

Operating Guide

# VLT® AutomationDrive FC 301/FC 302

0.25–75 kW, Enclosure sizes A-C





## Contents

<b>1</b>	<b>Introduction</b>	<b>6</b>
1.1	Purpose of this Operating Guide	6
1.2	Trademarks	6
1.3	Additional Resources	6
1.4	Manual and Software Version	6
1.5	Product Overview	6
1.5.1	Intended Use	6
1.5.2	Exploded Views	7
1.6	Type Approvals and Certifications	7
<b>2</b>	<b>Safety</b>	<b>9</b>
2.1	Safety Symbols	9
2.2	Qualified Personnel	9
2.3	Safety Precautions	9
<b>3</b>	<b>Mechanical Installation</b>	<b>12</b>
3.1	Unpacking	12
3.1.1	Items Supplied	12
3.1.2	Storage	12
3.2	Installation Environment	13
3.3	Mounting	13
3.3.1	Cooling	13
3.3.2	Lifting	14
3.3.3	Mounting	14
3.3.3.1	Mounting with Mounting Plate and Railings	14
<b>4</b>	<b>Electrical Installation</b>	<b>15</b>
4.1	Safety Instructions	15
4.2	EMC-compliant Installation	15
4.3	Grounding	15
4.4	Wiring Schematic	17
4.5	Connecting the Motor	18
4.5.1	Grounding the Cable Shield	18
4.6	Connecting AC Mains	19
4.6.1	Connecting the Drive to Mains	19
4.7	Control Wiring	19
4.7.1	Safe Torque Off (STO)	19
4.7.2	Mechanical Brake Control	20

4.8	Installation Check List	20
<b>5</b>	<b>Commissioning</b>	<b>22</b>
5.1	Safety Instructions	22
5.1.1	Before Applying Power	22
5.2	Local Control Panel Operation	23
5.3	System Set-up	24
<b>6</b>	<b>Basic I/O Configuration</b>	<b>25</b>
6.1	Application Examples	25
6.1.1	Programming a Closed-loop Drive System	25
6.1.2	Wiring Configuration for Automatic Motor Adaptation (AMA)	26
6.1.3	Wiring Configuration for Automatic Motor Adaptation without T27	26
6.1.4	Wiring Configuration: Speed	27
6.1.5	Wiring Configuration: Feedback	29
6.1.6	Wiring Configuration: Run/Stop	31
6.1.7	Wiring Configuration: Start/Stop	33
6.1.8	Wiring Configuration: External Alarm Reset	35
6.1.9	Wiring Configuration: RS485	36
6.1.10	Wiring Configuration: Motor Thermistor	36
6.1.11	Wiring for Regen	37
6.1.12	Wiring Configuration for a Relay Setup with Smart Logic Control	38
6.1.13	Wiring Configuration: Mechanical Brake Control	39
6.1.14	Wiring Configuration for the Encoder	39
6.1.15	Wiring Configuration for Torque and Stop Limit	41
<b>7</b>	<b>Maintenance, Diagnostics, and Troubleshooting</b>	<b>43</b>
7.1	Maintenance and Service	43
7.2	Warning and Alarm Types	43
7.3	Warning and Alarm Displays	44
7.4	Descriptions of Warnings and Alarms	44
<b>8</b>	<b>Specifications</b>	<b>60</b>
8.1	Electrical Data	60
8.1.1	Mains Supply 200–240 V	60
8.1.2	Mains Supply 380–500 V	62
8.1.3	Mains Supply 525–600 V (FC 302 only)	65
8.1.4	Mains Supply 525–690 V (FC 302 only)	67
8.1.5	Power Cable Cross-sections	70
8.2	Mains Supply	70

8.3	Motor Output and Motor Data	71
8.3.1	Motor Output (U, V, W)	71
8.3.2	Torque Characteristics	71
8.4	Ambient Conditions	71
8.5	Cable Specifications	72
8.5.1	Cable Lengths and Cross-sections for Control Cables	72
8.6	Control Input/Output and Control Data	72
8.6.1	Digital Inputs	72
8.6.2	STO Terminal 37 (Terminal 37 is Fixed PNP Logic)	72
8.6.3	Analog Inputs	73
8.6.4	Pulse/Encoder Inputs	73
8.6.5	Digital Outputs	74
8.6.6	Analog Output	74
8.6.7	Control Card, 24 V DC Output	74
8.6.8	Control Card, +10 V DC Output	74
8.6.9	Control Card, RS485 Serial Communication	74
8.6.10	Control Card, USB Serial Communication	74
8.6.11	Relay Outputs	75
8.6.12	Control Card Performance	75
8.6.13	Control Characteristics	75
8.7	Fuses and Circuit Breakers	76
8.7.1	Fuse Recommendations	76
8.7.2	CE Compliance	76
8.7.3	UL Compliance	79
8.8	Connection Tightening Torques	82
8.9	Power Ratings, Weight, and Dimensions	84
<b>9</b>	<b>Appendix</b>	<b>88</b>
9.1	Symbols and Abbreviations	88

## 1 Introduction

### 1.1 Purpose of this Operating Guide

This Operating Guide provides information for safe installation and commissioning of the AC drive. It is intended for use by qualified personnel. Read and follow the instructions to use the drive safely and professionally. Pay particular attention to the safety instructions and general warnings. Always keep this Operating Guide with the drive.

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

### 1.2 Trademarks

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

### 1.3 Additional Resources

Other resources are available to understand advanced drive functions and programming.

- The Programming Guide provides greater detail on working with parameters and shows many application examples.
- The Design Guide provides detailed information about capabilities and functionality to design motor control systems.
- The Safe Torque Off Operating Guide provides detailed specifications, requirements, and installation instructions for the Safe Torque Off function.
- Supplementary publications and manuals are available from Danfoss, see [www.danfoss.com](http://www.danfoss.com).

### 1.4 Manual and Software Version

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

Table 1: Manual and Software Version

Version	Remarks	Software version
AQ267037727118, version 0101	Editorial update.	8.43, 48.4x (IMC)

### 1.5 Product Overview

#### 1.5.1 Intended Use

The drive is an electronic motor controller intended for:

- Regulation of motor speed in response to system feedback or to remote commands from external controllers. A power drive system consists of the AC drive, the motor, and equipment driven by the motor.
- System and motor status surveillance.

The drive can also be used for motor overload protection.

Depending on the configuration, the drive can be used in standalone applications or form part of a larger appliance or installation.

The drive is allowed for use in residential, industrial, and commercial environments in accordance with local laws and standards.

## N O T I C E

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

#### Foreseeable misuse

Do not use the drive in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *Ambient Conditions*.

## N O T I C E

#### OUTPUT FREQUENCY LIMIT

Due to export control regulations, the output frequency of the drive is limited to 590 Hz. For demands exceeding 590 Hz, contact Danfoss.

### 1.5.2 Exploded Views

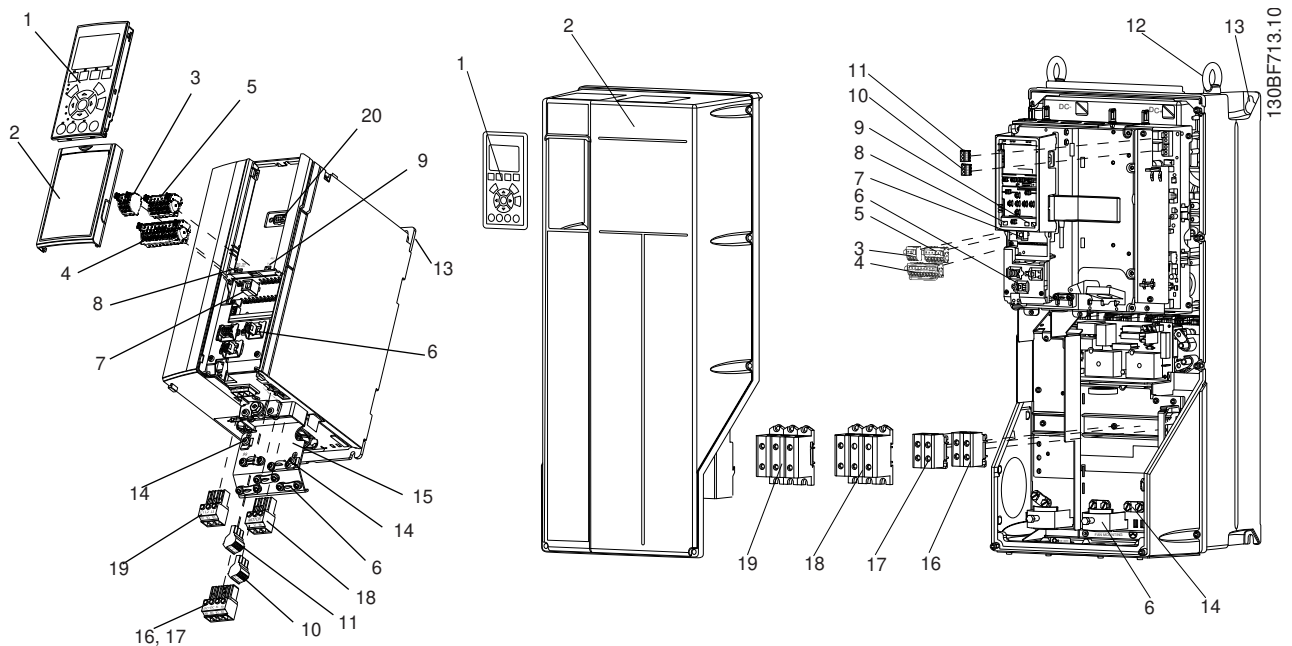


Illustration 1: Exploded View Enclosure Size A, IP20 (left) and Enclosure Size C, IP55/IP66 (right)

1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS485 fieldbus connector	13	Mounting slot
4	Digital input/output connector	14	Ground connection (PE)
5	Digital input/output connector	15	Cable shield connector
6	Shielded cable grounding and relief	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (-88, +89)
8	RS485 termination switch	18	Motor terminals 96 (U), 97 (V), 98 (W)
9	DIP switch for A53 and A54	19	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)	20	LCP connector

### 1.6 Type Approvals and Certifications

The following list is a selection of possible type approvals and certifications for Danfoss drives:

#### NOTICE

Drives of enclosure size T7 (525–690 V) are not UL listed.

Table 2: Type Approvals and Certifications

			 www.tuv.com ID 060000000		
--	--	--	---------------------------------	--	--



			OSH PD			
			ClassNK			

**NOTICE**

The specific approvals and certification for the drive are on the nameplate of the drive. For more information, contact the local Danfoss office or partner.

For more information on UL 508C thermal memory retention requirements, refer to the section *Motor Thermal Protection* in the product-specific Design Guide.

For more information on compliance with the European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN), refer to the section *ADN-compliant Installation* in the product-specific Design Guide.



## 2 Safety

### 2.1 Safety Symbols

The following symbols are used in this manual:

#### ⚠ D A N G E R ⚠

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

#### ⚠ W A R N I N G ⚠

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

#### ⚠ C A U T I O N ⚠

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

#### N O T I C E

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

### 2.2 Qualified Personnel

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

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

### 2.3 Safety Precautions

#### ⚠ W A R N I N G

##### HAZARDOUS VOLTAGE

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

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

#### ⚠ W A R N I N G

##### UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up software, or after a cleared fault condition.

- Press [Off] on the LCP before programming parameters.
- Disconnect the drive from the mains whenever personal safety considerations make it necessary to avoid unintended motor start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

**⚠ W A R N I N G ⚠**

**DISCHARGE TIME**

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

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

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

**Table 3: Discharge Time**

Voltage [V]	Minimum waiting time (minutes)		
	4	7	15
200–240	0.25–3.7 kW (0.34–5 hp)	–	5.5–37 kW (7.5–50 hp)
380–500	0.25–7.5 kW (0.34–10 hp)	–	11–75 kW (15–100 hp)
525–600	0.75–7.5 kW (1–10 hp)	–	11–75 kW (15–100 hp)
525–690	–	1.5–7.5 kW (2–10 hp)	11–75 kW (15–100 hp)

**⚠ W A R N I N G ⚠**

**LEAKAGE CURRENT HAZARD**

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

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

**⚠ W A R N I N G ⚠**

**ROTATING SHAFTS**

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

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

**⚠ W A R N I N G ⚠**

**UNINTENDED MOTOR ROTATION WINDMILLING**

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

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

**⚠ CAUTION ⚠****INTERNAL FAILURE HAZARD**

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

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

### 3 Mechanical Installation

#### 3.1 Unpacking

##### 3.1.1 Items Supplied

Items supplied vary according to product configuration.

- Make sure that the items supplied and the information on the nameplate correspond to the order confirmation.
- Check the packaging and the drive visually for damage caused by inappropriate handling during shipment. File any claim for damage with the carrier. Retain damaged parts for clarification.

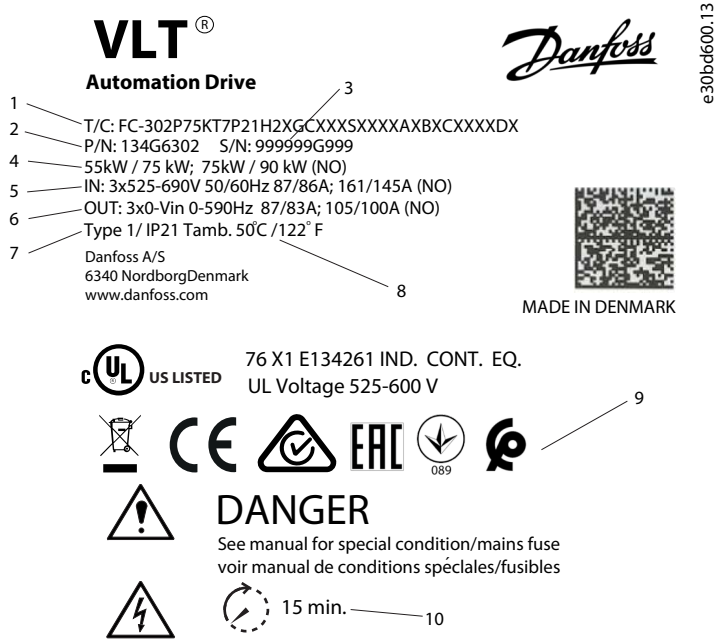


Illustration 2: Product Nameplate (Example)

1	Type code	6	Output voltage, frequency, and current (at low/high voltages)
2	Code number	7	Enclosure size and IP rating
3	Serial number	8	Maximum ambient temperature
4	Power rating	9	Certifications
5	Input voltage, frequency, and current (at low/high voltages)	10	Discharge time (Warning)

### NOTICE

Do not remove the nameplate from the drive (loss of warranty).

##### 3.1.2 Storage

Ensure that the requirements for storage are fulfilled, see [8.4 Ambient Conditions](#).

### 3.2 Installation Environment

#### NOTICE

**REDUCED LIFETIME**

In environments with airborne liquids, particles, or corrosive gases, ensure that the IP/Type rating of the equipment matches the installation environment. Failure to meet requirements for ambient conditions can reduce lifetime of the drive.

- Ensure that requirements for air humidity, temperature, and altitude are met.

**Vibration and shock**

The drive complies with requirements for units mounted on the walls and floors of production premises, and in panels bolted to walls or floors. For detailed ambient conditions, refer to [8.4 Ambient Conditions](#).

### 3.3 Mounting

#### 3.3.1 Cooling

- Ensure that top and bottom clearance for air cooling is provided. See [Table 4](#) for clearance requirements.

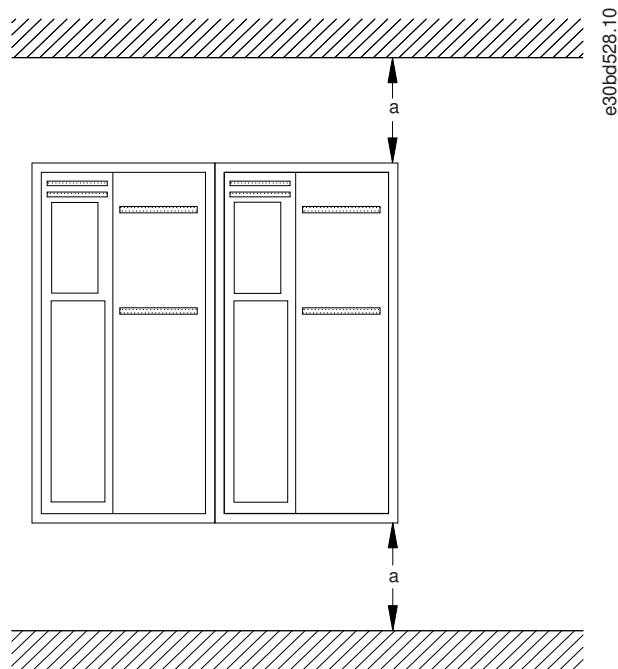


Illustration 3: Top and Bottom Cooling Clearance

Table 4: Minimum Airflow Clearance Requirements

Enclosure	A1–A5	B1–B4	C1, C3	C2, C4
a [mm (in)]	100 (3.9)	200 (7.8)	200 (7.8)	225 (8.9)

### 3.3.2 Lifting

#### ⚠ WARNING ⚠

##### HEAVY LOAD

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

- Never walk under suspended loads.
- 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. To determine a safe lifting method, check the weight of the unit.
- 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.

- To determine a safe lifting method, check the weight of the unit in [8.9 Power Ratings, Weight, and Dimensions](#).
- Ensure that the lifting device is suitable for the task.
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit.
- For lifting, use hoist rings on the unit, when provided.

### 3.3.3 Mounting

#### Procedure

1. Ensure that the strength of the mounting location supports the unit weight.

The drive allows side-by-side installation.

2. Locate the unit as near to the motor as possible. Keep the motor cables as short as possible.
3. Mount the unit vertically to a solid flat surface or to the optional backplate to provide cooling airflow.
4. Use the slotted mounting holes on the unit for wall mount, when provided.

#### 3.3.3.1 Mounting with Mounting Plate and Railings

A mounting plate is required when mounted on railings.

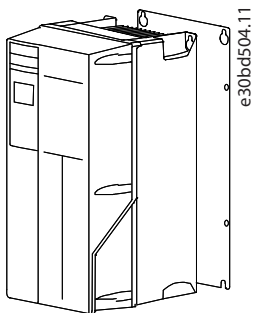


Illustration 4: Proper Mounting with Mounting Plate

## 4 Electrical Installation

### 4.1 Safety Instructions

See [2.3 Safety Precautions](#) for general safety instructions.

#### ⚠ WARNING ⚠

##### INDUCED VOLTAGE

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

- Run output motor cables separately or use shielded cables.
- Simultaneously lock out all the drives.

#### ⚠ WARNING ⚠

##### SHOCK HAZARD

The unit can cause a DC current in the PE conductor. Failure to use a Type B residual current-operated protective device (RCD) may lead to the RCD not providing the intended protection and therefore may result in death or serious injury.

- When an RCD is used for protection against electrical shock, only a Type B device is allowed on the supply side.

#### Overcurrent protection

- Extra protective equipment, such as short-circuit protection or motor thermal protection between drive and motor, is required for applications with multiple motors.
- Input fusing is required to provide short circuit and overcurrent protection. If not factory-supplied, the installer must provide fuses. See maximum fuse ratings in [8.7.2 CE Compliance](#) and [8.7.3 UL Compliance](#).

#### 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 (167 °F) rated copper wire. See [Table 29](#) to [Table 40](#), and [8.5.1 Cable Lengths and Cross-sections for Control Cables](#) for recommended wire sizes and types.

### 4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in [4.3 Grounding](#), [4.4 Wiring Schematic](#), [4.5 Connecting the Motor](#), and [4.7 Control Wiring](#).

#### NOTICE

##### POTENTIAL EQUALIZATION

Risk of burst transient when the ground potential between the drive and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm<sup>2</sup> (6 AWG).

### 4.3 Grounding

#### ⚠ WARNING ⚠

##### LEAKAGE CURRENT HAZARD

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

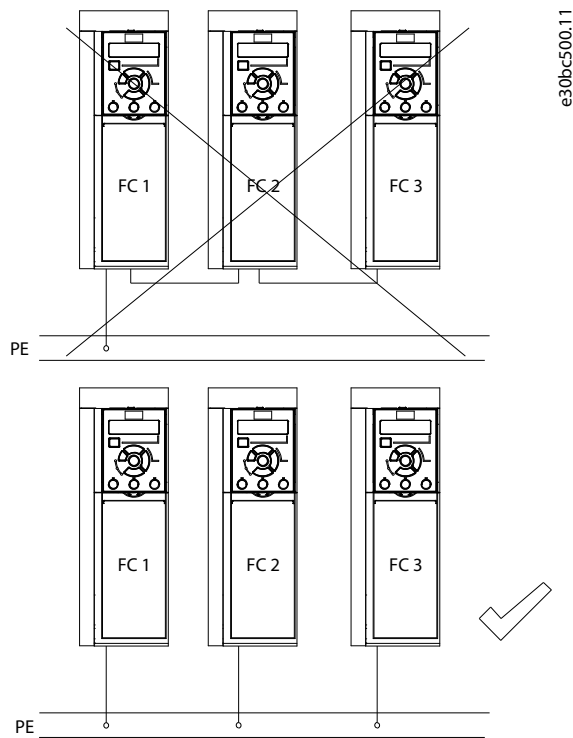
- Ensure that the minimum size of the ground conductor complies with the local safety regulations for high touch current equipment.

#### For electrical safety

- Ground the drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power, and control wiring.
- Do not ground 1 drive to another in a daisy-chain fashion (see [Illustration 5](#).)



- Keep the ground wire connections as short as possible.
- Follow motor manufacturer wiring requirements.
- Minimum cable cross-section for the ground wires: 10 mm<sup>2</sup> (7 AWG).
- Separately terminate individual ground wires, both complying with the dimension requirements.



