ENGINEERING TOMORROW

Installation Guide
VLT® Common AC Drive Modules
250–1200 kW

vlt-drives.danfoss.com

VLT® THE REAL DRIVE

Contents

1 Introduction

1.1 Purpose of the Manual

This manual is intended to provide requirements for mechanical and electrical installation of the VLT® Common AC Drive Modules basic kit. Separate installation instructions for optional components – bus bars and back-channel cooling – are provided with those kits.

This guide includes information on:

- Wiring of mains and motor connections.
- Wiring of control and serial communications.
- Control terminal functions.
- Detailed tests that must be performed before start-up.
- Initial programming to verify proper functioning of the drive system.

The installation guide is intended for use by qualified personnel.

To install the drive modules and paralleling kit safely and professionally, read and follow the installation guide. Pay particular attention to the safety instructions and general warnings. Always keep this installation guide with the panel containing the VLT® Common AC Drive Modules components.

VLT® is a registered trademark.

1.2 Additional Resources

Other resources are available to understand functions and programming of the VLT® Common AC Drive Modules.

- The *VLT® Common AC Drive Modules Design Guide* contains detailed information about the capabilities and functionality of motor control systems using these drive modules, and provides guidance for designing this type of system.
- The *VLT® Common AC Drive Modules User Guide* contains detailed procedures for start up, basic operational programming, and functional testing. Additional information describes the user interface, application examples, troubleshooting, and specifications.
- Refer to the *Programming Guide* applicable to the particular series of VLT® Common AC Drive Modules used in creating the drive system. The programming guide describes in greater detail how to work with parameters and provides automation application examples.
- The *VLT® FC Series, D-frame Service Manual* contains detailed service information, including information applicable to the VLT® Common AC Drive Modules.
- The *VLT® Common AC Drive Modules DC Fuses Installation Instructions* contains detailed information about installing the DC fuses.
- The *VLT® Common AC Drive Modules Bus Bar Kit Installation Instructions* contains detailed information about installing the bus bar kit.
- The *VLT® Common AC Drive Modules Duct Kit Installation Instructions* contains detailed information about installing the duct kit.

Refer to other supplemental publications and manuals, available from Danfoss. See *vlt-drives.danfoss.com/support/technical-documentation/* for listings.

1.3 Document and Software Version

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

Edition	Remarks	Software version
MG37K1xx	Original release	7.5x

Table 1.1 Document and Software Version

1.4 Approvals and Certifications

Table 1.2 Approvals

1.5 Disposal

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

2 Safety

2.1 Safety Symbols

The following symbols are used in this manual:

WARNING

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

CAUTION

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

NOTICE

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

2.2 Qualified Personnel

Correct and reliable transport, storage, and installation are required for the trouble-free and safe operation of the VLT® Common AC Drive Modules. Only qualified personnel are allowed to install this equipment.

Qualified personnel are defined as trained staff, who are authorized to install equipment, systems, and circuits in accordance with pertinent laws and regulations. Also, the personnel must be familiar with the instructions and safety measures described in this document.

2.3 Safety Precautions

WARNING

HIGH VOLTAGE

The drive system contains high voltage when connected to AC mains input. Failure to ensure that only qualified personnel perform the installation can result in death or serious injury.

WARNING

UNINTENDED START

When the drive system is connected to AC mains, the motor can start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, a cleared fault condition, or remote operation using MCT 10 software.

To prevent unintended motor start:

- **Disconnect the drive system from AC mains.**
- **Press [Off/Reset] on the LCP, before programming parameters.**
- **The drive system, motor, and any driven equipment must be fully wired and assembled when the drive is connected to AC mains.**

WARNING

DISCHARGE TIME

The drive module contains DC-link capacitors. Once mains power has been applied to the drive, these capacitors can remain charged even after the power has been removed. High voltage can be present even when the warning indicator lights are off. Failure to wait 20 minutes after power has been removed before performing service or repair work, can result in death or serious injury.

- **Stop the motor.**
- **Disconnect AC mains and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other drives.**
- **Disconnect or lock the PM motor.**
- **Wait 20 minutes for the capacitors to discharge fully before performing any service or repair work.**

⚠WARNING

LEAKAGE CURRENT HAZARD (>3.5 mA)

Leakage currents exceed 3.5 mA. Failure to ground the drive system properly can result in death or serious injury. Follow national and local codes regarding protective earthing of equipment with a leakage current >3.5 mA. Frequency converter technology implies high frequency switching at high power. This switching generates a leakage current in the ground connection. A fault current in the drive system at the output power terminals sometimes contain a DC component, which can charge the filter capacitors and cause a transient ground current. The ground leakage current depends on various system configurations including RFI filtering, shielded motor cables, and drive system power.
If the leakage current exceeds 3.5 mA, EN/IEC 61800-5-1 (Power Drive System Product Standard) requires special care.

Grounding must be reinforced in 1 of the following ways:

- **Ensure the correct grounding of the equipment by a certified electrical installer.**
- **Ground wire of at least 10 mm^2 (6 AWG).**
- **Two separate ground wires, both complying with the dimensioning rules.**

See EN 60364-5-54 § 543.7 for further information.

⚠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 the installation.**
- **Ensure that electrical work conforms to national and local electrical codes.**
- **Follow the procedures in this document.**

⚠CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

There is a risk of personal injury when the drive modules are not properly closed.

- **Before applying power, ensure that all safety covers are in place and securely fastened.**

⚠WARNING

HEAVY LOAD

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

- **Never walk under suspended loads.**
- **To guard against injury, wear personal protective equipment such as gloves, safety glasses, and safety shoes.**
- **Be sure to use lifting devices with the appropriate weight rating. The lifting bar must be able to handle the weight of the load.**
- **The load's center of gravity may be in an unexpected location. Failure to locate the center of gravity correctly, and position the load accordingly before lifting the load, can cause the unit to fall over or tilt unexpectedly during lifting and transport.**
- **The angle from the top of the drive module to the lifting cables has an impact on the maximum load force on the cable. This angle must be 65° or greater. Attach and dimension the lifting cables properly.**

⚠WARNING

UNINTENDED MOTOR ROTATION WINDMILLING

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

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

⚠WARNING

DISCONNECT POWER BEFORE SERVICING

Sometimes during installation, AC mains power is applied but then must be disconnected to change the line connections. Failure to follow these steps can result in death or serious injury.

- **Disconnect the frequency converters from the AC mains, 230 V supply, and motor lines.**
- **After the lines have been disconnected, wait 20 minutes for the capacitors to discharge.**

3 Product Overview

3.1 Intended Use

A frequency converter is an electronic motor controller that uses 1 or more drive modules to convert AC mains input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The frequency converter varies the motor speed based on system feedback, such as position sensors on a conveyor belt. The frequency converter also regulates the motor in response to remote commands from external controllers.

The VLT® Common AC Drive Modules basic kit described in this guide is UL 508 C compliant. The kit is used to create drive systems of 2 or 4 drive modules. These drive modules are based on the D4h frequency converter and can provide a greater power range in a smaller enclosure. The basic kit is designed to allow the flexibility to either order components through Danfoss or fabricate custom components.

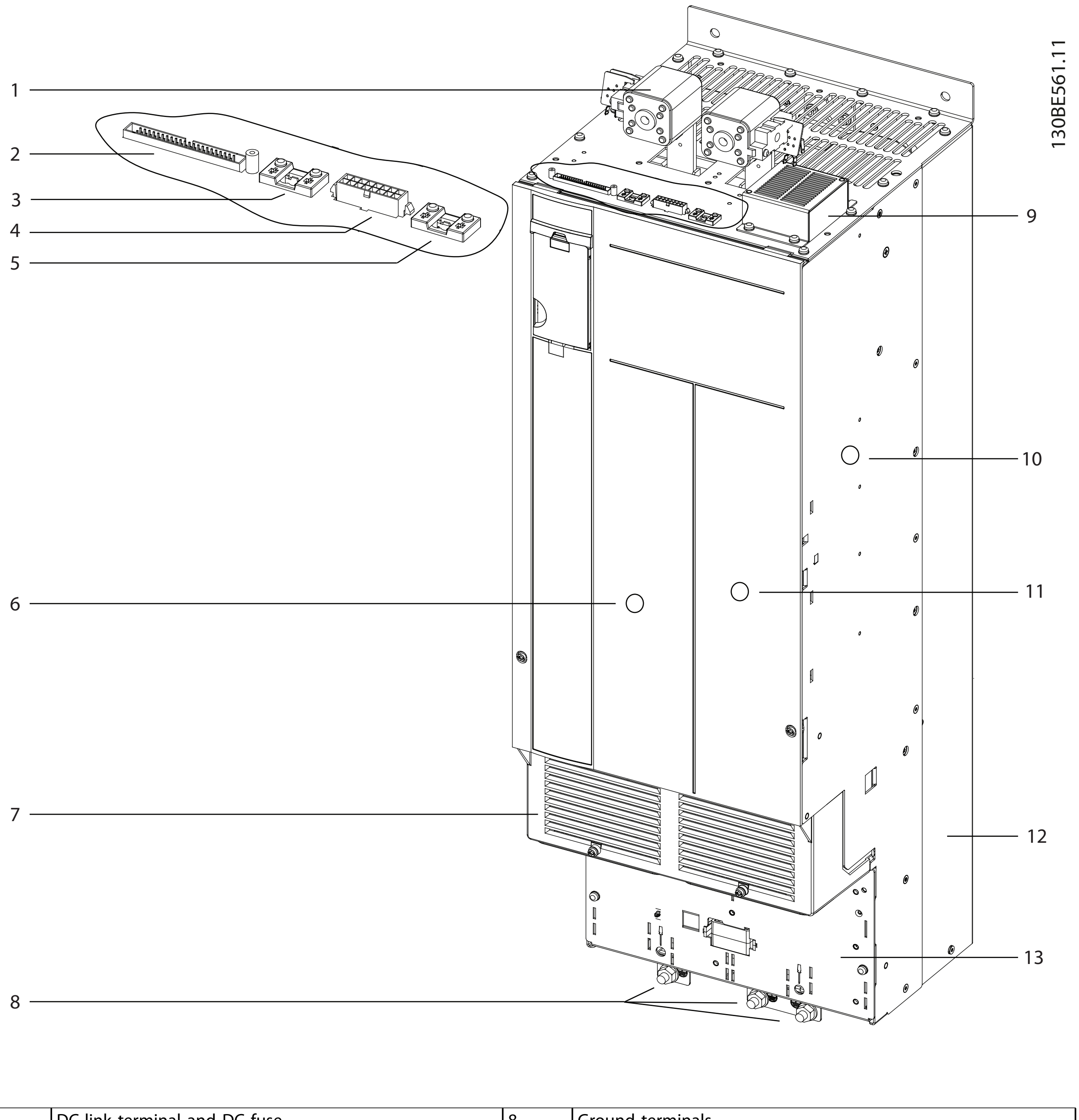
The basic kit contains the following components:

- Drive modules
- Control shelf
- Wire harnesses
    - Ribbon cable with 44-pin connector (on both ends of the cable)
    - Relay cable with 16-pin connector (on 1 end of the cable)
    - DC fuse microswitch cable with 2-pin connectors (on 1 end of the cable)
- DC fuses

Other components, such as bus bar kits and back-channel cooling duct kits, are available to customize the drive system.

3.2 Drive Modules

Each drive module has an IP00 protection rating. Either 2 or 4 drive modules can be connected in parallel to create a drive system, based on power requirements.

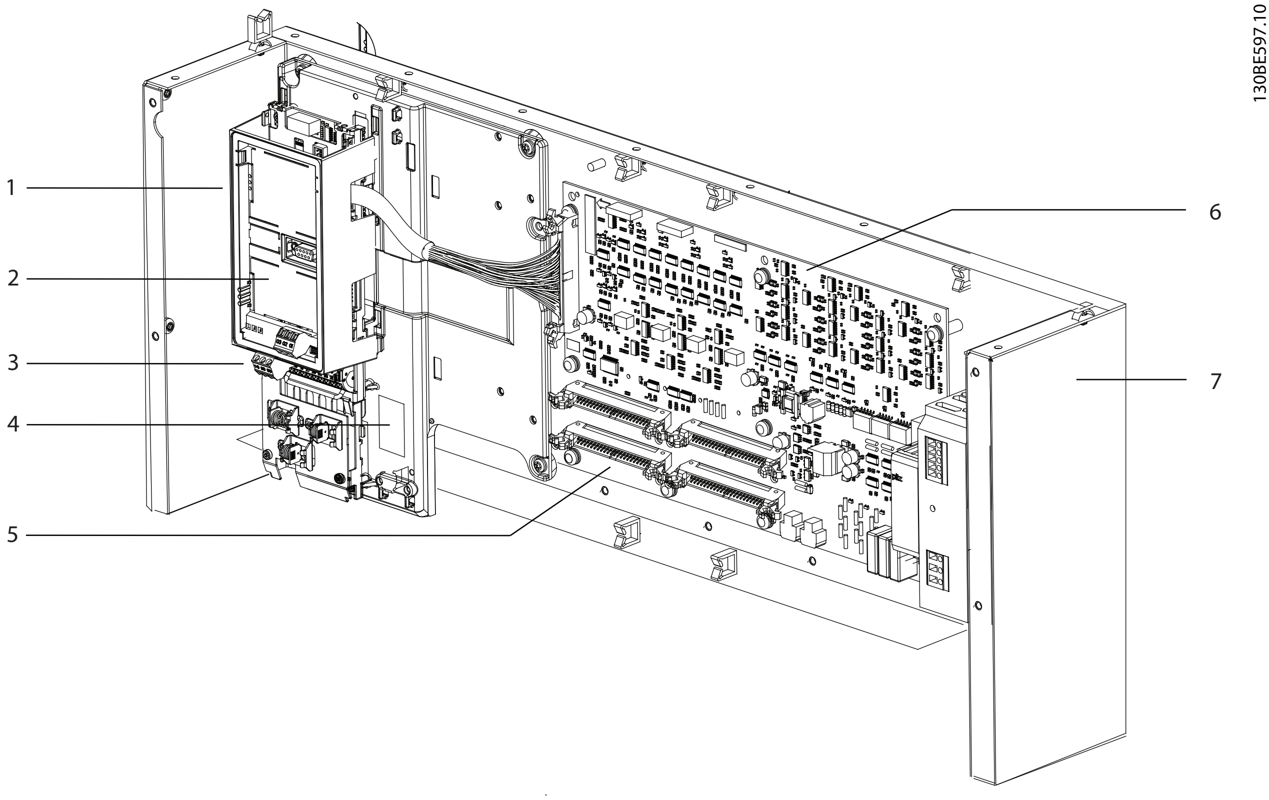


1	DC-link terminal and DC fuse	8	Ground terminals
2	MDCIC plug	9	Top fan
3	Microswitch to DC fuse	10	Drive module label. See *Illustration 4.2*.
4	Relays 1 and 2	11	Motor output terminals
5	Brake fault jumper and connector	12	Heat sink and heat sink fan
6	Mains input terminals	13	Ground plate
7	Enclosure door vents	–	–

Illustration 3.1 Drive Module Overview

3.3 Control Shelf

The control shelf contains the LCP, MDCIC, and control card. The LCP provides access to the system parameters. The MDCIC is connected to each of the drive modules via a ribbon cable and communicates to the control card. The control card controls the operation of the drive modules.



1	LCP cradle	5	44-pin cables from MDCIC board to drive modules
2	Control card (underneath cover)	6	MDCIC card
3	Control terminal blocks	7	Control shelf
4	Top-level drive system label. See *Illustration 4.1*.	–	–

Illustration 3.2 Control Shelf

3.4 Wire Harness

The VLT® Common AC Drive Modules basic kit contains the following wire harnesses:

- Ribbon cable with 44-pin connector (on both ends of the cable)
- Relay cable with 16-pin connector (on 1 end of the cable)
- DC fuse microswitch cable with 2-pin connectors (on 1 end of the cable)

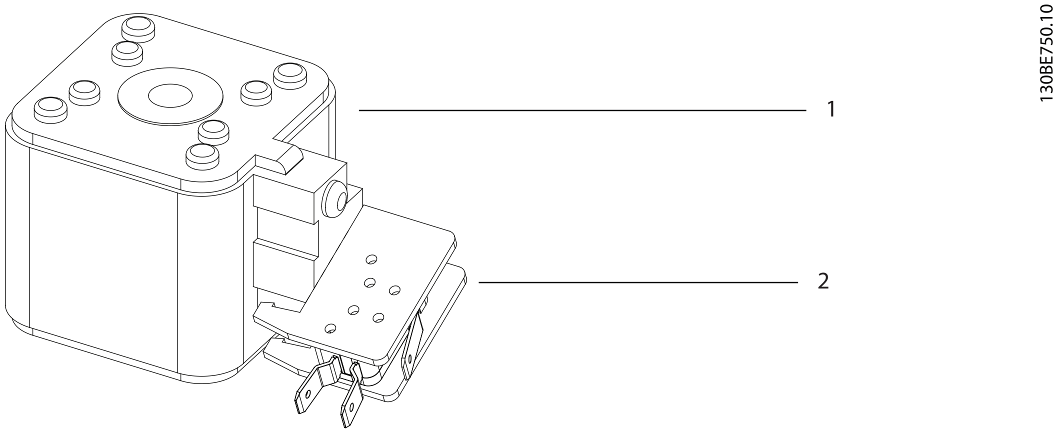
3

3.5 DC Fuses

The VLT® Common AC Drive Modules kit contains 2 DC fuses per drive module. These fuses on the supply side ensure that any damages are contained to inside the drive modules.

NOTICE

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



1	DC fuse	2	Microswitch connector

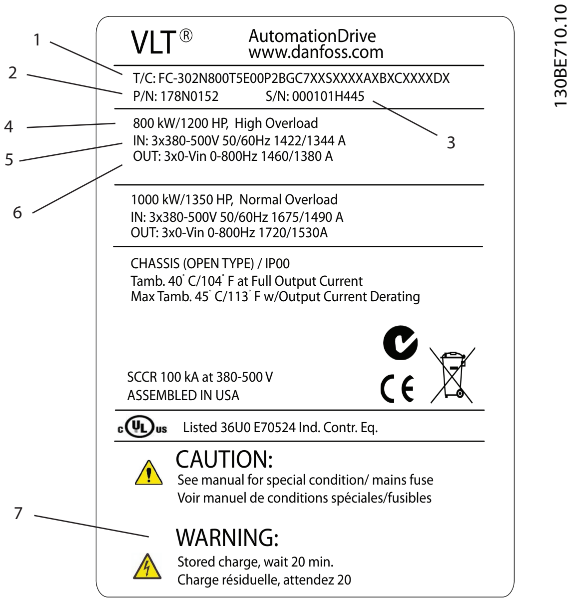
Illustration 3.3 DC Fuse and Microswitch Connector

4 Mechanical Installation

4.1 Receiving and Unpacking the Unit

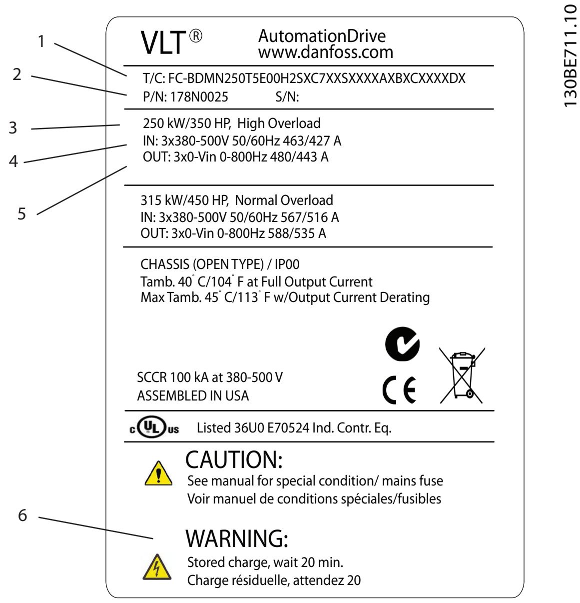
4.1.1 Items Supplied

- Make sure the items supplied and the information on the labels correspond to the order.
    - Top-level drive system. This label is found on the control shelf, lower right side of the LCP. See *Illustration 3.2*.
    - Drive module. This label is found inside the drive module enclosure, on the right side panel. See *Illustration 3.1*.
- Visually check the packaging and the VLT® Common AC Drive Modules components for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts, in case clarification is needed.



1	Type code
2	Code number
3	Serial number (last 3 digits indicate the week and year that the unit was built, for example 384 = week 38 of 2014)
4	Power rating
5	Input voltage, frequency, and current
6	Output voltage, frequency, and current
7	Discharge time

Illustration 4.1 Top-level Drive System Label (Example)



1	Type code
2	Code number
3	Power rating
4	Input voltage, frequency, and current
5	Output voltage, frequency, and current
6	Discharge time

Illustration 4.2 Drive Module Label (Example)

NOTICE

LOSS OF WARRANTY

Removing the labels from the VLT® Common AC Drive Modules can result in loss of warranty.

Receiving and unloading

- I-beam and hooks rated to lift a drive module having a weight of 125 kg (275 lb), with the necessary safety margins.
- Crane or other lifting aid rated to lift the minimum weight specified in the documentation package supplied with the drive module.
- Crowbar to disassemble the wooden shipping container.

Installation

- Drill with 10 mm or 12 mm drill bits.
- Tape measurer.
- Screwdriver.
- Wrench with relevant metric sockets (7–17 mm).
- Wrench extensions.
- Torx T50 tool.

Cabinet Construction
Acquire the tools necessary for assembly of the panel – according to the design plans and established practices.

4.1.2 Lifting the Unit

For measurements and center of gravity, see *chapter 7.8 Kit Dimensions*.

- Ensure that the lifting device is suitable for the task.
- Move the unit using a hoist, crane, or forklift with the appropriate rating.
- Always use the dedicated lifting eye bolts.

