MAKING MODERN LIVING POSSIBLE

Instruction Manual

VLT® AQUA Drive FC 202

0.25–90 kW

www.DanfossDrives.com

VLT®
THE REAL DRIVE

Contents

1 Introduction

1.1 Purpose of the Manual

This instruction manual provides information for safe installation and commissioning of the adjustable frequency drive.

This instruction manual is intended for use by qualified personnel.
Read and follow the instruction manual to use the adjustable frequency drive safely and professionally, and pay particular attention to the safety instructions and general warnings. Keep this instruction manual available with the adjustable frequency drive at all times.

1.2 Additional Resources

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

- The *VLT® Programming Guide* provides greater detail on working with parameters and many application examples.
- The *VLT® Design Guide* provides detailed information about capabilities and functionality to design motor control systems.
- Instructions for operation with optional equipment.

Supplementary publications and manuals are available from Danfoss. See *www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/VLT+Technical+Documentation.htm* for listings.

1.3 Document and Software Version

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

Edition	Remarks	Software version
MG20MAxx	Replaces MG20M9xx	2.xx

Table 1.1 Document and Software Version

1.4 Product Overview

1.4.1 Intended Use

The adjustable frequency 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 adjustable frequency drive, the motor, and equipment driven by the motor.
- system and motor status surveillance.

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

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

Single phase adjustable frequency drives (S2 and S4) installed in the EU
The following limitations apply:
Units with an input current below 16 A and an input power above 1 kW are only intended for professional use in trades, professions, or industries and not for sale to the general public. Designated application areas are public pools, public water supplies, agriculture, commercial buildings, and industries. All other single phase units are only intended for use in private low-voltage systems interfacing with public supply only at a medium or high voltage level. Operators of private systems must ensure that the EMC environment complies with IEC 610000-3-6 and/or the contractual agreements.

NOTICE!

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

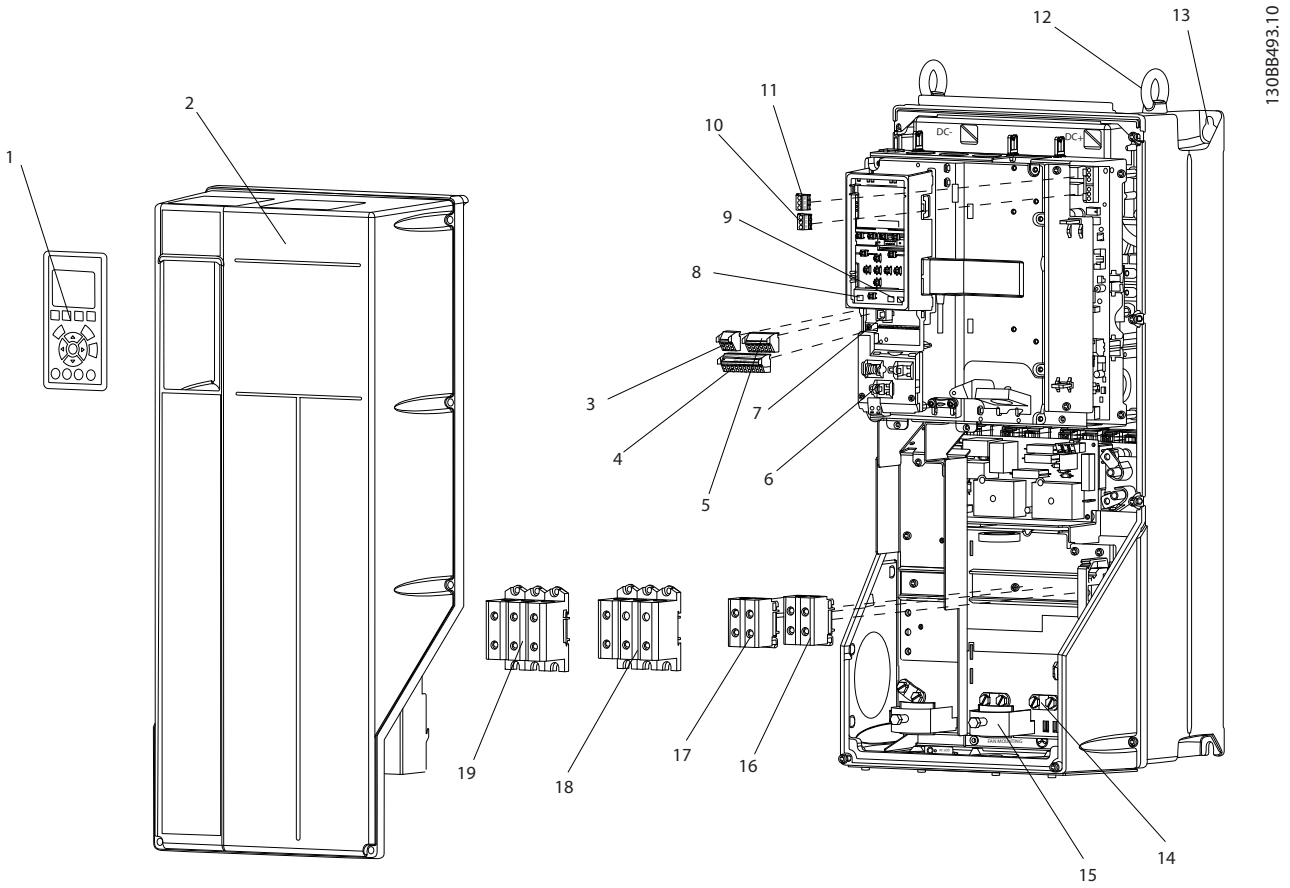
Foreseeable misuse
Do not use the adjustable frequency drive in applications which are non-compliant with specified operating conditions and environments. Ensure compliance with the conditions specified in *chapter 8 Specifications*.

1.4.2 Features

The VLT® AQUA Drive FC 202 is designed for water and wastewater applications. The range of standard and optional features includes:

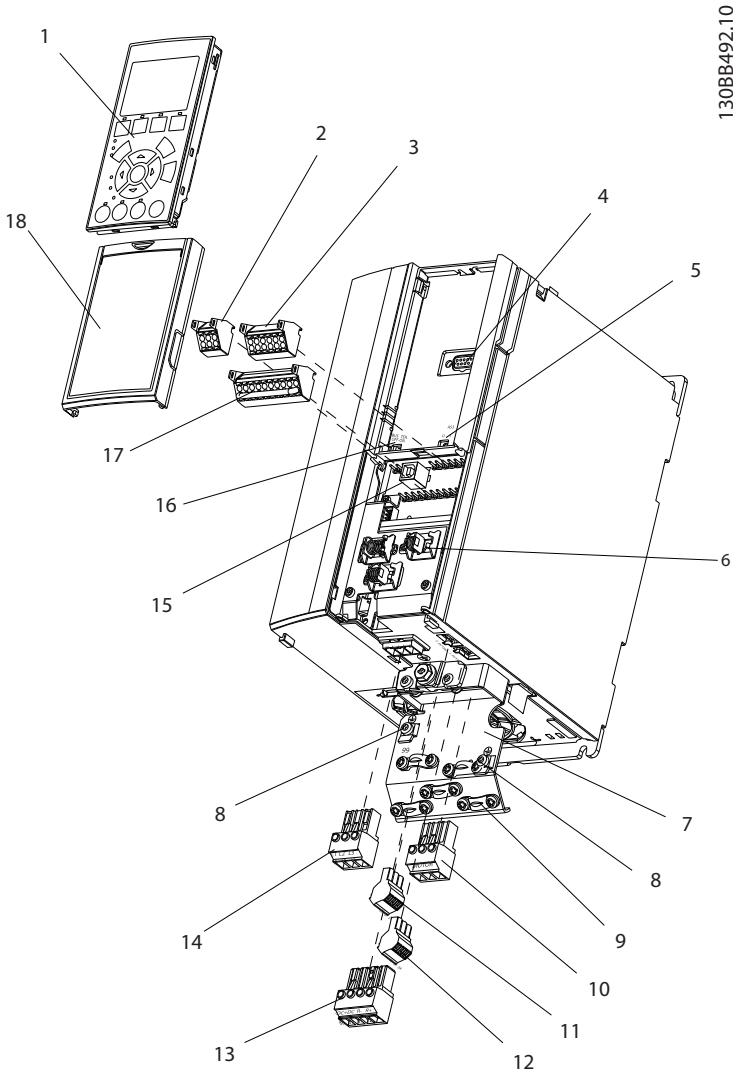
- Cascade control
- Dry run detection
- End of curve detection
- Motor alternation
- Deragging
- 2-step ramps
- Check valve protection
- Safe Torque Off
- Low flow detection
- Pipe fill mode
- Sleep mode
- Real time clock
- Password protection
- Overload protection
- Smart logic control

1.4.3 Exploded Views



1	Local control panel (LCP)	11	Relay 2 (04, 05, 06)
2	Cover	12	Lifting ring
3	RS-485 serial bus connector	13	Mounting slot
4	Digital I/O and 24 V power supply	14	Grounding clamp (PE)
5	Analog I/O connector	15	Cable shield connector
6	Cable shield connector	16	Brake terminal (-81, +82)
7	USB connector	17	Load sharing terminal (DC bus) (-88, +89)
8	Serial bus terminal switch	18	Motor output terminals 96 (U), 97 (V), 98 (W)
9	Analog switches (A53), (A54)	19	Line power input terminals 91 (L1), 92 (L2), 93 (L3)
10	Relay 1 (01, 02, 03)		

Figure 1.1 Exploded View Enclosure Types B and C, IP55 and IP66



1	Local control panel (LCP)	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS-485 serial bus connector (+68, -69)	11	Relay 2 (01, 02, 03)
3	Analog I/O connector	12	Relay 1 (04, 05, 06)
4	LCP input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Line power input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable shield connector	15	USB connector
7	Decoupling plate	16	Serial bus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V power supply
9	Shielded cable grounding clamp and strain relief	18	Cover

Figure 1.2 Exploded View Enclosure Type A, IP20

1.4.4 Block Diagram of the Adjustable Frequency Drive

Figure 1.3 is a block diagram of the internal components of the adjustable frequency drive. See *Table 1.2* for their functions.

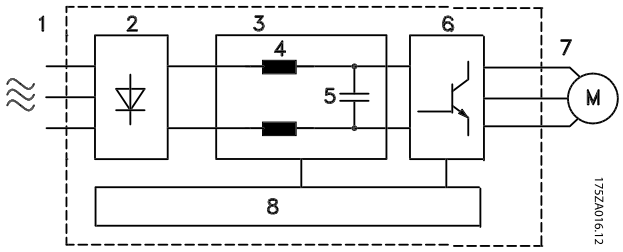


Figure 1.3 Adjustable Frequency Drive Block Diagram

Area	Title	Functions
1	Line power input	• 3-phase AC line power supply to the adjustable frequency drive
2	Rectifier	• The rectifier bridge converts the AC input to DC current to supply inverter power
3	DC bus	• Intermediate DC bus circuit handles the DC current
4	DC reactors	• Filter the intermediate DC circuit voltage • Prove line transient protection • Reduce RMS current • Raise the power factor reflected back to the line • Reduce harmonics on the AC input
5	Capacitor bank	• Stores the DC power • Provides ride-through protection for short power losses
6	Inverter	• Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor
7	Output to motor	• Regulated 3-phase output power to the motor
8	Control circuitry	• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control • User interface and external commands are monitored and performed • Status output and control can be provided

Table 1.2 Legend to *Figure 1.3*

1.4.5 Enclosure Types and Power Ratings

For enclosure types and power ratings of the adjustable frequency drives, refer to *chapter 8.9 Power Ratings, Weight and Dimensions*.

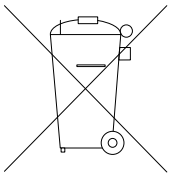
1.5 Approvals and Certifications

Table 1.3 Approvals and Certifications

More approvals and certifications are available. Contact local Danfoss partner. Adjustable frequency drives of enclosure type T7 (525–690 V) are not certified for UL.

The adjustable frequency drive complies with UL508C thermal memory retention requirements. For more information, refer to the section *Motor Thermal Protection* in the *Design Guide*.

1.6 Disposal



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

Table 1.4 Disposal Instruction

2 Safety

2.1 Safety Symbols

The following symbols are used in this document:

⚠WARNING

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

⚠CAUTION

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

NOTICE!

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

2.2 Qualified Personnel

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

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

2.3 Safety Precautions

⚠WARNING

HIGH VOLTAGE

Adjustable frequency drives contain high voltage when connected to AC line power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- **Installation, start-up, and maintenance must be performed by qualified personnel only.**

⚠WARNING

UNINTENDED START

When the adjustable frequency drive is connected to AC line power, the motor may start at any time, causing risk of death, serious injury, equipment, or property damage. The motor can start by means of an external switch, a serial bus command, an input reference signal from the LCP or LOP, or after a cleared fault condition.

- **Disconnect the adjustable frequency drive from line power whenever personal safety considerations make it necessary to avoid unintended motor start.**
- **Press [Off] on the LCP before programming parameters.**
- **The adjustable frequency drive, motor, and any driven equipment must be in operational readiness when the adjustable frequency drive is connected to AC line power.**

2

⚠WARNING

DISCHARGE TIME

The adjustable frequency drive contains DC link capacitors which can remain charged even when the adjustable frequency drive is not powered. Failure to wait the specified time after power has been removed before performing service or repair work, could result in death or serious injury.

1. **Stop motor.**
2. **Disconnect AC line power, permanent magnet type motors, and remote DC link power supplies, including battery backups, UPS, and DC link connections to other adjustable frequency drives.**
3. **Wait for the capacitors to discharge fully before performing any service or repair work. The duration of waiting time is specified in *Table 2.1*.**

Voltage [V]	Minimum waiting time [minutes]		
	4	7	15
200–240	0.34–5 hp [0.25–3.7 kW]		7.5–60 hp [5.5–45 kW]
380–480	0.5–10 hp [0.37–7.5 kW]		15–125 hp [11–90 kW]
525–600	1–10 hp [0.75–7.5 kW]		15–125 hp [11–90 kW]
525–690		1.5–10 hp [1.1–7.5 kW]	15–125 hp [11–90 kW]
High voltage may be present even when the warning LED indicator lights are off.			

Table 2.1 Discharge Time

⚠WARNING

LEAKAGE CURRENT HAZARD

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

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

⚠WARNING

EQUIPMENT HAZARD

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

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

⚠CAUTION

WINDMILLING

Unintended rotation of permanent magnet motors causes risk of personal injury and equipment damage.

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

⚠CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

Risk of personal injury when the adjustable frequency drive is not properly closed.

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

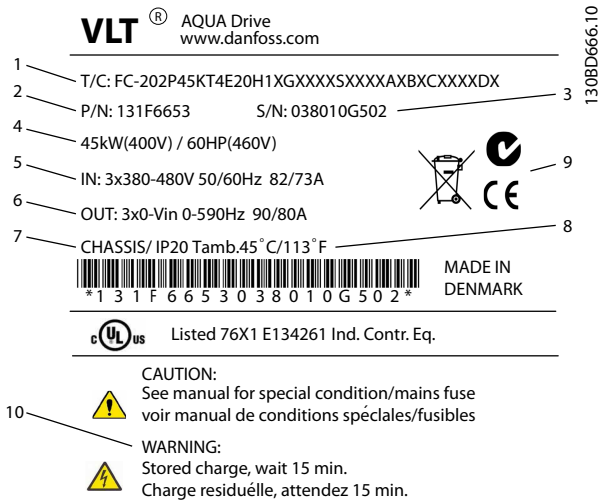
3 Mechanical Installation

3.1 Unpacking

3.1.1 Items Supplied

Items supplied may vary according to product configuration.

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



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

Figure 3.1 Product Nameplate (Example)

NOTICE!

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

3.1.2 Storage

Ensure that requirements for storage are fulfilled. Refer to *chapter 8.4 Ambient Conditions* for further details.

3.2 Installation Environments

NOTICE!

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 adjustable frequency drive. Ensure that requirements for air humidity, temperature and altitude are met.

Vibration and Shock

The adjustable frequency drive complies with requirements for units mounted on the walls and floors of production premises, as well as in panels bolted to walls or floors.

For detailed ambient conditions specifications, refer to *chapter 8.4 Ambient Conditions*.

3

3.3 Mounting

NOTICE!

Improper mounting can result in overheating and reduced performance.

Cooling

- Ensure that top and bottom clearance for air cooling is provided. See *Figure 3.2* for clearance requirements.