**Illustration 5: Grounding Principle**

For EMC-compliant installation

- Establish electrical contact between the cable shield and the drive enclosure by using metal cable glands or by using the clamps provided on the equipment.
- Use high-strand wire to reduce burst transient.
- Do not use pigtails.

**NOTICE**

**POTENTIAL EQUALIZATION**

Risk of burst transient when the ground potential between the drive and the control system is different. Install equalizing cables between the system components. Recommended cable cross-section: 16 mm<sup>2</sup> (6 AWG).

### 4.4 Wiring Schematic

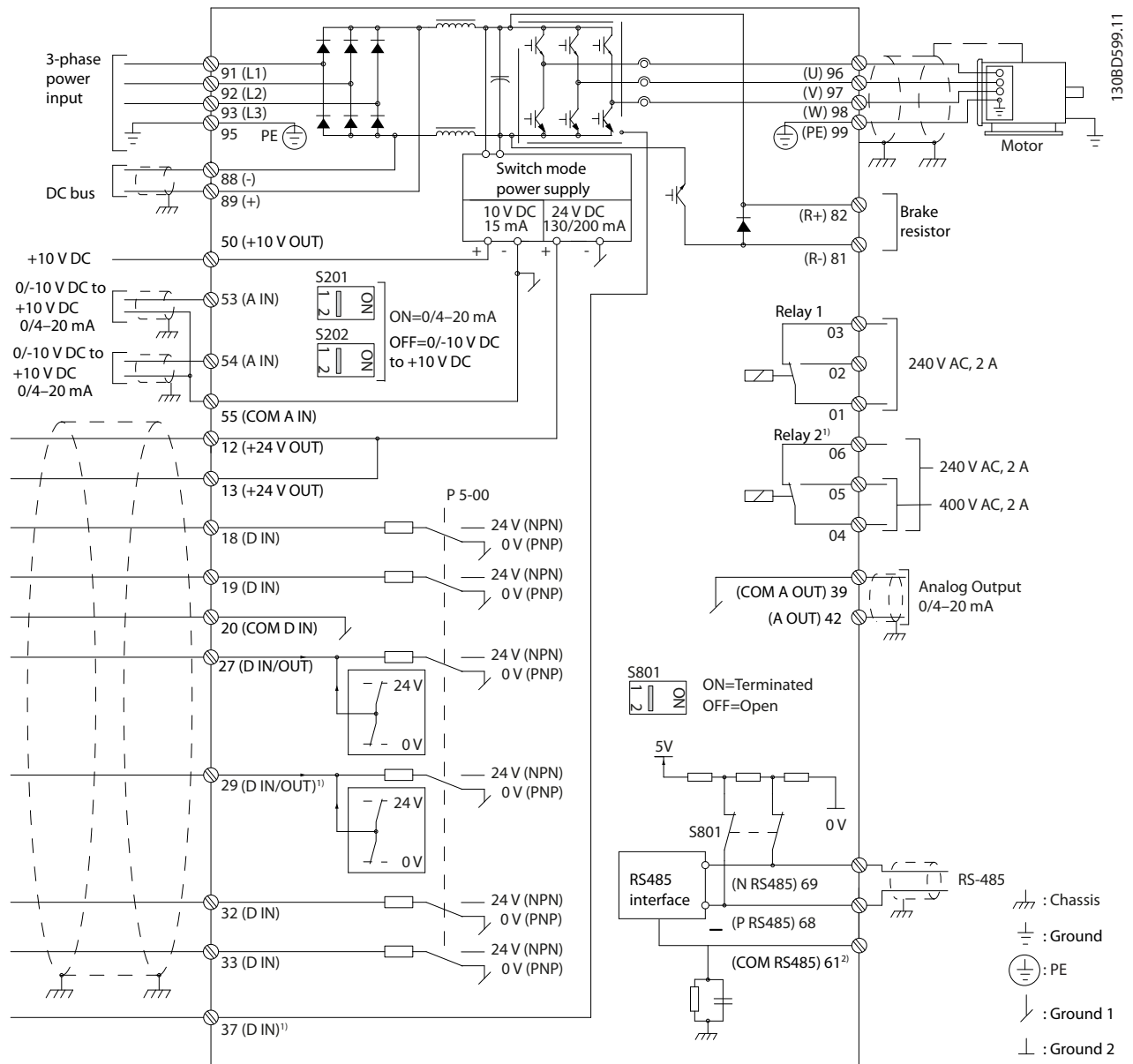


Illustration 6: Basic Wiring Schematic

<p>A      Analog</p> <p>D      Digital</p>	<p>1      Terminal 37 (optional) is used for Safe Torque Off (STO). For installation instructions, refer to the VLT® Safe Torque Off Operating Guide. For FC 301, terminal 37 is only included in enclosure size A1. Relay 2 and terminal 29 have no function in FC 301.</p> <p>2      Do not connect cable shield.</p>
--	---

Read more in *EMC-Compliant Installation*.

## 4.5 Connecting the Motor

### ⚠ WARNING ⚠

#### INDUCED VOLTAGE

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

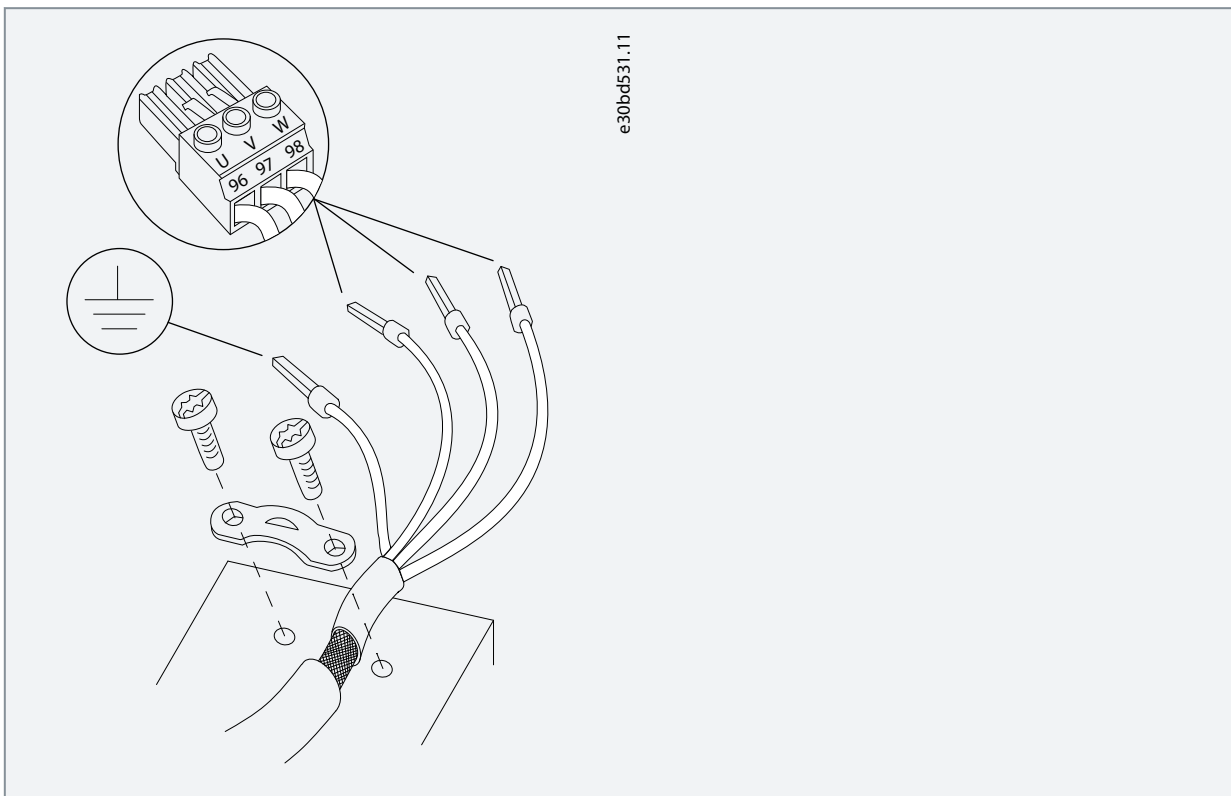
- Run output motor cables separately or use shielded cables.
- Simultaneously lock out all the drives.

- Run output separately or
- Use shielded cables.
- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see [Table 29](#) to [Table 40](#).
- Follow motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA 1/12) and higher units.
- Do not wire a starting or pole-changing device (for example a Dahlander motor or slip ring asynchronous motor) between the drive and the motor.

### 4.5.1 Grounding the Cable Shield

#### Procedure

1. Strip a section of the outer cable insulation.
2. Position the stripped wire under the cable clamp to establish mechanical fixation and electrical contact between the cable shield and ground.
3. Connect the ground wire to the nearest grounding terminal in accordance with the grounding instructions, see [4.3 Grounding](#).



4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W).
5. Torque-tighten the terminals, see [8.8 Connection Tightening Torques](#).

#### Example

Mains input, motor, and grounding for basic drives. Actual configurations vary with unit types and optional equipment.

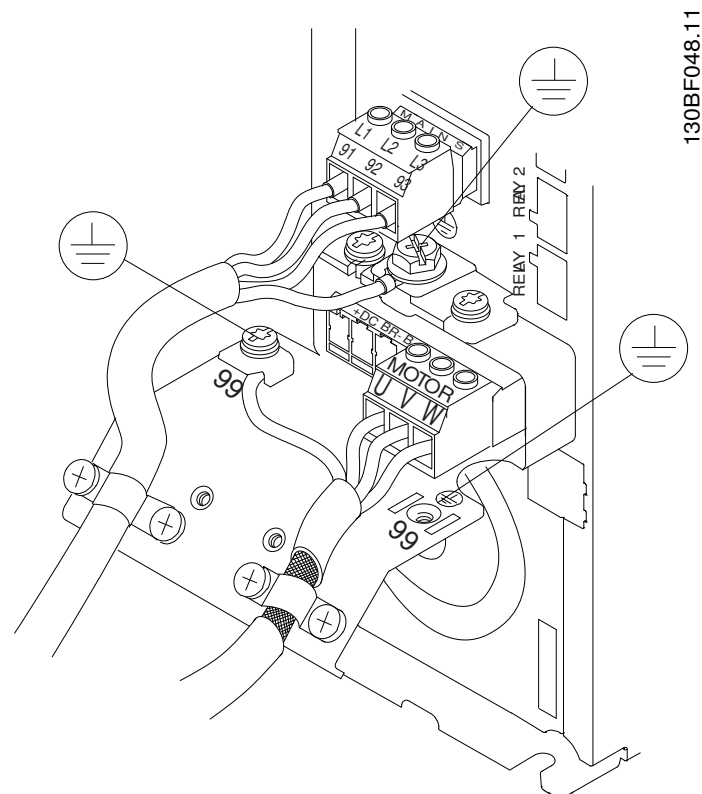


Illustration 7: Example of Motor, Mains, and Ground Wiring

## 4.6 Connecting AC Mains

- Size the wiring based on the input current of the drive. For maximum wire sizes, see [Table 29](#) to [Table 40](#).
- Comply with local and national electrical codes for cable sizes.

### 4.6.1 Connecting the Drive to Mains

#### Procedure

1. Connect the 3-phase AC input power wiring to terminals L1, L2, and L3.
2. Depending on the configuration of the equipment, connect the input power to the mains input terminals or the input disconnect.
3. Ground the cable in accordance with the grounding instructions, see [4.3 Grounding](#) and [4.5.1 Grounding the Cable Shield](#).
4. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), ensure that *parameter 14-50 RFI Filter* is set to [0] Off. This setting prevents damage to the DC link and reduces ground capacity currents in accordance with IEC 61800-3.

## 4.7 Control Wiring

- Isolate the control wiring from the high-power components in the drive.
- When the drive 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.

### 4.7.1 Safe Torque Off (STO)

To run STO, additional wiring for the drive is required.

Refer to the VLT® Frequency Converters Safe Torque Off Operating Guide for further information.

### 4.7.2 Mechanical Brake Control

In hoisting/lowering applications, it is necessary to control an electro-mechanical brake.

- Control the brake using any relay output or digital output (terminal 27 or 29).
- Keep the output closed (voltage-free) as long as the drive is unable to keep the motor at standstill, for example due to the load being too heavy.
- Select [32] Mechanical brake control in parameter group 5-4\* Relays for applications with an electromechanical brake.
- The brake is released when the motor current exceeds the value in parameter 2-20 Release Brake Current.
- The brake is engaged when the output frequency is less than the frequency set in parameter 2-21 Activate Brake Speed [RPM] or parameter 2-22 Activate Brake Speed [Hz], and only if the drive carries out a stop command.

If the drive is in alarm mode or in an overvoltage situation, the mechanical brake immediately closes.

## N O T I C E

The drive is not a safety device. It is the responsibility of the system designer to integrate safety devices according to relevant national crane/lift regulations.

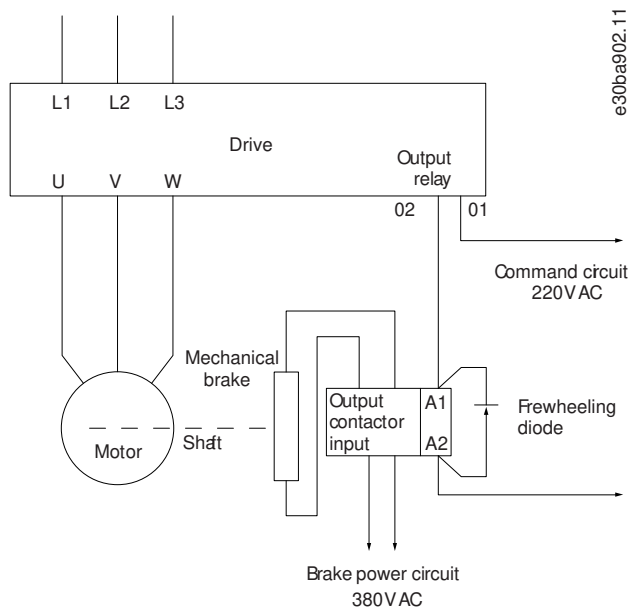


Illustration 8: Connecting the Mechanical Brake to the Drive

### 4.8 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in the following table. Check and mark the items when completed.

Table 5: Installation Check List

Inspect for	Description	√
Auxiliary equipment	<ul style="list-style-type: none"> <li>• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers residing on the input power side of the drive, or output side to the motor. Ensure that they are ready for full-speed operation.</li> <li>• Check the function and installation of any sensors used for feedback to the drive.</li> <li>• Remove any power factor correction capacitors on the motor.</li> <li>• Adjust any power factor correction capacitors on the mains side and ensure that they are dampened.</li> </ul>	√
Cable routing	<ul style="list-style-type: none"> <li>• Ensure that the motor wiring and control wiring are separated, shielded, or in 3 separate metallic conduits for high-frequency interference isolation.</li> </ul>	√

Inspect for	Description	√
Control wiring	<ul style="list-style-type: none"> <li>• Check for broken or damaged wires and loose connections.</li> <li>• Check that the control wiring is isolated from power and motor wiring for noise immunity.</li> <li>• Check the voltage source of the signals, if necessary.</li> </ul> <p>The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.</p>	
Cooling clearance	<ul style="list-style-type: none"> <li>• Ensure that the top and bottom clearance is adequate to ensure proper airflow for cooling, see <a href="#">3.3.1 Cooling</a>.</li> </ul>	
Ambient conditions	<ul style="list-style-type: none"> <li>• Check that requirements for ambient conditions are met.</li> </ul>	
Fusing and circuit breakers	<ul style="list-style-type: none"> <li>• Check for proper fusing or circuit breakers.</li> <li>• Check that all fuses are inserted firmly and are in operational condition, and that all circuit breakers are in the open position.</li> </ul>	
Grounding	<ul style="list-style-type: none"> <li>• Check for sufficient ground connections and ensure that those connections are tight and free of oxidation.</li> <li>• Grounding to conduit, or mounting the back panel to a metal surface, is not a suitable grounding.</li> </ul>	
Input and output power wiring	<ul style="list-style-type: none"> <li>• Check for loose connections.</li> <li>• Check that the motor and mains cables are in separate conduit or separated shielded cables.</li> </ul>	
Panel interior	<ul style="list-style-type: none"> <li>• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion.</li> <li>• Check that the unit is mounted on an unpainted metal surface.</li> </ul>	
Switches	<ul style="list-style-type: none"> <li>• Ensure that all switch and disconnect settings are in the proper positions.</li> </ul>	
Vibration	<ul style="list-style-type: none"> <li>• Check that the unit is mounted solidly, or that shock mounts are used, as necessary.</li> <li>• Check for an unusual amount of vibration.</li> </ul>	

### ⚠ CAUTION ⚠

#### INTERNAL FAILURE HAZARD

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

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

## 5 Commissioning

### 5.1 Safety Instructions

See chapter Safety for general safety instructions.

#### ! W A R N I N G

##### HAZARDOUS VOLTAGE

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

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

#### N O T I C E

The front covers with warning signs are an integrated part of the drive and considered safety covers. The covers must be in place before applying power and at all times.

### 5.1.1 Before Applying Power

#### Procedure

1. Close the safety cover properly.
2. Check that all cable glands are firmly tightened.
3. Ensure that input power to the unit is off and locked out. Do not rely on the drive disconnect switches for input power isolation.
4. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase, and phase-to-ground.
5. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase, and phase-to-ground.
6. Confirm continuity of the motor by measuring  $\Omega$  values on U–V (96–97), V–W (97–98), and W–U (98–96).
7. Check for proper grounding of the drive and the motor.
8. Inspect the drive for loose connections on the terminals.
9. Confirm that the supply voltage matches the voltage of the drive and the motor.



## 5.2 Local Control Panel Operation

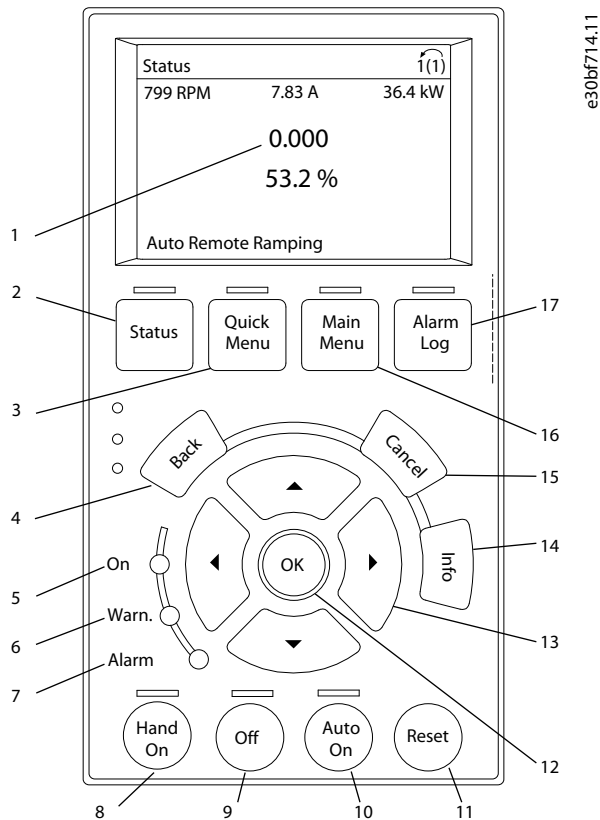


Illustration 9: Graphical Local Control Panel (GLCP)

<p>1 The information shown in the display area depends on the selected function or menu (in this case <i>Quick Menu Q3-13 Display Settings</i>).</p>	<p>10 [Auto On] puts the system in remote operational mode.</p> <ul style="list-style-type: none"> <li>• Responds to an external start command by control terminals or serial communication.</li> </ul>
<p>2 [Status] shows operational status.</p>	
<p>3 [Quick Menu] allows access to programming parameters for initial set-up instructions and many detailed application instructions.</p>	<p>11 [Reset] resets the drive manually after a fault has been cleared.</p>
<p>4 [Back] reverts to the previous step or list in the menu structure.</p>	<p>12 [OK] gives access to parameter groups or enables a selection.</p>
<p>5 A green indicator light indicates that power is on.</p>	<p>13 [▲][▶] [▼] [◀] enables moving between items in the menu.</p>
<p>6 A yellow indicator light comes on when a warning is active. A text appears in the display area identifying the problem.</p>	<p>14 [Info] shows a definition of the function being shown.</p>
<p>7 A red flashing indicator light indicates a fault condition, and an alarm text is shown.</p>	<p>15 [Cancel] cancels the last change or command as long as the display mode is not changed.</p>
<p>8 [Hand On] puts the drive in local control mode, so that it responds to the LCP.</p> <ul style="list-style-type: none"> <li>• An external stop signal by control input or serial communication overrides local [Hand On] key.</li> </ul>	<p>16 [Main Menu] gives access to all programming parameters.</p>
<p>9 [Off] stops the motor but does not remove power to the drive.</p>	<p>17 [Alarm Log] shows a list of current warnings, the last 10 alarms, and the maintenance log.</p>

## 5.3 System Set-up

### Procedure

1. Perform automatic motor adaptation (AMA):
  - a. Set the basic motor parameters before performing AMA.

**Table 6: Basic Parameters to be Checked before AMA**

	Parameter 1-10 Motor Construction				
	ASM	SPM	IPM	SynRM	PMaSynRM
Parameter 1-20 Motor Power [kW]/parameter 1-21 Motor Power [hp]	X				
Parameter 1-22 Motor Voltage	X				
Parameter 1-23 Motor Frequency	X			X	X
Parameter 1-24 Motor Current	X	X	X	X	X
Parameter 1-25 Motor Nominal Speed	X	X	X	X	X
Parameter 1-26 Motor Cont. Rated		X	X	X	X
Parameter 1-39 Motor Poles		X	X	X	X

- b. Optimize the compatibility between motor and drive via *parameter 1-29 Automatic Motor Adaptation (AMA)*.
2. Check motor rotation.
3. If encoder feedback is used, perform the following steps:
  - a. Select [0] Speed open loop in *parameter 1-00 Configuration Mode*.
  - b. Select [1] 24V encoder in *parameter 7-00 Speed PID Feedback Source*.
  - c. Press [Hand On].
  - d. Press [▶] for positive speed reference (*parameter 1-06 Clockwise Direction at [0]*).
  - e. In *parameter 16-57 Feedback [RPM]*, check that the feedback is positive.

