MAKING MODERN LIVING POSSIBLE

Installation Guide

VLT® Plus Panel

VLT® Frequency Converter Series FC 102 • FC 202 • FC 301 • FC 302

vlt-drives.danfoss.com

THE REAL DRIVE

Contents

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1 Introduction

1.1 Purpose of the Manual

This installation guide provides information for safe installation of the VLT® Plus Panel.

The dedicated documentation set of each VLT® Plus Panel provides all information for connecting conditions, maximum cross-sections of mains/motor cables, and so on.

NOTICE

The documentation set is specific per order. The shown values in this manual provide average data.

The installation guide is intended for use by qualified personnel.
Read and follow the installation guide to use the VLT® Plus Panel safely and professionally. Pay particular attention to the safety instructions and general warnings. Incorrect handling of the VLT® Plus Panel may cause improper operation of the frequency converter or related equipment, shorten lifetime, or cause other troubles. Always keep this installation guide available with the VLT® Plus Panel.

VLT® is a registered trademark.

This manual is structured in the following way:

- *Chapter 1 Introduction* introduces the manual and informs about approvals, symbols, and abbreviations used in this manual.
- *Chapter 2 Safety* entails instructions on how to handle the VLT® Plus Panel in a safe way.
- *Chapter 3 Mechanical Installation* and *Chapter 4 Electrical Installation* guide through the mechanical and electrical installation.
- *Chapter 5 Specifications* contains technical data about the VLT® Plus Panel.
- An alphabetical index concludes the manual.

1.2 Additional Resources

Additional information on the VLT® Plus Panel can be found in the enclosure door pocket:

- Documentation for all components of the VLT® Plus Panel
- Wiring diagrams
- Test certificates from unit assembly
- EC declaration of conformity

All information related to the frequency converter is not part of this manual and provided via the separate documentation for the different frequency converters:

- The *Operating Instructions* provide detailed information for the installation and start-up of the frequency converter. This manual is provided with the VLT® Plus Panel documentation set.
- The *Design Guide* entails all technical information about the frequency converter and customer design and applications.
- The *Programming Guide* provides information on how to programme and includes complete parameter descriptions.
- Manuals for frequency converter options are listed in the documentation for the frequency converter. *Operating Instructions* or *Installation Instructions* for the built-in options are provided with the VLT® Plus Panel documentation set.

Danfoss technical literature is also available online at *vlt-drives.danfoss.com/support/technical-documentation/*.

1.3 Document Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome. *Table 1.1* shows the document version.

Edition	Remarks
MG13B1xx	Initial creation

Table 1.1 Document Version

1

1.4 Product Overview

1.4.1 Intended Use

⚠WARNING

FUNCTIONAL SAFETY-COMPLIANT USE

The VLT® Plus Panel is a product in accordance with the Low Voltage Directive 2006/95/EG, but does not provide safety-related control functionality in accordance with Machine Safety Directive 2006/42/EG. CE declaration is therefore related to EMC (2004/108/EG) and LV Directive. Failure to take the necessary safety-related control measures can result in death or serious injury.

- **The panel operator has to ensure the proper use of the product, even when Safe Torque Off (STO) functionality is used, for example for ATEX-conform motor thermal protection. In this case, the safety function is part of the approved motor thermal protection, using the function as appropriate energy cut-off.**
- **Any other use of the safety functions is in sole responsibility of the end user, including certification, documentation, and so on.**
- **Customized variants can differ and are not subject to the Panel configurator products description.**

NOTICE

For VLT® AutomationDrive FC 302, NO (Normal overload) values are used for the design. Due to the 80% design rule of EN 61439-2, design is adjusted for the HO (High overload) use. Details are provided per power rating in the relevant documents.

The VLT® Plus Panel is designed to provide high shaft performance on electrical motors along with extra features (see *chapter 1.4.2 Features*).

Depending on configuration, the VLT® Plus Panel can be used in stand-alone applications or form part of a larger appliance or installation.
It is intended to be used solely for the application it was tailored to (see documentation provided with the VLT® Plus Panel).
The intended use of the frequency converter, as described in the frequency converter documentation applies, and must be observed.
The VLT® Plus Panel is allowed for use in residential, industrial, and commercial environments in accordance with local laws, standards, and emission limits as described in the documentation provided with the VLT® Plus Panel.

NOTICE

In a residential environment, this product can cause radio interference, in which case supplementary mitigation measures may be required.

Foreseeable misuse
Do not use the frequency converter in applications, which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 5 Specifications*.

1.4.2 Features

The VLT® Plus Panel is designed to provide high shaft performance on electrical motors along with extra features.

The range of standard and optional features includes:

- Engineered solution, tailored to specific application needs.
- VLT® technology.
- Standard and optional features of the embedded VLT® frequency converters (see manuals provided for the frequency converters).
- Ready-to-install.
- Up to 90% heat losses eliminated, by using:
  - Optimised duct cooling
  - Intelligent door fan usage
- Available in all protection ratings up to IP54.
- IEC EN 61439 compliant.
- Based on Rittal TS8-series industry-standard enclosures.
- Enclosure options:
  - Cabinet light with power outlet
  - Transformer taps
  - Optional 24 V DC supply
- On-demand integration of
  - Switchgear.
  - Output filters.
  - Air-conditioning.

Optimised duct cooling
A dedicated option allows optimised installation of IP00 rated frequency converters in Rittal TS8 enclosures. Therefore, the fan of the frequency converter is used for forced air cooling of the backchannel. The exhaust air on the top of the enclosure can be ducted outside a facility. So, the heat losses from the backchannel are not dissipated within the control room. Hence, the air-conditioning requirements of the facility are not impacted.

See *Installation of Duct Cooling Kit in Rittal Enclosures*, for further information.

The remaining heat losses are handled via fans and filter combinations in the VLT® Plus Panel front doors.

Door fan
One or more door fans remove the heat losses not contained in the frequency converter backchannel and any additional losses generated from other components installed inside the enclosure. The total required air flow is calculated with a dedicated software tool and the required air flow is shown in the panel documentation.

The frequency converter fan runs for the following reasons:

- AMA.
- DC hold.
- Pre-mag.
- DC brake.
- 60% of nominal current is exceeded.
- Specific heat sink temperature exceeded (power size dependent).
- Specific power card ambient temperature exceeded (power size dependent).
- Specific control card ambient temperature exceeded.

Once the frequency converter fan is started, it runs for minimum 10 minutes.

The door fans run, whenever the thermostat inside the panel reaches the adjusted limit. Once the off-setpoint is reached, it switches the fans off. The duration of the on-time varies and depends on the load and local conditions, as well as on the pollution of the air filters.

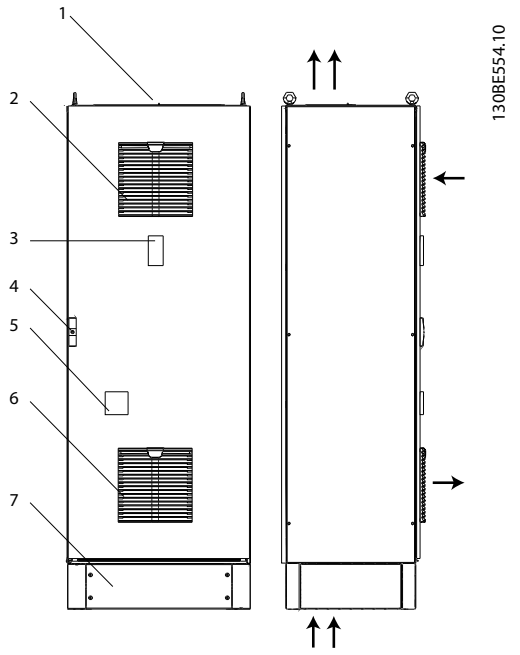
Cabinet light with power outlet
A light mounted on the cabinet interior increases visibility during servicing and maintenance. The light housing includes a power outlet (230 V, 50 Hz, 2.5 A, CE/ENEC) for temporarily supplying power to tools or other devices.

Transformer taps
The auxiliary supply transformer is factory-set to the nominal supply voltage of the cabinet. The transformer taps can be adjusted to the local conditions, to avoid over- and undervoltage. Additional information is provided in the documentation for the optional transformer.

Optional 24 V DC supply

- Specifications: 5 A, 120 W, 24 V DC.
- Purpose: Supplying power for customer-supplied accessory devices, such as:
  - Sensors.
  - PLC I/O.
  - Contactors.
  - Temperature probes.
  - Indicator lights.
  - Other electronic hardware used for internal control/auxiliary circuits.
- Protected against output overcurrent, overload, short circuits, and overtemperature.
- Diagnostics include a dry DC-ok contact, a green DC-ok indicator light, and a red overload indicator light.

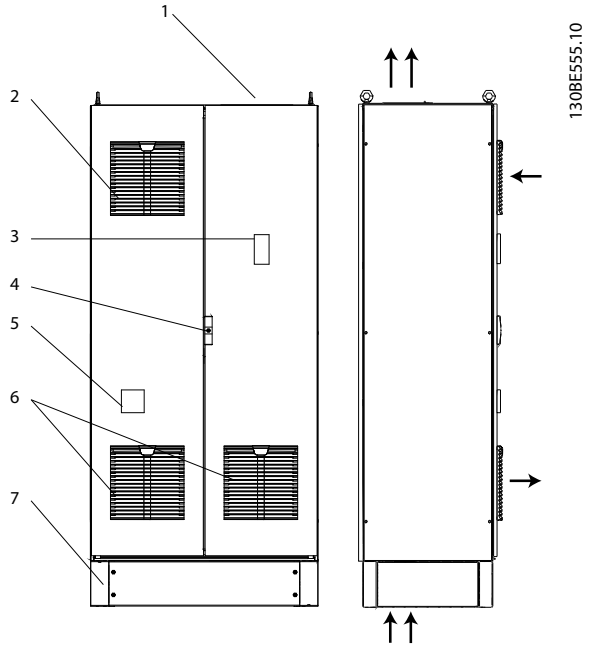
1.4.3 Product Variant Examples



1	Air outlet, top
2	Air inlet, control
3	Local control panel
4	Door handle
5	Mains switch
6	Air outlet, control
7	Plinth with air inlet, front (optional)

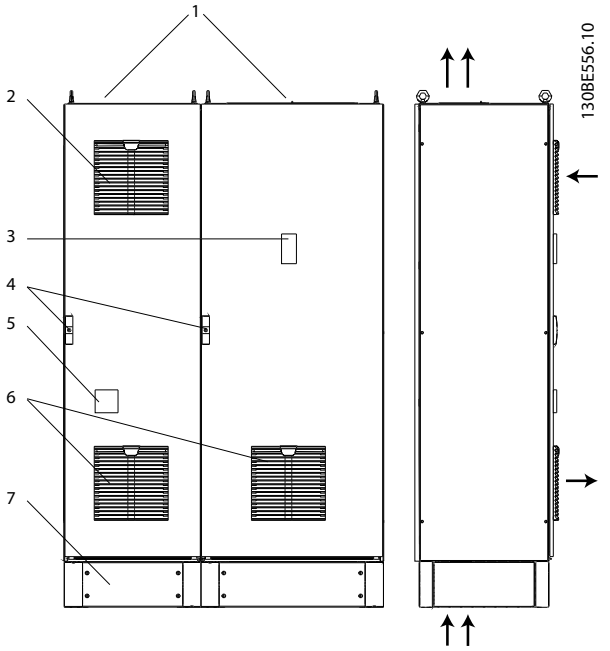
Illustration 1.1 VLT® Plus Panel, 90 kW Enclosure

1



1	Air outlet, top
2	Air inlet, control
3	Local control panel
4	Door handle
5	Mains switch
6	Air outlet, electronic equipment/control
7	Plinth with air inlet, front (optional)

Illustration 1.2 VLT® Plus Panel, 250 kW Enclosure



1	Air outlet, top
2	Air inlet, control
3	Local control panel
4	Door handle
5	Mains switch
6	Air outlet, electronic equipment/control
7	Plinth with air inlet, front (optional)

Illustration 1.3 VLT® Plus Panel, 315 kW and 400 kW Enclosure

1.5 Approvals and Certifications

Illustration 1.4 CE

The VLT® Plus Panel carries a CE mark in accordance with the Low Voltage Directive 2006/95/EC and EMC Directive 2004/108/EC of the European Union.

