ENGINEERING TOMORROW

Design Guide

VLT® Compressor Drive CDS 803

6–30 kW

Contents

1 Introduction

1.1 Purpose of this Design Guide

This design guide is intended for qualified personnel, such as:

- Project and systems engineers.
- Design consultants.
- Application and product specialists.

The design guide provides technical information to understand the capabilities of the VLT® Compressor Drive CDS 803 for integration into motor control and monitoring systems. Its purpose is to provide design considerations and planning data for integration of the drive into a system. It caters for selection of drives and options for a diversity of applications and installations. Reviewing the detailed product information in the design stage enables developing a well-conceived system with optimal functionality and efficiency.

This manual is targeted at a worldwide audience. Therefore, wherever occurring, both SI and imperial units are shown.

VLT® is a registered trademark for Danfoss A/S.

1.2 Additional Resources

1.2.1 Supplementary Documentation

Various resources are available to understand advanced drive operation, programming, and directives compliance.

- The *Programming Guide* provides information on how to program and includes complete parameter descriptions.
- The *Operating Guide* provides detailed information about installation and commissioning of the drive.

See www.danfoss.com for supplementary documentation.

1.2.2 VLT® Motion Control Tool MCT 10 Software Support

Download the software from the Service and Support download page on www.danfoss.com.

During the installation process of the software, enter CD-key 34544400 to activate the CDS 803 functionality. An activation key is not required for using the CDS 803 functionality.

The latest software does not always contain the latest updates for the drive. Contact the local sales office for the latest drive updates (in the form of *.upd files), or download the drive updates from the Service and Support download page on www.danfoss.com.

1.3 Manual and Software Version

This manual is regularly reviewed and updated. All suggestions for improvement are welcome.

Table 1: Manual and Software Version

Edition	Remarks	Software version
AJ330233902305, version 0301	Power sizes 11 and 15 kW added.	6.0–10 kW (8–15 hp): Version 2.10 11–15 kW (15–20 hp): Version 51.00 18–30 kW (25–40 hp): Version 61.30

1.4 Approvals and Certifications

Description	Conformity mark
EU/EC Declaration of Conformity (EC/CE - European Conformity/Conformité Européenne) Low Voltage Directive/Electromagnetic compatibility (EMC)/Restriction of Hazardous Substances (RoHS) **Countries of use:** Europe	CE
UKCA Declaration of Conformity (UKCA - UK Conformity Assessed) Low Voltage Directive/Electromagnetic compatibility (EMC)/Restriction of Hazardous Substances (RoHS) **Countries of use:** Great Britain	UK CA

Description	Conformity mark
ACMA Declaration of Conformity (RCM - Regulatory Compliance Mark) Australian Communications Media Authority (ACMA) Low Voltage Directive/Electromagnetic compatibility (EMC) **Countries of use:** Australia and New Zealand	
VIT-SEPRO Declaration of Conformity (VIT - All-Union Institute of Transformer Engineering) Low Voltage Directive/Electromagnetic compatibility (EMC) **Country of use:** Ukraine	089
Moroccan Declaration of Conformity (CMIM - Moroccan Conformity Mark) Low Voltage Directive/Electromagnetic compatibility (EMC) **Country of use:** Morocco	
Eurasian Economic Union Declaration of Conformity (EAC - Eurasian Conformity Mark) Customs Union Technical Regulations (CU TR) Low voltage Directive/Electromagnetic compatibility (EMC)/Restriction of Hazardous Substances Directive (RoHS) **Countries of use:** Eurasian Economic Union (Russia, Belarus, Kazakhstan, Armenia, and Kyrgyzstan)	EAC
Certification of Compliance UL listed (UL - Underwriters Laboratories) Safety organization **Countries of use:** USA and Canada	C UL US LISTED
Certification of Compliance UL recognized (UL - Underwriters Laboratories) Safety organization **Countries of use:** USA and Canada	C RU US
KC Declaration of Conformity (KC - Korea Certification) Low Voltage Directive/Electromagnetic compatibility (EMC)/Restriction of Hazardous Substances (RoHS) **Countries of use:** Korea	KC

N O T I C E

The VLT® Compressor Drive CDS 803 with SXXX in the type code is certified against UL 508C/EN61800-5-1. Example:
CDS803P7K5T4E20H4XXCXXX**SXXX**XAXBXCXXXXDX
The VLT® Compressor Drive CDS 803 with S129 in the type code is certified against EN/IEC 60730-1. Example:
CDS803P15KT4E20H2XXCXXX**S129**XAXBXCXXXXDX
The VLT® Compressor Drive CDS 803 with S096 in the type code is certified against UL/EN/IEC 60730-1. Example:
CDS803P30KT4E20H2XXXXXX**S096**XAXBXCXXXXDX

2 Safety

2.1 Safety Symbols

The following symbols are used in this guide:

⚠ D A N G E R ⚠

Indicates a hazardous situation which, if not avoided, will result in death or serious injury.

⚠ W A R N I N G ⚠

Indicates a hazardous situation which, if not avoided, could result in death or serious injury.

⚠ C A U T I O N ⚠

Indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

N O T I C E

Indicates information considered important, but not hazard-related (for example, messages relating to property damage).

2.2 Qualified Personnel

To allow trouble-free and safe operation of the unit, only qualified personnel with proven skills are allowed to transport, store, assemble, install, program, commission, maintain, and decommission this equipment.

Persons with proven skills:

- Are qualified electrical engineers, or persons who have received training from qualified electrical engineers and are suitably experienced to operate devices, systems, plant, and machinery in accordance with pertinent laws and regulations.
- Are familiar with the basic regulations concerning health and safety/accident prevention.
- Have read and understood the safety guidelines given in all guides provided with the unit, especially the instructions given in the installation guide and safety guide.
- Have good knowledge of the generic and specialist standards applicable to the specific application.

2.3 Safety Precautions

⚠ W A R N I N G ⚠

HAZARDOUS VOLTAGE

AC drives contain hazardous voltage when connected to the AC mains or connected on the DC terminals. Failure to perform installation, start-up, and maintenance by skilled personnel can result in death or serious injury.

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

⚠ W A R N I N G ⚠

UNINTENDED START

When the drive 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. Start the motor with an external switch, a fieldbus command, an input reference signal from the local control panel (LCP), via remote operation using MCT 10 software, or after a cleared fault condition.

- Disconnect the drive from the mains.
- Press [Off/Reset] on the LCP before programming parameters.
- Ensure that the drive is fully wired and assembled when it is connected to AC mains, DC supply, or load sharing.

⚠ WARNING ⚠

DISCHARGE TIME

The drive contains DC-link capacitors, which can remain charged even when the drive is not powered. High voltage can be present even when the warning indicator lights are off.

Failure to wait the specified time after power has been removed before performing service or repair work could result in death or serious injury.

- Stop the motor.
- Disconnect AC mains, permanent magnet type motors, and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other drives.
- Wait for the capacitors to discharge fully. The minimum waiting time is specified in the table *Discharge time* and is also visible on the nameplate on the top of the drive.
- Before performing any service or repair work, use an appropriate voltage measuring device to make sure that the capacitors are fully discharged.

Table 2: Discharge Time

Voltage [V]	Power range [kW (hp)]	Minimum waiting time (minutes)
3x200	6.0–10 (8.0–15)	15
3x400	6.0–7.5 (8.0–10)	4
3x400	10–30 (15–40)	15

⚠ WARNING ⚠

LEAKAGE CURRENT HAZARD

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

- Ensure that the minimum size of the ground conductor complies with the local safety regulations for high touch current equipment.

⚠ 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.

⚠ CAUTION ⚠

INTERNAL FAILURE HAZARD

An internal failure in the drive can result in serious injury when the drive is not properly closed.

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

3 Product Overview

3.1 VLT® Compressor Drive CDS 803 Family Overview

Danfoss offers CDS drives in different-sized enclosures with power ratings from 6.0–30 kW (8.0–40 hp). Common for all drives are the following:

- I/Os
  - 4 digital inputs (PNP or NPN)
  - 2 digital outputs
  - 2 analog inputs (voltage or current)
  - 2 analog outputs
  - 2 relay outputs
- RS485 serial communication
  - Danfoss FC protocol and VLT® Motion Control Tool MCT 10 support
  - Modbus RTU

The drive is a free-standing, wall-mountable, or cabinet-mountable drive available in different ratings to fit various applications. The complete overview is listed in Table 3.

Illustration 1: VLT® Compressor Drive CDS 803 Family

Table 3: Overview of VLT® Compressor Drive CDS 803 Family

Power [kW]	P6K0	P7K5	P10K	P11K	P15K	P18K	P22K	P30K
Electrical								
Mains voltage [V]	3x200–240 3x380–480	3x200–240 3x380–480	3x200–240 3x380–480	3x380–480	3x380–480	3x380–480	3x380–480	3x380–480
Typical shaft output [hp]	8.0	10	15	15	20	25	30	40
Mechanical								
Enclosure size	H4 H3	H4 H3	H5 H4	H5	H5	H5	H5	H6
IP protection rating(1)	IP20	IP20	IP20	IP20	IP20	IP20	IP20	IP20
Compliance								
RFI filter	H4 RFI filter • EN 55011 A1 • EN/IEC 61800-3 C2			H2 RFI filter • EN 55011 A2 • EN/IEC 61800-3 C3				
UL rating	UL Listed • UL 508C			Non-UL		UL Recognized • UL 60730-1		

[1] All CDS 803 drives can be upgraded to IP21/NEMA Type 1 with an IP21/NEMA Type 1 Conversion Kit.

3.2 VLT® Compressor Drive CDS 803 Features

Various application functions are programmed in the drive for enhanced system performance. The functions require minimum programming or setup. For activation of the functions, refer to the VLT® Compressor Drive CDS 803 Programming Guide listed in 1.2 Additional Resources.

3.2.1 Compressor Features

The VLT® Compressor Drive CDS 803 offers various specialized functions for use in combination with compressor systems.

3.2.1.1 Secure Start-up

To ensure that the compressor ramps fast to the defined start speed, the VLT® Compressor Drive CDS 803 always runs a start-up sequence. The compressor runs at the start speed for a defined fixed time.

- If a locked rotor or flooded compressor occurs, it is detected during start-up.
- If the drive fails to start the compressor, it trips on *Alarm 18, Start failed*.

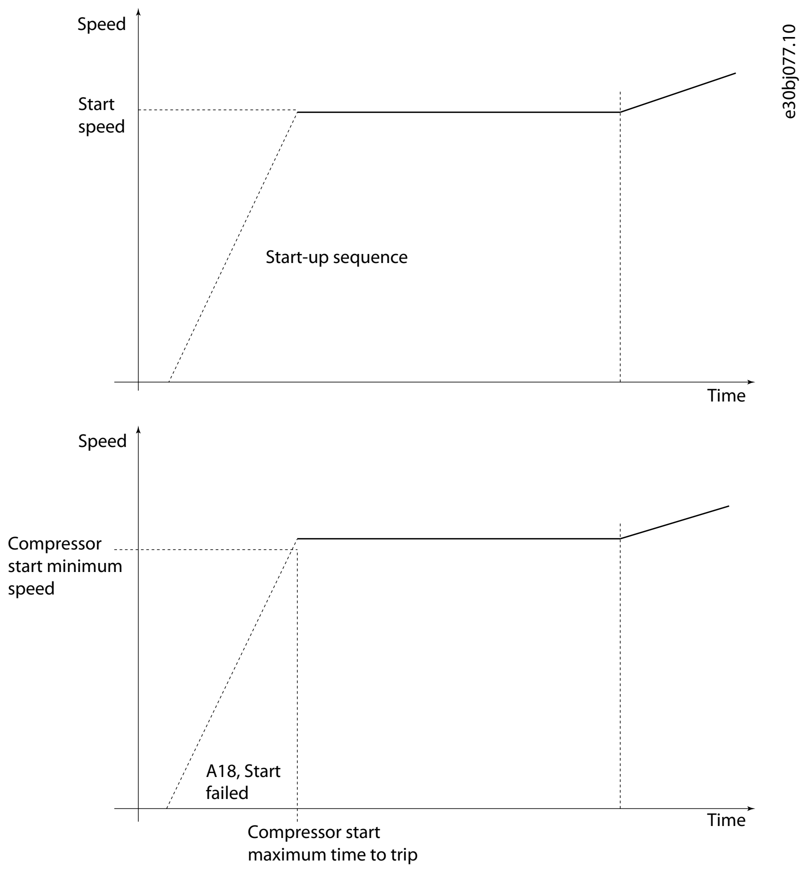


Illustration 2: Compressor Start-up Sequence

3.2.1.2 Compressor Minimum Speed Detection

To avoid a malfunction inside the compressor due to missing or low lubrication the VLT® Compressor Drive CDS 803 protects the compressor if the speed drops below the minimum speed detection limit for too long.

- In case of excessive low speed the drive issues *Alarm 49, Speed limit*.

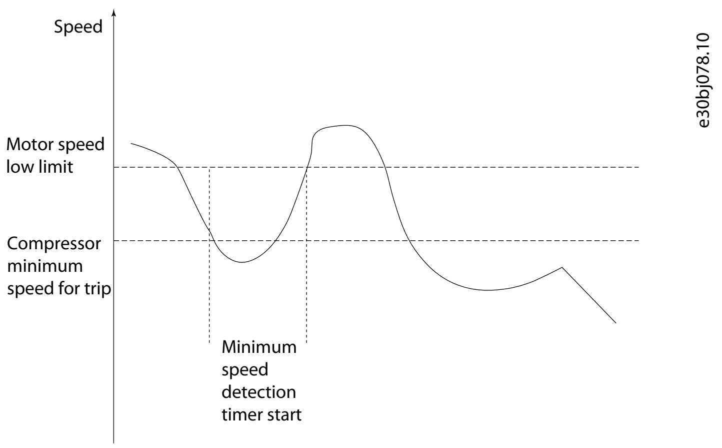


Illustration 3: Minimum Speed Detection

3.2.1.3 Short-cycle Protection

The VLT® Compressor Drive CDS 803 includes a compressor short-cycling protection that prevents mechanical wear to the compressor and reduces the risk of oil shortage caused by starting and stopping too often. The short-cycle protection consists of 2 timers:

- The interval between starts ensures that a new start first becomes active when the start time has expired.
- The minimum run-time ensures that the compressor always runs for a defined minimum time before stopping the compressor.
- *Warning 96, Start Delay* is shown in the display if there is a start signal and the INTERVAL BETWEEN STARTS has not expired.
- *Warning 97, Stop Delay* is shown in the display if there is a stop signal and the MINIMUM RUN-TIME has not expired.

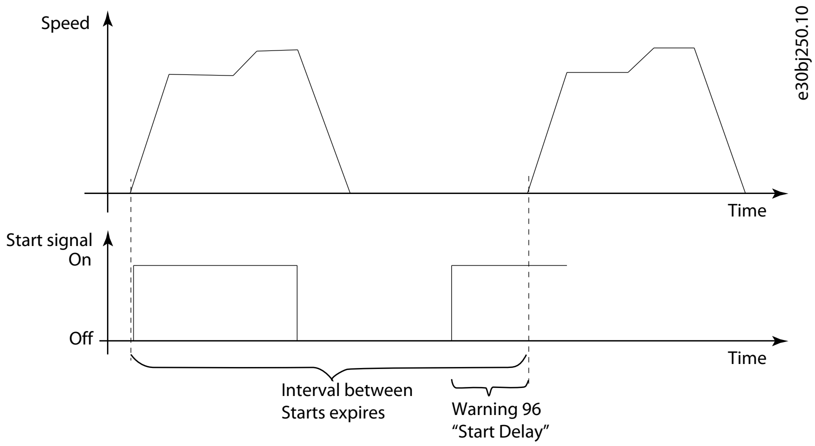


Illustration 4: Short-cycle Protection, Start Delay

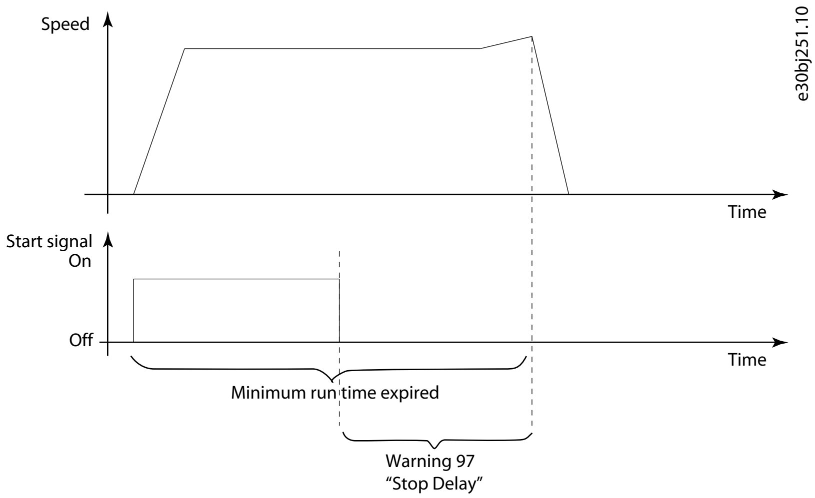


Illustration 5: Short-cycle Protection, Stop Delay

3.2.1.4 Anti-reverse Protection

The anti-reverse protection function prevents the compressor scroll set from running in the wrong direction during stop.

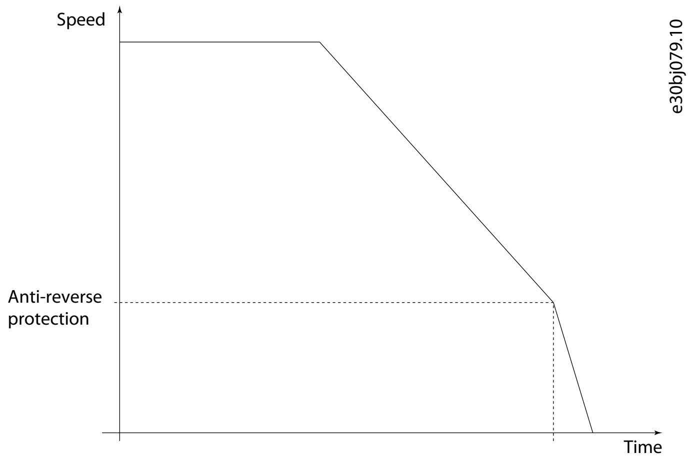


Illustration 6: Anti-reverse Protection

3.2.1.5 Oil Return Management

The oil return management (ORM) function helps retrieve oil trapped in the cooling system by ramping up periodically (oil boost speed).

- The ORM becomes active when the compressor has run below the ORM minimum speed limit for a given time defined by ORM running time.
- When ORM is active, the speed increases to a predefined ORM boost speed for a given time defined by ORM boost time.
- Additionally a fixed boost interval timer shall trigger the ORM function if no ORM has run within the defined ORM interval.

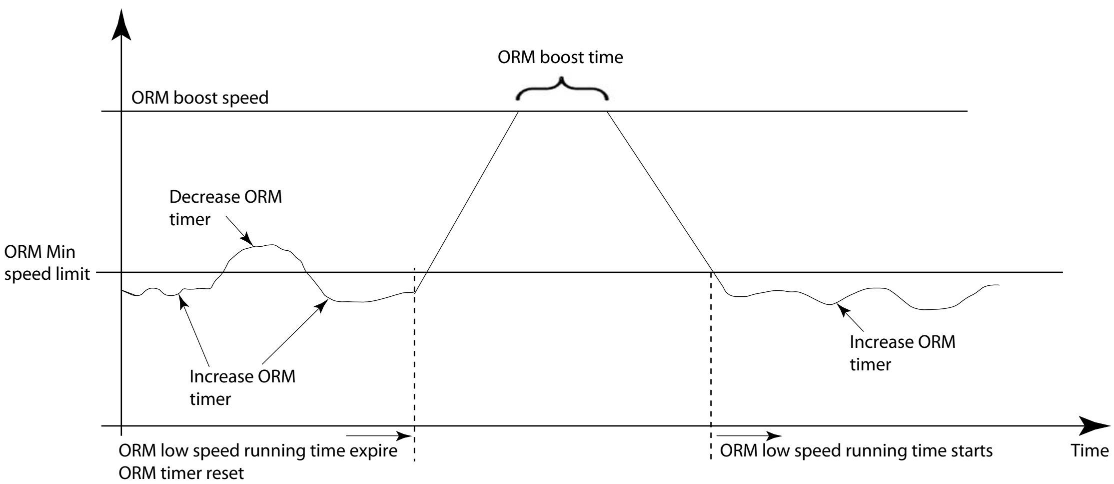


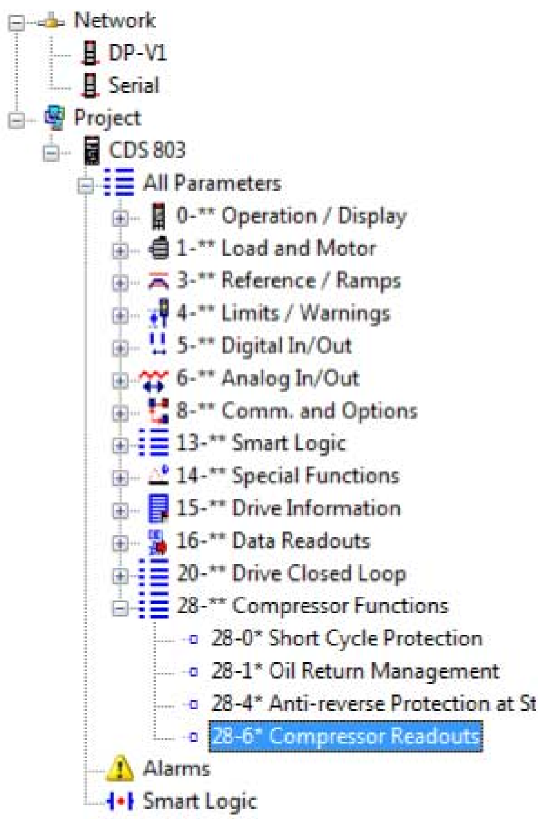
Illustration 7: Oil Return Management

3.2.1.6 Data Readouts and Commissioning

The VLT® Motion Control Tool MCT 10 supports the VLT® Compressor Drive CDS 803. The MCT 10 is an efficient tool, for example for readouts and commissioning.