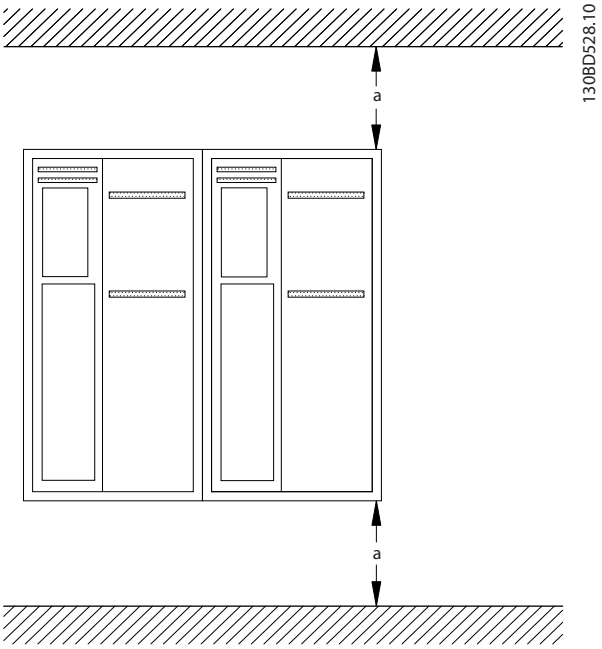


Figure 3.2 Top and Bottom Cooling Clearance

Enclosure	A2-A5	B1-B4	C1, C3	C2, C4
a (ins [mm])	3.94 [100]	7.87 [200]	7.87 [200]	8.86 [225]

Table 3.1 Minimum Airflow Clearance Requirements

Lifting

- To determine a safe lifting method, check the weight of the unit, see *chapter 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.

Mounting

1. Ensure that the strength of the mounting location supports the unit weight. The adjustable frequency 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 mounting, when provided.

Mounting with backplate and railings

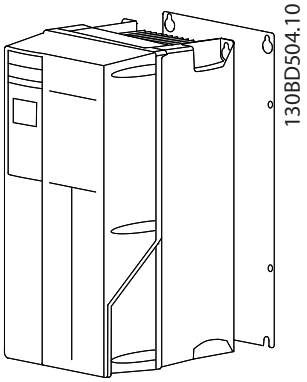


Figure 3.3 Proper Mounting with Backplate

NOTICE!

Backplate is required when mounted on railings.

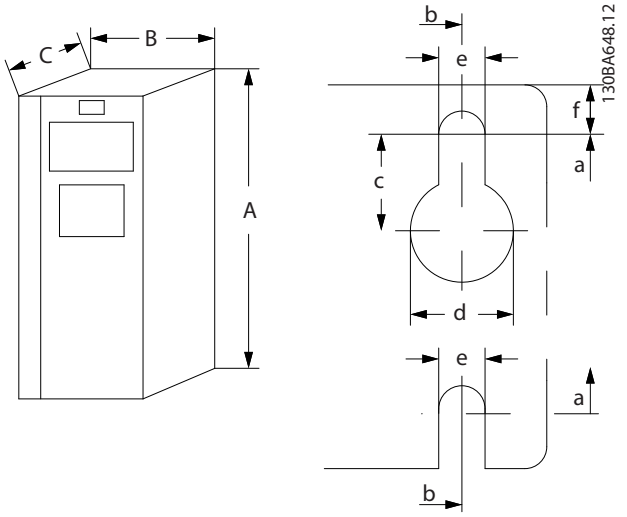


Figure 3.4 Top and Bottom Mounting Holes (See *chapter 8.9 Power Ratings, Weight and Dimensions*)

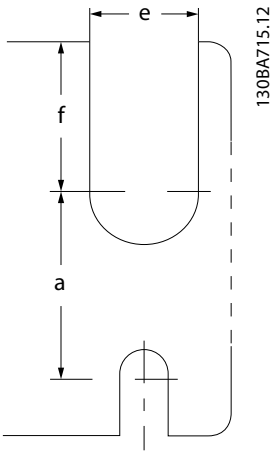


Figure 3.5 Top and Bottom Mounting Holes (B4, C3, C4)

4 Electrical Installation

4.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

4

⚠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 use shielded cables or metal conduits could result in death or serious injury.

- **run output motor cables separately, or**
- **use shielded cables or metal conduits**

⚠CAUTION

SHOCK HAZARD

The adjustable frequency drive can cause a DC current in the PE conductor. Failure to follow the recommendation below means the RCD may not provide the intended protection.

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

NOTICE!

The adjustable frequency drive is supplied with Class 20 motor overload protection.

Overcurrent Protection:

- Additional protective equipment such as short-circuit protection or motor thermal protection between adjustable frequency 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, fuses must be provided by the installer. See maximum fuse ratings in *chapter 8.8 Fuses and Circuit Breakers*.

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 167 °F [75 °C] rated copper wire.

See *chapter 8.1 Electrical Data* and *chapter 8.5 Cable Specifications* for recommended wire sizes and types.

4.2 EMC-compliant Installation

To obtain an EMC-compliant installation, follow the instructions provided in *chapter 4.3 Grounding*, *chapter 4.4 Wiring Schematic*, *chapter 4.6 Motor Connection*, and *chapter 4.8 Control Wiring*.

4.3 Grounding

⚠WARNING

LEAKAGE CURRENT HAZARD

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

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

For electrical safety

- Ground the adjustable frequency drive in accordance with applicable standards and directives.
- Use a dedicated ground wire for input power, motor power and control wiring.
- Do not ground one adjustable frequency drive to another in a “daisy chain” fashion.
- Keep the ground wire connections as short as possible.
- Follow the motor manufacturer wiring requirements.
- Minimum cable cross-section: AWG 7 [10 mm^2] (or two rated ground wires terminated separately).

For EMC-compliant installation

- Establish electrical contact between cable shield and adjustable frequency drive enclosure by using metal cable connectors or by using the clamps provided on the equipment (see *Figure 4.5* and *Figure 4.6*).
- Use high-strand wire to reduce electrical interference.
- Do not use pigtails.

NOTICE!

POTENTIAL EQUALIZATION!

Risk of electrical interference, when the ground potential between the adjustable frequency drive and the system is different. Install equalizing cables between the system components. Recommended cable cross-section: AWG 6 [16 mm^2].

4

4.4 Wiring Schematic

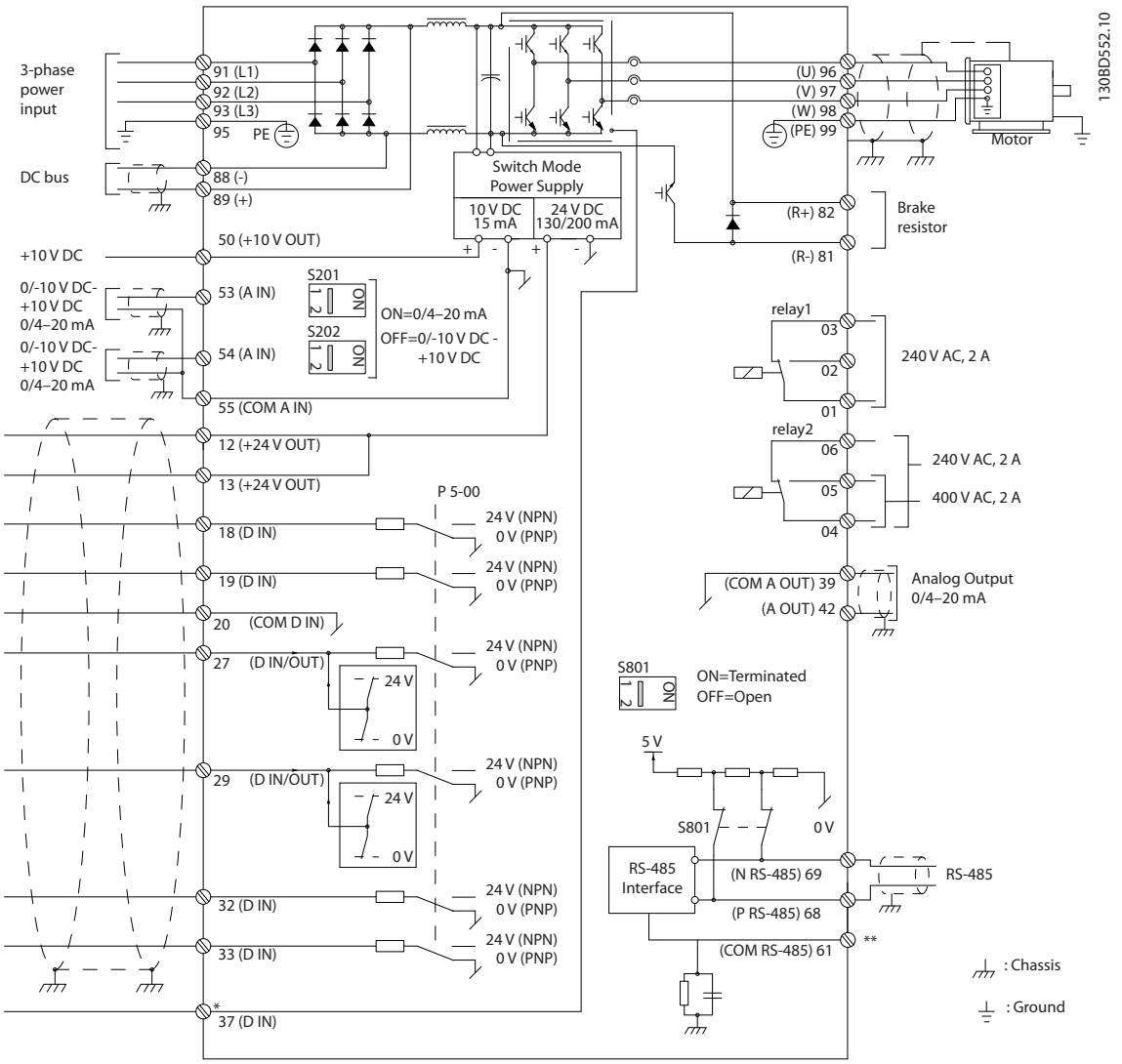


Figure 4.1 Basic Wiring Schematic

A=Analog, D=Digital

*Terminal 37 (optional) is used for Safe Torque Off. For Safe Torque Off installation instructions, refer to the *Safe Torque Off Instruction Manual for* Danfoss *VLT® Adjustable Frequency Drives*.

**Do not connect cable shield.

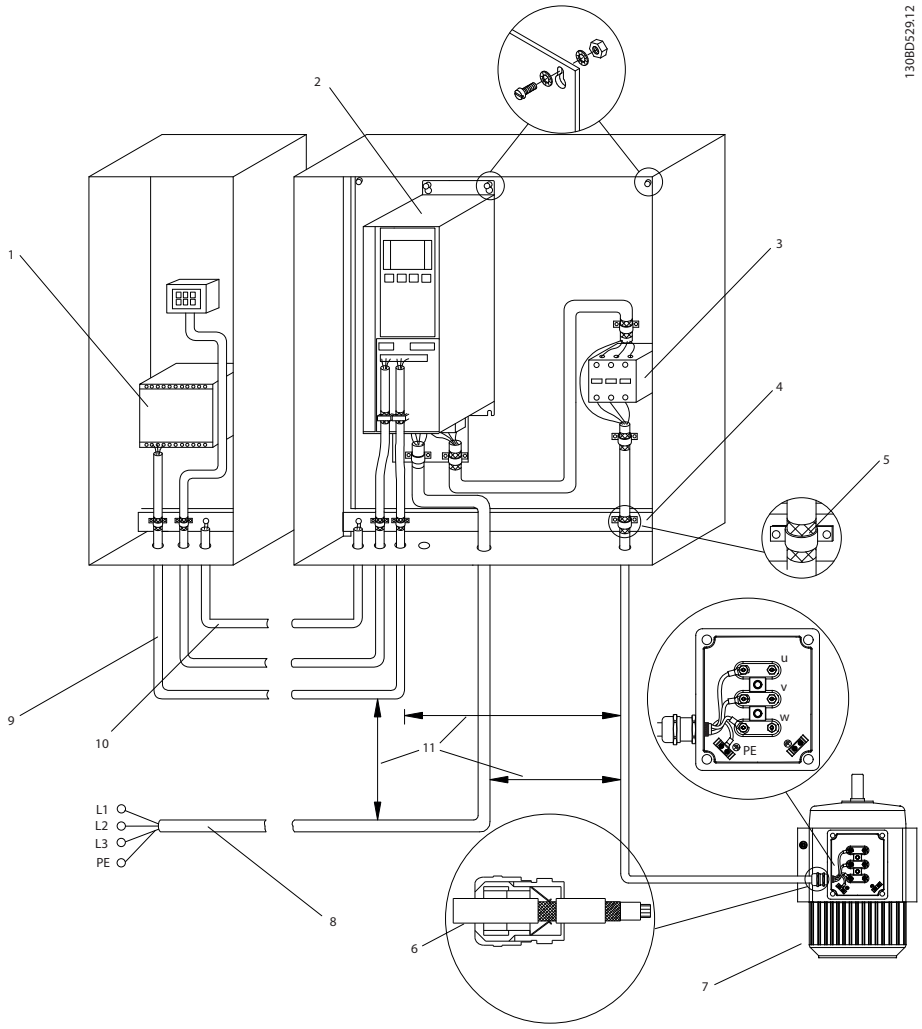


Figure 4.2 EMC-compliant Electrical Connection

1	PLC	6	Cable connector
2	Adjustable frequency drive	7	Motor, 3-phase and PE
3	Output contactor	8	Line power, 3-phase and reinforced PE
4	Grounding rail (PE)	9	Control wiring
5	Cable insulation (stripped)	10	Equalizing min. 0.025 in^2 [16 mm^2]

Table 4.1 Legend to *Figure 4.2*

NOTICE!

EMC INTERFERENCE!

Run cables for input power, motor wiring and control wiring in three separate metallic conduits. Failure to isolate power, motor and control cables can result in unintended behavior or reduced performance. Minimum 7.9 in [200 mm] clearance between power, motor and control cables is required.

4.5 Access

- Remove cover with a screwdriver (See *Figure 4.3*) or by loosening attaching screws (See *Figure 4.4*).

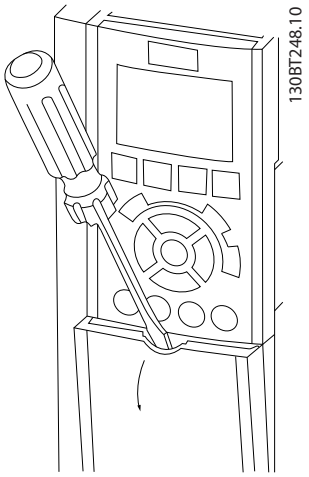


Figure 4.3 Access to Wiring for IP20 and IP21 Enclosures

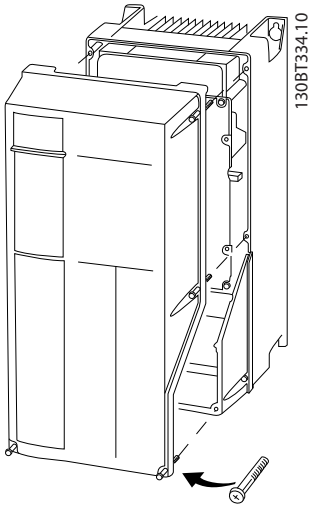


Figure 4.4 Access to Wiring for IP55 and IP66 Enclosures

See *Table 4.2* before tightening the covers.

Enclosure	IP55	IP66
A4/A5	2	2
B1/B2	2.2	2.2
C1/C2	2.2	2.2
No screws to tighten for A2/A3/B3/B4/C3/C4.		

Table 4.2 Tightening Torques for Covers [Nm]

4.6 Motor Connection

⚠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 use shielded cables or metal conduits could result in death or serious injury.

- **run output motor cables separately, or**
- **use shielded cables or metal conduits**

- Comply with local and national electrical codes for cable sizes. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Follow the motor manufacturer wiring requirements.
- Motor wiring knockouts or access panels are provided at the base of IP21 (NEMA1/12) and higher units.
- Do not wire a starting or pole-changing device (e.g., Dahlander motor or slip ring induction motor) between the adjustable frequency drive and the motor.

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 cable shield and ground.
3. Connect ground wire to the nearest grounding terminal in accordance with grounding instructions provided in *chapter 4.3 Grounding*, see *Figure 4.5*.
4. Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W), see *Figure 4.5*.
5. Tighten terminals in accordance with the information provided in *chapter 8.7 Connection Tightening Torques*.

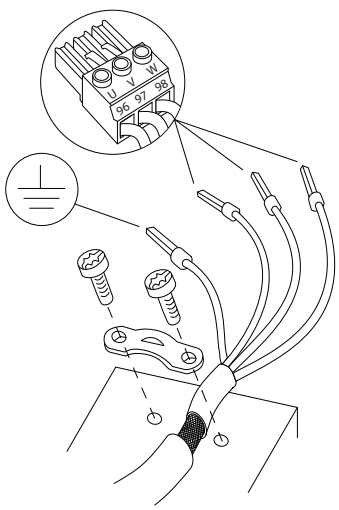


Figure 4.5 Motor Connection

Figure 4.6 represents line power input, motor, and grounding for basic adjustable frequency drives. Actual configurations vary with unit types and optional equipment.