## 6 Basic I/O Configuration

### 6.1 Application Examples

The examples in this section are intended as a quick reference for common applications.

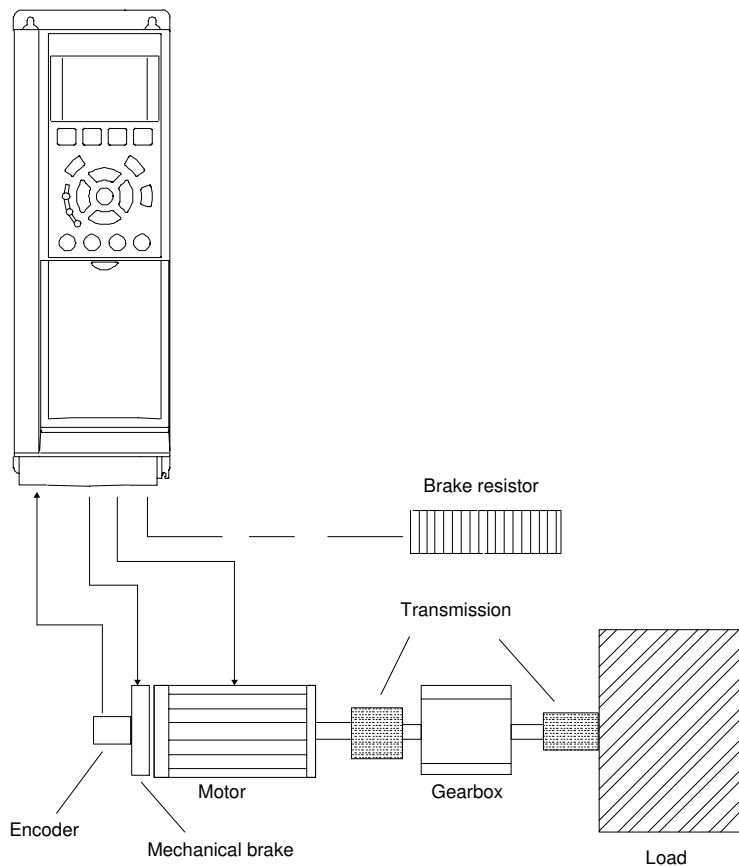
- Parameter settings are the regional default values unless otherwise indicated (selected in *parameter 0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Required switch settings for analog terminals A53 or A54 are also shown.

#### 6.1.1 Programming a Closed-loop Drive System

A closed-loop drive system usually consists of:

- Motor.
- Drive.
- Encoder (as feedback system).
- Mechanical brake.
- Brake resistor (for dynamic braking).
- Transmission.
- Gear box.
- Load.

Applications demanding mechanical brake control typically need a brake resistor.



e30b1865.10

**Illustration 10: Basic Set-up for Closed-loop Speed Control**

### 6.1.2 Wiring Configuration for Automatic Motor Adaptation (AMA)

Table 7: Wiring Configuration for AMA with T27 Connected

		Parameters	
		Function	Setting
		Parameter 1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
		Parameter 5-12 Terminal 27 Digital Input	[2]* Coast inverse
		*=-Default value	
		<b>Notes/comments:</b> Set parameter group 1-2* Motor Data according to motor nameplate.	

### 6.1.3 Wiring Configuration for Automatic Motor Adaptation without T27

Table 8: AMA without T27 Connected

		Parameters	
		Function	Setting
		Parameter 1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
		Parameter 5-12 Terminal 27 Digital Input	[0] No operation
		*=-Default value	
		<b>Notes/comments:</b> Parameter group 1-2* Motor Data must be set according to motor.	

### 6.1.4 Wiring Configuration: Speed

Table 9: Analog Speed Reference (Voltage)

Parameters	
Function	Setting
Parameter 6-10 Terminal 53 Low Voltage	0.07 V*
Parameter 6-11 Terminal 53 High Voltage	10 V*
Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
* = Default value	
<b>Notes/comments:</b> D IN 37 is an option.	

Table 10: Analog Speed Reference (Current)

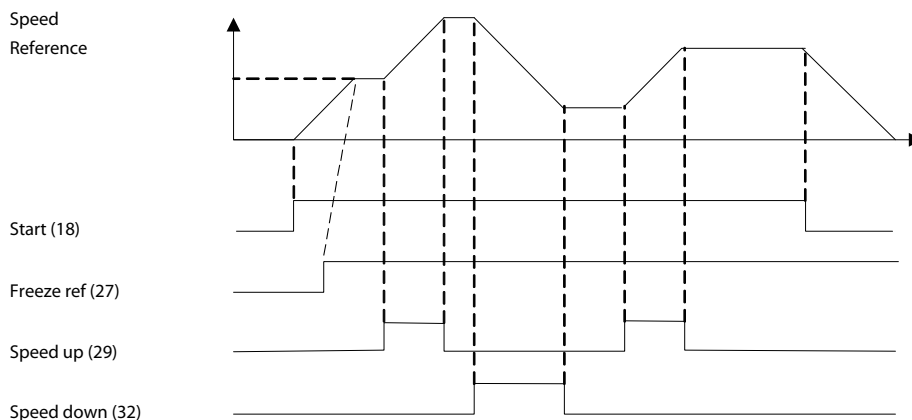
Parameters	
Function	Setting
Parameter 6-12 Terminal 53 Low Current	4 mA*
Parameter 6-13 Terminal 53 High Current	20 mA*
Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
* = Default value	
<b>Notes/comments:</b> D IN 37 is an option.	

Table 11: Speed Reference (Using a Manual Potentiometer)

Parameters											
	<table border="1"> <thead> <tr> <th>Function</th> <th>Setting</th> </tr> </thead> <tbody> <tr> <td>Parameter 6-10 Terminal 53 Low Voltage</td> <td>0.07 V*</td> </tr> <tr> <td>Parameter 6-11 Terminal 53 High Voltage</td> <td>10 V*</td> </tr> <tr> <td>Parameter 6-14 Terminal 53 Low Ref./Feedb. value</td> <td>0 Hz</td> </tr> <tr> <td>Parameter 6-15 Terminal 53 High Ref./Feedb. Value</td> <td>50 Hz</td> </tr> </tbody> </table>	Function	Setting	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*	Parameter 6-11 Terminal 53 High Voltage	10 V*	Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz	Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz
	Function	Setting									
	Parameter 6-10 Terminal 53 Low Voltage	0.07 V*									
	Parameter 6-11 Terminal 53 High Voltage	10 V*									
	Parameter 6-14 Terminal 53 Low Ref./Feedb. value	0 Hz									
Parameter 6-15 Terminal 53 High Ref./Feedb. Value	50 Hz										
* = Default value											
<b>Notes/comments:</b> D IN 37 is an option.											

Table 12: Speed Up/Down

Parameter											
	<table border="1"> <thead> <tr> <th>Function</th> <th>Setting</th> </tr> </thead> <tbody> <tr> <td>Parameter 5-10 Terminal 18 Digital Input</td> <td>[8] Start*</td> </tr> <tr> <td>Parameter 5-12 Terminal 27 Digital Input</td> <td>[19] Freeze Reference</td> </tr> <tr> <td>Parameter 5-13 Terminal 29 Digital Input</td> <td>[21] Speed Up</td> </tr> <tr> <td>Parameter 5-14 Terminal 32 Digital Input</td> <td>[22] Speed Down</td> </tr> </tbody> </table>	Function	Setting	Parameter 5-10 Terminal 18 Digital Input	[8] Start*	Parameter 5-12 Terminal 27 Digital Input	[19] Freeze Reference	Parameter 5-13 Terminal 29 Digital Input	[21] Speed Up	Parameter 5-14 Terminal 32 Digital Input	[22] Speed Down
	Function	Setting									
	Parameter 5-10 Terminal 18 Digital Input	[8] Start*									
	Parameter 5-12 Terminal 27 Digital Input	[19] Freeze Reference									
	Parameter 5-13 Terminal 29 Digital Input	[21] Speed Up									
Parameter 5-14 Terminal 32 Digital Input	[22] Speed Down										
* = Default value											
<b>Notes/comments:</b> D IN 37 is an option.											



e30bb840.12

Illustration 11: Speed Up/Down

### 6.1.5 Wiring Configuration: Feedback

Table 13: Analog Current Feedback Transducer (2-wire)

		Parameters	
		Function	Setting
		Parameter 6-22 Terminal 54 Low Current	4 mA*
		Parameter 6-23 Terminal 54 High Current	20 mA*
		Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
		Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
		* = Default value	
<p><b>Notes/comments:</b> D IN 37 is an option.</p>			



Table 14: Analog Voltage Feedback Transducer (3-wire)

Parameters	
Function	Setting
Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
Parameter 6-21 Terminal 54 High Voltage	10 V*
Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
* = Default value	
<b>Notes/comments:</b> D IN 37 is an option.	

Table 15: Analog Voltage Feedback Transducer (4-wire)

Parameters	
Function	Setting
Parameter 6-20 Terminal 54 Low Voltage	0.07 V*
Parameter 6-21 Terminal 54 High Voltage	10 V*
Parameter 6-24 Terminal 54 Low Ref./Feedb. value	0*
Parameter 6-25 Terminal 54 High Ref./Feedb. Value	50*
* = Default value	
<b>Notes/comments:</b> D IN 37 is an option.	

### 6.1.6 Wiring Configuration: Run/Stop

Table 16: Run/Stop Command with External Interlock

Parameter	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
*=Default value	
<b>Notes/comments:</b> D IN 37 is an option.	

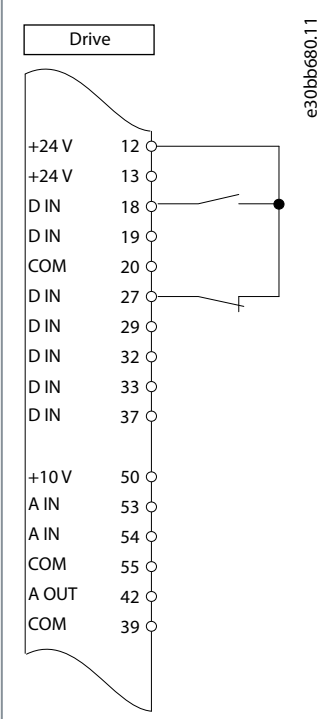


Table 17: Run/Stop Command without External Interlock

Parameter	
Function	Setting
Parameter 5-10 Terminal 18 Digital Input	[8] Start*
Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
* = Default value	
<p><b>Notes/comments:</b></p> <p>If parameter 5-12 Terminal 27 Digital Inputs is set to [0] No operation, a jumper wire to terminal 27 is not needed.</p> <p>D IN 37 is an option.</p>	

e30bb681.11

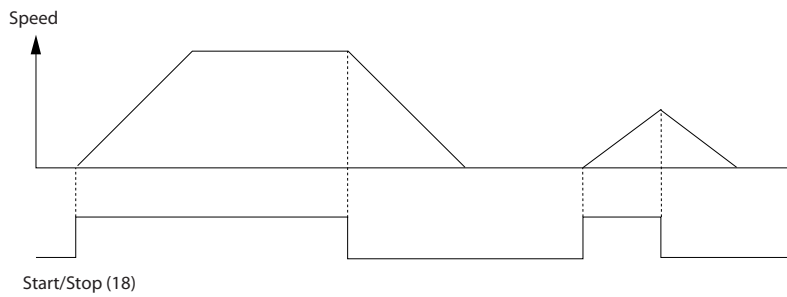
Table 18: Run Permissive

		Parameter	
		<b>Function</b>	<b>Setting</b>
		Parameter 5-10 Terminal 18 Digital Input	[8] Start*
		Parameter 5-11 Terminal 19 Digital Input	[52] Run permissive
		Parameter 5-12 Terminal 27 Digital Input	[7] External interlock
		Parameter 5-40 Function Relay	[167] Start command act.
		* = Default value	
		<b>Notes/comments:</b> D IN 37 is an option.	

### 6.1.7 Wiring Configuration: Start/Stop

Table 19: Start/Stop Command with Safe Torque Off Option

		Parameter	
		<b>Function</b>	<b>Setting</b>
		Parameter 5-10 Terminal 18 Digital Input	[Start]*
		Parameter 5-12 Terminal 27 Digital Input	[0] No operation
		Parameter 5-19 Terminal 37 Safe Stop	[1] Safe Stop Alarm
		* = Default value	
		<b>Notes/comments:</b> If parameter 5-12 Terminal 27 Digital Input is set [0] No operation, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	



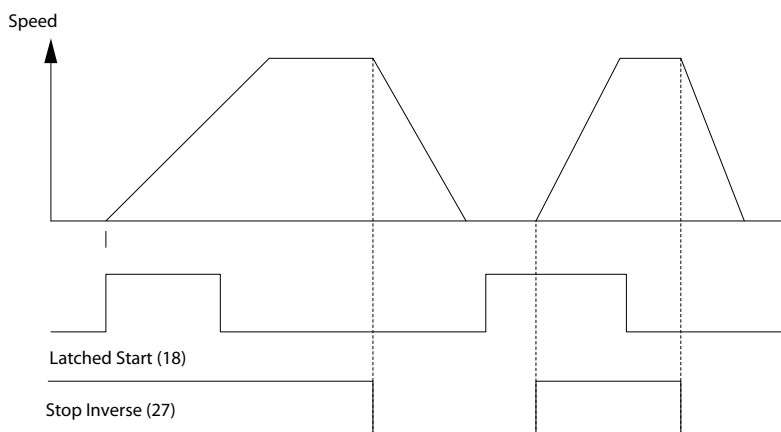
e30bb805.13

Illustration 12: Start/Stop Command with Safe Torque Off

Table 20: Pulse Start/Stop

		Parameter	
		Function	Setting
		Parameter 5-10 Terminal 18 Digital Input	[9] Latched Start
		Parameter 5-12 Terminal 27 Digital Input	[6] Stop Inverse
		*=Default value	
		<b>Notes/comments:</b> If parameter 5-12 Terminal 27 Digital Input is set [0] No operation, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

e30bb803.10



e130bb806.11

Illustration 13: Latched Start/Stop Inverse

Table 21: Start/Stop with Reversing and 4 Preset Speeds

		Parameters	
		<b>Function</b>	<b>Setting</b>
		Parameter 5-10 Terminal 18 Digital Input	[8] Start
		Parameter 5-11 Terminal 19 Digital Input	[10] Reversing*
		Parameter 5-12 Terminal 27 Digital Input	[0] No operation
		Parameter 5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
		Parameter 5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
		Parameter 3-10 Preset Reference	25% Preset ref. 0 50% Preset ref. 1 75% Preset ref. 2 100% Preset ref. 3
		*-=Default value	
		<b>Notes/comments:</b> D IN 37 is an option.	

### 6.1.8 Wiring Configuration: External Alarm Reset

Table 22: External Alarm Reset

		Parameter	
		<b>Function</b>	<b>Setting</b>
		Parameter 5-11 Terminal 19 Digital Input	[1] Reset
		*-=Default value	
		<b>Notes/comments:</b> D IN 37 is an option.	

### 6.1.9 Wiring Configuration: RS485

Table 23: RS485 Network Connection

	Parameter	
	Function	Setting
Parameter 8-30 Protocol	FC*	
Parameter 8-31 Address	1*	
Parameter 8-32 Baud Rate	9600*	
* = Default value		
<b>Notes/comments:</b> Select protocol, address, and baud rate in the above-mentioned parameters. D IN 37 is an option.		

### 6.1.10 Wiring Configuration: Motor Thermistor

**⚠ CAUTION ⚠**

**THERMISTOR INSULATION**

Risk of personal injury or equipment damage.

- To meet PELV insulation requirements, use only thermistors with reinforced or double insulation.

Table 24: Motor Thermistor

		Parameters	
	e30bb686.13	<b>Function</b>	<b>Setting</b>
		<i>Parameter 1-90 Motor Thermal Protection</i>	[2] Thermistor trip
		<i>Parameter 1-93 Thermistor Source</i>	[1] Analog input 53
		* = Default value	
If only a warning is required, set <i>parameter 1-90 Motor Thermal Protection</i> to [1] Thermistor warning. D IN 37 is an option.			

### 6.1.11 Wiring for Regen

Table 25: Regen

		Parameters	
	e30bd667.11	<b>Function</b>	<b>Setting</b>
		<i>Parameter 1-90 Motor Thermal Protection</i>	100%*
		* = Default value	

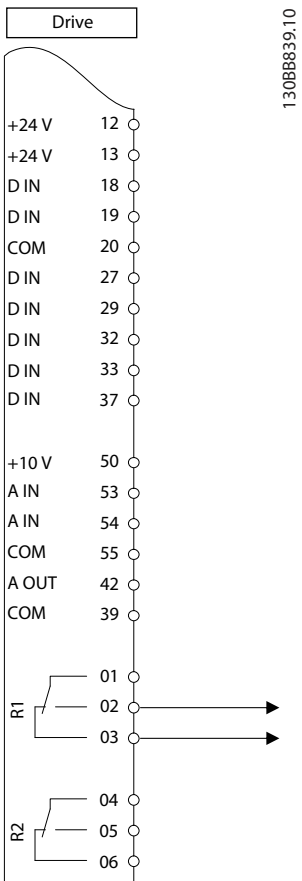


Parameters	
	To disable regen, decrease <i>parameter 1-90 Motor Thermal Protection</i> to 0%. If the application uses motor brake power and regen is not enabled, the unit trips.

### 6.1.12 Wiring Configuration for a Relay Setup with Smart Logic Control

Table 26: Wiring Configuration for a Relay Setup with Smart Logic Control

Parameters	
Function	Setting
<i>Parameter 4-30 Motor Feedback Loss Function</i>	[1] Warning
<i>Parameter 4-31 Motor Feedback Speed Error</i>	100 RPM
<i>Parameter 4-32 Motor Feedback Loss Timeout</i>	5 s
<i>Parameter 7-00 Speed PID Feedback Source</i>	[2] MCB 102
<i>Parameter 17-11 Resolution (PPR)</i>	1024*
<i>Parameter 13-00 SL Controller Mode</i>	[1] On
<i>Parameter 13-01 Start Event</i>	[19] Warning
<i>Parameter 13-02 Stop Event</i>	[44] Reset key
<i>Parameter 13-10 Comparator Operand</i>	[21] Warning no.
<i>Parameter 13-11 Comparator Operator</i>	[1] ≈ (equal)*
<i>Parameter 13-12 Comparator Value</i>	90
<i>Parameter 13-51 SL Controller Event</i>	[22] Comparator 0
<i>Parameter 13-52 SL Controller Action</i>	[32] Set digital out A low
<i>Parameter 5-40 Function Relay</i>	[80] SL digital output A
* = Default value	
<b>Notes/comments:</b> If the limit in the feedback monitor is exceeded, <i>warning 90, Feedback Mon.</i> is issued. The SLC monitors <i>warning 90, Feedback Mon.</i> and if the warning becomes true, relay 1 is triggered. External equipment may require service. If the feedback error goes below the limit again within 5 s, the drive continues and the warning disappears. Reset relay 1 by pressing [Reset] on the LCP.	



### 6.1.13 Wiring Configuration: Mechanical Brake Control

Table 27: Mechanical Brake Control

		Parameters			
		Function	Setting		
			[32] Mech. brake ctrl.		
		Parameter 5-10 Terminal 18 Digital Input	[8] Start*		
		Parameter 5-11 Terminal 19 Digital Input	[11] Start reversing		
		Parameter 1-71 Start Delay	0.2		
		Parameter 1-72 Start Function	[5] VVC+/ FLUX Clockwise		
		Parameter 1-76 Start Current	$I_{m,n}$		
		Parameter 2-20 Release Brake Current	Application dependent		
		Parameter 2-21 Activate Brake Speed [RPM]	Half of nominal slip of the motor		
		* = Default value			
				-	

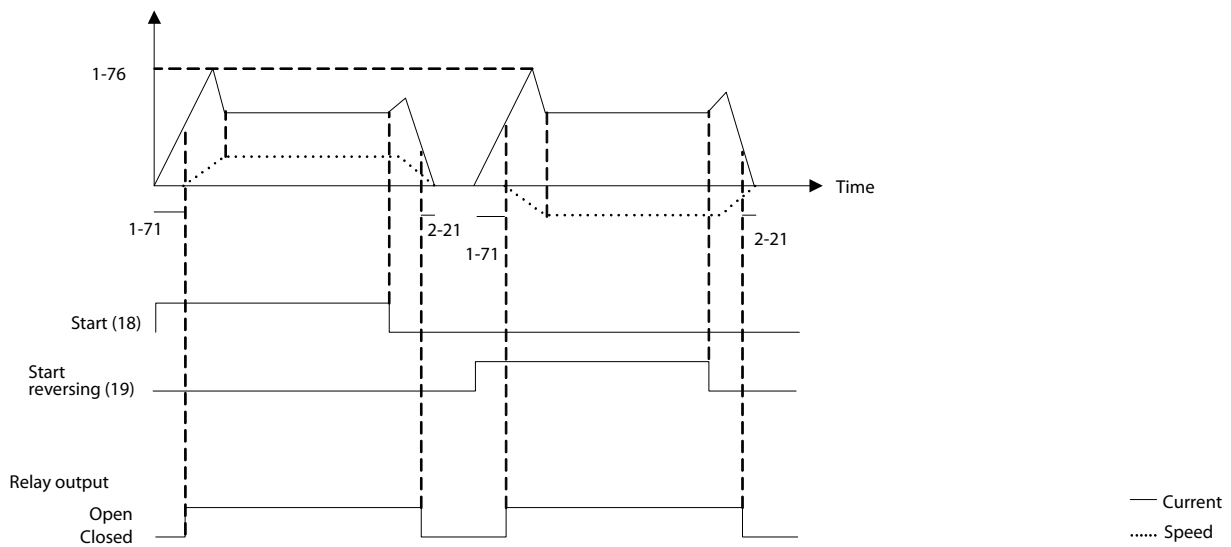
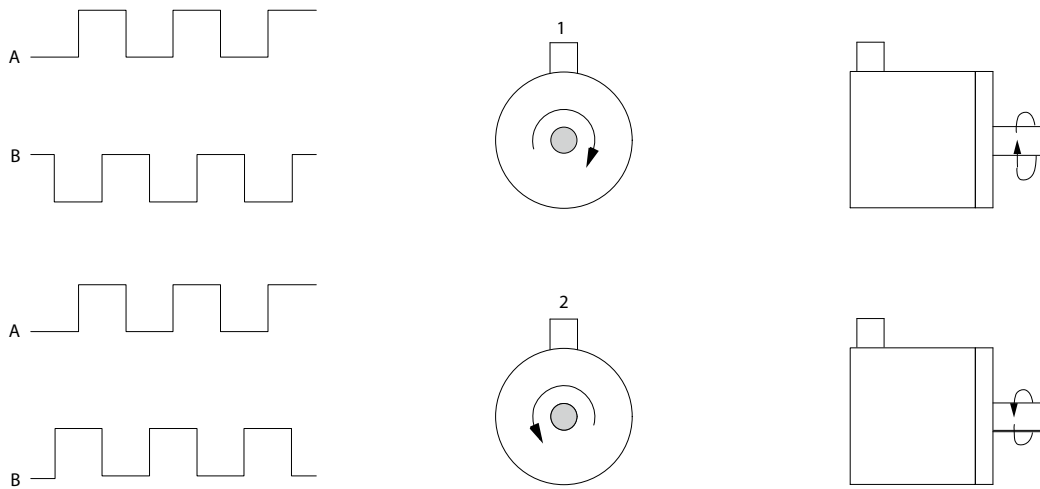


Illustration 14: Mechanical Brake Control

### 6.1.14 Wiring Configuration for the Encoder

The direction of the encoder, identified by looking into the shaft end, is determined by which order the pulses enter the drive.