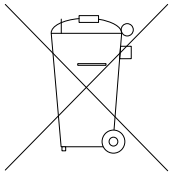
The frequency converter complies with UL 508C thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the product-specific *design guide*.

NOTICE

Imposed limitations on the output frequency (due to export control regulations):

From software version 6.72 onwards, the output frequency of the frequency converter is limited to 590 Hz. Software versions 6.xx also limit the maximum output frequency to 590 Hz, but these versions cannot be flashed, that is, neither downgraded nor upgraded.

1.6 Disposal



Do not dispose of equipment containing electrical components together with domestic waste.
Collect it separately in accordance with local and currently valid legislation.

1.7 Symbols, Abbreviations, and Conventions

Abbreviation	Definition
AC	Alternating current
AMA	Automatic motor adaptation
AVM	Asynchronous vector modulation
DC	Direct current
DE	Drive-end
ELCB	Earth (ground) leakage circuit breaker
EMC	Electromagnetic compatibility
EMI	Electromagnetic interference
HO	High overload
IGBT	Insulated-gate bipolar transistor
LCP	Local control panel
LED	Light-emitting diode
NED	Non-drive end
NO	Normal overload
RCD	Residual current device
RDF	Rated diversity factor according to DIN EN 61439
RFI	Radio-frequency interference, see EMI
SFAVM	Stator flux-oriented asynchronous vector modulation
STO	Safe Torque Off
UPS	Uninterruptible power supply

Table 1.2 Symbols and Abbreviations

Conventions

Numbered lists indicate procedures.
Bullet lists indicate other information and description of illustrations.
Italicized text indicates:

- Cross-reference.
- Link.
- Footnote.
- Parameter name.
- Parameter group name.
- Parameter option.

2 Safety

2

2.1 Safety Symbols

The following symbols are used in this manual:

⚠WARNING

Indicates a potentially hazardous situation that could result in death or serious injury.

⚠CAUTION

Indicates a potentially hazardous situation that could result in minor or moderate injury. It can also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations that can result in damage to equipment or property.

2.2 Qualified Personnel

Correct and reliable transport, storage, installation, operation, and maintenance are required for the trouble-free and safe operation of the frequency converter. Only qualified personnel are allowed to install and operate this equipment.

Qualified personnel are defined as trained staff, who are authorised to install, commission, and maintain equipment, systems, and circuits in accordance with pertinent laws and regulations. Additionally, the qualified personnel must be familiar with the instructions and safety measures described in these operating instructions.

2.3 Safety Precautions

⚠WARNING

HIGH VOLTAGE

Frequency converters contain high voltage when connected to AC mains input, DC supply, or load sharing. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

- **Only qualified personnel must perform installation, start-up, and maintenance.**

⚠WARNING

INSTALLATION IN HIGH ALTITUDES

All VLT® Plus Panels are designed for installations in altitudes not exceeding 1000 m (3280 ft), even if the installed frequency converters are specified for use in higher altitudes.

Do not start up VLT® Plus Panels in altitudes exceeding 1000 m (3280 ft) without contacting Danfoss.

NOTICE

All thermal calculations are performed on maximum altitudes of 1000 m (3280 ft) and maximum 30 °C (86 °F) ambient conditions. Contact Danfoss if the values are exceeded.

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, DC supply, or load sharing, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start with an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up Software, or after a cleared fault condition.

To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**
- **Press [Off/Reset] on the LCP before programming parameters.**
- **Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains, DC supply, or load sharing.**

⚠WARNING

DISCHARGE TIME

The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. High voltage can be present even when the warning LED indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link power supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.**
- **Disconnect or lock PM motor.**
- **Wait for the capacitors to discharge fully. The minimum duration of waiting time is specified in *Table 2.1*.**
- **Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.**

Voltage	Minimum waiting time/power range		
	20 minutes	30 minutes	40 minutes
380–500 V	90–200 kW (125–275 hp)	–	250–800 kW (350–1075 hp)
525–690	37–315 kW (50–450 hp)	–	355–1200 kW (500–1600 hp)

Table 2.1 Discharge Time

⚠WARNING

UNEXPECTED ELECTRICAL SHOCK HAZARD

Parts of the VLT® Plus Panel can still be powered when the frequency converter is switched off. Solely removing the fuses, or switching the mains disconnect do not switch the VLT® Plus Panel off. A contactor is not a safe disconnection method, when any manipulation in the panel or at the frequency converter is performed.

- **Always follow the local technical and safety rules.**
- **Do not use contactors for safe disconnect.**
- **Always use a voltage meter to make sure that any parts are voltage-free before touching them.**
- **Access to the VLT® Plus Panels for any handling and operation is allowed for qualified personnel only.**

⚠WARNING

LEAKAGE CURRENT HAZARD

Leakage currents exceed 3.5 mA. Failure to ground frequency converter properly can result in death or serious injury.

- **Ensure the correct grounding of the equipment by a certified electrical installer.**

⚠WARNING

EQUIPMENT HAZARD

Contact with rotating shafts and electrical equipment can result in death or serious injury.

- **Ensure that only trained and qualified personnel perform installation, start-up, and maintenance.**
- **Ensure that electrical work conforms to national and local electrical codes.**
- **Follow the procedures in this manual.**

⚠WARNING

UNINTENDED MOTOR ROTATION WINDMILLING

Unintended rotation of permanent magnet motors creates voltage and can charge the unit, resulting in death, serious injury, or equipment damage.

- **Ensure that permanent magnet motors are blocked to prevent unintended rotation.**

⚠CAUTION

INTERNAL FAILURE HAZARD

An internal failure in the frequency converter can result in serious injury, when the frequency converter is not properly closed.

- **Ensure that all safety covers are in place and securely fastened before applying power.**

To run STO, additional wiring for the frequency converter is required. Refer to *VLT® Frequency Converters Safe Torque Off Operating Instructions* for further information.

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2.3.1 Before Commencing Repair Work

1. Disconnect the VLT® Plus Panel from mains.
2. Disconnect DC bus terminals 88 and 89 from load share applications.
3. Wait for discharge of the DC-link, see *Table 2.1*. The discharge time is also printed on the warning label.
4. Remove motor cable.

3 Mechanical Installation

3.1 Planning the Installation Site

NOTICE

It is important to plan the installation of the VLT® Plus Panel thoroughly. Neglecting to plan can result in extra work during and after installation.

General considerations for the installation site

Select the best possible operation site by considering the following (see details on the following pages, and the respective design data of the VLT® Plus Panel):

- Ambient operating temperature.
- Installation method.
- Requirements on tools and personnel.
- Transport and lifting devices.
- Accessibility of the installation site.
- How to cool the unit.
- Position of the frequency converter.
- Cable routing.
- Ensure that the power source supplies the correct voltage and necessary current.
- Ensure that all electrical conditions match with the VLT® Plus Panel design, such as, but not limited to, short circuit capability, short circuit withstand capability, and voltage.
- Ensure that the motor current rating is within the maximum current from the frequency converter.
- If the VLT® Plus Panel is without built-in fuses, ensure that the external fuses are rated correctly.

Wire access

Ensure that proper cable access is present including necessary bending allowance. Cables must be fixed to remove force and weight from the cable termination points. This can be done while using the C rails provided in the plinth, applying cable clamps (not part of the delivery). For EMC reasons, cable shields have to be connected to the construction, for example with EMC cable glands (not provided).

NOTICE

All cable lugs/shoes must mount within the width of the terminal bus bar.

Space

Ensure proper space above and below the VLT® Plus Panel to allow airflow and cable access. In addition, consider space in front of the unit to enable opening of the door of the panel.

Terminal locations

Terminal locations can be found in the detail documentation, as provided per unit. The terminal locations vary because of multiple options on the infeed options, power rating, and so on. Data on maximum torque for the termination points are provided in the panel documentation.

NOTICE

All cable and terminal dimensions can be found in the documentation package supplied with the unit.
The power cables are heavy and hard to bend. Consider the optimum position of the frequency converter for ensuring easy installation of the cables.

3.2 Cooling

NOTICE

The unit sucks the cooling air in from the bottom. To allow cooling air intake from the bottom:

- **Place the unit on a double-floor (standard installation).**
- **For non double-floor environments: Make sure to adapt for instance the plinth to allow cooling air intake in from the bottom.**

The VLT® Plus Panel dissipates power in the form of heat. Cooling can be obtained in different ways, by using the cooling ducts in the bottom and the top of the unit. See *Installation of Duct Cooling Kit in Rittal Enclosures*, for further information.

The following recommendations are necessary for effective cooling of the units:

- Mount the unit allowing for unhindered cooling airflow through the cooling fins.
- Provide 225.0 mm (8.86 in) minimum clearance above the unit for airflow.
- Provide clearance for airflow. Do not cover all air inlets and air outlets.

For airflow path, see *Illustration 1.1*, *Illustration 1.2*, and *Illustration 1.3*.

NOTICE

Improper cooling can lead to derating and result in reduced performance or failure of the application.

3.3 Derating

Consider derating when any of the following conditions are present.

- Operating above 1000 m (low air pressure)
- High ambient temperature
- Insufficient cooling
- High switching frequency
- Low-speed operation
- Long motor cables
- Cables with a large cross-section

3.4 Operating Environment

For specifications regarding ambient conditions, see *chapter 5 Specifications*.

NOTICE

CONDENSATION

Moisture can condense on the electronic components and cause short circuits. Avoid installation in areas subject to frost. Install an enclosure heater when the VLT® Plus Panel is colder than the ambient air. Operating in stand-by mode reduces the risk of condensation as long as the power dissipation keeps the circuitry free of moisture.