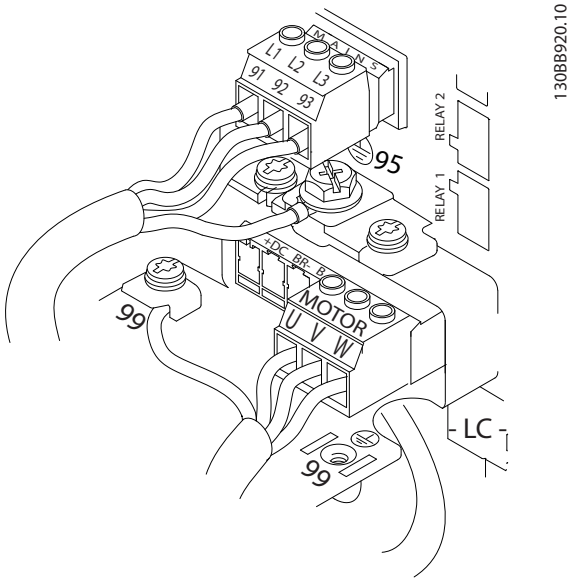


Figure 4.6 Example of Motor, Line Power and Ground Wiring

4.7 AC Line Input Connection

- Size wiring based upon the input current of the adjustable frequency drive. For maximum wire sizes, see *chapter 8.1 Electrical Data*.
- Comply with local and national electrical codes for cable sizes.

Procedure

1. Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Figure 4.6*).
2. Depending on the configuration of the equipment, input power is connected to the line power input terminals or the input disconnect.
3. Ground the cable in accordance with grounding instructions provided in *chapter 4.3 Grounding*.
4. When supplied from an isolated line power source (IT line power or floating delta) or TT/TN-S line power with a grounded leg (grounded delta), ensure that *14-50 RFI 1* is set to OFF to avoid damage to the intermediate circuit and to reduce ground capacity currents in accordance with IEC 61800-3.

4.8 Control Wiring

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

4.8.1 Control Terminal Types

Figure 4.7 and *Figure 4.8* show the removable adjustable frequency drive connectors. Terminal functions and default settings are summarized in *Table 4.3*.

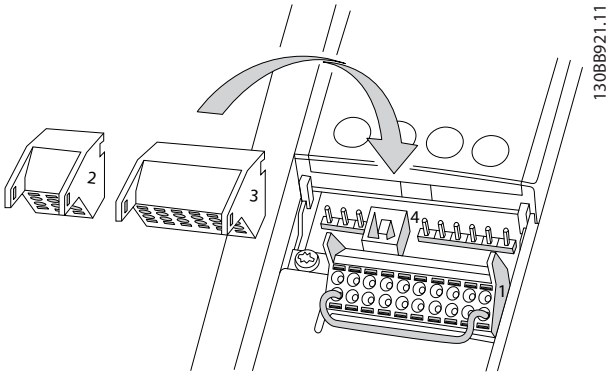


Figure 4.7 Control Terminal Locations

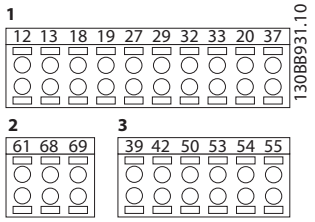


Figure 4.8 Terminal Numbers

- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24 V DC terminal supply voltage, and a common for optional customer supplied 24 V DC voltage.
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communication connection.
- **Connector 3** provides two analog inputs, one analog output, 10 V DC supply voltage, and commons for the inputs and output.
- **Connector 4** is a USB port available for use with the MCT 10 Set-up Software.

Terminal	Parameter	Default setting	Description
Terminal description			
Digital Inputs/Outputs			
12, 13	-	+24 V DC	24 V DC supply voltage for digital inputs and external transducers. Maximum output current 200 mA for all 24 V loads.
18	5-10	[8] Start	Digital inputs.
19	5-11	[0] No operation	
32	5-14	[0] No operation	
33	5-15	[0] No operation	
27	5-12	[2] Coast inverse	For digital input or output. Default setting is input.
29	5-13	[14] JOG	
20	-		Common for digital inputs and 0 V potential for 24 V supply.
37	-	Safe Torque Off (STO)	Safe input (optional). Used for STO.
Analog Inputs/Outputs			
39	-		Common for analog output.
42	6-50	Speed 0 - High Limit	Programmable analog output. 0–20 mA or 4–20 mA at a maximum of 500 Ω.
50	-	+10 V DC	10 V DC analog supply voltage for potentiometer or thermistor. 15 mA maximum
53	6-1	Reference	Analog input. For voltage or current. Switches A53 and A54 select mA or V.
54	6-2	Feedback	
55	-		Common for analog input.
Serial Communication			
61	-		Integrated RC filter for cable shield. ONLY for connecting the shield in the event of EMC problems.
68 (+)	8-3		RS-485 Interface. A control card switch is provided for termination resistance.
69 (-)	8-3		
Relays			

Term-inal	Parameter	Default setting	Description
01, 02, 03	5-40 [0]	[9] Alarm	Form C relay output. For AC or DC voltage and resistive or inductive loads.
04, 05, 06	5-40 [1]	[5] Running	

Table 4.3 Terminal Description

Additional terminals:

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

4.8.2 Wiring to Control Terminals

Control terminal connectors can be unplugged from the adjustable frequency drive for ease of installation, as shown in *Figure 4.7*.

NOTICE!

Keep control wires as short as possible and separate from high power cables to minimize interference.

1. Open the contact by inserting a small screwdriver into the slot above the contact and push the screwdriver slightly upwards.

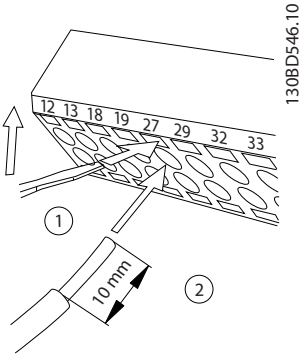


Figure 4.9 Connecting Control Wires

2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See *chapter 8.5 Cable Specifications* for control terminal wiring sizes and *chapter 6 Application Set-up Examples* for typical control wiring connections.

4.8.3 Enabling Motor Operation (Terminal 27)

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

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

NOTICE!

The adjustable frequency drive cannot operate without a signal on terminal 27 unless terminal 27 is re-programmed.

4.8.4 Voltage/Current Input Selection (Switches)

The analog input terminals 53 and 54 allow setting of input signal to voltage (0–10 V) or current (0/4–20 mA).

Default parameter settings:

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

NOTICE!

Disconnect power to the adjustable frequency drive before changing switch positions.

1. Remove the local control panel (see *Figure 4.10*).
2. Remove any optional equipment covering the switches.
3. Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.

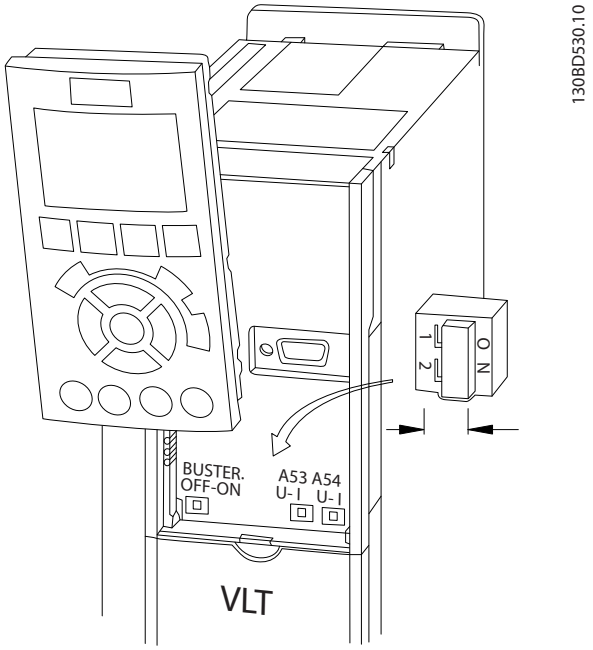


Figure 4.10 Location of Terminals 53 and 54 Switches

4.8.5 Safe Torque Off (STO)

To run Safe Torque Off, additional wiring for the adjustable frequency drive is required, refer to *Safe Torque Off Instruction Manual for* Danfoss *VLT® Adjustable Frequency Drives* for further information.

4.8.6 RS-485 Serial Communication

Connect RS-485 serial communication wiring to terminals (+)68 and (-)69.

- Use shielded serial communication cable (recommended)
- See *chapter 4.3 Grounding* for proper grounding

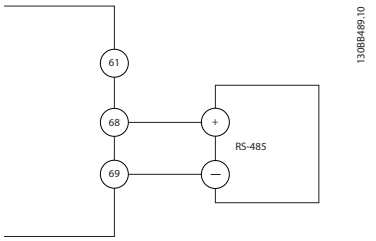


Figure 4.11 Serial Communication Wiring Diagram

For basic serial communication set-up, select the following:

1. Protocol type in *8-30 Protocol*.
2. Adjustable frequency drive address in *8-31 Address*.
3. Baud rate in *8-32 Baud Rate*.

- Two communication protocols are internal to the adjustable frequency drive.

  Danfoss FC

  Modbus RTU

- Functions can be programmed remotely using the protocol software and RS-485 connection or in parameter group 8-** Communications and Options.
- Selecting a specific communication protocol changes various default parameter settings to match that protocol's specifications along with making additional protocol-specific parameters available.
- Option cards which can be installed in the adjustable frequency drive are available to provide additional communication protocols. See the option-card documentation for installation and instruction manual.

4.9 Installation Check List

Before completing installation of the unit, inspect the entire installation as detailed in *Table 4.4*. Check and mark the items when completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on the input power side of the adjustable frequency drive or output side to the motor. Ensure that they are ready for full-speed operation. • Check function and installation of any sensors used for feedback to the adjustable frequency drive. • Remove any power factor correction caps on motor(s). • Adjust any power factor correction caps on the line power side and ensure that they are dampened.	
Cable routing	• Ensure that motor wiring and control wiring are separated or shielded or in three separate metallic conduits for high-frequency interference isolation.	
Control wiring	• Check for broken or damaged wires and loose connections. • Check that control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.	
Cooling clearance	• Measure that top and bottom clearance is adequate to ensure proper air flow for cooling, see *chapter 3.3 Mounting*.	
Ambient conditions	• Check that requirements for ambient conditions are met.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and are in operational condition and that all circuit breakers are in the open position.	
Grounding	• Check for sufficient ground connections that are tight and free of oxidation. • Grounding to conduit or mounting the back panel to a metal surface is not a suitable grounding.	
Input and output power wiring	• Check for loose connections. • Check that motor and line power are in separate conduits or separated shielded cables.	
Panel interior	• Make sure that the unit interior is free of dirt, metal chips, moisture, and corrosion. • Check that the unit is mounted on an unpainted, metal surface.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly or that shock mounts are used, as necessary. • Check for an unusual amount of vibration.	

Table 4.4 Installation Check List

⚠CAUTION

POTENTIAL HAZARD IN THE EVENT OF INTERNAL FAILURE

Risk of personal injury when the adjustable frequency drive is not properly closed.

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

5 Commissioning

5.1 Safety Instructions

See *chapter 2 Safety* for general safety instructions.

⚠WARNING

HIGH VOLTAGE

Adjustable frequency drives contain high voltage when connected to AC line power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- **Installation, start-up, and maintenance must be performed by qualified personnel only.**

Before applying power:

1. Close cover properly.
2. Check that all cable connectors are firmly tightened.
3. Ensure that input power to the unit is OFF and locked out. Do not rely on the adjustable frequency 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 ohm values on U-V (96-97), V-W (97-98), and W-U (98-96).
7. Check for proper grounding of the adjustable frequency drive as well as the motor.
8. Inspect the adjustable frequency drive for loose connections on terminals.
9. Confirm that the supply voltage matches voltage of adjustable frequency drive and motor.

5.2 Applying Power

⚠WARNING

UNINTENDED START

When the adjustable frequency drive is connected to AC line power, the motor may start at any time, causing risk of death, serious injury, equipment, or property damage. Examples: start by means of an external switch; via a serial bus command; via an input reference signal from the LCP or LOP; or after a cleared fault condition.

- **Disconnect the adjustable frequency drive from line power whenever personal safety considerations make it necessary to avoid unintended motor start.**
- **Press [Off] on the LCP before programming parameters.**
- **The adjustable frequency drive, motor, and any driven equipment must be in operational readiness when the adjustable frequency drive is connected to AC line power.**

1. Confirm that the input voltage is balanced within 3%. If not, correct input voltage imbalance before proceeding. Repeat this procedure after the voltage correction.
2. Ensure that optional equipment wiring (if present) matches the installation application.
3. Ensure that all operator devices are in the OFF position. Panel doors must be closed or cover mounted.
4. Apply power to the unit. DO NOT start the adjustable frequency drive at this time. For units with a disconnect switch, turn to the ON position to apply power to the adjustable frequency drive.

NOTICE!

If the status line at the bottom of the LCP reads AUTO REMOTE COASTING or *Alarm 60 External Interlock* is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27. See *chapter 4.8.3 Enabling Motor Operation (Terminal 27)* for details.

5.3 Local Control Panel Operation

5.3.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit.

The LCP has several user functions:

- Start, stop, and control speed when in local control
- Display operational data, status, warnings and cautions
- Programming adjustable frequency drive functions
- Manually reset the adjustable frequency drive after a fault when auto-reset is inactive

An optional numeric LCP (NLCP) is also available. The NLCP operates in a manner similar to the LCP. See the *Programming Guide* for details on use of the NLCP.

NOTICE!

For commissioning via PC, install MCT 10 Set-up Software. The software is available for download (basic version) or for ordering (advanced version, order number 130B1000). For more information and downloads, see *www.danfoss.com/BusinessAreas/DrivesSolutions/Software+MCT10/MCT10+Downloads.htm*.

5.3.2 LCP Layout

The LCP is divided into four functional groups (see *Figure 5.1*).

A. Display area

B. Display menu keys

C. Navigation keys and indicator lights (LEDs)

D. Operation keys and reset

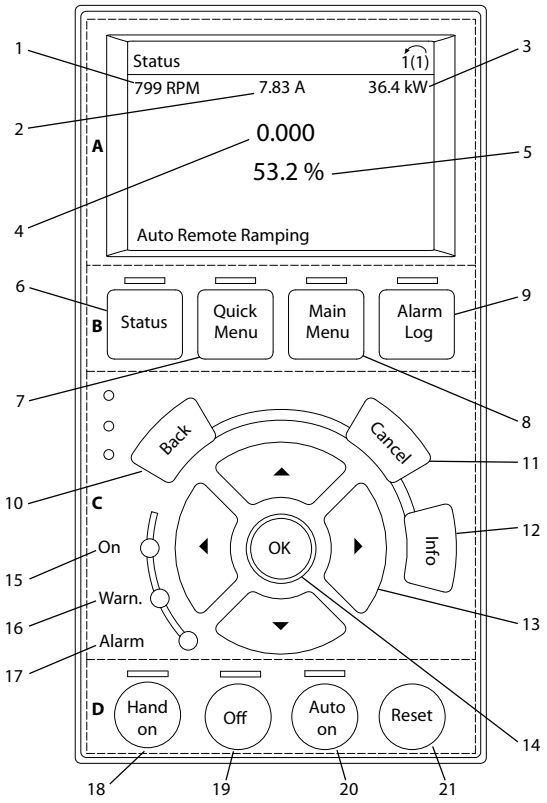


Figure 5.1 Local Control Panel (LCP)

A. Display area
The display area is activated when the adjustable frequency drive receives power from AC line voltage, a DC bus terminal, or an external 24 V DC supply.

The information displayed on the LCP can be customized for user application. Select options in the *Quick Menu Q3-13 Display Settings*.

Display	Parameter number	Default setting
1	0-20	Speed [RPM]
2	0-21	Motor Current
3	0-22	Power [kW]
4	0-23	Frequency
5	0-24	Reference [%]

Table 5.1 Legend to *Figure 5.1*, Display Area

5

B. Display menu keys

Menu keys are used for menu access for parameter set-up, toggling through status display modes during normal operation, and viewing fault log data.

	Key	Function
6	**Status**	Shows operational information.
7	**Quick Menu**	Allows access to programming parameters for initial set-up instructions and many detailed application instructions.
8	**Main Menu**	Allows access to all programming parameters.
9	**Alarm Log**	Displays a list of current warnings, the last ten alarms, and the maintenance log.

Table 5.2 Legend to *Figure 5.1*, Display Menu Keys

C. Navigation keys and LEDs

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local operation. There are also three adjustable frequency drive status indicator lights in this area.

	Key	Function
10	**Back**	Reverts to the previous step or list in the menu structure.
11	**Cancel**	Cancels the last change or command as long as the display mode has not changed.
12	**Info**	Press for a definition of the function being displayed.
13	**Navigation Keys**	Use the four navigation keys to move between items in the menu.
14	**OK**	Use to access parameter groups or to enable a choice.