⚠CAUTION

HEAVY LOAD

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

- **Never walk under suspended loads.**
- **To guard against injury, wear personal protective equipment such as gloves, safety glasses, and safety shoes.**
- **Be sure to use lifting devices with the appropriate weight rating. The lifting bar must be able to handle the weight of the load.**
- **The load’s center of gravity may be in an unexpected location. Failure to locate the center of gravity correctly and position the load accordingly before lifting the load can cause the unit to fall over or tilt unexpectedly during lifting and transport.**
- **The angle from the top of the drive module to the lifting cables has an impact on the maximum load force on the cable. This angle must be 65° or greater. Attach and dimension the lifting cables properly.**

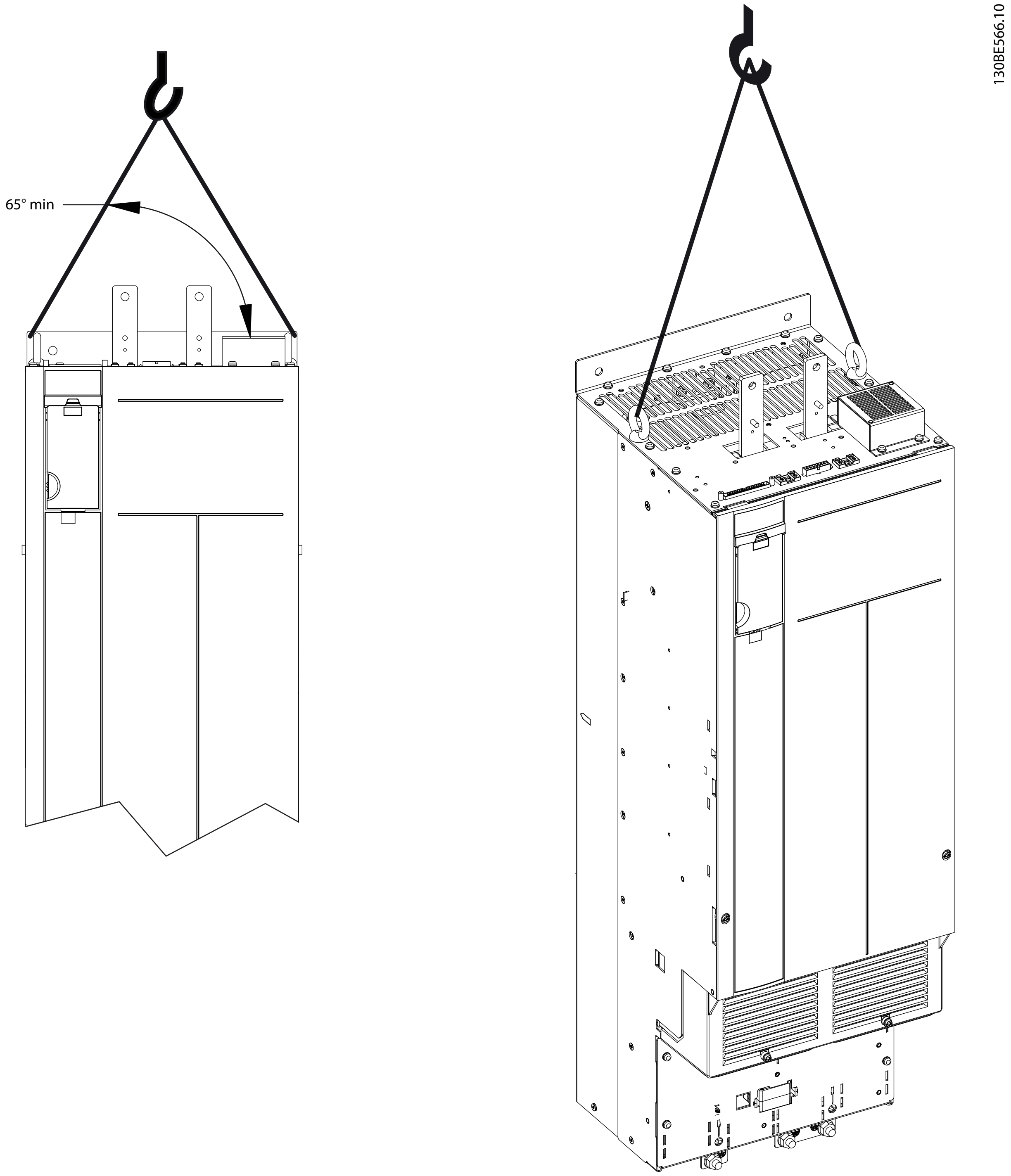


Illustration 4.3 Lifting the Drive Module

4.1.3 Storage

Store the kit in a dry location. Keep the equipment sealed in its packaging until installation. Refer to *chapter 7.5 Ambient Conditions for Drive Modules* for recommended ambient conditions.

4.2 Requirements

4.2.1 Environmental

Refer to *chapter 7.5 Ambient Conditions for Drive Modules* for information on required operating temperature, humidity, and other environmental conditions.

For information on the heat dissipation, refer to *chapter 7.1 Power-dependent Specifications*. For required cooling air, refer to *chapter 4.2.4 Cooling and Airflow Requirements*.

4.2.2 Cabinet

The kit consists of either 2 or 4 drive modules, depending on the power rating. The cabinets have to meet the following minimum requirements:

Width [mm (in)]	2-drive: 800 (31.5), 4-drive: 1600 (63)
Depth [mm (in)]	600 (23.6)
Height [mm (in)]	2000 (78.7)[1]
Weight capacity [kg (lb)]	2-drive: 450 (992), 4-drive: 910 (2006)
Ventilation openings	See *chapter 4.2.4 Cooling and Airflow Requirements*.

Table 4.1 Cabinet Requirements

1) Required if Danfoss bus bar or cooling kits are used.

4.2.3 Bus Bars

For terminal dimensions for creating bus bars, refer to *chapter 7.8.2 Terminal Dimensions* and *chapter 7.8.3 DC Bus Dimensions*.

Description	Width [mm (in)]	Thickness [mm (in)]
AC motor	143.6 (5.7)	6.4 (0.25)
AC mains	143.6 (5.7)	6.4 (0.25)
DC bus	76.2 (3.0)	12.7 (0.50)

Table 4.2 Bus Bar Cross-section Measurements

NOTICE

To allow the maximum flow of cooling air, align bus bars vertically.

4.2.4 Cooling and Airflow Requirements

The recommendations provided in this section are necessary for effective cooling of the drive modules within the panel enclosure. Waste heat is removed through a combination of back-channel cooling and fans mounted on the top of the drive module and in the cabinet.

NOTICE

Make sure that the total flow of the cabinet fans meets the recommended airflow.

Drive module cooling fans

The drive module is equipped with a heat sink fan, which provides the required flow rate of 840 m^3/h (500 cfm) across the heat sink. Also, there is a cooling fan mounted on the top of the unit, and a small 24 V DC mixing fan mounted under the input plate that operates any time the drive module is powered on.

In each drive module, the power card provides DC voltage to power the fans. The mixing fan is powered by 24 V DC from the main switch mode power supply. The heat sink fan and the top fan are powered by 48 V DC from a dedicated switch mode power supply on the power card. Each fan has a tachometer feedback to the control card to confirm that the fan is operating correctly. On/off and speed control of the fans is provided to reduce unnecessary acoustical noise and extend the life of the fans.

Cabinet fans

With back-channel cooling, 1 or more fans may be mounted in the cabinet to remove waste heat not contained by the back channel, and any additional heat generated by other components inside the enclosure. When back-channel cooling and its associated ducts are not used, fans mounted in the cabinet must remove all the heat generated inside the enclosure.

For each enclosure housing 2 drive modules, the cabinet fan flow recommendation is as follows:

- When back-channel cooling is used, the recommended flow of the cabinet fans is 680 m^3/h (400 cfm).
- When back-channel cooling is not used, the recommended total flow of the cabinet fans is 4080 m^3/h (2400 cfm).

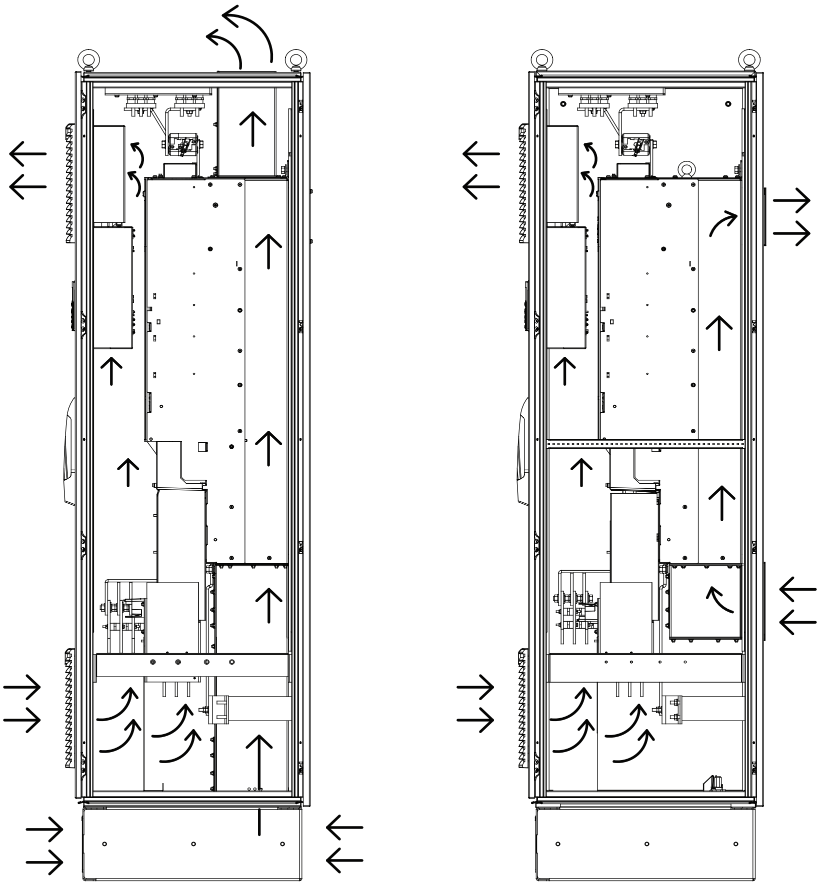


Illustration 4.4 Airflow, Standard Unit (left) and with Back-channel Cooling Kit (right)

4.3 Installing the Drive Modules

Install the drive modules into the cabinet frame as described in the following steps.

1. Unpack the drive modules from the packaging. See *chapter 4.1 Receiving and Unpacking the Unit*.
2. Install 2 eye bolts in the top of the first drive module. Prepare the drive module for lifting, using an appropriate lifting harness and an overhead hoist or crane with the necessary lifting capacity. See *chapter 4.1.2 Lifting the Unit*.

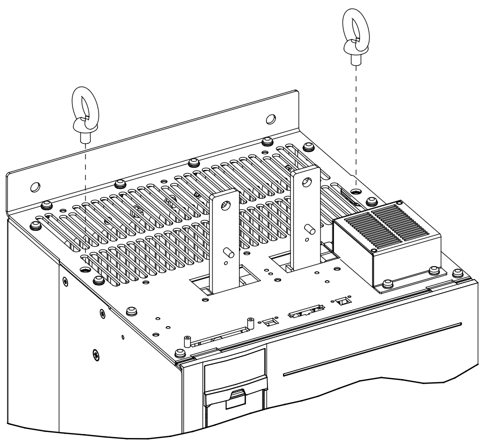


Illustration 4.5 Installation of Eye Bolts

3. Install the 2 bottom mounting bolts and gaskets onto the backplate.
4. Using the crane or hoist, lift the drive module and then lower the unit through the top of the cabinet frame. Align the bottom mounting holes of the unit with the 2 bottom mounting bolts on the backplate.
5. Verify that the drive module is correctly aligned on the backplate and then secure the bottom of the unit to the backplate with the 2 hex nuts. See *Illustration 4.6*. Torque the hex nuts. Refer to *chapter 7.9 Fastener Tightening Torques*.
6. Secure the top of the unit to the backplate with M10x26 bolts, and then torque the bolts.
7. Install the next drive module.

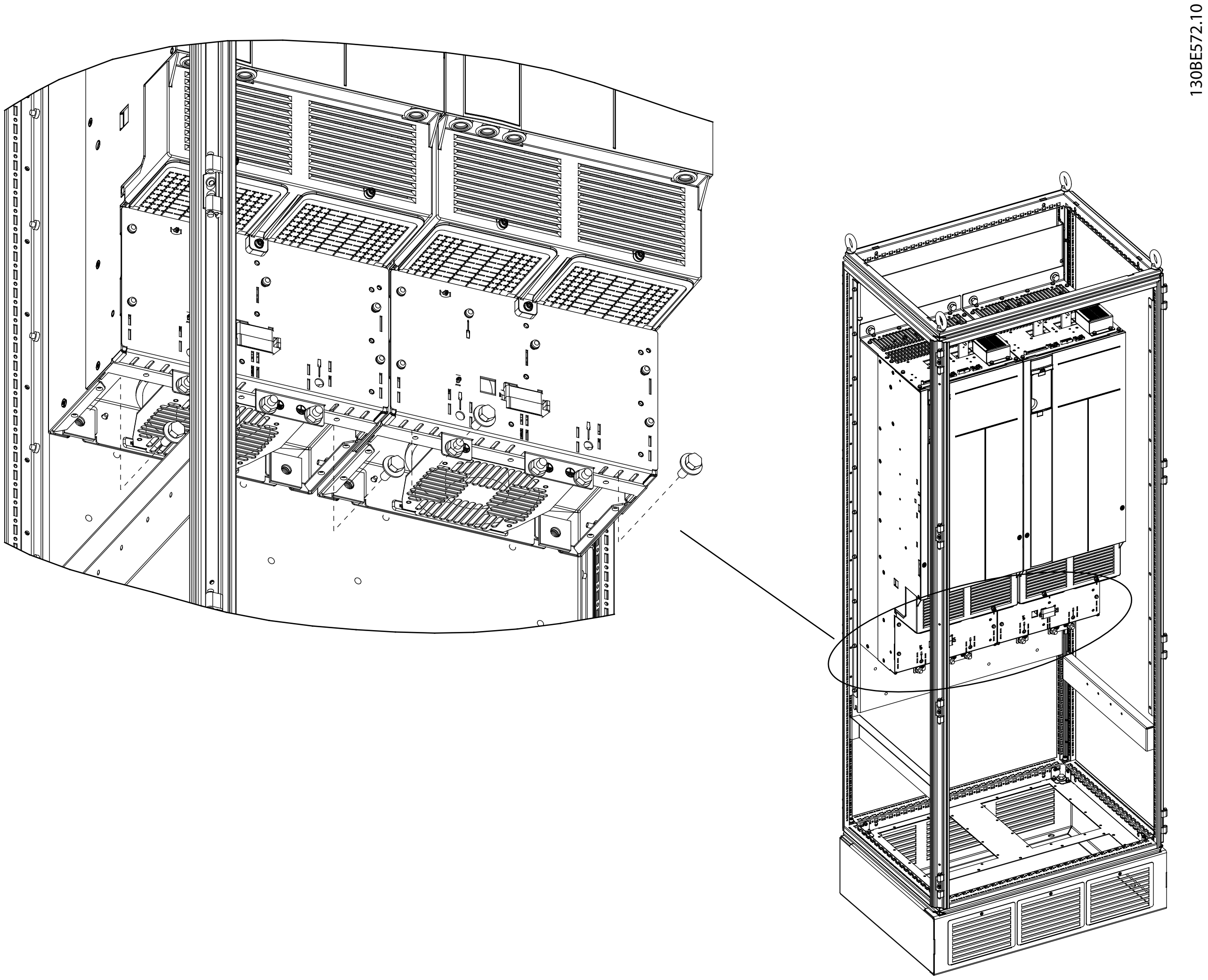


Illustration 4.6 Installation of Bottom Mounting Bolts

4.4 Installing the Control Shelf

Install the control shelf assembly as follows:

NOTICE

To avoid RFI, do not route control wiring together with power cables or bus bars.

1. Remove the control shelf assembly from its package.
2. Remove the LCP from the control shelf.
3. Install the control shelf mounting brackets on the cabinet frame. Ensure that the brackets are mounted at the correct height.
4. Install the control shelf assembly onto the mounting brackets. See *Illustration 4.7*.
5. Remove the MDCIC cover from the control shelf assembly.
6. Connect the 44-pin ribbon cables from the MDCIC card to the top of the drive modules, following the sequence numbers indicated next to the connectors on the MDCIC.
7. Route the 44-pin ribbon cables inside the cabinet.
8. Connect the external brake fault wiring harness between the microswitch terminals and the brake jumper connector on the top of the drive module.
9. Connect the relay wiring between relay 1 or 2 on the control shelf and the corresponding relay connector on the top of the drive module.
10. Connect the microswitch to the microswitch connector provided on the top of the drive module. Refer to *Illustration 3.3*.

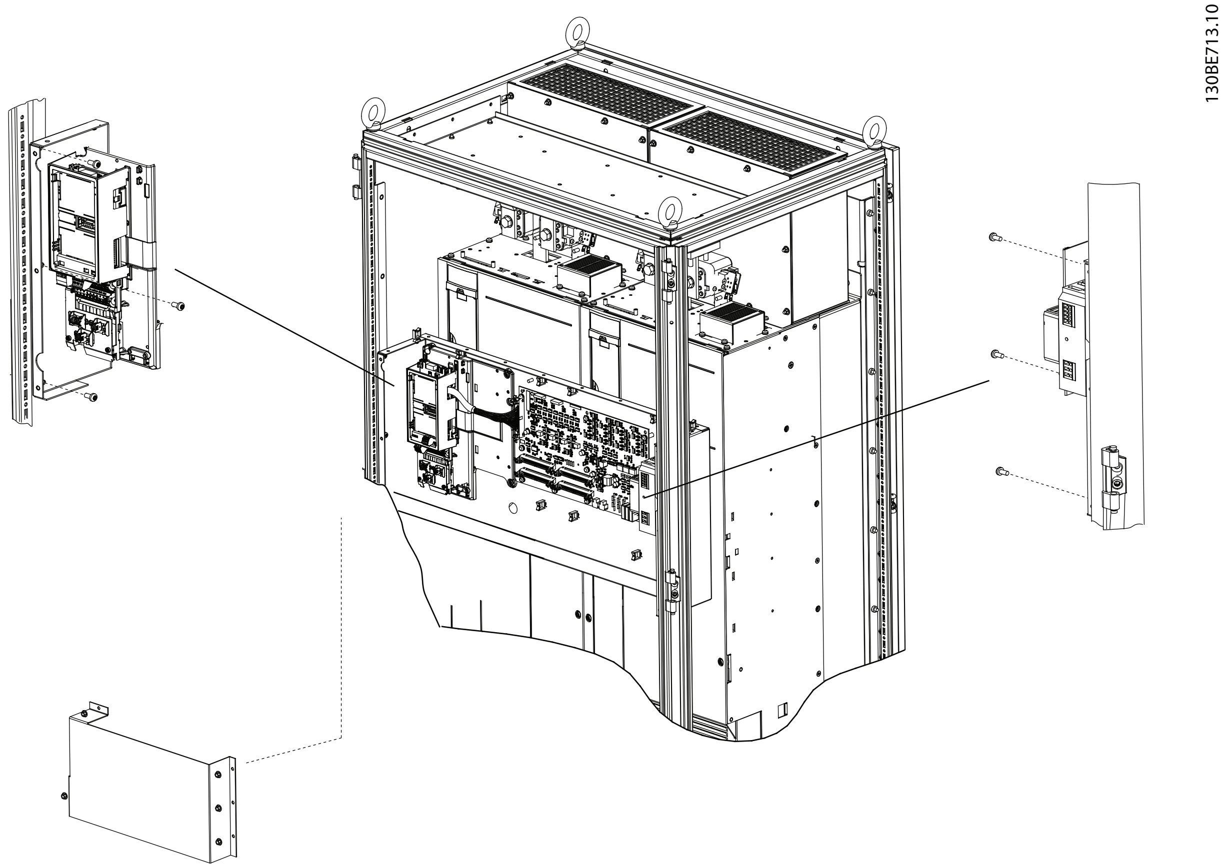


Illustration 4.7 Control Shelf Installation

5 Electrical Installation

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

WARNING

INDUCED VOLTAGE!

When output motor cables from different frequency converters are run together, induced voltage can charge equipment capacitors even with the equipment turned off and locked out.

To avoid death or serious injury:

- **Run output motor cables separately or use shielded cables.**
- **Simultaneously lock out all the frequency converters.**

CAUTION

SHOCK HAZARD

The drive system can cause a DC current in the protective earth (PE) conductor.

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

Failure to follow this recommendation could prevent the RCD from providing the intended protection.

Overcurrent protection

- Extra protective equipment such as short-circuit protection or motor thermal protection between the drive modules and the motors is required for applications with multiple motors.
- The correct input fusing is required to acquire approvals and meet certification requirements, and to provide short circuit and overcurrent protection. These fuses are not factory-supplied, and must be provided by the installer. See maximum fuse ratings in *chapter 7.1 Power-dependent Specifications*.

Wire type and ratings

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

See *chapter 7.6 Cable Specifications* for recommended wire sizes and types.

CAUTION

PROPERTY DAMAGE

Protection against motor overload is not included in the default setting. To program the LCP for this function, refer to the *VLT® Common AC Drive Modules User Guide*.

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5.2 Wiring Diagram

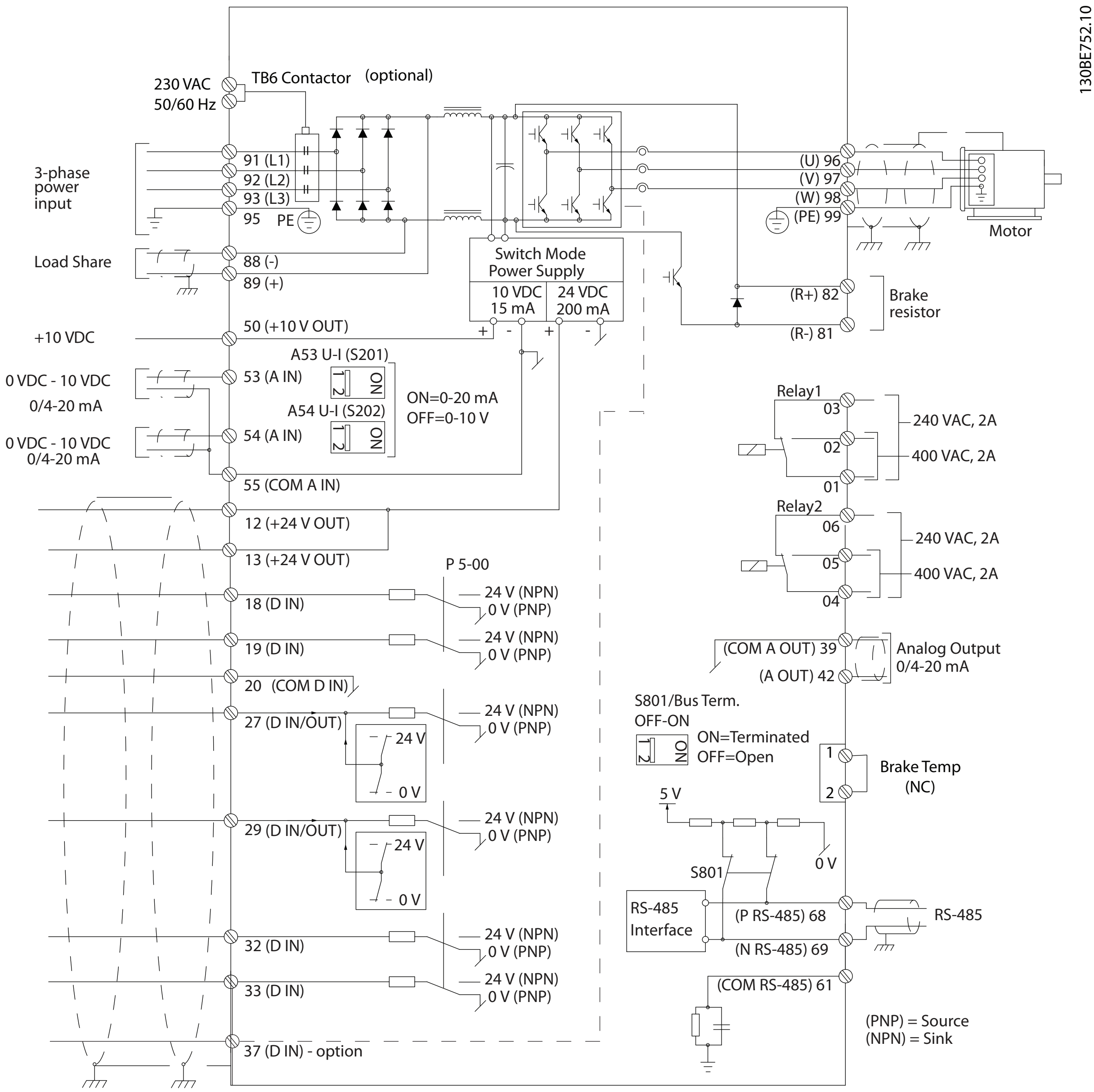


Illustration 5.1 Wiring Diagram

5.3 Electrical Requirements for Certifications and Approvals

5.3.1 Fuse Selection

It is recommended to use fuses and/or circuit breakers at the mains supply side as protection if a breakdown of 1 or more internal components of the drive module occur.

NOTICE

The use of fuses and/or circuit breakers is mandatory to ensure compliance with CE IEC 60364 or UL NEC2009.

5.3.1.1 Branch Circuit Protection

To protect the installation against electrical and fire hazards, protect all branch circuits in an installation, for example in switch gear and machines, against short circuit and overcurrent according to national and international regulations.

5.3.1.2 Short-circuit Protection

Danfoss recommends the fuses listed in *chapter 5.3.1.3 Recommended Fuses for CE Compliance* and *chapter 5.3.1.4 Recommended Fuses for UL Compliance* to achieve CE or UL compliance in the protection of service personnel and property against the consequences of component breakdown in the drive modules.

