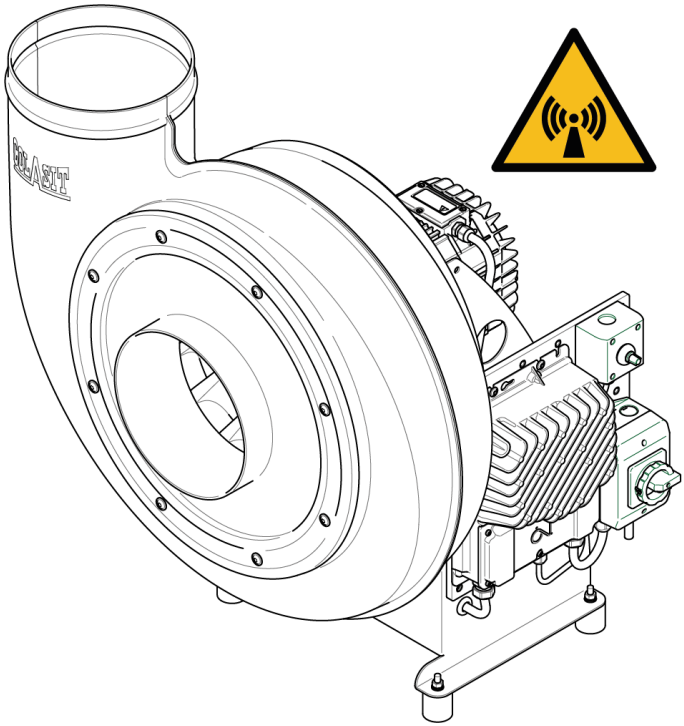
EMC Quick Reference



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Version 1.0 | 02.2026

Revision history table

Version	Description	Date	Name
1-en	First version published.	1/30/2026	A. Roth

Document identification

Translation of the original German document
Colasit TD-000 969

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1 Preface

COLASIT AG provides this EMC Quick Reference upon request as a supplemental document if the supplied fan is designed for operation with a frequency converter (FC).

COLASIT AG also provides an EMC Handbook in German or English for distributors and their service technicians.

2 Instructions for frequency converter use

2.1 Safety instructions

⚠WARNING Risk of injury due to dangerous residual voltage

Injury by electric shock.

- After the fan has been switched off, dangerous residual voltage is still present in the frequency converter.
- ▶ The operating instructions of the frequency converter provide information about the time to be observed until this residual voltage has dropped to a safe value.
- ▶ Before beginning the electrical installation of the fan, always establish an electrically safe work condition of the frequency converter.

⚠WARNING Risk of injury due to impeller explosion

Bruises, eye injuries, or other injuries.

- Exceeding the maximum speed after a malfunction or faulty operating condition of the frequency converter.
- The fan housing has splinter protection for such a malfunction.
- ▶ Use a frequency converter with an integrated SLS safety function.
- ▶ Alternatively, implement higher-level drive control with an SLS safety subfunction.
- ✔ The SLS (Safely Limited Speed) safety function prevents the electric motor from exceeding a specified speed limit.

2.2 Environmental considerations

Important environmental considerations

Frequency converters
- Are highly energy efficient.
- Minimize operating costs.
- Extend the service life of the fan.

2.3 Parameterizing the frequency converter

NOTICE Risk of damage due to erroneous parameterization

Unpredictable fan behavior resulting in damage.

- ▶ Carefully perform parameterization per the operating instructions of the frequency converter.
- ▶ For basic setup, enter the motor data per the nameplate on the electric motor.
- ▶ Enter the maximum frequency/speed limit according to the fan nameplate or technical data sheet.
- ▶ Enter the acceleration and braking times with regard to the following table.
- ▶ Record and save the parameters as a related document.

If the fan is supplied with a frequency converter, the frequency converter is already coordinated with the electric motor and properly parameterized.

To prevent mechanically overloading the fan, observe the minimum permissible acceleration and braking times per the table below.