VLT® Motion Control Tool MCT 10 supports the following readouts:

- Readouts of alarms, warnings, and fault log in 1 view.
- Compare a saved project with an online drive.
- Scope & logging: Easy problem analysis.
- Offline commissioning.
- Save/send/mail projects anywhere.
- Multiple drives in project file. Enables the service organization to be more efficient.
- Compressor readout of frequency in RPS.



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3.2.1.7 Undersized Compressor

Programmable compressor choices allow downscaling of a drive to operate with an undersized compressor or running an oversized drive under extreme conditions. This functionality is useful in applications which are outside the specified appliance area:

- High-ambient-temperature installations.
- High-altitude installations.

N O T I C E

UL 60730-1 certification restricts for only allowing 1 dedicated compressor combination and does not offer the ability to run an undersized compressor.

3.2.2 Application Features

The VLT® Compressor Drive CDS 803 offers custom application functions for enhanced performance.

3.2.2.1 Automatic Motor Adaptation (AMA)

Automatic motor adaptation (AMA) is an automated test procedure used to measure the electrical characteristics of the motor. AMA provides an accurate electronic model of the motor, allowing the drive to calculate optimal performance and efficiency. Running the AMA procedure also maximizes the automatic energy optimization feature of the drive.

AMA is performed without the motor rotating and without uncoupling the load from the motor.

N O T I C E

Automatic motor adaptation (AMA) is not required when used with a VZH Danfoss compressor.

3.2.2.2 Motor Thermal Protection

Motor thermal protection can be provided via:

- Mechanical thermal switch (Klixon type) on a DI.
- Built-in electronic relay (ETR).

N O T I C E

Electronic thermal protection (ETR) is used in combination with a VZH Danfoss compressor.

ETR calculates motor temperature by measuring current, frequency, and operating time. The drive shows the thermal load on the motor in percentage and can issue a warning at a programmable overload setpoint. Programmable options at the overload allow the drive to stop the motor, reduce output, or ignore the condition. Even at low speeds, the drive meets I2t Class 20 electronic motor overload standards.

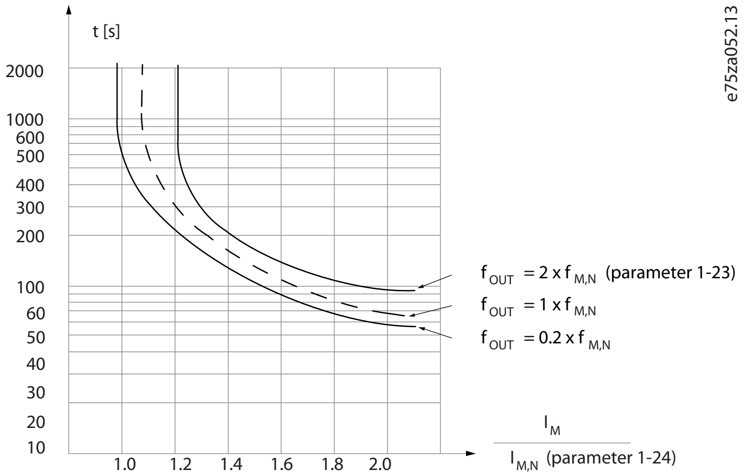


Illustration 8: ETR Characteristics

The X-axis shows the ratio between I_{motor} and I_{motor} nominal. The Y-axis shows the time in seconds before the ETR cuts off and trips the drive. The curves show the characteristic nominal speed at twice the nominal speed and at 0.2 x the nominal speed. At lower speed, the ETR cuts off at lower heat due to less cooling of the motor. In that way, the motor is protected from being overheated even at low speed. The ETR feature calculates the motor temperature based on actual current and speed. The calculated temperature is visible as a readout parameter in *parameter 16-18 Motor Thermal*.

3.2.2.3 Built-in PID Controller

The built-in proportional, integral, derivative (PID) controller eliminates the need for auxiliary control devices. The PID controller maintains constant control of closed-loop systems where regulated pressure, flow, temperature, or other system requirements must be maintained.

The drive can use 2 feedback signals from 2 different devices, allowing the system to be regulated with different feedback requirements. The drive makes control decisions by comparing the 2 signals to optimize system performance.

3.2.2.4 Automatic Restart

The drive can be programmed to restart the motor automatically after a minor trip, such as momentary power loss or fluctuation. This feature eliminates the need for manual resetting and enhances automated operation for remotely controlled systems. The number of restart attempts and the duration between attempts can be limited.

3.2.2.5 Flying Start

Flying start allows the drive to synchronize with an operating motor rotating at up to full speed in either direction. This prevents trips due to overcurrent draw. It minimizes mechanical stress to the system since the motor receives no abrupt change in speed when the drive starts.

3.2.2.6 Frequency Bypass

In some applications, the system can have operational speeds that create a mechanical resonance. This mechanical resonance can generate excessive noise and possibly damage mechanical components in the system. The drive has 4 programmable bypass-frequency bandwidths (*parameters 4-60* to *4-63*). The bandwidths allow the motor to step over speeds that induce system resonance.

3.2.2.7 Motor Preheat

Instead of using a space heater, Danfoss provides motor preheat functionality. To preheat a motor in a cold or damp environment, a small amount of DC current can be trickled continuously into the motor to protect it from condensation and cold starts.

3.2.2.8 Programmable Setups

The drive has 2 setups that can be independently programmed. Using multi-setup, it is possible to switch between independently programmed functions activated by digital inputs or a serial command. Independent setups are used, for example, to change references, or for day/night or summer/winter operation, or to control multiple motors. The LCP shows the active setup.

Setup data can be copied from drive to drive by downloading the information from the removable LCP or by using VLT® Motion Control Tool MCT 10.

3.2.2.9 Smart Logic Control (SLC)

Smart logic control (SLC) is a sequence of user-defined actions (see *parameter 13-52 SL Controller Action [x]*) executed by the SLC when the associated user-defined event (see *parameter 13-51 SL Controller Event [x]*) is evaluated as TRUE by the SLC.

The condition for an event can be a particular status, or that the output from a logic rule or a comparator operand becomes TRUE. The condition leads to an associated action as shown in Illustration 9.

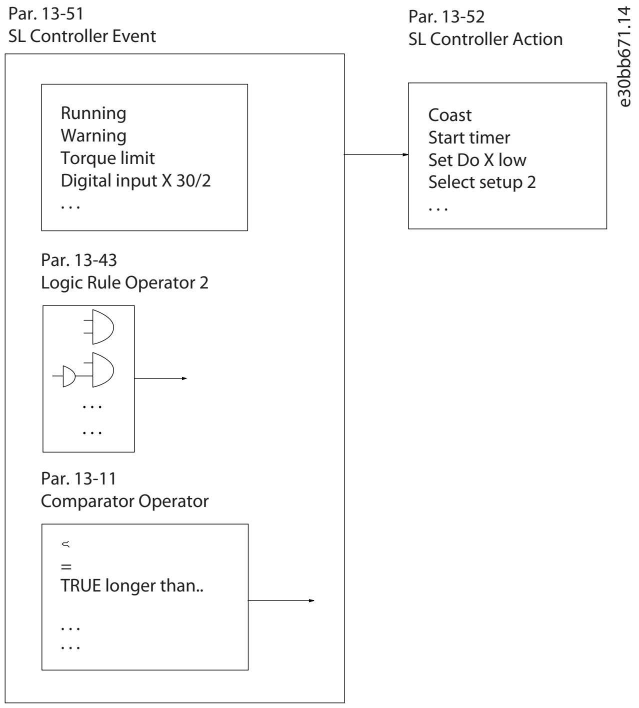


Illustration 9: SLC Event and Action

Events and actions are each numbered and linked in pairs (states), which means that when event [0] is fulfilled (attains the value TRUE), action [0] is executed. After the 1st action is executed, the conditions of the next event are evaluated. If this event is evaluated as true, then the corresponding action is executed. Only 1 event is evaluated at any time. If an event is evaluated as false, nothing happens in the SLC during the current scan interval, and no other events are evaluated. When the SLC starts, it only evaluates event [0] during each scan interval. Only when event [0] is evaluated as true, the SLC executes action [0] and starts evaluating the next event. It is possible to program 1–20 events and actions.

When the last event/action has been executed, the sequence starts over again from event [0]/action [0]. An example with 4 events/actions is shown in Illustration 10:

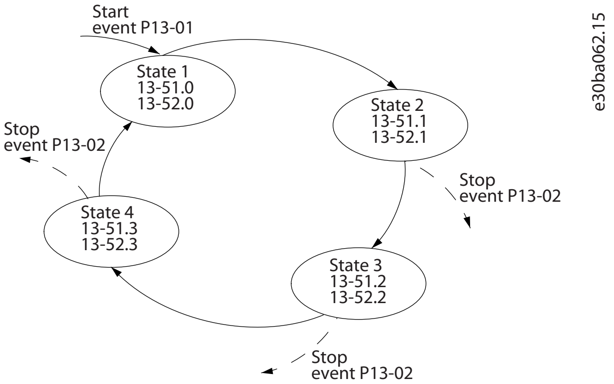


Illustration 10: Order of Execution when 4 Events/Actions are Programmed

3.2.2.9.1 Comparators

Comparators are used for comparing continuous variables (output frequency, output current, analog input, and so on) to fixed pre-set values.

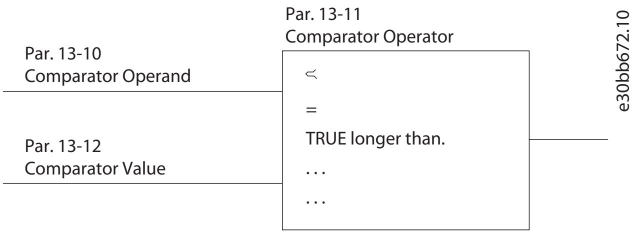


Illustration 11: Comparators

3.2.2.9.2 Logic Rules

Combine up to 3 boolean inputs (TRUE/FALSE inputs) from timers, comparators, digital inputs, status bits, and events using the logical operators AND, OR, and NOT.

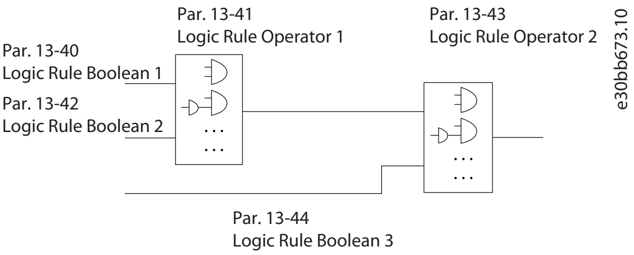


Illustration 12: Logic Rules

3.3 VLT® Compressor Drive CDS 803 Protections

The drive has a range of built-in protection functions to protect itself and the compressor during operation. For details of any required setup, in particular compressor parameters, refer to the VLT® Compressor Drive CDS 803 Programming Guide listed in 1.2 Additional Resources for parameter details and programming.

3.3.1 Mains Input Protection

The VLT® Compressor Drive CDS 803 offers various built-in input protections for the 3-phase power terminals L1, L2, and L3.

3.3.1.1 Mains Supply Failure, Momentary Dropouts, and Surges

During a mains dropout, the drive keeps running until the internal DC-link voltage drops below the minimum stop level, which is typically around 15% or more below the lowest rated supply voltage of the drive. The mains voltage before the dropout and the motor load determine how long it takes for the drive to coast.

The drive withstands mains fluctuations such as:

- Transients
- Momentary dropouts
- Short voltage drops
- Surges

The drive automatically compensates for input voltages ±10% from the mains nominal to provide full rated output current. With auto restart selected, the drive automatically powers up after a voltage trip. With flying start parameterization, the drive can synchronize to a motor spinning freely after a mains dropout and bring it back to normal operation.

3.3.1.2 Missing-mains-phase Detection

The drive monitors the mains input and reacts according to the programmed configuration if improper conditions, such as missing or detecting too high imbalance between the input phases.

Operation under severe mains imbalance conditions reduces the lifetime of the drive. Conditions are considered severe if the motor is operated continuously near nominal load. The default setting issues a warning, but automated derating of the load can also be parameterized among multiple choices.

3.3.2 Output Protection

The VLT® Compressor Drive CDS 803 offers various built-in protection features for the compressor terminals U, V, and W.

3.3.2.1 Short-circuit Protection (Phase-to-phase)

The drive is protected against short circuits on the output side by current measurements. A short circuit between 2 output phases causes an overcurrent internally and turns off all outputs once the short-circuit current exceeds the maximum limit. A drive that works correctly limits the current it can draw from the supply. Still, it is recommended to use fuses and/or circuit breakers on the supply side as protection if there is a component breakdown inside the drive (1st fault). Mains side fuses are mandatory for UL compliance.

NOTICE

To ensure compliance with IEC 60364 for CE or NEC 2017 for UL, it is mandatory to use fuses and/or circuit breakers.

3.3.2.2 Ground Fault Protection (Output Phase-to-Ground)

The drive is protected against ground faults on all output terminals, U, V, and W.

3.3.2.3 Locked-rotor Detection

Sometimes the rotor is locked because of excessive load or other factors preventing the compressor from rotating.

The drive detects the locked-rotor situation and trips accordingly to prevent overheating the compressor and the drive.

NOTICE

In regulation with UL 60730-1 certified products, the locked-rotor detection cannot be disabled.

3.3.2.4 Output-phase-loss Detection

The drive monitors all outputs to detect any missing or interrupted connections. If no currents are drawn on any output, it is assumed that no motor is connected and will cause this event to be triggered. If a single-phase is lost, an output-phase-missing event is triggered. In both scenarios, all outputs are turned off. The missing-output-phase function is enabled by default to avoid motor damage. Disabling this protection is possible via parameterization.

NOTICE

In regulation with UL 60730-1 certified products, the output-phase-loss detection cannot be disabled.

3.3.2.5 Overload Protection

If excessive current outputs or high temperatures are observed for an unwanted period, the protections trip the drive and turn all the outputs off. The time before the drive trips is controlled by parameterization of the monitored protections.

Voltage limit

The inverter turns off to self-protect the internal components when the maximum voltage limits are reached.

Output current limit

The inverter turns off to self-protect the internal components when the maximum current limits are reached.

Overtemperature

The inverter turns off to self-protect the internal components when the maximum temperature limits are reached.

Electronic thermal relay (ETR)

ETR is an electronic feature that simulates a bimetal relay based on internal measurements. See also 3.2.2.2 Motor Thermal Protection.

NOTICE

In regulation wih UL 60730-1 certified products, the output overload conditions, such as motor overload (ETR), cannot be disabled.

3.3.3 Temperature Protection

The VLT® Compressor Drive CDS 803 offers various built-in temperature protection features for monitoring the operation environment.

3.3.3.1 Minimum and Maximum Temperature Protection

The drive has built-in temperature sensors and reacts immediately to critical temperature limits. At low temperature, a warning is triggered. If high-temperature limits are exceeded, the drive trips on an alarm and turns off all outputs.

3.3.3.2 Automatic Temperature Derating

Automatic temperature derating can be enabled via parameterization to allow continued operation during high temperatures.

3.3.3.3 Temperature-controlled Fans

Sensors in the drive regulate the operation of the internal cooling fans. Often, the cooling fans do not run during low-load operation, when in sleep mode, or in standby. The sensors reduce noise, increase efficiency, and extend the operating life of the fan.

3.3.4 Internal Protection

The VLT® Compressor Drive CDS 803 offers various built-in internal protection features ensuring that the drive is fully operational.

3.3.4.1 DC Overvoltage Protection

The internal DC-link voltage is increased when the motor acts as a generator. This occurs in the following situations:

- The load drives the motor (at constant output frequency from the drive), that is, the load generates energy.
- During deceleration (ramp-down) if the moment inertia is high, the friction is low, and the ramp-down time is too short for the energy to be dissipated as a loss in the drive, the motor, and the installation.
- Incorrect slip compensation setting may cause higher DC-link voltage.
- Back EMF from PM motor operation. If coasted at high RPM, the PM motor back EMF may potentially exceed the maximum voltage tolerance of the drive and cause damage. To prevent this, the maximum output frequency is automatically limited based on an internal calculation. This calculation is based on motor parameterizations.

Monitoring of the internal voltage ensures that the drive trips when the DC-link voltage is too high. The drive turns off the output to protect itself when a certain voltage level is reached. Enabling overvoltage control (OVC) reduces the risk of the drive tripping due to an overvoltage on the DC link. This is controlled by automatically extending the ramp-down time.

3.3.4.2 Internal Faults

The drive has various internal self-monitoring functions which ensure that the drive is fully operational. For warning and alarm details, refer to VLT® Compressor Drive CDS 803 Programming Guide listed in 1.2 Additional Resources.

3.4 Ecodesign for Power Drive Systems

The Ecodesign Directive is the legislative framework that sets requirements on all energy-related products in the domestic, commercial, and industrial sectors throughout Europe.

The Ecodesign requirements are only mandatory within the European Union. These requirements are like the legislative requirements for energy-related products which apply in North America and Australia.

Terms like Complete Drive Module (CDM) and Power Drive Systems (PDS) are used to define the elements in the design. The objective is to make more efficient and fewer energy-consuming designs.

The CDM contains the drive controller as well as auxiliary devices and input components.

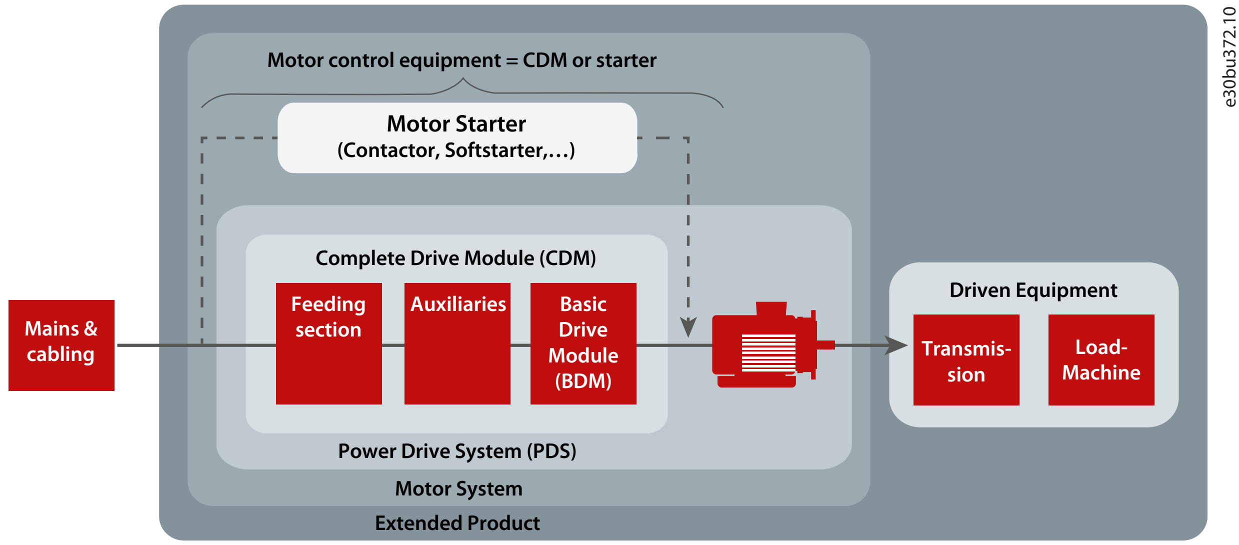


Illustration 13: Drive System Design

The efficiency classes IE0 to IE2 of the drive controller as specified in IEC 61800-9-2 (EN 50598-2) refer to the 90/100 operating point that is 90 % motor stator frequency and 100% torque current (see Illustration 14).

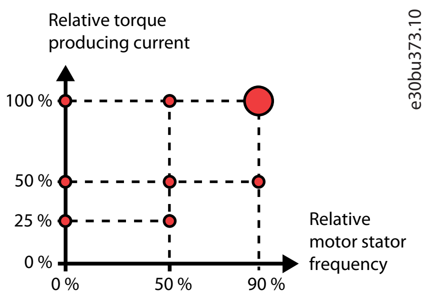


Illustration 14: Operating Point according to IEC 61800-9-2 (EN 50598)

Since, in the future, all component manufacturers will disclose their loss data according to this new standard, optimized applications can be designed with a wide range of different components. The new Standard allows an accurate preliminary calculation of the power losses, so that the ROI (Return of Investment) can be reliably determined. Up to now, the overall efficiency of speed-regulated electric motors was estimated with the aid of approximate energy consumption calculations.

It is now possible to determine the total losses of a system for the 8 operating points defined in the standard, including the part load operation, via a simple addition of power losses. Danfoss helps its customers to avoid having to rely on system solution providers, to ensure that their systems will retain a competitive advantage also in the future.