5.3.1.3 Recommended Fuses for CE Compliance

Drive modules in system	FC 302 modules [kW]	FC 102 and FC 202 modules [kW]	Recommended fuse	Recommended fuse (maximum)
2	N250	N315	aR-630	aR-630
2	N315	N355	aR-630	aR-630
2	N355	N400	aR-630	aR-630
2	N400	N450	aR-800	aR-800
2	N450	N500	aR-800	aR-800
4	N500	N560	aR-900	aR-900
4	N560	N630	aR-900	aR-900
4	N630	N710	aR-1600	aR-1600
4	N710	N800	aR-1600	aR-1600
4	N800	N1M0	aR-1600	aR-1600

Table 5.1 12-Pulse Drive Systems (380–500 V AC)

Drive modules in system	FC 302 modules [kW]	FC 102 and FC 202 modules [kW]	Recommended fuse	Recommended fuse (maximum)
2	N450	N500	aR-1600	aR-1600
4	N500	N560	aR-2500	aR-2500
4	N560	N630	aR-2500	aR-2500
4	N630	N710	aR-2500	aR-2500
4	N710	N800	aR-2500	aR-2500
4	N800	N1M0	aR-2500	aR-2500

Table 5.2 6-Pulse Drive Systems (380–500 V AC)

Drive modules in system	FC 302 modules [kW]	FC 102 and FC 202 modules [kW]	Recommended fuse	Recommended fuse (maximum)
2	N250	N315	aR-550	aR-550
2	N315	N355	aR-630	aR-630
2	N355	N400	aR-630	aR-630
2	N400	N500	aR-630	aR-630
2	N500	N560	aR-630	aR-630
2	N560	N630	aR-900	aR-900
4	N630	N710	aR-900	aR-900
4	N710	N800	aR-900	aR-900
4	N800	N900	aR-900	aR-900
4	N900	N1M0	aR-1600	aR-1600
4	N1M0	N1M2	aR-1600	aR-1600

Table 5.3 12-Pulse Drive Systems (525–690 V AC)

Drive modules in system	FC 302 modules [kW]	FC 102 and FC 202 modules [kW]	Recommended fuse	Recommended fuse (maximum)
4	N630	N710	aR-1600	aR-1600
4	N710	N800	aR-2000	aR-2000
4	N800	N900	aR-2500	aR-2500
4	N900	N1M0	aR-2500	aR-2500
4	N1M0	N1M2	aR-2500	aR-2500

Table 5.4 6-Pulse Drive Systems (525–690 V AC)

5

5.3.1.4 Recommended Fuses for UL Compliance

- The drive modules are supplied with built-in AC fuses. The modules have been qualified for 100 kA short circuit current rating (SCCR) for the standard bus bar configurations at all voltages (380–690 V AC).
- The drive system is qualified for 100 kA SCCR with any Class L or Class T UL-listed fuses connected at the input terminals of the drive modules, if no power options or extra bus bars are connected externally.
- The current rating of the Class L or Class T fuses should not exceed the listed fuse rating in *Table 5.5* to *Table 5.8*.

Drive modules in system	FC 302 modules [kW]	FC 102 and FC 202 modules [kW]	Recommended fuse (maximum)
2	N250	N315	aR-630
2	N315	N355	aR-630
2	N355	N400	aR-630
2	N400	N450	aR-800
2	N450	N500	aR-800
4	N500	N560	aR-900
4	N560	N630	aR-900
4	N630	N710	aR-1600
4	N710	N800	aR-1600
4	N800	N1M0	aR-1600

Table 5.5 12-Pulse Drive Systems (380–500 V AC)

Any minimum 500 V UL-listed fuse can be used for the 380–500 V AC drive systems.

Drive modules in system	FC 302 modules [kW]	FC 102 and FC 202 modules [kW]	Recommended fuse (maximum)
2	N450	N500	aR-1600
4	N500	N560	aR-2500
4	N560	N630	aR-2500
4	N630	N710	aR-2500
4	N710	N800	aR-2500
4	N800	N1M0	aR-2500

Table 5.6 6-Pulse Drive Systems (380–500 V AC)

Any minimum 500 V UL-listed fuse can be used for the 380–500 V AC drive systems.

Drive modules in system	FC 302 modules [kW]	FC 102 and FC 202 modules [kW]	Recommended fuse (maximum)
2	N250	N315	aR-550
2	N315	N355	aR-630
2	N355	N400	aR-630
2	N400	N500	aR-630
2	N500	N560	aR-630
2	N560	N630	aR-900
4	N630	N710	aR-900
4	N710	N800	aR-900
4	N800	N900	aR-900
4	N900	N1M0	aR-1600
4	N1M0	N1M2	aR-1600

Table 5.7 12-Pulse Drive Systems (525–690 V AC)

Any minimum 700 V UL-listed fuse can be used for the 525–690 V AC drive systems.

Drive modules in system	FC 302 modules [kW]	FC 102 and FC 202 modules [kW]	Recommended fuse (maximum)
4	N630	N710	aR-1600
4	N710	N800	aR-2000
4	N800	N900	aR-2500
4	N900	N1M0	aR-2500
4	N1M0	N1M2	aR-2500

Table 5.8 6-Pulse Drive Systems (525–690 V AC)

Any minimum 700 V UL-listed fuse can be used for the 525–690 V AC drive systems.

5.4 Electrical Kit Installation

This section describes how the electrical kit is used to connect 2 or 4 drive modules in parallel – to provide controlled power to an AC motor. A diagram is provided for each of the 4 configurations which, if followed, meet specific agency approvals and certifications. If designing and building other configurations, seek agency approvals or certifications apart from Danfoss.

Read the following section for guidance in making electrical connections when assembling the drive modules into a panel.

5.5 DC Bus Fuse Installation

DC fuses are provided in the basic kit. Install the DC fuses at the available DC terminals at individual drive modules, using the recommended bolts. Each DC fuse has a fixture for mounting the micro switches, which are used to detect a fuse failure. See *Illustration 3.3*. Install the supplied harness between the microswitch terminals and the brake fault jumper port on the top of the drive modules. If the jumper is not installed properly, the drive does not power up and the error *Brake IGBT Fault* is shown. The microswitch has 3 terminals: NO, NC, and COM. Connect the wire harness between the NC and COM terminals. If it is connected between any other terminals, the drive does not power up, and the error *Brake IGBT Fault* is shown.

NOTICE

The Microswitch is a snap fit onto the fuse. Ensure that the switch is properly installed on the fuses.

5.6 Motor Connections

5.6.1 Motor Cables

See *chapter 7.6 Cable Specifications* for more information on wire type and sizes.

NOTICE

SHIELDED CABLE LENGTH

With a standard VLT® Common AC Drive Modules drive system, shielded cables up to 150 m (492 ft) long or unshielded up to 300 m (984 ft) long provide full voltage at the motor. If this cable length is exceeded, use a dU/dt filter. For information on the selection of a dU/dt filter, refer to the *VLT® Common AC Drive Modules Design Guide*.

5.6.1.1 Voltage Rating

Peak voltages up to 2.8 times the mains voltage of the VLT® Common AC Drive Modules drive system can occur in the motor cable. High peak voltages can severely stress the motor cable. Use motor cables with rated voltage specification of at least 0.6/1 kV. Cables in this range provide good resistance to insulation breakdown.

5.6.1.2 Dimensions

Follow local codes for current capacity data for cables and conductors. Widely used codes include: NFPA 70, EN 60204-1, VDE 0113-1, and VDE 0298-4. Overdimensioning for harmonics is not required.

5.6.1.3 Length

Keep cables as short as possible. Voltage drop and heat dissipation depends on the frequency and is approximately proportional to cable length. Consult the cable manufacturer specifications regarding the length and expected voltage drop when connected to the drive system. See *chapter 7.6 Cable Specifications*.

5.6.1.4 Shielding

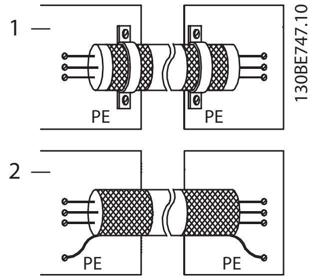
The following factors are important for effective shielding:

- Make sure that the amount of cable surface covered by the shield is at least 80%.
- Use a single-layer braided copper shield. Ensure that the shield is braided to reduce surface area for leakage currents.
- Use cables with double shielding to improve the attenuation of interference further. Twisted conductors reduce magnetic fields.
- Use cables that are shielded at both ends between the drive system and the motor.
- To comply with radio frequency interference limits, cables between the drive system and the motor must be shielded at both ends.
- Ensure that the shield fully surrounds the cable.
- Route cable glands or cable clamps directly to the grounding point.
- Keep connections as short as possible at each end of the cable.
- Bridge shield gaps such as terminals, switches, or contactors by using connections with the lowest possible impedance and the largest possible surface area.

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. To avoid twisted shield ends, use integrated shield clamps. Refer to *Illustration 5.2*.



1	Correct grounding of shielded ends
2	Incorrect grounding using twisted shield ends (pigtail)

Illustration 5.2 Example of Shield Ends

5.6.2 Installing Thermal Protection

5.6.2.1 PTC Thermistor

Using a digital input and 10 V supply

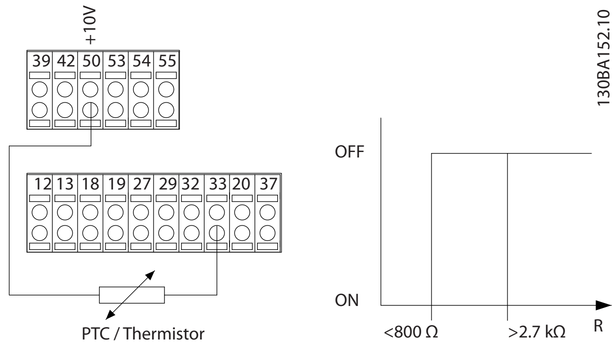


Illustration 5.3 PTC Thermistor Connection - Digital Input with 10 V Supply

Using an analog input and 10 V supply

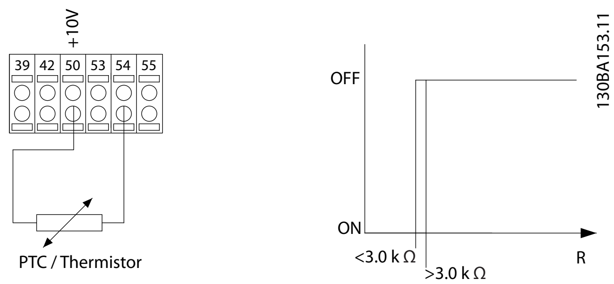


Illustration 5.4 PTC Thermistor Connection - Analog Input with 10 V Supply

Using a digital input and 24 V as supply

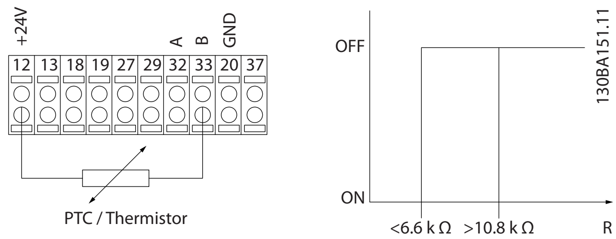


Illustration 5.5 PTC Thermistor Connection - Digital Input with 24 V Supply

Check that the selected supply voltage follows the specification of the used thermistor element.

Input digital/ analog	Supply voltage [V]	Trip resistance kΩ	Reset resistance
Digital	10	> 2.7	<800 Ω
Analog	10	> 3.0	<3.0 kΩ
Digital	24	> 10.8	<6.6 kΩ

Table 5.9 PTC Thermistor Resistance Parameters

5.6.2.2 KTY Sensor

FC 302 can handle 3 types of KTY sensors:

- KTY Sensor 1: 1 kΩ at 100 °C (for example, Philips KTY 84–1).
- KTY Sensor 2: 1 kΩ at 25 °C (for example, Philips KTY 83–1).
- KTY Sensor 3: 1 kΩ at 25 °C (for example, Philips KTY–10).

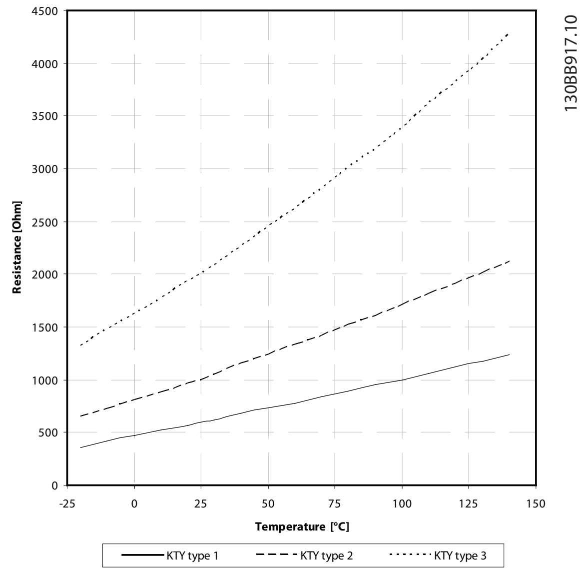


Illustration 5.6 KTY Type Selection

NOTICE

PELV COMPLIANCE

When motor temperature is monitored via a thermistor or KTY sensor, PELV compliance is not achieved if short circuits occur between motor windings and the sensor. Ensure that the sensor is isolated better.

5.6.2.3 Brake Resistor Thermal Switch Installation

Each drive module has a brake fault jumper connector on the top plate. This connector has a pre-installed jumper as shown in *Illustration 8.3*.

The brake fault jumper must always be in place to ensure proper operation of the drive module. Without this jumper connection, the drive module does not allow the inverter to operate, and a brake IGBT fault is shown.

The brake fault jumper connector is provided for connection of the Klixon thermal switch on the brake resistors. The thermal switch is a normally-closed type. If the temperature of the brake resistor exceeds the recommended values, the thermal switch opens. Make the connection as shown in *Illustration 8.5*, using 1 mm^2 (18 AWG), reinforced and doubly insulated wire.

NOTICE

Danfoss is not responsible for the failure of any Klixon thermal switch.

5.6.3 Motor Terminal Connections

⚠WARNING

INDUCED VOLTAGE

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

- **Run output motor cables separately.**

Or

- **Use shielded cables.**
- **Simultaneously lock out all the frequency converters.**

- Comply with local and national electrical codes for cable sizes. For maximum cable sizes, see *chapter 7.1 Power-dependent Specifications*.
- Follow motor manufacturer wiring requirements.
- Do not wire a starting or pole-changing device (for example, Dahlander motor or slip ring induction motor) between the drive system and the motor.

5.6.3.1 Motor Cable

All types of 3-phase asynchronous standard motors can be used with the drive system.

Connect the motor to the following terminals:

- U/T1/96
- V/T2/97
- W/T3/98
- Ground to terminal 99

Factory setting is for clockwise rotation with the drive system output connected as follows:

Terminal number	Function
96	Mains U/T1
97	V/T2
98	W/T3
99	Ground

Table 5.10 Motor Cable Terminals

- Terminal U/T1/96 connected to U-phase
- Terminal V/T2/97 connected to V-phase
- Terminal W/T3/98 connected to W-phase

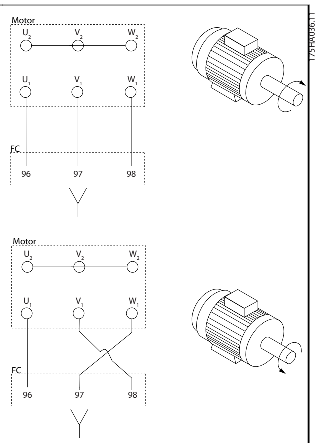


Table 5.11 Changing Motor Rotation

The direction of rotation can be changed by switching 2 phases in the motor cable, or by changing the setting of *parameter 4-10 Motor Speed Direction*.

Motor rotation check can be performed using *parameter 1-28 Motor Rotation Check* and following the steps shown in *Table 5.11*.

5.6.3.2 Motor Terminal Connections in 2-Drive Module Systems

Illustration 8.9 and *Illustration 8.10* show the bus bar connections for 6-pulse and 12-pulse 2-D systems, respectively.

5

1. There is 1 set of common terminals for the motor.

NOTICE

If it is decided not to use common terminals in the construction of a system using 2 drive modules, then use cable quantities in multiples of 2.

2. If there are multiple runs, make sure that the cables are within 10% of one another. Measure between the common terminals and the first common point of a phase, normally the motor terminals.
3. Strip a section of the outer cable insulation.
4. Connect the ground wire to the nearest protective earth terminal.
5. Connect the 3-phase motor wiring to terminals U/96, V/97, and W/98, using the recommended bolts. See *chapter 7.9.1 Tightening Torques for Terminals*.
6. Tighten the motor terminals 19–40 Nm (168–354 in-lb).

5.6.3.3 Motor Terminal Connections in 4-Drive Module Systems

Illustration 8.11 shows the bus bar connections for 4-D system. There is a common terminal in each cabinet. Route the cables from input terminals 1 and 2 separately to the mains terminal. Similarly, cables from motor terminal 1 and motor terminal 2 should be routed separately and connected at the motor terminal. The recommended cable runs are in even numbers that must be shared equally between the terminals. To ensure equal sharing of current and for proper operation of the drive modules, the length of the cable from terminal 1 should be equal to the length of the cable from the terminal 2. The maximum size of the cable is given in *chapter 7.1 Power-dependent Specifications*.

1. Use cable quantities in multiples of 2 to obtain an equal number of wires attached to both terminals. Do not use 1 cable.

NOTICE

If it is decided not to use common terminals in the construction of a system using 4 drive modules, then use cable quantities in multiples of 4.

2. Make sure that the cables are within 10% of one another. Measure between the common terminals and the first common point of a phase, normally the motor terminals.
3. Strip a section of the outer cable insulation.
4. Connect the ground wire to the nearest protective earth (ground) terminal.
5. Connect the 3-phase motor wiring to terminals U/96, V/97, and W/98, using the recommended bolts. See *chapter 7.9.1 Tightening Torques for Terminals*.
6. Tighten the motor terminals 19–40 Nm (168–354 in-lb).

5.7 Mains Input Connections

There are several types of AC mains systems for supplying power to frequency converters. Each affects the EMC characteristics of the system. The 5-wire TN-S systems are regarded as best regarding EMC, while the isolated IT system is the least desirable.

System type	Description
TN Mains Systems	There are 2 types of TN mains distribution systems: TN-S and TN-C.
TN-S	A 5-wire system with separate neutral (N) and protective earth (PE) conductors. It provides the best EMC properties and avoids transmitting interference.
TN-C	A 4-wire system with a common neutral and protective earth (PE) conductor throughout the system. The combined neutral and PE conductor results in poor EMC characteristics.
TT Mains Systems	A 4-wire system with a grounded neutral conductor and individual grounding of the drive system. It has good EMC characteristics when grounded properly.
IT Grid System	An isolated 4-wire system with the neutral conductor either not grounded or grounded via an impedance.

Table 5.12 AC Mains Systems and EMC Characteristics

5.7.1 AC Mains Terminal Connections

When making mains connections, observe the following:

- Size the wiring based on the input current of the frequency converter. For maximum wire sizes, see *chapter 7.1 Power-dependent Specifications*.
- Comply with local and national electrical codes for cable sizes.

5.7.1.1 Mains Terminal Connections in 2-Drive Module Systems

Illustration 8.9 and *Illustration 8.10* show the bus bar connections for 6-pulse and 12-pulse 2-D systems, respectively.

- If there are 12-pulse connections in 2-drive module systems, the common terminal is available for the motor only. The mains cables are connected directly to the drive input terminals. In such a case, an equal number of cables should go to each drive terminal.

- There are individual brake terminals available in each drive module. Connect an equal number of recommended cables to the individual brake terminals.

NOTICE

To avoid any current imbalances, the length of the individual cables must be equal.

1. There is 1 set of common terminals for the mains.

NOTICE

If it is decided not to use common terminals in the construction of a system using 2 drive modules, use cable quantities in multiples of 2.

2. In the case of multiple runs, make sure that the cables are within 10% of one another. Measure between the common terminals and the first common point of a phase, normally the mains terminals.
3. For 12-pulse drive modules, the set of cables from the 1st drive module connects to the star-secondary winding of the 12-pulse transformer. The set from the 2nd drive module connects to the delta-secondary winding of the 12-pulse transformer.
4. Strip a section of the outer cable insulation.
5. Connect the ground wire to the nearest ground terminal.
6. Connect the 3-phase mains wiring to terminals U/96, V/97, and W/98, using the recommended bolts. See *chapter 7.9.1 Tightening Torques for Terminals*.
7. Tighten the mains terminals 19–40 Nm (168–354 in-lb).

5.7.1.2 Mains Terminal Connections in 4-Drive Module Systems

Illustration 8.11 shows the bus bar connections for 4-D systems.

1. Use cable quantities in multiples of 2 to obtain an equal number of wires attached to both terminals. Do not use 1 cable.
2. Make sure that the cables are within 10% of one another. Measure between the common terminals and the 1st common point of a phase, which, for 6 pulse drive modules, is normally the mains terminals.
3. For 12-pulse drive modules, the set of cables from the 1st cabinet connects to the star-secondary winding of the 12-pulse transformer. The set from the 2nd cabinet connects to the delta-secondary winding of the 12-pulse transformer.
4. Strip a section of the outer cable insulation.
5. Connect the ground wire to the nearest ground terminal.
6. Connect the 3-phase mains wiring to terminals R/91, S/92, and T/93, using the recommended bolts. See *chapter 7.9.1 Tightening Torques for Terminals*.
7. Tighten the motor terminals 8.5–20.5 Nm (75–181 in-lb).

5

5.7.2 12-Pulse Disconnector Configuration

This section describes how to use a disconnector for a 12-pulse drive system. When using disconnectors or contactors, make sure to install an interlock. When installed, both contactors or disconnectors should close to avoid 1 set of rectifiers not working. See *Illustration 8.1* for a diagram of these connections.

The selected contactors or mains disconnectors should have NC auxiliary contacts routed as shown. Connect the interlock in series with the Klixon switch of the brake. If only 1 contactor/disconnector has closed, the LCP shows the error *Brake IGBT Fault* and does not allow the drive system to power the motor. See *Illustration 8.2* for a diagram showing a BRF connection with 12-pulse disconnector and interlock.

NOTICE

If the brake option is not selected, the Klixon switch can be bypassed.

NOTICE

Danfoss is not responsible for any failure or malfunction in the disconnector/contactor switch.

5.7.3 Discharge Resistors

There are common positive and negative DC terminals on each drive module. If a shorter time to achieve the reduced run functionality is wanted, connect the external discharge resistor for quicker discharge of DC-link voltage. It is possible to connect a discharge resistor in an additional cabinet, through a contactor. This discharge contactor should have an interlock with the mains contactor/disconnector's auxiliary NC contacts, to avoid a discharge when the drive system is powered. See *Illustration 8.7* for a diagram showing a 4-D system with discharge resistor connections.

Base the selection of a discharge resistor on the energy and power levels given in *Table 5.13* for different power sizes, on both 12-pulse and 6-pulse systems.

FC 102 FC 202	**N500**	**N560**	**N630**	**N710**	**N800**	**N1M0**
FC 302	**N450**	**N500**	**N560**	**N630**	**N710**	**N800**
Drive modules required (HO rating)	**2xN250**	**4xN160**	**4xN200**	**4xN200**	**4xN250**	**4xN250**
Resistance required to reduce DC voltage below 50 V within 300 s (5 min), Ω	3036	2277	1822	1822	1518	1518
Power rating of resistor (W)	182	242	303	303	363	363
Energy dissipated by resistor (J)	7773	10365	12956	12956	15547	15547

Table 5.13 Discharge Resistors Recommended for Drive Systems with 380–480 V AC Mains Supply

FC 102 FC 202	**N630**	**N710**	**N800**	**N900**	**N1M0**	**N1M2**
FC 302	**N560**	**N630**	**N710**	**N800**	**N900**	**N1M0**
Drive modules required (HO rating)	**2xN315**	**4xN200**	**4xN250**	**4xN250**	**4xN315**	**4xN315**
Resistance required to reduce DC voltage below 50 V within 300 s (5 min), Ω	4571	3047	2285	2285	2285	2285
Power rating of resistor (W)	230	345	459	459	459	459
Energy dissipated by resistor (J)	8819	13229	17638	17638	17638	17638

Table 5.14 Discharge Resistors Recommended for Drive Systems with 525–690 V AC Mains Supply

NOTICE

Danfoss is not responsible for any failure or malfunction of the resistor, or for any misconnections made by the installer.