Table 5.3 Legend to *Figure 5.1*, Navigation Keys

	Indicator	Light	Function
15	On	Green	The ON light activates when the adjustable frequency drive receives power from AC line voltage, a DC bus terminal, or an external 24 V supply.
16	Warn.	Yellow	When warning conditions are met, the yellow WARN light comes on and text appears in the display area identifying the problem.
17	Alarm	Red	A fault condition causes the red alarm light to flash and an alarm text is displayed.

Table 5.4 Legend to *Figure 5.1*, Indicator Lights (LEDs)

D. Operation keys and reset

Operation keys are located at the bottom of the LCP.

	Key	Function
18	**Hand On**	Starts the adjustable frequency drive in local control. • An external stop signal by control input or serial communication overrides the local hand on
19	**Off**	Stops the motor but does not remove power to the adjustable frequency drive.
20	**Auto On**	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication
21	**Reset**	Resets the adjustable frequency drive manually after a fault has been cleared.

Table 5.5 Legend to *Figure 5.1*, Operation Keys and Reset

NOTICE!

The display contrast can be adjusted by pressing [Status] and [▲]/[▼] keys.

5.3.3 Parameter Settings

Establishing the correct programming for applications often requires setting functions in several related parameters. Details for parameters are provided in *chapter 9.2 Parameter Menu Structure*.

Programming data are stored internally in the adjustable frequency drive.

- For backup, upload data into the LCP memory
- To download data to another adjustable frequency drive, connect the LCP to that unit and download the stored settings
- Restoring factory default settings does not change data stored in the LCP memory

5.3.4 Uploading/Downloading Data to/from the LCP

1. Press [Off] to stop the motor before uploading or downloading data.
2. Go to [Main Menu] *0-50 LCP Copy* and Press [OK].
3. Select *[1] All to LCP* to upload data to LCP or select *[2] All from LCP* to download data from the LCP.
4. Press [OK]. A progress bar shows the uploading or downloading process.
5. Press [Hand On] or [Auto On] to return to normal operation.

5.3.5 Changing Parameter Settings

View changes
Quick Menu Q5 - Changes Made lists all parameters changed from default settings.

- The list shows only parameters which have been changed in the current edit set-up.
- Parameters which have been reset to default values are not listed.
- The message 'Empty' indicates that no parameters have been changed.

Changing settings
Parameter settings can be accessed and changed from the [Quick Menu] or from the [Main Menu]. The [Quick Menu] only gives access to a limited number of parameters.

1. Press [Quick Menu] or [Main Menu] on the LCP.
2. Press [▲] [▼] to browse through the parameter groups, press [OK] to select a parameter group.
3. Press [▲] [▼] to browse through the parameters, press [OK] to select a parameter.
4. Press [▲] [▼] to change the value of a parameter setting.
5. Press [◄] [►] to shift digit when a decimal parameter is in the editing state.
6. Press [OK] to accept the change.
7. Press either [Back] twice to enter “Status”, or press [Main Menu] once to enter “Main Menu”.

5.3.6 Restoring Default Settings

NOTICE!

Risk of losing programming, motor data, localization, and monitoring records by restoration of default settings. To provide a backup, upload data to the LCP before initialization.

Restoring the default parameter settings is done by initialization of the adjustable frequency drive. Initialization is carried out through *14-22 Operation Mode* (recommended) or manually.

- Initialization using *14-22 Operation Mode* does not reset adjustable frequency drive settings such as operating hours, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.
- Manual initialization erases all motor, programming, localization, and monitoring data and restores factory default settings.

Recommended initialization procedure, via *14-22 Operation Mode*

1. Press [Main Menu] twice to access parameters.
2. Scroll to *14-22 Operation Mode* and press [OK].
3. Scroll to *Initialization* and press [OK].
4. Remove power to the unit and wait for the display to turn off.
5. Apply power to the unit.

Default parameter settings are restored during start-up. This may take slightly longer than normal.

6. Alarm 80 is displayed.
7. Press [Reset] to return to operation mode.

Manual initialization procedure

1. Remove power to the unit and wait for the display to turn off.
2. Press and hold [Status], [Main Menu], and [OK] at the same time while applying power to the unit (approximately 5 s or until audible click and fan starts).

Factory default parameter settings are restored during start-up. This may take slightly longer than normal.

Manual initialization does not reset the following adjustable frequency drive information:

- *15-00 Operating hours*
- *15-03 Power-ups*
- *15-04 Over Temps*
- *15-05 Over Volts*

5.4 Basic Programming

5.4.1 Commissioning with SmartStart

The SmartStart wizard enables fast configuration of basic motor and application parameters.

- At first power-up or after initialization of the adjustable frequency drive, SmartStart starts by itself.
- Follow on-screen instructions to complete commissioning of the adjustable frequency drive. Always reactivate SmartStart by selecting *Quick Menu Q4 - SmartStart*.
- For commissioning without use of the SmartStart wizard, refer to *chapter 5.4.2 Commissioning via [Main Menu]* or the *Programming Guide*.

NOTICE!

Motor data are required for the SmartStart set-up. The required data are normally available on the motor nameplate.

The SmartStart configures the adjustable frequency drive in three phases, each consisting of several steps, see *Table 5.6*.

Phase		Comment
1	Basic Programming	Program, e.g., motor data
2	Application Section	Select and program appropriate application: • Single pump/motor • Motor alternation • Basic cascade control • Master/follower
3	Water and Pump Features	Go to water and pump dedicated parameters

Table 5.6 SmartStart, Set-up in three Phases

5.4.2 Commissioning via [Main Menu]

Recommended parameter settings are intended for start-up and checkout purposes. Application settings may vary.

Enter data with power ON, but before operating the adjustable frequency drive.

1. Press [Main Menu] on the LCP.
2. Press the navigation keys to scroll to parameter group *0-** Operation/Display* and press [OK].

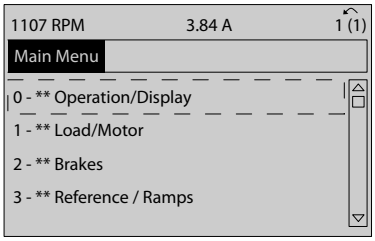


Figure 5.2 Main Menu

3. Press navigation keys to scroll to parameter group *0-0* Basic Settings* and press [OK].

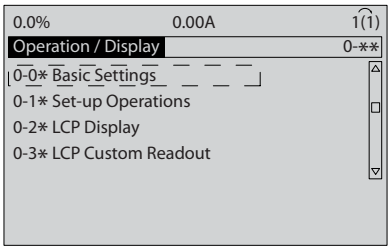


Figure 5.3 Operation/Display

4. Press navigation keys to scroll to *0-03 Regional Settings* and press [OK].

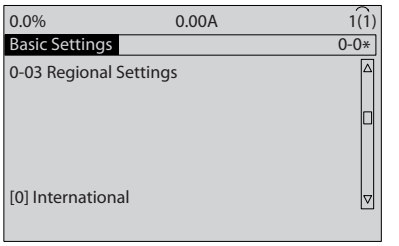


Figure 5.4 Basic Settings

5. Press navigation keys to select *[0] International* or *[1] North America* as appropriate and press [OK]. (This changes the default settings for a number of basic parameters).
6. Press [Main Menu] on the LCP.
7. Press the navigation keys to scroll to *0-01 Language*.
8. Select language and press [OK].
9. If a jumper wire is in place between control terminals 12 and 27, leave *5-12 Terminal 27 Digital Input* at factory default. Otherwise, select *No Operation* in *5-12 Terminal 27 Digital Input*. For adjustable frequency drives with an optional bypass, no jumper wire is required between control terminals 12 and 27.
10. *3-02 Minimum Reference*.
11. *3-03 Maximum Reference*.
12. *3-41 Ramp 1 Ramp-up Time*.
13. *3-42 Ramp 1 Ramp-down Time*.
14. *3-13 Reference Site*. Linked to Hand/Auto Local Remote.

5.4.3 Asynchronous Motor Set-up

Enter the motor data in parameter *1-20 Motor Power [kW]* or *1-21 Motor Power [HP]* to *1-25 Motor Nominal Speed*. The information can be found on the motor nameplate.

1. *1-20 Motor Power [kW]* or *1-21 Motor Power [HP]*
2. *1-22 Motor Voltage*
3. *1-23 Motor Frequency*
4. *1-24 Motor Current*
5. *1-25 Motor Nominal Speed*

5.4.4 PM Motor Set-up in VVC^{plus}

NOTICE!

Only use permanent magnet (PM) motor with fans and pumps.

Initial Programming Steps

1. Activate PM motor operation *1-10 Motor Construction*, select *[1] PM, non salient SPM*
2. Set *0-02 Motor Speed Unit* to *[0] RPM*

Programming motor data
After selecting PM motor in *1-10 Motor Construction*, the PM motor-related parameters in parameter groups *1-2* Motor Data*, *1-3* Addl. Motor Data* and *1-4** are active.
The necessary data can be found on the motor nameplate and in the motor data sheet.
Program the following parameters in the listed order

1. *1-24 Motor Current*
2. *1-26 Motor Cont. Rated Torque*
3. *1-25 Motor Nominal Speed*
4. *1-39 Motor Poles*
5. *1-30 Stator Resistance (Rs)*
   Enter line to common stator winding resistance (Rs). If only line-line data are available, divide the line-line value by 2 to achieve the line to common (starpoint) value.

6. *1-37 d-axis Inductance (Ld)*
   Enter line to common direct axis inductance of the PM motor.
   If only line-line data are available, divide the line-line value by 2 to achieve the line-common (starpoint) value.
7. *1-40 Back EMF at 1000 RPM*
   Enter line-to-line back EMF of PM Motor at 1000 RPM mechanical speed (RMS value). Back EMF is the voltage generated by a PM motor when no drive is connected and the shaft is turned externally. Back EMF is normally specified for nominal motor speed or for 1,000 RPM measured between two lines. If the value is not available for a motor speed of
   1000 RPM, calculate the correct value as follows: If back EMF is, e.g., 320 V at 1800 RPM, it can be calculated at 1000 RPM as follows: Back EMF = (Voltage / RPM)*1000 = (320/1800)*1000 = 178. This is the value that must be programmed for *1-40 Back EMF at 1000 RPM*.

Test Motor Operation

1. Start the motor at low speed (100 to 200 RPM). If the motor does not turn, check installation, general programming and motor data.
2. Check if start function in *1-70 PM Start Mode* fits the application requirements.

Rotor detection
This function is the recommended choice for applications where the motor starts from standstill, e.g., pumps or conveyors. On some motors, an acoustic sound is heard when the impulse is sent out. This does not harm the motor.

Parking
This function is the recommended choice for applications where the motor is rotating at slow speed, e.g., windmilling in fan applications. *2-06 Parking Current* and *2-07 Parking Time* can be adjusted. Increase the factory setting of these parameters for applications with high inertia.

Start the motor at nominal speed. If the application does not run well, check the VVC^{plus} PM settings. Recommendations for different applications can be seen in *Table 5.7*.

Application	Settings
Low inertia applications I_{Load}/I_{Motor} <5	*1-17 Voltage filter time const.* to be increased by factor 5 to 10 *1-14 Damping Gain* should be reduced *1-66 Min. Current at Low Speed* should be reduced (<100%)
Low inertia applications 50>I_{Load}/I_{Motor} >5	Keep calculated values
High inertia applications I_{Load}/I_{Motor} > 50	*1-14 Damping Gain*, *1-15 Low Speed Filter Time Const.* and *1-16 High Speed Filter Time Const.* should be increased
High load at low speed <30% (rated speed)	*1-17 Voltage filter time const.* should be increased *1-66 Min. Current at Low Speed* should be increased (>100% for a prolonged time can overheat the motor)

Table 5.7 Recommendations for Different Applications

If the motor starts oscillating at a certain speed, increase *1-14 Damping Gain*. Increase the value in small steps. Depending on the motor, a good value for this parameter can be 10% or 100% higher than the default value.

Starting torque can be adjusted in *1-66 Min. Current at Low Speed*. 100% provides nominal torque as starting torque.

5.4.5 Automatic Energy Optimization (AEO)

NOTICE!

AEO is not relevant for PM motors.

Automatic Energy Optimization (AEO) is recommended for

- Automatic compensation for oversized motors
- Automatic compensation for slow system load change
- Automatic compensation for seasonal changes
- Automatic compensation for low motor loading
- Reduced energy consumption
- Reduced motor heating
- Reduced motor noise

To activate AEO, set parameter *1-03 Torque Characteristics* to *[2] Auto Energy Optim. CT* or *[3] Auto Energy Optim. VT*.

5.4.6 Automatic Motor Adaptation (AMA)

NOTICE!

AMA is not relevant for PM motors.

Automatic motor adaptation (AMA) is a procedure that optimizes compatibility between the adjustable frequency drive and the motor.

- The adjustable frequency drive builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the data entered in parameters 1-20 to 1-25.
- The motor shaft does not turn and no harm is done to the motor while running the AMA.
- Some motors may be unable to run the complete version of the test. In that case, select *[2] Enable reduced AMA*.
- If an output filter is connected to the motor, select *Enable reduced AMA*.
- If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*.
- Run this procedure on a cold motor for best results.

To run AMA

1. Press [Main Menu] to access parameters.
2. Scroll to parameter group *1-** Load and Motor* and press [OK].
3. Scroll to parameter group *1-2* Motor Data* and press [OK].
4. Scroll to *1-29 Automatic Motor Adaptation (AMA)* and press [OK].
5. Select *[1] Enable complete AMA* and press [OK].
6. Follow the on-screen instructions.
7. The test runs automatically and indicate when it is complete.

5.5 Checking Motor Rotation

⚠WARNING

MOTOR START

Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage. Before start,

- **Ensure equipment is safe to operate under any condition.**
- **Ensure that the motor, system, and any attached equipment are ready for start.**

NOTICE!

Risk of damage to pumps/compressors caused by motor running in wrong direction. Before running the adjustable frequency drive, check the motor rotation.

The motor runs briefly at 5 Hz or the minimum frequency set in *4-12 Motor Speed Low Limit [Hz]*.

1. Press [Main Menu].
2. Scroll to *1-28 Motor Rotation Check* and press [OK].
3. Scroll to *[1] Enable*.

The following text appears: *Note! Motor may run in wrong direction*.

4. Press [OK].
5. Follow the on-screen instructions.

NOTICE!

To change the direction of rotation, remove power to the adjustable frequency drive and wait for power to discharge. Reverse the connection of any two of the three motor wires on the motor or adjustable frequency drive side of the connection.

5.6 Local Control Test

⚠WARNING

MOTOR START

Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage. Before start,

- **Ensure equipment is safe to operate under any condition.**
- **Ensure that the motor, system, and any attached equipment are ready for start.**

1. Press [Hand On] to provide a local start command to the adjustable frequency drive.
2. Accelerate the adjustable frequency drive by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [Off]. Note any deceleration problems.

In the event of acceleration or deceleration problems, see *chapter 7.5 Troubleshooting*. See *chapter 7.4 List of Warnings and Alarms* for resetting the adjustable frequency drive after a trip.

5.7 System Start-up

The procedure in this section requires user-wiring and application programming to be completed. The following procedure is recommended after application set-up is completed.

⚠WARNING

MOTOR START

Failure to ensure that the motor, system, and any attached equipment are ready for start can result in personal injury or equipment damage. Before start,

- **Ensure equipment is safe to operate under any condition.**
- **Ensure that the motor, system, and any attached equipment are ready for start.**

1. Press [Auto On].
2. Apply an external run command.
3. Adjust the speed reference throughout the speed range.
4. Remove the external run command.
5. Check sound and vibration level of the motor to ensure that the system is working as intended.

If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*.

6 Application Set-up Examples

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

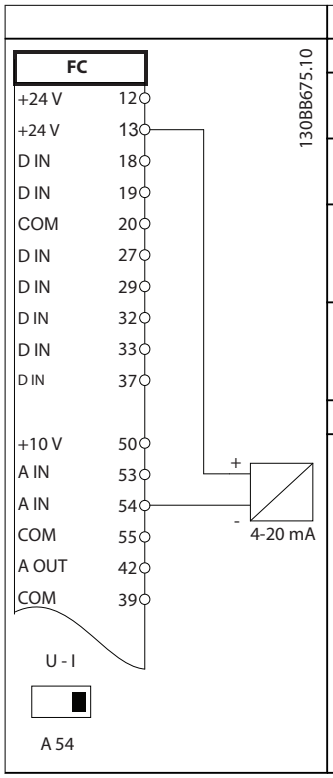
- Parameter settings are the regional default values unless otherwise indicated (selected in *0-03 Regional Settings*).
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Where switch settings for analog terminals A53 or A54 are required, these are also shown.

NOTICE!

When the optional Safe Torque Off feature is used, a jumper wire may be required between terminal 12 (or 13) and terminal 37 for the adjustable frequency drive to operate when using factory default programming values.