EC 61800-9-2 (EN 50598-2) shifts the focus from the individual component to the efficiency of the whole drive system. The new efficiency classes (International Efficiency for Systems, IES) allow a simple determination of the total losses for a whole drive system (PDS).

Danfoss offers the MyDrive® ecoSmart™ tool, which is available online or as a Smartphone app to assist with the efficiency calculation. Use MyDrive® ecoSmart™ to:

- Look up part load data as defined in IEC 61800-9-2, for VLT® and VACON® drives.
- Calculate efficiency class and part load efficiency for drives and power drive systems.
- Create a report documenting part load loss data and IE or IES efficiency class.

For more information, refer to http://ecosmart.danfoss.com.

Refer to Illustration 15 to see the components in the PDS which contribute to losses in the design. Mains cables and the load machine are not a part of the PDS, even though their losses can be significant and could be a part of the evaluation of the overall energy efficiency of the installation.

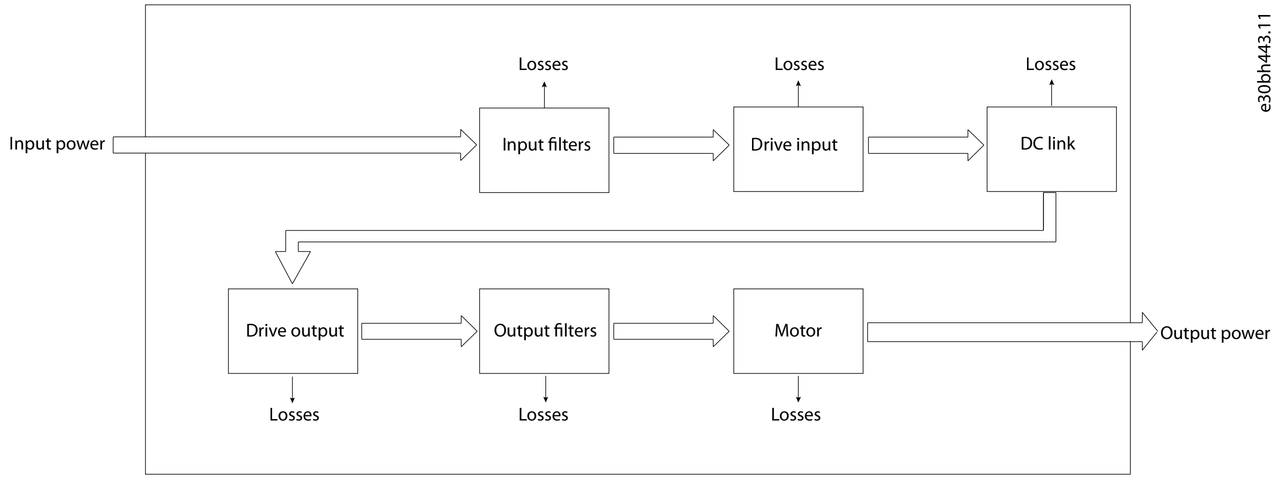


Illustration 15: Losses in a Power Drive System

3.4.1 Losses in Mains Cabling

The cabling from the supply must be considered, as the selection of suitable cables is often a problem, especially when dedicated feeding transformers are installed. From the impedance of the cables, the energy losses are created in the ohmic part. Calculate the active power losses for a 3-phase system with a star point grounding as follows:

$P_{L,mains} = 3 \times R \times I_{L1}^2$

Because the load, when using drives and motors, also include reactive power and harmonic currents, these parameters also contribute to losses. The ratio between active and apparent power is normally called the power factor. Having a PDS with a power factor close to 1 result in the lowest losses in the mains. Using filters on the input side of the drive can lower the power factor.

3.4.2 Input Filters: Line Reactors and Harmonic Filters

Line reactor

A line reactor is an inductor which is wired in series between a power source and a load. Line reactors, also called input AC reactors, are typically used in motor drive applications.

The main function of the line reactor lies into its current-limiting characteristics. Line reactors also reduce the main harmonics, limit the inrush currents, and protect drives and motors. An overall improvement of the true power factor and the quality of the input current waveform can be achieved.

Line reactors are classified by their percent impedance (denoted as percent IZ or %IZ), which is the voltage drop due to impedance, at the rated current, expressed as a percent of rated voltage. The most common line reactors have either 3% or 5% impedance.

When to use line reactors

It is important to consider the installation environment for the drives. In some situations, distortion from the grid can damage the drive and precautions must be taken.

A simple means of prevention is to ensure a minimum of impedance in front of the drive.

When calculating the impedance, the contribution from the supply transformer and the supply cables is also a part of the circuit. In specific cases, an additional transformer or reactor is recommended. If the conditions listed exist, consider adding impedance (line reactor or transformer) in front of the drive:

- The installation site has switched power factor correction capacitors.
- The installation site has lightening strikes or voltage spikes.
- The installation site has power interruptions or voltage dips.

Danfoss offers the line reactor program VLT® Line Reactor MCC 103, see Danfoss.com.

Harmonic filters

The purpose of using harmonic filters is to reduce the distortion on the mains. The distortion is generated by the drives when switching the voltage to generate a frequency on the output. The harmonics should be limited both seen from energy consumption perspective and disturbance of other users in the grid.

There are 2 categories of harmonic solutions:

- Passive.
- Active.

Passive solutions consist of capacitors, inductors, or a combination of both in different arrangements. The simplest solution is to add inductors/reactors of typically 3–5% in front of the drive. This added inductance reduces the number of harmonic currents produced by the drive. More advanced passive solutions combine capacitors and inductors in trap arrangements specially tuned to eliminate harmonics starting from, for example, the 5th harmonic.

For more details on the Danfoss passive solutions, refer to VLT® Advanced Harmonic Filters AHF 005/AHF 010 Design Guide.

The active solutions determine the exact current that cancels the harmonics present in the circuit and synthesizes and injects that current into the system. Thus, the active solution mitigates the real-time harmonic disturbances, which makes these solutions effective at any load profile.

For more details on the Danfoss active solutions, refer to VLT® Low Harmonic Drive Operating Instructions, and VLT® Advanced Active Filter AAF 006 Operating Instructions.

3.4.3 Drive, Input Side

RFI (radio frequency interference)

Drives generate radio frequency interference (RFI) due to their variable-width current pulses. Drives and motor cables radiate these components and conduct them into the mains system.

RFI filters are used to reduce this interference on the mains according to IEC 61800-3 in order not to disturb radio services. Maximum allowed emission depends on the environment where the PDS is used.

The need for reducing the interferences and the losses created by the coils is a trade-off that is hard to influence in the use of drives. Even though the losses exist, it is important to fulfill the legislation demands for the installation environment.

RFI filter on IT grid

If the drive is supplied from an isolated mains source (IT mains, floating delta) or TT/TN-S mains with grounded leg (grounded delta), the RFI filter must be turned off.

In the OFF position, the internal capacitors between the chassis (ground), the input RFI filter, and the DC link are cut off. As the RFI switch is turned off, the drive is not able to meet optimum EMC performance.

By opening the RFI filter switch, the ground leakage currents are also reduced, but not the high-frequency leakage currents caused by the switching frequency of the drive. It is important to use isolation monitors that are designed for use with power electronics (IEC 61557-8). For example, Deif type SIMQ, Bender type IRDH 275/375, or similar.

The Danfoss VLT® drives can be ordered with different types of RFI filters. See more details on RFI, the use of RFI filters, and EMC compliance in 6.5 Electromagnetic Compatibility.

Passive diode rectifier input

The use of diode rectifiers on the input side of the drives are the most cost-effective design. The energy flow goes from the mains to the load and have low losses. On the other hand, diodes create harmonics in the mains when rectifying and thereby create losses. These harmonics can be reduced by having DC-link coils, which are used in the Danfoss VLT® drives.

An energy flow from the drive back to the grid is not possible with this design as the energy is generated back from the application to the DC link. Use a DC chopper and a connected resistor to absorb the energy. This reduces the energy efficiency significantly.

3.4.4 DC Link

The DC link is a power storage facility for the output section of the drive. There are 2 major components to the DC-link section:

- Capacitors
- Coils

In Illustration 16 only 1 capacitor is shown, but it is always a series of capacitors.

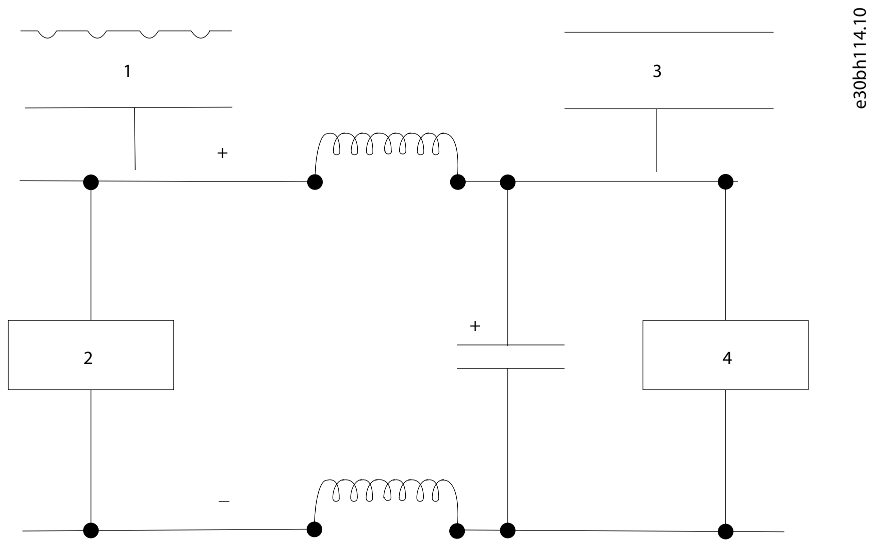


Illustration 16: Wiring Diagram of the DC Link

1	Direct current (AC ripple)	3	Direct current
2	Rectifier	4	Inverter

With Danfoss VLT® drives, this intermediate section always uses DC coils, also known as DC line reactors or DC chokes. For cost considerations, most other drive manufacturers do not offer these DC line reactors as standard equipment. Danfoss regards these coils as essential for 2 main reasons:

- The ability to reduce harmonic noise (interference) by 40%.
- The ability to ride through a temporary loss of power. This allows the drive to avoid numerous unplanned shutdowns.

3.4.5 Drive, Output Side

The output side of the drive contains IGBTs used for generating a variable AC voltage with variable frequency. If no filters are used, overvoltage spikes, due to reflection of the voltage waveform, can be measured on the motor connection. This situation is often linked with long motor cables used in the installation and can reach values up to twice the level of the DC-link voltage.

From a user perspective, losses on the output side of the drive can be influenced by using a lower switching frequency, but this also contributes to higher losses in the motor and filters installed. To optimize energy efficiency, a compromise must be found when selecting the components used, for example, filters, motor type, and others. Often, output filters are used with the purpose of reducing stress on the insulation.

In the following sections, the aspect of different filter types is discussed in perspective of energy efficiency versus function.

Common-mode filters

Common-mode HF filters are placed between the drive and the motor. They are nanocrystaline cores that mitigate high-frequency noise in the motor cable (shielded or unshielded) and eliminate bearing currents, and hence Electro Discharge Machining (EDM) or bearing etching in the motor. Bearing currents caused by drives are also referred to as common-mode currents.

Since the common-mode filters mitigate high frequency, these filters absorb energy and contribute also to losses. Here, the trade-off is the advantage described compared with the losses.

More information on VLT® Common Mode Filters MCC 105 can be found on www.Danfoss.com.

dU/dt filters

At the IGBTs on the output switch, the voltage is not a clean sinus curve. It contains fast changes in voltage levels over a very short time. The use of dU/dt filters increases the raise time of the motor voltage to reduce the stress on the motor insulation. If not avoided, the problem will typically not show at once, but after some time, the insulation breaks and creates problems.

The switching frequency influences the losses in the dU/dt filters. These losses can be up to 1% of the rated power. Here, the trade-off is the possible damage of the motor over time compared with the cost of energy losses.

Danfoss offers the VLT® dU/dt Filter MCC 102 as a possible solution. Find more information on www.Danfoss.com.

Sine-wave filters

A more advanced, but also more costly solution, is using sine-wave filters.

The VLT® Sine-Wave Filter MCC 101 is a differential-mode low-pass filter that suppresses the switching frequency component coming from the drive and smoothes out the phase-to-phase voltage of the drive to become sinusoidal. This reduces the motor insulation stress and bearing currents. By supplying the motor with a sinusoidal voltage waveform, the switching acoustic noise from the motor is also eliminated.

For more detailed information, see the VLT® Sine-Wave Filter MCC 101 factsheet.

However, this type of filter also produces a voltage drop and there may be a reduction in the available control bandwidth. This can sometimes make it impossible to use this filter type. Again, as for the dU/dt filter, losses are linked to the switching frequency.

For more detailed information, see the VLT® Output Filters Design Guide.

3.4.6 Motor Cables and Motor

Motor cables

Motor cables introduce mainly ohmic losses: the longer the cables, the more resistance. In general, when correctly selected, the losses in cables shorter than 25 m (82 ft) can be neglected. In single-wire cables with individual shielding, current causes losses in the cable shielding. These losses can be neglected when using 3-wire cables.

Motor

There are many different types of motors that can be operated with a drive. The solution for dealing with losses in motors is therefore depending on the individual motor type and installation. In standard IEC 61800-9-2:2017 annex D, a discussion on motor load and losses is found.

A method to evaluate the losses generated in the motor operated with a drive can be found in the standards IEC 60034-2-1 and IEC TS 60034-2-4.

4 Specifications

4.1 Electrical Data

4.1.1 Electrical Data 3x200–240 V AC

Table 4: 3x200–240 V AC

	P6K0	P7K5	P10K
Typical shaft output [kW]	6.0	7.5	10
Typical shaft output [hp]	8.0	10	15
Enclosure size	H4	H4	H5
Maximum cable size in terminals (mains, compressor) [mm^2 (AWG)]	16 (6)	16 (6)	16 (6)
Output current @ 40 °C (104 °F) ambient temperature			
Continuous (3x200–240 V) [A]	-	-	-
Intermittent (3x200–240 V) [A]	-	-	-
Output current @ 50 °C (122 °F) ambient temperature			
Continous (3x200–240 V) [A]	20.7	25.9	33.7
Intermittent (3x200–240 V) [A]	22.8	28.5	37.1
Maximum input current			
Continuous (3x200–240 V) [A]	23.0	28.3	37.0
Intermittent (3x200–240 V) [A]	25.3	31.1	40.7
Maximum mains fuses, see 6.2.1 Recommendation of Fuses and Circuit Breakers			
Estimated power loss [W][(1)]	182	229	369
Weight enclosure protection IP20 [kg (lb)]	7.9 (17.4)	7.9 (17.4)	9.5 (22.9)
Efficiency [%][(2)]	97.3	98.5	97.2

[1] Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to Danfoss MyDrive® ecoSmart website.

[2] Efficiency measured at nominal current. For energy efficiency class, see 4.6 Conforming Standards. For part load losses, see Danfoss MyDrive® ecoSmart website.

4.1.2 Electrical Data 3x380–480 V AC

Table 5: 3x380–480 V AC

	P6K0	P7K5	P10K	P11K	P15K	P18K	P22K	P30K
Typical shaft output [kW]	6.0	7.5	10	11	15	18.5	22	30
Typical shaft output [hp]	8.0	10	15	15	20	25	30	40
Enclosure size	H3	H3	H4	H5	H5	H5	H5	H6
Maximum cable size in terminals (mains, motor) [mm^2 (AWG)]	4 (10)	4 (10)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	35 (2)

	P6K0	P7K5	P10K	P11K	P15K	P18K	P22K	P30K
Output current @ 40 °C (104 °F) ambient temperature (45 °C (113 °F) for 30 kW)								
Continuous (3x380–440 V) [A]	-	-	-	23	31	37	44	61
Intermittent (3x380–440 V)[A]	-	-	-	25.3	34.1	40.7	48.4	67.1
Continuous (3x441–480 V) [A]	-	-	-	23	31	37	44	61
Intermittent (3x441–480 V) [A]	-	-	-	25.3	25.3	40.7	48.4	67.1
Output current @ 50 °C (122 °F) ambient temperature (52 °C (125 °F) for 11–22 kW)								
Continuous (3x380–440 V) [A]	11.6	14.3	16.4	23	31	37	44	48.8
Intermittent (3x380–440 V) [A]	12.8	15.7	18	25.3	34.1	40.7	48.4	53.7
Continuous (3x441–480 V) [A]	9.8	12.3	15.5	23	31	37	44	41.6
Intermittent (3x441–480 V) [A]	10.8	13.5	17.1	25.3	34.1	40.7	48.4	45.8
Maximum input current								
Continuous (3x380–440 V) [A]	12.7	15.1	18	22.1	29.9	35.2	42.6	57
Intermittent (3x380–440 V) [A]	14	16.6	19.8	24.3	32.9	38.7	45.7	62.7
Continuous (3x441–480 V) [A]	10.8	12.6	17	19	25.2	34.8	41.5	55.8
Intermittent (3x441–480 V) [A]	11.9	13.9	18.7	20.9	27.7	38.2	44.2	60.5
Maximum mains fuses, see 6.2.1 Recommendation of Fuses and Circuit Breakers.								
Estimated power loss [W][(1)]	104	159	248	243	306	412	475	733
Weight enclosure protection rating IP20 [kg (lb)]	4.3 (9.5)	4.5 (9.9)	7.9 (17.4)	9.5 (20.9)	9.5 (20.9)	9.5 (20.9)	9.5 (20.9)	24.5 (54)
Efficiency [%][(2)]	98.4	98.2	98.1	97.8	97.8	98.1	98.1	97.8

[1] Applies to dimensioning of drive cooling. If the switching frequency is higher than the default setting, the power losses may increase. LCP and typical control card power consumptions are included. For power loss data according to EN 50598-2, refer to Danfoss MyDrive® ecoSmart website.

[2] Efficiency measured at nominal current. For energy efficiency class, see 4.6 Conforming Standards. For part load losses, see Danfoss MyDrive® ecoSmart website.

4.2 Mains Supply (L1, L2, L3)

Supply voltage	200–240 V ±10%
Supply voltage	380–480 V ±10%
Supply frequency	50/60 Hz
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥0.9 nominal at rated load
Displacement power factor (cosφ) near unity	(>0.98)
Switching on the input supply L1, L2, L3 (power-ups)	Maximum 2 times/minute
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2
The unit is suitable for use on a circuit capable of delivering not more than 100000 A_{rms} symmetrical Amperes, 240/480 V maximum.	

4.3 Compressor Output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency (U/f)	0–400 Hz
Output frequency (VVC+) [1]	0–200 Hz
Output frequency (VVC+) [2]	0–400 Hz
Switching on output	Unlimited
Ramp times	0.05–3600 s

[1] VVC+ combined with induction motor type.

[2] VVC+ combined with permanent magnet motor type.

4.4 Control Input/Output

4.4.1 10 V DC Output

Terminal number	50
Output voltage	10.5 V ±0.5 V
Maximum load	25 mA

The 10 V DC output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.4.2 24 V DC Output

Terminal number	12
Maximum load	80 mA

The 24 V DC output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.4.3 Analog Inputs

Number of analog inputs	2
Terminal number	53, 54
Terminal 53 mode	*Parameter 6-61 Terminal 53 Setting*: 1=voltage, 0=current
Terminal 54 mode	*Parameter 6-63 Terminal 54 Setting*: 1=voltage, 0=current
Voltage level	0–10 V
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	20 V
Current level	0/4–20 mA (scalable)
Input resistance, R_i	<500 Ω
Maximum current	29 mA
Resolution on analog input	10 bit

The analog inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.4.4 Analog Outputs

Number of programmable analog outputs	2
Terminal number	42, 45[1]
Current range at analog output	0/4–20 mA
The load resistor to common at analog out	500 Ω
Maximum voltage at analog output	17 V
Accuracy on analog output	Maximum error: 0.4% of full scale

Resolution on analog output	10 bit

[1] Terminals 42 and 45 can also be programmed as digital outputs.

The analog outputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.4.5 Digital Inputs

Programmable digital inputs	4
Terminal number	18, 19, 27, 29
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN	>19 V DC
Voltage level, logic 1 NPN	<14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Digital input 29 as thermistor input	Fault: >2.9 kΩ and no fault: <800 Ω
Digital input 29 as pulse input	Maximum frequency 32 kHz push-pull-driven & 5 kHz (O.C.)

The digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.4.6 Digital Outputs

Number of digital outputs	2
Terminals 42 and 45	
Terminal number	42, 45[1]
Voltage level at digital output	17 V
Maximum output current at digital output	20 mA
The load resistor at digital output	1 kΩ

[1] Terminals 42 and 45 can also be programmed as analog output.