Nominal power of electric motor [kW]	Acceleration/braking time [s]
< 1.5	min. 15
> 1.5	min. 30

To avoid an FC error message, a longer acceleration or braking time could be necessary.

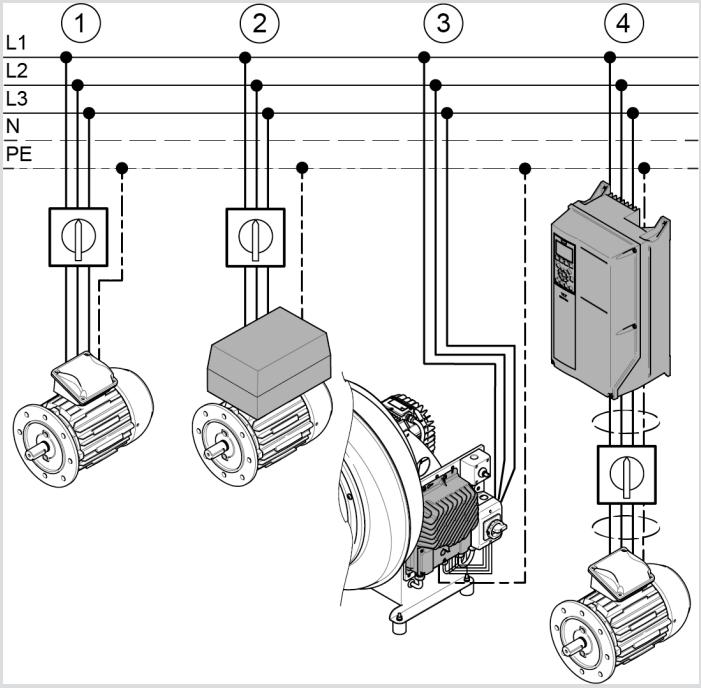
Parameterization for PM motors

Parameterization for PM motors differs significantly from three-phase motors. The FC and motor manufacturers offer support for this.

3 Frequency converter installation options

For centrifugal fans, different executions of electric motors (IEC, EC, PM) can be selected as a drive:

- IEC ... Standard asynchronous motor/three-phase motor
- EC ... Brushless DC motor (highest energy efficiency)
- PM ... Permanent magnet motor

Motor type	Connection options			
				
IEC	X	X	X	X
EC		X		
PM		X	X	

Depending on the execution, an electric motor can either be connected directly to the electrical mains (1) or can/must be operated with a frequency converter.

The frequency converter is either

- combined directly with the electric motor (2, order option),
- mounted on the fan support (3, order option),
- or installed separately in the control cabinet (4, customer solution).

4 EMC-compliant wiring

This chapter contains basic information required for connecting the electric motor to the frequency converter.

⚠WARNING Risk of injury due to high contact voltage

Injury by electric shock.

- If cable shields are not connected/grounded, high contact voltages can occur during operation.

▶ Connect cable shields with other shields to a common reference potential (isolated ground).

▶ Do not use protective earthing connections to establish an isolated ground.

4.1 Requirements of the motor connection cable

High-frequency components and transient responses at the output of the frequency converter subject the motor connection cable to

- Voltage spikes two to three times the nominal motor voltage.
- Capacitive leakage currents that travel to ground via the cable shield and motor housing.
- Reactive currents due to higher capacitance-to-ground with increasing cable length.

Therefore, the motor connection requires a special EMC cable with

- High withstand voltage.
- Double shielding (aluminum foil and copper braiding) if possible.
- A large shielding cross-section to prevent overheating due to leakage currents.
- A low coupling resistance and low total equivalent capacitance.
- A sufficient cross-section ⇨ Chap. 5 [▶ 16].

Alternative cable shielding for short distances

A short motor connection cable can also be shielded by a metal tube or metal cable conduit. These shielding components must also be grounded.

