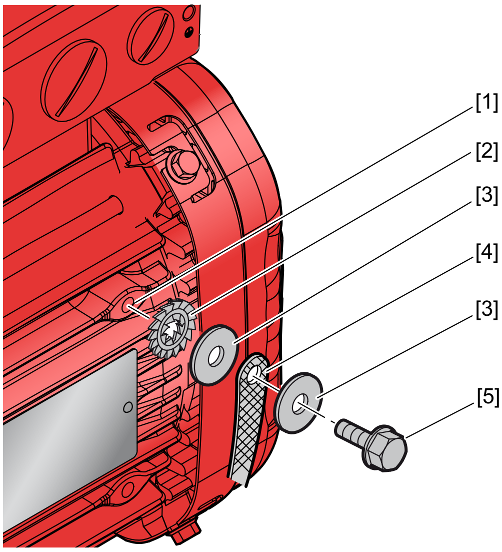
[3] Disk 7093

[4] Ground strap (not included in the scope of delivery)

[5] Self-tapping screw DIN 7500 M6 x 16, tightening torque 10 Nm (88.5 lb-in)

Size DR.90M / L

The following figure shows how the grounding kit is installed:



9007204722451083

[1] Use of the pre-cast bore at the stator housing

[2] Serrated lock washer

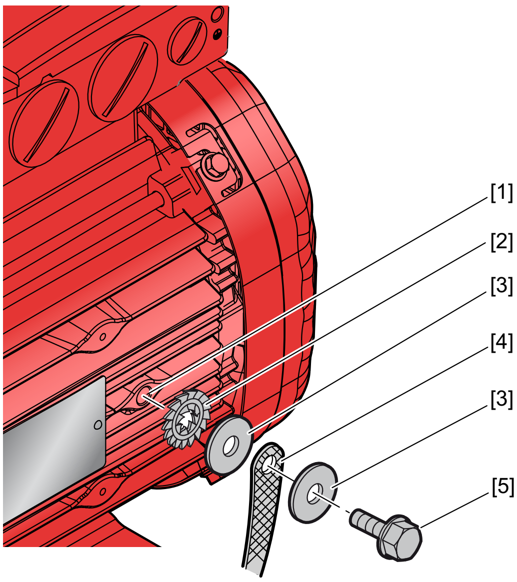
[3] Washer 7093

[4] Ground strap (not included in the scope of delivery)

[5] Self-tapping screw DIN 7500 M6 x 16, tightening torque 10 Nm (88.5 lb-in)

Size DR.100M

The following figure shows how the grounding kit is installed:



9007204735364875

[1] Use of the pre-cast bore at the stator housing

[2] Serrated lock washer

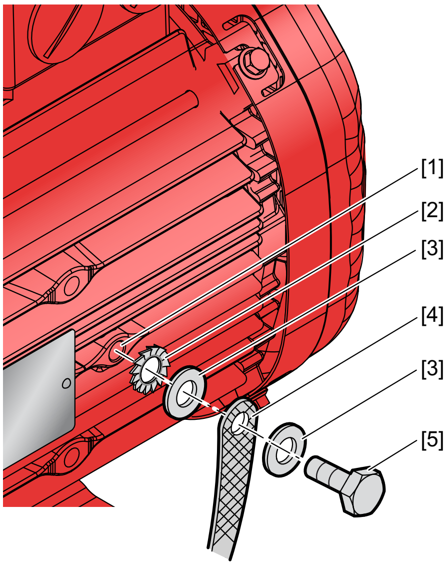
[3] Washer 7093

[4] Ground strap (not included in the scope of delivery)

[5] Self-tapping screw DIN 7500 M6 x 16, tightening torque 10 Nm (88.5 lb-in)

Size DR.100L – DR.132

The following figure shows how the grounding kit is installed:



9007204735369227

[1] Use of tapped hole for lifting eyes

[2] Serrated lock washer DIN 6798

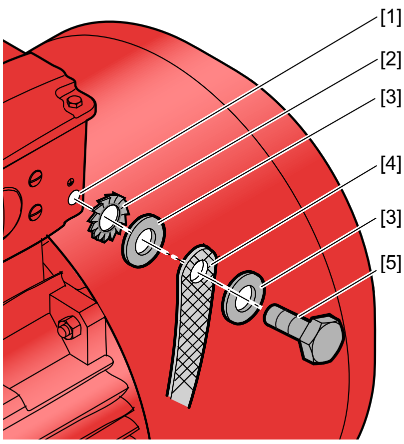
[3] Washer 7089 / 7090

[4] Ground strap (not included in the scope of delivery)

[5] Hexagon screw ISO 4017 M8 x 18, tightening torque 10 Nm (88.5 lb-in)

Sizes DR.160 – DR.315

The following figure shows how the grounding kit is installed:



9007204735374603

[1] Use of the tapped holes at the terminal box
[2] Serrated lock washer DIN 6798
[3] Washer 7089 / 7090
[4] Ground strap (not included in the scope of delivery)
[5]
- Hex head screw ISO 4017 M8 x 18 (with aluminum terminal boxes of size DR.160 – 225), tightening torque 10 Nm (88.5 lb-in)
- Hex head screw ISO 4017 M10 x 25 (with gray cast iron terminal boxes size DR.160 – 225), tightening torque 10 Nm (88.5 lb-in)
- Hex head screw ISO 4017 M12 x 30 (terminal boxes of size DR.250 – 315), tightening torque 15.5 Nm (137.2 lb-in)

2 Electromagnetic Interference

2.1 Fault diagnosis

Careful observation and documentation of the errors that occurred will help you to determine the cause of the fault. The more detailed the error description, the more quickly and easily the fault can be eliminated. Make sure that the error description cannot be misinterpreted.

Identification of interference source

- Do the malfunctions occur permanently or only from time to time?
- Is there a connection between the occurrence of the malfunction, the error rate, and the operating modes of the malfunctioning system when other units are operated?
- Identify the interference source by successively switching off units in the system.
- Check the supply voltages.

Identification of susceptible equipment

- Can you clearly rule out a malfunction due to hardware or software errors?
- Are there units or system components that are malfunctioning, but the malfunction cannot clearly be determined? For example, an encoder that can affect the entire system?
- Use the diagnostics options of the system (LEDs, error display, error counter, etc.) to identify the affected unit.
- Selective shutdown, disconnection, or replacement of system components helps you to locate the affected unit. Disconnection, for example, by
  - Changing the operating mode
  - Deactivating functions

2.2 Fault clearance

To clear faults that result from poor EMC, you can do the following:

- Eliminate or reduce the noise emitted by the interference source by means of coils, filters, or shield plates.
- Increase the interference immunity of the affected unit by using filters and/or shielded housings.
- Eliminate coupling sections to prevent the noise getting from the interference source to the susceptible equipment, e.g. by
  - Keeping sufficient distance between power and signal cables
  - Using shielded cables
  - Routing cables near ground
- Check compliance with the requirements described in this document and in the relevant product documentation.

2.3 Fault list

The following fault list helps you to identify EMI-related faults.

Malfunction	Cause	Solution
Sporadic malfunction	No interference suppression circuits (spark quenching) for coils of contactors, valves, or horns installed.	Install interference suppression elements (spark quenchers) for the coils. Use the interference suppression circuits recommended by the manufacturer.
	Spark-producing machines (e.g. welding machines)	Check/correct the routing of the control cables of the interference-emitting machine. Increase the distance to the interference-emitting machine.
	Radio transmitter, ripple control system	Install additional shielding.
	Cables with poor shield connections, incorrect conductor twisting, or incorrect characteristic values	Use original part cables. Check the conductor assignment.
	Interruptions in the cable shield, e.g. cable branching	Connect the cable shields of the incoming and outgoing cables with each other by connecting them either to a common large metal surface or an EMC shield cable gland or a shield plate.
	Incorrectly installed equipotential bonding cable	Re-install the equipotential bonding cable, see previous chapters.
	Dirt in the controller	Clean the dirty controller and assemblies. Ensure clean air supply.
Permanent axis offset	See "Sporadic malfunction"	
	No/insufficient equipotential bonding of the actual value conductor of an encoder	Install an equipotential bonding conductor between the encoder housing and the controller housing. Improve the equipotential bonding connection.
Encoder error	Shield of encoder cable interrupted	Replace the encoder cable with an original part encoder cable (product-specific).
	Encoder cable with poor shielding properties	
	Encoder cable shield connected via separate wire/conductor	Connect the shield of the encoder cable to an EMC shield clamp / shield glands on both ends.
	Encoder cable with incorrect characteristic values used	Use the encoder cable type recommended by the manufacturer or replace the encoder cable with an original part encoder cable (product-specific).
	Encoder track cores not twisted in pairs	Only use twisted pair cables as encoder cables: Connect them in pairs according to the wiring diagram.
	Shield of TF cable not grounded on both ends	Always use shielded cables as TF cables. Connect the shield of the TF cable on both ends.

Malfunction	Cause	Solution
Sporadic malfunction of stations in bus systems (e.g. PROFIBUS)	Incorrect terminating resistor e.g. PROFIBUS: 220 Ω CAN bus (SBus): 120 Ω	Measure with the ohmmeter whether the two terminating resistors are active in the bus segment. **Example:** PROFIBUS terminating resistor 220 Ω The two terminating resistors must be active at the start and end of the bus segment. Both terminating resistors are connected in parallel through the bus conductors. Resistance measurement between "Data+" and "Data -" (or "A" and "B") must produce about half the value of a terminating resistor (with PROFIBUS: about 95 – 110 Ω).
	Terminating resistor in the wrong place	During the resistance measurement, check whether the terminating resistor is in the right place by switching it off and on.

Index

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Driving the world

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