The digital outputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.4.7 Relay Outputs, Enclosure Sizes H3–H5

Programmable relay output	2
Relay 01 and 02	01–03 (NC), 01–02 (NO), 04–06 (NC), 04–05 (NO)
Maximum terminal load (AC-1)[1] on 01–02/04–05 (NO) (Resistive load)	250 V AC, 3 A
Maximum terminal load (AC-15)[1] on 01–02/04–05 (NO) (Inductive load @ cosφ 0.4)	250 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 01–02/04–05 (NO) (Resistive load)	30 V DC, 2 A
Maximum terminal load (DC-13)[1] on 01–02/04–05 (NO) (Inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1] on 01–03/04–06 (NC) (Resistive load)	250 V AC, 3 A
Maximum terminal load (AC-15)[1] on 01–03/04–06 (NC) (Inductive load @ cosφ 0.4)	250 V AC, 0.2 A
Maximum terminal load (DC-1)[1] on 01–03/04–06 (NC) (Resistive load)	30 V DC, 2 A
Minimum terminal load on 01–03 (NC), 01–02 (NO)	24 V DC 10 mA, 24 V AC 20 mA

Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

[1] IEC 60947 parts 4 and 5. Endurance of the relay varies with different load type, switching current, ambient temperature, drive configuration, working profile, and so forth. Mount a snubber circuit when connecting inductive loads to the relays.

The relay outputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.4.8 Relay Outputs, Enclosure Size H6

Programmable relay output	2
Relay 01 and 02	01–03 (NC), 01–02 (NO), 04–06 (NC), 04–05 (NO)
Maximum terminal load (AC-1)[(1)] on 04–05 (NO) (Resistive load)[(2)] [(3)]	400 V AC, 2 A
Maximum terminal load (AC-15)[(1)] on 04–05 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[(1)] on 04–05 (NO) (Resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[(1)] on 04–05 (NO) (Inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[(1)] on 04–06 (NC) (Resistive load)	240 V AC, 4 A
Maximum terminal load (AC-15)[(1)] on 04–06 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[(1)] on 04–06 (NC) (Resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[(1)] on 04–06 (NC) (Inductive load)	24 V DC, 0.1 A
Minimum terminal load on 01–03 (NC), 01–02 (NO), 04–06 (NC), 04–05 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

[1] IEC 60947 parts 4 and 5. Endurance of the relay varies with different load type, switching current, ambient temperature, drive configuration, working profile, and so forth. Mount a snubber circuit when connecting inductive loads to the relays.

[2] Overvoltage Category II.

[3] UL applications 250 V AC, 3 A.

The relay outputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.4.9 RS485 Serial Communication

Terminal number	68 (P, TX+, RX+), 69 (N, TX-, RX-)
Terminal number	61 common for terminals 68 and 69

The RS485 serial communication outputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

4.5 Ambient Conditions

Enclosure protection rating	IP20
Enclosure kit available	IP21, TYPE 1
Maximum vibration exposure[(1)]	1.0 g
Maximum relative humidity	5–95% (IEC 60721-3-3; Class 3K3 (non-condensing) during operation)
Aggressive environment (IEC 60721-3-3), coated (standard), enclosure sizes H3–H5	Class 3C3
Aggressive environment (IEC 60721-3-3), non-coated enclosure size H6	Class 3C2
Environmental testing (IEC 60068-2-43 H2S)	10 days
Ambient temperature, enclosure sizes H3–H5 (6–10 kW (8–15 hp)) [(2)]	50 °C (122 °F)
Ambient temperature, enclosure size H5 (18–22 kW (25–30 hp))[(2)]	52 °C (125.6 °F)
Ambient temperature, enclosure size H6 (30 kW (40 hp))[(2)]	45 °C (113 °F)

Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance, enclosure sizes H3–H5	-20 °C (-4 °F)
Minimum ambient temperature at reduced performance, enclosure size H6	-10 °C (14 °F)
Temperature during storage/transport	-30 to +65/70 °C (-22 to +149/158°F)
Maximum altitude above sea level without derating	1000 m (3281 ft)
Maximum altitude above sea level with derating	3000 m (9843 ft)
Derating for high altitude, see 5.3.6 Derating for Low Air Pressure and High Altitudes.	

[1] Refer to 5.3.4 Vibration and Shock for more details.

[2] Refer to 5.3 Operating Environment.

4.6 Conforming Standards

Safety standards	EN/IEC 61800-5-1, UL 508C, EN/IEC/UL 60730-1
EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3
EMC standards, Immunity	EN 61800-3, EN 61000-3-12, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6
Energy efficiency class[1]	IE2

[1] Determined according to EN 50598-2 at:

- Rated load.
- 90% rated frequency.
- Switching frequency factory setting.
- Switching pattern factory setting.
- For power loss data according to EN 50598-2, refer to Danfoss MyDrive® ecoSmart website.

NOTICE

The VLT® Compressor Drive CDS 803 with SXXX in the type code is certified against UL 508C/EN61800-5-1. Example:
CDS803P7K5T4E20H4XXCXXX**SXXX**XAXBXCXXXXDX
The VLT® Compressor Drive CDS 803 with S129 in the type code is certified against EN/IEC 60730-1. Example:
CDS803P15KT4E20H2XXCXXX**S129**XAXBXCXXXXDX
The VLT® Compressor Drive CDS 803 with S096 in the type code is certified against UL/EN/IEC 60730-1. Example:
CDS803P30KT4E20H2XXXXXX**S096**XAXBXCXXXXDX

4.7 Cable Lengths and Cross-sections

Maximum compressor cable length, shielded/armored (EMC-correct installation)	See 6.5.1 EMC Emission Test Results.
Maximum compressor cable length, unshielded/unarmored	50 m (164 ft)
Maximum cross-section to compressor, mains	See 4.1 Electrical Data for more information
Cross-section DC terminals for filter feedback on enclosure size H3	4 mm^2/11 AWG
Cross-section DC terminals for filter feedback on enclosure sizes H4–H6	16 mm^2/6 AWG
Maximum cross-section to control terminals, rigid wire	2.5 mm^2/14 AWG
Maximum cross-section to control terminals, flexible wire	2.5 mm^2/14 AWG
Minimum cross-section to control terminals	0.05 mm^2/30 AWG

4.8 Acoustic Noise

Acoustic noise from the drives comes from 3 sources:

- DC-link coils
- Integral fan
- RFI filter inductor

Table 6: Typical Values Measured at a Distance of 1 m (3.28 ft) from the Unit

Enclosure	Level [dBA][1]
H3	53.8
H4	64
H5	63.7
H6	71.5

[1] The values are measured under the background of 35 dBA noise and the fan running at full speed.

4.9 Mechanical Dimensions

4.9.1 Drive Dimensions

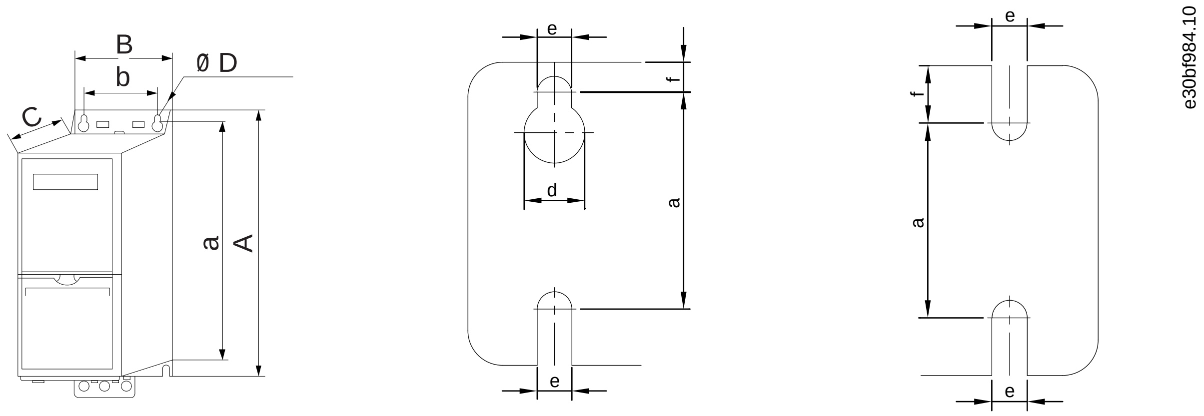


Illustration 17: Dimensions

Table 7: Dimensions, Enclosure Sizes H3–H6

Enclosure Size		H3	H4	H5	H6
IP class		IP20	IP20	IP20	IP20
Power [kW (hp)]	**3x200–240 V**	–	–	6.0–7.5 (8.0–10)	10 (15)
	3x380–480 V	6.0–7.5 (8.0–10)	10 (15)	11–22 (15–30)	30 (40)
Height [mm (in)]	**A**	255 (10.0)	296 (11.7)	334 (13.1)	518 (20.4)
	A[1]	329 (13.0)	359 (14.1)	402 (15.8)	595 (23.4)/635 (25), 45 kW
	a	240 (9.4)	275 (10.8)	314 (12.4)	495 (19.5)
Width [mm (in)]	**B**	100 (3.9)	135 (5.3)	150 (5.9)	239 (9.4)
	b	74 (2.9)	105 (4.1)	120 (4.7)	200 (7.9)

Enclosure Size		H3	H4	H5	H6
Depth [mm (in)]	C	206 (8.1)	241 (9.5)	255 (10)	242 (9.5)
Mounting hole [mm (in)]	d	11 (0.43)	12.6 (0.50)	12.6 (0.50)	–
	e	5.5 (0.22)	7 (0.28)	7 (0.28)	8.5 (0.33)
	f	8.1 (0.32)	8.4 (0.33)	8.5 (0.33)	15 (0.6)
Maximum weight kg (lb)		4.5 (9.9)	7.9 (17.4)	9.5 (20.9)	5.3 (11.7)

[1] Including decoupling plate.

The dimensions are only for the physical units. When installing in an application, allow space above and below the units for cooling. The amount of space for free air passage is listed in 5.2 Side-by-side Installation.

4.9.2 Shipping Dimensions

Table 8: Shipping Dimensions

Enclosure size	200–240 V AC [kW (hp)]	380–480 V AC [kW (hp)]	IP rating	Maximum weight [kg (lb)]	Height [mm (in)]	Width [mm (in)]	Depth [mm (in)]
H3	–	6.0–7.5 (8.0–10)	IP20	4.5 (9.9)	280 (11)	155 (6.1)	320 (12.6)
H4	6.0–7.5 (8.0–10)	10 (15)	IP20	7.9 (17.4)	380 (15)	200 (7.9)	315 (12.4)
H5	10 (15)	11–22 (15–30)	IP20	9.5 (20.9)	395 (15.6)	233 (9.2)	380 (15)
H6	–	30 (40)	IP20	24.5 (54.0)	850 (33.5)	370 (15.6)	460 (18.1)

4.10 dU/dt

Table 9: dU/dt Data

	Cable length [m (ft)]	AC line voltage [V]	Rise time [μsec]	V_{peak} [kV]	dU/dt [kV/μsec]
200 V 6.0 kW (8.0 hp)	5 (16)	240	0.128	0.445	2.781
	25 (82)	240	0.224	0.594	2.121
	50 (164)	240	0.328	0.596	1.454
200 V 7.5 kW (10 hp)	5 (16)	240	0.18	0.502	2.244
	25 (82)	240	0.22	0.598	2.175
	50 (164)	240	0.292	0.615	1.678
200 V 10 kW (15 hp)	36 (118)	240	0.176	0.56	2.545
	50 (164)	240	0.216	0.599	2.204
400 V 6.0 kW (8.0 hp)	5 (16)	400	0.168	0.81	3.857
	25 (82)	400	0.239	1.026	3.434
	50 (164)	400	0.328	1.05	2.560
400 V 7.5 kW (10 hp)	5 (16)	400	0.168	0.81	3.857
	25 (82)	400	0.239	1.026	3.434
	50 (164)	400	0.328	1.05	2.560

	Cable length [m (ft)]	AC line voltage [V]	Rise time [µsec]	V_{peak} [kV]	dU/dt [kV/µsec]
400 V 11 kW (15 hp)	5 (16)	400	0.132	0.88	5.220
	25 (82)	400	0.172	1.026	4.772
	50 (164)	400	0.222	1.00	3.603
400 V 15 kW (20 hp)	5 (16)	400	0.132	0.88	5.220
	25 (82)	400	0.172	1.026	4.772
	50 (164)	400	0.222	1.00	3.603
400 V 18.5 kW (25 hp)	5 (16)	400	0.132	0.88	5.220
	25 (82)	400	0.172	1.026	4.772
	50 (164)	400	0.222	1.00	3.603
400 V 22 kW (30 hp)	5 (16)	400	0.132	0.88	5.220
	25 (82)	400	0.172	1.026	4.772
	50 (164)	400	0.222	1.00	3.603
400 V 30 kW (40 hp)	10 (33)	400	0.376	0.92	1.957
	50 (164)	400	0.536	0.97	1.448
	100 (328)	400	0.696	0.95	1.092
	150 (492)	400	0.8	0.965	0.965
	10 (33)	480	0.384	1.2	2.5
	50 (164)	480	0.632	1.18	1.494
	100 (328)	480	0.712	1.2	1.348
	150 (492)	480	0.832	1.17	1.125
	10 (33)	500	0.408	1.24	2.431
	50 (164)	500	0.592	1.29	1.743
	100 (328)	500	0.656	1.28	1.561
	150 (492)	500	0.84	1.26	1.2

5 Mechanical Installation Considerations

5.1 Safe Transportation and Storage

Store the drive in a dry location and keep the equipment sealed in its packaging until installation. Follow all instructions on transportation and storage, and make sure that the ambient conditions are according to the specifications given in 4.5 Ambient Conditions.

- If the package is kept in storage for more than 2 months, keep it in controlled conditions:
  - Make sure that the temperature variation is low.
  - Make sure that the humidity is <50%.
- Only use lifting and handling equipment rated and suitable for the purpose.
  - Check the weight of the drive and lift the drive with a lifting device if needed. In this case, use the lifting eyes/bars designed for this purpose.
  - Check the center of gravity on the packaging or on the drive before lifting the drive. Avoid tilting the drive to prevent it from overturning.
- Keep the drive in its package until it has to be installed. After unpacking, protect the drive from dust, debris, and moisture.

5.1.1 Reforming the Capacitors

For drives that are in storage and do not have voltage applied, maintenance of the capacitors in the drive may be required.

To avoid damage to the internal DC-link capacitors, reforming is required if the drive has been stored without applying voltage for more than 3 years. Reforming is possible only with drives with DC terminals. When reforming the capacitors:

- The reforming voltage must be 1.35–1.45 times the rated mains voltage. If the DC-link voltage stays at a low level and does not reach approximately 1.41 x mains voltage, contact the local service agent.
- The supply current draw must not exceed 500 mA.

Table 10: Drive Storage Duration and Reforming Recommendations

Storage duration	Duration reforming guideline
Under 2 years	No reforming required. Connect to mains voltage.
2–3 years	Connect to mains voltage and wait a minimum of 30 minutes before loading the drive.
Over 3 years	Using a DC supply connected directly to the DC-link terminals of the drive, ramp up the voltage 0–100% of DC-bus voltage in increments of 25%, 50%, 75%, and 100% rated voltage under no load for 30 minutes at each increment. See Illustration 18 for an illustration of this method.

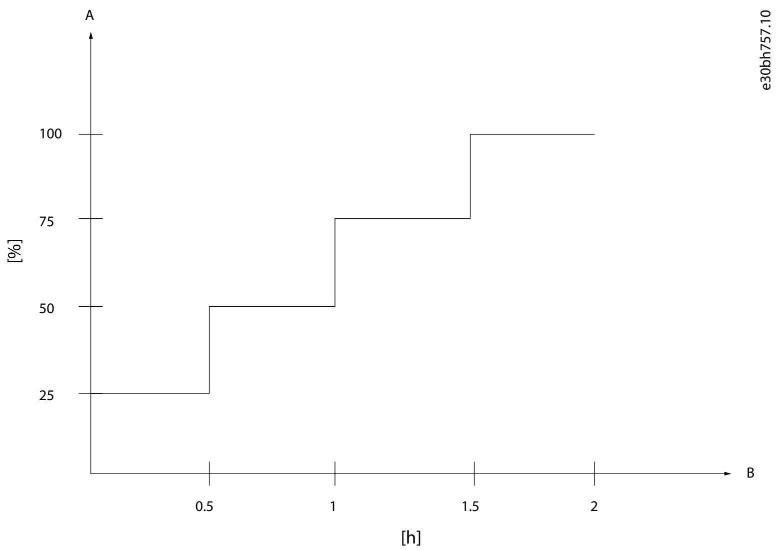


Illustration 18: Percent of DC Voltage Increments and Reforming Time

A	Percent of DC voltage
B	Hours

5.2 Side-by-side Installation

The drive can be mounted side by side but requires the clearance specified in Table 11 above and below for cooling.

Table 11: Clearance Required for Cooling

		Power [kW (hp)]		Clearance above/below [mm (in)]
Size	**IP protection rating**	**3x200–240 V**	**3x380–480 V**	
H3	IP20	–	6.0–7.5 (8.0–10)	100 (4)
H4	IP20	6.0–7.5 (8.0–10)	10 (15)	100 (4)
H5	IP20	10 (15)	11–22 (15–30)	100 (4)
H6	IP20	–	30(40)	200 (7.9)

N O T I C E

With IP21/NEMA Type1 option kit mounted, a distance of 50 mm (2 in) between the units is required.

5.3 Operating Environment

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/Type rating of the equipment matches the installation environment.

For specifications regarding ambient conditions, see 4.5 Ambient Conditions.

N O T I C E

CONDENSATION

Moisture can condense on the electronic components and cause short circuits. Avoid installation in areas subject to frost. Install an optional space heater when the drive is colder than the ambient air. Operating in standby mode reduces the risk of condensation as long as the power dissipation keeps the circuitry free of moisture.

N O T I C E

EXTREME AMBIENT CONDITIONS

Hot or cold temperatures compromise unit performance and longevity.

- Do not operate in environments where the ambient temperature exceeds 55 °C (131 °F).
- The drive can operate at temperatures down to -10 °C (14 °F). However, proper operation at rated load is only guaranteed at 0 °C (32 °F) or higher.
- If the temperature exceeds ambient temperature limits, extra air conditioning of the cabinet or installation site is required.

5.3.1 Gases

Aggressive gases, such as hydrogen sulfide, chlorine, or ammonia, can damage electrical and mechanical components of a drive. Contamination of the cooling air can also cause the gradual decomposition of PCB tracks and door seals. Aggressive contaminants are often present in sewage treatment plants or swimming pools. A clear sign of an aggressive atmosphere is corroded copper.

In aggressive atmospheres, restricted IP enclosures are recommended along with conformal-coated circuit boards.

The electronic components are, as standard, coated as per IEC60721-3-3, class 3C2. For harsh and aggressive environments, coating as per IEC60721-3-3, class 3C3 is available.

Table 12: Conformal Coating Class Ratings

		Class				
		3C1	3C2		3C3	
Gas type	**Unit**	**Value**	**Mean value**	**Maximum value[(1)]**	**Mean value**	**Maximum value[(1)]**
Sea salt	n/a	None	Salt mist		Salt mist	
Sulfur oxide	mg/m^3	0.1	0.3	1.0	5.0	10
Hydrogen sulfide	mg/m^3	0.01	0.1	0.5	3.0	10
Chlorine	mg/m^3	0.01	0.1	0.3	0.3	1.0
Hydrogen chloride	mg/m^3	0.01	0.1	0.5	1.0	5.0
Hydrogen fluoride	mg/m^3	0.003	0.01	0.03	0.1	2.0
Ammonia	mg/m^3	0.3	1.0	3.0	10	35
Ozone	mg/m^3	0.01	0.05	0.1	0.1	0.3
Nitrogen Oxides	mg/m^3	0.1	0.5	1.0	3.0	9.0

[1] Maximum values are transient peak values and are not to exceed 30 minutes per day.

Refer to 7.1 Drive Configurator for ordering the correct protective rating.

5.3.2 Dust

Installation of drives in environments with high dust exposure is often unavoidable. Consider the following when installing drives in such environments:

- Reduced cooling.
- Cooling fans.
- Periodic maintenance.

Reduced cooling

Dust forms deposits on the surface of the device and inside on the circuit boards and the electronic components. These deposits act as insulation layers and hamper heat transfer to the ambient air, reducing the cooling capacity. The components become warmer. This causes accelerated aging of the electronic components and the service life of the unit decreases. Dust deposits on the heat sink in the back of the unit also decrease the service life of the unit.

Cooling fans

The airflow for cooling the unit is produced by cooling fans, usually on the back of the unit. The fan rotors have small bearings into which dust can penetrate and act as an abrasive. This leads to bearing damage and fan failure.

Periodic maintenance

Under the conditions described above, it is recommended to clean the drive during periodic maintenance. Remove dust from the heat sink and fans.

5.3.3 Air Humidity

The drive has been designed to meet the IEC/EN 60068-2-3 standard, EN 50178 9.4.2.2 at 50 °C (122 °F).

5.3.4 Vibration and Shock

The drive has been tested according to the following standards:

- IEC/EN 60068-2-6: Vibration (sinusoidal) - 1970
- IEC/EN 60068-2-64: Vibration, broad-band random

The drive complies with the requirements that exist for units mounted on the walls and floors of production premises, and in panels bolted to walls or floors.

5.3.5 Derating for Ambient Temperature and Switching Frequency

Ensure that the ambient temperature measured over 24 h is at least 5 °C (9 °F) lower than the maximum ambient temperature that is specified for the drive. If the drive is operated at high ambient temperature, decrease the constant output current. If the ambient temperature is higher than 50 °C (122 °F) or the installation by altitude is higher than 1000 m (3281 ft), a larger VLT® Compressor Drive CDS 803 might be needed to run an undersized compressor. Consult Danfoss for support.