NOTICE

EXTREME AMBIENT CONDITIONS

Extremely hot or cold temperatures compromise unit performance and longevity.

- **Do not operate in environments where the ambient temperature exceeds 30 °C (86 °F).**
- **Extra air conditioning of the enclosure or installation site can be required.**

3.4.1 Gases

Aggressive gases, such as hydrogen sulphide, chlorine, or ammonia can damage the electrical and mechanical components.

3.4.2 Dust

When installing the VLT® Plus Panel in dusty environments, pay attention to the following:

Periodic maintenance

When dust accumulates on electronic components, it acts as a layer of insulation. This layer reduces the cooling capacity of the components, and the components become warmer. The hotter environment decreases the life of the electronic components.

Keep the heat sink and fans free from dust build-up.

Cooling fans

Fans provide airflow to cool the VLT® Plus Panel. When fans are exposed to dusty environments, the dust can damage the fan bearings and cause premature fan failure.

3.4.3 Potentially Explosive Atmospheres

⚠WARNING

EXPLOSIVE ATMOSPHERE!

Do not install a VLT® Plus Panel in a potentially explosive atmosphere. Install the unit in a cabinet outside of this area. Failure to follow this guideline increases risk of death or serious injury.

Systems operated in potentially explosive atmospheres must fulfil special conditions. EU Directive 94/9/EC (ATEX 95) classifies the operation of electronic devices in potentially explosive atmospheres.

- Class d specifies that if a spark occurs, it is contained in a protected area.
- Class e prohibits any occurrence of a spark.

Motors with class d protection

Does not require approval. Special wiring and containment are required.

Motors with class e protection

When combined with an ATEX approved PTC monitoring device like the VLT® PTC Thermistor Card MCB 112, installation does not need an individual approval from an approbated organisation.

Motors with class d/e protection

The motor itself has an e ignition protection class, while the motor cabling and connection environment comply with the d classification. Use a sine-wave filter at the active front-end drive output to attenuate the high peak voltage.

NOTICE

MOTOR THERMISTOR SENSOR MONITORING

VLT® AutomationDrive units with the option are PTB-certified for potentially explosive atmospheres.

3.5 Receiving and Unpacking the Unit

3.5.1 Unpacking

NOTICE

Before unpacking the VLT® Plus Panel, place the unit as close as possible to the final installation site. Refer to *chapter 3.5.3 Lifting the Unit*.
Remove the box and handle the VLT® Plus Panel on the pallet as long as possible.

The VLT® Plus Panel shipment consists of:

- Panels.
- Documentation package in the enclosure.
- Pedestal.
- Accessory bag.
- Installation guide.

- Make sure that the items supplied and the information on the nameplate correspond to the order confirmation.
- Visually check the packaging and the VLT® Plus Panel for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.

NOTICE

LOSS OF WARRANTY

Removing the nameplate from the VLT® Plus Panel can result in loss of warranty.

3.5.2 Tools Needed

Receiving/Unloading

- I-beam and hooks rated to lift minimum the weight given in the shipping documents accompanying the VLT® Plus Panel.
- Crane or other lifting aid to place the unit into position.
- Crowbar to disassemble the wooden shipping container (if shipped in such).

Installation

- Drill with 10 mm or 12 mm drill bits.
- Tape measure.
- Screwdriver.
- Wrench with relevant metric sockets (7–17 mm).
- Wrench extensions.
- Sheet metal punch for conduits or cable glands.
- Lifting aid rated to lift minimum weight given in the documentation package supplied with the VLT® Plus Panel. See *chapter 5.3 Weights*, and *chapter 3.5.3 Lifting the Unit*.
- Crane or other lifting aid to place the unit onto pedestal and into position.
- Torx T50 tool.

3.5.3 Lifting the Unit

NOTICE

UPRIGHT TRANSPORT AND LIFTING ONLY!

The unit must be transported in upright position only. Failure to do so can result in damage to the unit. Refer to *Illustration 3.1*

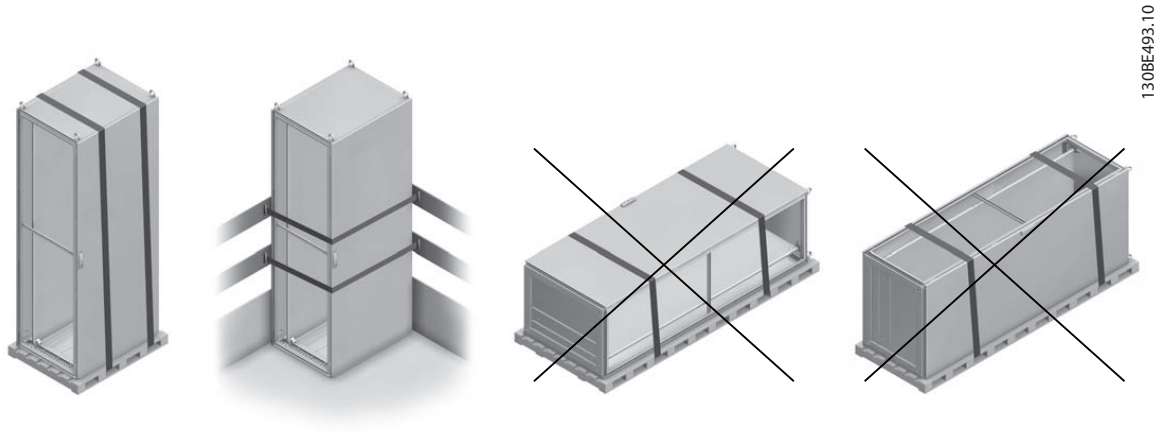
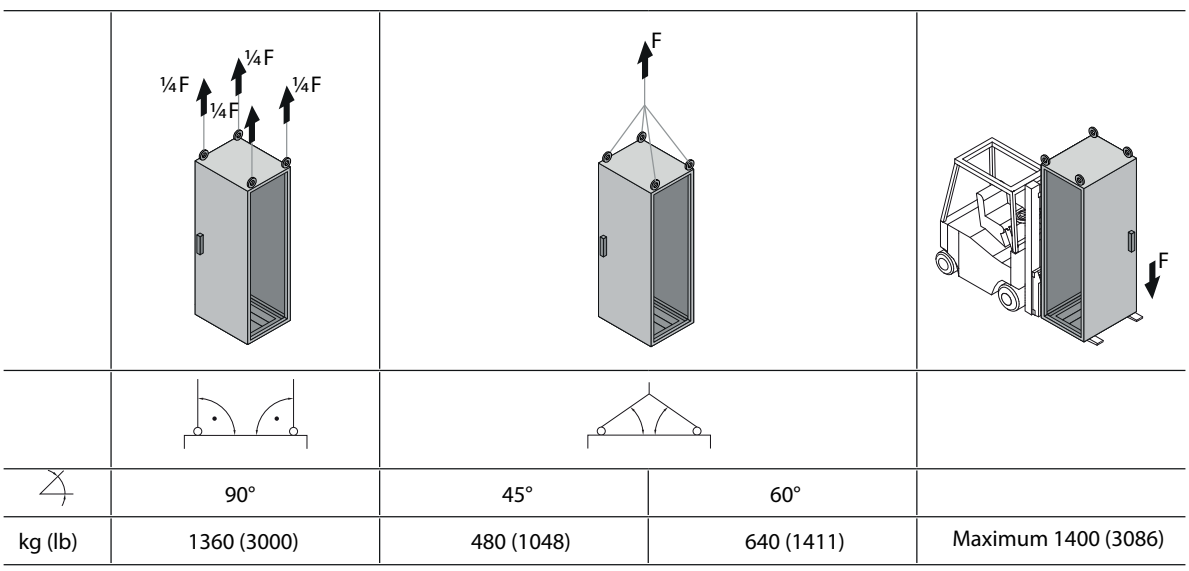


Illustration 3.1 Transport Orientation



	90°	45°	60°	
kg (lb)	1360 (3000)	480 (1048)	640 (1411)	Maximum 1400 (3086)

Illustration 3.2 Load Distribution for different Lifting Procedures

For measurements and center of gravity, see *chapter 5.2 Dimensions*.

- Check the weight of the unit, see *chapter 5.3 Weights*
- Ensure that the lifting device is suitable for the task.
- Move the unit using a hoist, crane, or forklift with the appropriate rating.
- Always lift the unit using the dedicated lifting eyes.

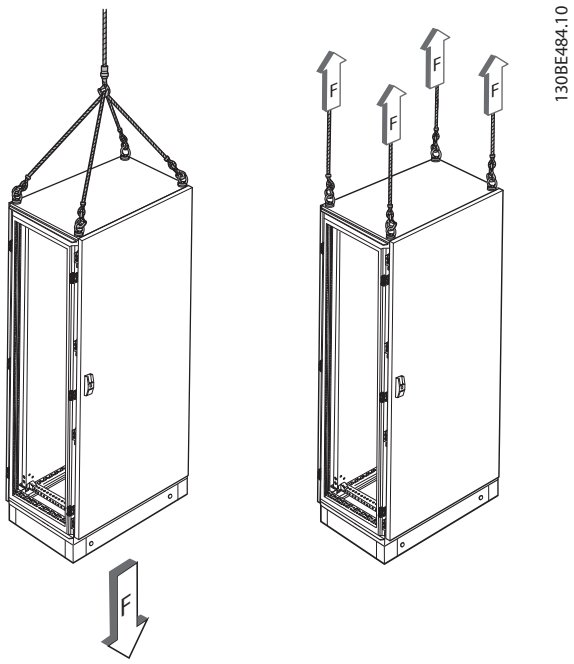
3.5.3.1 Crane Transport and Lifting

⚠WARNING

HEAVY LOAD!

Unbalanced loads can fall and loads can tip over. Failure to take proper lifting precautions increases risk of death, serious injury, or equipment damage.