NOTICE

The wire used with the brake resistor should be double-insulated or have reinforced insulation.

5.8 Control Shelf Installation

The control shelf is preassembled. However, verify its various connections against the connection diagram. See *Illustration 8.6* for a diagram showing the various control shelf connections.

NOTICE

INCORRECT CONNECTION ORDER

If the connections are not made in the correct order, the drive modules do not function.

Check the following connections:

- Connection of the 44-pin ribbon cable between the MDCIC and the control card.
- When used, Safe Torque Off (STO) jumper connection must be made between the 12th and 27th pins to ensure proper STO operation.
- Connect the 44-pin ribbon cable to the MDCIC connectors in the correct order.
  - For systems with 4 drive modules, connect the ribbon cables to inverter 1, inverter 2, inverter 3, and then inverter 4.
  - For systems with 2 drive modules, connect the ribbon cables to inverter 1, then inverter 2. Leave inverter 3 and inverter 4 terminals unconnected.
- Place the corresponding current scaling card on each respective connector.
  - For systems with 4 drive modules, Inv1, Inv2, Inv3, and Inv4.
  - For systems with 2 drive modules, Inv1 and Inv2. Leave connectors Inv3 and Inv4 unconnected.

  NOTICE

  SCALING CARD POSITION

  If the scaling cards are not placed in the correct order, the drive modules do not function.
- Do not reverse the current scaling card. Check that the PCB spacer is fixed on the MDCIC board.
- Ensure correct installation of the STO relay and the power supply on the DIN rail. Make the connections as shown in *Illustration 8.6*.
- The external supply (100–230 V) must be available at terminals 1 and 2 on the terminal block.
- Make more checks to ensure that the wiring of the fuse microswitches and the BRF jumpers are properly routed.
- Check that all the screws on the PCBs are secure.
- To ensure proper EMC protection, verify that the MDCIC plate is properly attached to the control shelf assembly.

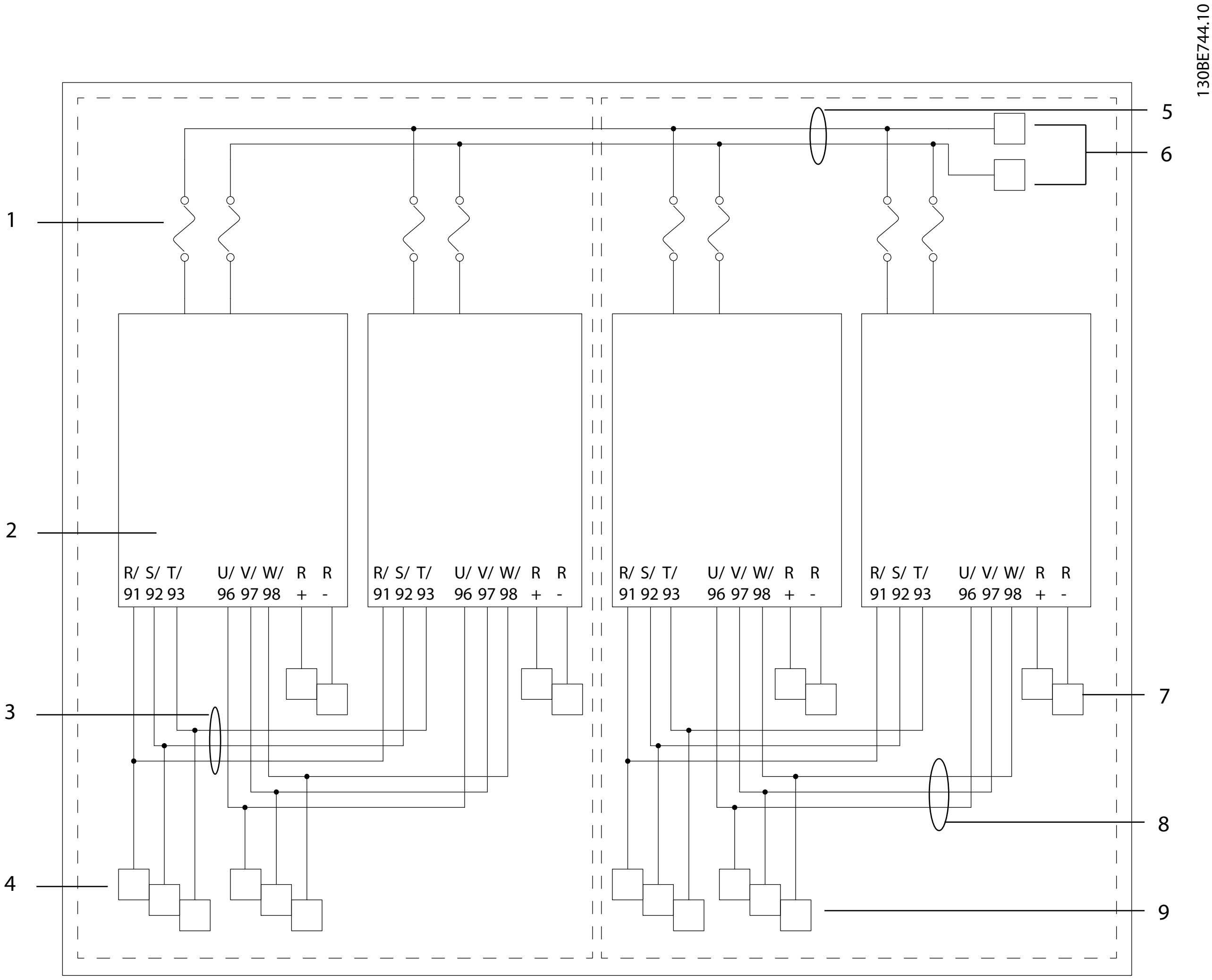
5.9 Control Wiring Connections

Make sure to use the provided wire pathway when routing the control wires from the bottom of the drive system cabinet to the control terminal.

5.9.1 Control Cable Routing

Cable routing

Route the cable inside the drive cabinets as shown. *Illustration 5.7* shows an example of a 4-drive configuration. Wire routing for a 2-drive configuration is identical, except for the number of drive modules used.



1	Microswitch cable	3	44-pin ribbon cable from MDCIC to drive module 4
2	44-pin ribbon cable from MDCIC to drive modules 1 and 2	4	Bracket to support ribbon cable

Illustration 5.7 Customer 230 V Cable Routing

5.9.2 Control Wiring

- Isolate the control wiring from the high-power components in the drive modules.
- When the drive module is connected to a thermistor, ensure that the thermistor control wiring is shielded and reinforced/double insulated. A 24 V DC supply voltage is recommended. See *Illustration 5.8*.

NOTICE

MINIMIZE INTERFERENCE

To minimize interference, keep control wires as short as possible and separate them from high-power cables.

The control terminals are on the control shelf, directly below the LCP. The control cable is routed at the bottom of the cabinet.

1. Follow the designated control cable routing as shown in *chapter 5.9.1 Control Cable Routing*.
2. Tie down all control wires.
3. Ensure optimum electrical immunity by properly connecting the shields.

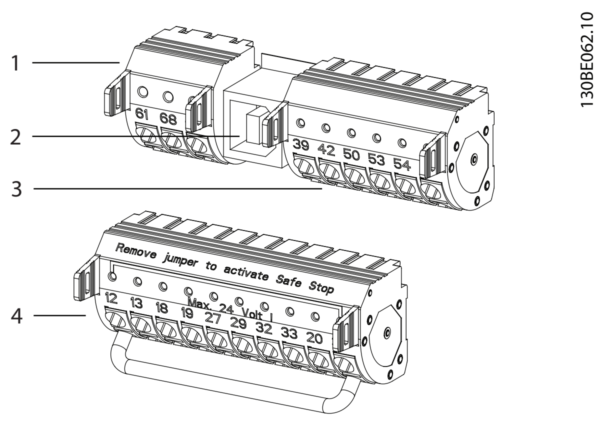
Fieldbus connection

For details, see the relevant fieldbus instructions.

1. Follow the designated control cable routing as shown in *chapter 5.9.1 Control Cable Routing*.
2. Tie down all control wires.
3. Connect the relevant options on the control card.

5.9.2.1 Control Terminal Types

Illustration 5.8 shows the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 5.15*. See *Illustration 5.8* for the location of the control terminals within the unit.



1	Terminals (+)68 and (-)69 are for an RS485 serial communication connection.
2	USB port available for use with the MCT 10 Set-up Software.
3	2 analog inputs, 1 analog output, 10 V DC supply voltage, and commons for the inputs and output.
4	4 programmable digital inputs terminals, 2 extra digital terminals programmable as either input or output, a 24 V DC terminal supply voltage, and a common for optional customer-supplied 24 V DC voltage.

Illustration 5.8 Control Terminal Locations

5

Terminal	Parameter	Default setting	Description
Digital inputs/outputs			
12, 13	–	+24 V DC	Digital inputs. 24 V DC supply voltage. Maximum output current is 200 mA total for all 24 V loads. Usable for digital inputs and external transducers.
18	*Parameter 5-10 Terminal 18 Digital Input*	*[8] Start*	
19	*Parameter 5-11 Terminal 19 Digital Input*	*[10] Reversing*	
32	*Parameter 5-14 Terminal 32 Digital Input*	*[0] No operation*	
33	*Parameter 5-15 Terminal 33 Digital Input*	*[0] No operation*	
27	*Parameter 5-12 Terminal 27 Digital Input*	*[2] Coast inverse*	Selectable for digital input and output. Default setting is input.
29	*Parameter 5-13 Terminal 29 Digital Input*	*[14] Jog*	
20	–	–	Common for digital inputs and 0 V potential for 24 V supply.
37	–	Safe Torque Off (STO)	Safe input (optional). Used for STO.
Analog inputs/outputs			
39	–	–	Common for analog output
42	*Parameter 6-50 Terminal 42 Output*	Speed 0 – high limit	Programmable analog output. The analog signal is 0–20 mA or 4–20 mA at a maximum of 500 Ω
50	–	+10 V DC	10 V DC analog supply voltage. 15 mA maximum commonly used for potentiometer or thermistor.
53	Parameter group *6-1* Analog Input 1*	Reference	Analog input. Selectable for voltage or current. Switches A53 and A54 select mA or V.
54	Parameter group *6-2* Analog Input 2*	Feedback	
55	–	–	Common for analog input
Serial communication			
61	–	–	Integrated RC-filter for cable shield. ONLY for connecting the shield when experiencing EMC problems.
68 (+)	Parameter group *8-3 FC Port Settings*	–	RS485 Interface. A control card switch is provided for termination resistance.
69 (-)	Parameter group *8-3 FC Port Settings*	–	
Relays			
01, 02, 03	*Parameter 5-40 Function Relay* [0]	*[9] Alarm*	Form C relay output. Usable for AC or DC voltage and resistive or inductive loads.
04, 05, 06	*Parameter 5-40 Function Relay* [1]	*[5] Running*	

Table 5.15 Terminal Description

Extra terminals:

- Two form C relay outputs. Location of the outputs depends on frequency converter configuration.
- Terminals on built-in optional equipment. See the manual provided with the equipment option.

5.9.2.2 Wiring to Control Terminals

Terminal plugs can be removed for easy access.

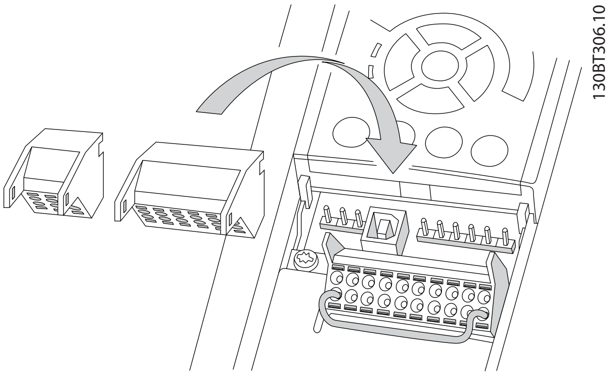


Illustration 5.9 Removal of Control Terminals

5.9.2.3 Enabling Motor Operation (Terminal 27)

A jumper wire is required between terminal 12 (or 13) and terminal 27 for the frequency converter to operate when using factory default programming values.

- Digital input terminal 27 is designed to receive 24 V DC external interlock command.
- When no interlock device is used, wire a jumper between control terminal 12 (recommended) or 13 to terminal 27. The jumper provides an internal 24 V signal on terminal 27.
- When the status line at the bottom of the LCP reads *AUTO REMOTE COAST*, it indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- When factory installed optional equipment is wired to terminal 27, do not remove that wiring.

5.9.2.4 Voltage/Current Input Selection (Switches)

The analog mains terminals 53 and 54 allow the setting of the input signal to voltage (0–10 V) or current (0/4–20 mA). See *Illustration 5.8* for the location of the control terminals within the drive system.

Default parameter settings:

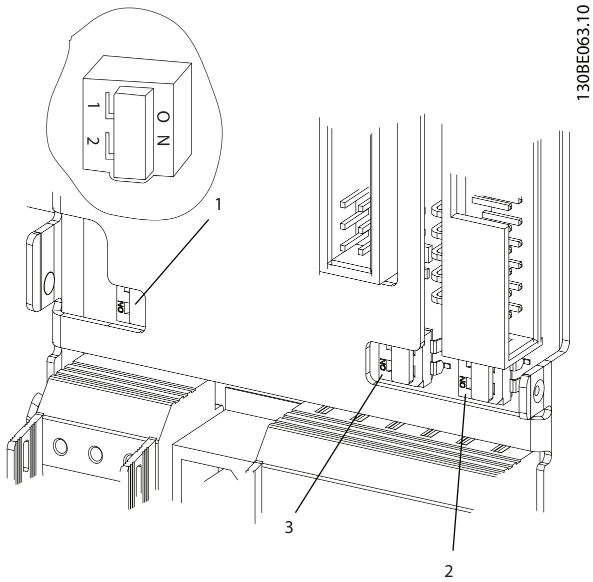
- Terminal 53: Speed reference signal in open loop (see *parameter 16-61 Terminal 53 Switch Setting*).
- Terminal 54: Feedback signal in closed loop (see *parameter 16-63 Terminal 54 Switch Setting*).

NOTICE

REMOVE POWER

Remove power to the frequency converter before changing switch positions.

1. Remove the LCP (see *Illustration 5.10*).
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.



1	Bus termination switch
2	A54 switch
3	A53 switch

Illustration 5.10 Locations of Bus Termination Switch and Switches A53 and A54

5.9.2.5 RS485 Serial Communication

An RS485 serial communications bus can be used with the drive system. Up to 32 nodes can be connected as a bus, or via drop cables from a common trunk line to 1 network segment. Repeaters can be used to divide network segments. Each repeater functions as a node within the segment in which it is installed. Each node connected within a given network must have a unique node address, across all segments.

- Connect RS485 serial communication wiring to terminals (+)68 and (-)69.
- Terminate each segment at both ends, using either the termination switch (bus term on/off, see *Illustration 5.10*) on the drive module, or a biased network termination resistor.
- Connect a large surface of the shield to ground, for example with a cable clamp or a conductive cable gland.
- Maintain the same ground potential throughout the network by applying potential-equalizing cables.

- Prevent impedance mismatch by using the same type of cable throughout the entire network.

Cable	Shielded twisted pair (STP)
Impedance	120 Ω
Maximum cable length [m]	1200 (including drop lines) 500 station-to-station

Table 5.16 Cable Information

5.9.3 Safe Torque Off (STO)

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

5.10 Relay Output

The relay terminal is on the top plate of the drive module. See *Illustration 3.1*. Use an extended wiring harness to connect the relay terminal of drive module 1 (the drive module on the far left) to the terminal blocks on the control shelf.

NOTICE

For reference, drive modules are numbered from left to right.

Relay 1

- Terminal 01: Common
- Terminal 02: Normally open 400 V AC
- Terminal 03: Normally closed 240 V AC

Relay 2

- Terminal 04: Common
- Terminal 05: Normally open 400 V AC
- Terminal 06: Normally closed 240 V AC

Relay 1 and relay 2 are programmed in *parameter 5-40 Function Relay*, *parameter 5-41 On Delay, Relay*, and *parameter 5-42 Off Delay, Relay*.

Use option module MCB 105 for extra relay outputs.

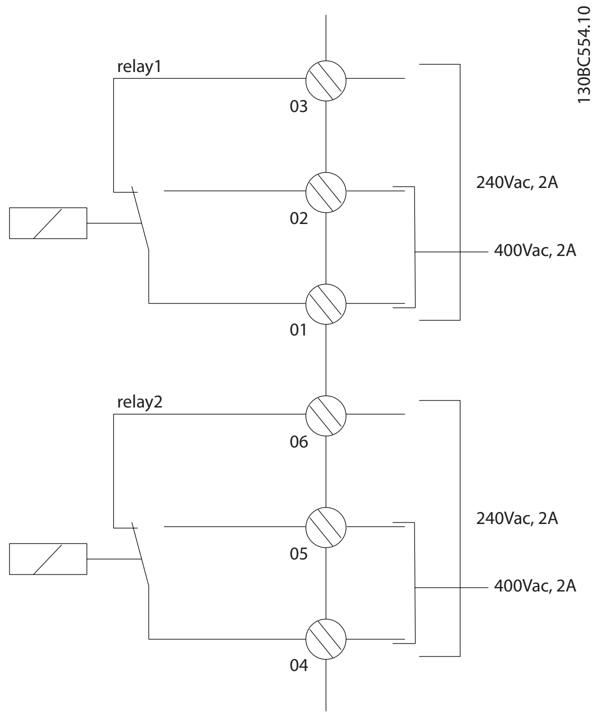


Illustration 5.11 Extra Relay Outputs

5.11 EMC Recommendations

The following is a guideline to good engineering practice when installing frequency converters. Follow these guidelines in compliance with EN 61800-3 *First environment*. If the installation is in EN 61800-3 *Second environment,* industrial networks, or in an installation with its own transformer, deviation from these guidelines is allowed but not recommended. See the *VLT® Common AC Drive Modules Design Guide*.

Good engineering practice to ensure EMC-correct electrical installation:

- Use only braided shielded/armored motor cables and braided shielded control cables. The shield provides a minimum coverage of 80%. The shield material must be metal, not limited to but typically copper, aluminum, steel, or lead. There are no special requirements for the mains cable.
- Installations using rigid metal conduits are not required to use shielded cable, but the motor cable must be installed in conduit separate from the control and mains cables. Full connection of the conduit from the frequency converter to the motor is required. The EMC performance of flexible conduits varies a lot and information from the manufacturer must be obtained.
- Connect the shield conduit to ground at both ends for motor cables and for control cables. Sometimes, it is not possible to connect the

shield in both ends. If so, connect the shield at the frequency converter. See also *chapter 5.11.2 Grounding of Shielded Control Cables*.

- Avoid terminating the shield with twisted ends (pigtails). It increases the high frequency impedance of the shield, which reduces its effectiveness at high frequencies. Use low impedance cable clamps or EMC cable glands instead.
- Avoid using unshielded motor or control cables inside cabinets housing the frequency converter, whenever possible.

Leave the shield as close to the connectors as possible.

Illustration 5.12 shows an example of an EMC-correct electrical installation of an IP20 frequency converter. The frequency converter is fitted in an installation cabinet with an output contactor and connected to a PLC, which is installed in a separate cabinet. Other ways of doing the installation could have just as good an EMC performance, provided the guidelines to engineering practice are followed.

If the installation is not carried out according to the guideline, and if unshielded cables and control wires are used, some emission requirements are not in compliance, although the immunity requirements are fulfilled.

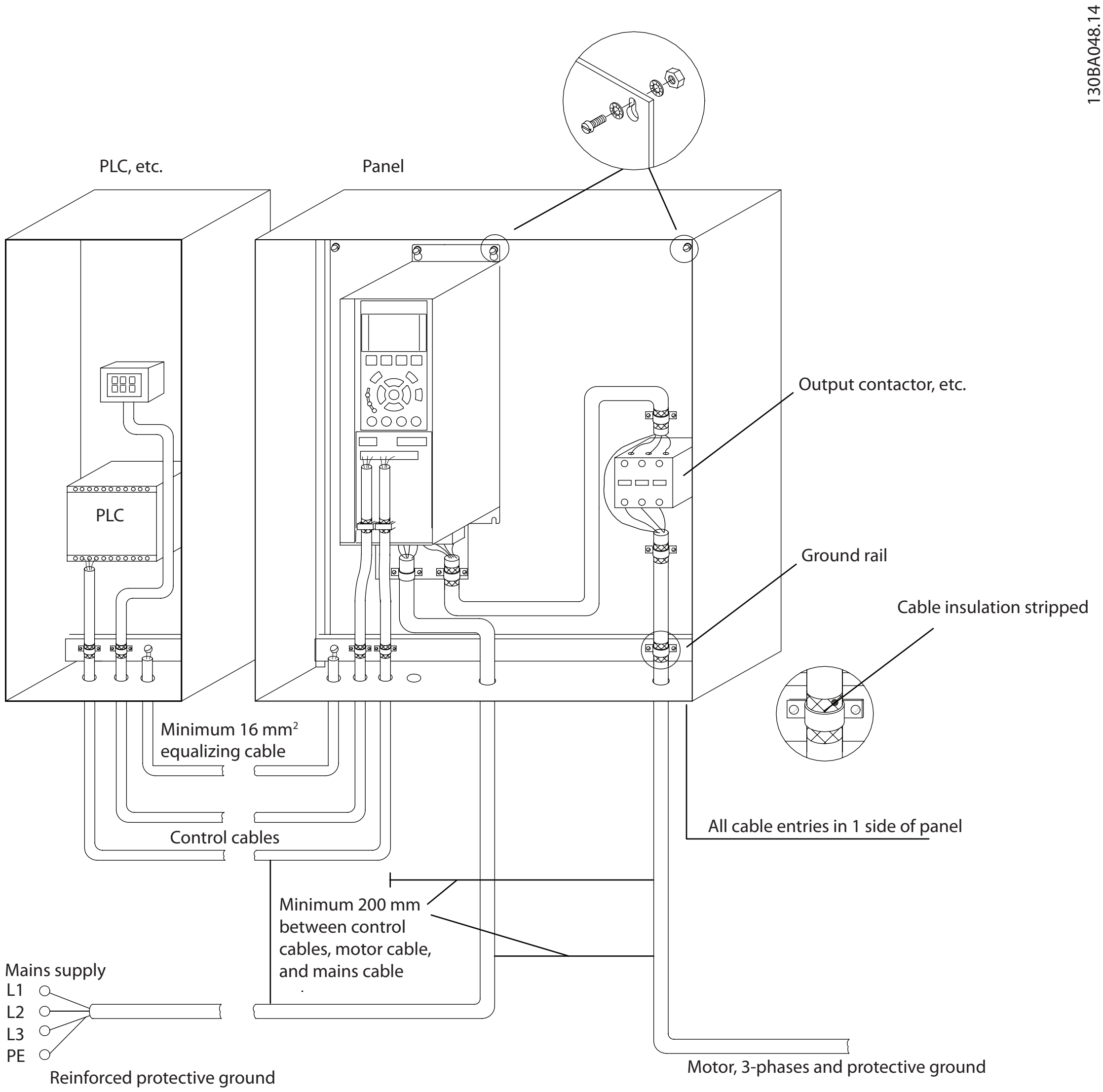


Illustration 5.12 EMC-correct Electrical Installation of a Frequency Converter in Cabinet

5

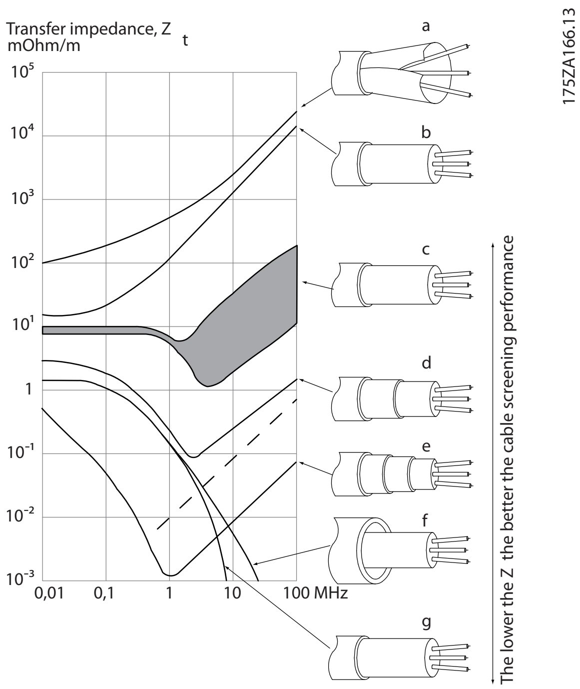
5.11.1 Using Shielded Control Cables

Danfoss recommends braided shielded/armored cables to optimize EMC immunity of the control cables and the EMC emission from the motor cables.