4.2 Requirements of the control and signal lines of the frequency converter

- In general, use shielded cables.
  - Use double-shielded cables for more stringent requirements. Connect the inner cable shield on one side and the outer cable shield on both sides.
- For sensitive signals, use separate shielded twisted-pair cables.
  - Twisted-pair cables attenuate magnetic fields and reduce common mode interference.
  - If common mode interference occurs, use a common mode choke or ferrite bead.
  - Twist cables all the way up to the terminals.

4.3 Information on routing cables

- Use the shortest cable lengths possible.
  - Locate external frequency converters near the fan.
  - With increasing cable length, the effectiveness of shielding declines, and magnetic interference and inductive coupling increase.
- Keep cable connections and conductor lengths at connection points as short as possible.
- Route motor and power supply cables separately from control and signal lines.
  - Maintain a clearance of 20 cm, or use partitions or separate metal cable channels or conduits.
  - Route unavoidable cable crossings at a right angle (minimum influence of lines on each other).
  - If possible, route control and signal cables on metal surfaces.
- Do not route motor and power supply cables parallel to each other (inductive coupling).
- Route shielded cables in continuous runs.
  - Prevent damage to shielded cables and interruptions in runs of shielded cables.
  - Bridge unavoidable interruptions in the shielding (terminals, isolation switches, etc.) over as large a surface area as possible.
- Use the shortest length possible and an appropriate cross-section for the potential equalization cable.

4.4 Information on shielding

- Keep shield connections and ground connections as short as possible.
- Connect shield connections over a large surface area.
  - Large-area shielding (copper strands) and ground connections are important for dissipating high-frequency interference because of the skin effect.

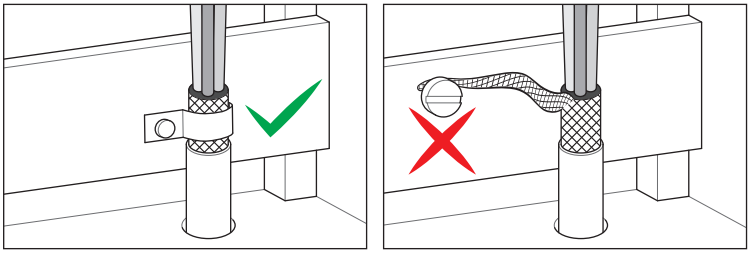
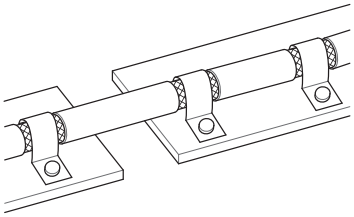


Fig. 1: Correct connection of cable shield

- Connect cable shields around the entire circumference (360°).
  - Ground cable shields with metal cable clamps or metal cable glands.
  - Do not use pigtails to extend the cable shield to a grounding point.

- Ground cable shields at both ends of the cable.
  - Grounding the cable at only one end is not effective and can cause the cable shield to act as an antenna.



- Ground long shielded cables at multiple points.
  - For cable lengths of 10 m or longer, connect the cable shield to the same reference potential multiple times.
  - When doing so, do not exceed 10 m between grounding points.

Fig. 2: Multi-point grounding of the cable shield

Multi-point grounding of the cable shield can cause interference from potential equalization currents. To prevent this, ground the additional grounding points of the cable shield using a capacitor (C = 100 nF) or an RC circuit (R = 1 MΩ, in parallel with C = 10 nF) with short connection leads.

- Establish a single reference potential for grounding at the installation site.
  - Use appropriately dimensioned potential equalization cables.
  - Prevent ground loops that result from ground and protective earthing connections creating a path for current flow.