- Clockwise (CW) direction means channel A is 90 electrical degrees before channel B.
- Counterclockwise (CCW) direction means channel B is 90 electrical degrees before A.

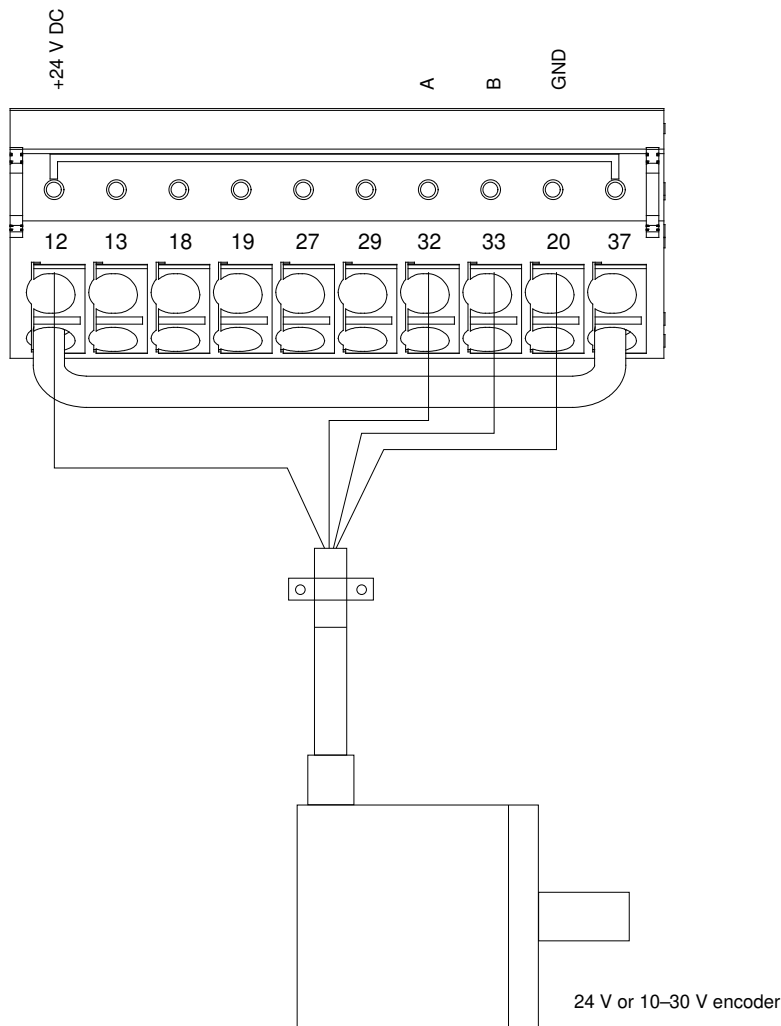


e30ba646.10

Illustration 15: Determining Encoder Direction

**NOTICE**

Maximum cable length is 5 m (16 ft.)



e30ba090.12

Illustration 16: Wire Configuration for the Encoder

### 6.1.15 Wiring Configuration for Torque and Stop Limit

In applications with an external electro-mechanical brake, such as hoisting applications, it is possible to stop the drive via a standard stop command and simultaneously activate the external electro-mechanical brake. Programming of these drive connections is shown in [Illustration 17](#).

If a stop command is active via terminal 18 and the drive is not at the torque limit, the motor ramps down to 0 Hz. If the drive is at the torque limit and a stop command is activated, the system activates terminal 29 output (programmed to [27] *Torque limit & stop*). The signal to terminal 27 changes from logic 1 to logic 0 and the motor starts to coast. This process ensures that the hoist stops even if the drive itself cannot handle the required torque, for example due to excessive overload.

To program the stop and torque limit, connect to the following terminals:

- Start/stop via terminal 18 (*Parameter 5-10 Terminal 18 Digital Input [8] Start*).
- Quick stop via terminal 27 (*Parameter 5-12 Terminal 27 Digital Input [2] Coasting Stop, Inverse*).
- Terminal 29 output (*Parameter 5-02 Terminal 29 Mode [1] Terminal 29 Mode Output and parameter 5-31 Terminal 29 Digital Output [27] Torque limit & stop*).
- Relay output [0] (Relay 1) (*Parameter 5-40 Function Relay [32] Mechanical Brake Control*).

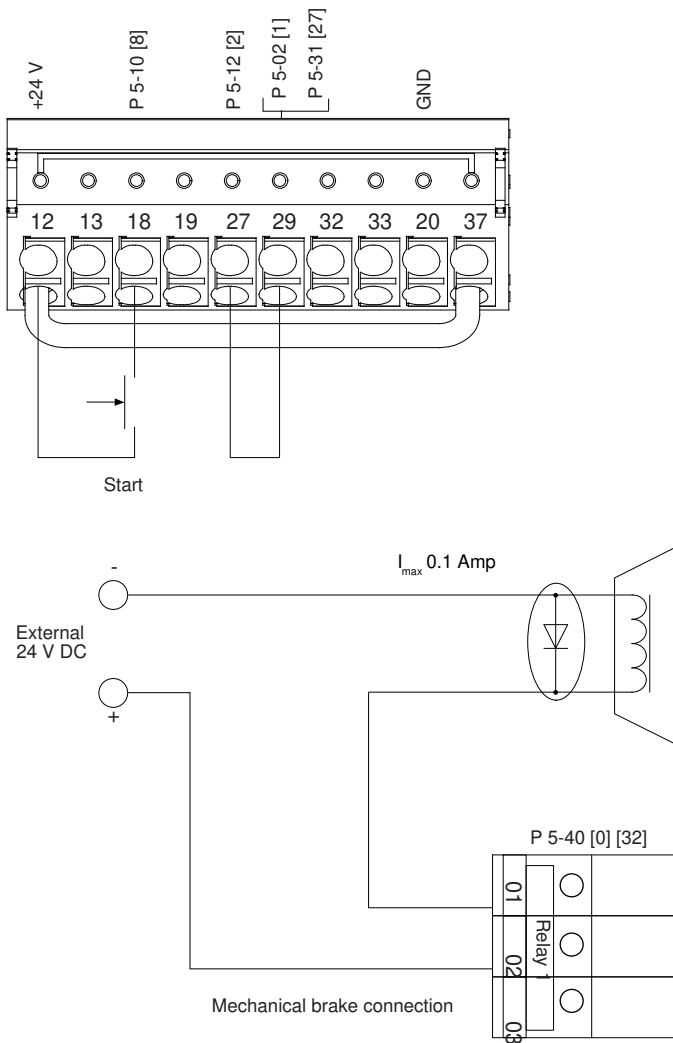


Illustration 17: Wire Configuration for Torque and Stop Limit

## 7 Maintenance, Diagnostics, and Troubleshooting

### 7.1 Maintenance and Service

Under normal operating conditions and load profiles, the drive is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the drive for loose terminal connections, excessive dust buildup, and so on, at regular intervals. Replace worn or damaged parts with Danfoss authorized parts. For service and support, contact the local Danfoss supplier.

#### W A R N I N G

##### UNINTENDED START

When the drive is connected to the AC mains, DC supply, or load sharing, the motor may start at any time, causing risk of death, serious injury, and equipment or property damage. The motor may start by activation of an external switch, a fieldbus command, an input reference signal from the LCP or LOP, via remote operation using MCT 10 Set-up software, or after a cleared fault condition.

- Press [Off] on the LCP before programming parameters.
- Disconnect the drive from the mains whenever personal safety considerations make it necessary to avoid unintended motor start.
- Check that the drive, motor, and any driven equipment are in operational readiness.

### 7.2 Warning and Alarm Types

#### Warnings

A warning is issued when an alarm condition is impending, or when an abnormal operating condition is present and may result in the drive issuing an alarm. A warning clears by itself when the abnormal condition ceases.

#### Alarms

An alarm indicates a fault that requires immediate attention. The fault always triggers a trip or a trip lock. Reset the system after an alarm.

#### Trip

An alarm is issued when the drive is tripped, meaning that the drive suspends operation to prevent damage to the drive or system. The motor coasts to a stop. The drive logic continues to operate and monitor the drive status. After the fault condition is remedied, the drive can be reset. It is then ready to start operation again.

#### Trip lock

Input power is cycled. The motor coasts to a stop. The drive continues to monitor the drive status. Remove input power to the drive, correct the cause of the fault, and reset the drive.

#### Resetting the drive after a trip/trip lock

A trip can be reset in any of 4 ways:

- Press [Reset] on the LCP.
- Digital reset input command.
- Serial communication reset input command.
- Auto reset.

Operating Guide

### 7.3 Warning and Alarm Displays

- A warning is shown in the LCP along with the warning number.
- An alarm flashes along with the alarm number.

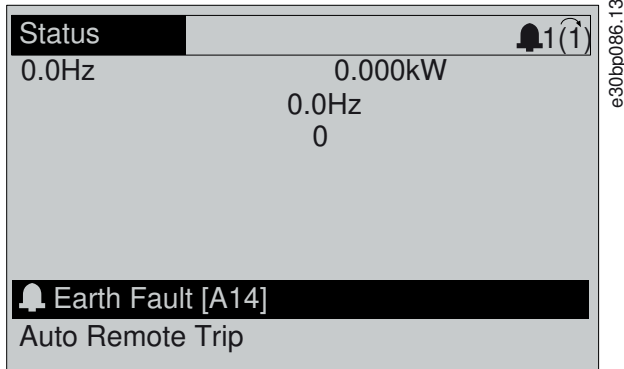


Illustration 18: Alarm Example

In addition to the text and alarm code in the LCP there are 3 status indicator lights.

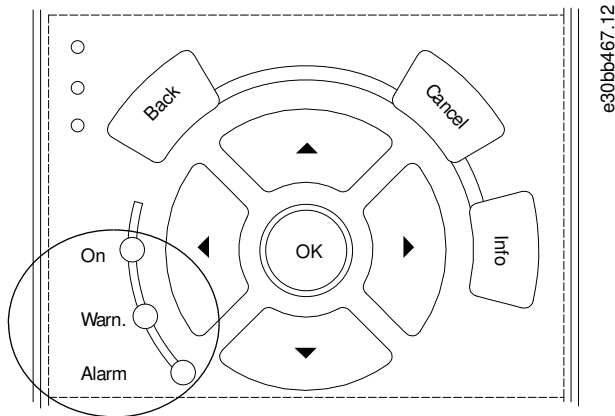


Illustration 19: Status Indicator Lights

	Warning indicator light	Alarm indicator light
Warning	On	Off
Alarm	Off	On (flashing)
Trip lock	On	On (flashing)

### 7.4 Descriptions of Warnings and Alarms

Depending on settings, FC 301/302 is able to give warnings or trigger alarms. In the Programming Guide for VLT® AutomationDrive FC 301/302, a full list of all warnings and alarms can be found. Below, an extract of most common alarms and warnings can be found.

The following warning and alarm information defines each warning or alarm condition, provides the probable cause for the condition, and entails a remedy or troubleshooting procedure.

#### 7.4.1 WARNING 1, 10 Volts Low

**Cause**

The control card voltage is less than 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Maximum 15 mA or minimum 590 Ω.

A short circuit in a connected potentiometer or incorrect wiring of the potentiometer can cause this condition.

## Operating Guide

---

### Troubleshooting

- Remove the wiring from terminal 50. If the warning clears, the problem is with the wiring. If the warning does not clear, replace the control card.

### 7.4.2 WARNING/ALARM 2, Live Zero Error

#### Cause

This warning or alarm only appears if programmed in *parameter 6-01 Live Zero Timeout Function*. The signal on 1 of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or a faulty device sending the signal can cause this condition.

#### Troubleshooting

- Check connections on all analog mains terminals.
  - Control card terminals 53 and 54 for signals, terminal 55 common.
  - VLT® General Purpose I/O MCB 101 terminals 11 and 12 for signals, terminal 10 common.
  - VLT® Analog I/O Option MCB 109 terminals 1, 3, and 5 for signals, terminals 2, 4, and 6 common.
- Check that the drive programming and switch settings match the analog signal type.
- Perform an input terminal signal test.

### 7.4.3 WARNING/ALARM 3, No Motor

#### Cause

No motor is connected to the output of the drive.

### 7.4.4 WARNING/ALARM 4, Mains Phase Loss

#### Cause

A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears for a fault in the input rectifier. Options are programmed in *parameter 14-12 Function at Mains Imbalance*.

#### Troubleshooting

- Check the supply voltage and supply currents to the drive.

### 7.4.5 WARNING 5, DC Link Voltage High

#### Cause

The DC-link voltage (DC) is higher than the high-voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

### 7.4.6 WARNING 6, DC Link Voltage Low

#### Cause

The DC-link voltage (DC) is lower than the low voltage warning limit. The limit depends on the drive voltage rating. The unit is still active.

### 7.4.7 WARNING/ALARM 7, DC Overvoltage

#### Cause

If the DC-link voltage exceeds the limit, the drive trips after a certain time.

#### Troubleshooting

- Extend the ramp time.
- Change the ramp type.
- Activate the functions in *parameter 2-10 Brake Function*.
- Increase *parameter 14-26 Trip Delay at Inverter Fault*.
- If the alarm/warning occurs during a power sag, use kinetic back-up (*parameter 14-10 Mains Failure*).
- Connect a brake resistor.

### 7.4.8 WARNING/ALARM 8, DC Undervoltage

#### Cause

If the DC-link voltage drops below the undervoltage limit, the drive checks for 24 V DC back-up supply. If no 24 V DC back-up supply is connected, the drive trips after a fixed time delay. The time delay varies with unit size.



## Operating Guide

---

### Troubleshooting

- Check that the supply voltage matches the drive voltage.
- Perform an input voltage test.
- Perform a soft-charge circuit test.

### 7.4.9 WARNING/ALARM 9, Inverter Overload

#### Cause

The drive has run with more than 100% overload for too long and is about to cut out. The counter for electronic thermal inverter protection issues a warning at 98% and trips at 100% with an alarm. The drive cannot be reset until the counter is below 90%.

#### Troubleshooting

- Compare the output current shown on the LCP with the drive rated current.
- Compare the output current shown on the LCP with the measured motor current.
- Show the thermal drive load on the LCP and monitor the value. When running above the drive continuous current rating, the counter increases. When running below the drive continuous current rating, the counter decreases.

### 7.4.10 WARNING/ALARM 10, Motor Overload Temperature

#### Cause

According to the electronic thermal protection (ETR), the motor is too hot.

Select 1 of these options:

- The drive issues a warning or an alarm when the counter is >90% if *parameter 1-90 Motor Thermal Protection* is set to warning options.
- The drive trips when the counter reaches 100% if *parameter 1-90 Motor Thermal Protection* is set to trip options.

The fault occurs when the motor runs with more than 100% overload for too long.

#### Troubleshooting

- Check for motor overheating.
- Check if the motor is mechanically overloaded.
- Check that the motor current set in *parameter 1-24 Motor Current* is correct.
- Ensure that the motor data in *parameters 1-20 to 1-25* is set correctly.
- If an external fan is in use, check that it is selected in *parameter 1-91 Motor External Fan*.
- Running AMA in *parameter 1-29 Automatic Motor Adaptation (AMA)* tunes the drive to the motor more accurately and reduces thermal loading.

### 7.4.11 WARNING/ALARM 11, Motor Thermistor Overtemp

#### Cause

The motor thermistor indicates that the motor temperature is too high.

#### Troubleshooting

- Check for motor overheating.
- Check that the thermistor is securely connected.
- Check if the motor is mechanically overloaded.
- When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply). Also check that the terminal switch for 53 and 54 is set for voltage. Check that *parameter 1-93 Thermistor Resource* selects 53 or 54.
- When using terminal 18, 19, 31, 32, or 33 (digital inputs), check that the thermistor is connected correctly between the digital input terminal used (digital input PNP only) and terminal 50. Select the terminal to use in *parameter 1-93 Thermistor Resource*.

### 7.4.12 WARNING/ALARM 12, Torque Limit

#### Cause

The torque has exceeded the value in *parameter 4-16 Torque Limit Motor Mode* or the value in *parameter 4-17 Torque Limit Generator Mode*. *Parameter 14-25 Trip Delay at Torque Limit* can change this warning from a warning-only condition to a warning followed by an alarm.

## Operating Guide

---

### Troubleshooting

- If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.
- If the generator torque limit is exceeded during ramp-down time, extend the ramp-down time.
- If torque limit occurs while running, increase the torque limit. Make sure that the system can operate safely at a higher torque.
- Check the application for excessive current draw on the motor.

### 7.4.13 WARNING/ALARM 13, Overcurrent

#### Cause

The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts approximately 1.5 s, then the drive trips and issues an alarm. Shock loading or quick acceleration with high-inertia loads can cause this fault. If the acceleration during ramp-up is quick, the fault can also appear after kinetic back-up. If extended mechanical brake control is selected, a trip can be reset externally.

#### Troubleshooting

- Remove power and check if the motor shaft can be turned.
- Check that the motor size matches the drive.
- Check that the motor data is correct in *parameters 1-20 to 1-25*.

### 7.4.14 ALARM 14, Earth (Ground) Fault

#### Cause

There is current from the output phase to ground, either in the cable between the drive and the motor, or in the motor itself. The current transducers detect the ground fault by measuring current going out from the drive and current going into the drive from the motor. Ground fault is issued if the deviation of the 2 currents is too large. The current going out of the drive must be the same as the current going into the drive.

#### Troubleshooting

- Remove power to the drive and repair the ground fault.
- Check for ground faults in the motor by measuring the resistance to ground of the motor cables and the motor with a megohmmeter.
- Reset any potential individual offset in the 3 current transducers in the drive. Perform a manual initialization or perform a complete AMA. This method is most relevant after changing the power card.

### 7.4.15 ALARM 15, Hardware Mismatch

#### Cause

A fitted option is not operational with the present control card hardware or software.

#### Troubleshooting

Record the value of the following parameters and contact Danfoss.

- *Parameter 15-40 FC Type.*
- *Parameter 15-41 Power Section.*
- *Parameter 15-42 Voltage.*
- *Parameter 15-43 Software Version.*
- *Parameter 15-45 Actual Typecode String.*
- *Parameter 15-49 SW ID Control Card.*
- *Parameter 15-50 SW ID Power Card.*
- *Parameter 15-60 Option Mounted.*
- *Parameter 15-61 Option SW Version (for each option slot).*

### 7.4.16 ALARM 16, Short Circuit

#### Cause

There is short-circuiting in the motor or motor wiring.

## Troubleshooting

 **W A R N I N G**
**HAZARDOUS VOLTAGE**

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

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

- Disconnect power before proceeding.
- Remove the power to the drive and repair the short circuit.

**7.4.17 WARNING/ALARM 17, Control Word Timeout**

## Cause

There is no communication to the drive. The warning is only active when *parameter 8-04 Control Word Timeout Function* is NOT set to [0] Off.

If *parameter 8-04 Control Word Timeout Function* is set to [5] Stop and trip, a warning appears, and the drive ramps down to a stop and shows an alarm.

## Troubleshooting

- Check the connections on the serial communication cable.
- Increase *parameter 8-03 Control Word Timeout Time*.
- Check the operation of the communication equipment.
- Verify that proper EMC installation was performed.

**7.4.18 WARNING/ALARM 20, Temp. Input Error**

## Cause

The temperature sensor is not connected.

**7.4.19 WARNING/ALARM 21, Parameter Error**

## Cause

The parameter is out of range. The parameter number is shown in the display.

## Troubleshooting

- Set the affected parameter to a valid value.