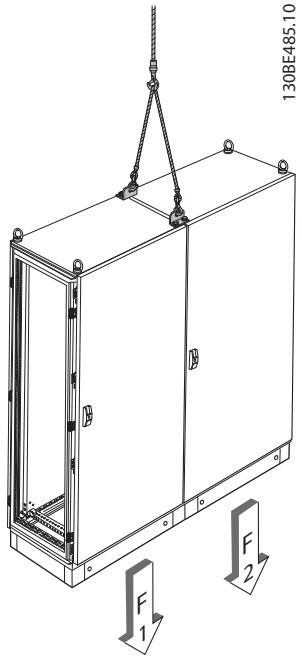
- **Never walk under suspended loads and wear personal protective equipment.**
- **Make sure to use lifting devices with the appropriate rating. The lifting bar must be able to handle the weight of the unit.**
- **The center of gravity can be in an unexpected area. If that is not observed, the unit can fall over or tilt unexpectedly during lifting and transport. Check the center of gravity, before lifting the load. Refer to *Illustration 5.1*, *Illustration 5.2*, and *Illustration 5.3*.**
- **Secure cabinets by suitable means to prevent them from tipping over, particularly during transportation.**
- **When using a pedestal/plinth or Flex-Block system during transportation, lifting, and setting down, ensure that the load is always resting on the pedestal/plinth corner pieces and never on the base/plinth trim panels.**
- **The angle from the top of the enclosure to the lifting cables has an impact on the maximum load force on the cable. The angle must be 60° or greater. Attach and dimension the lifting cables properly. Refer to *Illustration 3.2*.**



F: Weight force
Left: Central lifting cable transport (Full weight force on central lifting cable)
Right: 4-corner lifting cable transport (1/4 of the weight force on each of the lifting cables)

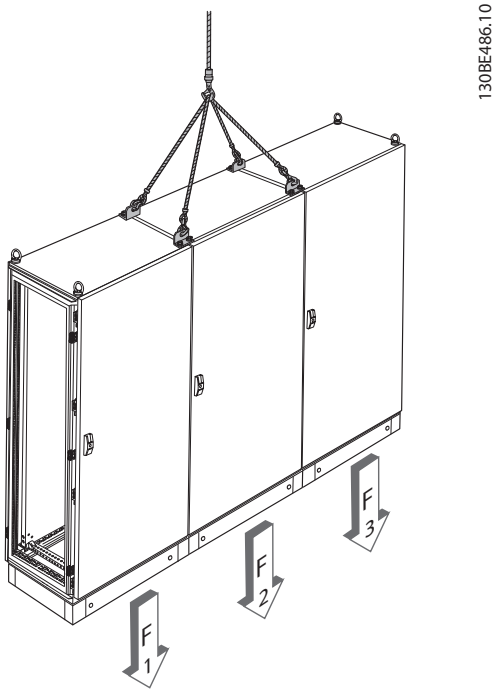
Illustration 3.3 Crane Transport of a Single Enclosure

3



F: Weight force

Illustration 3.4 Crane Transport of a Double Enclosure (Full Weight Force on Central Lifting Cable)



F: Weight force

Illustration 3.5 Crane Transport of a Triple Enclosure (Full Weight Force on Central Lifting Cable)

3.5.3.2 Fork Lift Transport and Lifting

⚠WARNING

HEAVY LOAD!

Unbalanced loads can fall and loads can tip over. Failure to take proper lifting precautions increases risk of death, serious injury, or equipment damage.

- **Never walk under suspended loads and wear personal protective equipment.**
- **Make sure to use lifting devices with the appropriate rating.**
- **The center of gravity can be in an unexpected area. If that is not observed, the unit can fall over or tilt unexpectedly during lifting and transport. Check the center of gravity, before lifting the load. Refer to *Illustration 5.1*, *Illustration 5.2*, and *Illustration 5.3*.**
- **Secure cabinets by suitable means to prevent them from tipping over, particularly during transportation.**
- **When using a pedestal/plinth or Flex-Block system during transportation, lifting, and setting down, ensure that the load is always resting on the pedestal/plinth corner pieces and never on the base/plinth trim panels.**
- **Do not use fork lifts for units which do not fit on a transport pallet or the fully extended forks.**
- **Make sure that the unit has a firm stand on the pallet or the forks, so that it would not fall over.**
- **Make sure that the forks are placed under the base/plinth corner pieces and not on the base/plinth trim panels.**

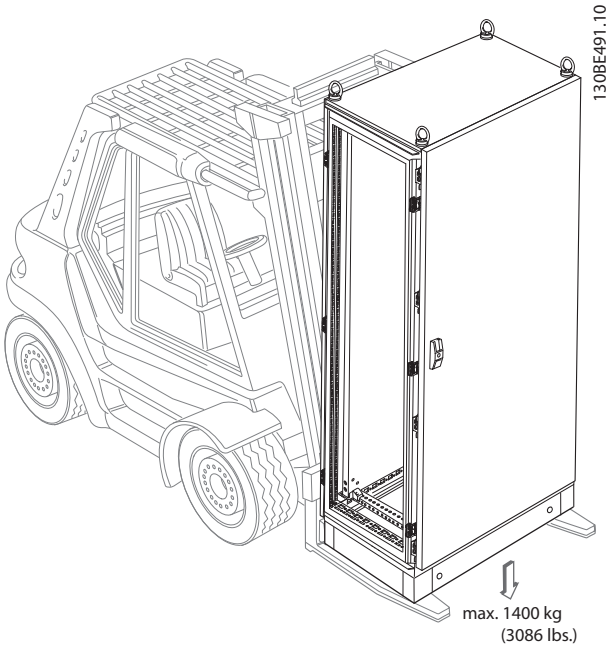


Illustration 3.6 Approved Procedure for Fork Lift Transport of a Single Enclosure

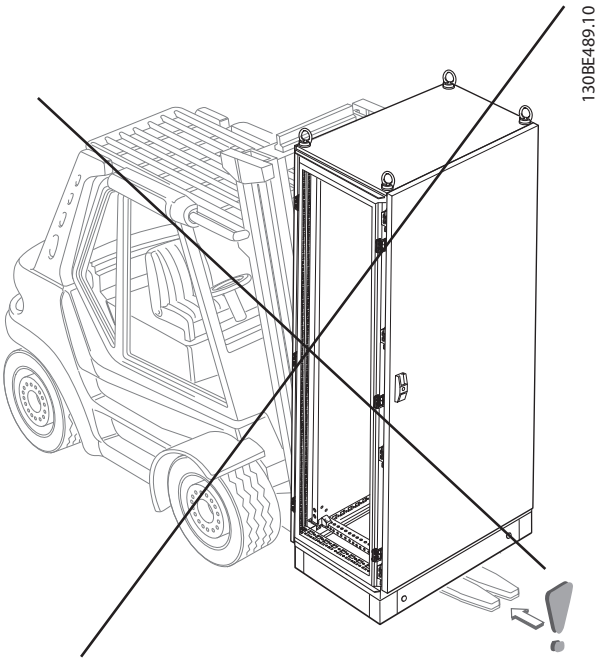


Illustration 3.7 Non-approved Procedure for Fork Lift Transport of a Single Enclosure

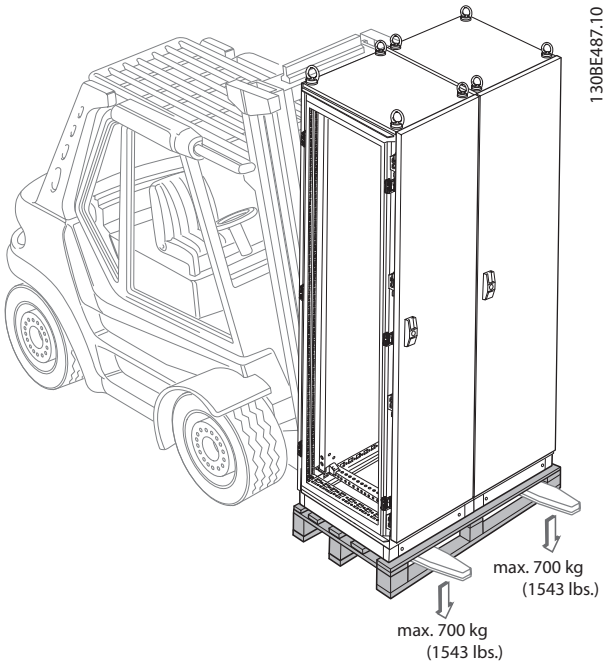


Illustration 3.8 Approved Procedure for Fork Lift Transport of a Double Enclosure

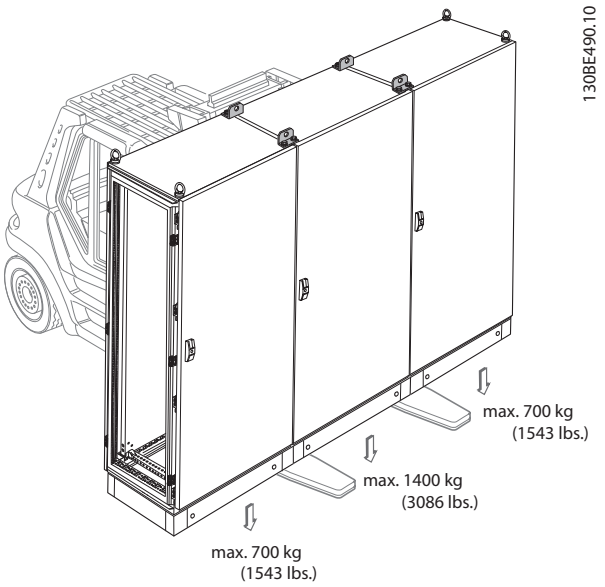


Illustration 3.9 Approved Procedure for Fork Lift Transport of a Triple Enclosure

3.5.4 Storage

Store the unit in a dry location. Keep the equipment sealed in its packaging until installation.

Periodic forming (capacitor charging) is not necessary during storage.

3.6 Assembling a Standard Unit with a Pedestal

In most applications, the pedestal is used to allow airflow into the unit cabinets to provide proper cooling.

⚠CAUTION

The pedestal/plinth can be installed already, or delivered as lose component, depending on the customer request or transport limitations. The pedestal/plinth can be required to allow air flow for proper cooling and/or cable termination for maximum bending space.

3.6.1 Positioning the Pedestal

NOTICE

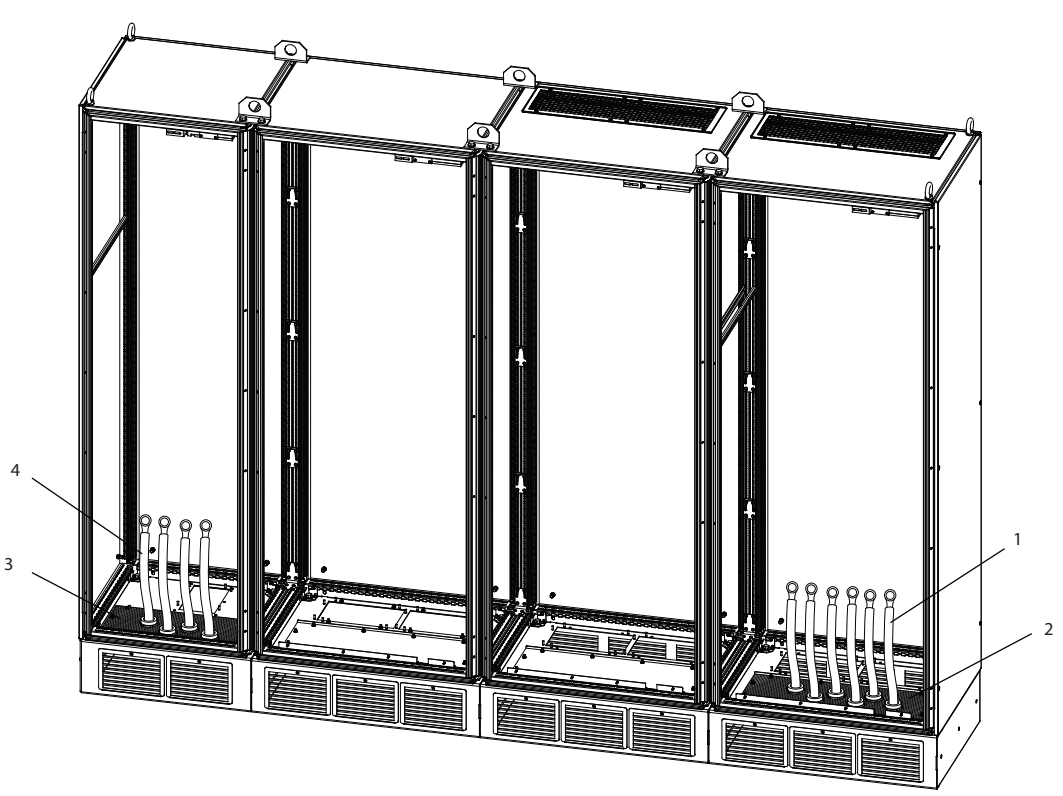
Prepare the mechanical installation of the VLT® Plus Panel carefully to ensure a proper result and avoid extra work during installation. To become familiar with the space demands, start taking a close look at the mechanical drawings in this manual and in the customer documentation, delivered with the VLT® Plus Panel for latest information.