4.5 Permissible cable routings in the control cabinet

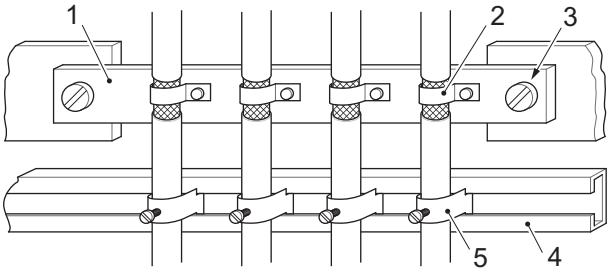
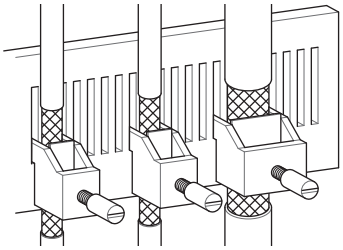


Fig. 3: Shielding bracket rail and cable clamp rail

1	Shielding bracket rail	4	Cable clamp rail
2	Grounding clamp	5	Cable clamp with clamp screw
3	Conductive connection to control cabinet housing		

- When executed as a cable entry system with shielding bracket rail and cable clamp rail:
  - The shielding bracket rail must be highly conductive and connected to the control cabinet housing over a large surface area or grounded at the protective earthing connection of the control cabinet.
  - Do not use the shielding bracket rail for cable strain relief.



- When executed as a cable entry system with an EMC busbar:
  - Use shield connection terminal blocks with screws, or EMC shielding brackets with springs.
  - Do not use the EMC busbar for cable strain relief.

Fig. 4: EMC busbar

- When executed as EMC feed-throughs for signal and control cables:
  - Use conductive cable glands and cable entry plates.
  - Expose the cable shield at the cable gland or cable entry plate.
- When executed as a cable entry system with EMC cable glands:
  - Use metal cable glands with integrated clamping rings for shielding contact.
  - Expose the cable shield at the cable gland.

4.6 Information on control cabinet installation

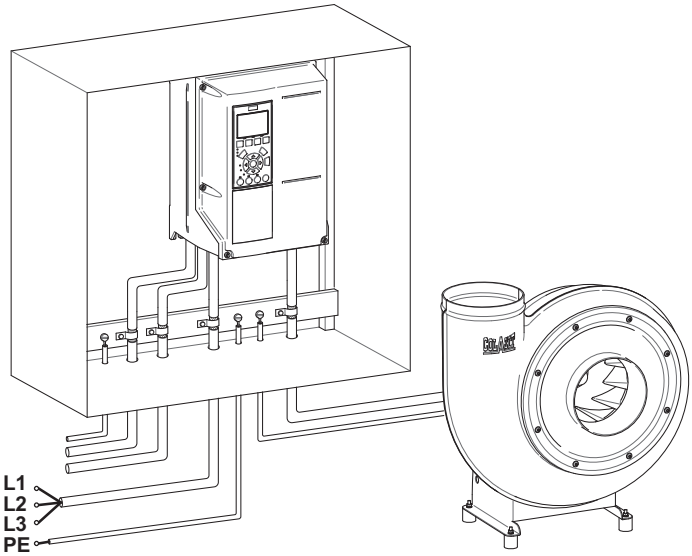


Fig. 5: Control cabinet installation (example)

- Ground cable shields at the knock-out of the control cabinet directly.
- At the connection point, remove the braided shielding from the end of the cable, or insulate it with heat-shrink tubing.
- Separate power lines from control and signal lines.
  - Route power lines in separate cable conduits from control and signal lines.

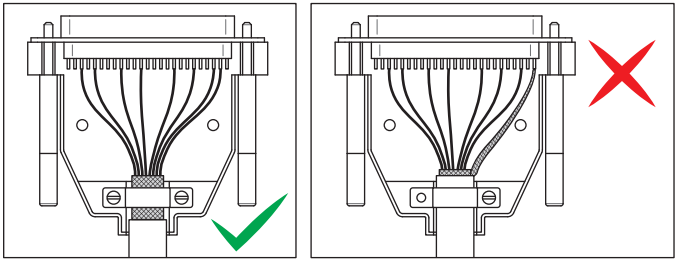


Fig. 6: Correct connection of cable shield to connectors

- For control and signal lines with connectors:
  - Use shielded connectors with metal housings.
  - Connect the cable shield over a large surface area and around the entire circumference to the metal cable strain relief of the connector housing.
  - Do not use pigtails to connect the cable shield to a connector (renders shielding ineffective).