**7.4.20 WARNING/ALARM 22, Hoist Mechanical Brake**

## Cause

The value of this warning/alarm shows the type of warning/alarm.

0 = The torque reference was not reached before timeout (*parameter 2-27 Torque Ramp Up Time*).

1 = Expected brake feedback was not received before timeout (*parameter 2-23 Activate Brake Delay*, *parameter 2-25 Brake Release Time*).

**7.4.21 WARNING 23, Internal Fan Fault**

## Cause

The fan warning function is a protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor* ([0] Disabled).

For drives with DC fans, a feedback sensor is mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this alarm appears. For drives with AC fans, the voltage to the fan is monitored.

## Troubleshooting

- Check for proper fan operation.
- Cycle power to the drive and check that the fan operates briefly at start-up.
- Check the sensors on the control card.

---

## Operating Guide

---

### 7.4.22 WARNING 24, External Fan Fault

#### Cause

The fan warning function is a protective function that checks if the fan is running/mounted. The fan warning can be disabled in *parameter 14-53 Fan Monitor ([0] Disabled)*.

For drives with DC fans, a feedback sensor is mounted in the fan. If the fan is commanded to run and there is no feedback from the sensor, this warning appears. For drives with AC fans, the voltage to the fan is monitored.

#### Troubleshooting

- Check for proper fan operation.
- Cycle power to the drive and check that the fan operates briefly at start-up.
- Check the sensors on the heat sink.

### 7.4.23 WARNING 25, Brake Resistor Short Circuit

#### Cause

The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The drive is still operational, but without the brake function.

#### Troubleshooting

- Remove the power to the drive and replace the brake resistor (refer to *parameter 2-15 Brake Check*).

### 7.4.24 WARNING/ALARM 26, Brake Resistor Power Limit

#### Cause

The power transmitted to the brake resistor is calculated as a mean value over the last 120 s of run time. The calculation is based on the DC-link voltage and the brake resistor value set in *parameter 2-16 AC Brake Max. Current*. The warning is active when the dissipated braking power is higher than 90% of the brake resistor power. If option [2] *Trip* is selected in *parameter 2-13 Brake Power Monitoring*, the drive trips when the dissipated braking power reaches 100%.

### 7.4.25 WARNING/ALARM 27, Brake Chopper Fault

#### Cause

The brake transistor is monitored during operation, and if a short circuit occurs, the brake function is disabled, and a warning is issued. The drive is still operational, but since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.

#### Troubleshooting

- Remove the power to the drive and remove the brake resistor.

### 7.4.26 WARNING/ALARM 28, Brake Check Failed

#### Cause

The brake resistor is not connected or not working.

#### Troubleshooting

- Check *parameter 2-15 Brake Check*.

### 7.4.27 ALARM 29, Heat Sink Temp

#### Cause

The maximum temperature of the heat sink is exceeded. The temperature fault is not reset until the temperature drops below a defined heat sink temperature. The trip and reset points are different based on the drive power size.

#### Troubleshooting

Check for the following conditions:

- The ambient temperature is too high.
- The motor cables are too long.
- Incorrect airflow clearance above and below the drive.
- Blocked airflow around the drive.
- Damaged heat sink fan.
- Dirty heat sink.

### 7.4.28 ALARM 30, Motor Phase U Missing

#### Cause

Motor phase U between the drive and the motor is missing.

#### Troubleshooting

## ⚠ WARNING

### HAZARDOUS VOLTAGE

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

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

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase U.

### 7.4.29 ALARM 31, Motor Phase V Missing

#### Cause

Motor phase V between the drive and the motor is missing.

#### Troubleshooting

## ⚠ WARNING

### HAZARDOUS VOLTAGE

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

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

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase V.

### 7.4.30 ALARM 32, Motor Phase W Missing

#### Cause

Motor phase W between the drive and the motor is missing.

#### Troubleshooting

## ⚠ WARNING

### HAZARDOUS VOLTAGE

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

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

- Disconnect power before proceeding.
- Remove the power from the drive and check motor phase W.

### 7.4.31 ALARM 33, Inrush Fault

#### Cause

Too many power-ups have occurred within a short time period.

#### Troubleshooting

- Let the unit cool to operating temperature.
- Check potential DC-link fault to ground.

### 7.4.32 WARNING/ALARM 34, Fieldbus Communication Fault

#### Cause

The fieldbus on the communication option card is not working.

### 7.4.33 WARNING/ALARM 35, Option Fault

#### Cause

An option alarm is received. The alarm is option-specific. The most likely cause is a power-up or a communication fault.

### 7.4.34 WARNING/ALARM 36, Mains Failure

#### Cause

This warning/alarm is only active if the supply voltage to the drive is lost and *parameter 14-10 Mains Failure* is not set to [0] *No Function*.

#### Troubleshooting

- Check the fuses to the drive and mains supply to the unit.

### 7.4.35 ALARM 37, Phase Imbalance

#### Cause

There is a current imbalance between the power units.

### 7.4.36 ALARM 38, Internal Fault

#### Cause

When an internal fault occurs, a code number defined in [Table 28](#) is shown.

#### Troubleshooting

- Cycle power.
- Check that the option is properly installed.
- Check for loose or missing wiring.

It may be necessary to contact the Danfoss supplier or service department. Note the code number for further troubleshooting directions.

**Table 28: Internal Fault Codes**

Number	Text
0	The serial port cannot be initialized. Contact the Danfoss supplier or Danfoss service department.
256–258	The power EEPROM data is defective or too old. Replace the power card.
512–519	Internal fault. Contact the Danfoss supplier or Danfoss service department.
783	Parameter value outside of minimum/maximum limits.
1024–1284	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1299	The option software in slot A is too old.
1300	The option software in slot B is too old.
1302	The option software in slot C1 is too old.
1315	The option software in slot A is not supported/allowed.
1316	The option software in slot B is not supported/ allowed.
1318	The option software in slot C1 is not supported/ allowed.
1379–2819	Internal fault. Contact the Danfoss supplier or Danfoss service department.
1792	Hardware reset of digital signal processor.
1793	Motor-derived parameters not transferred correctly to the digital signal processor.
1794	Power data not transferred correctly at power-up to the digital signal processor.
1795	The digital signal processor has received too many unknown SPI telegrams. The AC drive also uses this fault code if the MCO does not power up correctly. This situation can occur due to poor EMC protection or improper grounding.

Number	Text
1796	RAM copy error.
2561	Replace the control card.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
3072–5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with the control board hardware.
5124	Option in slot B: Hardware incompatible with the control board hardware.
5125	Option in slot C0: Hardware incompatible with the control board hardware.
5126	Option in slot C1: Hardware incompatible with the control board hardware.
5376– 6231	Internal fault. Contact the Danfoss supplier or Danfoss service department.

#### 7.4.37 ALARM 39, Heat Sink Sensor

##### Cause

No feedback from the heat sink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card, on the gate-drive card, or on the ribbon cable between the power card and the gatedrive card.

#### 7.4.38 WARNING 40, Overload of Digital Output Terminal 27

##### Troubleshooting

- Check the load connected to terminal 27 or remove the short-circuit connection.
- Check *parameter 5-00 Digital I/O Mode* and *parameter 5-01 Terminal 27 Mode*.

#### 7.4.39 WARNING 41, Overload of Digital Output Terminal 29

##### Troubleshooting

- Check the load connected to terminal 29 or remove the short-circuit connection.
- Check *parameter 5-00 Digital I/O Mode* and *parameter 5-02 Terminal 29 Mode*.

#### 7.4.40 WARNING 42, OvrlD X30/6-7

##### Troubleshooting

For terminal X30/6:

- Check the load connected to the terminal, or remove the short-circuit connection.
- Check *parameter 5-32 Term X30/6 Digi out (MCB 101)* (VLT® General Purpose I/O MCB 101).

For terminal X30/7:

- Check the load connected to the terminal, or remove the short-circuit connection.
- Check *parameter 5-33 Term X30/7 Digi Out (MCB 101)* (VLT® General Purpose I/O MCB 101).

#### 7.4.41 ALARM 43, Ext. Supply

##### Cause

VLT® Extended Relay Option MCB 113 is mounted without 24 V DC.

##### Troubleshooting

Choose 1 of the following:

## Operating Guide

---

- Connect a 24 V DC external supply.
- Specify that no external supply is used via *parameter 14-80 Option Supplied by External 24VDC, [0] No.* A change in *parameter 14-80 Option Supplied by External 24VDC* requires a power cycle.

### 7.4.42 ALARM 45, Earth Fault 2

#### Cause

Ground fault.

#### Troubleshooting

- Check for proper grounding and loose connections.
- Check for proper wire size.
- Check the motor cables for short circuits or leakage currents.

### 7.4.43 ALARM 46, Power Card Supply

#### Cause

The supply on the power card is out of range. Another reason can be a defective heat sink fan.

There are 3 supplies generated by the switch mode supply (SMPS) on the power card:

- 24 V.
- 5 V.
- $\pm 18$  V.

When powered with VLT® 24 V DC Supply MCB 107, only 24 V and 5 V supplies are monitored. When powered with 3-phase mains voltage, all 3 supplies are monitored.

#### Troubleshooting

- Check for a defective power card.
- Check for a defective control card.
- Check for a defective option card.
- If a 24 V DC supply is used, verify proper supply power.
- Check for a defective heat sink fan.

### 7.4.44 WARNING 47, 24 V Supply Low

#### Cause

The supply on the power card is out of range.

There are 3 supplies generated by the switch mode supply (SMPS) on the power card:

- 24 V
- 5 V
- $\pm 18$  V

#### Troubleshooting

- Check for a defective power card.

### 7.4.45 WARNING 48, 1.8 V Supply Low

#### Cause

The 1.8 V DC supply used on the control card is outside of the allowed limits. The supply is measured on the control card.

#### Troubleshooting

- Check for a defective control card.
- If an option card is present, check for overvoltage.

### 7.4.46 WARNING 49, Speed Limit

#### Cause

The warning is shown when the speed is outside of the specified range in *parameter 4-11 Motor Speed Low Limit [RPM]* and *parameter 4-13 Motor Speed High Limit [RPM]*. When the speed is below the specified limit in *parameter 1-86 Trip Speed Low [RPM]* (except when starting or stopping), the drive trips.



---

**Operating Guide**

---

**7.4.47 ALARM 50, AMA Calibration Failed**

## Cause

A calibration error has occurred.

## Troubleshooting

- Contact the Danfoss supplier or Danfoss service department.

**7.4.48 ALARM 51, AMA Check Unom and Inom**

## Cause

The settings for motor voltage, motor current, and motor power are wrong.

## Troubleshooting

- Check settings in *parameters 1-20 to 1-25*.

**7.4.49 ALARM 52, AMA Low Inom**

## Cause

The motor current is too low.

## Troubleshooting

- Check the settings in *parameter 1-24 Motor Current*.

**7.4.50 ALARM 53, AMA Motor Too Big**

## Cause

The motor is too big for the AMA to operate.

## Troubleshooting

- Check the settings in *parameter group 1-2\* Motor Data*.

**7.4.51 ALARM 54, AMA Motor Too Small**

## Cause

The motor is too small for the AMA to operate.

## Troubleshooting

- Check the settings in *parameter group 1-2\* Motor Data*.

**7.4.52 ALARM 55, AMA Parameter Out of Range**

## Cause

The AMA cannot run because the parameter values of the motor are out of the acceptable range.

## Troubleshooting

- Check the settings in *parameter group 1-2\* Motor Data*.

**7.4.53 ALARM 56, AMA Interrupted by User**

## Cause

The AMA is manually interrupted.

## Troubleshooting

- Re-run th AMA calibration.

**7.4.54 ALARM 57, AMA Internal Fault**

## Troubleshooting

Try to restart the AMA. Repeated restarts can overheat the motor.

**7.4.55 ALARM 58, AMA Internal Fault**

## Troubleshooting

Contact the Danfoss supplier.

**7.4.56 WARNING 59, Current Limit**

## Cause

The current is higher than the value in *parameter 4-18 Current Limit*.

## Operating Guide

---

### Troubleshooting

- Ensure that the motor data in *parameters 1-20 to 1-25* is set correctly.
- Increase the current limit if necessary. Ensure that the system can operate safely at a higher limit.

### 7.4.57 WARNING 60, External Interlock

#### Cause

A digital input signal indicates a fault condition external to the drive. An external interlock has commanded the drive to trip.

#### Troubleshooting

- Clear the external fault condition.
- To resume normal operation, apply 24 V DC to the terminal programmed for external interlock.
- Reset the drive.

### 7.4.58 WARNING/ALARM 61, Feedback Error

#### Cause

An error between calculated speed and speed measurement from feedback device.

#### Troubleshooting

- Check the settings for warning/alarm/disabling in *parameter 4-30 Motor Feedback Loss Function*.
- Set the tolerable error in *parameter 4-31 Motor Feedback Speed Error*.
- Set the tolerable feedback loss time in *parameter 4-32 Motor Feedback Loss Timeout*.

### 7.4.59 WARNING 62, Output Frequency at Maximum Limit

#### Cause

The output frequency has reached the value set in *parameter 4-19 Max Output Frequency*.

#### Troubleshooting

- Check the application for possible causes.
- Increase the output frequency limit. Be sure that the system can operate safely at a higher output frequency.

The warning clears when the output drops below the maximum limit.

### 7.4.60 ALARM 63, Mechanical Brake Low

#### Cause

The actual motor current has not exceeded the release brake current within the start delay time window.

### 7.4.61 WARNING 64, Voltage Limit

#### Cause

The load and speed combination demands a motor voltage higher than the actual DC-link voltage.

### 7.4.62 WARNING/ALARM 65, Control Card Overtemperature

#### Cause

The cutout temperature of the control card has exceeded the upper limit.

#### Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check for clogged filters.
- Check fan operation.
- Check the control card.

### 7.4.63 WARNING 66, Heat Sink Temperature Low

#### Cause

The drive is too cold to operate. This warning is based on the temperature sensor in the IGBT module.

## Operating Guide

---

### Troubleshooting

- Increase the ambient temperature of the unit.
- Supply a trickle amount of current to the drive whenever the motor is stopped by setting *parameter 2-00 DC Hold/Preheat Current* to 5% and *parameter 1-80 Function at Stop*.

### 7.4.64 ALARM 67, Option Module Configuration has Changed

#### Cause

One or more options have either been added or removed since the last power-down.

#### Troubleshooting

- Check that the configuration change is intentional and reset the unit.

### 7.4.65 ALARM 68, Safe Stop Activated

#### Cause

Safe Torque Off (STO) has been activated.

#### Troubleshooting

- To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital, or by pressing [Reset]).

### 7.4.66 ALARM 69, Power Card Temperature

#### Cause

The temperature sensor on the power card is either too hot or too cold.

#### Troubleshooting

- Check that the ambient operating temperature is within the limits.
- Check for clogged filters.
- Check fan operation.
- Check the power card.

### 7.4.67 ALARM 70, Illegal FC Configuration

#### Cause

The control card and power card are incompatible.

#### Troubleshooting

- To check compatibility, contact the Danfoss supplier with the type code from the unit nameplate and the part numbers on the cards.

### 7.4.68 ALARM 71, PTC 1 Safe Stop

#### Cause

Because the motor is too warm, the VLT® PTC Thermistor Card MCB 112 activated the Safe Torque Off (STO).

#### Troubleshooting

- Once the motor temperature reaches an acceptable level and the digital input from MCB 112 is deactivated, perform 1 of the following:
  - Send a reset signal via bus or digital I/O.
  - Press [Reset].

### 7.4.69 ALARM 72, Dangerous Failure

#### Cause

Safe Torque Off (STO) with trip lock.

#### Troubleshooting

An unexpected combination of STO commands has occurred:

- VLT® PTC Thermistor Card MCB 112 enables X44/10, but STO is not enabled.
- MCB 112 is the only device using STO (specified through selection [4] *PTC 1 alarm* or [5] *PTC 12 warning* in *parameter 5-19 Terminal 37 Safe Stop*). STO is activated, but X44/10 is not activated.

---

## Operating Guide

---

### 7.4.70 WARNING 73, Safe Stop Auto Restart

#### Cause

STO activated.

#### Troubleshooting

- With automatic restart enabled, the motor can start when the fault is cleared.

### 7.4.71 ALARM 74, PTC Thermistor

#### Cause

The PTC is not working. Alarm is related to VLT® PTC Thermistor Card MCB 112.

### 7.4.72 ALARM 75, Illegal Profile Sel.

#### Cause

There was an attempt to write the parameter value while the motor was running.

#### Troubleshooting

- Stop the motor before writing the MCO profile to *parameter 8-10 Control Word Profile*.

### 7.4.73 WARNING 77, Reduced Power Mode

#### Cause

The drive is operating in reduced power mode (less than allowed number of inverter sections). The warning is generated on power cycle when the drive is set to run with fewer inverters and remains on.

### 7.4.74 ALARM 78, Tracking Error

#### Cause

The difference between setpoint value and actual value exceeds the value in *parameter 4-35 Tracking Error*.

#### Troubleshooting

- Disable the function or select an alarm/warning in *parameter 4-34 Tracking Error Function*.
- Investigate the mechanics around the load and motor. Check feedback connections from motor encoder to drive.
- Select motor feedback function in *parameter 4-30 Motor Feedback Loss Function*.
- Adjust the tracking error band in *parameter 4-35 Tracking Error* and *parameter 4-37 Tracking Error Ramping*.

### 7.4.75 ALARM 79, Illegal Power Section Configuration

#### Cause

The scaling card has an incorrect part number or is not installed. The MK102 connector on the power card could not be installed.

### 7.4.76 ALARM 80, Drive Initialized to Default Value

#### Cause

Parameter settings are initialized to default settings after a manual reset.

#### Troubleshooting

To clear the alarm, reset the unit.

### 7.4.77 ALARM 81, CSIV Corrupt

#### Cause

The CSIV file has syntax errors.

### 7.4.78 ALARM 82, CSIV Parameter Error

#### Cause

CSIV failed to initialize a parameter.

### 7.4.79 ALARM 83, Illegal Option Combination

#### Cause

The mounted options are incompatible.

---

## Operating Guide

---

### 7.4.80 ALARM 84, No Safety Option

#### Cause

The safety option was removed without applying a general reset.

#### Troubleshooting

Reconnect the safety option.

### 7.4.81 ALARM 88, Option Detection

#### Cause

A change in the option layout is detected. *Parameter 14-89 Option Detection* is set to [0] *Frozen configuration* and the option layout has been changed.

#### Troubleshooting

- To apply the change, enable option layout changes in *parameter 14-89 Option Detection*.
- Alternatively, restore the correct option configuration.

### 7.4.82 WARNING 89, Mechanical Brake Sliding

#### Cause

The hoist brake monitor detects a motor speed exceeding 10 RPM.

### 7.4.83 ALARM 90, Feedback Monitor

#### Troubleshooting

- Check the connection to the encoder/resolver option and, if necessary, replace the VLT® Encoder Input MCB 102 or VLT® Resolver Input MCB 103.

### 7.4.84 ALARM 91, Analog Input 54 Wrong Settings

#### Troubleshooting

- Set switch S202 in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

### 7.4.85 ALARM 99, Locked Rotor

#### Cause

The rotor is blocked.

#### Troubleshooting

- Check if the motor shaft is locked.
- Check if the start current triggers the current limit set in *parameter 4-18 Current Limit*.
- Check if it increases the value in *parameter 30-23 Locked Rotor Detection Time [s]*.

### 7.4.86 WARNING/ALARM 104, Mixing Fan Fault

#### Cause

The fan is not operating. The fan monitor checks that the fan is spinning at power-up or whenever the mixing fan is turned on. The mixing fan fault can be configured as a warning or an alarm in *parameter 14-53 Fan Monitor*.

#### Troubleshooting

- Cycle power to the drive to determine if the warning/alarm returns.

### 7.4.87 WARNING/ALARM 122, Mot. Rotat. Unexp.

#### Cause

The drive performs a function that requires the motor to be at standstill, for example DC hold for PM motors.

### 7.4.88 WARNING 163, ATEX ETR Cur.Lim.Warning

#### Cause

The drive has run above the characteristic curve for more than 50 s. The warning is activated at 83% and deactivated at 85% of the allowed thermal overload.

### 7.4.89 ALARM 164, ATEX ETR Cur.Lim.Alarm

#### Cause

Running above the characteristic curve for more than 60 s within a period of 600 s activates the alarm, and the drive trips.

## Operating Guide

---

### 7.4.90 WARNING 165, ATEX ETR Freq.Lim.Warning

#### Cause

The drive has run for more than 50 s below the allowed minimum frequency (*parameter 1-98 ATEX ETR Interpol. Points Freq.*).

### 7.4.91 ALARM 166, ATEX ETR Freq.Lim.Alarm

#### Cause

The drive has run for more than 60 s (in a period of 600 s) below the allowed minimum frequency (*parameter 1-98 ATEX ETR Interpol. Points Freq.*).

### 7.4.92 WARNING 250, New Spare Part

#### Cause

A component in the drive system has been replaced.

#### Troubleshooting

- Reset the drive system to restore normal operation.

### 7.4.93 WARNING 251, New Typecode

#### Cause

The power card or other components have been replaced, and the typecode has changed.