The ability of a cable to reduce the incoming 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).

Transfer impedance (Z_T) is rarely stated by cable manufacturers, but it is often possible to estimate transfer impedance (Z_T) by assessing the physical design of the cable, such as:

- 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, that is braided or twisted pattern.

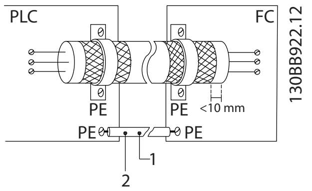


a	Aluminum-clad with copper wire
b	Twisted copper wire or armored steel wire cable
c	Single-layer braided copper wire with varying percentage shield coverage (this is the typical Danfoss reference cable).
d	Double-layer braided copper wire
e	Twin layer of braided copper wire with a magnetic, shielded/armored intermediate layer
f	Cable that runs in copper tube or steel tube
g	Lead cable with 1.1 mm (0.04 in) wall thickness

Illustration 5.13 Cable Shielding Performance

5.11.2 Grounding of Shielded Control Cables

Correct shielding
The preferred method usually is to secure control and serial communication cables with shielding clamps provided at both ends to ensure best possible high frequency cable contact. If the ground potential between the frequency converter and the PLC is different, electric noise may occur that disturbs the entire system. Solve this problem by fitting an equalizing cable next to the control cable. Minimum cable cross-section: 16 mm^2 (4 AWG).



1	Minimum 16 mm^2 (4 AWG)	2	Equalizing cable

Illustration 5.14 Correct Shielding

50/60 Hz ground loops
With very long control cables, ground loops may occur. To eliminate ground loops, connect 1 end of the shield-to-ground with a 100 nF capacitor (keeping leads short).

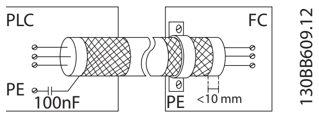
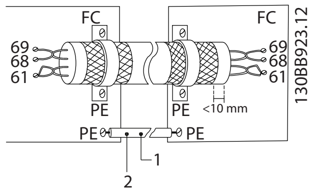


Illustration 5.15 Avoiding Ground Loops

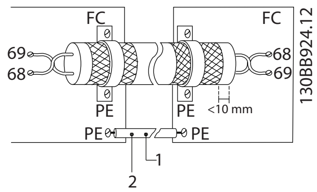
Avoid EMC noise on serial communication
This terminal is connected to ground via an internal RC link. Use twisted-pair cables to reduce interference between conductors.



1	Minimum 16 mm^2 (4 AWG)	2	Equalizing cable

Illustration 5.16 Recommended Method for Avoiding EMC Noise

Alternatively, the connection to terminal 61 can be omitted:



1	Minimum 16 mm^2 (4 AWG)	2	Equalizing cable

Illustration 5.17 Screening without Using Terminal 61

5

6 Initial Start-up

6.1 Pre-start Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 6.1*. Mark the check-list items when they are completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that reside on the input power side of the drive system or on the output side to the motor. Ensure that they are ready for full-speed operation. • Check function and installation of any sensors used for feedback to the drive system. • Remove any power factor correction caps on motor(s). • Adjust any power factor correction caps on the mains side and ensure that they are dampened.	
Cable routing	• Ensure that motor wiring and control wiring are separated or shielded, or in 3 separate metallic conduits for high-frequency interference isolation.	
Control wiring	• Check for broken or damaged wires and loose connections. • Check that control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly. • Check that the DC-link fuse and microswitch fixtures are correct. Check the microswitch cabling and the connectors in the top of the drive module.	
Cooling clearance	• Check that there is 225 mm (9 in) of top clearance for adequate cooling.	
Ambient conditions	• Check that requirements for ambient conditions are met.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and are in operational condition and that all circuit breakers are in the open position.	
Grounding	• Check for good ground connections that are tight and free of oxidation. • Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.	
Input and output power wiring	• Check for loose connections. • Check that motor and mains are in separate conduit or separated shielded cables. • Check that the shields are properly grounded. • Check that the DC-link connections are properly made.	
Panel interior	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion. • Check that the unit is mounted on an unpainted, metal surface.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly, or that shock mounts are used, as necessary. • Check for an unusual amount of vibration.	

Table 6.1 Installation Check List

⚠CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

There is a risk of personal injury when the drive modules are not properly closed.

- **Before applying power, ensure that all safety covers are in place and securely fastened.**

6.2 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

HIGH VOLTAGE

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

Before applying power:

1. Ensure that input power to the unit is OFF and locked out. Do not rely on the drive system's disconnect switches for input power isolation.
2. Verify that there is no voltage on mains terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
3. Verify that there is no voltage on motor terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
4. Confirm continuity of the motor by measuring resistance values on U–V (96–97), V–W (97–98), and W–U (98–96).
5. Check for proper grounding of the drive system and the motor.
6. Inspect the drive system for loose connections on the terminals.
7. Confirm that the supply voltage matches the voltage of the drive system and the motor.

6.3 Applying Power

⚠WARNING

UNINTENDED START

When the drive system is connected to AC mains, the motor can start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the LCP, a cleared fault condition, or remote operation using MCT 10 software.

To prevent unintended motor start:

- **Disconnect the drive system from AC mains.**
- **Press [Off/Reset] on the LCP, before programming parameters.**
- **The drive system, motor, and any driven equipment must be fully wired and assembled when the drive is connected to AC mains.**

Apply power to the drive system, according to the following steps:

1. Confirm that the input voltage is balanced within 3%. If not, correct the input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that the wiring of any optional equipment matches the installation application.
3. Ensure that all operator devices are in the OFF position.
4. Close all panel doors and securely fasten all covers.
5. Apply power to the drive system. DO NOT start the drive now. For units with a disconnect switch, turn the switch to the ON position to apply power to the drive system.

6.4 Configuring the Drive System

Before the drive system is fully functional, it is necessary to configure the unit on the local control panel (LCP).

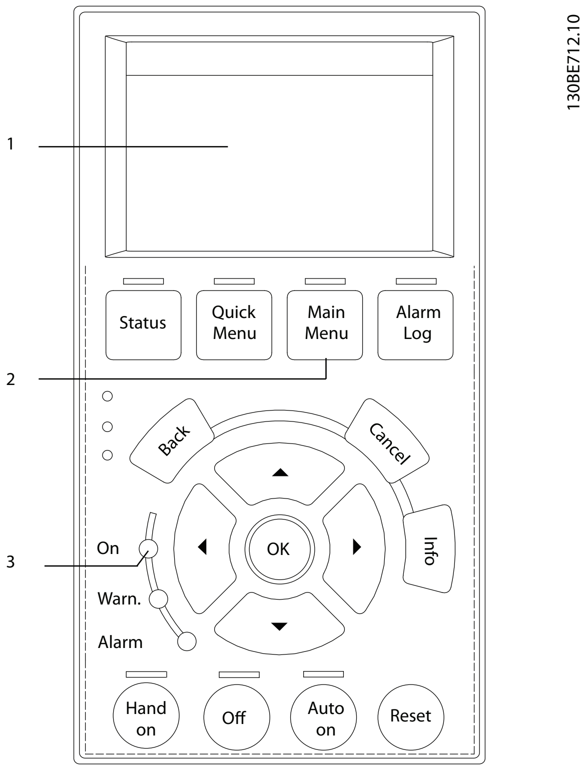
1. Apply power. At power-up, the LCP display shows *alarm 250, New spare part*.
2. Press [Main Menu] twice on the LCP. See *Illustration 6.1*.
3. Use the navigation keys and the [OK] key to navigate to parameter group *14-** Special Functions*. Then scroll down to *parameter 14-23 Typecode Setting*.
4. Scroll through the submenu to match the 39 characters in the typecode to the 20 index groups. See *Table 6.2*. Press [OK] to enter the value.

5. At index number 20, select Save to EEPROM and press [OK]. When the system finishes writing the EEPROM data, the display shows *No Function*.
6. Remove power to the drive system, and then reapply power. Press [RESET] to clear the alarm.

NOTICE

INCORRECT TYPECODE ENTERED

If the wrong typecode is entered, scroll to *parameter 14-29 Service Code* and enter 00006100. This step allows access to *parameter 14-23 Typecode Setting* to reenter the typecode.



1	LCP display
2	[Main Menu] key
3	Power-on indicator light

Illustration 6.1 Local Control Panel (LCP)

Index	Description	Typecode units
[0]	Product group	1–3
[1]	Series	4–6
[2]	Power	7–10
[3]	Voltage	11–12
[4]	Enclosure	13–15
[5]	RFI filter	16–17
[6]	Brake & stop	18
[7]	Display	19
[8]	Coating	20
[9]	Mains options	21
[10]	Adaptation A	22
[11]	Adaptation B	23
[12]	Software	24–27
[13]	Language	28
[14]	Options A	29–30
[15]	Options B	31–32
[16]	Options C0	33–34
[17]	Options C1	35
[18]	Options C	36–37
[19]	Options D	38–39

Table 6.2 Typecode Index

6.5 Testing the Motor Operation

1. Press [Main Menu] twice on the LCP.
2. Press the navigation keys and the [OK] key to navigate to parameter group *1-** Load and Motor* and press [OK].
3. Navigate to *parameter 1-23 Motor Frequency* and enter the frequency from the motor nameplate.
4. Navigate to *parameter 1-23 Motor Frequency* and enter the current from the motor nameplate.
5. Navigate to *parameter 1-25 Motor Nominal Speed* and enter the speed from the motor nameplate.
6. Press [Status] to return to the operational display.
7. Press [Hand On].
8. Press [▲] to accelerate the motor.
9. Press [▼] to decelerate the motor.
10. Press [Off].

7 Specifications

7.1 Power-dependent Specifications

7.1.1 VLT® HVAC Drive FC 102

Power range	N315	N355	N400	N450	N500
Drive modules	2	2	2	2	2
Rectifier configuration	12-pulse				6-pulse/12-pulse
High/normal load	NO	NO	NO	NO	NO
Output current [A]					
Continuous (at 380–440 V)	588	658	745	800	880
Intermittent (60 s overload) at 400 V	647	724	820	880	968
Continuous (at 460/500 V)	535	590	678	730	780
Intermittent (60 s overload) at 460/500 V	588	649	746	803	858
Input current [A]					
Continuous (at 400 V)	567	647	733	787	875
Continuous (at 460/500 V)	516	580	667	718	759
Power losses [W]					
Estimated power loss at 400 V	5825	6110	7069	7538	8468
Estimated power loss at 460 V	4998	5964	6175	6609	7140
Bus bar losses at 400 V	550	555	561	565	575
Bus bar losses at 460 V	548	551	556	560	563
DC bus bar losses during regeneration	93	95	98	101	105
Maximum cable size [mm² (mcm)]					
Mains	4x120 (250)				4x150 (300)
Motor	4x120 (250)				4x150 (300)
Brake	4x70 (2/0)			4x95 (3/0)	
Regeneration terminals	4x120 (250)		4x150 (300)	6x120 (250)	
Maximum external mains fuses					
6-pulse configuration	–	–	–	–	600 V, 1600 A
12-pulse configuration	700 A, 600 V				–

Table 7.1 FC 102, 380–480 V AC Mains Supply (2-Drive System)

Power range	N560	N630	N710	N800	N1M0
Drive modules	4	4	4	4	4
Rectifier configuration	6-pulse/12-pulse				
High/normal load	NO	NO	NO	NO	NO
Output current [A]					
Continuous (at 380–440 V)	990	1120	1260	1460	1720
Intermittent (60 s overload) at 400 V	1089	1232	1386	1606	1892
Continuous (at 460/500 V)	890	1050	1160	1380	1530
Intermittent (60 s overload) at 460/500 V	979	1155	1276	1518	1683
Input current [A]					
Continuous (at 400 V)	964	1090	1227	1422	1675
Continuous (at 460/500 V)	867	1022	1129	1344	1490
Power losses [W]					
Estimated power loss at 400 V	8810	10199	11632	13253	16463
Estimated power loss at 460 V	7628	9324	10375	12391	13958
Bus bar losses at 400 V	665	680	695	722	762
Bus bar losses at 460 V	656	671	683	710	732
DC bus bar losses during regeneration	218	232	250	276	318
Maximum cable size [mm^2 (mcm)]					
Mains	4x185 (350)	8x120 (250)			
Motor	4x185 (350)	8x120 (250)			
Brake	8x70 (2/0)			8x95 (3/0)	
Regeneration terminals	6x120 (250)	8x120 (250)		8x150 (300)	10x150 (300)
Maximum external mains fuses					
6-pulse configuration	600 V, 1600 A	600 V, 2000 A		600 V, 2500 A	
12-pulse configuration	600 V, 700 A	600 V, 900 A			600 V, 1500 A

Table 7.2 FC 102, 380–480 V AC Mains Supply (4-Drive System)

Power range	N315	N355	N450	N500	N560	N630
Drive modules	2	2	2	2	2	2
Rectifier configuration	12-pulse					
High/normal load	NO	NO	NO	NO	NO	NO
Output current [A]						
Continuous (at 550 V)	360	418	470	523	596	630
Intermittent (60 s overload) at 550 V	396	360	517	575	656	693
Continuous (at 575/690 V)	344	400	450	500	570	630
Intermittent (60 s overload) at 575/690 V	378	440	495	550	627	693
Input current [A]						
Continuous (at 550 V)	355	408	453	504	574	607
Continuous (at 575 V)	339	490	434	482	549	607
Continuous (at 690 V)	352	400	434	482	549	607
Power losses [W]						
Estimated power loss at 575 V	4401	4789	5457	6076	6995	7431
Estimated power loss at 690 V	4352	4709	5354	5951	6831	7638
Bus bar losses at 575 V	540	541	544	546	550	553
DC bus bar losses during regeneration	88	88.5	90	91	186	191
Maximum cable size [mm^2 (mcm)]						
Mains	2x120 (250)	4x120 (250)				
Motor	2x120 (250)	4x120 (250)				
Brake	4x70 (2/0)				4x95 (3/0)	
Regeneration terminals	4x120 (250)					
Maximum external mains fuses	700 V, 550 A		700 V, 630 A			

Table 7.3 FC 102, 525–690 V AC Mains Supply (2-Drive System)

Power range	N710	N800	N900	N1M0	N1M2
Drive modules	4	4		4	4
Rectifier configuration	6-pulse/12-pulse				
High/normal load	NO	NO	NO	NO	NO
Output current [A]					
Continuous (at 550 V)	763	889	988	1108	1317
Intermittent (60 s overload) at 550 V	839	978	1087	1219	1449
Continuous (at 575/690 V)	730	850	945	1060	1260
Intermittent (60 s overload) at 575/690 V	803	935	1040	1166	1590
Input current [A]					
Continuous (at 550 V)	743	866	962	1079	1282
Continuous (at 575 V)	711	828	920	1032	1227
Continuous (at 690 V)	711	828	920	1032	1227
Power losses [W]					
Estimated power loss at 575 V	8683	10166	11406	12852	15762
Estimated power loss at 690 V	8559	9996	11188	12580	15358
Bus bar losses at 575 V	644	653	661	672	695
DC bus bar losses during regeneration	198	208	218	231	256
Maximum cable size [mm^2 (mcm)]					
Mains	4x120 (250)	6x120 (250)			8x120 (250)
Motor	4x120 (250)	6x120 (250)			8x120 (250)
Brake	8x70 (2/0)			8x95 (3/0)	
Regeneration terminals	4x150 (300)	6x120 (250)		6x150 (300)	8x120 (250)
Maximum external mains fuses					
6-pulse configuration	700 V, 1600 A				700 V, 2000 A
12-pulse configuration	700 V, 900 A			700 V, 1500 A	

Table 7.4 FC 102, 525–690 V AC Mains Supply (4-Drive System)

7.1.2 VLT® AQUA Drive FC 202

Power range	N315		N355		N400		N450		N500	
Drive modules	2		2		2		2		2	
Rectifier configuration	12-pulse								6-pulse/12-pulse	
High/normal load	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Output current [A]										
Continuous (at 400 V)	480	588	600	658	658	745	695	800	810	880
Intermittent (60 s overload) at 400 V	720	647	900	724	987	820	1043	880	1215	968
Continuous (at 460/500 V)	443	535	540	590	590	678	678	730	730	780
Intermittent (60 s overload) at 460/500 V	665	588	810	649	885	746	1017	803	1095	858
Input current [A]										
Continuous (at 400 V)	463	567	590	647	647	733	684	787	779	857
Continuous (at 460/500 V)	427	516	531	580	580	667	667	718	711	759
Power losses [W]										
Estimated power loss at 400 V	4505	5825	5502	6110	6110	7069	6375	7538	7526	8468
Estimated power loss at 460 V	4063	4998	5384	5964	5271	6175	6070	6609	6604	7140
Bus bar losses at 400 V	545	550	551	555	555	561	557	565	566	575
Bus bar losses at 460 V	543	548	548	551	551	556	556	560	560	563
DC bus bar losses during regeneration	93	93	95	95	98	98	101	101	105	105
Maximum cable size [mm² (mcm)]										
Mains	4x120 (250)								4x150 (300)	
Motor	4x120 (250)								4x150 (300)	
Brake	4x70 (2/0)						4x95 (3/0)			
Regeneration terminals	4x120 (250)				6x120 (250)		6x120 (250)			
Maximum external mains fuses										
6-pulse configuration	–		–		–		–		600 V, 1600 A	
12-pulse configuration	600 V, 700 A								600 V, 900 A	

Table 7.5 FC 202, 380–480 V AC Mains Supply (2-Drive System)

Power range	N560		N630		N710		N800		N1M0	
Drive modules	4		4		4		4		4	
Rectifier configuration	6-pulse/12-pulse									
High/normal load	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Output current [A]										
Continuous (at 400 V)	880	990	990	1120	1120	1260	1260	1460	1460	1720
Intermittent (60 s overload) at 400 V	1320	1089	1485	1232	1680	1386	1890	1606	2190	1892
Continuous (at 460/500 V)	780	890	890	1050	1050	1160	1160	1380	1380	1530
Intermittent (60 s overload) at 460/500 V	1170	979	1335	1155	1575	1276	1740	1518	2070	1683
Input current [A]										
Continuous (at 400 V)	857	964	964	1090	1090	1227	1127	1422	1422	1675
Continuous (at 460 V)	759	867	867	1022	1022	1129	1129	1344	1344	1490
Power losses [W]										
Estimated power loss at 400 V	7713	8810	8918	10199	10181	11632	11390	13253	13479	16463
Estimated power loss at 460 V	6641	7628	7855	9324	9316	10375	12391	12391	12376	13958
Bus bar losses at 400 V	655	665	665	680	680	695	695	722	722	762
Bus bar losses at 460 V	647	656	656	671	671	683	683	710	710	732
DC bus bar losses during regeneration	218	218	232	232	250	250	276	276	318	318
Maximum cable size [mm² (mcm)]										
Mains	4x185 (350)		8x125 (250)							
Motor	4x185 (350)		8x125 (250)							
Brake	8x70 (2/0)						8x95 (3/0)			
Regeneration terminals	6x125 (250)		8x125 (250)				8x150 (300)		10x150 (300)	
Maximum external mains fuses										
6-pulse configuration	600 V, 1600 A		600 V, 2000 A				600 V, 2500 A			
12-pulse configuration	600 V, 900 A				600 V, 1500 A					

Table 7.6 FC 202, 380–480 V AC Mains Supply (4-Drive System)

Power range	N315		N400		N450	
Drive modules	2		2		2	
Rectifier configuration	12-pulse					
High/normal load	HO	NO	HO	NO	HO	NO
Output current [A]						
Continuous (at 550 V)	303	360	360	418	395	470
Intermittent (60 s overload) at 550 V	455	396	560	460	593	517
Continuous (at 575/690 V)	290	344	344	400	380	450
Intermittent (60 s overload) at 575/690 V	435	378	516	440	570	495
Input current [A]						
Continuous (at 550 V)	299	355	355	408	381	453
Continuous (at 575 V)	286	339	339	490	366	434
Continuous (at 690 V)	296	352	352	400	366	434
Power losses [W]						
Estimated power loss at 575 V	3688	4401	4081	4789	4502	5457
Estimated power loss at 690 V	3669	4352	4020	4709	4447	5354
Bus bar losses at 575 V	538	540	540	541	540	544
DC bus bar losses during regeneration	88	88	89	89	90	90
Maximum cable size [mm^2 (mcm)]						
Mains	2x120 (250)		4x120 (250)			
Motor	2x120 (250)		4x120 (250)			
Brake	4x70 (2/0)					
Regeneration terminals	4x120 (250)					
Maximum external mains fuses	700 V, 550 A					

Table 7.7 FC 202, 525–690 V AC Mains Supply (2-Drive System)

Power range	N500		N560		N630	
Drive modules	2		2		2	
Rectifier configuration	12-pulse					
High/normal load	HO	NO	HO	NO	HO	NO
Output current [A]						
Continuous (at 550 V)	429	523	523	596	596	630
Intermittent (60 s overload) at 550 V	644	575	785	656	894	693
Continuous (at 575/690 V)	410	500	500	570	570	630
Intermittent (60 s overload) at 575/690 V	615	550	750	627	627	693
Input current [A]						
Continuous (at 550 V)	413	504	504	574	574	607
Continuous (at 575 V)	395	482	482	549	549	607
Continuous (at 690 V)	395	482	482	549	549	607
Power losses [W]						
Estimated power loss at 575 V	4892	6076	6016	6995	6941	7431
Estimated power loss at 690 V	4797	5951	5886	6831	6766	7638
Bus bar losses at 575 V	542	546	546	550	550	553
DC bus bar losses during regeneration	91	91	186	186	191	191
Maximum cable size [mm^2 (mcm)]						
Mains	4x120 (250)					
Motor	4x120 (250)					
Brake	4x70 (2/0)		4x95 (3/0)			
Regeneration terminals	4x120 (250)					
Maximum external mains fuses	700 V, 630 A					

Table 7.8 FC 202, 525–690 V AC Mains Supply (2-Drive System)