1. Place the pedestal in desired location, paying attention to the following:
   - Ambient conditions (see *chapter 5.1 Technical Design Considerations*)
   - Cooling requirements (see *chapter 3.2 Cooling*)
   - Unit dimensions and door clearances (see *chapter 5.2 Dimensions*)
2. Pull the cables (mains, 230 V supply, and motor cables) up through the pedestal.
3. Bolt the pedestal to the floor.

3.6.2 Creating an Entry for Cables

Cables are connected from the bottom of the pedestal, through a metal gland plate, and into the cabinet. The gland plates must be fitted to the unit to ensure the specified degree of protection.

1. Open the mains cabinet and remove the nuts from the mains gland plate. Remove the plate.
2. Open the motor cabinet and remove the nuts from the motor gland plate. Remove the plate.
3. Use a sheet metal punch to create entry holes in the mains and motor plates. Refer to the gland plate dimensions in *chapter 5.2 Dimensions*.
4. Reattach the mains and motor gland plates after the unit has been lowered onto the pedestal, as shown in *Illustration 3.10*.



1	Motor cables.	3	Mains gland plate. See *chapter 5.2 Dimensions*.
2	Motor gland plate. See *chapter 5.2 Dimensions*.	4	Mains cables.

Illustration 3.10 Cable Entry through the Gland Plates (Example)

3

3.6.3 Attaching the Unit to the Pedestal

⚠CAUTION

IMPROPER ALIGNMENT

Improper alignment and insufficient installation, can cause damage to the unit and injury.
Only qualified and authorised personnel shall do this installation.

NOTICE

***Illustration 3.12* shows an example. The procedure to be applied depends on the surface the unit is mounted to, and is therefore application-specific. The procedure described here shows the general principle.**

1. Lift the unit and position it on the pedestal. Refer to *chapter 3.5.3 Lifting the Unit*.
2. Verify that there is 225 mm (9 in) top clearance for air exhaust.
3. Verify that the air intake from the bottom of the unit is not obstructed.
4. Make sure that the unit is aligned to the surface and the surrounding units. Refer to *Illustration 3.11*.
5. Install each M8x60 mm bolt with lock washer and flat washer through the frame into the threaded hole in the base. Install 4 bolts per cabinet. Refer to *Illustration 3.12*.
6. Install each M10x30 mm bolt with captive lock washer and flat washer through the base plate and into the threaded hole in the base. Install 4 bolts per cabinet. *Illustration 3.12*.

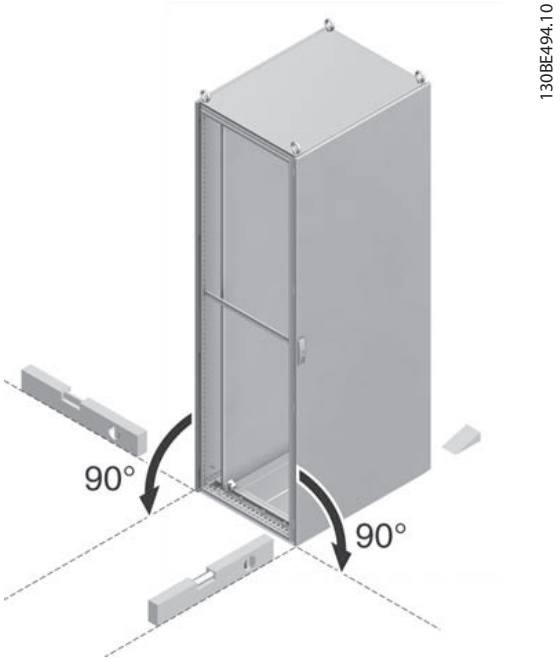
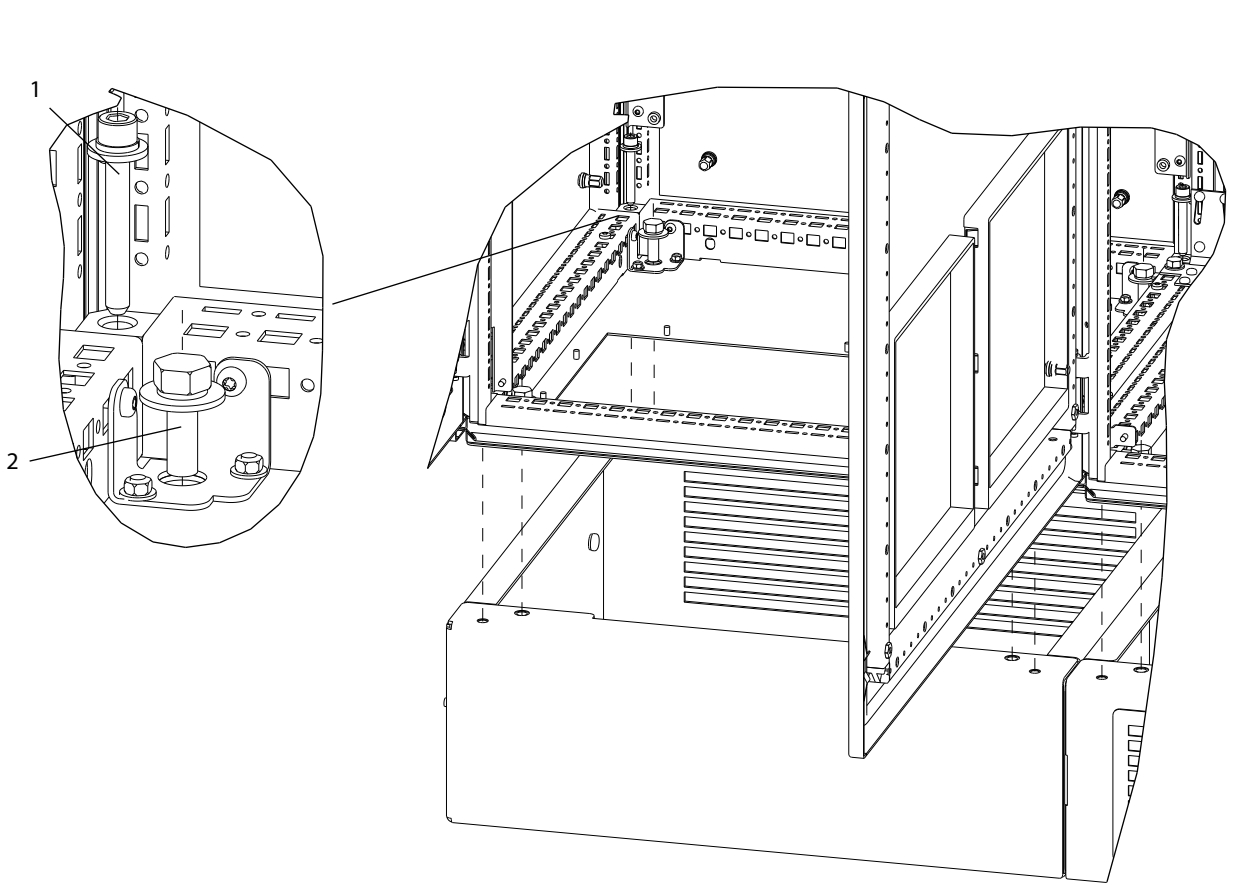


Illustration 3.11 Unit Alignment



1	M8x60 mm bolt with lock washer and flat washer
2	M10x30 mm bolt with captive lock washer and flat washer

Illustration 3.12 Location of Corner Fasteners for a Pedestal Installation (Example)

3.7 Assembling a Standard Unit without a Pedestal

Although a pedestal is shipped with the unit, the unit can be operated without a pedestal in the following situations:

- In applications where there is an open space beneath the unit in which the cabinets receive unrestricted air flow.
- In applications that use the in-back/out-back cooling kit.

NOTICE

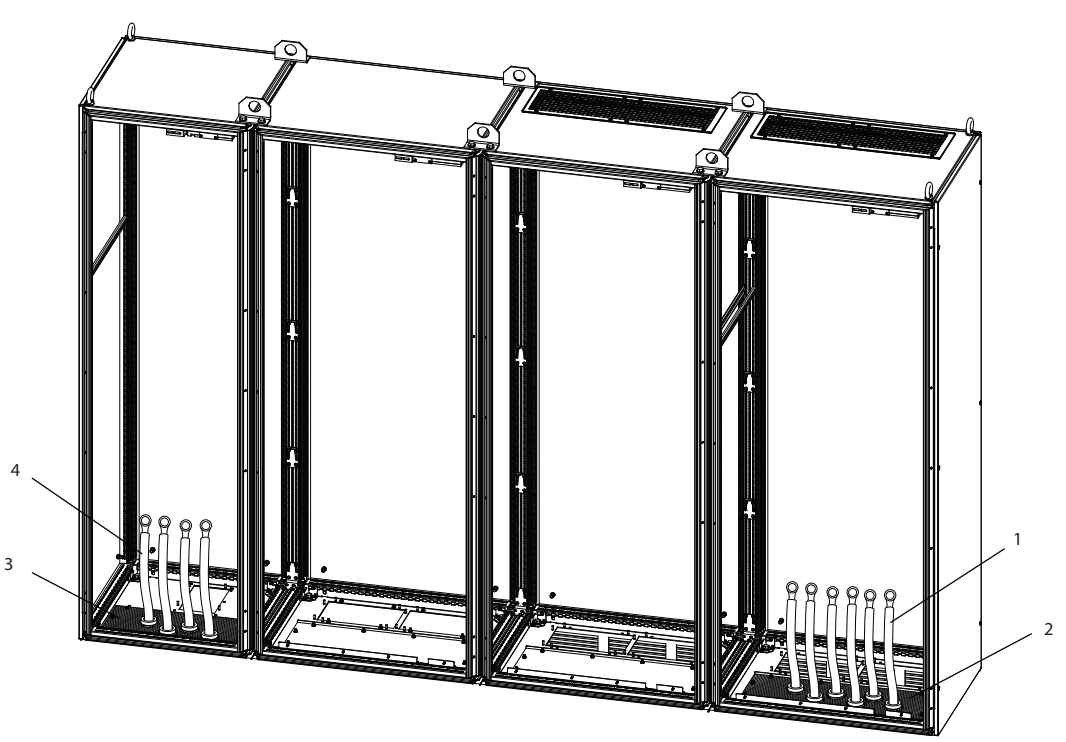
Prepare the mechanical installation of the VLT® Plus Panel carefully to ensure a proper result and avoid extra work during installation. To become familiar with the space demands, start taking a close look at the mechanical drawings in this manual and in the customer documentation, delivered with the VLT® Plus Panel for latest information.