## 8 Specifications

### 8.1 Electrical Data

#### 8.1.1 Mains Supply 200–240 V

Table 29: Mains Supply 200–240 V, PK25–P3K7

Type designation	PK25	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P3K7
Typical shaft output [kW/(hp)], high overload	0.25 (0.34)	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	3.7 (5.0)
Enclosure protection rating IP20 (FC 301 only)	A1	A1	A1	A1	A1	A1	–	–	–
Enclosure protection rating IP20, IP21	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure protection rating IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
<b>Output current</b>									
Continuous (200–240 V) [A]	1.8	2.4	3.5	4.6	6.6	7.5	10.6	12.5	16.7
Intermittent (200–240 V) [A]	2.9	3.8	5.6	7.4	10.6	12	17	20	26.7
Continuous kVA (208 V) [kVA]	0.65	0.86	1.26	1.66	2.38	2.70	3.82	4.50	6.0
<b>Maximum input current</b>									
Continuous (200–240 V) [A]	1.6	2.2	3.2	4.1	5.9	6.8	9.5	11.3	15
Intermittent (200–240 V) [A]	2.6	3.5	5.1	6.6	9.4	10.9	15.2	18.1	24
<b>Additional specifications</b>									
Estimated power loss at rated maximum load [W] <sup>(1)</sup>	21	29	42	54	63	82	116	155	185
Efficiency <sup>(2)</sup>	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96

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

<sup>2</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

Table 30: Mains Supply 200–240 V, P5K5–P11K

Type designation	P5K5		P7K5		P11K	
High/normal overload <sup>(1)</sup>	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	5.5 (7.5)	7.5 (10)	7.5 (10)	11 (15)	11 (15)	15 (20)
Enclosure protection rating IP20	B3		B3		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2	
<b>Output current</b>						
Continuous (200–240 V) [A]	24.2	30.8	30.8	46.2	46.2	59.4

Type designation	P5K5		P7K5		P11K	
Intermittent (60 s overload) (200–240 V [A])	38.7	33.9	49.3	50.8	73.9	65.3
Continuous kVA (208 V) [kVA]	8.7	11.1	11.1	16.6	16.6	21.4
<b>Maximum input current</b>						
Continuous (200–240 V) [A]	22	28	28	42	42	54
Intermittent (60 s overload) (200–240 V) [A]	35.2	30.8	44.8	46.2	67.2	59.4
<b>Additional specifications</b>						
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	239	310	371	514	463	602
Efficiency <sup>(3)</sup>	0.96		0.96		0.96	

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

**Table 31: Mains Supply 200–240 V, P15K–P37K**

Type designation	P15K		P18K		P22K		P30K		P37K	
High/normal overload <sup>(1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)	30 (40)	37 (50)	37 (50)	45 (60)
Enclosure protection rating IP20	B4		C3		C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1		C1		C1		C2		C2	
<b>Output current</b>										
Continuous (200–240 V) [A]	59.4	74.8	74.8	88	88	115	115	143	143	170
Intermittent (60 s overload) (200–240 V) [A]	89.1	82.3	112	96.8	132	127	173	157	215	187
Continuous kVA (208 V) [kVA]	21.4	26.9	26.9	31.7	31.7	41.4	41.4	51.5	51.5	61.2
<b>Maximum input current</b>										
Continuous (200–240 V) [A]	54	68	68	80	80	104	104	130	130	154
Intermittent (60 s overload) (200–240 V) [A]	81	74.8	102	88	120	114	156	143	195	169
<b>Additional specifications</b>										
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	624	737	740	845	874	1140	1143	1353	1400	1636



Type designation	P15K	P18K	P22K	P30K	P37K
Efficiency <sup>(3)</sup>	0.96	0.97	0.97	0.97	0.97

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

## 8.1.2 Mains Supply 380–500 V

Table 32: Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), PK37–P7K5

Type designation	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K7
Typical shaft output [kW/(hp)], high overload	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20 (FC 301 only)	A1	A1	A1	A1	A1	–	–	–	–	–
Enclosure protection rating IP20, IP21	A2	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure protection rating IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
<b>Output current high overload 160% for 1 minute</b>										
Shaft output [kW/(hp)]	0.37 (0.5)	0.55 (0.75)	0.75 (1.0)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Continuous (380–440 V) [A]	1.3	1.8	2.4	3.0	4.1	5.6	7.2	10	13	16
Intermittent (380–440 V) [A]	2.1	2.9	3.8	4.8	6.6	9.0	11.5	16	20.8	25.6
Continuous (441–500 V) [A]	1.2	1.6	2.1	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (441–500 V) [A]	1.9	2.6	3.4	4.3	5.4	7.7	10.1	13.1	17.6	23.2
Continuous kVA (400 V) [kVA]	0.9	1.3	1.7	2.1	2.8	3.9	5.0	6.9	9.0	11
Continuous kVA (460 V) [kVA]	0.9	1.3	1.7	2.4	2.7	3.8	5.0	6.5	8.8	11.6
<b>Maximum input current</b>										
Continuous (380–440 V) [A]	1.2	1.6	2.2	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (380–440 V) [A]	1.9	2.6	3.5	4.3	5.9	8.0	10.4	14.4	18.7	23
Continuous (441–500 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7	7.4	9.9	13

Type designation	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K7
Intermittent (441–500 V) [A]	1.6	2.2	3.0	4.3	5.0	6.9	9.1	11.8	15.8	20.8
<b>Additional specifications</b>										
Estimated power loss at rated maximum load [W] <sup>(1)</sup>	35	42	46	58	62	88	116	124	187	255
Efficiency <sup>(2)</sup>	0.93	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97

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

<sup>2</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

Table 33: Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), P11K–P22K

Type designation	P11K		P15K		P18K		P22K	
High/normal overload <sup>(1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)
Enclosure protection rating IP20	B3		B3		B4		B4	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2		B2	
<b>Output current</b>								
Continuous (380–440 V) [A]	24	32	32	37.5	37.5	44	44	61
Intermittent (60 s overload) (380–440 V) [A]	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1
Continuous (441–500 V) [A]	21	27	27	34	34	40	40	52
Intermittent (60 s overload) (441–500 V) [A]	33.6	29.7	43.2	37.4	54.4	44	64	57.2
Continuous kVA (400 V) [kVA]	16.6	22.2	22.2	26	26	30.5	30.5	42.3
Continuous kVA (460 V) [kVA]	–	21.5	–	27.1	–	31.9	–	41.4
<b>Maximum input current</b>								
Continuous (380–440 V) [A]	22	29	29	34	34	40	40	55
Intermittent (60 s overload) (380–440 V) [A]	35.2	31.9	46.4	37.4	54.4	44	64	60.5
Continuous (441–500 V) [A]	19	25	25	31	31	36	36	47
Intermittent (60 s overload) (441–500 V) [A]	30.4	27.5	40	34.1	49.6	39.6	57.6	51.751.7
<b>Additional specifications</b>								
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	291	392	379	465	444	525	547	739

Type designation	P11K	P15K	P18K	P22K
Efficiency <sup>(3)</sup>	0.98	0.98	0.98	0.98

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

**Table 34: Mains Supply 380–500 V (FC 302), 380–480 V (FC 301), P30K–P75K**

Type designation	P30K		P37K		P45K		P55K		P75K	
High/normal overload <sup>(1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	B4		C3		C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1		C1		C1		C2		C2	
<b>Output current</b>										
Continuous (380–440 V) [A]	61	73	73	90	90	106	106	147	147	177
Intermittent (60 s overload) (380–440 V) [A]	91.5	80.3	110	99	135	117	159	162	221	195
Continuous (441–500 V) [A]	52	65	65	80	80	105	105	130	130	160
Intermittent (60 s overload) (441–500 V) [A]	78	71.5	97.5	88	120	116	158	143	195	176
Continuous kVA (400 V) [kVA]	42.3	50.6	50.6	62.4	62.4	73.4	73.4	102	102	123
Continuous kVA (460 V) [kVA]	–	51.8	–	63.7	–	83.7	–	104	–	128
<b>Maximum input current</b>										
Continuous (380–440 V) [A]	55	66	66	82	82	96	96	133	133	161
Intermittent (60 s overload) (380–440 V) [A]	82.5	72.6	99	90.2	123	106	144	146	200	177
Continuous (441–500 V) [A]	47	59	59	73	73	95	95	118	118	145
Intermittent (60 s overload) (441–500 V) [A]	70.5	64.9	88.5	80.3	110	105	143	130	177	160
<b>Additional specifications</b>										
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	570	698	697	843	891	1083	1022	1384	1232	1474

Type designation	P30K	P37K	P45K	P55K	P75K
Efficiency <sup>(3)</sup>	0.98	0.98	0.98	0.98	0.99

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

### 8.1.3 Mains Supply 525–600 V (FC 302 only)

Table 35: Mains Supply 525–600 V (FC 302 only), PK75–P7K5

Type designation	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical shaft output [kW/(hp)]	0.75 (1)	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3 (4.0)	4 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20, IP21	A3	A3	A3	A3	A3	A3	A3	A3
Enclosure protection rating IP55	A5	A5	A5	A5	A5	A5	A5	A5
<b>Output current</b>								
Continuous (525–550 V) [A]	1.8	2.6	2.9	4.1	5.2	6.4	9.5	11.5
Intermittent (525–550 V) [A]	2.9	4.2	4.6	6.6	8.3	10.2	15.2	18.4
Continuous (551–600 V) [A]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11
Intermittent (551–600 V) [A]	2.7	3.8	4.3	6.2	7.8	9.8	14.4	17.6
Continuous kVA (525 V) [kVA]	1.7	2.5	2.8	3.9	5.0	6.1	9.0	11
Continuous kVA (57 V) [kVA]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11
<b>Maximum input current</b>								
Continuous (525–600 V) [A]	1.7	2.4	2.7	4.1	5.2	5.8	8.6	10.4
Intermittent (525–600 V) [A]	2.7	3.8	4.3	6.6	8.3	9.3	13.8	16.6
<b>Additional specifications</b>								
Estimated power loss at rated maximum load [W] <sup>(1)</sup>	35	50	65	92	122	145	195	261
Efficiency <sup>(2)</sup>	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97

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

<sup>2</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

Table 36: Mains Supply 525–600 V (FC 302 only), P11K–P30K

Type designation	P11K		P15K		P18K		P22K		P30K	
High/normal load <sup>(1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO	HI	NO
Typical shaft output [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)	30 (40)	37 (50)
Enclosure protection rating IP20	B3		B3		B4		B4		B4	

Type designation	P11K		P15K		P18K		P22K		P30K	
Enclosure protection rating IP21, IP55, IP66	B1		B1		B2		B2		C1	
<b>Output current</b>										
Continuous (525–550 V) [A]	19	23	23	28	28	36	36	43	43	54
Intermittent (525–550 V) [A]	30	25	37	31	45	40	58	47	65	59
Continuous (551–600 V) [A]	18	22	22	27	27	34	34	41	41	52
Intermittent (551–600 V) [A]	29	24	35	30	43	37	54	45	62	57
Continuous kVA (550 V) [kVA]	18.1	21.9	21.9	26.7	26.7	34.3	34.3	41	41	51.4
Continuous kVA (575 V) [kVA]	17.9	21.9	21.9	26.9	26.9	33.9	33.9	40.8	40.8	51.8
<b>Maximum input current</b>										
Continuous at 550 V [A]	17.2	20.9	20.9	25.4	25.4	32.7	32.7	39	39	49
Intermittent at 550 V [A]	28	23	33	28	41	36	52	43	59	54
Continuous at 575 V [A]	16	20	20	24	24	31	31	37	37	47
Intermittent at 575 V [A]	26	22	32	27	39	34	50	41	56	52
<b>Additional specifications</b>										
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	220	300	300	370	370	440	440	600	600	740
Efficiency <sup>(3)</sup>	0.98		0.98		0.98		0.98		0.98	

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

Table 37: Mains Supply 525–600 V P37K–P75K (FC 302 only), P37K–P75K

Type designation	P37K		P45K		P55K		P75K	
High/normal load <sup>(1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output [kW/(hp)]	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	C3	C3	C3		C4		C4	
Enclosure protection rating IP21, IP55, IP66	C1	C1	C1		C2		C2	
<b>Output current</b>								
Continuous (525–550 V) [A]	54	65	65	87	87	105	105	137
Intermittent (525–550 V) [A]	81	72	98	96	131	116	158	151
Continuous (551–600 V) [A]	52	62	62	83	83	100	100	131
Intermittent (551–600 V) [A]	78	68	93	91	125	110	150	144
Continuous kVA (550 V) [kVA]	51.4	61.9	61.9	82.9	82.9	100	100	130.5

Type designation	P37K		P45K		P55K		P75K	
Continuous kVA (575 V) [kVA]	51.8	61.7	61.7	82.7	82.7	99.6	99.6	130.5
<b>Maximum input current</b>								
Continuous at 550 V [A]	49	59	59	78.9	78.9	95.3	95.3	124.3
Intermittent at 550 V [A]	74	65	89	87	118	105	143	137
Continuous at 575 V [A]	47	56	56	75	75	91	91	119
Intermittent at 575 V [A]	70	62	85	83	113	100	137	131
<b>Additional specifications</b>								
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	740	900	900	1100	1100	1500	1500	1800
Efficiency <sup>(3)</sup>	0.98		0.98		0.98		0.98	

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

### 8.1.4 Mains Supply 525–690 V (FC 302 only)

Table 38: A3 Enclosure, Mains Supply 525–690 V IP20/Protected Chassis, P1K1–P7K5

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
High/normal overload <sup>(1)</sup>	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO	HO/NO
Typical shaft output [kW/(hp)]	1.1 (1.5)	1.5 (2.0)	2.2 (3.0)	3.0 (4.0)	4.0 (5.0)	5.5 (7.5)	7.5 (10)
Enclosure protection rating IP20	A3	A3	A3	A3	A3	A3	A3
<b>Output current</b>							
Continuous (525–550 V) [A]	2.1	2.7	3.9	4.9	6.1	9.0	11
Intermittent (525–550 V) [A]	3.4	4.3	6.2	7.8	9.8	14.4	17.6
Continuous (551–690 V) [A]	1.6	2.2	3.2	4.5	5.5	7.5	10
Intermittent (551–690 V) [A]	2.6	3.5	5.1	7.2	8.8	12	16
Continuous kVA 525 V	1.9	2.5	3.5	4.5	5.5	8.2	10
Continuous kVA 690 V	1.9	2.6	3.8	5.4	6.6	9.0	12
<b>Maximum input current</b>							
Continuous (525–550 V) [A]	1.9	2.4	3.5	4.4	5.5	8.1	9.9
Intermittent (525–550 V) [A]	3.0	3.9	5.6	7.0	8.8	12.9	15.8
Continuous (551–690 V) [A]	1.4	2.0	2.9	4.0	4.9	6.7	9.0
Intermittent (551–690 V) [A]	2.3	3.2	4.6	6.5	7.9	10.8	14.4
<b>Additional specifications</b>							

Type designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	44	60	88	120	160	220	300
Efficiency <sup>(3)</sup>	0.96	0.96	0.96	0.96	0.96	0.96	0.96

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

Table 39: B2/B4 Enclosure, Mains Supply 525–690 V IP20/IP21/IP55 - Chassis/NEMA 1/NEMA 12 (FC 302 only), P11K–P22K

Type designation	P11K		P15K		P18K		P22K	
High/normal overload <sup>(1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW/(hp)]	7.5 (10)	11 (15)	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)
Typical shaft output at 690 V [kW/(hp)]	11 (15)	15 (20)	15 (20)	18.5 (25)	18.5 (25)	22 (30)	22 (30)	30 (40)
Enclosure protection rating IP20	B4		B4		B4		B4	
Enclosure protection rating IP21, IP55	B2		B2		B2		B2	
<b>Output current</b>								
Continuous (525–550 V) [A]	14	19	19	23	23	28	28	36
Intermittent (60 s overload) (525–550 V) [A]	22.4	20.9	30.4	25.3	36.8	30.8	44.8	39.6
Continuous (551–690 V) [A]	13	18	18	22	22	27	27	34
Intermittent (60 s overload) (551–690 V) [A]	20.8	19.8	28.8	24.2	35.2	29.7	43.2	37.4
Continuous kVA (at 550 V) [kVA]	13.3	18.1	18.1	21.9	21.9	26.7	26.7	34.3
Continuous kVA (at 690 V) [kVA]	15.5	21.5	21.5	26.3	26.3	32.3	32.3	40.6
<b>Maximum input current</b>								
Continuous (at 550 V) (A)	15	19.5	19.5	24	24	29	29	36
Intermittent (60 s overload) (at 550 V) (A)	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Continuous (at 690 V) (A)	14.5	19.5	19.5	24	24	29	29	36
Intermittent (60 s overload) (at 690 V) (A)	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
<b>Additional specifications</b>								
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	150	220	220	300	300	370	370	440
Efficiency <sup>(3)</sup>	0.98		0.98		0.98		0.98	

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoSmart](#) website.

Table 40: B4, C2, C3 Enclosure, Mains Supply 525–690 V IP20/IP21/IP55 – Chassis/NEMA1/NEMA 12 (FC 302 only), P30K–P75K

Type designation	P30K		P37K		P45K		P55K		P75K	
High/normal overload <sup>(1)</sup>	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical shaft output at 550 V [kW/(hp)]	22 (30)	30 (40)	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)
Typical shaft output at 690 V [kW/(hp)]	30 (40)	37 (50)	37 (50)	45 (60)	45 (60)	55 (75)	55 (75)	75 (100)	75 (100)	90 (125)
Enclosure protection rating IP20	B4		C3		C3		D3h		D3h	
Enclosure protection rating IP21, IP55	C2		C2		C2		C2		C2	
<b>Output current</b>										
Continuous (525–550 V) [A]	36	43	43	54	54	65	65	87	87	105
Intermittent (60 s overload) (525–550 V) [A]	54	47.3	64.5	59.4	81	71.5	97.5	95.7	130.5	115.5
Continuous (551–690 V) [A]	34	41	41	52	52	62	62	83	83	100
Intermittent (60 s overload) (551–690 V) [A]	51	44.5	61.5	57.2	78	68.2	93	91.3	124.5	110
Continuous kVA (at 550 V) [kVA]	34.3	41	41	51.4	51.4	61.9	61.9	82.9	82.9	100
Continuous kVA (at 690 V) [kVA]	40.6	49	49	62.1	62.1	74.1	74.1	99.2	99.2	119.5
<b>Maximum input current</b>										
Continuous (at 550 V) [A]	36	49	49	59	59	71	71	87	87	99
Intermittent (60 s overload) (at 550 V) [A]	54	53.9	72	64.9	87	78.1	105	95.7	129	108.9
Continuous (at 690 V) [A]	36	48	48	58	58	70	70	86	–	–
Intermittent (60 s overload) (at 690 V) [A]	54	52.8	72	63.8	87	77	105	94.6	–	–
<b>Additional specifications</b>										
Estimated power loss at rated maximum load [W] <sup>(2)</sup>	600	740	740	900	900	1100	1100	1500	1500	1800
Efficiency <sup>(3)</sup>	0.98		0.98		0.98		0.98		0.98	

<sup>1</sup> High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

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

<sup>3</sup> Efficiency measured at nominal current. For energy efficiency class, see [8.4 Ambient Conditions](#). For part load losses, see Danfoss [MyDrive® ecoS-mart](#) website.



## 8.1.5 Power Cable Cross-sections

Table 41: Maximum Cable Cross-section [mm<sup>2</sup> (AWG)]

Enclosure	Mains	Motor	Brake	Loadshare	Disconnect
A1	4(12)	4(12)	4(12)	4(12)	4(12)
A2	4(12)	4(12)	4(12)	4(12)	4(12)
A3	4(12)	4(12)	4(12)	4(12)	4(12)
A4	4(12)	4(12)	4(12)	4(12)	4(12)
A5	4(12)	4(12)	4(12)	4(12)	4(12)
B1	10(7)	10(7)	10(7)	10(7)	10(7)
B2	35(2)	35(2)	35(2)	35(2)	35(2)
B3	10(7)	10(7)	10(7)	10(7)	10(7)
B4	35(2)	35(2)	35(2)	35(2)	35(2)
C1	50(1/0)	50(1/0)	50(1/0)	50(1/0)	50(1/0)
C2	95(4/0)	95(4/0)	95(4/0)	95(4/0)	95(4/0)
C3	50(1/0)	50(1/0)	50(1/0)	50(1/0)	50(1/0)
C4	95(4/0)	95(4/0)	95(4/0)	95(4/0)	95(4/0)

## 8.2 Mains Supply

Supply terminals (6-pulse)	L1, L2, L3
Supply terminals (12-pulse)	L1-1, L2-1, L3-1, L1-2, L2-2, L3-2
Supply voltage <sup>(1)(2)</sup>	200–240 V ±10%
Supply voltage <sup>(1)(2)</sup>	FC 301: 380–480 V/FC 302: 380–500 V ±10%
Supply voltage <sup>(1)(2)</sup>	FC 302: 525–600 V ±10%
Supply voltage <sup>(1)(2)</sup>	FC 302: 525–690 V ±10%
Supply frequency	47.5–63 Hz
Maximum imbalance temporary between mains phases	3.0% of rated supply voltage
True power factor ( $\lambda$ )	≥0.9 nominal at rated load
Displacement power factor ( $\cos \Phi$ )	Near unity (>0.98)
Switching on the input supply L1, L2, L3 (power-ups) ≤7.5 kW (10 hp)	Maximum twice per minute
Switching on input supply L1, L2, L3 (power-ups) 11–75 kW (15–101 hp)	Maximum once per minute
Switching on input supply L1, L2, L3 (power-ups) ≥90 kW (121 hp)	Maximum once per 2 minutes
Environment according to EN60664-1	Overtoltage category III/pollution degree 2

<sup>1</sup> Mains voltage low/mains dropout: During low mains voltage or a mains dropout, the drive continues until the DC-link voltage drops below the minimum stop level, which typically corresponds to 15% below the drive's lowest rated supply voltage. Power-up and full torque cannot be expected at mains voltage lower than 10% below the drive's lowest rated supply voltage.

<sup>2</sup> The unit is suitable for use on a circuit capable of delivering not more than 100000 RMS symmetrical Amperes, 240/500/600/690 V maximum.

## 8.3 Motor Output and Motor Data

### 8.3.1 Motor Output (U, V, W)

Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz <sup>(1)</sup>
Output frequency in flux mode	0–300 Hz
Switching on output	Unlimited
Ramp times	0.01–3600 s

<sup>1</sup> Dependent on voltage and power.