4.7 Information on EMC components

- For isolation switches, use an EMC-compliant housing.
  - The switch housing has a metal plate with shielding clamps at the cable inlet and outlet.
- Suppression filters
  - Are connected at the power mains of the frequency converter.
  - Protect the power supply network against low-frequency interference, interfering pulses during component start-up, and reactions within the supply network.
  - Can be used with a choke.
- Installation information for suppression filters:
  - Locate the filter as close to the frequency converter as possible.
  - Connect the filter to the mounting plate such that the connection is flush and highly conductive.
  - Use insulated lines between the filter and the frequency converter if the distance between them is greater than 30 cm.

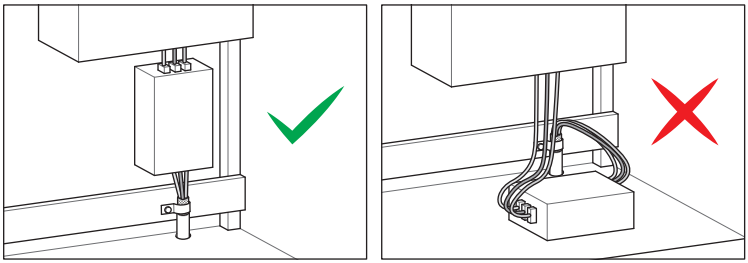


Fig. 7: Routing of lines to the suppression filter

  - Do not route input and output lines of the filter parallel to each other. Shield these lines from each other.

- Ground the filter per the manufacturer's instructions. Use as short a ground connection as possible.

Do not use a suppression filter in an ungrounded IT network.

Suppression filters cause leakage currents in a protective earthing conductor system, which can limit the functionality of an RCD (residual-current device).

4.8 Eliminating ground loops in control and signal lines

Very long cables can create interference from low-frequency ground loops. To prevent this, only ground the cable shield at the end connected to the frequency converter. At the other end of the cable, ground the shield using a capacitor (C = 100 nF) or an RC circuit (R = 1 MΩ, in parallel with C = 10 nF) with short connection leads.

4.9 Connecting the electric motor to a frequency converter

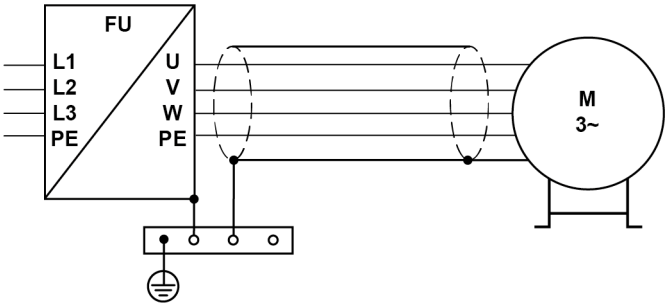


Fig. 8: Connection principle

1. Observe the operating instructions of the frequency converter.
   - Install the isolation switch per the guidelines of these operating instructions.
   - The isolation switch might require control contacts to shut down the frequency converter.
2. If possible, connect the cable shield of the motor connection cable directly to the output of the frequency converter using a grounding clamp.