5.3.5.1 Derating Curves, 6.0, 7.5, and 10 kW

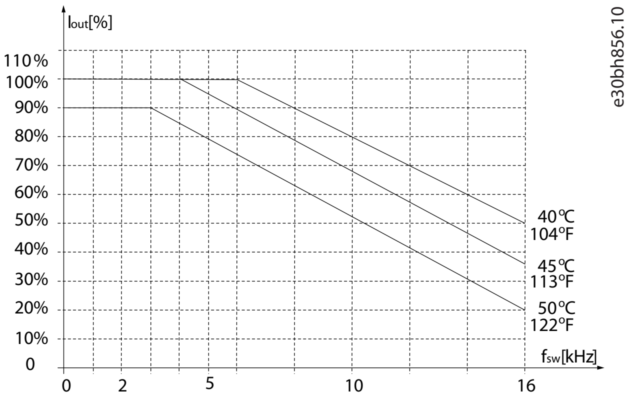


Illustration 19: 400 V IP20 H3 6.0–7.5 kW (8.0–10 hp)

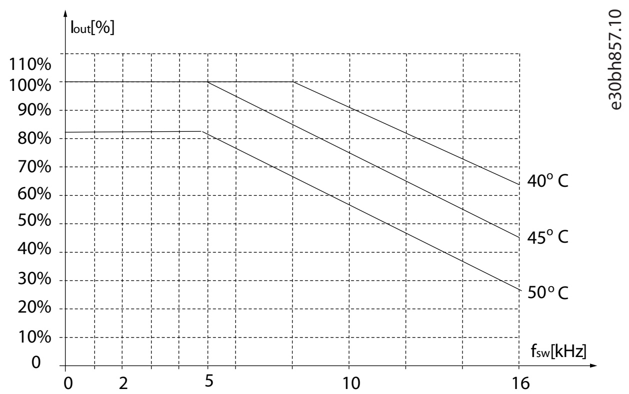


Illustration 20: 200 V IP20 H4 6.0–7.5 kW (8.0–10 hp)

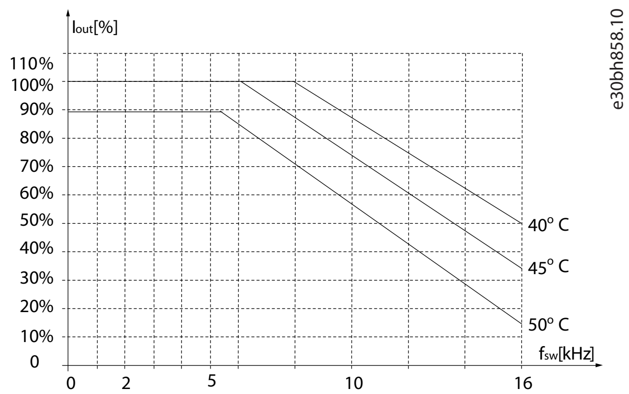


Illustration 21: 400 V IP20 H4 10 kW (15 hp)

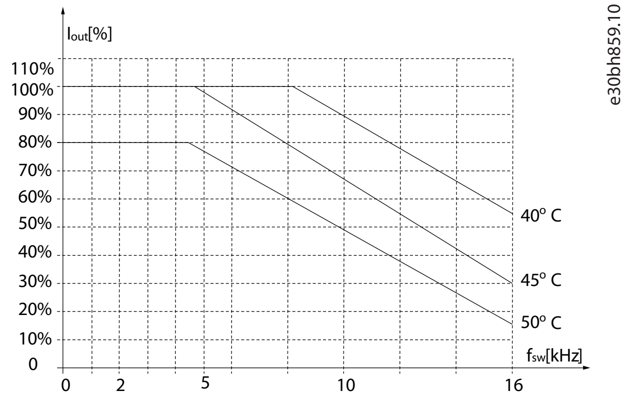


Illustration 22: 200 V IP20 H5 10 kW (15 hp)

5.3.5.2 Derating Curves, 11–15 kW

Drives in the power range 11–15 kW are able to deliver 100% current in ambient temperatures up to 52 °C (125 °F). If the switching frequency is increased, the following derating curves apply.

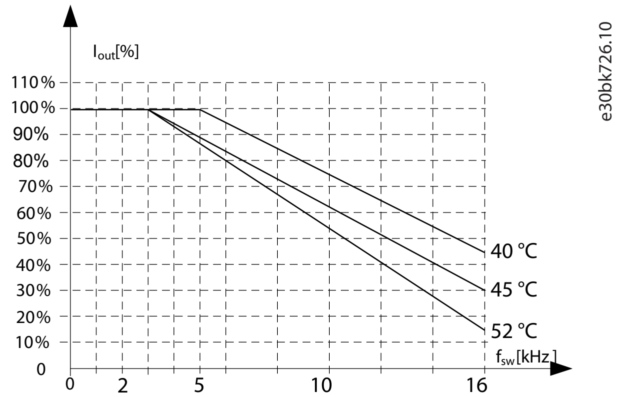


Illustration 23: 400 V IP20 H5 11–15 kW (15–20 hp)

5.3.5.3 Derating Curves, 18.5–22 kW

Drives in the power range 18.5–22 kW are able to deliver 100% current in ambient temperatures up to 52 °C (125 °F). If the switching frequency is increased, the following derating curves apply.

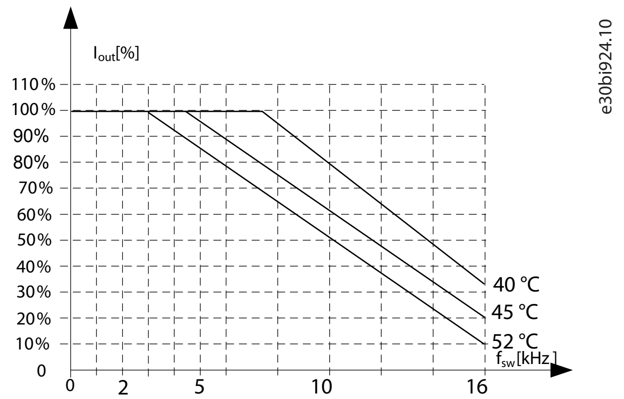


Illustration 24: 400 V IP20 H5 18.5–22 kW (25–30 hp)

5.3.5.4 Derating Curves, 30 kW

Drives in the power range 30 kW are able to deliver 100% current in ambient temperatures up to 45 °C (113 °F). If the switching frequency is increased, the following derating curves apply.

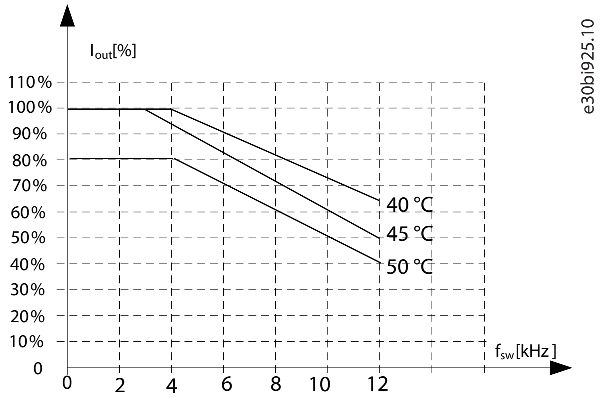


Illustration 25: 400 V IP20 H6 30 kW (40 hp)

5.3.6 Derating for Low Air Pressure and High Altitudes

The cooling capability of air is decreased at low air pressure. For altitudes above 2000 m (6562 ft), contact Danfoss regarding PELV. Below 1000 m (3281 ft) altitude, derating is not necessary. For altitudes above 1000 m (3281 ft), decrease the ambient temperature or the maximum output current. Decrease the output by 1% per 100 m (328 ft) altitude above 1000 m (3281 ft) or reduce the maximum ambient cooling air temperature by 1 °C (1.8 °F) per 200 m (656 ft).

5.4 IP21/NEMA Type 1 Enclosure Kit

If environment, air quality, or surroundings require extra protection, an IP21/NEMA Type 1 kit can be ordered, see 7.3 Accessories and Spare Parts. The IP21/NEMA Type 1 is an optional enclosure element available for IP20 units. If the enclosure kit is used, an IP20 unit is upgraded to comply with enclosure IP21/NEMA Type 1.

N O T I C E

The IP21/IP21 are not suitable for outdoor mounting.

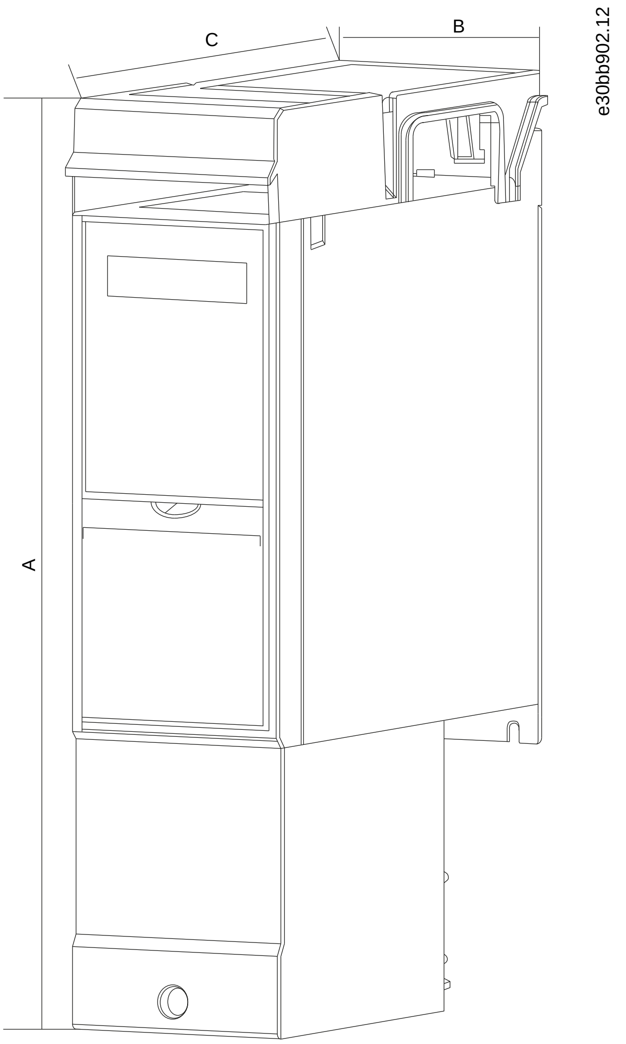


Illustration 26: H3–H6

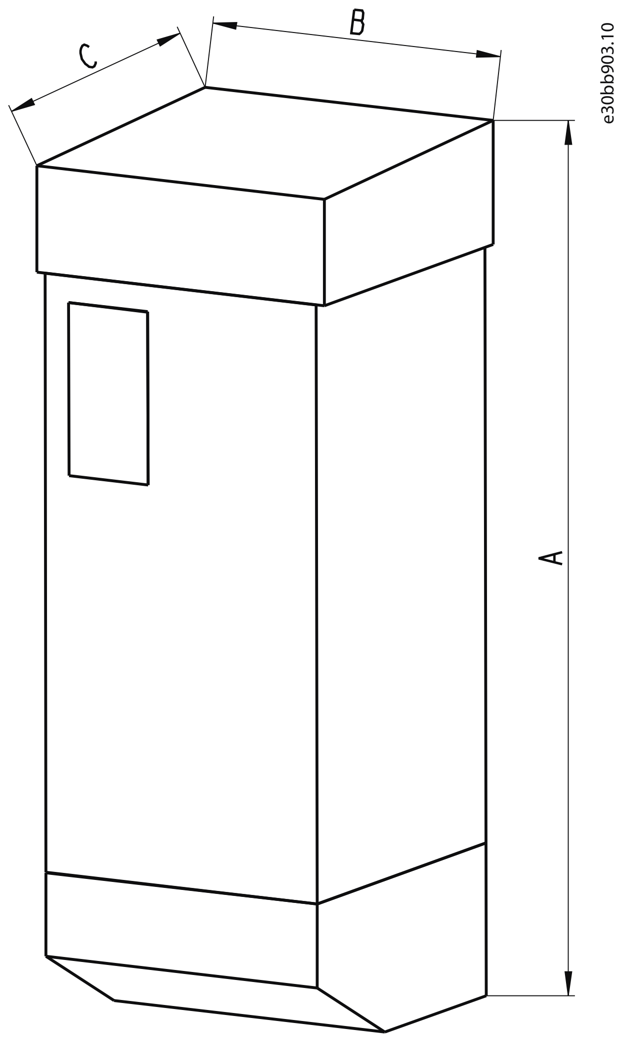


Illustration 27: Dimensions

Table 13: Enclosure Kit Specifications

Enclosure size	Power [kW (hp)]		Height [mm (in)] A	Width [mm (in)] B	Depth [mm (in)] C
	3x200-240 V	3x380-480 V			
H3	–	6.0–7.5 (8.0–10)	346 (13.6)	106 (4.2)	210 (8.3)
H4	6.0–7.5 (8.0–10)	10 (15)	374 (14.7)	141 (5.6)	245 (9.6)
H5	10 (15)	11–22 (15–30)	418 (16.5)	161 (6.3)	260 (10.2)
H6	–	30 (40)	663 (26.1)	260 (10.2)	242 (9.5)

5.5 Acoustic Noise or Vibration

If the compressor application makes noise or vibrations at certain frequencies, adjust the following parameters to avoid resonance problems within the system.

- Upper and lower frequency limits, *parameter group 4-6* Speed Bypass*.
- Switching pattern and switching frequency, *parameter group 14-0* Inverter Switching*.

5.6 Recommended Disposal

When the drive reaches the end of its service life, its primary components can be recycled.

Before the materials can be removed, the drive must be disassembled. Product parts and materials can be dismantled and separated. Generally, all metals, such as steel, aluminum, copper and its alloys, and precious metals can be recycled as material. Plastics, rubber, and cardboard can be used in energy recovery. Printed circuit boards and large electrolytic capacitors with a diameter of over 2.5 cm (1 in) need further treatment according to IEC 62635 guidelines. To ease recycling, plastic parts are marked with an appropriate identification code.

Contact a local Danfoss office for further information on environmental aspects and recycling instructions for professional recyclers. End-of-life treatment must follow international and local regulations.

All drives are designed and manufactured in accordance with Danfoss company guidelines on prohibited and restricted substances. A list of these substances is available at www.danfoss.com.

	This symbol on the product indicates that it must not be disposed of as household waste. Do not dispose of equipment containing electrical components together with domestic waste. It must be handed over to the applicable take-back scheme for the recycling of electrical and electronic equipment. • Dispose of the product through channels provided for this purpose. • Comply with all local and currently applicable laws and regulations.

6 Electrical Installation Considerations

6.1 Electrical Installation in General

All cabling must comply with national and local regulations on cable cross-sections and ambient temperature. Copper conductors are required. 75 °C (167 °F) is recommended.

6.1.1 Fastener Torque Ratings

Table 14: Tightening Torques for Enclosure Sizes H3–H6, 3x200–240 V & 3x380–480 V

Power [kW (hp)]				Torque [Nm (in-lb)]					
Enclosure size	IP protection rating	3x200–240 V	3x380–480 V	Mains	Motor	DC connection	Control terminals	Ground	Relay
H3	IP20	–	6.0–7.5 (8.0–10)	0.8 (7)	0.8 (7)	0.8 (7)	0.5 (4)	0.8 (7)	0.5 (4)
H4	IP20	6.0–7.5 (8.0–10)	10 (15)	1.2 (11)	1.2 (11)	1.2 (11)	0.5 (4)	0.8 (7)	0.5 (4)
H5	IP20	10 (15)	11–22 (15–30)	1.2 (11)	1.2 (11)	1.2 (11)	0.5 (4)	0.8 (7)	0.5 (4)
H6	IP20	–	30 (40)	4.5 (40)	4.5 (40)	–	0.5 (4)	3 (27)	0.5 (4)

6.2 Fuses and Circuit Breakers

Fuses and circuit breakers ensure that possible damage to the drive is limited to damage inside the unit. Danfoss recommends fuses on the supply side as protection. For further information, see the application note Fuses and Circuit Breakers found on www.danfoss.com under *Service and support/Documentation/Manuals & guides*.

NOTICE

Use of fuses on the supply side is mandatory for IEC 60364 (CE) and NEC 2009 (UL) compliant installations.

6.2.1 Recommendation of Fuses and Circuit Breakers

Table 15: Fuses and Circuit Breakers

	Circuit breakers[(1)]		Fuse				
	UL	Non-UL	UL				Non-UL
			Bussmann	Bussmann	Bussmann	Bussmann	Maximum fuse
Power [kW (hp)]			Type RK5	Type RK1	Type J	Type T	Type gG
3x200–240 V							
6.0 (8.0)	–	–	FRS-R-50	KTN-R50	JKS-50	JJN-50	gG-50
7.5 (10)			FRS-R-50	KTN-R50	JKS-50	JJN-50	gG-50
10 (15)			FRS-R-80	KTN-R80	JKS-80	JJN-80	gG-63
3x380–480 V							
6.0 (8.0)	–	–	FRS-R-25	KTS-R25	JKS-25	JJS-25	gG-25
7.5 (10)			FRS-R-25	KTS-R25	JKS-25	JJS-25	gG-25
10 (15)			FRS-R-50	KTS-R50	JKS-50	JJS-50	gG-50
11 (15)			–	–	–	–	gG-63
15 (20)						–	gG-63

	Circuit breakers[1]		Fuse				
	UL	Non-UL	UL				Non-UL
			Bussmann	Bussmann	Bussmann	Bussmann	Maximum fuse
Power [kW (hp)]			Type RK5	Type RK1	Type J	Type T	Type gG
18.5 (25)						JJS-80	gG-63
22 (30)						JJS-80	gG-63
30 (40)						JJS-125	gG-80

[1] Circuit breakers have not been evaluated by Danfoss as part of the certification process.

6.3 Electrical Wiring

6.3.1 Wiring Schematic

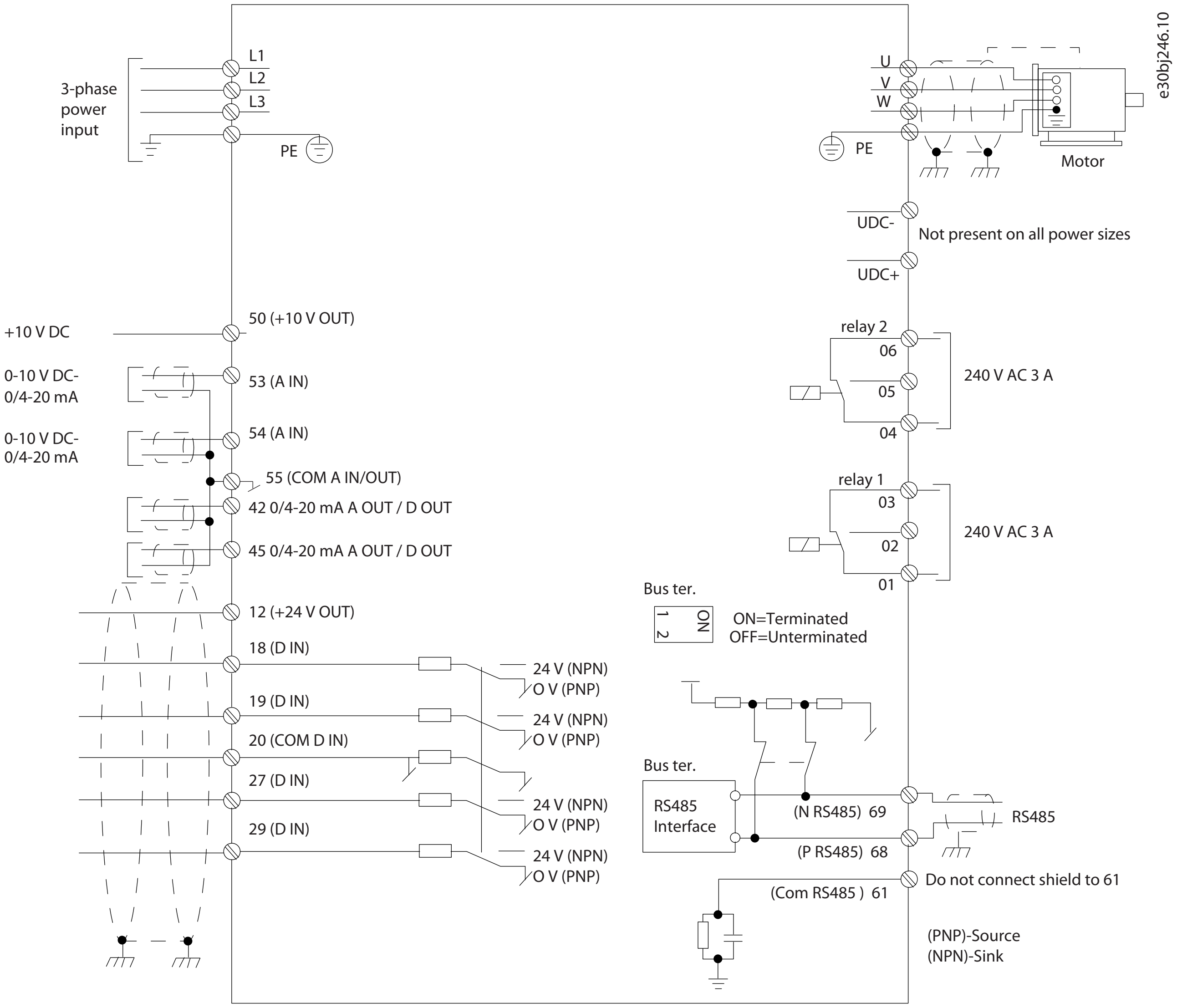


Illustration 28: Basic Wiring Schematic Drawing

NOTICE

There is no access to UDC- and UDC+ on the following units:

- IP20, 380–480 V, 30 kW (40 hp).