3.7.1 Creating an Entry for Cables

Cables are connected from the bottom of the unit, through a metal gland plate, and into the cabinet. Fit the gland plates to the active front-end drive to ensure the specified degree of protection.

3

1. Open the mains cabinet and remove the nuts from the mains gland plate. Remove the plate.
2. Open the motor cabinet and remove the nuts from the motor gland plate. Remove the plate.
3. Use a sheet metal punch to create entry holes in the mains and motor plates. Refer to the gland plate dimensions in *chapter 5.2 Dimensions*.
4. Reattach the mains and motor gland plates after the unit has been lowered onto the floor, as shown in *Illustration 3.13*.



1	Motor cables.	3	Mains gland plate. For dimensions, see *chapter 5.2 Dimensions*.
2	Motor gland plate. For dimensions, see *chapter 5.2 Dimensions*.	4	Mains cables.

Illustration 3.13 Cable Entry through the Gland Plates (Example)

3.7.2 Attaching the Unit to the Floor

⚠CAUTION

IMPROPER ALIGNMENT, DYNAMIC LOADS PROTECTION

Improper alignment and insufficient installation, especially for installation in environments with dynamic loads, can cause damage to the unit and injury.
Only qualified and authorised personnel shall do this installation.

1. Lift the unit and position it on the floor. Refer to *chapter 3.5.3 Lifting the Unit*.
2. Verify that there is 225 mm (9 in) top clearance for air exhaust.
3. Make sure that the unit is aligned to the surface and the surrounding units. Refer to *Illustration 3.11*.
4. Secure the unit at each corner, as shown in *Illustration 3.16*. The illustration shows the unit being secured with a nut on a floor-based stud. Other methods to secure the unit can be used.

NOTICE

SECURING THE UNIT

The unit must be securely fastened to the floor. Each cabinet requires 2 fasteners per corner for a total of 8 fasteners per cabinet.

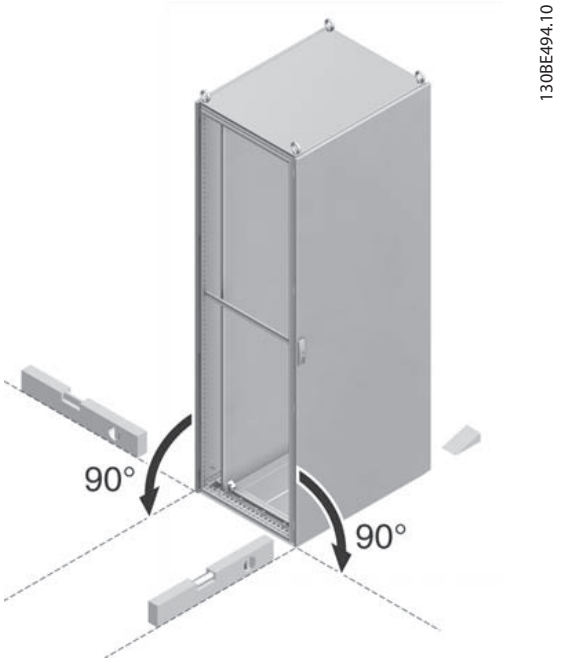


Illustration 3.14 Unit Alignment

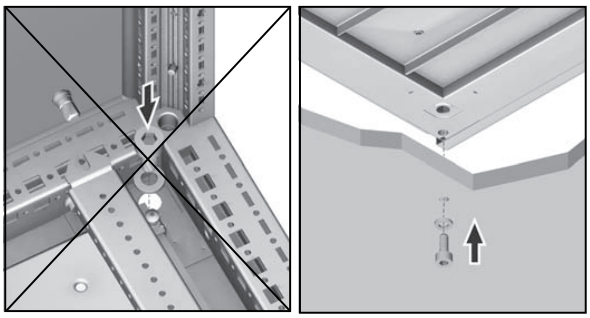
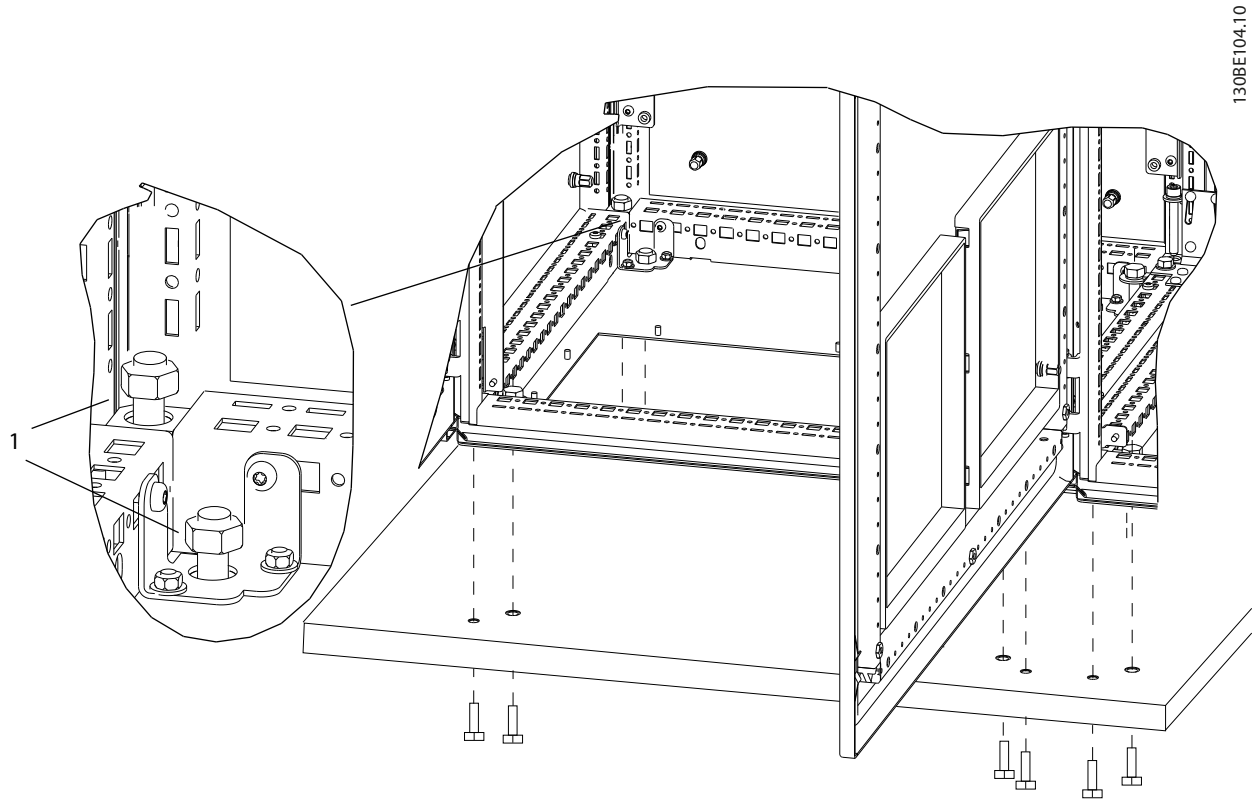


Illustration 3.15 Principle for Cabinet Mounting in Environments with Dynamic Loads (Example)

3



1	Nut on a floor-mounted stud

Illustration 3.16 Location of Corner Fasteners for a Non-pedestal Installation (Example)

4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

INDUCED VOLTAGE!

Induced voltage from output motor cables from different frequency converters that are run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately or use screened cables could result in death or serious injury.

- **Run output motor cables separately, or**
- **Use screened cables.**
- **Simultaneously lock out all the frequency converters.**

⚠WARNING

SHOCK HAZARD

The frequency converter can cause a DC current in the PE conductor and hence result in death or serious injury.

- **When a residual current-operated protective device (RCD) is used for protection against electrical shock, only an RCD of Type B is permitted on the supply side.**

Failure to follow the recommendation means that the RCD cannot provide the intended protection.

Overcurrent protection

- Extra protective equipment such as short-circuit protection or motor thermal protection between frequency converter and motor is required for applications with multiple motors.
- Input fusing is required to provide short-circuit and overcurrent protection. If fuses are not factory-supplied, the installer must provide them. See maximum fuse ratings in *chapter 4.4 Fuses*.

Wire type and ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Power connection wire recommendation: Minimum 75 °C rated copper wire.

See *chapter 5 Specifications* for recommended wire sizes and types.

4.1.1 General Notes on Cabling and Fusing

NOTICE

All cabling must comply with national and local regulations on cable cross-sections, cable types, and ambient temperature.

For protection of the frequency converter, use the recommended fuses or install a unit with built-in fuses. For recommended fuses, see *chapter 4.4 Fuses*. Always ensure that proper fusing is made according to local regulation.

The mains connection is fitted to the first switch gear in the mains circuit if this is included.

4.2 EMC Compliant Installation

Perform the following steps to support EMC-compliant installation:

NOTICE

TWISTED SCREEN ENDS (PIGTAILS)

Twisted screen ends increase the screen impedance at higher frequencies, which reduces the screen effect and increases the leakage current. Avoid twisted screen ends.

- Connect the screen to the enclosure at both ends for use with:
  - Relays.
  - Control cables.
  - A signal interface.
  - Fieldbus.
  - Brake.

  If the ground path has high impedance or is noisy or is carrying current, break the screen connection on 1 end to avoid ground current loops.
- Use a metal mounting plate to convey the currents back to the unit. Ensure good electrical contact from the mounting plate through the mounting screws to the frequency converter chassis.
- Use screened cables for motor output cables. An alternative is unscreened motor cables within metal conduit.

NOTICE

INSTALLATION AT HIGH ALTITUDE

There is a risk for overvoltage. Isolation between components and critical parts could be insufficient, and may not comply with PELV requirements. Reduce the risk for overvoltage by using external protective devices or galvanic isolation.

For installations above 1000 m (3281 ft) altitude, contact Danfoss regarding PELV compliance.

4

NOTICE

PELV COMPLIANCE

Prevent electric shock by using protective extra low voltage (PELV) electrical supply and complying with local and national PELV regulations.