Power range	N710		N800		N900		N1M0		N1M2	
Drive modules	4		4		4		4		4	
Rectifier configuration	6-pulse/12-pulse									
High/normal load	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Output current [A]										
Continuous (at 550 V)	659	763	763	889	889	988	988	1108	1108	1317
Intermittent (60 s overload) at 550 V	989	839	1145	978	1334	1087	1482	1219	1662	1449
Continuous (at 575/690 V)	630	730	730	850	850	945	945	1060	1060	1260
Intermittent (60 s overload) at 575/690 V	945	803	1095	935	1275	1040	1418	1166	1590	1590
Input current [A]										
Continuous (at 550 V)	642	743	743	866	866	962	1079	1079	1079	1282
Continuous (at 575 V)	613	711	711	828	828	920	1032	1032	1032	1227
Continuous (at 690 V)	613	711	711	828	828	920	1032	1032	1032	1227
Power losses [W]										
Estimated power loss at 575 V	7469	8683	8668	10166	10163	11406	11292	12852	12835	15762
Estimated power loss at 690 V	7381	8559	8555	9996	9987	11188	11077	12580	12551	15358
Bus bar losses at 575 V	637	644	644	653	653	661	661	672	672	695
DC bus bar losses during regeneration	198	198	208	208	218	218	231	231	256	256
Maximum cable size [mm² (mcm)]										
Mains	4x120 (250)		6x120 (250)						8x120 (250)	
Motor	4x120 (250)		6x120 (250)						8x120 (250)	
Brake	8x70 (2/0)						8x95 (3/0)			
Regeneration terminals	4x150 (300)		6x120 (250)				6x150 (300)		8x120 (250)	
Maximum external mains fuses										
6-pulse configuration	700 V, 1600 A								700 V, 2000 A	
12-pulse configuration	700 V, 900 A						700 V, 1500 A			

Table 7.9 FC 202, 525–690 V AC Mains Supply (4-Drive System)

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7.1.3 VLT® AutomationDrive FC 302

Power range	N250		N315		N355		N400		N450	
Drive modules	2		2		2		2		2	
Rectifier configuration	12-pulse								6-pulse/12-pulse	
High/normal load	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Output current [A]										
Continuous (at 380–440 V)	480	588	600	658	658	745	695	800	810	880
Intermittent (60 s overload) at 400 V	720	647	900	724	987	820	1043	880	1215	968
Continuous (at 460/500 V)	443	535	540	590	590	678	678	730	730	780
Intermittent (60 s overload) at 460/500 V	665	588	810	649	885	746	1017	803	1095	858
Input current [A]										
Continuous (at 400 V)	463	567	590	647	647	733	684	787	779	857
Continuous (at 460/500 V)	427	516	531	580	580	667	667	718	711	759
Power losses [W]										
Estimated power loss at 400 V	4505	5825	5502	6110	6110	7069	6375	7538	7526	8468
Estimated power loss at 460 V	4063	4998	5384	5964	5721	6175	6070	6609	6604	7140
Bus bar losses at 400 V	545	550	551	555	555	561	557	565	566	575
Bus bar losses at 460 V	543	548	548	551	556	556	556	560	560	563
Maximum cable size [mm^2 (mcm)]										
Mains	4x120 (250)								4x150 (300)	
Motor	4x120 (250)								4x150 (300)	
Brake	4x70 (2/0)								4x95 (3/0)	
Regeneration terminals	4x120 (250)				4x150 (300)		6x120 (250)			
Maximum external mains fuses										
6-pulse configuration	–		–		–		–		600 V, 1600 A	
12-pulse configuration	600 V, 700 A								600 V, 900 A	

Table 7.10 FC 302, 380–500 V AC Mains Supply (2-Drive System)

Power range	N500		N560		N630		N710		N800	
Drive modules	4		4		4		4		4	
Rectifier configuration	6-pulse/12-pulse									
High/normal load	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Output current [A]										
Continuous (at 380–440 V)	880	990	990	1120	1120	1260	1260	1460	1460	1720
Intermittent (60 s overload) at 400 V	1320	1089	1485	1232	1680	1386	1890	1606	2190	1892
Continuous (at 460/500 V)	780	890	890	1050	1050	1160	1160	1380	1380	1530
Intermittent (60 s overload) at 460/500 V	1170	979	1335	1155	1575	1276	1740	1518	2070	1683
Input current [A]										
Continuous (at 400 V)	857	964	964	1090	1090	1227	1227	1422	1422	1675
Continuous (at 460/500 V)	759	867	867	1022	1022	1129	1129	1344	1344	1490
Power losses [W]										
Estimated power loss at 400 V	7713	8810	8918	10199	10181	11632	11390	13253	13479	16463
Estimated power loss at 460 V	6641	7628	7855	9324	9316	10375	12391	12391	12376	13958
Bus bar losses at 400 V	655	665	665	680	680	695	695	722	722	762
Bus bar losses at 460 V	647	656	656	671	671	683	683	710	710	732
DC bus bar losses during regeneration	218	218	232	232	250	276	276	276	318	318
Maximum cable size [mm² (mcm)]										
Mains	4x185 (350)		8x120 (250)							
Motor	4x185 (350)		8x120 (250)							
Brake	8x70 (2/0)						8x95 (3/0)			
Regeneration terminals	6x125 (250)		8x125 (250)				8x150 (300)		10x150 (300)	
Maximum external mains fuses										
6-pulse configuration	600 V, 1600 A		600 V, 2000 A				600 V, 2500 A			
12-pulse configuration	600 V, 900 A				600 V, 1500 A					

Table 7.11 FC 302, 380–500 V AC Mains Supply (4-Drive System)

Power range	N250		N315		N355		N400	
Drive modules	2		2		2		2	
Rectifier configuration	12-pulse							
High/normal load	HO	NO	HO	NO	HO	NO	HO	NO
Output current [A]								
Continuous (at 550 V)	303	360	360	418	395	470	429	523
Intermittent (60 s overload) at 550 V	455	396	560	360	593	517	644	575
Continuous (at 575/690 V)	290	344	344	400	380	450	410	500
Intermittent (60 s overload) at 575/690 V	435	378	516	440	570	495	615	550
Input current [A]								
Continuous (at 550 V)	299	355	355	408	381	453	413	504
Continuous (at 575 V)	286	339	339	490	366	434	395	482
Continuous (at 690 V)	296	352	352	400	366	434	395	482
Power losses [W]								
Estimated power loss at 600 V	3688	4401	4081	4789	4502	5457	4892	6076
Estimated power loss at 690 V	3669	4352	4020	4709	4447	5354	4797	5951
Bus bar losses at 575 V	538	540	540	541	540	544	542	546
DC bus bar losses during regeneration	88	88	89	89	90	90	91	91
Maximum cable size [mm^2 (mcm)]								
Mains	2x120 (250)		4x120 (250)					
Motor	2x120 (250)		4x120 (250)					
Brake	4x70 (2/0)							
Regeneration terminals	4x120 (250)							
Maximum external mains fuses	700 V, 550 A							

Table 7.12 FC 302, 525–690 V AC Mains Supply (2-Drive System)

Power range	N500		N560	
Drive modules	2		2	
Rectifier configuration	12-pulse			
High/normal load	HO	NO	HO	NO
Output current [A]				
Continuous (at 550 V)	523	596	596	630
Intermittent (60 s overload) at 550 V	785	656	894	693
Continuous (at 575/690 V)	500	570	570	630
Intermittent (60 s overload) at 575/690 V	750	627	627	693
Input current [A]				
Continuous (at 550 V)	504	574	574	607
Continuous (at 575 V)	482	549	549	607
Continuous (at 690 V)	482	549	549	607
Power losses [W]				
Estimated power loss at 600 V	6016	6995	6941	7431
Estimated power loss at 690 V	5886	6831	6766	7638
Bus bar losses at 575 V	546	550	550	553
DC bus bar losses during regeneration	186	186	191	191
Maximum cable size [mm^2 (mcm)]				
Mains	4x120 (250)			
Motor	4x120 (250)			
Brake	4x95 (3/0)			
Regeneration terminals	4x120 (250)			
Maximum external mains fuses	700 V, 630 A			

Table 7.13 FC 302, 525–690 V AC Mains Supply (2-Drive System)

Power range	N630		N710		N800		N900		N1M0	
Drive modules	4		4		4		4		4	
Rectifier configuration	6-pulse/12-pulse									
High/normal load	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Output current [A]										
Continuous (at 550 V)	659	763	763	889	889	988	988	1108	1108	1317
Intermittent (60 s overload) at 550 V	989	839	1145	978	1334	1087	1482	1219	1662	1449
Continuous (at 575/690 V)	630	730	730	850	850	945	945	1060	1060	1260
Intermittent (60 s overload) at 575/690 V	945	803	1095	935	1275	1040	1418	1166	1590	1590
Input current [A]										
Continuous (at 550 V)	642	743	743	866	866	962	1079	1079	1079	1282
Continuous (at 575 V)	613	711	711	828	828	920	1032	1032	1032	1227
Continuous (at 690 V)	613	711	711	828	828	920	1032	1032	1032	1227
Power losses [W]										
Estimated power loss at 600 V	7469	8683	8668	10166	10163	11406	11292	12852	12835	15762
Estimated power loss at 690 V	7381	8559	8555	9996	9987	11188	11077	12580	12551	15358
Bus bar losses at 575 V	637	644	644	653	653	661	661	672	672	695
DC bus bar losses during regeneration	198	198	208	208	218	218	231	231	256	256
Maximum cable size [mm² (mcm)]										
Mains	4x120 (250)		6x120 (250)						8x120 (250)	
Motor	4x120 (250)		6x120 (250)						8x120 (250)	
Brake	8x70 (2/0)						8x95 (3/0)			
Regeneration terminals	4x150 (300)		6x120 (250)				6x150 (300)		8x120 (250)	
Maximum external mains fuses										
6-pulse configuration	700 V, 1600 A								700 V, 2000 A	
12-pulse configuration	700 V, 900 A						700 V, 1500 A			

Table 7.14 FC 302, 525–690 V AC Mains Supply (4-Drive System)

7.2 Mains Supply to Drive Module

Mains supply	
Supply terminals	R/91, S/92, T/93
Supply voltage	380–480 V ±10%, 525–690 V ±10%

Mains voltage low/mains voltage drop-out:
During low mains voltage, the drive module continues until the DC-link voltage drops below the minimum stop level, which corresponds typically to 15% below the lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the lowest rated supply voltage. The drive module trips for a detected mains drop-out.

Supply frequency	50/60 Hz ±5%
Maximum temporary imbalance between mains phases	3.0% of rated supply voltage
True power factor (λ)	≥0.99 nominal at rated load
Displacement power factor (cos Φ)	(Approximately 1)
Switching on input supply L1, L2, L3	Maximum 1 time per 2 minutes
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 85000 RMS symmetrical Amperes, 480/600 V

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7.3 Motor Output and Motor Data

Motor output	
Motor terminals	U/96, V/97, W/98
Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz
Switching on output	Unlimited
Ramp times	1–3600 s

Torque characteristics	
Overload torque (constant torque)	Maximum 150% for 60 s[1)]
Starting torque	Maximum 180% up to 0.5 s[1)]
Overload torque (variable torque)	Maximum 110% for s[1)]
Starting torque (variable torque)	Maximum 135% for s

1) Percentage relates to the nominal torque.

Efficiency	
Efficiency	98%[1)]

1) Efficiency measured at nominal current. For energy efficiency class, see chapter 7.5 Ambient Conditions for Drive Modules. For part load losses, see www.danfoss.com/vltenergyefficiency.

7.4 12-Pulse Transformer Specifications

Connection	Dy11 d0 or Dyn 11d0
Phase shift between secondaries	30°
Voltage difference between secondaries	<0.5%
Short-circuit impedance of secondaries	>5%
Short-circuit impedance difference between secondaries	<5% of short-circuit impedance
Other	No grounding of the secondaries allowed. Static shield recommended

7.5 Ambient Conditions for Drive Modules

Environment	
IP rating	IP00
Acoustic noise	84 dB (running at full load)
Vibration test	0.7 g
Vibration and shock (IEC 60721-33-3)	Class 3M3

Maximum relative humidity	5–95% (IEC 721–3–3; Class 3K3 (non-condensing)) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	Class Kd
Aggressive gases (IEC 60721-3-3)	Class 3C3
Ambient temperature[1)]	Maximum 45 °C (113 °F) (24-hour average maximum 40 °C (104 °F))
Minimum ambient temperature during full-scale operation	0 °C (32 °F)
Minimum ambient temperature at reduced performance	-10 °C (14 °F)
Temperature during storage/transport	-25 to +65 °C (-13 to 149 °F)
Maximum altitude above sea level without derating [1)]	1000 m (3281 ft)

EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-4-2, EN 61800-4-3, EN 61800-4-4, EN 61800-4-5, and EN 61800-4-6
Energy efficiency class[2)]	IE2

1) Refer to the VLT® Common AC Drive Modules Design Guide for derating for high ambient temperature and derating for high altitude.
2) Determined according to EN 50598-2 at:

- *Rated load.*
- *90% rated frequency.*
- *Switching frequency factory setting.*
- *Switching pattern factory setting.*

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7.6 Cable Specifications

Cable lengths and cross-sections for control cables[1)]	
Maximum motor cable length, shielded	150 m (492 ft)
Maximum motor cable length, unshielded	300 m (984 ft)
Maximum cross-section to control terminals, flexible or rigid wire without cable end sleeves	1.5 mm^2/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm^2/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm^2/20 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 AWG
Maximum cross-section to 230 V terminals	2.5 mm^2/14 AWG
Minimum cross-section to 230 V terminals	0.25 mm^2/24 AWG

1) For power cables, see electrical data tables in chapter 7.1 Power-dependent Specifications.

7.7 Control Input/Output and Control Data

Digital inputs	
Programmable digital inputs	4 (6)[1)]
Terminal number	18, 19, 27[1)], 29[1)], 32, 33
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[2)]	>19 V DC
Voltage level, logic 1 NPN[2)]	<14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0–110 kHz
(Duty cycle) Minimum pulse width	4.5 ms
Input resistance, R_i	Approximately 4 kΩ

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) Terminals 27 and 29 can also be programmed as output.
2) Except Safe Torque Off input terminal 37.

Safe Torque Off (STO) Terminal 37[1), 2)] (Terminal 37 is fixed PNP logic)	
Voltage level	0–24 V DC
Voltage level, logic 0 PNP	<4 V DC
Voltage level, logic 1 PNP	>20 V DC
Maximum voltage on input	28 V DC
Typical input current at 24 V	50 mA_{rms}
Typical input current at 20 V	60 mA_{rms}
Input capacitance	400 nF

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

1) See VLT® Frequency Converters – Safe Torque Off Operating Instructions for further information about terminal 37 and Safe Torque Off.

2) When using a contactor with a DC coil with STO, always make a return path for the current from the coil when turning it off. The return path can be made by using a freewheel diode across the coil. Alternatively, use a 30 V or 50 V MOV for quicker response time. Typical contactors can be bought with this diode.

Analog inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	-10 V to +10 V (scalable)
Input resistance, R_i	Approximately 10 kΩ
Maximum voltage	±20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4–20 mA (scalable)
Input resistance, R_i	Approximately 200 Ω
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	20 Hz/100 Hz

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

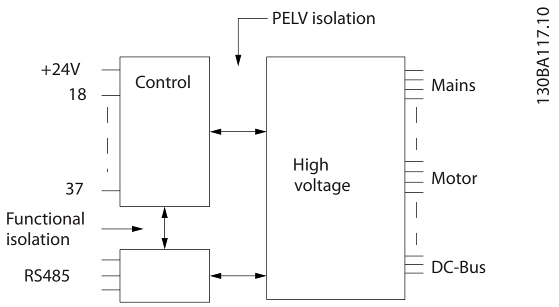


Illustration 7.1 PELV Isolation

Pulse input	
Programmable pulse	2/1
Terminal number pulse	29[1)], 32/33
Maximum frequency at terminal 29, 33	110 kHz (Push-pull driven)
Maximum frequency at terminal 29, 33	5 kHz (open collector)
Minimum frequency at terminal 29, 33	4 Hz
Voltage level	0–24 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error: 0.1% of full scale

Encoder input accuracy (1–11 kHz)	Maximum error: 0.05% of full scale

The pulse and encoder inputs (terminals 29, 32, 33) are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) Pulse inputs are 29 and 33.

Analog output

Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4–20 mA
Maximum load GND - analog output	500 Ω
Accuracy on analog output	Maximum error: 0.5% of full scale
Resolution on analog output	12 bit

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

Control card, 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 circuit is functionally separated from other central circuits and galvanically isolated from the supply voltage (PELV).

Digital output

Programmable digital/pulse outputs	2
Terminal number	27, 29[1)]
Voltage level at digital/frequency output	0–24 V
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 kΩ
Maximum capacitive load at frequency output	10 nF
Minimum output frequency at frequency output	0 Hz
Maximum output frequency at frequency output	32 kHz
Accuracy of frequency output	Maximum error: 0.1% of full scale
Resolution of frequency outputs	12 bit

1) Terminals 27 and 29 can also be programmed as input.
The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

Control card, 24 V DC output

Terminal number	12, 13
Output voltage	24 V +1, -3 V
Maximum load	200 mA

The 24 V DC supply is galvanically isolated from the supply voltage (PELV), but has the same potential as the analog and digital inputs and outputs.

Relay outputs

Programmable relay outputs	2
Relay 01 terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1)] on 1–3 (NC), 1–2 (NO) (Resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 1–2 (NO), 1–3 (NC) (Resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1)] (Inductive load)	24 V DC, 0.1 A
Relay 02 (FC 302 only) Terminal number	4–6 (break), 4–5 (make)
Maximum terminal load (AC-1)[1)] on 4–5 (NO) (Resistive load)[2)3)] Overvoltage category II	400 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 4–5 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 4–5 (NO) (Resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 4–5 (NO) (Inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1)] on 4–6 (NC) (Resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 4–6 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 4–6 (NC) (Resistive load)	50 V DC, 2 A

Maximum terminal load (DC-13)[1)] on 4–6 (NC) (Inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO), 4–6 (NC), 4–5 (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 part 4 and 5.
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).
2) Overvoltage Category II.
3) UL applications 300 V AC2A.

Control card, 10 V DC output

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

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

Control characteristics

Resolution of output frequency at 0–590 Hz	±0.003 Hz
Repeat accuracy of precise start/stop (terminals 18, 19)	≤±0.1 ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤10 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed control range (closed loop)	1:1000 of synchronous speed
Speed accuracy (open loop)	30–4000 RPM: error ±8 RPM
Speed accuracy (closed loop), depending on resolution of feedback device	0–6000 RPM: error ±0.15 RPM

All control characteristics are based on a 4-pole asynchronous motor

Control card performance

Scan interval	5 ms

Control card, USB serial communication

USB standard	1.1 (full speed)
USB plug	USB type B device plug

Connection to PC is carried out via a standard host/device USB cable.
The USB connection is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
The USB ground connection is NOT galvanically isolated from protective earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

7.8 Kit Dimensions

7.8.1 Drive Module

Illustration 7.2 shows the dimensions of the drive module related to its installation.

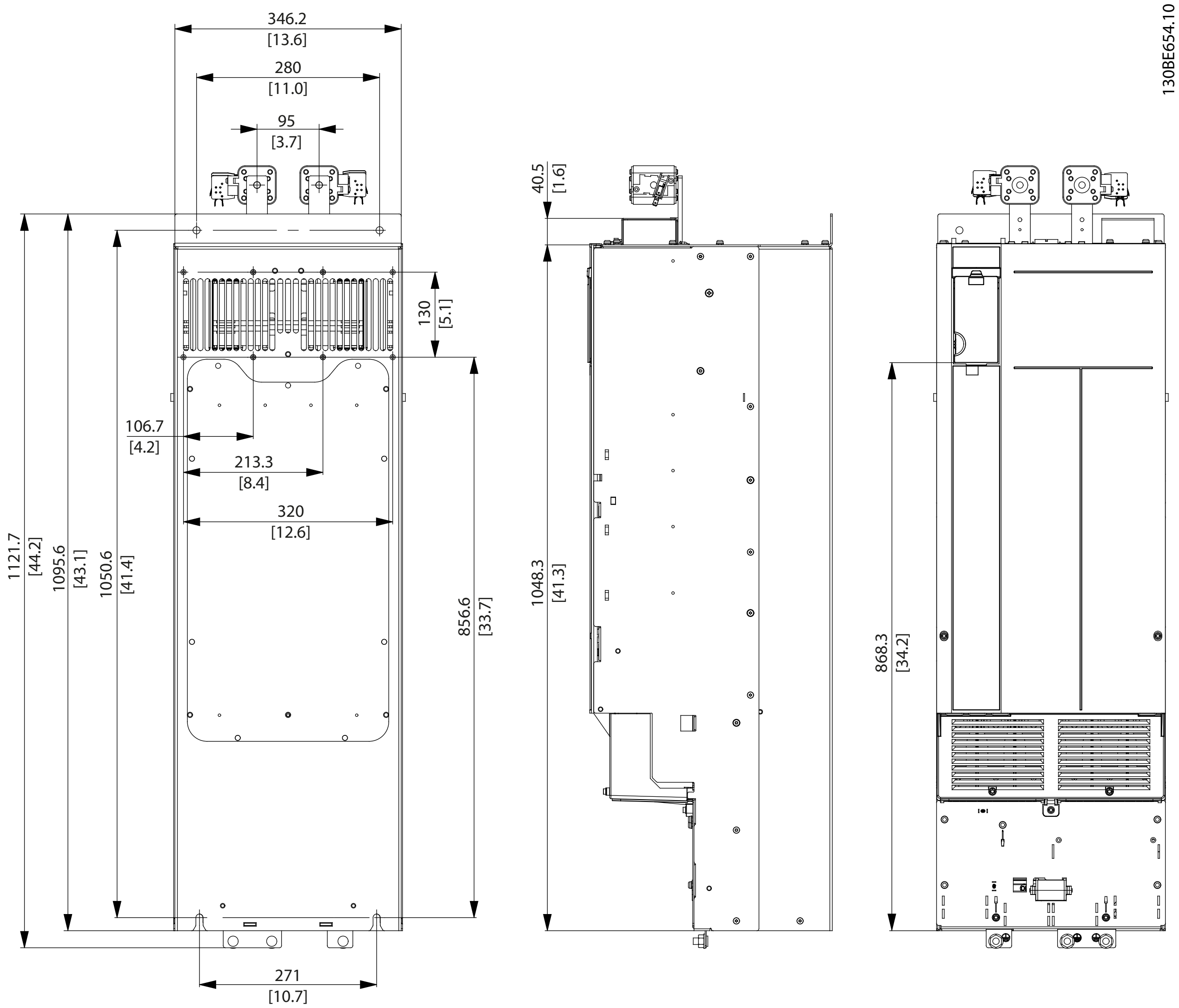


Illustration 7.2 Common AC Drive Modules Installation Dimensions

Description	Module weight [kg (lb)]	Length x width x depth [mm (in)]
Drive module	125 (275)	1121.7 x 346.2 x 375 (44.2 x 13.6 x 14.8)

Table 7.15 Drive Module Weight and Dimensions

7.8.2 Terminal Dimensions

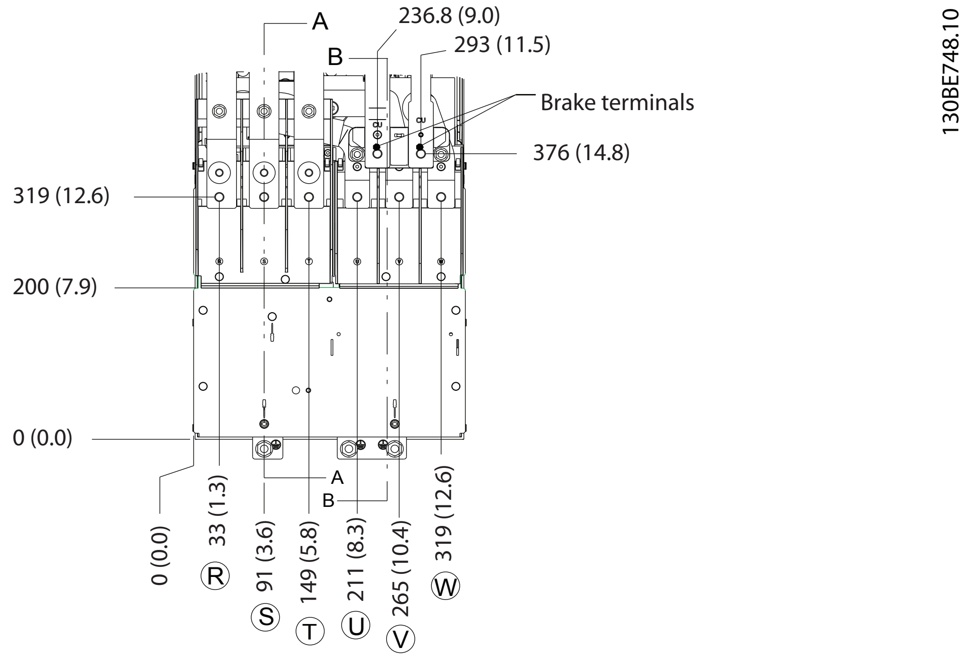


Illustration 7.3 Drive Module Terminal Dimensions (Front View)