6.3.2 Terminal Overview of Enclosure Sizes H3–H5

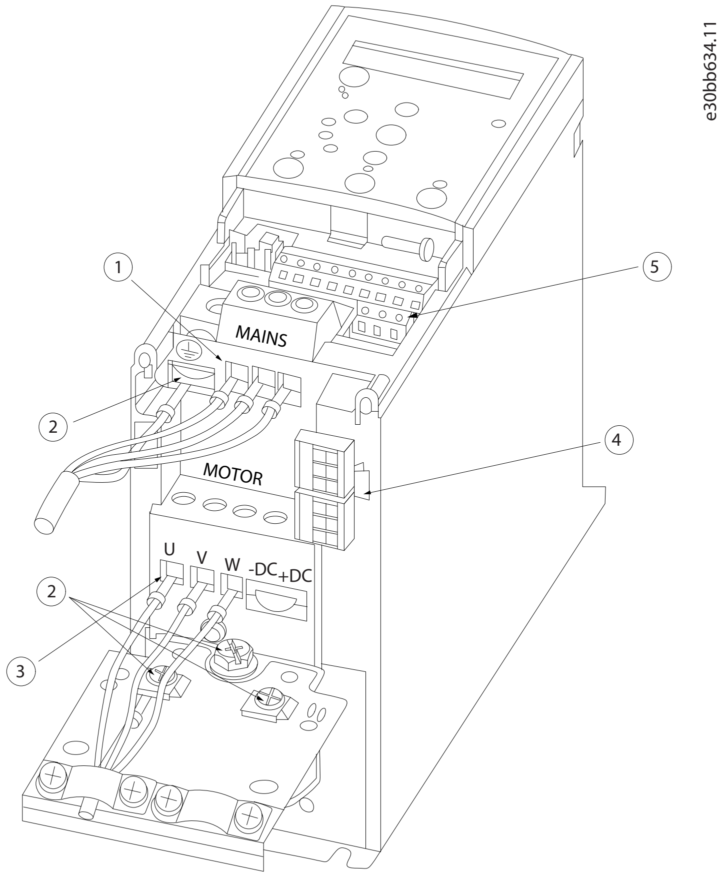


Illustration 29: Enclosure Sizes H3–H5

1	Mains	4	Relays
2	Ground	5	Control terminals
3	Compressor		

6.3.3 Terminal Overview of Enclosure Size H6

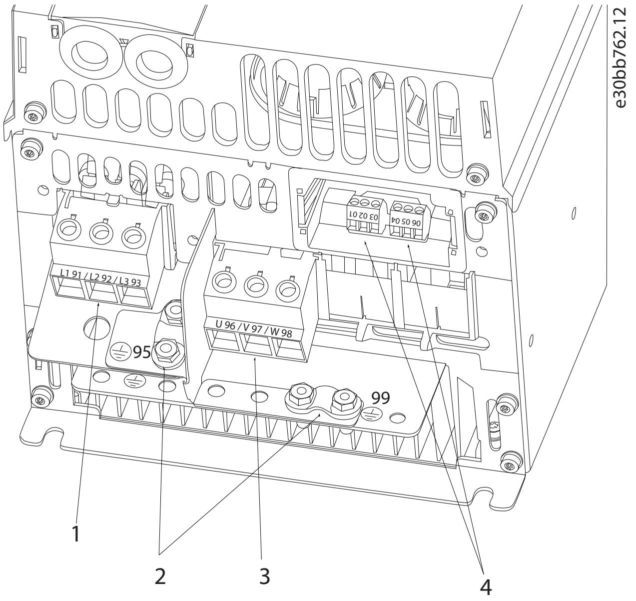


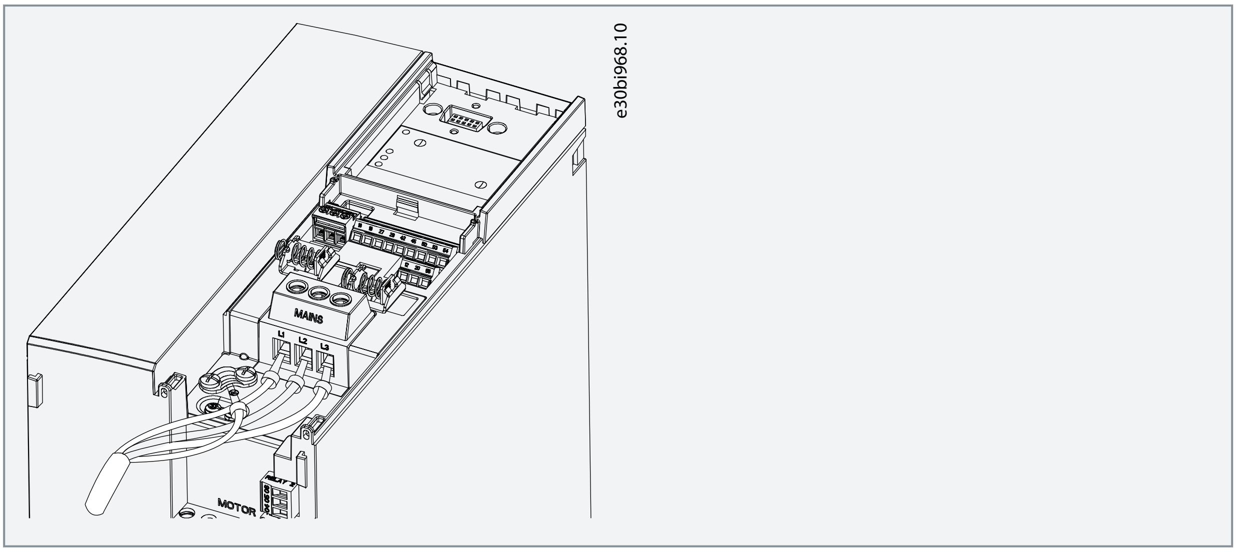
Illustration 30: Enclosure Size H6

1	Mains	3	Compressor
2	Ground	4	Relays

6.3.4 Connecting to Mains and Compressor Terminals

- Tighten all terminals in accordance with the information provided in 6.1.1 Fastener Torque Ratings.
- Keep the compressor cable as short as possible to reduce the noise level and leakage currents.
- Use a shielded/armored compressor cable to comply with the EMC emission specifications and connect this cable to both the decoupling plate and the compressor. Also see 6.5.5 EMC-compliant Electrical Installation.

1. Connect the ground cable to the ground terminal, then connect the mains supply to terminals L1, L2, and L3.



2. Connect the ground cable to the ground terminal, then connect the compressor to terminals U, V, and W.

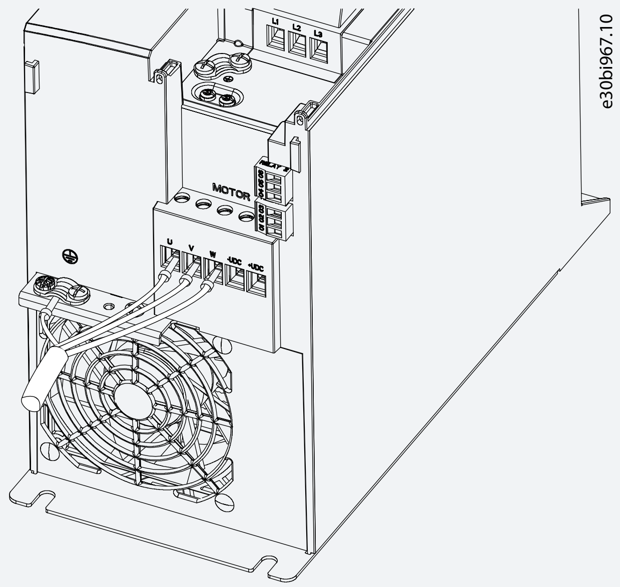


Table 16: Connection of Compressor to Terminals

Drive terminals	Compressor
U	T1
V	T2
W	T3

6.3.4.1 IT Grid Installations

NOTICE

If the drive is supplied from an isolated mains source or mains with grounded leg, the RFI filter is recommended to be disabled, see 6.5.8 RFI Filter Switch.

Once disabled, the filter capacitors between the chassis and the DC link are cut off to avoid damage to the DC link and to reduce the ground capacity currents, according to IEC 61800-3. If optimum EMC performance is required, avoid exceeding overvoltage limits within the DC bus by making sure that the energy charged into the DC link through the RFI filter is either discharged via loading the DC-bus terminals or output terminals U, V, and W.

It is important to use isolation monitors that are rated for use with power electronics (IEC 61557-8).

CAUTION

Ensure that the supply voltage does not exceed 440 V (3x380–480 V units) when connected to an IT mains source.

6.3.5 Relay Terminals

Relay 1

- Terminal 01: Common.
- Terminal 02: Normally open.
- Terminal 03: Normally closed.

Relay 2

- Terminal 04: Common.
- Terminal 05: Normally open.
- Terminal 06: Normally closed.

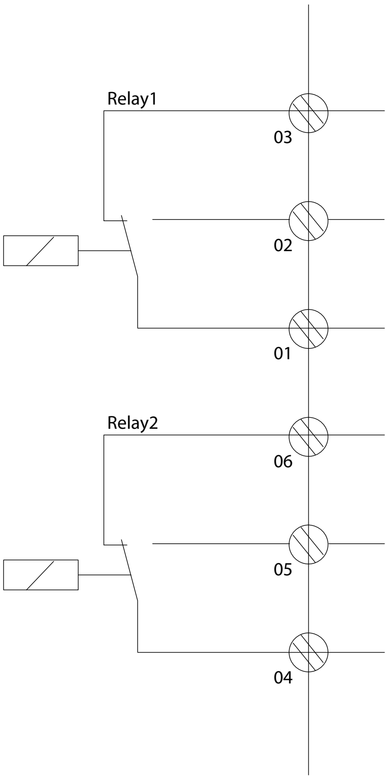


Illustration 31: Relay Outputs 1 and 2

6.3.6 Control Terminals

Remove the terminal cover to access the control terminals.

Use a flat-edged screwdriver to push down the lock lever of the terminal cover under the LCP, then remove the terminal cover as shown in the following illustration.

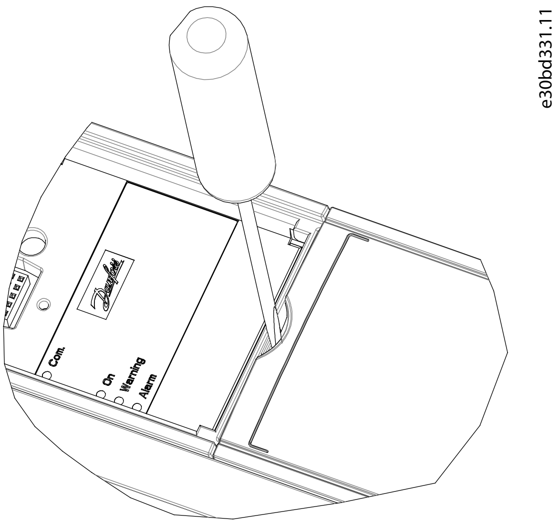


Illustration 32: Removing the Terminal Cover

The following illustration shows all the drive control terminals. Applying start (terminal 18), connection between terminals 12-27, and an analog reference (terminal 53 or 54, and 55) make the drive run.

The digital input mode of terminal 18, 19, 27, and 29 is set in *parameter 5-00 Digital Input Mode* (PNP is default value).

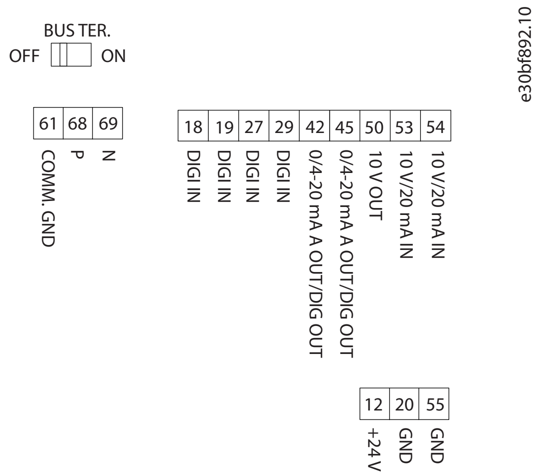


Illustration 33: Control Terminals

6.4 Setting Up RS485 Serial Communication

6.4.1 RS485 Features

RS485 is a 2-wire bus interface compatible with multi-drop network topology. This interface contains the following features:

- Ability to select from the following communication protocols:
  - FC (default protocol)
  - Modbus RTU
- Functions can be programmed remotely using the RS485 connection or in *parameter group 8-** Communications and Options*.
- A switch (BUS TER) is provided on the control card for bus termination resistance.

N O T I C E

Altering between the supported communication protocols can be accessed and changed via the LCP as *parameter 8-30 Protocol* is not available in VLT® Motion Control Tool MCT 10.

6.4.2 Configuring RS485 Serial Communication

Procedure

1. Connect RS485 serial communication wiring to terminals (P RS485) 68 and (N RS485) 69.
   - Use shielded serial communication cable.
   - Properly ground the wiring. Refer to 6.5.5 EMC-compliant Electrical Installation.

2. Configure all required settings such as address, baud rate, and so on in *parameter group 8-** Communications and Options*. For more details on parameters, refer to VLT® Compressor Drive CDS 803 Programming Guide listed in 1.2 Additional Resources.

Example

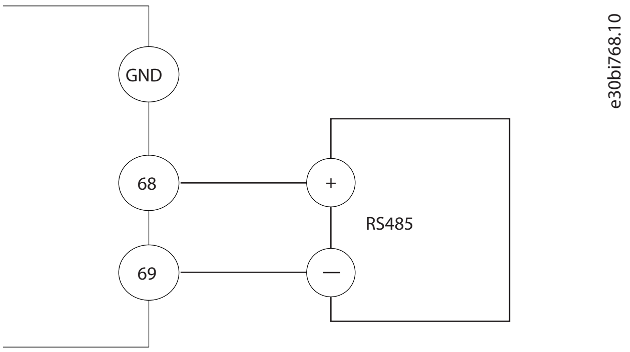


Illustration 34: RS485 Wiring Connection

6.5 Electromagnetic Compatibility

Electrical devices both generate interference and are affected by interference from other generated sources. The electromagnetic compatibility (EMC) of these effects depends on the power and the harmonic characteristics of the devices. Uncontrolled interaction between electrical devices in a system can degrade compatibility and impair reliable operation. Interference takes the form of the following:

- Electrostatic discharges
- Rapid voltage fluctuations
- High-frequency interference

Electrical interference is most commonly found at frequencies in the range 150 kHz to 30 MHz. Airborne interference from the drive system in the range 30 MHz to 1 GHz is generated from the inverter, motor cable, and the motor.

Capacitive currents in the motor cable, coupled with a high dU/dt from the motor voltage, generate leakage currents. See Illustration 35. Shielded motor cables have higher capacitance between the phase wires and the shield, and again between the shield and ground. This added cable capacitance, along with other parasitic capacitance and motor inductance, change the electromagnetic emission signature produced by the unit. The change in electromagnetic emission signature occurs mainly in emissions less than 5 MHz. Most of the leakage current (I1) is carried back to the unit through the PE (I3), leaving only a small electromagnetic field (I4) from the shielded motor cable. The shield reduces the radiated interference but increases the low-frequency interference on the mains.

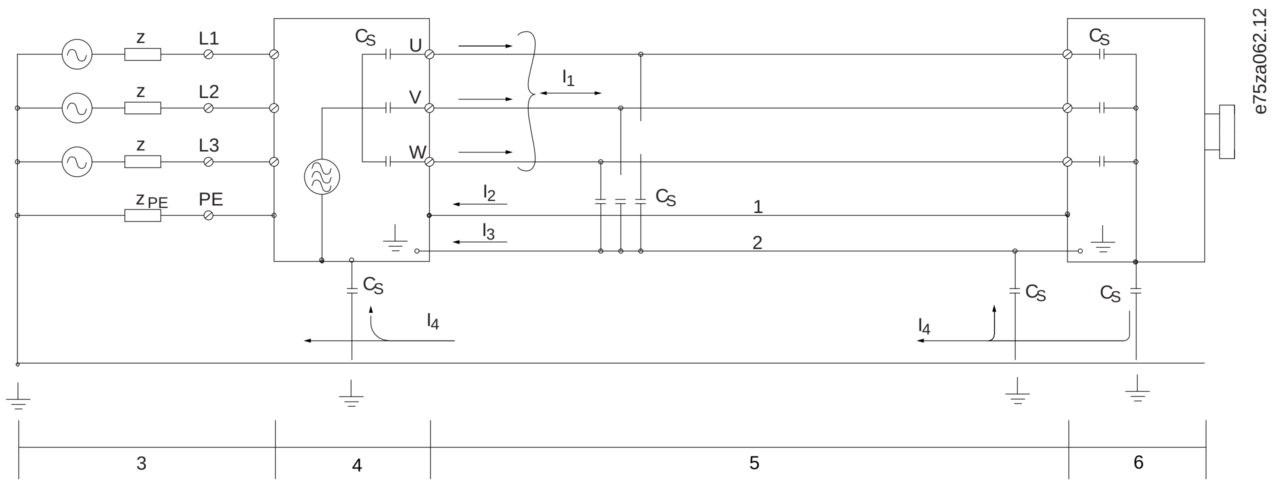


Illustration 35: Electric Model Showing Possible Leakage Currents

1	Ground wire	C_S	Possible shunt parasitic capacitance paths (varies with different installations)
2	Shield	I_1	Common-mode leakage current
3	AC mains supply	I_2	Shielded motor cable
4	Drive	I_3	Safety ground (4th conductor in motor cables)
5	Shielded motor cable	I_4	Unintended common-mode current
6	Motor		

6.5.1 EMC Emission Test Results

The following test results have been obtained using a system with a drive, a shielded control cable, a control box with potentiometer, and a shielded motor cable.

Table 17: EMC Emission Test Results

	Conduct emission Maximum shielded cable length [m (ft)]						**Radiated emission**					
EN 55011	**Class A Group 2** Industrial environment		**Class A Group 1** Industrial environment		**Class B** Housing, trades, and light industries		**Class A Group 2** Industrial environment		**Class A Group 1** Industrial environment		**Class B** Housing, trades, and light industries	
EN/IEC 61800-3	**Category C3** Second environment Industrial		**Category C2** First environment Home and office		**Category C1** First environment Home and office		**Category C3** Second environment Industrial		**Category C2** First environment Home and office		**Category C1** First environment Home and office	
External RFI filter	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**
H4 RFI filter (EN 55011 A1, EN/IEC61800-3 C2)												
6.0– 10 kW (8.0– 15 hp)	–	–	25 (82)	50 (164)	–	20 (66)	–	–	Yes	Yes	–	No
H2 RFI filter (EN 55011 A2, EN/IEC 61800-3 C3)												
11–30 kW (15– 40 hp)	5 (16.4)	–	–	–	–	–	Yes	–	No	–	No	–

6.5.2 Emission Requirements

According to the EMC product standard for AC drives, EN/IEC 61800-3:2004, the EMC requirements depend on the intended use of the drive. Four categories are defined in the EMC product standard. The definitions of the 4 categories together with the requirements for mains supply voltage conducted emissions are given in Table 18.

Table 18: Emission Requirements

Category	Definition	Conducted emission requirement according to the limits given in EN 55011
C1	Drives installed in the 1st environment (home and office) with a supply voltage less than 1000 V.	Class B
C2	Drives installed in the 1st environment (home and office) with a supply voltage less than 1000 V, which are neither plug-in nor movable and are intended for installation and commissioning by a professional.	Class A Group 1
C3	Drives installed in the 2nd environment (industrial) with a supply voltage lower than 1000 V.	Class A Group 2
C4	Drives installed in the 2nd environment (industrial) with a supply voltage equal to or above 1000 V or rated current equal to or above 400 A or intended for use in complex systems.	No limit line. Make an EMC plan.

When the generic emission standards are used, the drives are required to comply with the limits in Table 19.

Table 19: Emission Limit Classes

Environment	Generic standard	Conducted emission requirement according to the limits given in EN 55011
1st environment (home and office)	EN/IEC 61000-6-3 Emission standard for residential, commercial, and light industrial environments.	Class B
2nd environment (industrial environment)	EN/IEC 61000-6-4 Emission standard for industrial environments.	Class A Group 1

NOTICE

According to the EMC Directive, a system is defined as a combination of several types of equipment, finished products, and/or components combined, designed and/or put together by the same person (system manufacturer) intended to be placed on the market for distribution as a single functional unit for an end user and intended to be installed and operated together to perform a specific task. The EMC Directive applies to products/systems and installations, but in case the installation is built up of CE marked products/systems the installation can also be considered compliant with the EMC Directive. Installations shall not be CE marked.
According to the EMC Directive, Danfoss Drives as a manufacturer of product/systems is responsible for obtaining the essential requirements of the EMC Directive and attaching the CE mark. For systems involving load sharing and other DC terminals, Danfoss Drives can only ensure compliance to the EMC Directive when end users connect combinations of Danfoss Drives products as described in our technical documentation.
If any 3rd-party products are connected to the load share or other DC terminals on the AC drives, Danfoss Drives cannot guarantee that the EMC requirements are fulfilled.