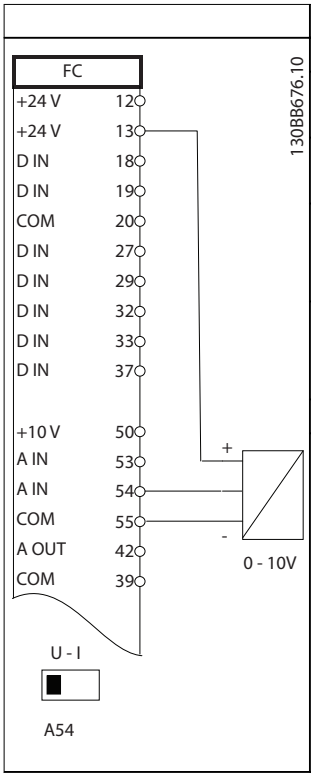
6.1 Application Examples

6.1.1 Feedback



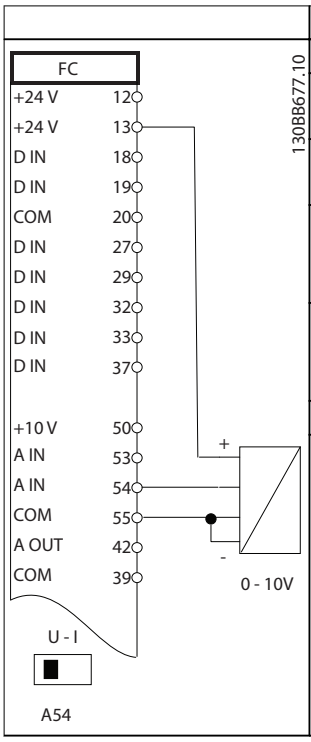
	Parameters	
	Function	**Setting**
	6-22 Terminal 54 Low Current	4 mA*
	6-23 Terminal 54 High Current	20 mA*
	6-24 Terminal 54 Low Ref./Feedb. Value	0*
	6-25 Terminal 54 High Ref./Feedb. Value	50*
	* = Default Value	
	Notes/comments: D IN 37 is an option.	

Table 6.1 Analog Current Feedback Transducer



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

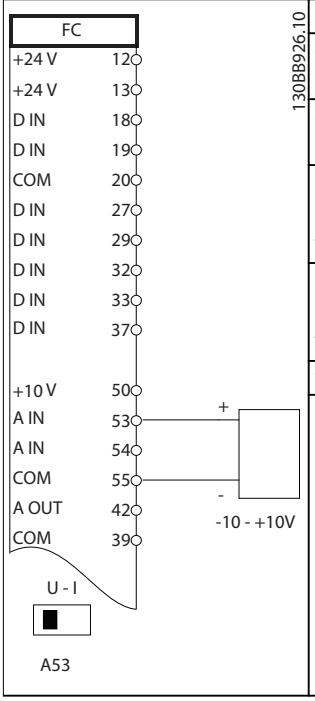
Table 6.2 Analog Voltage Feedback Transducer (3-wire)



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

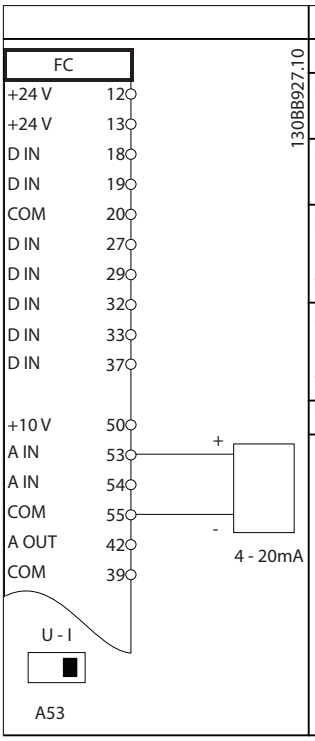
Table 6.3 Analog Voltage Feedback Transducer (4-wire)

6.1.2 Speed



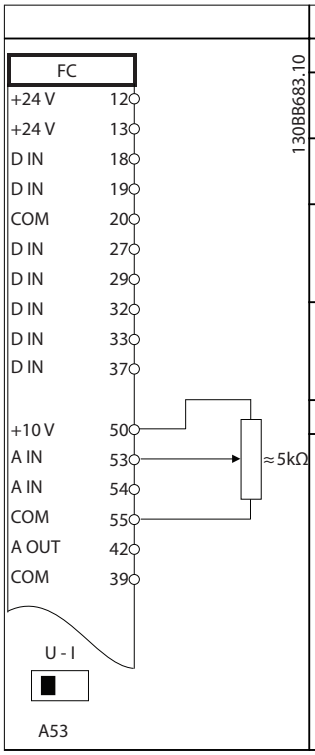
Parameters	
Function	**Setting**
6-10 Terminal 53 Low Voltage	0.07 V*
6-11 Terminal 53 High Voltage	10 V*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
* = Default Value	
Notes/comments: D IN 37 is an option.	

Table 6.4 Analog Speed Reference (Voltage)



Parameters	
Function	**Setting**
6-12 Terminal 53 Low Current	4 mA*
6-13 Terminal 53 High Current	20 mA*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
* = Default Value	
Notes/comments: D IN 37 is an option.	

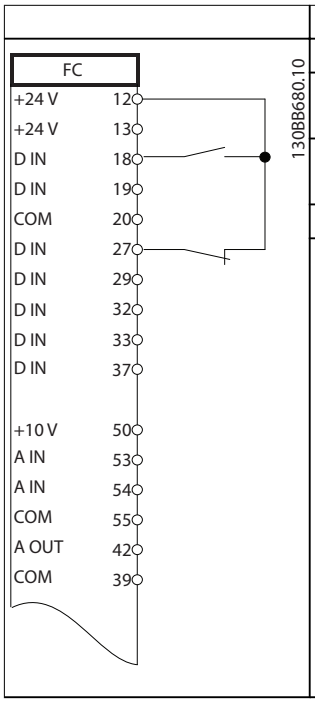
Table 6.5 Analog Speed Reference (Current)



Parameters	
Function	**Setting**
6-10 Terminal 53 Low Voltage	0.07 V*
6-11 Terminal 53 High Voltage	10 V*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1500 RPM
* = Default Value	
Notes/comments: D IN 37 is an option.	

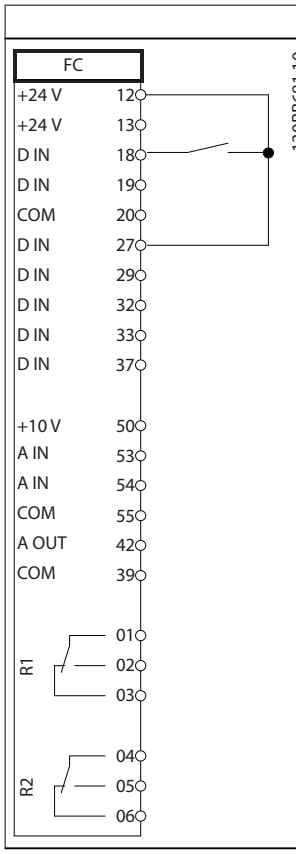
Table 6.6 Speed Reference (using a Manual Potentiometer)

6.1.3 Run/Stop



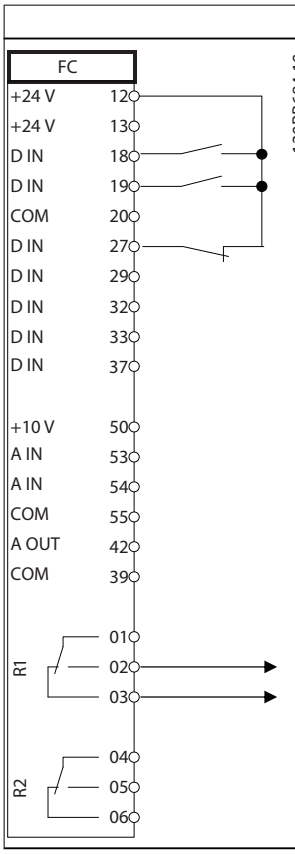
Parameters	
Function	**Setting**
5-10 Terminal 18 Digital Input	[8] Start*
5-12 Terminal 27 Digital Input	[7] External Interlock
* = Default Value	
Notes/comments: D IN 37 is an option.	

Table 6.7 Run/Stop Command with External Interlock



Parameters	
Function	**Setting**
5-10 Terminal 18 Digital Input	[8] Start*
5-12 Terminal 27 Digital Input	[7] External Interlock
* = Default Value	
Notes/comments: If *5-12 Terminal 27 Digital Input* is set to [0] No operation, a jumper wire to terminal 27 is not needed. D IN 37 is an option.	

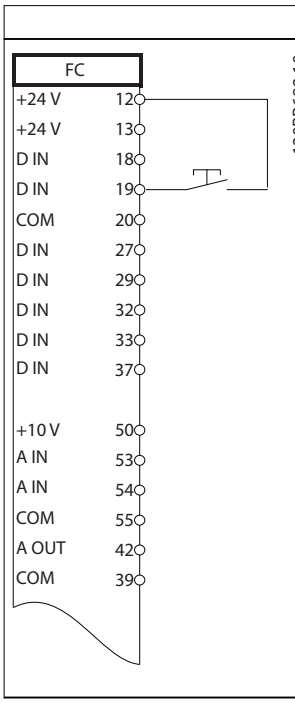
Table 6.8 Run/Stop Command without External Interlock



Parameters	
Function	**Setting**
5-10 Terminal 18 Digital Input	[8] Start*
5-11 Terminal 19 Digital Input	[52] Run Permissive
5-12 Terminal 27 Digital Input	[7] External Interlock
5-40 Function Relay	[167] Start command act.
* = Default Value	
Notes/comments: D IN 37 is an option.	

Table 6.9 Run Permissive

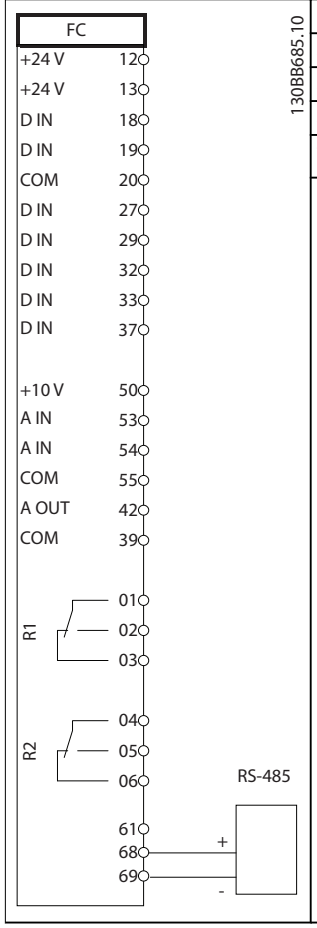
6.1.4 External Alarm Reset



Parameters	
Function	**Setting**
5-11 Terminal 19 Digital Input	[1] Reset
* = Default Value	
Notes/comments: D IN 37 is an option.	

Table 6.10 External Alarm Reset

6.1.5 RS-485



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

Table 6.11 RS-485 Network Connection

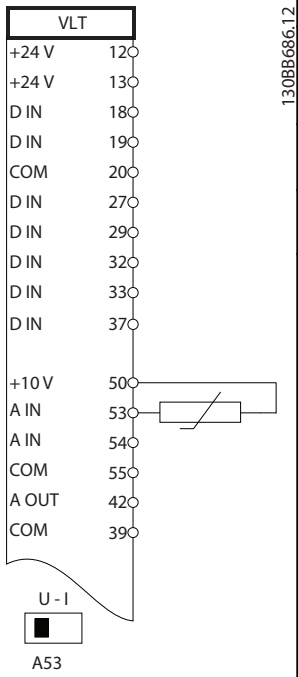
6.1.6 Motor Thermistor

⚠CAUTION

THERMISTOR INSULATION

Risk of equipment damage exists.

- **Use only thermistors with reinforced or double insulation to meet PELV insulation requirements.**



Parameters	
Function	**Setting**
1-90 Motor Thermal Protection	[2] Thermistor trip
1-93 Thermistor Source	[1] Analog input 53
* = Default Value	
Notes/comments: If only a warning is desired, *1-90 Motor Thermal Protection* should be set to [1] *Thermistor warning*. D IN 37 is an option.	

Table 6.12 Motor Thermistor

7 Maintenance, Diagnostics and Troubleshooting

This chapter includes maintenance and service guidelines, status messages, warnings and alarms and basic trouble-shooting.

7.1 Maintenance and Service

Under normal operating conditions and load profiles, the adjustable frequency drive is maintenance-free throughout its designed lifetime. To prevent breakdown, danger, and damage, examine the adjustable frequency drive at regular intervals depending on the operating conditions. Replace worn or damaged parts with original spare parts or standard parts. For service and support, refer to *www.danfoss.com/contact/sales_and_services/*.

⚠WARNING

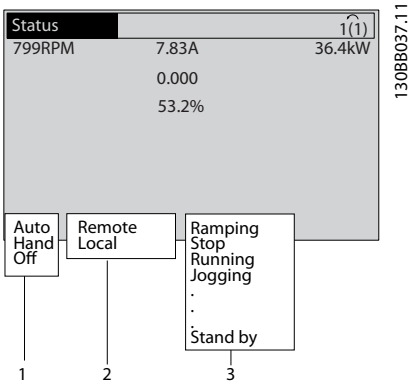
HIGH VOLTAGE

Adjustable frequency drives contain high voltage when connected to AC line power. Failure to perform installation, start-up, and maintenance by qualified personnel could result in death or serious injury.

- **Installation, start-up, and maintenance must be performed by qualified personnel only.**

7.2 Status Messages

When the adjustable frequency drive is in status mode, status messages are generated automatically and appear in the bottom line of the display (see *Figure 7.1*).



1	Operation mode (see *Table 7.1*)
2	Reference site (see *Table 7.2*)
3	Operation status (see *Table 7.3*)

Figure 7.1 Status Display

Table 7.1 to *Table 7.3* describe the displayed status messages.

Off	The adjustable frequency drive does not react to any control signal until [Auto On] or [Hand On] is pressed.
Auto On	The adjustable frequency drive is controlled from the control terminals and/or the serial communication.
	The adjustable frequency drive is controlled by the navigation keys on the LCP. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals override local control.

Table 7.1 Operation Mode

Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The adjustable frequency drive uses [Hand On] control or reference values from the LCP.

Table 7.2 Reference Site

AC Brake	AC Brake was selected in *2-10 Brake Function*. The AC brake overmagnetizes the motor to achieve a controlled slow-down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in *2-12 Brake Power Limit (kW)* has been reached.
Coast	• Coast inverse was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not connected. • Coast activated by serial communication
Ctrl. Ramp-down	Control Ramp-down was selected in *14-10 Mains Failure*. • The AC line voltage is below the value set in *14-11 Mains Voltage at Mains Fault* at line power fault. • The adjustable frequency drive ramps down the motor using a controlled ramp-down.
Current High	The adjustable frequency drive output current is above the limit set in *4-51 Warning Current High*.
Current Low	The adjustable frequency drive output current is below the limit set in *4-52 Warning Speed Low*.
DC Hold	DC Hold is selected in *1-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *2-00 DC Hold/ Preheat Current*.
DC Stop	The motor is held with a DC current (*2-01 DC Brake Current*) for a specified time (*2-02 DC Braking Time*). • DC Brake is activated in *2-03 DC Brake Cut-in Speed [RPM]* and a stop command is active. • DC Brake (inverse) is selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not active. • The DC Brake is activated via serial communication.
Feedback high	The sum of all active feedbacks is above the feedback limit set in *4-57 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *4-56 Warning Feedback Low*.
Freeze output	The remote reference is active, which holds the present speed. • Freeze output was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is active. Speed control is only possible via the terminal functions Speed Up and Slow. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command was given, but the motor remains stopped until a run permissive signal is received.
Freeze ref.	*Freeze Reference* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is active. The adjustable frequency drive saves the actual reference. Changing the reference is now only possible via terminal functions Speed Up and Slow.
Jog request	A jog command was given but the motor remains stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in *3-19 Jog Speed [RPM]*. • *Jog* was selected as function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal (e.g., Terminal 29) is active. • The Jog function is activated via the serial communication. • The Jog function was selected as a reaction for a monitoring function (e.g., No signal). The monitoring function is active.