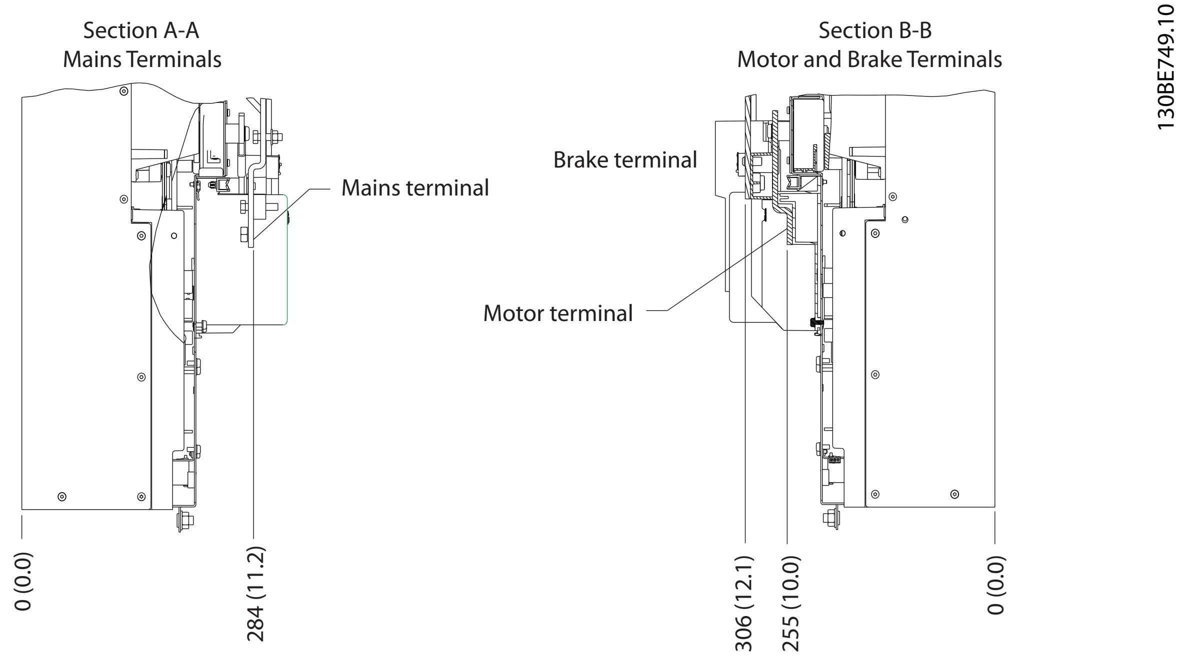


Illustration 7.4 Drive Module Terminal Dimensions (Side Views)

7.8.3 DC Bus Dimensions

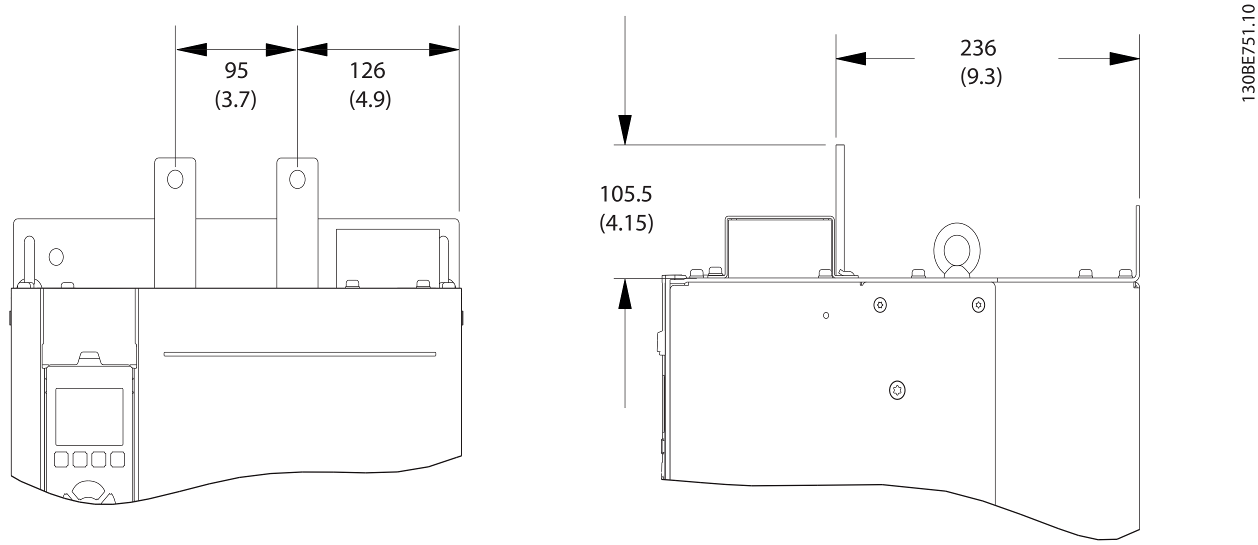


Illustration 7.5 DC Bus Dimensions

7.9 Fastener Tightening Torques

For fastening hardware described in this manual, use the torque values in *Table 7.16*. These torque values are not intended for fastening IGBTs. See the instructions included with those replacement parts for the correct torque values.

Shaft Size	Driver Size Torx/Hex	Torque (Nm)	Torque (in-lb)
M4	T20 Torx/7 mm hex	1.0	9
M5	T25 Torx/8 mm hex	2.3	20
M6	T30 Torx/10 mm hex	4.0	35
M8	T40 Torx/13 mm hex	9.6	85
M10	T50 Torx/17 mm hex	19.1	169
M12 (hex bolts only)	18 mm or 19 mm hex	19.1	169

Table 7.16 General Tightening Torques of Fasteners

7.9.1 Tightening Torques for Terminals

For fastening terminals, use the torque values in *Table 7.17*.

	Mains	Motor	Regen	Load sharing	Ground	Brake
Bolt size	M10	M10	M10	M10	M8	M8
Torque [Nm (in-lbs)]	19–40 (168–354)	19–40 (168–354)	19–40 (168–354)	19–40 (168–354)	8.5–20.5 (75–181)	8.5–20.5 (75–181)

Table 7.17 Tightening of Terminals

8 Appendix

8.1 Symbols, Abbreviations, and Conventions

°C	Degrees celsius
°F	Degrees fahrenheit
AC	Alternating current
AWG	American wire gauge
DC	Direct current
EMC	Electro magnetic compatibility
ETR	Electronic thermal relay
FC	Frequency converter
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
MDCIC	Multi-drive control interface
PCB	Printed circuit board
PELV	Protective extra low voltage
PM Motor	Permanent magnet motor
RCD	Residual current-operated protective device
Regen	Regenerative terminals
RFI	Radio frequency interference
RPM	Revolutions per minute

Table 8.1 Symbols and Abbreviations

Conventions
Numbered lists indicate procedures.
Bullet lists indicate other information and description of illustrations.

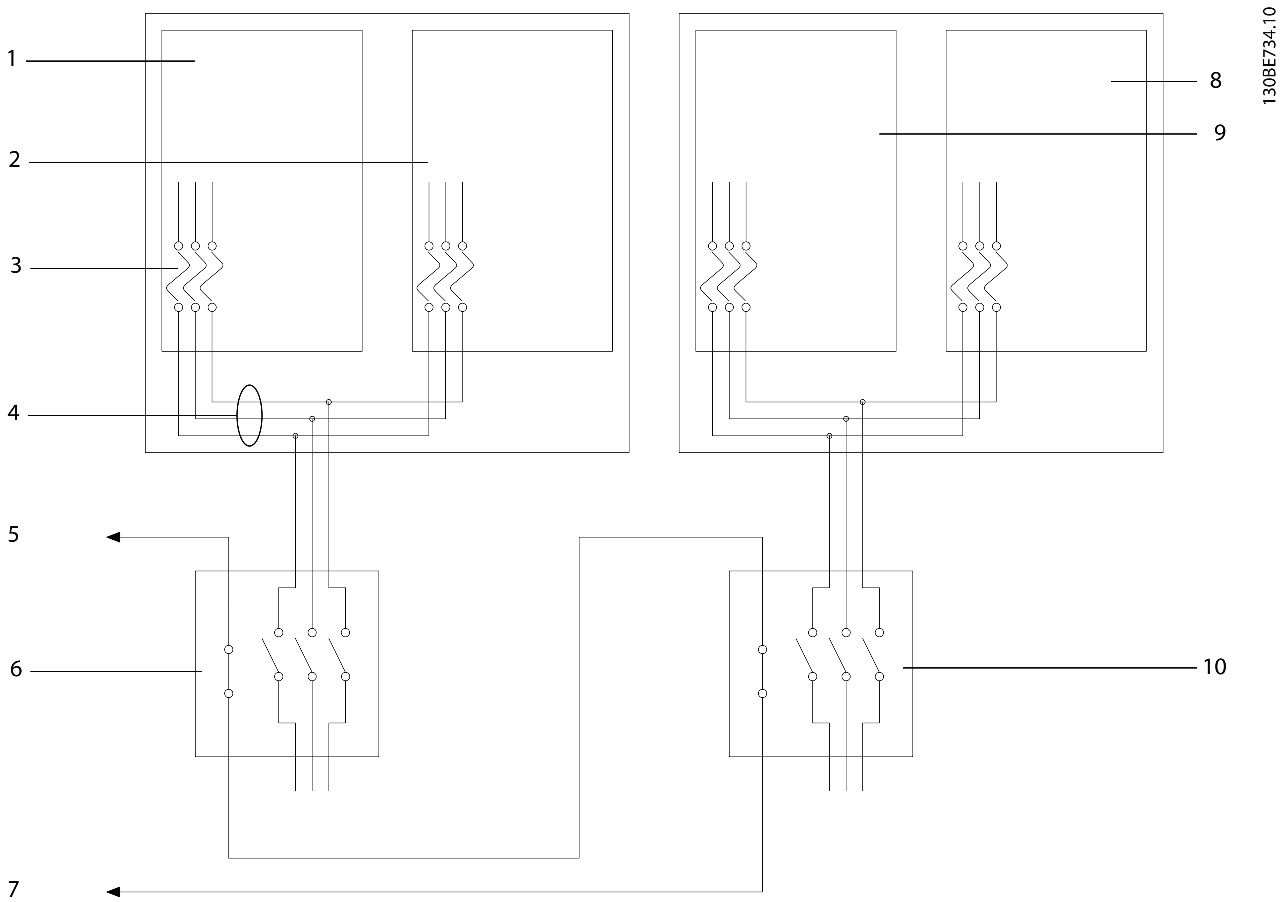
Italicized text indicates:

- Cross-reference.
- Link.
- Parameter name.

All measurements are given in both metric units and imperial units. Imperial units are in ().

8.2 Block Diagrams

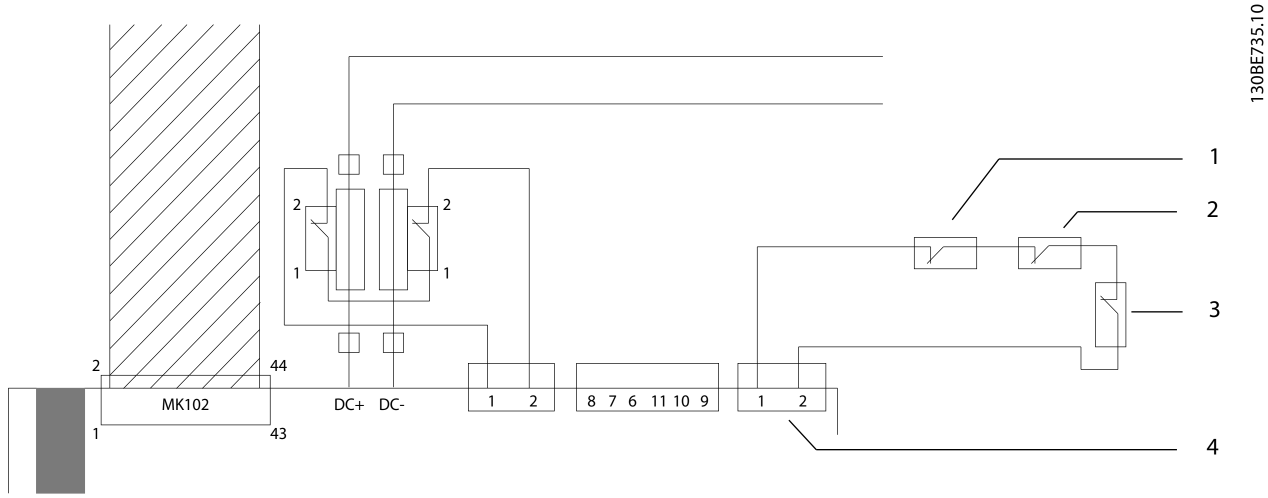
8.2.1 Connection of 12-Pulse Disconnector/Interlock



1	Drive module 1	6	Disconnector 1
2	Drive module 2	7	Brake fault
3	Supplementary fuses	8	Drive module 3
4	Mains input bus bars	9	Drive module 4
5	Brake fault	10	Disconnector 2

Illustration 8.1 Connection of 12-Pulse Disconnector/Interlock

8.2.2 BRF Connection with 12-Pulse Disconnector/Interlock

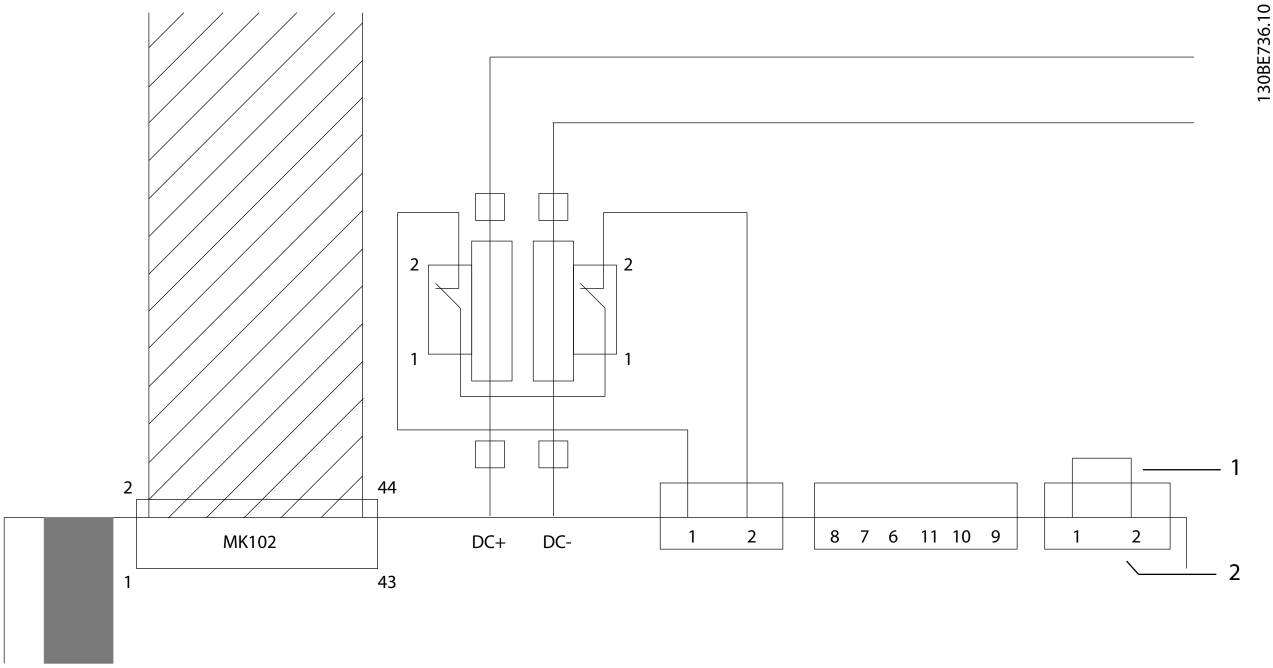


1	Auxiliary contact disconnector 1	3	Klixon switch
2	Auxiliary contact disconnector 2	4	BRF connector

Illustration 8.2 BRF Connection with 12-Pulse Disconnector/Interlock

8

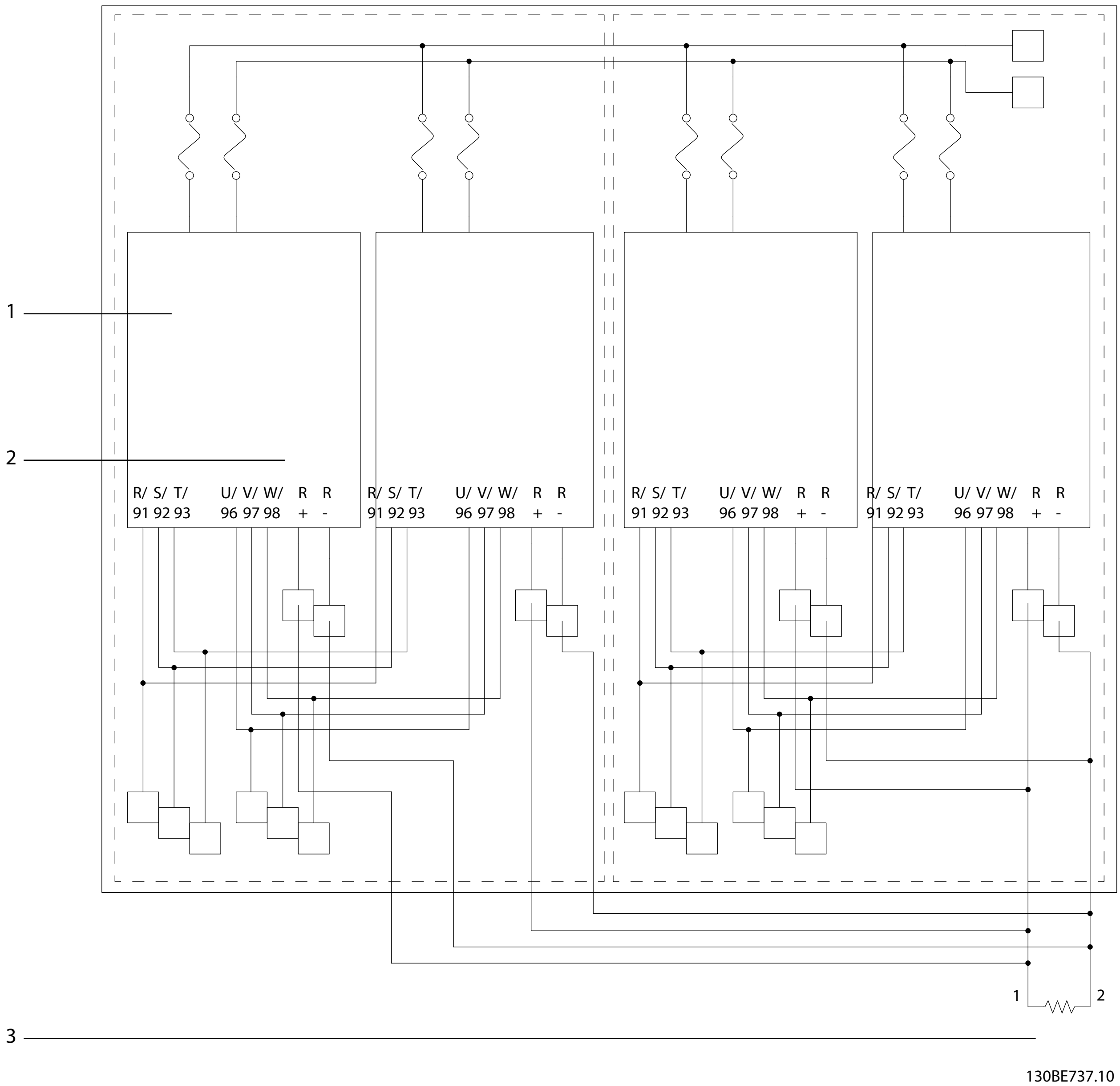
8.2.3 BRF Jumper Connection



1	BRF jumper (pre-installed)	2	BRF connector

Illustration 8.3 BRF Jumper Connection

8.2.4 Connection of Common Brake Resistor

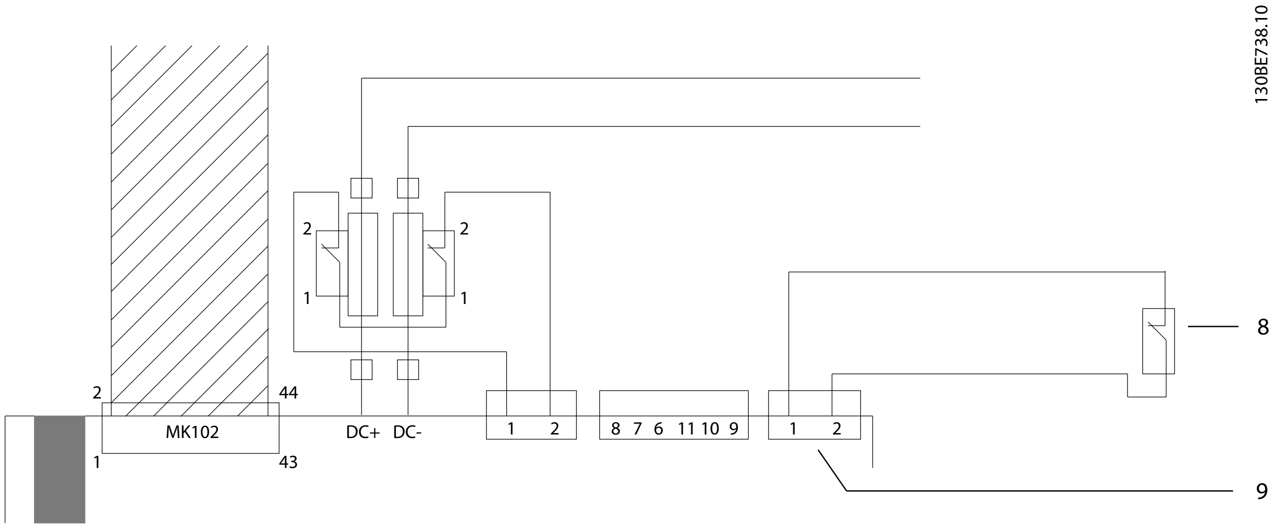


1	Drive module	3	Common brake resistor
2	Brake terminals	–	–

Illustration 8.4 Connection of Common Brake Resistor

8

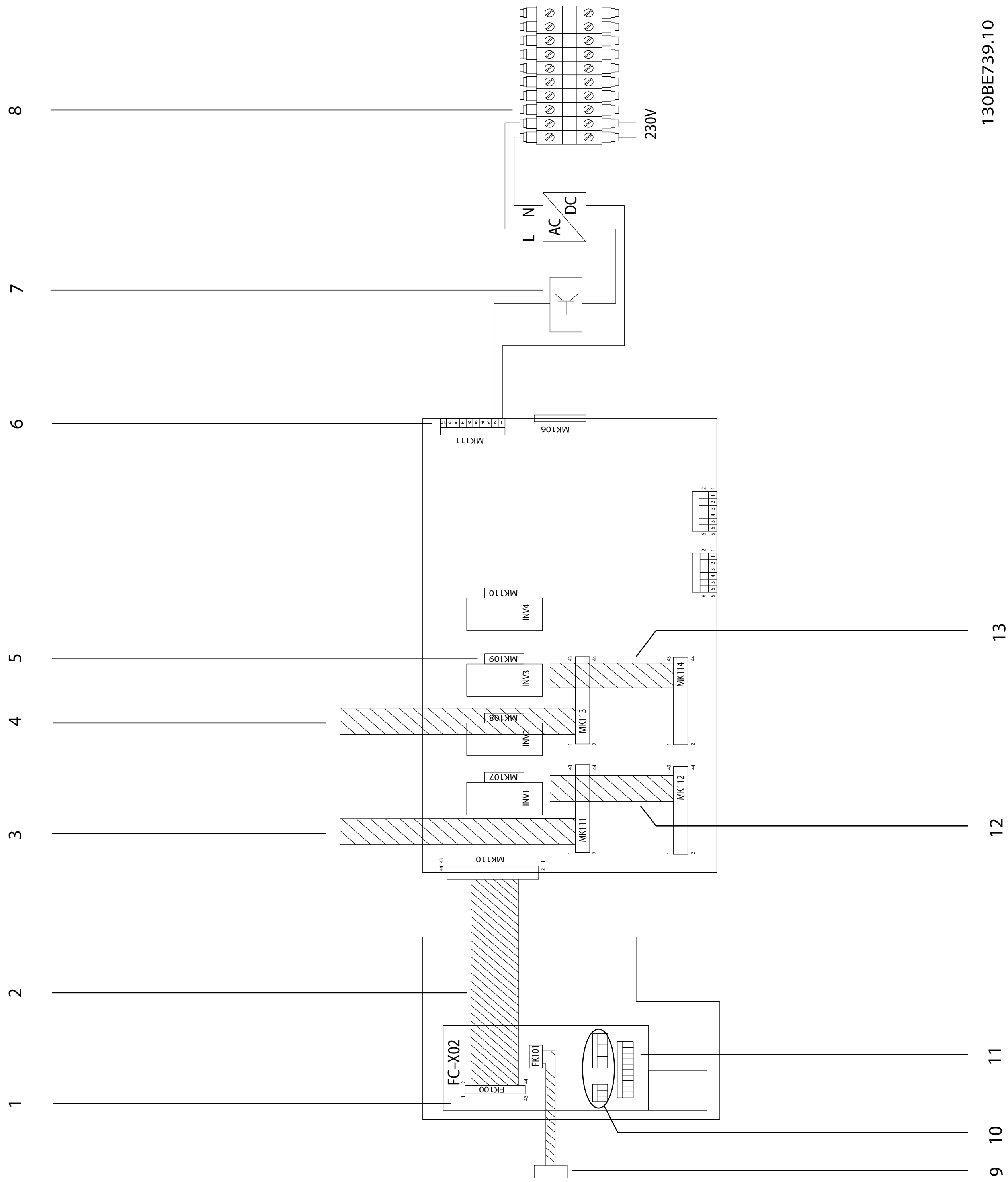
8.2.5 Klixon Switch Connection



1	Klixon switch	2	BRF connector

Illustration 8.5 Klixon Switch Connection

8.2.6 Control Shelf Connections



1	LCP cradle	8	Terminal block
2	Ribbon cable from LCP to MDCIC	9	Cable to remote-mounted LCP
3	44-pin cable to the drive module 1 (at MK 111)	10	Analog I/O terminals
4	44-pin cable to the drive module 3 (at MK 113)	11	Digital input terminals
5	Current scaling card	12	44-pin cable to the drive module 2 (at MK 112)
6	STO connector	13	44-pin cable to the drive module 4 (at MK 114)
7	STO relay	–	–