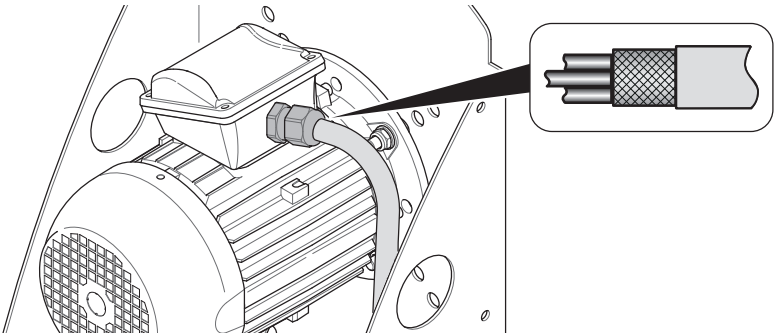


Fig. 9: EMC cable gland

3. Secure the motor connection cable to the motor terminal box with an EMC cable clamp.
   - The EMC cable clamp has an integrated contact system to ground the cable shield.
   - Strip the cable end appropriately so that contact can be made with the cable shield.
4. Connect the motor cable to the terminal board ⇨ Chap. 5 [▶ 16].
5. Connect a potential equalization cable with a minimum cross-section of 10 mm^2.
   - Connect this to the electric motor if there is a grounding clamp for this purpose on the casing near the terminal box.
   - Otherwise, connect this to the support.

4.10 Eliminating ground loops from the motor connection cable

- Connect all potential equalization cables to a central grounding bar (star connection).
- Connect the cable shield of the motor connection cable as close to the protective earthing connection as possible.
- As another option, use a shielded motor connection cable without a protective earthing conductor and connect a separate protective earthing conductor parallel to the motor cable. Connect this protective earthing conductor to the grounding clamp near the terminal box of the electric motor.

4.11 Making ATEX-compliant ground connections

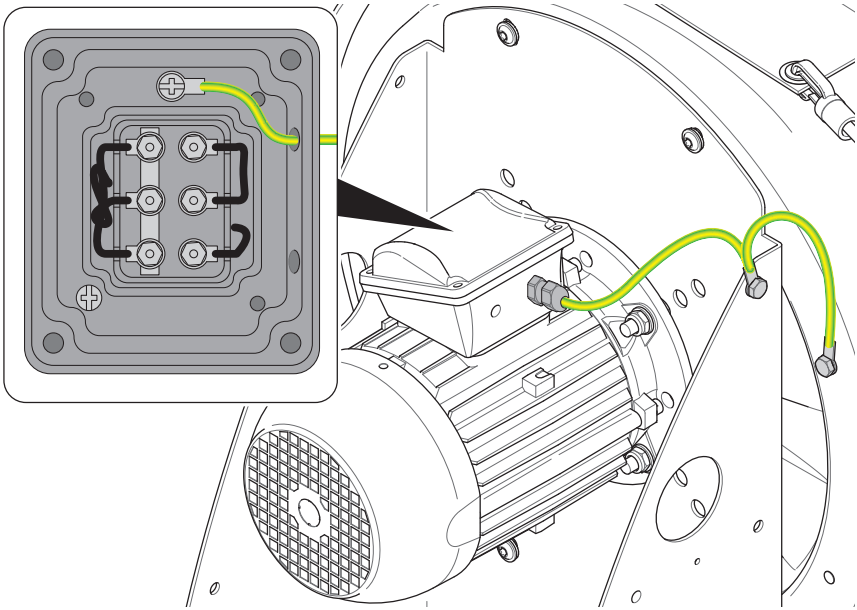


Fig. 10: Grounding cable of the fan (example)

To dissipate static charge, the housing and support of the fan are connected via grounding cables to the protective earthing connection in the terminal box, or at the external ground connection for explosion-proof motors (see detailed view).

The cross-section of the grounding cable must be at least 10 mm^2.

The ground connections between the fan assemblies are installed by the manufacturer or distributor before delivery.
The actual ground connections may differ from the images.

4.12 Final inspection

- Inspect the following at the cable connections:
  - Terminal assignment, shield connection, and cable strain relief.
- Check the key parameters and settings of the frequency converter:
  - Maximum output frequency, V/f characteristic curves, acceleration and braking times ⇨ Chap. 2 [▸ 5].

If required for control and placement in service, connect an external control unit to the frequency converter.

5 Connecting the electric motor

This chapter contains information on connecting three-phase IEC motors directly to the electrical mains. For instructions on connecting to a frequency converter ⇨ Chap. 4 [▶ 8].