4.3 Grounding

⚠WARNING

LEAKAGE CURRENT HAZARD!

Leakage currents exceed 3.5 mA. Failure to ground the frequency converter properly could result in death or serious injury.

- **Ensure the correct grounding of the equipment by a certified electrical installer.**

For electrical safety

- Ground the frequency converter in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground one frequency converter to another in a daisy chain fashion.
- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section: 10 mm^2.
- Terminate 2 rated ground wires separately, if applicable in accordance with national and local codes.

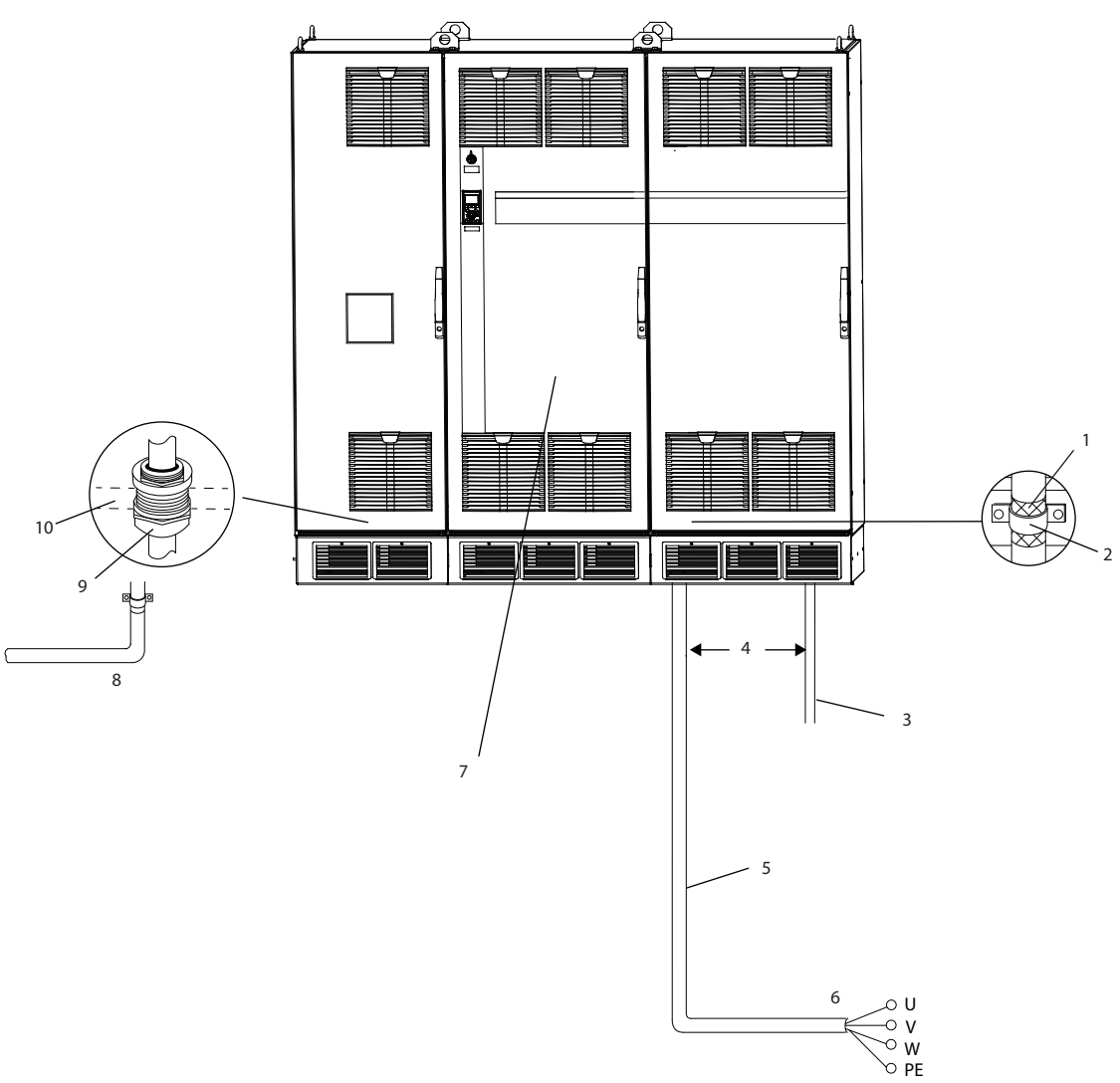
For EMC-compliant installation

- Establish electrical contact between the cable screen and the frequency converter enclosure by using metal cable glands or by using the clamps provided on the equipment. See *Illustration 4.1*.
- Reduce burst transient by using high-strand wire.
- Do not use pigtails.
- Use serrated washers or split washers with enclosure assembly screws. Anodized aluminum enclosures provide inadequate ground bonding when plain washers are used.
- To obtain a low impedance contact, scrape painted surfaces down to the bare metal.

NOTICE

POTENTIAL EQUALISATION

Risk of burst transient, when the ground potential between the frequency converter and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm^2 (4 AWG) or larger.



1	Stripped cable insulation	6	Motor cable, 3-phase cables, and ground
2	Clamped screen-to-ground point inside cabinet	7	To prevent ground loops due to variations in ground potential, fit an equalizing cable next to the control cable. Minimum cable cross-section is 16 mm^2 (4 AWG)
3	Control cables	8	Mains cable, 3-phase cables, and reinforced ground
4	Minimum 200 mm (7.9 in) between control cables, motor cable, and mains cable	9	EMC cable gland
5	Screened cable	10	Gland plate

Illustration 4.1 Proper EMC Installation

4.4 Fuses

4.4.1 Motor Insulation

For motor cable lengths ≤ the maximum cable length listed in *chapter 5 Specifications*, the recommended motor insulation ratings are in *Table 4.1*. The peak voltage can be up to twice the DC-link voltage, 2.8 times the mains voltage, due to transmission line effects in the motor cable. If a motor has a lower insulation rating, use a dU/dt or sine wave filter.

4

Nominal mains voltage	Motor insulation
U_N ≤420 V	Standard U_{LL} = 1300 V
420 V <U_N ≤500 V	Reinforced U_{LL} = 1600 V
500 V <U_N ≤600 V	Reinforced U_{LL} = 1800 V
600 V <U_N ≤690 V	Reinforced U_{LL} = 2000 V

Table 4.1 Motor Insulation at Various Nominal Mains Voltages

4.4.2 Motor Bearing Currents

All motors installed with FC 302 90 kW or higher power frequency converters should have NDE (non-drive end) insulated bearings installed to eliminate circulating bearing currents. To minimize DE (drive end) bearing and shaft currents, proper grounding of the frequency converter, motor, driven machine, and motor to the driven machine is required.

Standard mitigation strategies:

1. Use an insulated bearing.
2. Apply rigorous installation procedures.
   - 2a Ensure that the motor and load motor are aligned.
   - 2b Strictly follow the EMC installation guideline.
   - 2c Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads.
   - 2d Provide a good high frequency connection between the motor and the frequency converter. Achieve that for example by using a screened cable which has a 360° connection in the motor and the frequency converter.
   - 2e Make sure that the impedance from frequency converter to building ground is lower than the grounding impedance of the machine. This can be difficult for pumps.
   - 2f Make a direct ground connection between the motor and load motor.
3. Lower the IGBT switching frequency.
4. Modify the inverter waveform, 60° AVM versus SFAVM.
5. Install a shaft grounding system or use an isolating coupling.
6. Apply conductive lubrication.
7. Use minimum speed settings if possible.
8. Try to ensure that the line voltage is balanced to ground. This can be difficult for IT, TT, TN-CS or grounded leg systems.
9. Use a dU/dt or sinus filter.

4.4.3 Control Cable Routing

Tie down all control wires to the designated control cable routing. To ensure optimum electrical immunity, connect the screens properly.

Fieldbus connection
Connections are made to the relevant options on the control card. For details, see the relevant fieldbus instruction. Place the cable in the provided path inside the frequency converter and tie it down with other control wires.

5 Specifications

5.1 Technical Design Considerations

⚠WARNING

FUNCTIONAL-SAFETY COMPLIANT USE

The VLT® Plus Panel is a product in accordance with the Low Voltage Directive 2006/95/EG, but does not provide safety-related control functionality in accordance with Machine Safety Directive 2006/42/EG. CE declaration is therefore related to EMC (2004/108/EG) and LV Directive. Failure to take the necessary safety-related control measures can result in death or serious injury.

- **The panel operator has to ensure the proper use of the product, even when Safe Torque Off (STO) functionality is used, for example for ATEX-conform motor thermal protection. In this case, the safety function is part of the approved motor thermal protection, using the function as appropriate energy cut-off.**
- **Any other use of the safety functions is in sole responsibility of the end user, including certification, documentation, and so on.**
- **Customized variants can differ and are not subject to the panel configurator product description.**

NOTICE

The notification of maximum possible cross-section and number of wires is shown in drawings for each main component, where mains and motor cables can be directly connected. The drawings are provided with the panel.

Electrical specifications

Mains supply	400 V, 500 V, or 690 V, PEN, 3-phase, 50 Hz, IT or TN, as selected.
Maximum short circuit capabilities	I_{CW} = 35 kA on infeed terminals of the panel, see *Table 5.2*.
Assembly rated current I_{nA}	In accordance with the relevant frequency converter current rating. ***NOTICE*** **For VLT® AutomationDrive FC 302, NO (normal overload) values are used for the design. Due to the 80% design rule of EN 61439-2, design is adjusted for the HO (high overload) use. Details are provided per power rating in the relevant documents.**
RDF	RDF is specified to 1 for all power circuitry as only 1 frequency converter is foreseen per panel/infeed.
Cables/wires	Cables/wires used according to DIN standards, cross-section in mm^2. Any specified power cable can be used. Always consider local standards must always be taken into considerations.
Energy cabling	Energy cabling is done directly to the relevant terminals of switchgear, frequency converter, or filter.
Cable entry	Bottom cable entry.
Wiring color code	According to DIN EN 60204-1.

Table 5.1 Electrical Specifications

Power [kW]	Fuse[1)]	I_{CW} (200 ms)	I_C	Let through energy (200 ms)	I_{CC} for I_{CW}@35 kA	I^2t@35 kA	PE [mm^2]
90 kW	3NA7 140	2.2 kA	5.6 kA	945 kA^2s	15 kA	400 kA^2s	30x5
110 kW	3NA7 144	2.9 kA	7.4 kA	1673 kA^2s	19.3 kA	780 kA^2s	30x5
132 kW	3NA7 252	4 kA	10.2 kA	3238 kA^2s	24.1 kA	1275 kA^2s	30x10
160 kW	3NA7 260	5.1 kA	12.9 kA	5508 kA^2s	29.5 kA	2150 kA^2s	30x10
200 kW	3NA3 365	7.7 kA	19.5 kA	11409 kA^2s	39.3 kA	2700 kA^2s	30x10
250 kW	3NA3 365	7.7 kA	19.5 kA	11409 kA^2s	39.3 kA	2700 kA^2s	30x10
315 kW	3NA3 372	10.5 kA	26.8 kA	21848 kA^2s	48.7 kA	5400 kA^2s	30x10

Table 5.2 Short Circuit Withstand Capability According to DIN EN 61439

1) Siemens example; fuses with same characteristics from other suppliers can be used.