Illustration 8.6 Control Shelf Connections

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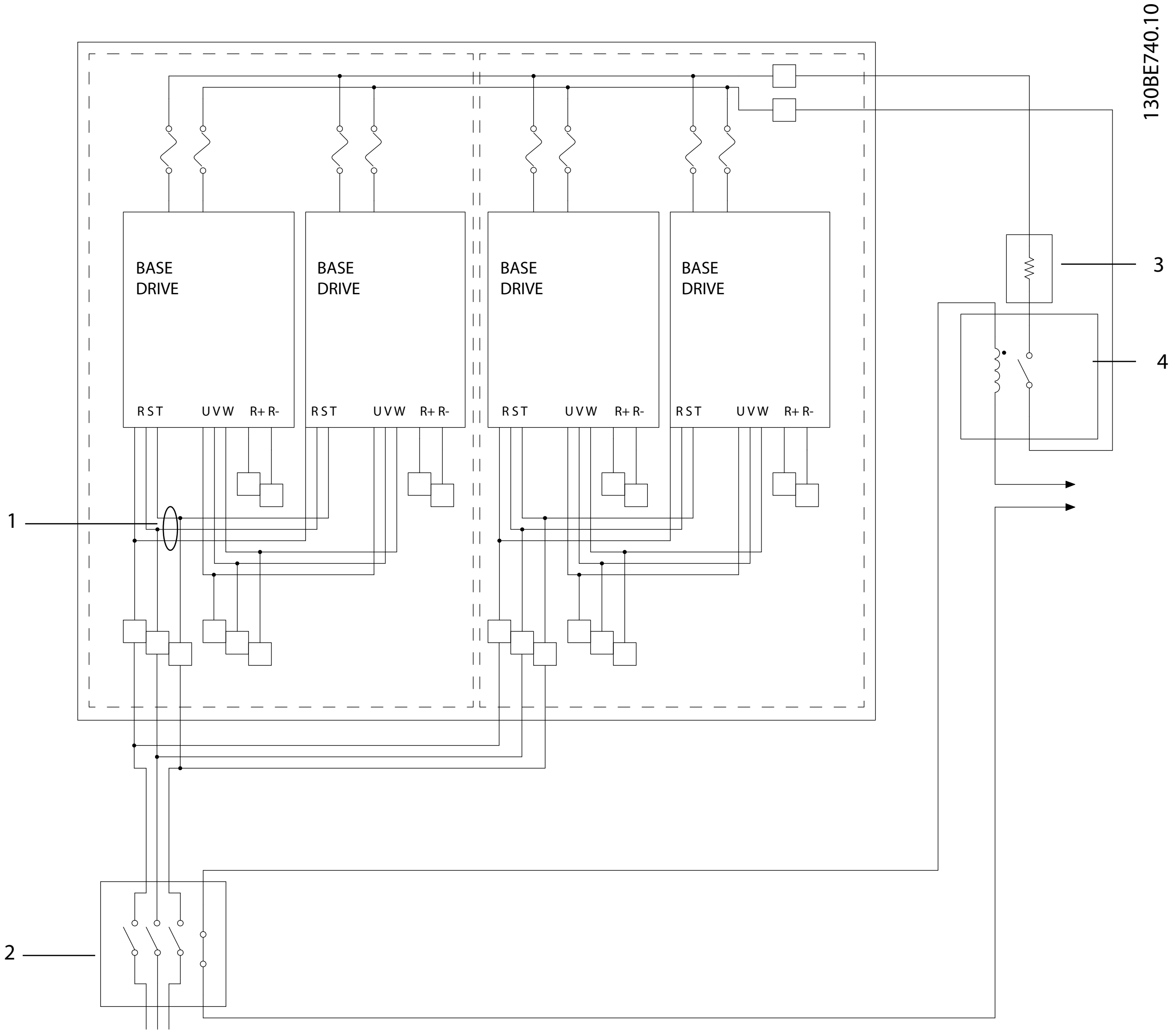
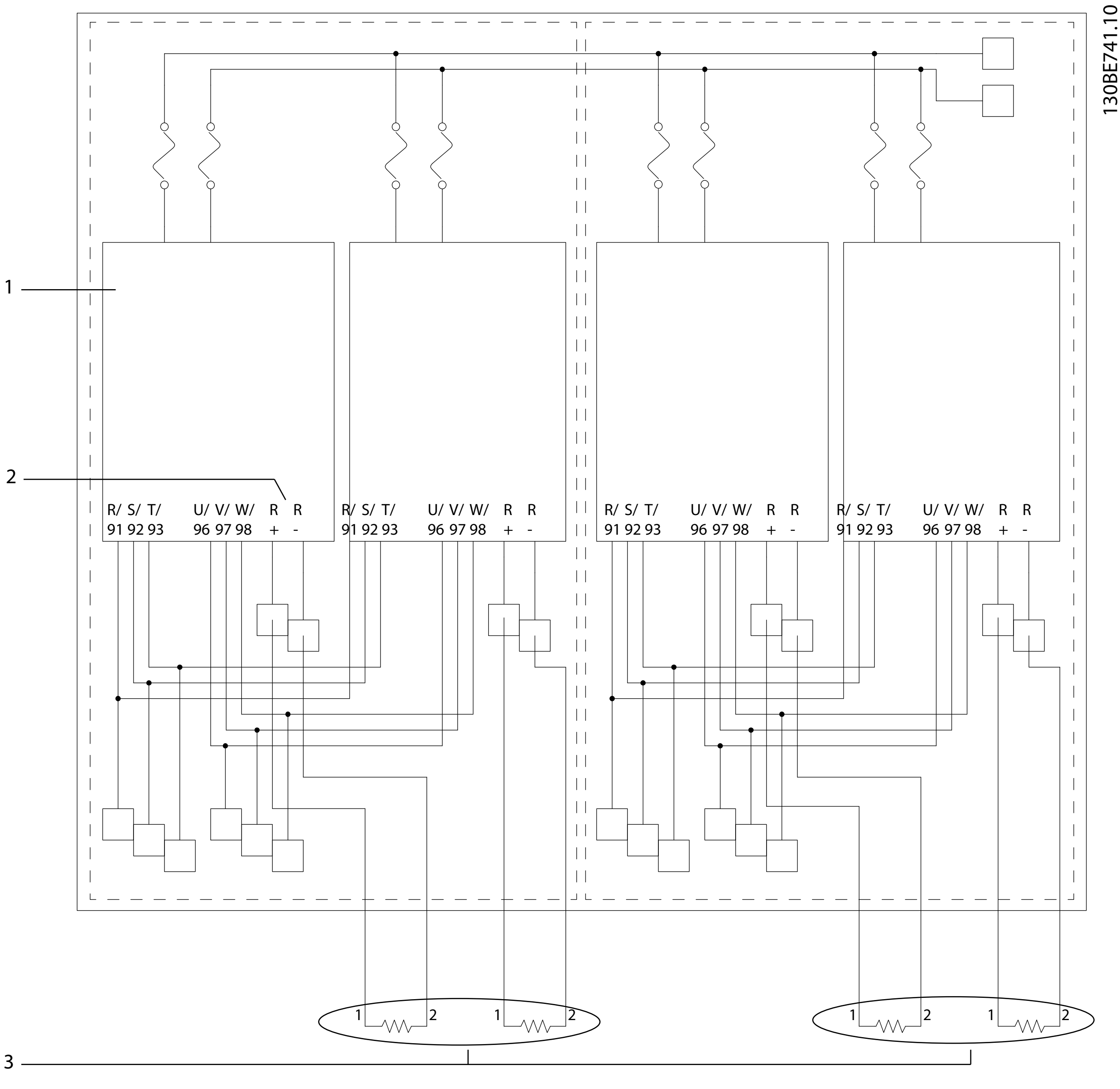
8.2.7 Discharge Resistor Connections



1	Mains input bus bars	3	Discharge resistor
2	Mains contactor/disconnector auxiliary contacts	4	Discharge contactor

Illustration 8.7 Discharge Resistor Connections

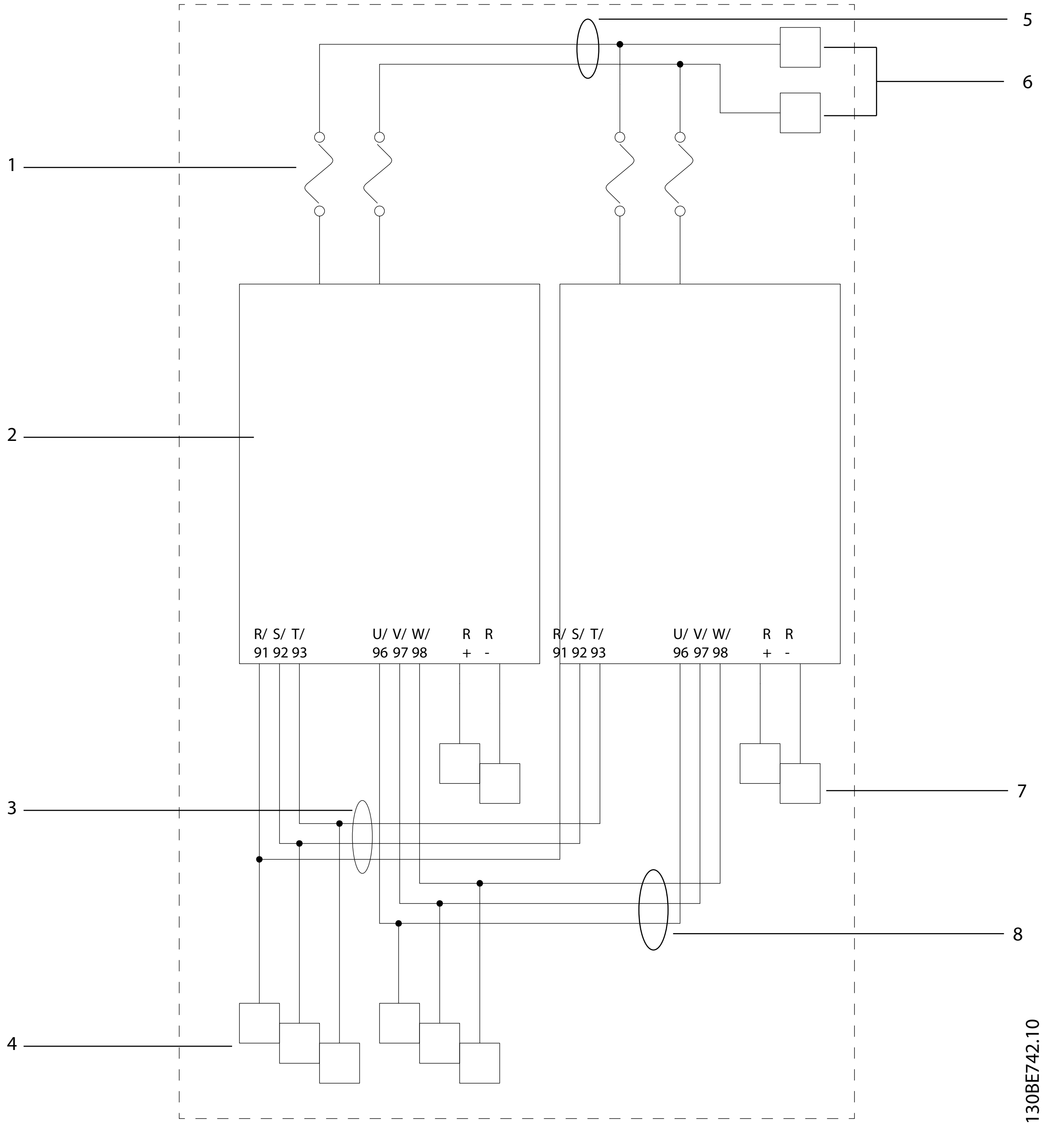
8.2.8 Connection of Individual Brake Resistor to Each Drive Module



1	Drive module	3	Individual brake resistors
2	Brake terminals	–	–

Illustration 8.8 Connection of Individual Brake Resistor to Each Drive Module

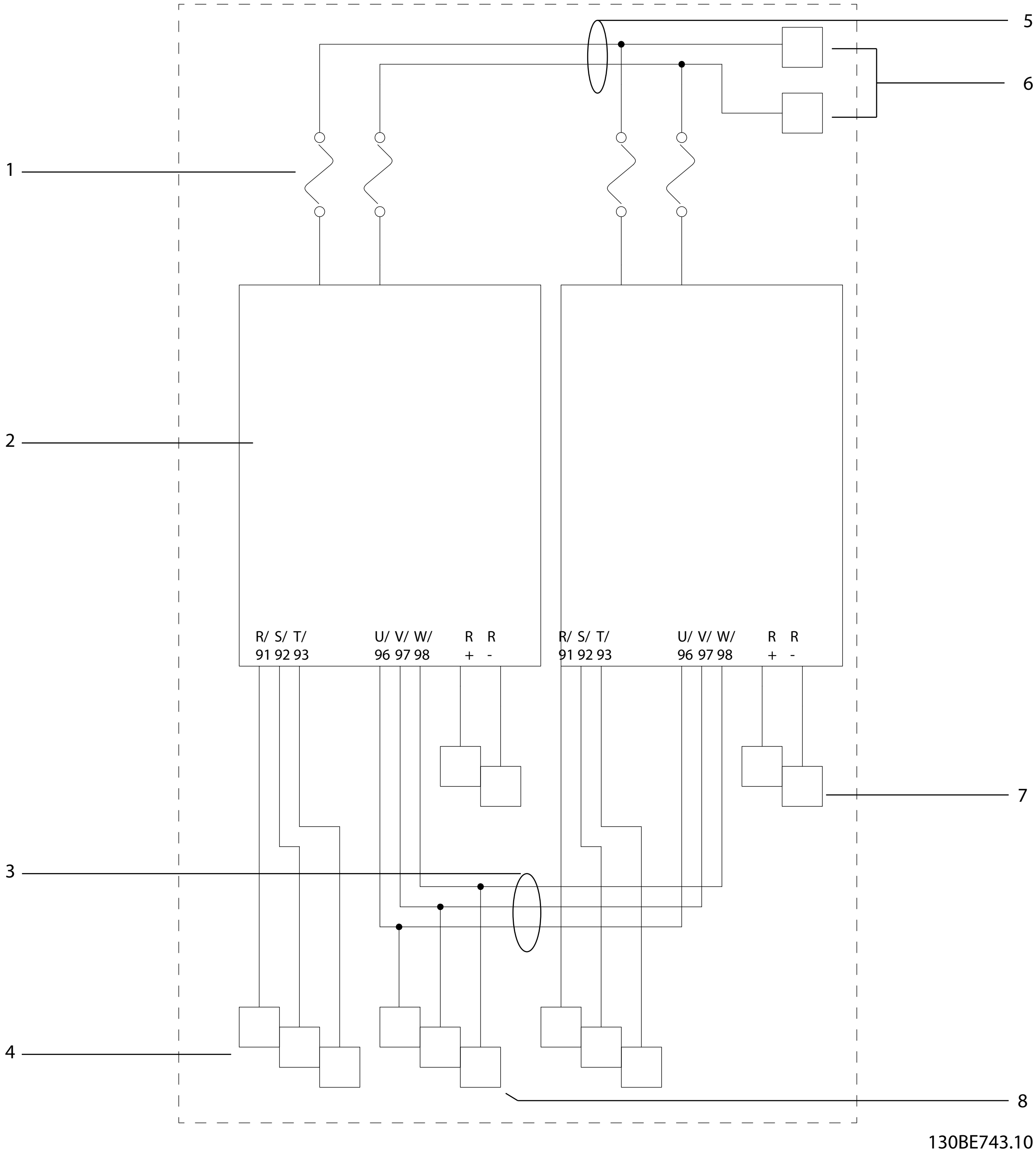
8.2.9 Connections in 6-Pulse 2-Drive Module System



1	DC fuses	5	DC-link bus bars
2	Drive modules	6	DC terminals
3	Mains input bus bars	7	Brake terminals
4	Mains input terminals	8	Motor output bus bars

Illustration 8.9 Connections in 6-Pulse 2-Drive Module System

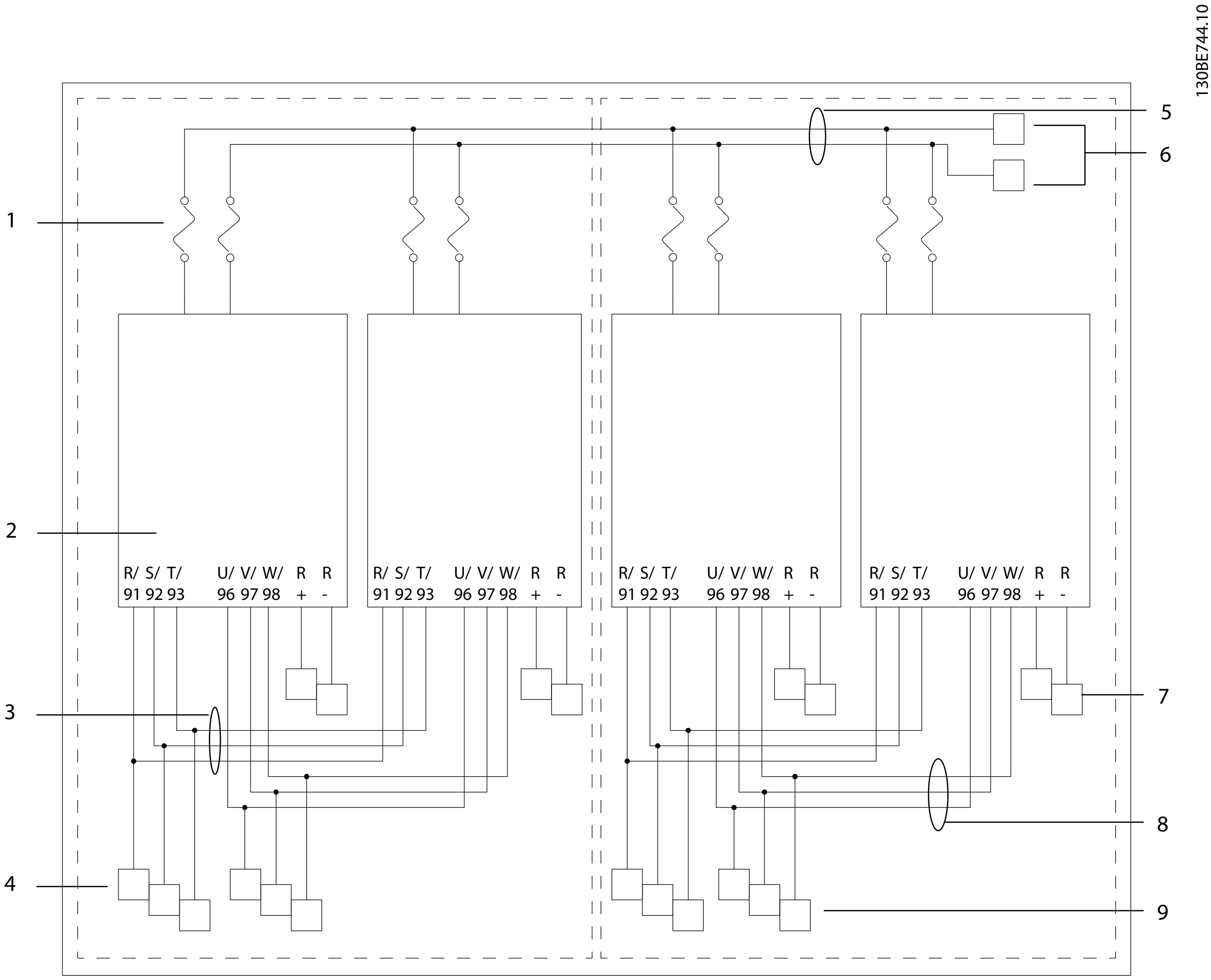
8.2.10 Connections in 12-Pulse 2-Drive Module System



1	DC fuses	5	DC-link bus bars
2	Drive modules	6	DC terminals
3	Motor output bus bars	7	Brake terminals
4	Mains input terminals	8	Motor output terminals

Illustration 8.10 Connections in 12-Pulse 2-Drive Module System

8.2.11 Connections in 4-Drive Module System



1	DC fuses	6	DC terminals
2	Drive module	7	Brake terminals
3	Mains input bus bars	8	Motor output bus bars
4	Mains input terminals	9	Motor output terminals
5	DC-link bus bars	–	–

Illustration 8.11 Connections in 4-Drive Module System

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