6.5.3 Immunity Requirements

The immunity requirements for drives depend on the environment in which they are installed. The requirements for the industrial environment are higher than the requirements for the home and office environment. All Danfoss VLT® drives comply with the requirements for the industrial environment and therefore also comply with the lower requirements for home and office environment with a large safety margin.

To document immunity against burst transient from electrical phenomena, the following immunity tests have been carried out on a system consisting of:

- A drive (with options if relevant).
- A shielded control cable.
- A control box with potentiometer, motor cable, and motor.

The tests were performed in accordance with the following basic standards:

- **EN 61000-4-2 (IEC 61000-4-2) Electrostatic discharges (ESD):** Simulation of electrostatic discharges from human beings.
- **EN 61000-4-3 (IEC 61000-4-3) Radiated immunity:** Amplitude modulated simulation of the effects of radar and radio communication equipment and mobile communications equipment.
- **EN 61000-4-4 (IEC 61000-4-4) Burst transients:** Simulation of interference brought about by switching a contactor, relay, or similar devices.
- **EN 61000-4-5 (IEC 61000-4-5) Surge transients:** Simulation of transients brought about by, for example, lightning that strikes near installations.
- **EN 61000-4-6 (IEC 61000-4-6) RF Common mode:** Simulation of the effect from radio-transmission equipment joined by connection cables.

The immunity requirements should follow product standard IEC 61800-3. See Table 20.

Table 20: EMC Immunity, Voltage Range: 200–240 V, 380–480 V

Basic standard	Burst IEC 61000-4-4	Surge IEC 61000-4-5	ESD IEC 61000-4-2	Radiated electro-magnetic field IEC 61000-4-3	RF common mode voltage IEC 61000-4-6
Acceptance criterion	**B**	**B**	**B**	**A**	**A**
Line	4 kV CM	2 kV/2 Ω DM 4 kV/12 Ω CM	–	–	10 V_{RMS}
Motor	4 kV CM	4 kV/2 Ω(1)	–	–	10 V_{RMS}
Brake	4 kV CM	4 kV/2 Ω(1)	–	–	10 V_{RMS}
Load sharing	4 kV CM	4 kV/2 Ω(1)	–	–	10 V_{RMS}
Control wires	2 kV CM	2 kV/2 Ω(1)	–	–	10 V_{RMS}
Standard bus	2 kV CM	2 kV/2 Ω(1)	–	–	10 V_{RMS}
Relay wires	2 kV CM	2 kV/2 Ω(1)	–	–	10 V_{RMS}
Application and Fieldbus options Application and network options	2 kV CM	2 kV/2 Ω(1)	–	–	10 V_{RMS}
LCP cable	2 kV CM	2 kV/2 Ω(1)	–	–	10 V_{RMS}
External 24 V DC	2 kV CM	0.5 kV/2 Ω DM 1 kV/12 Ω CM	–	–	10 V_{RMS}
Enclosure	–	–	8 kV AD 6 kV CD	10 V/m	–

1 Injection on cable shield.

AD: Air Discharge
CD: Contact Discharge
CM: Common Mode
DM: Differential Mode

6.5.4 EMC Compatibility

NOTICE

OPERATOR RESPONSIBILITY

According to the EN 61800-3 standard for variable-speed drive systems, the operator is responsible for ensuring EMC compliance. Manufacturers can offer solutions for operation conforming to the standard. Operators are responsible for applying these solutions and for paying the associated costs.

There are 2 options for ensuring electromagnetic compatibility:

- Eliminate or minimize interference at the source of emitted interference.
- Increase the immunity to interference in devices affected by its reception.

RFI filters

The goal is to obtain systems that operate stably without radio frequency interference between components. To achieve a high level of immunity, use drives with high-quality RFI filters.

NOTICE

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

PELV and galvanic isolation compliance

All control and relay terminals comply with PELV (excluding grounded delta leg above 400 V). To obtain galvanic (ensured) isolation, fulfill requirements for higher isolation and provide the relevant creepage/clearance distances. These requirements are described in EN 61800-5.1.

Electrical isolation is provided as shown in Illustration 36. The components described comply with both PELV and the galvanic isolation requirements.

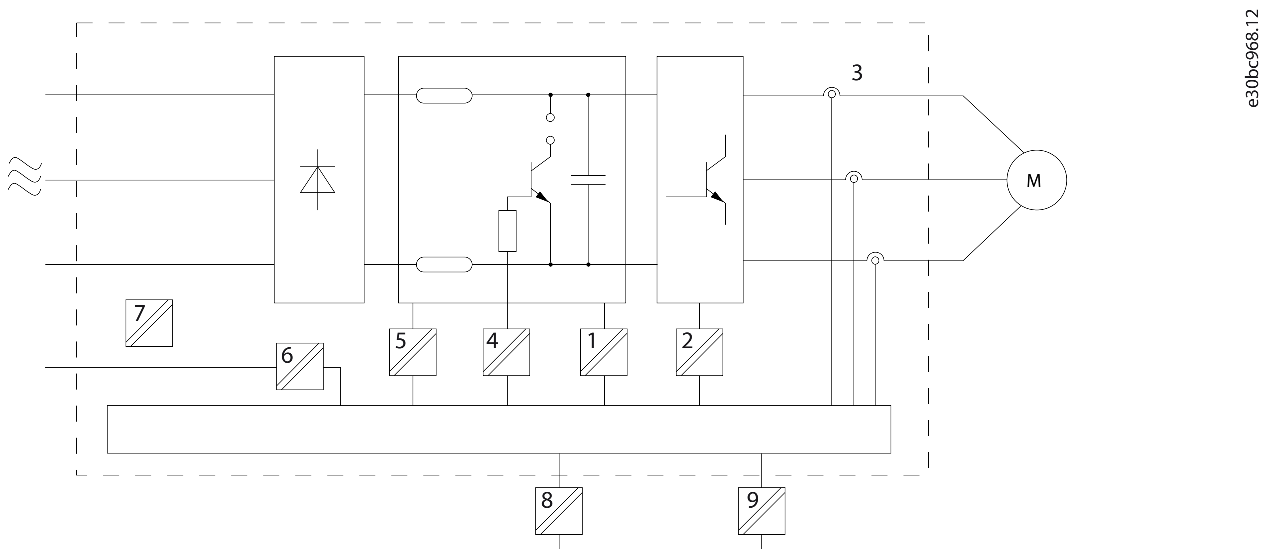


Illustration 36: Galvanic Isolation

1	Power supply (SMPS) including signal isolation of DC link	5	Internal inrush, RFI, and temperature measurement circuits
2	Gate drive for the IGBTs	6	Custom relays
3	Current transducers	7	Mechanical brake
4	Opto-coupler, brake module (optional)		

6.5.5 EMC-compliant Electrical Installation

To obtain an EMC-compliant installation, be sure to follow all electrical installation instructions.

Also, remember to practice the following:

- When using relays, control cables, a signal interface, fieldbus, or brake, connect the shield to the enclosure at both ends. If the ground path has high impedance, is noisy, or is carrying current, break the shield connection on 1 end to avoid ground current loops.
- Convey the currents back to the unit using a metal mounting plate. Ensure good electrical contact from the mounting plate by securely fastening the mounting screws to the drive chassis.
- Use shielded cables for motor output cables. An alternative is unshielded motor cables within metal conduit.
- Ensure that motor and brake cables are as short as possible to reduce the interference level from the entire system.
- Avoid placing cables with a sensitive signal level alongside motor and brake cables.
- For communication and command/control lines, follow the particular communication protocol standards. For example, USB must use shielded cables, but RS485/ethernet can use shielded UTP or unshielded UTP cables.
- Ensure that all control terminal connections are rated protective extra low voltage (PELV).

NOTICE

TWISTED SHIELD ENDS (PIGTAILS)

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

- Use integrated shield clamps instead of twisted shield ends.

NOTICE

SHIELDED CABLES

If shielded cables or metal conduits are not used, the unit and the installation do not meet regulatory limits on radio frequency (RF) emission levels.

NOTICE

EMC INTERFERENCE

Failure to isolate power, motor, and control cables can result in unintended behavior or reduced performance.

- Use shielded cables for motor and control wiring.
- Provide a minimum 200 mm (7.9 in) separation between mains input, motor cables, and control cables.

NOTICE

INSTALLATION AT HIGH ALTITUDE

There is a risk of overvoltage. Isolation between components and critical parts could be insufficient and may not comply with PELV requirements.

- Use external protective devices or galvanic isolation. For installations above 2000 m (6500 ft) altitude, contact Danfoss regarding protective extra low voltage (PELV) compliance.

NOTICE

PROTECTIVE EXTRA LOW VOLTAGE (PELV) COMPLIANCE

Prevent electric shock by using PELV electrical supply and complying with local and national PELV regulations.

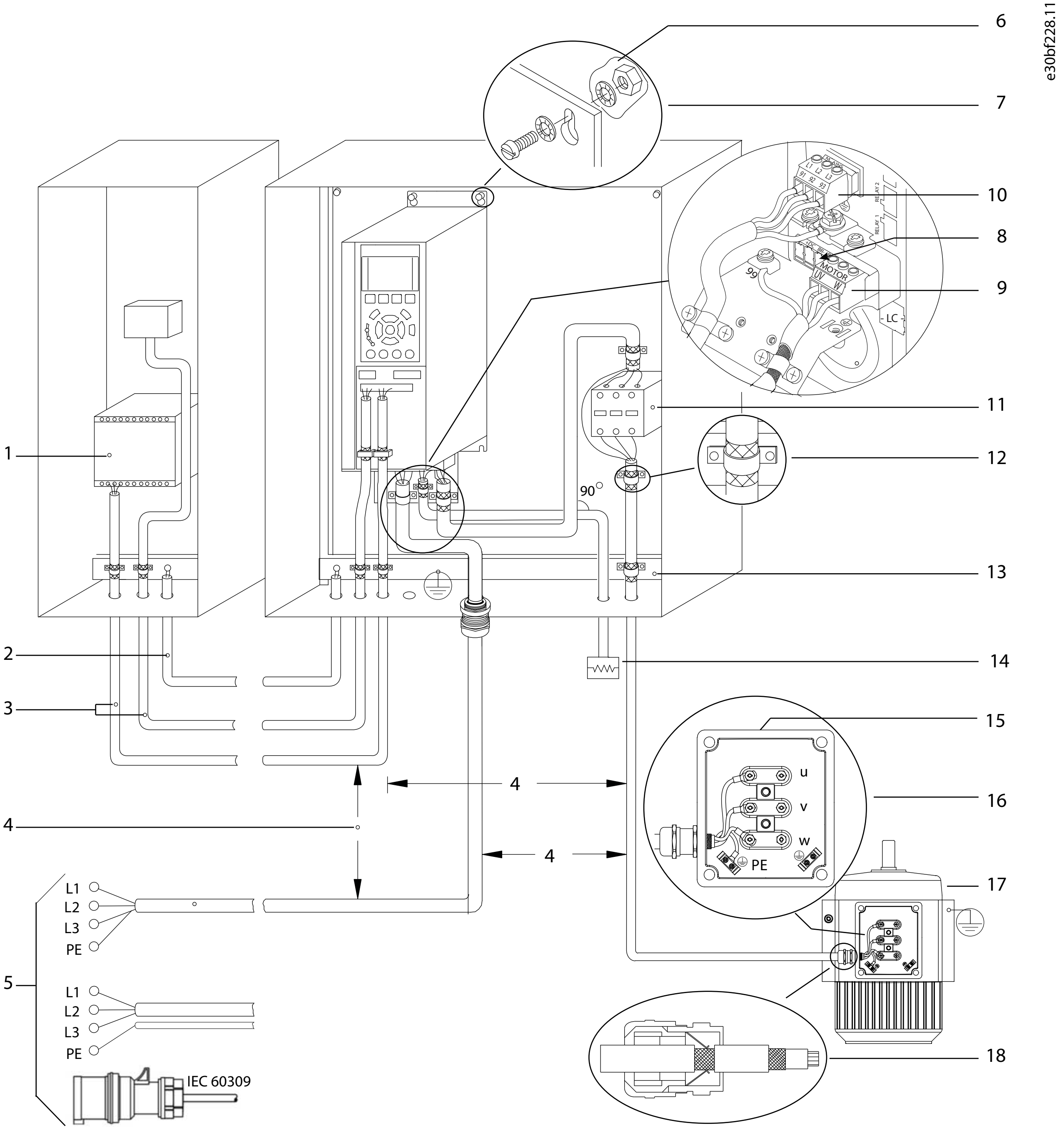


Illustration 37: Example of Proper EMC Installation

1	Programmable logic controller (PLC)	10	Mains cable (unshielded)
2	Minimum 16 mm^2 (6 AWG) equalizing cable	11	Output contactor
3	Control cables	12	Cable insulation stripped
4	Minimum 200 mm (7.9 in) between control cables, motor cables, and mains cables	13	Common ground busbar. Follow local and national requirements for cabinet grounding.
5	Mains supply options, see IEC/EN 61800-5-1	14	Brake resistor
6	Bare (unpainted) surface	15	Terminal box
7	Star washers	16	Connection to motor
8	Brake cable (shielded) – not shown, but same gounding principle applies as for motor cable	17	Motor
9	Motor cable (shielded)	18	EMC cable gland

6.5.6 EMC-compliant Cables

To optimize EMC immunity of the control cables and emission from the motor cables, use braided shielded/armored cables.

The ability of a cable to reduce the in- and outgoing radiation of electric noise depends on the transfer impedance (Z_T). The shield of a cable is normally designed to reduce the transfer of electric noise. However, a shield with a lower transfer impedance (Z_T) value is more effective than a shield with a higher transfer impedance (Z_T).

Cable manufacturers rarely state the transfer impedance (Z_T), but it is often possible to estimate transfer impedance (Z_T) by assessing the physical design of the cable.

Transfer impedance (Z_T) can be assessed based on the following factors:

- The conductibility of the shield material.
- The contact resistance between the individual shield conductors.
- The shield coverage, that is, the physical area of the cable covered by the shield - often stated as a percentage value.
- Shield type (braided or twisted).

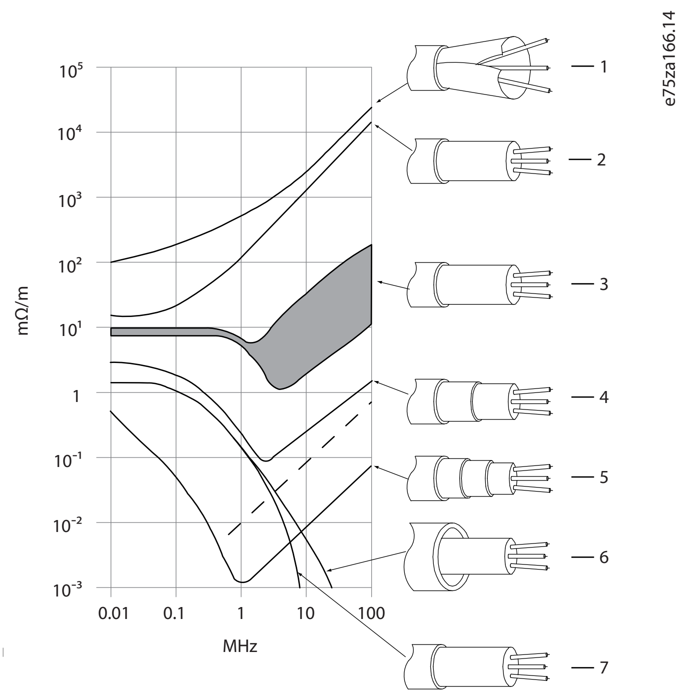


Illustration 38: Transfer Impedance (Z_T)

1	Aluminum-clad with copper wire.	5	Twin layer of braided copper wire with a magnetic, shielded/armored intermediate layer.
2	Twisted copper wire or armored steel wire cable.	6	Cable that runs in copper tube or steel tube.
3	Single-layer braided copper wire with varying percentage shield coverage. This is the typical reference cable.	7	Lead cable with 1.1 mm (0.04 in) wall thickness.
4	Double-layer braided copper wire.		

6.5.7 Shielded Control Cables

Usually, the preferred method is to secure control and serial communication cables with shielding clamps provided at both ends to ensure the best possible high frequency cable contact.

If the ground potential between the drive and the PLC is different, electric noise could disturb the entire system. Solve this problem by fitting an equalizing cable as close as possible to the control cable. Minimum cable cross-section: 16 mm² (6 AWG).

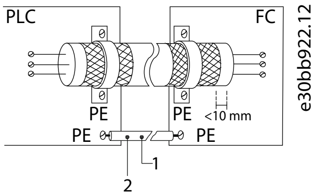


Illustration 39: Shielding Clamps at Both Ends

1	Minimum 16 mm² (6 AWG)
2	Equalizing cable

6.5.7.1 50/60 Hz Ground Loops

With long control cables, ground loops may occur. To eliminate ground loops, connect 1 end of the shield to the ground with a 100 nF capacitor (keeping leads short).

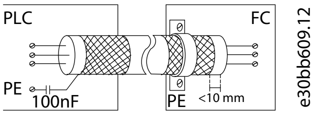


Illustration 40: Connection with a 100 nF Capacitor

6.5.7.2 Avoid EMC Noise on Serial Communication

This terminal is connected to ground via an internal RC link. Use twisted-pair cables to reduce interference between conductors. The recommended method is shown in the following illustration.

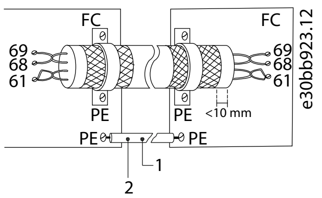


Illustration 41: Twisted-pair Cables

1	Minimum 16 mm² (6 AWG)
2	Equalizing cable

Alternatively, the connection to terminal 61 can be omitted.

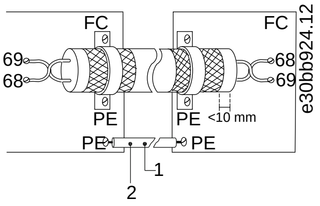


Illustration 42: Twisted-pair Cables without Terminal 61

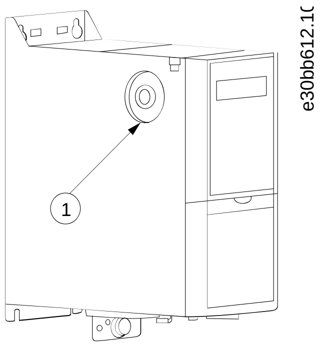
1	Minimum 16 mm^2 (6 AWG)
2	Equalizing cable

6.5.8 RFI Filter Switch

For power sizes 6.0–10 kW (8.0–15 hp), disable the RFI filter by removing the screw.

For power sizes 11–22 kW (15–30 hp), removing the screw does not have any electrical effect and does not alter any RFI settings.

For power size 30 kW (40 hp), no options are available for disabling the RFI filter.



1	EMC screw

N O T I C E

If reinserted, use only M3x12 screw.

6.6 Harmonics Emission

A drive takes up a non-sinusoidal current from mains, which increases the input current I_{RMS}. A non-sinusoidal current is transformed with a Fourier analysis and split into sine-wave currents with different frequencies, that is, different harmonic currents I_n with 50 Hz basic frequency:

Table 21: Harmonic Currents

	I_1	I_5	I_7
Hz	50	250	350

The harmonics do not affect the power consumption directly, but increase the heat losses in the installation (transformer, cables). So, in plants with a high percentage of rectifier load, maintain harmonic currents at a low level to avoid overload of the transformer and high temperature in the cables.

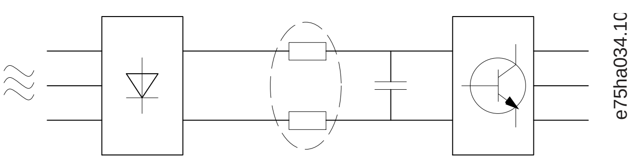


Illustration 43: DC-link Coils

N O T I C E

Some of the harmonic currents might disturb communication equipment connected to the same transformer or cause resonance with power factor correction batteries.

To ensure low harmonic currents, the drive is equipped with DC-link coils as standard. This normally reduces the input current I_{RMS} by 40%.

The voltage distortion on the mains supply voltage depends on the size of the harmonic currents multiplied by the mains impedance for the frequency in question. The total voltage distortion THDv is calculated based on the individual voltage harmonics using this formula:

$$THD\% = \sqrt{U_5^2 + U_7^2 + ... + U_N^2}$$

(U_N% of U)

6.6.1 Harmonics Emission Requirements

Equipment is connected to the public supply network.

Table 22: Connected Equipment

Options	Definition
1	IEC/EN 61000-3-2 Class A for 3-phase balanced equipment (for professional equipment only up to 1 kW (1.3 hp) total power).
2	IEC/EN 61000-3-12 Equipment 16–75 A and professional equipment as from 1 kW (1.3 hp) up to 16 A phase current.

6.6.2 Harmonics Test Results (Emission)

Power sizes up to 10 kW (15 hp) [200–240 V AC] comply with IEC/EN 61000-3-12, Table 4. Power sizes up to 30 kW (40 hp) [380–480 V AC] comply with IEC/EN 61000-3-2 Class A and IEC/EN 61000-3-12, Table 4.