Motor check	In *1-80 Function at Stop*, *Motor Check* was selected. A stop command is active. To ensure that a motor is connected to the adjustable frequency drive, a permanent test current is applied to the motor.
Over Voltage Control (OVC)	*Overvoltage* control was activated in *2-17 Overvoltage Control*, *[2] Enabled*. The connected motor is supplying the adjustable frequency drive with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the adjustable frequency drive from tripping.
PowerUnit Off	(Only adjustable frequency drives with an external 24 V power supply installed). Line power supply to the adjustable frequency drive was removed, and the control card is supplied by the external 24 V.
Protection md	Protection mode is active. The unit has detected a critical status (overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10 s. • Protection mode can be restricted in *14-26 Trip Delay at Inverter Fault*.
QStop	The motor is decelerating using *3-81 Quick Stop Ramp Time*. • *Quick stop inverse* was selected as a function for a digital input (parameter group *5-1* Digital Inputs*). The corresponding terminal is not active. • The quick stop function was activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active Ramp-Up/Down. The reference, a limit value, or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *4-55 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *4-54 Warning Reference Low*.
Run on ref.	The adjustable frequency drive is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command was given, but the motor remains stopped until a run permissive signal is received via digital input.
Running	The motor is driven by the adjustable frequency drive.
Sleep Mode	The energy-saving function is enabled. The motor has stopped but restarts automatically when required.
Speed high	Motor speed is above the value set in *4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *4-52 Warning Speed Low*.
Standby	In Auto On mode, the adjustable frequency drive starts the motor with a start signal from a digital input or serial communication.
Start delay	In *1-71 Start Delay*, a delay starting time was set. A start command is activated and the motor starts after the start delay time expires.
Start fwd/rev	Start forward and start reverse were selected as functions for two different digital inputs (parameter group *5-1* Digital Inputs*). The motor starts in forward or reverse depending on which corresponding terminal is activated.
Stop	The adjustable frequency drive has received a stop command from the LCP, digital input, or serial communication.
Trip	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the adjustable frequency drive can be reset manually by pressing [Reset] or remotely by control terminals or serial communication.
Trip lock	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, power must be cycled to the adjustable frequency drive. The adjustable frequency drive can then be reset manually by pressing [Reset] or remotely by control terminals or serial communication.

Table 7.3 Operation Status

NOTICE!

In auto/remote mode, the adjustable frequency drive requires external commands to execute functions.

7

7.3 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 adjustable frequency drive issuing an alarm. A warning clears by itself when the abnormal condition is removed.

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

Resetting the adjustable frequency drive after trip/trip lock
A trip can be reset in any of four ways:

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

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

Warning and Alarm Displays

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

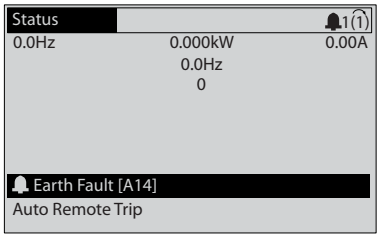


Figure 7.2 Alarm Display Example

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

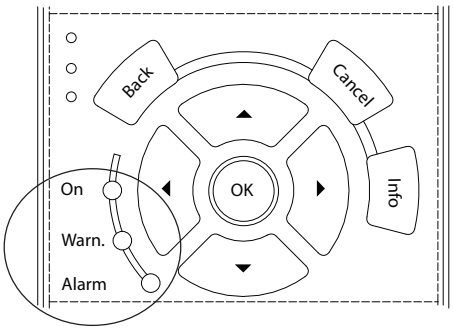


Figure 7.3 Status Indicator Lights

	Warning LED	Alarm LED
Warning	On	Off
Alarm	Off	On (Flashing)
Trip Lock	On	On (Flashing)

Table 7.4 Status Indicator Lights Explanations

7.4 List of Warnings and Alarms

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

WARNING 1, 10 Volts low
The control card voltage is below 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω.

This condition can be caused by a short in a connected potentiometer or improper wiring of the potentiometer.

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

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed by the user in *6-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. Broken wiring or faulty device sending the signal can cause this condition.

Troubleshooting

- Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. MCB 101 terminals 11 and 12 for signals, terminal 10 common. MCB 109 terminals 1, 3, 5 for signals, terminals 2, 4, 6 common.
- Check that the adjustable frequency drive programming and switch settings match the analog signal type.
- Perform Input Terminal Signal Test.

WARNING/ALARM 3, No motor
No motor has been connected to the output of the adjustable frequency drive.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the line voltage imbalance is too high. This message also appears for a fault in the input rectifier on the adjustable frequency drive. Options are programmed at *14-12 Function at Mains Imbalance*.

Troubleshooting
Check the supply voltage and supply currents to the adjustable frequency drive.

WARNING 5, DC link voltage high
The intermediate circuit voltage (DC) is higher than the high voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING 6, DC link voltage low
The intermediate circuit voltage (DC) is lower than the low voltage warning limit. The limit is dependent on the adjustable frequency drive voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage
If the intermediate circuit voltage exceeds the limit, the adjustable frequency drive trips after a time.

Troubleshooting

- Connect a brake resistor
- Extend the ramp time
- Change the ramp type
- Activate the functions in *2-10 Brake Function*
- Increase *14-26 Trip Delay at Inverter Fault*

WARNING/ALARM 8, DC undervoltage
If the intermediate circuit voltage (DC link) drops below the undervoltage limit, the adjustable frequency drive checks if a 24 V DC backup supply is connected. If no 24 V DC backup supply is connected, the adjustable frequency drive trips after a fixed time delay. The time delay varies with unit size.

Troubleshooting

- Make sure that the supply voltage matches the adjustable frequency drive voltage.
- Perform input voltage test.
- Perform soft charge circuit test.

WARNING/ALARM 9, Inverter overload
The adjustable frequency drive is about to cut out because of an overload (too high current for too long). The counter for electronic, thermal inverter protection gives a warning at 98% and trips at 100%, while giving an alarm. The adjustable frequency drive *cannot* be reset until the counter is below 90%.
The fault is that the adjustable frequency drive is overloaded by more than 100% for too long.

Troubleshooting

- Compare the output current shown on the LCP with the adjustable frequency drive rated current
- Compare the output current shown on the LCP with measured motor current
- Display the Thermal Drive Load on the LCP and monitor the value. When running above the adjustable frequency drive continuous current rating, the counter should increase. When running below the adjustable frequency drive continuous current rating, the counter should decrease

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection (ETR), the motor is too hot. Select whether the adjustable frequency drive gives a warning or an alarm when the counter reaches 100% in *1-90 Motor Thermal Protection*. The fault occurs when the motor is overloaded by more than 100% for too long.

Troubleshooting

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

WARNING/ALARM 11, Motor thermistor over-temp
The thermistor might be disconnected. Select whether the adjustable frequency drive gives a warning or an alarm in *1-90 Motor Thermal Protection*.

Troubleshooting

- Check for motor overheating
- Check if the motor is mechanically overloaded.
- Check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10 V supply) and that the terminal switch for 53 or 54 is set for voltage. Check *1-93 Thermistor Source* selects terminal 53 or 54
- When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50
- If a KTY sensor is used, check for correct connection between terminals 54 and 55
- If using a thermal switch or thermistor, check that the programming of 1-93 Thermistor Resource matches sensor wiring
- If using a KTY sensor, check the programming of 1-95 KTY Sensor Type, 1-96 KTY Thermistor Resource, and 1-97 KTY Threshold level match sensor wiring

WARNING/ALARM 12, Torque limit
The torque has exceeded the value in *4-16 Torque Limit Motor Mode* or the value in *4-17 Torque Limit Generator Mode*. *14-25 Trip Delay at Torque Limit* can change this from a warning only condition to a warning followed by an alarm.

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, extend the ramp-down time
- If torque limit occurs while running, possibly increase the torque limit. Be sure the system can operate safely at a higher torque
- Check the application for excessive current draw on the motor

WARNING/ALARM 13, Overcurrent
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the adjustable frequency drive trips and issues an alarm. This fault may be caused by shock loading or fast acceleration with high inertia loads. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting

- Remove power and check if the motor shaft can be turned
- Check that the motor size matches the adjustable frequency drive
- Check parameters 1-20 to 1-25 for correct motor data

ALARM 14, Ground fault
There is current from the output phases to ground, either in the cable between the adjustable frequency drive and the motor or in the motor itself.

Troubleshooting:

- Remove power to the adjustable frequency drive and repair the ground fault
- Check for ground faults in the motor by measuring the resistance to ground of the motor leads and the motor with a megohmmeter
- Perform current sensor test

ALARM 15, Hardware mismatch
A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact the Danfoss supplier:

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

ALARM 16, Short-circuit
There is short-circuiting in the motor or motor wiring.

Remove power to the adjustable frequency drive and repair the short circuit.

WARNING/ALARM 17, Control word timeout
There is no communication to the adjustable frequency drive.
The warning is only active when *8-04 Control Timeout Function* is NOT set to OFF.
If *8-04 Control Timeout Function* is set to *Stop* and *Trip*, a warning appears and the adjustable frequency drive ramps down until it trips then displays an alarm.

Troubleshooting:
- Check connections on the serial communication cable
- Increase *8-03 Control Timeout Time*
- Check the operation of the communication equipment
- Verify a proper installation based on EMC requirements

WARNING/ALARM 22, Hoist mechanical brake
Report value shows what kind it is.
0 = The torque ref. was not reached before timeout.
1 = There was no brake feedback before timeout.

WARNING 23, Internal fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* (*[0] Disabled*).

Troubleshooting
- Check fan resistance
- Check soft charge fuses

WARNING 24, External fan fault
The fan warning function is an extra protective function that checks if the fan is running/mounted. The fan warning can be disabled in *14-53 Fan Monitor* (*[0] Disabled*).

Troubleshooting
- Check fan resistance
- Check soft charge fuses

WARNING 25, Brake resistor short-circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The adjustable frequency drive is still operational but without the brake function. Remove power to the adjustable frequency drive and replace the brake resistor (see *2-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit
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 intermediate circuit voltage and the brake resistance value set in *2-16 AC Brake Max. Current*. The warning is active when the dissipated braking energy is higher than 90% of the brake resistance power. If *[2] Trip* is selected in *2-13 Brake Power Monitoring*, the adjustable frequency drive trips when the dissipated braking energy reaches 100%.

⚠WARNING

There is a risk of substantial power being transmitted to the brake resistor if the brake transistor is short-circuited.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation and if a short circuit occurs, the brake function is disabled and a warning is issued. The adjustable frequency 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.

Remove power to the adjustable frequency drive and remove the brake resistor.
This alarm/warning could also occur should the brake resistor overheat. Terminals 104 and 106 are available as brake resistors Klixon inputs, see *Brake Resistor Temperature Switch* in the *Design Guide*.

WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working. Check *2-15 Brake Check*.

ALARM 29, Heatsink temp
The maximum temperature of the heatsink has been exceeded. The temperature fault does not reset until the temperature drops below a defined heatsink temperature. The trip and reset points are different based on the adjustable frequency drive power size.

Troubleshooting
Check for the following conditions

- Ambient temperature too high
- Motor cable too long
- Incorrect airflow clearance above and below the adjustable frequency drive
- Blocked airflow around the adjustable frequency drive
- Damaged heatsink fan
- Dirty heatsink

This alarm is based on the temperature measured by the heatsink sensor mounted inside the IGBT modules.

Troubleshooting

- Check fan resistance
- Check soft charge fuses
- IGBT thermal sensor

ALARM 30, Motor phase U missing
Motor phase U between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase U.

ALARM 31, Motor phase V missing
Motor phase V between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase V.

ALARM 32, Motor phase W missing
Motor phase W between the adjustable frequency drive and the motor is missing.

Remove power from the adjustable frequency drive and check motor phase W.

ALARM 33, Inrush fault
Too many power-ups have occurred within a short time period. Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault
The serial communication bus on the communication option card is not working.

WARNING/ALARM 36, Mains failure
This warning/alarm is only active if the supply voltage to the adjustable frequency drive is lost and *14-10 Mains Failure* is NOT set to *[0] No Function*. Check the fuses to the adjustable frequency drive and line power supply to the unit.

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in the *Table 7.5* is displayed.

Troubleshooting

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

Contact the Danfoss supplier or service department if required. Note the code number for further trouble-shooting directions.

No.	Text
0	Serial port cannot be initialized. Contact theDanfoss supplier or Danfoss Service Department.
256-258	Power EEPROM data is defective or too old.
512	Control board EEPROM data is defective or too old.
513	Communication timeout reading EEPROM data.
514	Communication timeout reading EEPROM data.
515	Application oriented control cannot recognize the EEPROM data.
516	Cannot write to the EEPROM because a write command is on progress.
517	Write command is under timeout.
518	Failure in the EEPROM.
519	Missing or invalid barcode data in EEPROM.
783	Parameter value outside of min/max limits.
1024-1279	A CAN message that has to be sent couldn't be sent.
1281	Digital signal processor flash timeout.
1282	Power micro software version mismatch.
1283	Power EEPROM data version mismatch.
1284	Cannot read digital signal processor software version.
1299	Option SW in slot A is too old.
1300	Option SW in slot B is too old.
1301	Option SW in slot C0 is too old.
1302	Option SW in slot C1 is too old.

No.	Text
1315	Option SW in slot A is not supported (not allowed).
1316	Option SW in slot B is not supported (not allowed).
1317	Option SW in slot C0 is not supported (not allowed).
1318	Option SW in slot C1 is not supported (not allowed).
1379	Option A did not respond when calculating platform version.
1380	Option B did not respond when calculating platform version.
1381	Option C0 did not respond when calculating platform version.
1382	Option C1 did not respond when calculating platform version.
1536	An exception in the application oriented control is registered. Debug information written in LCP.
1792	DSP watchdog is active. Debugging of power part data, motor oriented control data not transferred correctly.
2049	Power data restarted.
2064-2072	H081x: option in slot x has restarted.
2080-2088	H082x: option in slot x has issued a power-up wait.
2096-2104	H983x: option in slot x has issued a legal power-up wait.
2304	Could not read any data from power EEPROM.
2305	Missing SW version from power unit.
2314	Missing power unit data from power unit.
2315	Missing SW version from power unit.
2316	Missing lo_statepage from power unit.
2324	Power card configuration is determined to be incorrect at power-up.
2325	A power card has stopped communicating while line power is applied.
2326	Power card configuration is determined to be incorrect after the delay for power cards to register.
2327	Too many power card locations have been registered as present.
2330	Power size information between the power cards does not match.
2561	No communication from DSP to ATACD.
2562	No communication from ATACD to DSP (state running).
2816	Stack overflow control board module.
2817	Scheduler slow tasks.
2818	Fast tasks.
2819	Parameter thread.
2820	LCP stack overflow.
2821	Serial port overflow.
2822	USB port overflow.
2836	cfListMempool too small.
3072-5122	Parameter value is outside its limits.
5123	Option in slot A: Hardware incompatible with control board hardware.
5124	Option in slot B: Hardware incompatible with control board hardware.
5125	Option in slot C0: Hardware incompatible with control board hardware.
5126	Option in slot C1: Hardware incompatible with control board hardware.
5376-6231	Out of memory.

Table 7.5 Code Numbers for Internal Faults

ALARM 39, Heatsink sensor
No feedback from the heatsink 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 the ribbon cable between the power card and gate drive card.

WARNING 40, Overload of digital output terminal 27
Check the load connected to terminal 27 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-01 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29
Check the load connected to terminal 29 or remove short-circuit connection. Check *5-00 Digital I/O Mode* and *5-02 Terminal 29 Mode*.

WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7
For X30/6, check the load connected to X30/6 or remove the short-circuit connection. Check *5-32 Term X30/6 Digi Out (MCB 101)*.

For X30/7, check the load connected to X30/7 or remove the short-circuit connection. Check *5-33 Term X30/7 Digi Out (MCB 101)*.

ALARM 46, Power card supply
The supply on the power card is out of range.

There are three power supplies generated by the switch mode power supply (SMPS) on the power card: 24 V, 5 V, ±18 V. When powered with 24 V DC with the MCB 107 option, only the 24 V and 5 V supplies are monitored. When powered with three phase AC line voltage, all three supplies are monitored.

WARNING 47, 24 V supply low
The 24 V DC is measured on the control card. The external 24 V DC backup power supply may be overloaded, otherwise contact the Danfoss supplier.

WARNING 48, 1.8 V supply low
The 1.8 V DC supply used on the control card is outside of allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for an overvoltage condition.

WARNING 49, Speed limit
When the speed is not within the specified range in *4-11 Motor Speed Low Limit [RPM]* and *4-13 Motor Speed High Limit [RPM]*, the adjustable frequency drive shows a warning. When the speed is below the specified limit in *1-86 Trip Speed Low [RPM]* (except when starting or stopping) the adjustable frequency drive trips.

ALARM 50, AMA calibration failed
Contact the Danfoss supplier or Danfoss Service Department.

ALARM 51, AMA check U_{nom} and I_{nom}
The settings for motor voltage, motor current, and motor power are wrong. Check the settings in parameters 1-20 to 1-25.

ALARM 52, AMA low I_{nom}
The motor current is too low. Check the settings.

ALARM 53, AMA motor too big
The motor is too big for the AMA to operate.

ALARM 54, AMA motor too small
The motor is too small for the AMA to operate.

ALARM 55, AMA parameter out of range
The parameter values of the motor are outside of the acceptable range. AMA will not run.

ALARM 56, AMA interrupted by user
The user has interrupted the AMA.

ALARM 57, AMA internal fault
Try to restart AMA again a number of times until the AMA is carried out. Note that repeated runs may heat the motor to a level where the resistance R_s and R_r are increased. In most cases, however, this is not critical.

AMA internal fault
Contact the Danfoss supplier.

WARNING 59, Current limit
The current is higher than the value in *4-18 Current Limit*. Ensure that motor data in parameters 1-20 to 1-25 are set correctly. Possibly increase the current limit. Be sure that the system can operate safely at a higher limit.