### 8.3.2 Torque Characteristics

Starting torque (constant torque)	Maximum 160% for 60 s <sup>(1)</sup> once in 10 minutes
Starting/overload torque (variable torque)	Maximum 110% up to 0.5 s <sup>(1)</sup> once in 10 minutes
Torque rise time in flux (for 5 KHz $f_{sw}$ )	1 ms
Torque rise time in VVC <sup>+</sup> (independent of $f_{sw}$ )	10 ms

<sup>1</sup> Percentage relates to the nominal torque

## 8.4 Ambient Conditions

Enclosure	IP20 (Chassis), IP21 (Type 1), IP54 (Type 12)
Vibration test (standard/ruggedized)	0.7 g/1.0 g
Relative humidity	5%-95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation)
Aggressive environment (IEC 60068-2-43) H <sub>2</sub> S test	Class Kd
Aggressive gases (IEC 60721-3-3)	Class 3C3
Test method according to IEC 60068-2-43	H2S (10 days)
Ambient temperature (at SFAVM switching mode)	
- with derating	Maximum 55° C (131° F) <sup>(1)</sup>
- with full output power of typical EFF2 motors (up to 90% output current)	Maximum 50° C (122° F) <sup>(1)</sup>
- at full continuous FC output current	Maximum 45° C (113° F) <sup>(1)</sup>
Minimum ambient temperature during full-scale operation	0° C (32° F)
Minimum ambient temperature at reduced speed performance	-10° C (14° F)
Temperature during storage/transport	-25 to +65/70° C (-13 to +149/158° F)
Maximum altitude above sea level without derating	1000 m (3280 ft)
Maximum altitude above sea level with derating	3000 m (9842 ft)
EMC standards, Emission	IEC/EN 61800-3
EMC standards, Immunity	IEC/EN 61800-3
Energy efficiency class	IE2 <sup>(2)</sup>

<sup>1</sup> For more information, see the Derating section in the Design Guide.

<sup>2</sup> Determined according to IEC 61800-9-2 (EN 50598-2) at:

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

## 8.5 Cable Specifications

### 8.5.1 Cable Lengths and Cross-sections for Control Cables

Maximum motor cable length, shielded	FC 301: 50 m (164 ft)/FC 302: 150 m (492 ft)
Maximum motor cable length, unshielded	FC 301: 75 m (246 ft)/FC 302: 300 m (984 ft)
Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	1.5 mm <sup>2</sup> /16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1 mm <sup>2</sup> /18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5 mm <sup>2</sup> /20 AWG
Minimum cross-section to control terminals	0.25 mm <sup>2</sup> /24 AWG

For power cables, see [Table 29](#) to [Table 40](#)

For power cables cross-sections, see [8.1.5 Power Cable Cross-sections](#).

## 8.6 Control Input/Output and Control Data

### 8.6.1 Digital Inputs

Programmable digital inputs	FC 301: 4 (5) <sup>(1)</sup> /FC 302: 4 (6) <sup>(1)</sup>
Terminal number	18, 19, 27 <sup>(1)</sup> , 29 <sup>(1)</sup> , 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 <sup>(2)</sup>	>19 V DC
Voltage level, logic 1 NPN <sup>(2)</sup>	<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 <sub>i</sub>	Approximately 4 kΩ

<sup>1</sup> Terminals 27 and 29 can also be programmed as output.

<sup>2</sup> Except STO input terminal 37.

### 8.6.2 STO Terminal 37 (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.

See [4.7.1 Safe Torque Off \(STO\)](#) for further information about terminal 37 and Safe Torque Off.

When using a contactor with a DC coil inside in combination with STO, it is important to make a return way for the current from the coil when turning it off. This can be done by using a freewheel diode (or, alternatively, a 30 V or 50 V MOV for quicker response time) across the coil. Typical contactors can be bought with this diode.

### 8.6.3 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 (scaleable)
Input resistance, $R_i$	Approximately 10 k $\Omega$
Maximum voltage	$\pm 20$ V
Current mode	Switch S201/S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, $R_i$	Approximately 200 $\Omega$
Maximum current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Maximum error 0.5% of full scale
Bandwidth	100 Hz

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

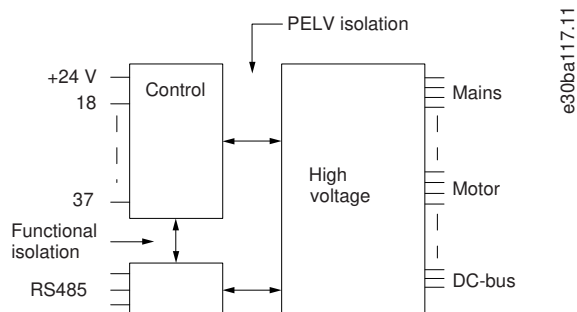


Illustration 20: PELV Isolation

### 8.6.4 Pulse/Encoder Inputs

Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29 <sup>(1)</sup> , 33 <sup>(2)</sup> /32 <sup>(3)</sup> , 33 <sup>(3)</sup>
Maximum frequency at terminals 29, 32, 33	110 kHz (Push-pull driven)
Maximum frequency at terminals 29, 32, 33	5 kHz (Open collector)
Maximum frequency at terminals 29, 32, 33	4 Hz
Voltage level	See <a href="#">8.6.1 Digital Inputs</a> .
Maximum voltage on input	28 V DC
Input resistance, $R_i$	Approximately 4 k $\Omega$
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

<sup>1</sup> FC 302 only.

<sup>2</sup> Pulse inputs are 29 and 33.

<sup>3</sup> Encoder inputs: 32=A, 33=B.

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

### 8.6.5 Digital Outputs

Programmable digital/pulse outputs	2
Terminal number	27, 29 <sup>(1)</sup>
Voltage level at digital/frequency output	0–24 V
Maximum output current (sink or source)	40 mA
Maximum load at frequency output	1 k $\Omega$
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

<sup>1</sup> 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.

### 8.6.6 Analog Output

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

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

### 8.6.7 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.

### 8.6.8 Control Card, +10 V DC Output

Terminal number	50
Output voltage	10.5 V $\pm$ 0.5 V
Maximum load	15 mA

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

### 8.6.9 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 galvanically isolated from the supply voltage (PELV).

### 8.6.10 Control Card, USB Serial Communication

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

Connection to the 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 drive.

### 8.6.11 Relay Outputs

Programmable relay outputs	FC 301 all kW: 1/FC 302 all kW: 2
Relay 01 terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1) <sup>(1)</sup> on 1–3 (NC), 1–2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) <sup>(1)</sup> (inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>(1)</sup> on 1–2 (NO), 1–3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13) <sup>(1)</sup> (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) <sup>(1)</sup> on 4–5 (NO) (resistive load) <sup>(2)(3)</sup>	400 V AC, 2 A
Maximum terminal load (AC-15) <sup>(1)</sup> on 4–5 (NO) (inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>(1)</sup> on 4–5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13) <sup>(1)</sup> on 4–5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1) <sup>(1)</sup> on 4–6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15) <sup>(1)</sup> on 4–6 (NC) (inductive load @ $\cos\phi$ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1) <sup>(1)</sup> on 4–6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13) <sup>(1)</sup> 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

<sup>1</sup> IEC 60947 parts 4 and 5. The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV)

<sup>2</sup> Overvoltage Category II

<sup>3</sup> UL applications 300 V AC 2 A.

### 8.6.12 Control Card Performance

Scan interval	1 ms
---------------	------

### 8.6.13 Control Characteristics

Resolution of output frequency at 0–590 Hz	$\pm 0.003$ Hz
Repeat accuracy of precise start/stop (terminals 18, 19)	$\leq \pm 0.1$ ms
System response time (terminals 18, 19, 27, 29, 32, 33)	$\leq 2$ 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 $\pm 8$ RPM
Speed accuracy (closed loop), depending on resolution of feedback device	0–6000 RPM: Error $\pm 0.15$ RPM
Torque control accuracy (speed feedback)	Maximum error $\pm 5\%$ of rated torque

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

## 8.7 Fuses and Circuit Breakers

### 8.7.1 Fuse Recommendations

Fuses ensure that possible damage to the drive is limited to damage inside the unit. Danfoss recommends fuses and/or circuit breakers on the supply side as protection. For further information, see *Application Note Fuses and Circuit Breakers*.

#### N O T I C E

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

#### Recommendations

- gG type fuses.
- Moeller type circuit breakers. For other circuit breaker types, ensure that the energy into the drive is equal to or lower than the energy provided by Moeller types.

For further information, see *Application Note Fuses and Circuit Breakers*.

The recommended fuses in [8.7.2 CE Compliance](#) and [8.7.3 UL Compliance](#) are suitable for use on a circuit capable of 100000 A<sub>rms</sub> (symmetrical), depending on the drive voltage rating. With the proper fusing, the drive short circuit current rating (SCCR) is 10000 A<sub>rms</sub>.

### 8.7.2 CE Compliance

Table 42: 200–240 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A1	0.25–1.5 (0.34–2.0)	gG-10	gG-25	PKZM0-16	16
A2	0.25–1.5 (0.34–2.0)	gG-10	gG-25	PKZM0-25	25
	2.2 (3.0)	gG-16			
A3	3.0 (4.0)	gG-16	gG-32	PKZM0-25	25
	3.7 (5.0)	gG-20			
A4	0.25–1.5 (0.34–2.0)	gG-10	gG-32	PKZM0-25	25
	2.2 (3.0)	gG-16			
A5	0.25–1.5 (0.34–2.0)	gG-10	gG-32	PKZM0-25	25
	2.2–3.0 (3.0–4.0)	gG-16			
	3.7 (5.0)	gG-20			
B1	5.5 (7.5)	gG-25	gG-80	PKZM4-63	63
	7.5 (10.0)	gG-32			
B2	11.0 (15.0)	gG-50	gG-100	NZMB1-A100	100
B3	5.5 (7.5)	gG-25	gG-63	PKZM4-50	50
B4	7.5 (10.0)	gG-32	gG-125	NZMB1-A100	100
	11.0 (15.0)	gG-50			
	15.0 (20.0)	gG-63			
C1	15.0 (20.0)	gG-63	gG-160	NZMB2-A200	160
	18.5 (25.0)	gG-80			

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
	22.0 (30.0)	gG-100	aR-160		
C2	30.0 (40.0)	aR-160	aR-200	NZMB2-A250	250
	37.0 (50.0)	aR-200	aR-250		
C3	18.5 (25.0)	gG-80	gG-150	NZMB2-A200	150
	22.0 (30.0)	aR-125	aR-160		
C4	30.0 (40.0)	aR-160	aR-200	NZMB2-A250	250
	37.0 (50.0)	aR-200	aR-250		

Table 43: 380–500 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A1	0.37–1.5 (0.5–2.0)	gG-10	gG-25	PKZM0-16	16
A2	0.37–3.0 (0.5–4.0)	gG-10	gG-25	PKZM0-25	25
	4.0 (5.0)	gG-16			
A3	5.5–7.5 (7.5–10.0)	gG-16	gG-32	PKZM0-25	25
A4	0.37–3.0 (0.5–4.0)	gG-10	gG-32	PKZM0-25	25
	4.0 (5.0)	gG-16			
A5	0.37–3.0 (0.5–4.0)	gG-10	gG-32	PKZM0-25	25
	4.0–7.5 (5.0–10.0)	gG-16			
B1	11–15 (15.0–20.0)	gG-40	gG-80	PKZM4-63	63
B2	18.5 (25.0)	gG-50	gG-100	NZMB1-A100	100
	22.0 (30.0)	gG-63			
B3	11–15 (15.0–20.0)	gG-40	gG-63	PKZM4-50	50
B4	18.5 (25.0)	gG-50	gG-125	NZMB1-A100	100
	22.0 (30.0)	gG-63			
	30.0 (40.0)	gG-80			
C1	30.0 (40.0)	gG-80	gG-160	NZMB2-A200	160
	37.0 (50.0)	gG-100			
	45.0 (60.0)	gG-160			
C2	55.0 (75.0)	aR-200	aR-250	NZMB2-A250	250
	75.0 (100.0)	aR-250			
C3	37.0 (50.0)	gG-100	gG-150	NZMB2-A200	150
	45.0 (60.0)	gG-160	gG-160		



Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
C4	55.0 (75.0)	aR-200	aR-250	NZMB2-A250	250
	75.0 (100.0)	aR-250			

Table 44: 525–600 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A2	0-75-4.0 (1.0-5.0)	gG-10	gG-25	PKZM0-25	25
A3	5.5 (7.5)	gG-10	gG-32	PKZM0-25	25
	7.5 (10.0)	gG-16			
A5	5.5 (7.5)	gG-10	gG-32	PKZM0-25	25
	7.5 (10.0)	gG-16			
B1	11.0 (15.0)	gG-25	gG-80	PKZM4-63	63
	15.0 (20.0)	gG-32			
	18.5 (25.0)	gG-40			
B2	22.0 (30.0)	gG-50	gG-100	NZMB1-A100	100
	30.0 (40.0)	gG-63			
B3	11.0 (15.0)	gG-25	gG-63	PKZM4-50	50
	15.0 (20.0)	gG-32			
B4	18.5 (25.0)	gG-40	gG-125	NZMB1-A100	100
	22.0 (30.0)	gG-50			
	30.0 (40.0)	gG-63			
C1	37.0 (50.0)	gG-63	gG-160	NZMB2-A200	160
	45.0 (60.0)	gG-100			
	55.0 (60.0)	aR-160			
C2	75.0 (100.0)	aR-200	aR-250	NZMB2-A250	250
C3	37.0 (50.0)	gG-63	gG-150	NZMB2-A200	150
	45.0 (60.0)	gG-100	gG-150	NZMB2-A200	
C4	55.0 (75.0)	aR-160	aR-250	NZMB2-A250	250
	75.0 (100.0)	aR-200			

Table 45: 525–690 V, Enclosure Sizes A, B, and C

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
A3	1.1 (1.5)	gG-6	gG-25	PKZM0-16	16
	1.5 (2.0)	gG-6	gG-25		

Enclosure	Power [kW (hp)]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker Moeller	Maximum trip level [A]
	2.2 (3.0)	gG-6	gG-25		
	3.0 (4.0)	gG-10	gG-25		
	4.0 (5.0)	gG-10	gG-25		
	5.5 (7.5)	gG-16	gG-25		
	7.5 (10.0)	gG-16	gG-25		
B2/B4	11.0 (15.0)	gG-25	gG-63	-	-
	15.0 (20.0)	gG-32			
	18.5 (25.0)	gG-32			
	22.0 (30.0)	gG-40			
B4/C2	30.0 (40.0)	gG-63	gG-80	-	-
C2/C3	37.0 (50.0)	gG-63	gG-100	-	-
	45.0 (60.0)	gG-80	gG-125		
C2	55.0 (75.0)	gG-100	gG-160	-	-
	75.0 (100.0)	gG-125			

### 8.7.3 UL Compliance

Fuse classification for UL Compliance

**NOTICE**

**UL COMPLIANCE**

To comply with NEC 2017, it is mandatory to use fuses or circuit breakers. Danfoss recommends using a selection of the fuses listed in the following tables. These fuses are suitable for use on a circuit capable of delivering 100000 A<sub>rms</sub> (symmetrical), 240 V, 480 V, 500 V, or 600 V depending on the drive voltage rating. With the proper fusing, the drive short circuit current rating (SCCR) is 10000 A<sub>rms</sub>.

For semiconductor fuse types, the drive controller and the overcurrent protection device must be integrated within the same overall assembly.

Table 46: UL Fuse Classification Chart

UL class	Fuse overload characteristics	Interrupting rating [A]	AC voltage rating [V]	Available ampere rating
RK1	Ultra fast-acting	200.000	250 600	1–600
T	Fast-acting	200.000	300 600	1–1.200
J	Fast-acting	200.000	600	1–600
CC	Fast acting	200.000	600	5–30

Table 47: Recommended Maximum UL Fuse Class, Voltage Range 3x200–240 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	Class fuses		Semiconductor fuses			
	RK1/J/T [A]	CC [A]	SIBA	Littelfuse	Ferraz-Shawmut (Mersen)	Bussmann (Eaton)
0.25–0.37 (0.34–0.5)	5	5	5017906-005	–	–	FWX-5
0.55–1.1 (0.75–1.5)	10	10	5017906-010	–	–	FWX-10
1.5 (2.0)	15	15	5017906-016	–	–	FWX-15
2.2 (3.0)	20	20	5017906-020	–	–	FWX-20
3.0 (4.0)	25	25	5017906-025	–	–	FWX-25
3.7 (5.0)	30	30	5012406-032	–	–	FWX-30
5.5 (7.5)	50	–	5014006-050	–	–	FWX-50
7.5 (10.0)	60	–	5014006-063	–	–	FWX-60
11.0 (15.0)	80	–	5014006-080	–	–	FWX-80
15–18.5 (20.0–25.0)	125	–	2028220-125	–	–	FWX-125
22.0 (30.0)	150	–	2028220-150	L25S-150	A25X-150	FWX-150
30.0 (40.0)	200	–	2028220-200	L25S-200	A25X-200	FWX-200
37.0 (50.0)	250	–	2028220-250	L25S-250	A25X-250	FWX-250

Table 48: Recommended Maximum UL Fuse Class, Voltage Range 380–500 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	Class fuses		Semiconductor fuses			
	RK1/J/T [A]	CC [A]	SIBA	Littelfuse	Ferraz-Shawmut (Mersen)	Bussmann (Eaton)
0.37–1.1 (0.5–1.5)	6	6	5017906-006	–	–	FWH-6
1.5–2.2 (2.0–3.0)	10	10	5017906-010	–	–	FWH-10
3.0 (4.0)	15	15	5017906-016	–	–	FWH-15
4.0 (5.0)	20	20	5017906-020	–	–	FWH-20
5.5 (7.5)	25	25	5017906-025	–	–	FWH-25
7.5 (10.0)	30	30	5012406-032	–	–	FWH-30
11.0 (15.0)	40	–	5014006-040	–	–	FWH-40
15.0 (20.0)	50	–	5014006-050	–	–	FWH-50
18.5 (25.0)	60	–	5014006-063	–	–	FWH-60
22.0 (30.0)	80	–	2028220-100	–	–	FWH-80
30.0 (40.0)	100	–	2028220-125	–	–	FWH-100
37.0 (50.0)	125	–	2028220-125	–	–	FWH-125
45.0 (60.0)	150	–	2028220-160	–	–	FWH-150
55.0 (75.0)	200	–	2028220-200	L50-S-225	A50-P-225	FWH-200
75.0 (100.0)	250	–	2028220-250	L50-S-250	A50-P-250	FWH-250

Table 49: Recommended Maximum UL Fuse Class, Voltage Range 525–690 V, Enclosure Sizes A, B, and C

Power [kW (hp)]	Class fuses		Semiconductor fuses
	RK1/J/T [A]	CC [A]	SIBA
1.1 (1.5)	5 <sup>(1)</sup>	5	5017906-005
1.5–2.2 (2.0–3.0)	10	10	5017906-010
3.0 (4.0)	15	15	5017906-016
4.0 (5.0)	20	20	5017906-020
5.5 (7.5)	25	25	5017906-025
7.5 (10.0)	30	30	5017906-030
11.0 (15.0)	35	–	5014006-040
15.0 (20.0)	45	–	5014006-050
18.5 (25.0)	50	–	5014006-050
22.0 (30.0)	60	–	5014006-063
30.0 (40.0)	80	–	5014006-080
37.0 (50.0)	100	–	5014006-100
45.0 (60.0)	125	–	2028220-125
55.0 (75.0)	150	–	2028220-150
75.0 (100.0)	175	–	2028220-200

<sup>1</sup> Bussmann Class T allowed up to 6 A.

Table 50: External (Customer Supplied) Branch Circuit Protection

Enclosure sizes	Enclosure <sup>(1)</sup>	Voltage	Power [kW (hp)] HO	Maximum interrupting rating for listed circuit breakers	Maximum ampere rating	Further information
A4/A5	Type 12, 4X	380–500 V (T5)	0.37 (0.5), 0.55 (0.75), 0.75 (1), 1.1 (1.5), 2.2 (3), 3.0 (4), 4.0 (5), 5.5 (7.5), 7.5 (10)	100 kA (at 480 V)	25 A	Any UL 489 listed circuit breaker maximum 25 A.
A5	Type 12, 4X	200–240 V (T2)	3.0 (4), 3.7 (5)	Specific type	25 A	ABB MS165–25 480 V/277 Y 65 kA
A5	Type 12, 4X	380–500 V (T5)	5.5 (7.5), 7.5 (10)	Specific type	25 A	ABB MS165–25 480 V/277 Y 65 kA
A5	Type 12, 4X	525–600 V (T6)	4.0 (5), 5.5 (7.5), 7.5 (10)	Specific type	25 A	ABB MS165–25 600 V/347 Y 30 kA
B1	Type 12, 4X	200–240 V (T2)	7.5 (15), 11.0 (20)	Specific type	40..54 A	ABB MS165–54 480 V/277 Y 65 kA
B1	Type 12, 4X	380–500 V (T5)	11.0 (15), 15.0 (20), 18.0 (25)	Specific type	40..54 A	ABB MS165–54 480 V/277 Y 65 kA

Enclosure sizes	Enclosure <sup>(1)</sup>	Voltage	Power [kW (hp)] HO	Maximum interrupting rating for listed circuit breakers	Maximum ampere rating	Further information
B1	Type 12, 4X	380–500 V (T5)	11.0 (15), 15.0 (20), 18.0 (25)	100 kA	60 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.
B1	Type 12, 4X	525–600 V (T6)	11.0 (15), 15.0 (20), 18.0 (25)	50 kA	40 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.
B2	Type 12, 4X	380–500 V (T5)	22.0 (30), 30.0 (40)	100 kA	100 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.
B2	Type 12, 4X	525–600 V (T6)	22.0 (30), 30.0 (40)	100 kA	60 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.
C1	Type 12, 4X	380–500 V (T5)	37.0 (50), 45.0 (60), 55.0 (75)	100 kA	200 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.
C2	Type 12, 4X	380–500 V (T5)	75.0 (100)	100 kA	250 A	Any UL 489 circuit breaker type with maximum interrupt rating and maximum ampere rating i list.