Table 23: Harmonic Current 6.0–10 kW (8.0–15 hp), 200 V

	Individual harmonic current I_n/I_1 (%)			
	I_5	I_7	I_{11}	I_{13}
Actual 6.0–10 kW (8.0–15 hp), IP20, 200 V (typical)	32.6	16.6	8.0	6.0
Limit for R_{sce}≥120	40	25	15	10
	Harmonic current distortion factor (%)			
	THDi		**PWHD**	
Actual 6.0–10 kW (8.0–15 hp), 200 V (typical)	39		41.4	
Limit for R_{sce}≥120	48		46	

Table 24: Harmonic Current 6.0–22 kW (8.0–30 hp), 380–480 V

	Individual harmonic current I_n/I_1 (%)			
	I_5	I_7	I_{11}	I_{13}
Actual 6.0–22 kW (8.0–30 hp), IP20, 380–480 V (typical)	36.7	20.8	7.6	6.4
Limit for R_{sce}≥120	40	25	15	10
	Harmonic current distortion factor (%)			

	THDi	PWHD
Actual 6.0–22 kW (8.0–30 hp), 380–480 V (typical)	44.4	40.8
Limit for R_{sce}≥120	48	46

Table 25: Harmonic Current 30 kW (40 hp), 380–480 V

	Individual harmonic current I_n/I_1 (%)			
	I_5	I_7	I_{11}	I_{13}
Actual 30 kW (40 hp), IP20, 380–480 V (typical)	36.7	13.8	6.9	4.2
Limit for R_{sce}≥120	40	25	15	10
	Harmonic current distortion factor (%)			
	THDi		**PWHD**	
Actual 30 kW (40 hp), 380–480 V (typical)	40.6		28.8	
Limit for R_{sce}≥120	48		46	

If the short-circuit power of the supply S_{sc} is greater than or equal to:

$$S_{SC} = \sqrt{3} \times R_{SCE} \times U_{mains} \times I_{equ} = \sqrt{3} \times 120 \times 400 \times I_{equ}$$

at the interface point between the user's supply and the public system (R_{sce}).

The installer or user of the equipment is responsible for ensuring that the equipment is connected only to a supply with a short-circuit power S_{sc} greater than or equal to what is specified above. If necessary, consult the distribution network operator. Other power sizes can be connected to the public supply network by consultation with the distribution network operator.

Compliance with various system level guidelines: The harmonic current data in Table 23 to Table 25 are given in accordance with IEC/EN 61000-3-12 with reference to the Power Drive Systems product standard. They may be used as the basis for calculation of the harmonic currents' influence on the power supply system and for the documentation of compliance with relevant regional guidelines: IEEE 519 -1992; G5/4.

If there is a need for further reduction of harmonic currents, passive or active filters in front of the drives can be installed. Consult Danfoss for further information.

6.7 Galvanic Isolation (PELV)

All control terminals and output relay terminals are galvanically isolated from mains power, which completely protects the controller circuitry from the input current. The output relay terminals require their own grounding. This isolation meets the stringent protective extra-low voltage (PELV) requirements for isolation.

The components that make up the galvanic isolation are illustrated in Illustration 44:

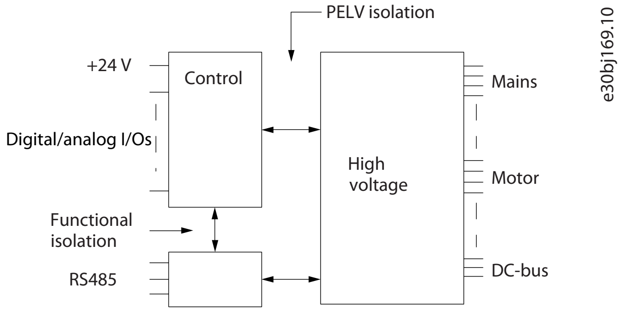


Illustration 44: Galvanic Isolation (PELV)

6.8 Ground Leakage Current

Follow national and local codes regarding protective earthing of equipment where leakage current exceeds 3.5 mA.

Drive technology implies high frequency switching at high power. This generates a leakage current in the ground connection.

The ground leakage current is made up of several contributions and depends on various system configurations, including:

- RFI filtering.
- Motor cable length.
- Motor cable shielding.
- Drive power.

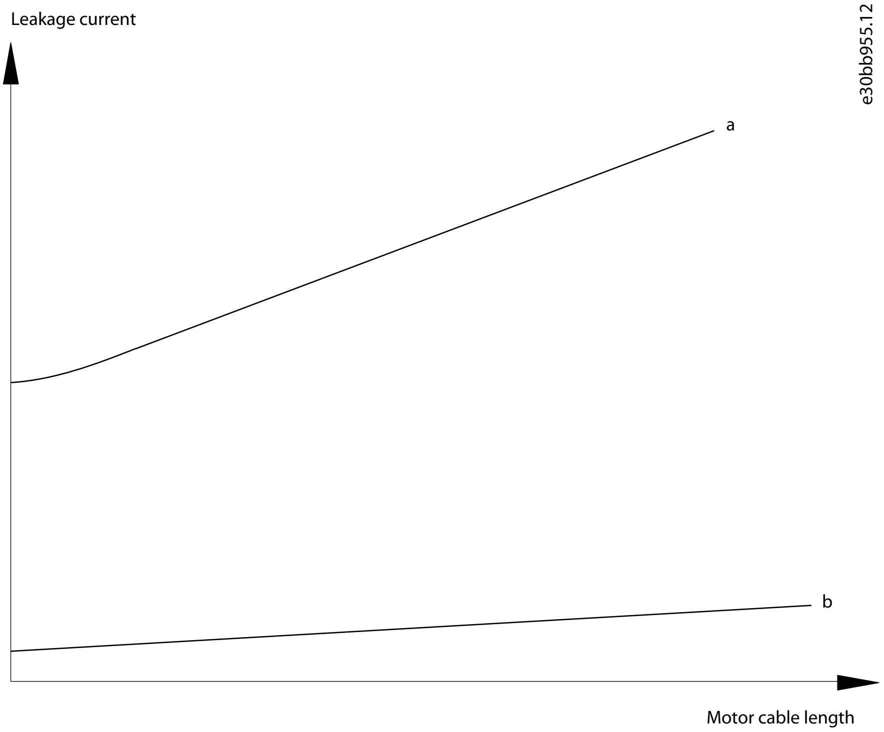


Illustration 45: Influence of the Cable Length and Power Size on Leakage Current, Power Size a > Power Size B

The leakage current also depends on the line distortion.

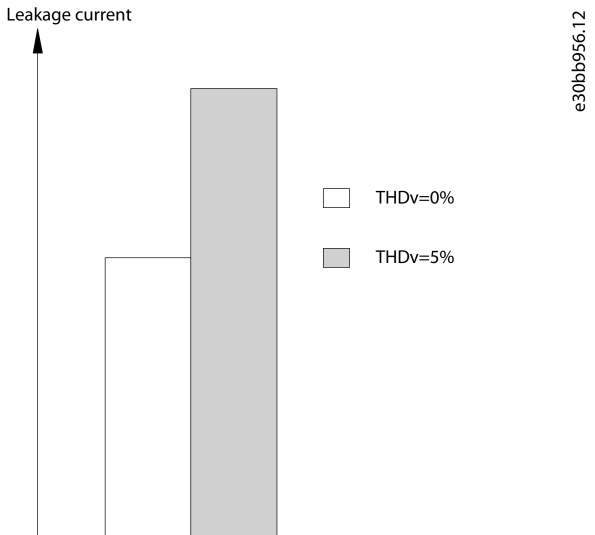


Illustration 46: Influence of Line Distortion on Leakage Current

If the leakage current exceeds 3.5 mA, compliance with EN/IEC 61800-5-1 (power drive system product standard) requires special care.

Reinforce grounding with the following protective earth connection requirements:

- Ground wire (terminal 95) of at least 10 mm^2 (8 AWG) cross-section.
- Two separate ground wires both complying with the dimensioning rules.

See EN/IEC 61800-5-1 and IEC EN 62477-1 for further information.

WARNING

DISCHARGE TIME

Touching the electrical parts, even after the equipment has been disconnected from mains, could be fatal.

- Make sure that other voltage inputs have been disconnected, such as load sharing (linkage of DC-link), and the motor connection for kinetic backup.
- Before touching any electrical parts, wait at least the amount of time indicated in the safety chapter. Shorter time is allowed only if indicated on the nameplate for the specific unit.

WARNING

LEAKAGE CURRENT HAZARD

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

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

6.8.1 Using a Residual Current Device (RCD)

Where residual current devices (RCDs), also known as earth leakage circuit breakers (ELCBs), are used, comply with the following:

- Use RCDs of type B only, which are capable of detecting AC and DC currents.
- Use RCDs with an inrush delay to prevent faults caused by transient ground currents.
- Dimension RCDs according to the system configuration and environmental considerations.

The leakage current includes several frequencies originating from both the mains frequency and the switching frequency. Whether the switching frequency is detected depends on the type of RCD used.

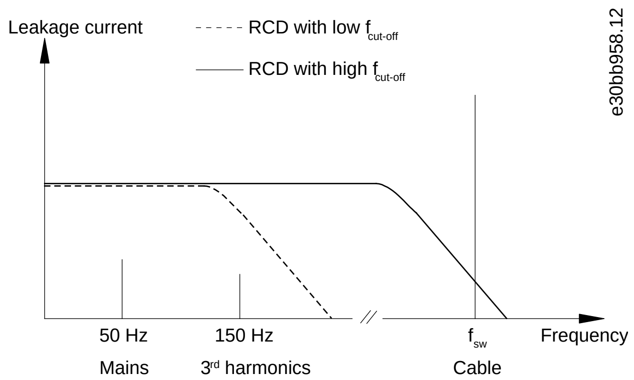


Illustration 47: Mains Contributions to Leakage Current

The amount of leakage current detected by the RCD depends on the cut-off frequency of the RCD.

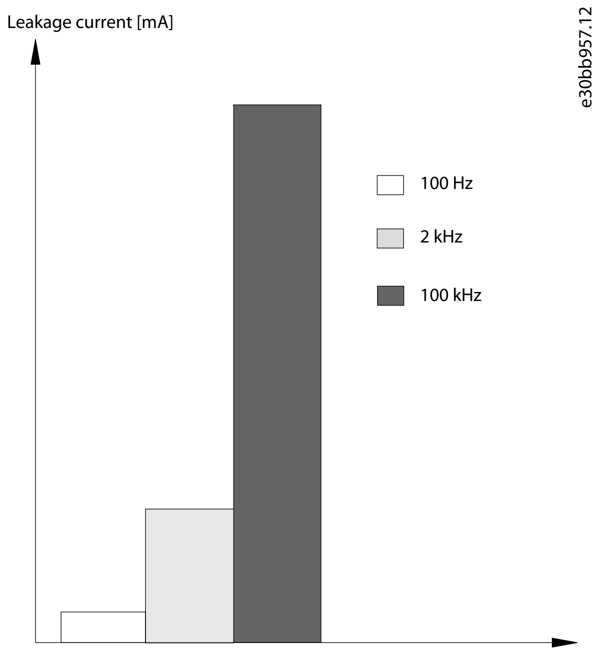


Illustration 48: Influence of Cut-off Frequency of the RCD on what is Responded to/Measured

For more details, refer to the RCD Application Note.

⚠ WARNING ⚠

RESIDUAL CURRENT DEVICE PROTECTION

This product can cause a DC current in the protective conductor. Where a residual current device (RCD) is used for protection in case of direct or indirect contact, only an RCD of Type B is allowed on the supply side of this product. Otherwise, apply another protective measure, such as separation from the environment by double or reinforced insulation, or isolation from the supply system by a transformer. See also application note Protection against Electrical Hazards.

- Protective grounding of the drive and the use of RCDs must always follow national and local regulations.

7 How to Order

7.1 Drive Configurator

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
C	D	S	8	0	3	P				T					H		X		

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
X	X	X	S	X	X	X	X	A	X	B	X	C	X	X	X	X	D	X

e30bd938.11

Illustration 49: Type Code Example

Configure the right drive for the right application from the internet-based Drive Configurator and generate the type code string. The Drive Configurator automatically generates an 8-digit sales number to be delivered to the local sales office. Furthermore, it is possible to establish a project list with several products and send it to a Danfoss sales representative.

The Drive Configurator can be found on the global website: www.danfoss.com/drives.

7.2 Type Code Description

Table 26: Type Code Descriptions

Position	Description	Options
01–06	Product group	CDS 803
07–10	Power rating	6.0–30 kW (8.0–40 hp)
11	Number of phases	3
11–12	Mains voltage	T2: 200–240 V AC
		T4: 380–480 V AC
13–15	Enclosure	E20: IP20/Chassis
16–17	RFI	H2: RFI filter class A2
		H4: RFI filter class A1
18	Brake	X: No brake chopper included
19	Display	A: Alpha-numeric LCP
		X: No LCP
20	Coating PCB	X: Not coated PCB (Class 3C2)
		C: Coated PCB (Class 3C3)
21	Mains option	X: No mains option
22–23	Adaptation	X: No adaptation
24–27	Software release	SXXX: Latest release in combination with UL 508C S096: Latest release in combination with UL/EN/IEC 60730-1 S129: Latest release in combination with EN/IEC 60730-1
28	Software language	X: Standard
29–30	A options	AX: No A options
31–32	B options	BX: No B options
33–34	C0 options	CX: No C options

Position	Description	Options
35	C1 options	X: No C1 options
36–37	C option software	XX: No options
38–39	D option	DX: No D options

7.3 Accessories and Spare Parts

For further details on available accessories and spare parts, visit store.danfoss.com.

Table 27: Descriptions and Order Numbers for Accessories

Description	Order number
LCP for all units	120Z0581
LCP kit for remote mounting, 3 m (9.85 ft) cable	120Z0617
LCP cable, 3 m (9.85 ft)	132B0132
Enclosure kits	
IP21/Type 1 conversion kit, enclosure size H3	132B0214
IP21/Type 1 conversion kit, enclosure size H4	132B0215
IP21/Type 1 conversion kit, enclosure size H5	132B0216
IP21/Type 1 conversion kit, enclosure size H6	132B0217
Decoupling plates	
Decoupling plate, enclosure size H3	120Z0582
Decoupling plate, enclosure sizes H4 and H5	120Z0583
Decoupling plate, enclosure size H6	120Z0837

Table 28: Descriptions and Order Numbers for Spare Parts

Description	Order Number
CDS front label (blue sticker)[(1)]	130A0032
Terminal cover, enclosure size H3	132B0250
Terminal cover, enclosure size H4	132B0251
Terminal cover, enclosure size H5	132B0252
Terminal cover, enclosure size H6	132B4431
Accessory bag (screws and plugs), enclosure sizes H3–H5	132B0253
Accessory bag (screws and plugs), enclosure size H6	132B1026
Control card, enclosure sizes H3–H5	132B0700
Control card, enclosure size H6	132B1174

1 Order a new sticker when replacing the terminal cover.

8 Appendix

8.1 Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
A	Ampere/AMP
AC	Alternating current
AWG	American wire gauge
DC	Direct current
EMC	Electro-magnetic compatibility
hp	Horsepower
Hz	Hertz
$I_{VLT,N}$	Rated output current supplied by the drive
kg	Kilogram
kHz	Kilohertz
kW	Kilowatt
LCP	Local control panel
m	Meter
mA	Milliampere
MCT	Motion Control Tool
ms	Millisecond
Nm	Newton meter
$P_{M,N}$	Nominal motor power
PCB	Printed circuit board
PELV	Protective extra low voltage
RPM	Revolutions per minute
RPS	Revolutions per second
s	Second
$U_{M,N}$	Nominal motor voltage
V	Volts

8.2 Conventions

- Numbered lists indicate procedures.
- Bulleted and dashed lists indicate listings of other information where the order of the information is not relevant.
- Bolded text indicates highlighting and section headings.
- Italicized text indicates the following:

    - Cross-reference.
    - Link.
    - Footnote.
    - Parameter name.
    - Parameter option.
    - Parameter group name.
    - Alarms/warnings.
- All dimensions in drawings are in metric values (imperial values in brackets).
- An asterisk (*) indicates the default setting of a parameter.

Index

VLT Drives Glossary - CDS 803

A

Analog reference

A signal transmitted to the analog inputs 53 or 54 (voltage or current).

- Current input: 0–20 mA and 4–20 mA
- Voltage input: 0–10 V DC

Analog inputs

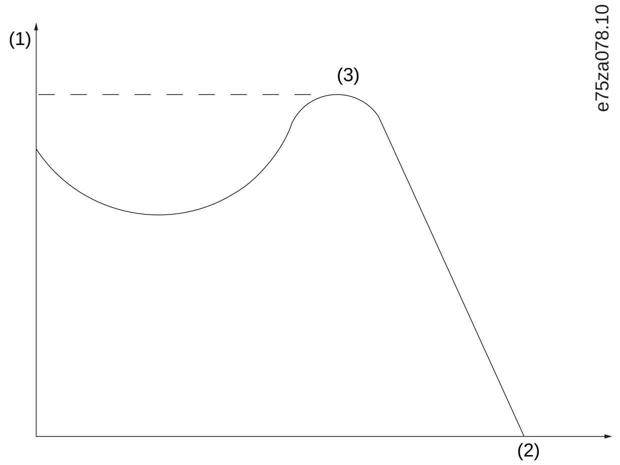
The analog inputs are used for controlling various functions of the drive.
There are 2 types of analog inputs:
Current input, 0–20 mA, and 4–20 mA
Voltage input, 0 V DC to +10 V DC

Analog outputs

The analog outputs can supply a signal of 0–20 mA, 4–20 mA.

B

Breakaway torque



Bus reference

A signal transmitted to the serial communication port (FC port).

C

Control command

Functions are divided into 2 groups.
Functions in group 1 have higher priority than functions in group 2.

Group 1	Reset, coast stop, reset and coast stop, quick stop, DC brake, stop, the [OFF] key.
Group 2	Start, pulse start, reversing, start reversing, jog, freeze output.

D

Digital inputs

The digital inputs can be used for controlling various functions of the drive.

Digital outputs

The drive features 2 solid-state outputs that can supply a 24 V DC (maximum 40 mA) signal.

F

f_M

Motor frequency.

$f_{M,N}$

Rated motor frequency (nameplate data).

f_{MAX}

Maximum compressor frequency.

f_{MIN}	Minimum compressor frequency.
f_{jog}	Motor frequency when the jog function is activated (via digital terminals).

I

I_M	Motor current (actual).
$I_{M,N}$	Rated motor current (nameplate data).
Intermittent duty cycle	An intermittent duty rating refers to a sequence of duty cycles. Each cycle consists of an on-load and an off-load period. The operation can be either periodic duty or non-periodic duty.

L

lsb	Least significant bit.

M

MCM	Short for "mille circular mil", an American measuring unit for cable cross-section. 1 MCM=0.5067 mm^2
msb	Most significant bit.

N

$n_{M,N}$	Nominal motor speed (nameplate data).

O

Online/offline parameters	Changes to online parameters are activated immediately after the data value is changed. Press [OK] to activate changes to off-line parameters.

P

PI controller

The PI controller maintains the required speed, pressure, temperature, and so on, by adjusting the output frequency to match the varying load.

$P_{M,N}$

Rated motor power (nameplate data in kW or hp).

Power factor

The power factor is the relation between I_1 and I_{RMS}

$$\text{Power factor} = \frac{\sqrt{3 \times U \times I_{1\cos\phi}}}{\sqrt{3 \times U \times I_{RMS}}}$$

The power factor for 3-phase control:

$$\text{Power factor} = \frac{I_1 \times \cos\phi 1}{I_{RMS}} = \frac{I_1}{I_{RMS}} \text{ since } \cos\phi 1 = 1$$

The power factor indicates to which extent the drive imposes a load on the mains supply.

The lower the power factor, the higher the I_{RMS} for the same kW performance.

$$I_{RMS} = \sqrt{I_1^2 + I_5^2 + I_7^2} + .. + I_n^2$$

In addition, a high-power factor indicates that the different harmonic currents are low.

The DC coils in the drive produce a high-power factor, which minimizes the imposed load on the mains supply.

Preset reference

A defined preset reference to be set from -100% to +100% of the reference range. Selection of 8 preset references via the digital terminals.

R

RCD	Residual-current device.
Relay outputs	The drive features 2 programmable relay outputs.

S

Setup	Save parameter settings in 4 setups. Change between the 4 parameter setups and edit 1 setup, while another setup is active.
Slip compensation	The drive compensates for the compressor slip by giving the frequency a supplement that follows the measured compressor load keeping the compressor speed almost constant.
Start-disable command	A stop command belonging to Group 1 control commands, see the table Function Groups under *Control Command*.
Stop command	A stop command belonging to Group 1 control commands, see the table Function Groups under *Control Command*.

T

Thermistor	A temperature-dependent resistor placed on the drive or the compressor.
Trip	A state entered in fault situations, for example, if the drive is subject to an overtemperature or when the drive is protecting the compressor, process, or mechanism. The drive prevents a restart until the cause of the fault has disappeared. To cancel the trip state, restart the drive. Do not use the trip state for personal safety.
Trip lock	The drive enters this state in fault situations to protect itself. The drive requires physical intervention, for example when there is a short circuit on the output. A trip lock can only be canceled by disconnecting mains, removing the cause of the fault, and reconnecting the drive. Restart is prevented until the trip state is canceled by activating reset or, sometimes, by being programmed to reset automatically. Do not use the trip lock state for personal safety.

U

U_M	Instant motor voltage.
$U_{M,N}$	Rated motor voltage (nameplate data).

V

VT characteristics	Variable torque characteristics used for pumps and fans.

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