WARNING 60, External interlock
External interlock has been activated. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock and reset the adjustable frequency drive (via serial communication, digital I/O, or by pressing [Reset]).

WARNING 62, Output frequency at maximum limit
The output frequency is higher than the value set in *4-19 Max Output Frequency*.

ALARM 64, Voltage Limit
The load and speed combination demands a motor voltage higher than the actual DC link voltage.

WARNING/ALARM 65, Control card over temperature
The control card has reached its trip temperature of 167 °F [75 °C].

WARNING 66, Heatsink temperature low
The adjustable frequency drive is too cold to operate. This warning is based on the temperature sensor in the IGBT module.
Increase the ambient temperature of the unit. Also, a trickle amount of current can be supplied to the adjustable frequency drive whenever the motor is stopped by setting *2-00 DC Hold/Preheat Current* at 5% and *1-80 Function at Stop*

Troubleshooting
The heatsink temperature measured as 32 °F [0 °C] could indicate that the temperature sensor is defective, causing the fan speed to increase to the maximum. If the sensor wire between the IGBT and the gate drive card is disconnected, this warning would result. Also, check the IGBT thermal sensor.

ALARM 67, Option module configuration has changed
One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

ALARM 68, Safe Stop activated
Safe stop has been activated. To resume normal operation, apply 24 V DC to terminal 37, then send a reset signal (via bus, digital I/O, or by pressing [Reset]).

ALARM 69, Power card temperature
The temperature sensor on the power card is either too hot or too cold.

Troubleshooting

- Check the operation of the door fans
- Check that the filters for the door fans are not blocked
- Check that the connector plate is properly installed on IP21/IP54 (NEMA 1/12) adjustable frequency drives

ALARM 70, Illegal FC configuration
The control card and power card are incompatible. Contact the supplier with the type code of the unit from the nameplate and the part numbers of the cards to check compatibility.

ALARM 71, PTC 1 safe stop
Safe Stop has been activated from the MCB 112 PTC Thermistor Card (motor too warm). Normal operation can be resumed when the MCB 112 applies 24 V DC to T37 again (when the motor temperature reaches an acceptable level) and when the digital input from the MCB 112 is deactivated. When that happens, a reset signal must be sent (via Bus, Digital I/O, or by pressing [Reset]).

NOTICE!

If automatic restart is enabled, the motor may start when the fault is cleared.

ALARM 72, Dangerous failure
Safe Stop with Trip Lock. Unexpected signal levels on safe stop and digital input from the MCB 112 PTC thermistor card.

WARNING 73, Safe Stop auto restart
Safe stopped. With automatic restart enabled, the motor may start when the fault is cleared.

WARNING 76, Power unit set-up
The required number of power units does not match the detected number of active power units.

Troubleshooting:
When replacing an F-frame module, this occurs if the power specific data in the module power card does not match the rest of the adjustable frequency drive. Confirm the spare part and its power card are the correct part number.

WARNING 77, Reduced power mode
This warning indicates that the adjustable frequency drive is operating in reduced power mode (i.e., less than the allowed number of inverter sections). This warning is generated on power cycle when the adjustable frequency drive is set to run with fewer inverters and remains on.

ALARM 79, Illegal power section configuration
The scaling card is the incorrect part number or not installed. Also MK102 connector on the power card could not be installed.

ALARM 80, Drive initialized to default value
Parameter settings are initialized to default settings after a manual reset. Reset the unit to clear the alarm.

ALARM 81, CSIV corrupt
CSIV (Customer Specific Initialization Values) file has syntax errors.

ALARM 82, CSIV parameter error
CSIV (Customer Specific Initialization Values) failed to init a parameter.

ALARM 85, Dang fail PB
Profibus/Profisafe Error.

ALARM 92, No-Flow
A no-flow condition has been detected in the system. *22-23 No-Flow Function* is set for alarm. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 93, Dry pump
A no-flow condition in the system with the adjustable frequency drive operating at high speed may indicate a dry pump. *22-26 Dry Pump Function* is set for alarm. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 94, End of curve
Feedback is lower than the setpoint. This may indicate leakage in the system. *22-50 End of Curve Function* is set for alarm. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 95, Broken belt
Torque is below the torque level set for no load, indicating a broken belt. *22-60 Broken Belt Function* is set for alarm. Troubleshoot the system and reset the adjustable frequency drive after the fault has been cleared.

ALARM 100, Derag limit fault
The Deragging feature failed during execution. Check pump impeller for blockage.

WARNING/ALARM 104, Mixing fan fault
The fan monitor checks that the fan is spinning at adjustable frequency drive power-up or whenever the mixing fan is turned on. If the fan is not operating, then the fault is annunciated. The mixing-fan fault can be

configured as a warning or an alarm trip by *14-53 Fan Monitor*.

Troubleshooting
Cycle power to the adjustable frequency drive to determine if the warning/alarm returns.

WARNING 250, New spare part
A component in the adjustable frequency drive has been replaced. Reset the adjustable frequency drive for normal operation.

WARNING 251, New type code
The power card or other components have been replaced and the type code changed. Reset to remove the warning and resume normal operation.

7.5 Troubleshooting

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power	See *Table 4.4*.	Check the input power source.
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this table for possible causes.	Follow the recommendations provided.
	No power to the LCP	Check the LCP cable for proper connection or damage.	Replace the faulty LCP or connection cable.
	Shortcut on control voltage (terminal 12 or 50) or at control terminals	Check the 24 V control voltage supply for terminals 12/13 to 20-39 or 10 V supply for terminals 50 to 55.	Wire the terminals properly.
	Incompatible LCP (LCP from VLT® 2800 or 5000/6000/8000/ FCD or FCM)		Use only LCP 101 (P/N 130B1124) or LCP 102 (P/N 130B1107).
	Wrong contrast setting		Press [Status] + [▲]/[▼] to adjust the contrast.
	Display (LCP) is defective	Test using a different LCP.	Replace the faulty LCP or connection cable.
	Internal voltage supply fault or SMPS is defective		Contact supplier.
Intermittent display	Overloaded power supply (SMPS) due to improper control wiring or a fault within the adjustable frequency drive	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, then the problem is in the control wiring. Check the wiring for short circuits or incorrect connections. If the display continues to cut out, follow the procedure for display dark.
Motor not running	Service switch open or missing motor connection	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No line power with 24 V DC option card	If the display is functioning but no output, check that line power is applied to the adjustable frequency drive.	Apply line power to run the unit.
	LCP Stop	Check if [Off] has been pressed.	Press [Auto On] or [Hand On] (depending on operation mode) to run the motor.
	Missing start signal (Standby)	Check *5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting)	Check *5-12 Coast inv.* for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to *No operation*.
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check *3-13 Reference Site*. Set preset reference active in parameter group *3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit	Check that *4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group *5-1* Digital inputs*.	Deactivate reversing signal.
	Wrong motor phase connection		See *chapter 5.5 Checking Motor Rotation*.

Symptom	Possible cause	Test	Solution
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in *4-13 Motor Speed High Limit [RPM]*, *4-14 Motor Speed High Limit [Hz]* and *4-19 Max Output Frequency*.	Program correct limits.
	Reference input signal not scaled correctly	Check reference input signal scaling in *6-0* Analog I/O Mode* and parameter group *3-1* References*. Reference limits in parameter group *3-0* Reference Limits*.	Program correct settings.
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed-loop operation, check PID settings.	Check settings in parameter group *1-6* Load Depen. Setting*. For closed-loop operation, check settings in parameter group *20-0* Feedback*.
Motor runs rough	Possible overmagnetization	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups *1-2* Motor Data, 1-3* Addl. Motor Data*, and *1-5* Load Indep. Setting*.
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short ramp-down times	Check brake parameters. Check ramp time settings.	Check parameter group *2-0* DC Brake* and *3-0* Reference Limits*.
Open power fuses or circuit breaker trip	Phase-to-phase short	Motor or panel has a short phase-to-phase. Check motor and panel phase for shorts.	Eliminate any short circuits detected.
	Motor overload	Motor is overloaded for the application.	Perform start-up test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application.
	Loose connections	Perform pre-start-up check for loose connections.	Tighten loose connections.
Line power current imbalance greater than 3%	Problem with line power (See *Alarm 4 Mains phase loss* description)	Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check line power supply.
	Problem with the adjustable frequency drive	Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with the adjustable frequency drive	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
Adjustable frequency drive acceleration problems	Motor data are entered incorrectly	If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*. Check that motor data are entered correctly.	Increase the ramp-up time in *3-41 Ramp 1 Ramp-up Time*. Increase current limit in *4-18 Current Limit*. Increase torque limit in *4-16 Torque Limit Motor Mode*.
Adjustable frequency drive deceleration problems	Motor data are entered incorrectly	If warnings or alarms occur, see *chapter 7.4 List of Warnings and Alarms*. Check that motor data are entered correctly.	Increase the ramp-down time in *3-42 Ramp 1 Ramp-down Time*. Enable overvoltage control in *2-17 Over-voltage Control*.

Symptom	Possible cause	Test	Solution
Acoustic noise or vibration	Resonances	Bypass critical frequencies by using parameters in parameter group *4-6* Speed Bypass*.	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off over-modulation in *14-03 Overmodulation*.	
		Change switching pattern and frequency in parameter group *14-0* Inverter Switching*.	
		Increase Resonance Dampening in *1-64 Resonance Damping*.	

Table 7.6 Troubleshooting

8 Specifications

8.1 Electrical Data

8.1.1 Line Power Supply 1x200–240 V AC

Type designation	P1K1	P1K5	P2K2	P3K0	P3K7	P5K5	P7K5	P15K	P22K
Typical shaft output [kW]	1.1	1.5	2.2	3.0	3.7	5.5	7.5	15	22
Typical shaft output at 240 V [hp]	1.5	2.0	2.9	4.0	4.9	7.5	10	20	30
Protection rating IP20/Chassis	A3	-	-	-	-	-	-	-	-
Protection rating IP21/Type 1	-	B1	B1	B1	B1	B1	B2	C1	C2
Protection rating IP55/Type 12	A5	B1	B1	B1	B1	B1	B2	C1	C2
Protection rating IP66/NEMA 4X	A5	B1	B1	B1	B1	B1	B2	C1	C2
Output current									
Continuous (3x200–240 V) [A]	6.6	7.5	10.6	12.5	16.7	24.2	30.8	59.4	88
Intermittent (3x200–240 V) [A]	7.3	8.3	11.7	13.8	18.4	26.6	33.4	65.3	96.8
Continuous kVA at 208 V [kVA]	2.4	2.7	3.8	4.5	6.0	8.7	11.1	21.4	31.7
Maximum input current									
Continuous (1x200–240 V) [A]	12.5	15	20.5	24	32	46	59	111	172
Intermittent (1x200–240 V) [A]	13.8	16.5	22.6	26.4	35.2	50.6	64.9	122.1	189.2
Maximum pre-fuses [A]	20	30	40	40	60	80	100	150	200
Additional specifications									
Maximum cable cross-section (mains, motor, brake) [mm^2] ([AWG])	0.2-4 (4-10)					10 (7)	35 (2)	50 (1/0)	95 (4/0)
Maximum cable cross-section for mains with disconnect switch [mm2] ([AWG])	5.26 (10)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	2 x 50 (2 x 1/0)[9) 10)]
Maximum cable cross-section for mains without disconnect switch [mm2] ([AWG])	5.26 (10)	16 (6)	16 (6)	16 (6)	16 (6)	16 (6)	25 (3)	50 (1/0)	95 (4/0)
Cable insulation temperature rating [°C] ([°F])	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)	75 (167)
Estimated power loss[3)] at rated maximum load [W][4)]	44	30	44	60	74	110	150	300	440
Efficiency[5)]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 8.1 Mains Supply 1x200–240 V AC, Normal Overload 110% for 1 Minute, P1K1–P22K

8.1.2 Line Power Supply 3x200–240 V AC

Type Designation	PK25	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P3K7
Typical Shaft Output [kW]	0.25	0.37	0.55	0.75	1.1	1.5	2.2	3.0	3.7
Typical Shaft Output [HP] at 208 V	0.25	0.37	0.55	0.75	1.5	2.0	2.9	4.0	4.9
IP20/Chassis [6]	A2	A2	A2	A2	A2	A2	A2	A3	A3
IP21/Type 1	A2	A2	A2	A2	A2	A2	A2	A3	A3
IP55/Type 12	A5	A5	A5	A5	A5	A5	A5	A5	A5
IP66/NEMA 4X	A5	A5	A5	A5	A5	A5	A5	A5	A5
Output current									
Continuous (3x200–240 V) [A]	1.8	2.4	3.5	4.6	6.6	7.5	10.6	12.5	16.7
Intermittent (3x200–240 V) [A]	1.98	2.64	3.85	5.06	7.26	8.3	11.7	13.8	18.4
Continuous kVA (208 V AC) [kVA]	0.65	0.86	1.26	1.66	2.38	2.70	3.82	4.50	6.00
Max. input current									
Continuous (3x200–240 V) [A]	1.6	2.2	3.2	4.1	5.9	6.8	9.5	11.3	15.0
Intermittent (3x200–240 V) [A]	1.7	2.42	3.52	4.51	6.5	7.5	10.5	12.4	16.5
Max. pre-fuses [1] [A]	10	10	10	10	20	20	20	32	32
Additional Specifications									
Estimated power loss at rated max. load [W] [4]	21	29	42	54	63	82	116	155	185
Max. cable size (line power, motor, brake) [mm^2/(AWG)] [2]	[0.2–4]/(4–10)								
Efficiency [3]	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96

Table 8.2 Line Power Supply 3x200–240 V AC - Normal overload 110% for 1 minute, PK25-P3K7

8

Type Designation	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K
Typical Shaft Output [kW]	5.5	7.5	11	15	18.5	22	30	37	45
Typical Shaft Output [HP] at 208 V	7.5	10	15	20	25	30	40	50	60
IP20/Chassis [7]	B3	B3	B3	B4	B4	C3	C3	C4	C4
IP21/Type 1	B1	B1	B1	B2	C1	C1	C1	C2	C2
IP55/Type 12	B1	B1	B1	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X	B1	B1	B1	B2	C1	C1	C1	C2	C2
Output current									
Continuous (3x200–240 V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	115	143	170
Intermittent (3x200–240 V) [A]	26.6	33.9	50.8	65.3	82.3	96.8	127	157	187
Continuous kVA (208 V AC) [kVA]	8.7	11.1	16.6	21.4	26.9	31.7	41.4	51.5	61.2
Max. input current									
Continuous (3x200–240 V) [A]	22.0	28.0	42.0	54.0	68.0	80.0	104.0	130.0	154.0
Intermittent (3x200–240 V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	114.0	143.0	169.0
Max. pre-fuses [1] [A]	63	63	63	80	125	125	160	200	250
Additional Specifications									
Estimated power loss at rated max. load [W] [4]	269	310	447	602	737	845	1140	1353	1636
Max. cable size (line power, motor, brake) [mm²/(AWG)] [2]	[10]/(7)			[35]/(2)	[50]/(1/0)			[95]/(4/0)	[120]/(250 MCM)
Efficiency [3]	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97

Table 8.3 Line Power Supply 3x200–240 V AC - Normal overload 110% for 1 minute, P5K5-P45K

8.1.3 Line Power Supply 1x380–480 V AC

Type Designation	P7K5	P11K	P18K	P37K
Typical Shaft Output [kW]	7.5	11	18.5	37
Typical Shaft Output [HP] at 240 V	10	15	25	50
IP21/Type 1	B1	B2	C1	C2
IP55/Type 12	B1	B2	C1	C2
IP66/NEMA 4X	B1	B2	C1	C2
Output current				
Continuous (3x380–440 V) [A]	16	24	37.5	73
Intermittent (3x380–440 V) [A]	17.6	26.4	41.2	80.3
Continuous (3x441–480 V) [A]	14.5	21	34	65
Intermittent (3x441–480 V) [A]	15.4	23.1	37.4	71.5
Continuous kVA (400 V AC) [kVA]	11.0	16.6	26	50.6
Continuous kVA (460 V AC) [kVA]	11.6	16.7	27.1	51.8
Max. input current				
Continuous (1x380–440 V) [A]	33	48	78	151
Intermittent (1x380–440 V) [A]	36	53	85.5	166
Continuous (1x441–480 V) [A]	30	41	72	135
Intermittent (1x441–480 V) [A]	33	46	79.2	148
Max. pre-fuses[1] [A]	63	80	160	250
Additional specifications				
Estimated power loss at rated max. load [W] [4]	300	440	740	1480
Max. cable size (line power, motor, brake) [mm²]/(AWG) [2]	[10]/(7)	[35]/(2)	[50]/(1/0)	[120]/(4/0)
Efficiency [3]	0.96	0.96	0.96	0.96

Table 8.4 Line Power Supply 1x380–480 V AC - Normal Overload 110% for 1 Minute, P7K5-P37K