<sup>1</sup> Only type 12 and 4X enclosures can be used. Not valid for open type (IP20) or type 1 (IP21) units.

## NOTICE

UL Compliance only 525–600 V.

## 8.8 Connection Tightening Torques

Table 51: Tightening Torque for Cables

Enclosure size	200–240 V [kW (hp)]	380–500 V [kW (hp)]	525–690 V [kW (hp)]	Purpose	Tightening torque [Nm] [(in-lb)]
A2	0.25–2.2 (0.34–3.0)	0.37–4 (0.5– 5.0)	–	Mains, brake resistor, load sharing, motor cables.	0.5–0.6 (4.4–5.3)
A3	3–3.7 (4.0– 5.0)	5.5–7.5 (7.5–10.0)	1.1–7.5 (1.5–10.0)		
A4	0.25–2.2 (0.34–3.0)	0.37–4 (0.5– 5.0)	–		
A5	3–3.7 (4.0– 5.0)	5.5–7.5 (7.5–10.0)	–		
B1	5.5–7.5 (7.5–10.0)	11–15 (15–20)	–	Mains, brake resistor, load sharing, motor cables.	1.8 (15.9)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
B2	18.5–22 (25–30)	11–22 (15– 30)	11–22 (15– 30)	Mains, brake resistor, load sharing cables.	4.5 (39.8)
				Motor cables.	4.5 (39.8)

Enclosure size	200–240 V [kW (hp)]	380–500 V [kW (hp)]	525–690 V [kW (hp)]	Purpose	Tightening torque [Nm] ([in-lb])
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
B3	5.5–7.5 (7.5–10.0)	11–15 (15–20)	–	Mains, brake resistor, load sharing, motor cables.	1.8 (15.9)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
B4	11–15 (15–20)	18.5–30 (25–40)	11–30 (15–40)	Mains, brake resistor, load sharing, motor cables.	4.5 (39.8)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C1	15–22 (20–30)	30–45 (40–60)	–	Mains, brake resistor, load sharing cables.	10 (89)
				Motor cables.	10 (89)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C2	30–37 (40–50)	55–75 (75–100)	30–75 (40–100)	Mains, motor cables.	14 (124) (up to 95 mm <sup>2</sup> (3 AWG)) 24 (212) (over 95 mm <sup>2</sup> (3 AWG))
				Load sharing, brake cables.	14 (124)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C3	18.5–22 (25–30)	30–37 (40–50)	37–45 (50–60)	Mains, brake resistor, load sharing, motor cables.	10 (89)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)
C4	37–45 (50–60)	55–75 (75–100)	11–22 (15–30)	Mains, motor cables.	14 (124) (up to 95 mm <sup>2</sup> (3 AWG)) 24 (212) (over 95 mm <sup>2</sup> (3 AWG))
				Load sharing, brake cables.	14 (124)
				Relay.	0.5–0.6 (4.4–5.3)
				Ground.	2–3 (17.7–26.6)

## 8.9 Power Ratings, Weight, and Dimensions

Table 52: Power Ratings, Weight, and Dimensions, Enclosure Size A

Enclosure size		A1	A2		A3		A4	A5
Rated power [kW (hp)]	200–240 V	0.25–1.5 (0.34–2)	0.25–2.2 (0.34–3)		3–3.7 (4–5)		0.25–2.2 (0.34–3)	0.25–3.7 (0.34–5)
	380–480/500 V	0.37–1.5 (0.5–2)	0.37–4 (0.5–5)		5.5–7.5 (7.5–10)		0.37–4 (0.5–5)	0.37–7.5 (0.5–10)
	525–600 V	–	–		0.75–7.5 (1–10)		–	0.75–7.5 (1–10)
	525–690 V	–	–		1.1–7.5 (1.5–10)		–	–
IP NEMA	–	20 Chassis	20 Chassis	21 Type 1	20 Chassis	21 Type 1	55/66 Type 12/4X	55/66 Type 12/4X
<b>Height [mm (in)]</b>								
Height of mounting plate	A <sup>(1)</sup>	200 (7.9)	268 (10.6)	375 (14.8)	268 (10.6)	375 (14.8)	390 (15.4)	420 (16.5)
Height with ground termination plate for fieldbus cables	A	316 (12.4)	374 (14.7)	–	374 (14.7)	–	–	–
Distance between mounting holes	a	190 (7.5)	257 (10.1)	350 (13.8)	257 (10.1)	350 (13.8)	401 (15.8)	402 (15.8)
<b>Width [mm (in)]</b>								
Width of mounting plate	B	75 (3)	90 (3.5)	90 (3.5)	130 (5.1)	130 (5.1)	200 (7.9)	242 (9.5)
Width of mounting plate with 1 C option	B	–	130 (5.1)	130 (5.1)	170 (6.7)	170 (6.7)	–	242 (9.5)
Width of mounting plate with 2 C options	B	–	150 (5.9)	150 (5.9)	190 (7.5)	190 (7.5)	–	242 (9.5)
Distance between mounting holes	b	60 (2.4)	70 (2.8)	70 (2.8)	110 (4.3)	110 (4.3)	171 (6.7)	215 (8.5)
<b>Depth [mm (in)]</b>								
Depth without option A/B	C	207 (8.1)	205 (8.1)	207 (8.1)	205 (8.1)	207 (8.1)	175 (6.9)	200 (7.9)
With option A/B	C	222 (8.7)	220 (8.7)	222 (8.7)	220 (8.7)	222 (8.7)	175 (6.9)	200 (7.9)
<b>Screw holes [mm (in)]</b>								
	c	6.0 (0.24)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.0 (0.31)	8.25 (0.32)	8.25 (0.32)
	d	ø8 (ø0.31)	ø11 (ø0.43)	ø11 (ø0.43)	ø11 (ø0.43)	ø11 (ø0.43)	ø12 (ø0.47)	ø12 (ø0.47)
	e	ø5 (ø0.2)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø5.5 (ø0.22)	ø6.5 (ø0.26)	ø6.5 (ø0.26)
	f	5 (0.2)	9 (0.35)	9 (0.35)	6.5 (0.26)	6.5 (0.26)	6 (0.24)	9 (0.35)

Enclosure size	A1	A2		A3		A4	A5
Maximum weight [kg (lb)]	2.7 (6)	4.9 (10.8)	5.3 (11.7)	6.6 (14.6)	7 (15.4)	9.7 (21.4)	13.5/14.2 (30/31)
<b>Front cover tightening torque [Nm (in-lb)]</b>							
Plastic cover (low IP)	Click	Click		Click		–	–
Metal cover (IP55/66)	–	–		–		1.5 (13.3)	1.5 (13.3)

<sup>1</sup> See [Illustration 21](#) and [Illustration 22](#).

Table 53: Power Ratings, Weight, and Dimensions, Enclosure Size B

Enclosure size		B1	B2	B3	B4
Rated power [kW (hp)]	200–240 V	5.5–7.5 (7.5–10)	15	5.5–7.5 (7.5–10)	11–15 (15–20)
	380–480/500 V	11–15 (15–20)	18.5–22 (25–30)	11–15 (15–20)	18.5–30 (25–40)
	525–600 V	11–15 (15–20)	18.5–22 (25–30)	11–15 (15–20)	18.5–30 (25–40)
	525–690 V	–	11–22 (15–30)	–	11–30 (15–40)
IP NEMA	–	21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis
<b>Height [mm (in)]</b>					
Height of mounting plate	A <sup>(1)</sup>	480 (18.9)	650 (25.6)	399 (15.7)	520 (20.5)
Height with ground termination plate for fieldbus cables	A	–	–	420 (16.5)	595 (23.4)
Distance between mounting holes	a	454 (17.9)	624 (24.6)	380 (15)	495 (19.5)
<b>Width [mm (in)]</b>					
Width of mounting plate	B	242 (9.5)	242 (9.5)	165 (6.5)	230 (9.1)
Width of mounting plate with 1 C option	B	242 (9.5)	242 (9.5)	205 (8.1)	230 (9.1)
Width of mounting plate with 2 C options	B	242 (9.5)	242 (9.5)	225 (8.9)	230 (9.1)
Distance between mounting holes	b	210 (8.3)	210 (8.3)	140 (5.5)	200 (7.9)
<b>Depth [mm (in)]</b>					
Depth without option A/B	C	260 (10.2)	260 (10.2)	249 (9.8)	242 (9.5)
With option A/B	C	260 (10.2)	260 (10.2)	262 (10.3)	242 (9.5)
<b>Screw holes [mm (in)]</b>					
	c	12 (0.47)	12 (0.47)	8 (0.31)	–
	d	∅19 (∅0.75)	∅19 (∅0.75)	12 (0.47)	–
	e	∅9 (∅0.35)	∅9 (∅0.35)	6.8 (0.27)	8.5 (0.33)
	f	9 (0.35)	9 (0.35)	7.9 (0.31)	15 (0.59)



Enclosure size	B1	B2	B3	B4
Maximum weight [kg (lb)]	23 (51)	27 (60)	12 (26.5)	23.5 (52)
<b>Front cover tightening torque [Nm (in-lb)]</b>				
Plastic cover (low IP)	Click	Click	Click	Click
Metal cover (IP55/66)	2.2 (19.5)	2.2 (19.5)	–	–

<sup>1</sup> See [Illustration 21](#) and [Illustration 22](#).

Table 54: Power Ratings, Weight, and Dimensions, Enclosure Sizes C & D

Enclosure size		C1	C2	C3	C4	D3h
Rated power [kW (hp)]	200–240 V	15–22 (20–30)	30–37 (40–50)	18.5–22 (25–30)	30–37 (40–50)	–
	380–480/500 V	30–45 (40–60)	55–75 (75–100)	37–45 (50–60)	55–75 (75–100)	–
	525–600 V	30–45 (40–60)	55–90 (75–125)	37–45 (50–60)	55–90 (75–125)	–
	525–690 V	–	30–75 (40–100)	37–45 (50–60)	37–45 (50–60)	55–75 (75–100)
IP NEMA	–	21/55/66 Type 1/12/4X	21/55/66 Type 1/12/4X	20 Chassis	20 Chassis	20 Chassis
<b>Height [mm (in)]</b>						
Height of mounting plate	A <sup>(1)</sup>	680 (26.8)	770 (30.3)	550 (21.7)	660 (26)	909 (35.8)
Height with ground termination plate for fieldbus cables	A	–	–	630 (24.8)	800 (31.5)	–
Distance between mounting holes	a	648 (25.5)	739 (29.1)	521 (20.5)	631 (24.8)	–
<b>Width [mm (in)]</b>						
Width of mounting plate	B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	250 (9.8)
Width of mounting plate with 1 C option	B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	–
Width of mounting plate with 2 C options	B	308 (12.1)	370 (14.6)	308 (12.1)	370 (14.6)	–
Distance between mounting holes	b	272 (10.7)	334 (13.1)	270 (10.6)	330 (13)	–
<b>Depth [mm (in)]</b>						
Depth without option A/B	C	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)	375 (14.8)
With option A/B	C	310 (12.2)	335 (13.2)	333 (13.1)	333 (13.1)	375 (14.8)
<b>Screw holes [mm (in)]</b>						
	c	12.5 (0.49)	12.5 (0.49)	–	–	–
	d	ø19 (ø0.75)	ø19 (ø0.75)	–	–	–
	e	ø9 (ø0.35)	ø9 (ø0.35)	8.5 (0.33)	8.5 (0.33)	–

Enclosure size	C1	C2	C3	C4	D3h
f	9.8 (0.39)	9.8 (0.39)	17 (0.67)	17 (0.67)	–
Maximum weight [kg (lb)]	45 (99)	65 (143)	35 (77)	50 (110)	62 (137)
<b>Front cover tightening torque [Nm (in-lb)]</b>					
Plastic cover (low IP)	Click	Click	2 (17.7)	2 (17.7)	–
Metal cover (IP55/66)	2.2 (19.5)	2.2 (19.5)	2 (17.7)	2 (17.7)	–

<sup>1</sup> See [Illustration 21](#) and [Illustration 22](#).

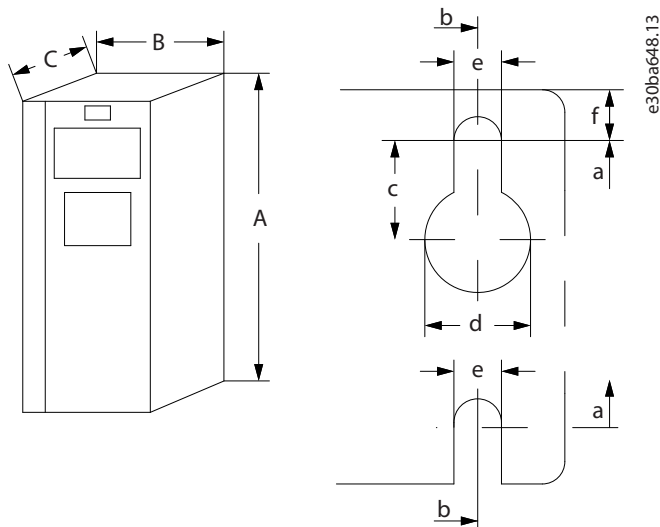


Illustration 21: Top and Bottom Mounting Holes

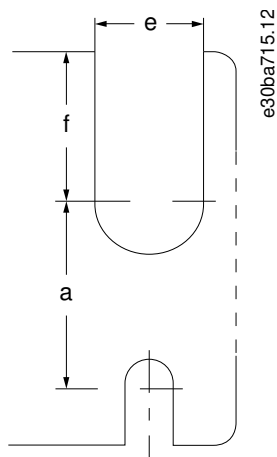


Illustration 22: Top and Bottom Mounting Holes, Enclosure Sizes B4, C3, and C4

## 9 Appendix

### 9.1 Symbols and Abbreviations

°C	Degrees Celsius
°F	Degrees Fahrenheit
AC	Alternating current
AEO	Automatic energy optimization
AWG	American wire gauge
AMA	Automatic motor adaptation
DC	Direct current
EMC	Electro-magnetic compatibility
ETR	Electronic thermal relay
$f_{M,N}$	Nominal motor frequency
$I_{INV}$	Rated inverter output current
$I_{LIM}$	Current limit
$I_{M,N}$	Nominal motor current
$I_{VLT,MAX}$	Maximum output current
$I_{VLT,N}$	Rated output current supplied by the drive
IP	Ingress protection
LCP	Local control panel
MCT	Motion control tool
$n_s$	Synchronous motor speed
$P_{M,N}$	Nominal motor power
PELV	Protective extra low voltage
PCB	Printed circuit board
PM motor	Permanent magnet motor
PWM	Pulse width motor
RPM	Revolutions per minute
Regen	Regenerative terminals
$T_{LIM}$	Torque limit
$U_{M,N}$	Nominal motor voltage

## Index

+	Dimensions, enclosure sizes C and D.....	86
+10 V DC output.....	Disconnect switch.....	22
<b>2</b>		
24 V DC output.....		74
<b>A</b>		
Abbreviations.....		88
AC input.....		19
AC mains.....		19
Access panel.....		18
Additional resources.....		6
Air cooling.....		13
Alarm.....		43
Alarms		
List of.....		44
AMA.....		24
Ambient conditions		
Specifications.....		71
Analog input.....		73
Analog output.....		74
Approvals and certifications.....		7
Automatic motor adaptation		
Wiring example.....		26
Preventing motor overheating.....		46
Alarms.....		54
Auxiliary equipment.....		20
<b>B</b>		
Backplate.....		14
Brake resistor.....		49, 49
Brake terminal.....		7
Brake wiring configuration.....		39
Burst transient.....		16
<b>C</b>		
Cable length, control cables.....		72
Cable routing.....		20
Cable specifications.....		72
Circuit breaker.....		76
Circuit breakers.....		21
Closed loop		
Basic set-up.....		25
Control card.....		74, 74, 74, 74
Control card performance.....		75
Control characteristics.....		75
Control wiring.....		15, 19, 20, 21
Cooling.....		13
Cooling clearance.....		13, 21
Cooling requirements.....		13
Cross-section, control cable.....		72
<b>D</b>		
DC overvoltage.....		45
Design guide.....		71
Digital input.....		72
Digital output.....		74
Dimensions, enclosure size A.....		84
Dimensions, enclosure size B.....		85
Dimensions, enclosure sizes C and D.....		86
Disconnect switch.....		22
<b>E</b>		
Electro-mechanical brake.....		20
EMC-compliant installation.....		15, 16
EN 60664-1.....		75
EN 61800-3.....		71
EN60664-1.....		70
Encoder feedback.....		24
Encoder input.....		73
Energy efficiency class.....		71
Environment.....		71
Exploded view.....		7
External alarm reset.....		35
External controller.....		6
External interlock.....		31, 55
<b>F</b>		
Fans		
Internal fault.....		48
External fault.....		49
Mixing fan fault.....		58
Feedback.....		20
Fieldbus		
Warning.....		50
Floating delta.....		19
Front cover tightening torque, enclosure size A.....		85
Front cover tightening torque, enclosure size B.....		86
Front cover tightening torque, enclosure sizes C and D.....		87
Fuse.....		15, 21, 76
Fuses		
Warning.....		51
<b>G</b>		
GLCP.....		23
Ground connection.....		21
Ground wire.....		15
Grounded delta.....		19
Grounding.....		19, 21, 22
Grounding principle.....		16
<b>H</b>		
Heat sink.....		49, 49, 52
Hoisting application.....		20
<b>I</b>		
IEC 60068-2-43.....		71
IEC 60364.....		76
IEC 61800-3.....		19, 71
IEC 721-3-3.....		71
Input current.....		19
Input disconnect.....		19
Input power.....		15, 19, 22, 43
Input power wiring.....		21
Input terminal.....		19, 22
Installation check list.....		20
Installation environment.....		13
Intended use.....		6, 6

Interference isolation.....	20
Isolated mains.....	19
Items supplied.....	12

**K**

Knockout.....	18
---------------	----

**L**

LCP.....	23
Leakage current.....	10, 15
Lifting.....	14
List of warnings and alarms.....	44

**M**

Mains	
Mains connection.....	19
Warning.....	45,51
Mains supply, 200–240 V.....	60, 60, 61
Mains supply, 380–500 V.....	62, 63, 64
Mains supply, 525–600 V.....	65, 65, 66
Mains supply, 525–690 V.....	67, 68, 69
Maintenance.....	43
Mechanical brake control.....	20, 39, 47
Motor	
Thermal protection.....	15
Motor power.....	15
Wiring thermistor.....	37
Warning.....	46,46,50,50,50
Motor cable.....	15, 82
Motor output.....	71
Motor overload protection.....	6
Motor status.....	6
Motor terminal.....	7
Motor wiring.....	20
Mounting.....	14
Mounting plate.....	14

**N**

Nameplate.....	12
NEC 2009.....	76

**O**

Open-loop speed control configurations.....	27
Output power wiring.....	21
Output terminal.....	22
Overcurrent protection.....	15

**P**

PELV.....	37
Phase imbalance.....	51
Power factor correction capacitor.....	20
Power rating, enclosure size B.....	85
Power ratings, enclosure size A.....	84
Power ratings, enclosure sizes C and D.....	86
Power wire connection.....	15
Pulse input.....	73
Pulse start/stop wiring configuration.....	34

**Q**

Qualified personnel.....	6, 9
--------------------------	------

**R**

Railings.....	14
Regen	
Wiring configuration.....	37
Relay output.....	75
Remote commands.....	6
Reset.....	43, 43, 56
RFI filter.....	19
RS485.....	36
RS485 serial communication.....	74
Run/stop command.....	32
Run/stop wiring configuration.....	31

**S**

Safe Torque Off.....	19
See STO	
Safe torque off	
Wiring of.....	33
Service.....	43
Shielded cable.....	18, 21
Shock.....	13
Short circuit	
Alarm.....	47
Speed reference.....	27
Start/stop command.....	33
STO.....	17, 19, 56, 56, 56, 57, 72
Storage.....	12
Supply voltage.....	19, 22, 70
Surveillance.....	6
Switches	
Disconnect.....	9,43
Symbols.....	9, 88
System feedback.....	6
System set-up.....	24

**T**

Thermal protection.....	8
Thermistor	
Wiring configuration.....	37,37
Warning.....	57
Thermistor control wiring.....	19
Torque	
Warning.....	46
Torque characteristics.....	71
Trip.....	43
Trip lock.....	43
Troubleshooting.....	44

**U**

UL certification.....	7
Unintended start.....	9, 43
USB serial communication.....	74

**V**

Vibration.....	13
Voltage	
Safety warning.....	9,22,48,50,50,50
Voltage level.....	72

**W**

Warning.....	43	Wire type and ratings.....	15
Warnings		Wiring configurations	
List of.....	44	Open loop.....	27
Website.....	6	Start/stop.....	33
Weight, enclosure size A.....	84	External alarm reset.....	35
Weight, enclosure size B.....	85	Thermistor.....	37
Weight, enclosure sizes C and D.....	86	Regen.....	37
Wire size.....	15	Wiring schematic.....	17

**Danfoss A/S**  
Ulsnaes 1  
DK-6300 Graasten  
[vlt-drives.danfoss.com](http://vlt-drives.danfoss.com)

---

Danfoss can accept no responsibility for possible errors in catalogs, brochures and other printed material. Danfoss reserves the right to alter its products without notice. This also applies to products already on order provided that such alterations can be made without subsequential changes being necessary in specifications already agreed. All trademarks in this material are property of the respective companies. Danfoss and the Danfoss logotype are trademarks of Danfoss A/S. All rights reserved.

---