5.1 Sizing and installing the motor connection cable

Dimension the conductor cross-section of the connection cable appropriately.

- Observe applicable provisions and standards, such as EN 60204-1.
- Account for the rated current of upstream electrical safety devices (motor protection switch). Determine the rated current based on the motor current rating per the nameplate.
- Route multi-conductor cables in a conduit or without conduit based on the type of installation.
- Account for ambient temperature and temperature limits/extremes.
- Account for cable lengths and permissible voltage drops.

To size the connection cable, consult the cable manufacturer's tables for current-carrying capacity.
For long connection lines, calculate the voltage drop for checking purposes.

When running the cable, observe the following principles:

- Avoid damaging the cable by pinching, cutting, pulling, etc. during installation.
- Run connection cables in the building securely with clamps or mounting brackets, and protect them from damage with cable conduit.
- For protection against vibration, run the connection cable between the fan and cable fasteners to the installation location such that it is flexible and movable.

5.2 Making the cable connection

- **DANGER** Establish an electrically safe work condition before beginning work.
- Connect the connection cable to the motor protection switch/fuses and the isolation switch.
  - Ensure correct connection of the phase conductors.
  - Seal all cable entries such that they are splash-proof.
- Compare the mains voltage and mains frequency with the data on the motor nameplate and determine the connection type of the electric motor (star or delta connection).

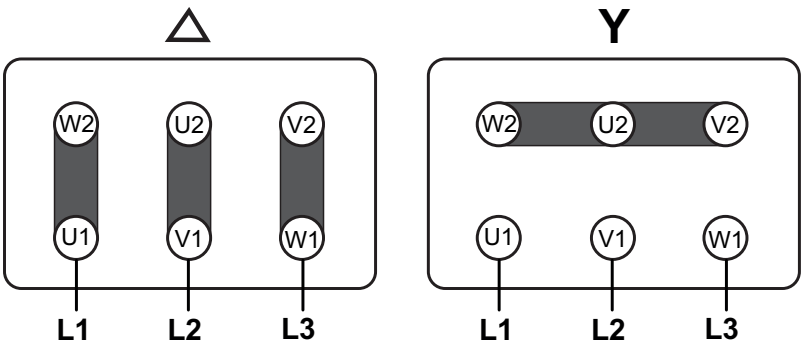


Fig. 11: Connection diagram for delta and star connection

- Open the terminal box on the electric motor.
- If necessary, move the jumpers on the terminal board per the connection diagram.

The connection diagrams are also on the inside of the terminal box covers.

- Connect the phase conductors of the motor connection cable to the terminal board in the correct order.
  - The electric motor rotates clockwise when connected per the connection diagram.
  - Also check the direction of rotation arrow on the fan.
  - Use insulated ring terminals for phase conductors.
- Attach the protective earthing conductor to the protective earthing connection in the terminal box using a ring terminal and serrated lock washer.
- Check:
  - Cable gland on the terminal box is suitable for the diameter of the connection cable.
  - All unused knock-outs on the terminal box are tightly sealed with blind plugs.
  - Sealing ring and sealing surface on the terminal box are clean.
- Close terminal box.

5.3 Final inspection

- Verify mains and motor connections with motor nameplate data.
- Check the sizing and setting of the electrical protective devices (fuses, motor protection switch).
- Check installation of motor connection cable and isolation switch.
  - Check that the mains voltage at the input of the isolation switch is three phase.
- Check the connections of the protective earthing conductor and potential equalization cable for secure attachment and for execution compliant with standards.

Notes

Innovative technology for the sake of the environment

- since 1945 -

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We set our targets high to see all our projects through to success and complete every job to your complete satisfaction. We combine tradition and innovation – our many years of experience are a foundational component of our work, just as is the incorporation of the latest technology.

Place your trust in us – we accompany you throughout all phases of your project, starting from planning with the manufacturer all the way down to commissioning.