5

Ambient conditions, cooling, and environmental protection

Maximum ambient temperature for the panel	30 °C
Maximum internal panel temperature	40 °C
Maximum altitude for mounting	1000 m above sea level
Cooling	Forced ventilation, door-mounted fans, and heat dissipation on surface. For calculation, IEC 60890 scenario “panel in a row, wall mounted, with cabinets on both sides”.
IP rating of the panel	IP rating of the panel is a matter of selection and is available in IP21/43/54, according to EN 60529.
IP rating of enclosed VLT® frequency converters	IP20 for enclosure size D, respectively IP00 for E enclosure sizes.
IP rating of enclosed output filter	IP00, mounted in the lowest possible position for lowest center of gravity. Disassembling of capacitor banks and restructuring can occur. If terminal is an open type, coverage of filter is applied.
Degree of pollution	Specified clearance to a degree of pollution class 3 in accordance to table F.1 of annex F of IEC 61439-1.

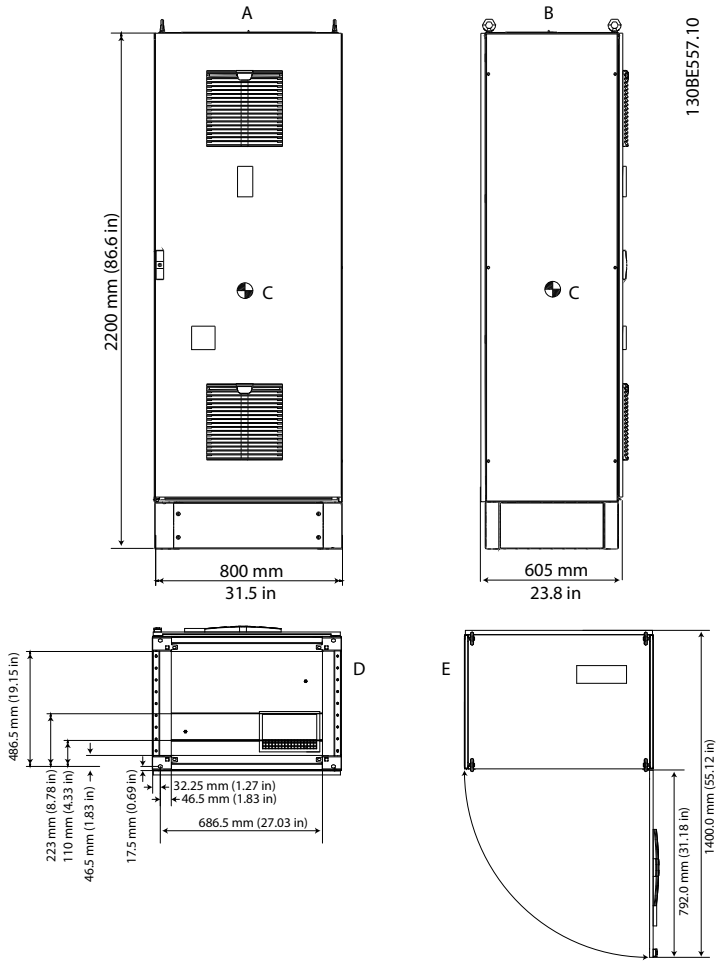
Panel information

Panel series	Rittal TS8, following IEC 62208
Panel dimensions	• Depth: 600 mm. • Height: 2000 mm. • Width: Depends on switchgear and power rating. Panels wider than 800 mm have 2 doors.
Plinth	200 mm plinth (standard). Options: No plinth, or 100 mm plinth.
Closure system	2-way-key bit.
Panel mounting	Panels are stationary, to be mounted on double floor, or other stable surface.
Panel Cooling	Cooling air for the power components must come from the double floor, else customer to provide suitable front covers for plinth to ensure sufficient air flow.
Panel doors	• 1 (for panel width <800 mm). • 2 (for panel width >800 mm).

Table 5.3 Panel Information

5.2 Dimensions

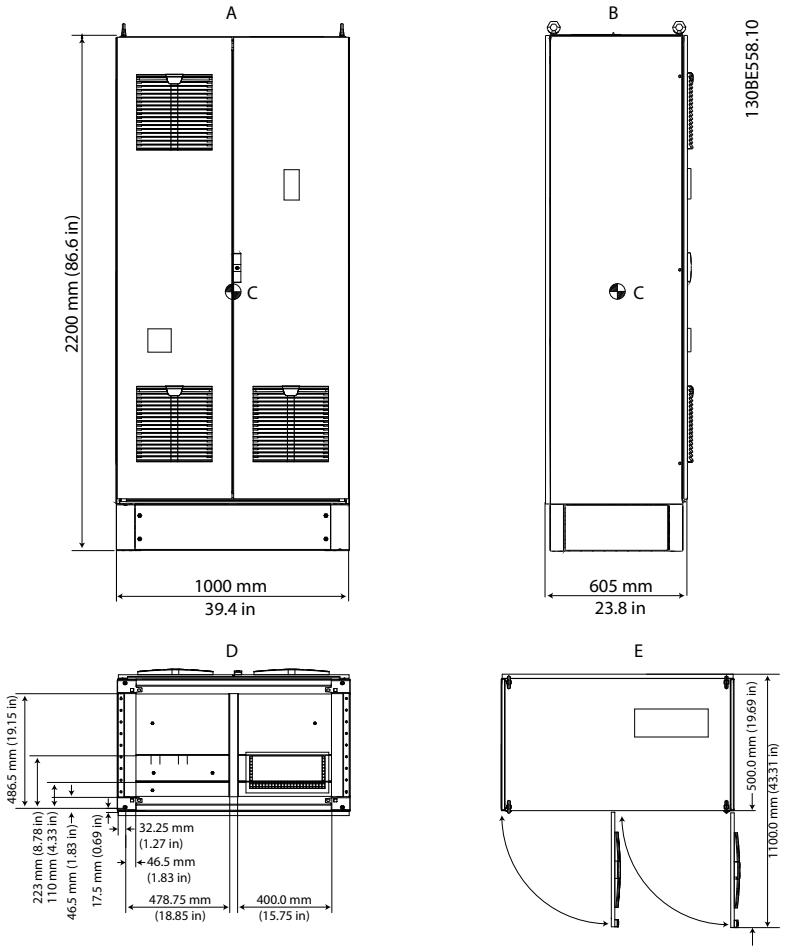
5.2.1 90 kW Enclosure



A	Front view	B	Side view	C	Center of gravity
D	Bottom view	E	Top view		

Illustration 5.1 Front, Side Dimensions, Door Clearance, and Center of Gravity for 90 kW Enclosure

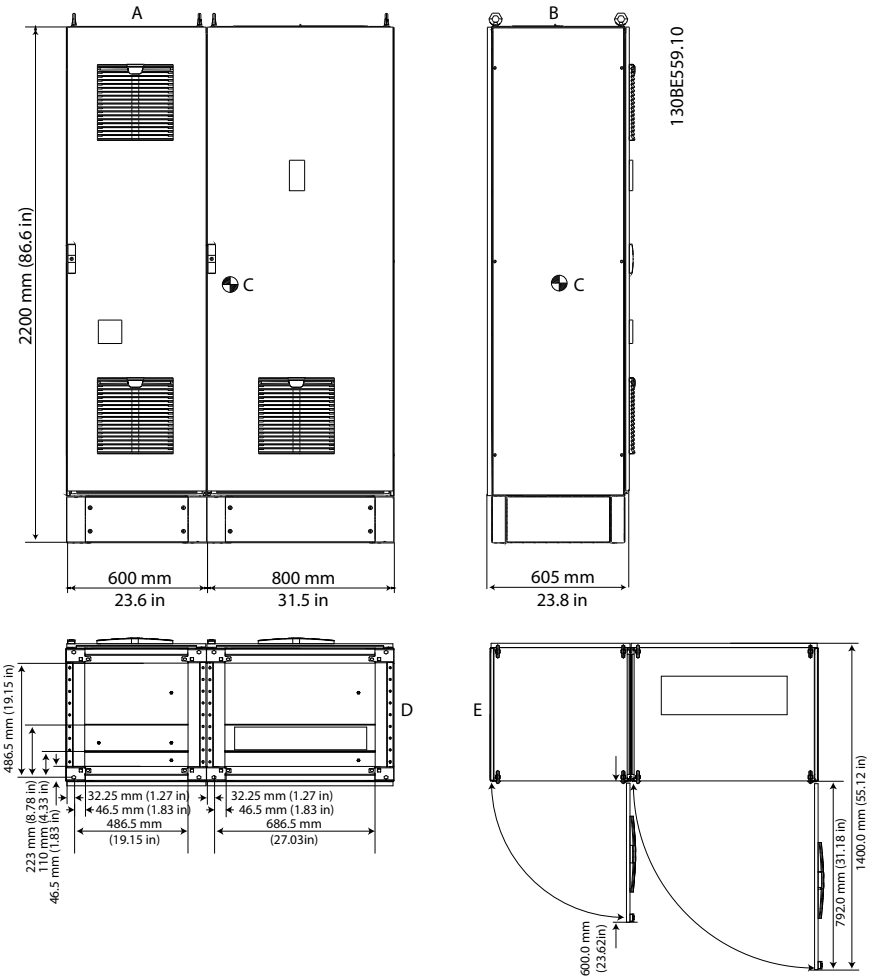
5.2.2 250 kW Enclosure



A	Front view	B	Side view	C	Center of gravity
D	Bottom view	E	Top view		

Illustration 5.2 Front, Side Dimensions, Door Clearance, and Center of Gravity for 250 kW Enclosure

5.2.3 315 kW and 400 kW Enclosure



A	Front view	B	Side view	C	Center of gravity
D	Bottom view	E	Top view		

Illustration 5.3 Front, Side Dimensions, Door Clearance, and Center of Gravity for 315 kW and 400 kW Enclosure

5.3 Weights

⚠CAUTION

DIVERGENT WEIGHT VALUES

The unit weight depends on the individual configurations. The shipping weight depends on the type of packing.

The values in *Table 5.4* are typical unit weight values valid for units equipped with

- **Contactor.**
- **Disconnect.**
- **Fuse.**
- **dU/dt-filter.**

Refer to the packing documentation for the precise unit and shipping weights.

Enclosure	Unit weight
90 kW	300 kg (661 lb)
250 kW	450 kg (992 lb)
315 kW	650 kg (1433 lb)
400 kW	750 kg (1653 lb)

Table 5.4 Unit Weights

Index

Danfoss A/S
Ulsnaes 1
DK-6300 Graasten
vlt-drives.danfoss.com

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