8.1.4 Line Power Supply 3x380–480 V AC

Type Designation	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output [kW]	0.37	0.55	0.75	1.1	1.5	2.2	3.0	4.0	5.5	7.5
Typical Shaft Output [HP] at 460 V	0.5	0.75	1.0	1.5	2.0	2.9	4.0	5.3	7.5	10
IP20/Chassis [6]	A2	A2	A2	A2	A2	A2	A2	A2	A3	A3
IP21/Type 1	-	-	-	-	-	-	-	-	-	-
IP55/Type 12	A5	A5	A5	A5	A5	A5	A5	A5	A5	A5
IP66/NEMA 4X	A5	A5	A5	A5	A5	A5	A5	A5	A5	A5
Output current										
Continuous (3x380–440 V) [A]	1.3	1.8	2.4	3.0	4.1	5.6	7.2	10	13	16
Intermittent (3x380–440 V) [A]	1.43	1.98	2.64	3.3	4.5	6.2	7.9	11	14.3	17.6
Continuous (3x441–480 V) [A]	1.2	1.6	2.1	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (3x441–480 V) [A]	1.32	1.76	2.31	3.0	3.7	5.3	6.9	9.0	12.1	15.4
Continuous kVA (400 V AC) [kVA]	0.9	1.3	1.7	2.1	2.8	3.9	5.0	6.9	9.0	11.0
Continuous kVA (460 V AC) [kVA]	0.9	1.3	1.7	2.4	2.7	3.8	5.0	6.5	8.8	11.6
Max. input current										
Continuous (3x380–440 V) [A]	1.2	1.6	2.2	2.7	3.7	5.0	6.5	9.0	11.7	14.4
Intermittent (3x380–440 V) [A]	1.32	1.76	2.42	3.0	4.1	5.5	7.2	9.9	12.9	15.8
Continuous (3x441–480 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7	7.4	9.9	13.0
Intermittent (3x441–480 V) [A]	1.1	1.54	2.09	3.0	3.4	4.7	6.3	8.1	10.9	14.3
Max. pre-fuses [1] [A]	10	10	10	10	10	20	20	20	30	30
Additional specifications										
Estimated power loss at rated max. load [W] [4]	35	42	46	58	62	88	116	124	187	225
Max. cable size (line power, motor, brake) [mm^2]/(AWG) [2]	[4]/(10)									
Efficiency [3]	0.93	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97

Table 8.5 Line Power Supply 3x380–480 V AC - Normal overload 110% for 1 minute, PK37-P7K5

Type Designation	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]	11	15	18.5	22	30	37	45	55	75	90
Typical Shaft Output [HP] at 460 V	15	20	25	30	40	50	60	75	100	125
IP20/Chassis 7)	B3	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/Type 1	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP55/Type 12	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
Output current										
Continuous (3x380–440 V) [A]	24	32	37.5	44	61	73	90	106	147	177
Intermittent (3x380–440 V) [A]	26.4	35.2	41.3	48.4	67.1	80.3	99	117	162	195
Continuous (3x441–480 V) [A]	21	27	34	40	52	65	80	105	130	160
Intermittent (3x441–480 V) [A]	23.1	29.7	37.4	44	61.6	71.5	88	116	143	176
Continuous kVA (400 V AC) [kVA]	16.6	22.2	26	30.5	42.3	50.6	62.4	73.4	102	123
Continuous kVA (460 V AC) [kVA]	16.7	21.5	27.1	31.9	41.4	51.8	63.7	83.7	104	128
Max. input current										
Continuous (3x380–440 V) [A]	22	29	34	40	55	66	82	96	133	161
Intermittent (3x380–440 V) [A]	24.2	31.9	37.4	44	60.5	72.6	90.2	106	146	177
Continuous (3x441–480 V) [A]	19	25	31	36	47	59	73	95	118	145
Intermittent (3x441–480 V) [A]	20.9	27.5	34.1	39.6	51.7	64.9	80.3	105	130	160
Max. pre-fuses 1) [A]	63	63	63	63	80	100	125	160	250	250
Additional specifications										
Estimated power loss at rated max. load [W] 4)	278	392	465	525	698	739	843	1083	1384	1474
Max. cable size (line power, motor, brake) [mm²]/(AWG) 2)	[10]/(7)			[35]/(2)		[50]/(1/0)			[120]/(4/0)	[120]/(4/0)
Efficiency 3)	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99

Table 8.6 Line Power Supply 3x380–480 V AC - Normal overload 110% for 1 minute, P11K-P90K

8.1.5 Line Power Supply 3x525–600 V AC

Type Designation	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5	P11K
Typical Shaft Output [kW]	0.75	1.1	1.5	2.2	3.0	4.0	5.5	7.5	11
IP20/Chassis	A2	A2	A2	A2	A2	A2	A3	A3	B3
IP21/Type 1	A2	A2	A2	A2	A2	A2	A3	A3	B1
IP55/Type 12	A5	A5	A5	A5	A5	A5	A5	A5	B1
IP66/NEMA 4X	A5	A5	A5	A5	A5	A5	A5	A5	B1
Output current									
Continuous (3 x 525–550 V) [A]	1.8	2.6	2.9	4.1	5.2	6.4	9.5	11.5	19
Intermittent (3 x 525–550 V) [A]	-	2.9	3.2	4.5	5.7	7.0	10.5	12.7	21
Continuous (3x525–600 V) [A]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0	18
Intermittent (3x525–600 V) [A]	-	2.6	3.0	4.3	5.4	6.7	9.9	12.1	20
Continuous kVA (525 V AC) [kVA]	1.7	2.5	2.8	3.9	5.0	6.1	9.0	11.0	18.1
Continuous kVA (575 V AC) [kVA]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0	17.9
Max. input current									
Continuous (3x525–600 V) [A]	1.7	2.4	2.7	4.1	5.2	5.8	8.6	10.4	17.2
Intermittent (3x525–600 V) [A]	-	2.7	3.0	4.5	5.7	6.4	9.5	11.5	19
Max. pre-fuses[1] [A]	10	10	10	20	20	20	32	32	40
Additional specifications									
Estimated power loss at rated max. load [W] [4]	35	50	65	92	122	145	195	261	225
Max. cable size (line power, motor, brake) [mm^2]/(AWG) [2]	[0.2–4]/(24–10)								[16]/(6)
Efficiency [3]	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.98

Table 8.7 Line Power Supply 3x525–600 V AC - Normal overload 110% for 1 minute, PK75-P11K

8

Type Designation	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]	15	18.5	22	30	37	45	55	75	90
IP20/Chassis	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/Type 1	B1	B1	B2	B2	B2	C1	C1	C2	C2
IP55/Type 12	B1	B1	B2	B2	B2	C1	C1	C2	C2
IP66/NEMA 4X	B1	B1	B2	B2	B2	C1	C1	C2	C2
Output current									
Continuous (3 x 525–550 V) [A]	23	28	36	43	54	65	87	105	137
Intermittent (3 x 525–550 V) [A]	25	31	40	47	59	72	96	116	151
Continuous (3x525–600 V) [A]	22	27	34	41	52	62	83	100	131
Intermittent (3x525–600 V) [A]	24	30	37	45	57	68	91	110	144
Continuous kVA (525 V AC) [kVA]	21.9	26.7	34.3	41	51.4	61.9	82.9	100	130.5
Continuous kVA (575 V AC) [kVA]	21.9	26.9	33.9	40.8	51.8	61.7	82.7	99.6	130.5
Max. input current									
Continuous (3x525–600 V) [A]	20.9	25.4	32.7	39	49	59	78.9	95.3	124.3
Intermittent (3x525–600 V) [A]	23	28	36	43	54	65	87	105	137
Max. pre-fuses[1] [A]	40	50	60	80	100	150	160	225	250
Additional specifications									
Estimated power loss at rated max. load [W] [4]	285	329	460	560	740	860	890	1020	1130
Max. cable size (line power, motor, brake) [mm²]/(AWG) [2]	-		[35]/(2)			[50]/(1)		[95[5]]/(3/0)	
Efficiency [3]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 8.8 Line power supply 3x525–600 V AC - Normal overload 110% for 1 minute, P15K-P90K

8.1.6 Line Power Supply 3 x 525–690 V AC

Type Designation	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft output (kW)	1.1	1.5	2.2	3.0	4.0	5.5	7.5
IP20/ Chassis	A3	A3	A3	A3	A3	A3	A3
Output current							
Continuous (3 x 525–550 V) [A]	2.1	2.7	3.9	4.9	6.1	9.0	11.0
Intermittent (3 x 525–550 V) [A]	3.4	4.3	6.2	7.8	9.8	14.4	17.6
Continuous (3x551–690 V) [A]	1.6	2.2	3.2	4.5	5.5	7.5	10.0
Intermittent (3x551–690 V) [A]	2.6	3.5	5.1	7.2	8.8	12.0	16.0
Continuous KVA 525 V AC	1.9	2.5	3.5	4.5	5.5	8.2	10.0
Continuous KVA 690 V AC	1.9	2.6	3.8	5.4	6.6	9.0	12.0
Max. input current							
Continuous (3 x 525–550 V) [A]	1.9	2.4	3.5	4.4	5.5	8.1	9.9
Intermittent (3 x 525–550 V) [A]	3.0	3.9	5.6	7.0	8.8	12.9	15.8
Continuous (3x551–690 V) [A]	1.4	2.0	2.9	4.0	4.9	6.7	9.0
Intermittent (3x551–690 V) [A]	2.3	3.2	4.6	6.5	7.9	10.8	14.4
Additional specifications							
Max. cable cross-section [5] for line power, motor, brake and load sharing [mm²] ([AWG])	4, 4, 4 (12, 12, 12) (min. 0.2 (24)						
Max. cable cross-section [5] for disconnect [mm²] ([AWG])	6, 4, 4 (10, 12, 12)						
Estimated power loss at rated max. load (W) [4]	44	60	88	120	160	220	300
Efficiency [3]	0.96	0.96	0.96	0.96	0.96	0.96	0.96

Table 8.9 A3 Enclosure, Line Power Supply 3x525–690 V AC IP20/Protected Chassis, P1K1-P7K5

Type Designation	P11K	P15K	P18K	P22K
Typical Shaft output at 550 V [kW]	11	15	18.5	22
Typical Shaft output at 690 V [kW]	15	18.5	22	30
IP20/Chassis	B4	B4	B4	B4
IP21/Type 1, IP55/Type 12	B2	B2	B2	B2
Output current				
Continuous (3 x 525–550 V) [A]	19.0	23.0	28.0	36.0
Intermittent (60 s overload) (3x525–550 V) [A]	20.9	25.3	30.8	39.6
Continuous (3x551–690 V) [A]	18.0	22.0	27.0	34.0
Intermittent (60 s overload) (3x551–690 V) [A]	19.8	24.2	29.7	37.4
continuous KVA (at 550 V) [KVA]	18.1	21.9	26.7	34.3
continuous KVA (at 690 V AC) [KVA]	21.5	26.3	32.3	40.6
Max. input current				
Continuous (at 550 V) (A)	19.5	24.0	29.0	36.0
Intermittent (60 s overload) (at 550 V) (A)	21.5	26.4	31.9	39.6
Continuous (at 690 V) (A)	19.5	24.0	29.0	36.0
Intermittent (60 s overload) (at 690 V) (A)	21.5	26.4	31.9	39.6
Additional specifications				
Max. cable cross-section [5] for line power/motor, load share and brake [mm^2] ([AWG])	35, 25, 25 (2, 4, 4)			
Max cable cross-section [54] for line power disconnect [mm^2] ([AWG])	16,10,10 (6, 8, 8)			
Estimated power loss at rated max. load (W) [4]	220	300	370	440
Efficiency [3]	0.98	0.98	0.98	0.98

Table 8.10 B2/B4 Enclosure, Line Power Supply 3x525–690 V AC IP20/IP21/IP55 - Chassis/NEMA 1/NEMA 12, P11K-P22K

8

Type Designation	P30K	P37K	P45K	P55K	P75K
Typical Shaft output at 550 V hp [kW]	30	37	45	55	75
Typical Shaft output at 690 V [kW]	37	45	55	75	90
IP20/Chassis	B4	C3	C3	D3h	D3h
IP21/Type 1, IP55/Type 12	C2	C2	C2	C2	C2
Output current					
Continuous (3 x 525–550 V) [A]	43.0	54.0	65.0	87.0	105
Intermittent (60 s overload) (3x525–550 V) [A]	47.3	59.4	71.5	95.7	115.5
Continuous (3x551–690 V) [A]	41.0	52.0	62.0	83.0	100
Intermittent (60 s overload) (3x551–690 V) [A]	45.1	57.2	68.2	91.3	110
continuous KVA (at 550 V AC) [KVA]	41.0	51.4	61.9	82.9	100
continuous KVA (at 690 V AC) [KVA]	49.0	62.1	74.1	99.2	119.5
Max. input current					
Continuous (at 550 V) [A]	49.0	59.0	71.0	87.0	99.0
Intermittent (60 s overload) (at 550 V) [A]	53.9	64.9	78.1	95.7	108.9
Continuous (at 690 V) [A]	48.0	58.0	70.0	86.0	-
Intermittent (60 s overload) (at 690 V) [A]	52.8	63.8	77.0	94.6	-
Additional specifications					
Max. cable-cross section for line power and motor [mm^2] ([AWG])	150 (300 MCM)				
Max. cable cross-section for load share and brake [mm^2] ([AWG])	95 (3/0)				
Max cable cross-section [5] for line power disconnect [mm^2] ([AWG])	95, 70, 70 (3/0, 2/0, 2/0)			185, 150, 120 (350 MCM, 300 MCM, 4/0)	-
Estimated power loss at rated max. load [W] [4]	740	900	1100	1500	1800
Efficiency [3]	0.98	0.98	0.98	0.98	0.98

Table 8.11 B4, C2, C3 Enclosure, Line Power Supply 3x525–690 V AC IP20/IP21/IP55 - Chassis/NEMA1/NEMA 12, P30K-P75K

For fuse ratings see chapter 8.8 Fuses and Circuit Breakers.

1) High overload=150% or 160% torque for a duration of 60 s. Normal overload=110% torque for a duration of 60 s.

2) The 3 values for the maximum cable cross-section are for single core, flexible wire and flexible wire with sleeve, respectively.

3) Applies for dimensioning of frequency converter 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 www.danfoss.com/vltenergyefficiency.

4) Efficiency measured at nominal current. For energy efficiency class see chapter 8.4.1 Ambient Conditions. For part load losses see www.danfoss.com/vltenergyefficiency.

5) Measured using 5 m screened motor cables at rated load and rated frequency.

6) Enclosure sizes A2+A3 can be converted to IP21 using a conversion kit. See also Mechanical mounting and IP21/Type 1 Enclosure kit in the Design Guide.

7) Enclosure sizes B3+B4 and C3+C4 can be converted to IP21 using a conversion kit. See also Mechanical mounting and IP21/Type 1 Enclosure kit in the Design Guide.

8) Enclosure sizes for N75K, N90K are D3h for IP20/Chassis, and D5h for IP54/Type 12.

9) 2 wires are required.

10) Variant not available in IP21.

8.2 Line Power Supply

Line power supply (L1, L2, L3)	
Supply voltage	200–240 V ±10%
Supply voltage	380–480 V ±10%
Supply voltage	525–600 V ±10%
Supply voltage	525–690 V ±10%

AC line voltage low/line drop-out:
During low AC line voltage or a line drop-out, the adjustable frequency drive continues until the intermediate circuit voltage drops below the minimum stop level which corresponds typically to 15% below the lowest rated supply voltage of the adjustable frequency drive. Power-up and full torque cannot be expected at AC line voltage lower than 10% below the lowest rated supply voltage of the adjustable frequency drive.

Supply frequency	50/60 Hz +4/-6%

The adjustable frequency drive power supply is tested in accordance with IEC61000-4-28, 50 Hz +4/-6%.

Max. temporary imbalance between line phases	3.0% of rated supply voltage
True Power Factor (λ)	≥ 0.9 nominal at rated load
Displacement Power Factor (cosφ) near unity	(> 0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤ 7.5 kW	maximum 2 times/min.
Switching on input supply L1, L2, L3 (power-ups) 11–90 kW	maximum 1 time/min.
Environment according to EN60664-1	Overvoltage category III/pollution degree 2

The unit is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 240/480/600/690 V maximum.

8.3 Motor Output and Motor Data

Motor output (U, V, W)	
Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz*
Switching on output	Unlimited
Ramp times	1–3600 s

** Dependent on power size.*

Torque characteristics	
Starting torque (Constant torque)	Maximum 110% for 1 min.*
Starting torque	maximum 135% up to 0.5 s*
Overload torque (Constant torque)	Maximum 110% for 1 min.*

**Percentage relates to the nominal torque of the adjustable frequency drive.*

8.4 Ambient Conditions

Environment	
Enclosure type A	IP20/Chassis, IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure type B1/B2	IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure type B3/B4	IP20/Chassis
Enclosure type C1/C2	IP21/Type 1, IP55/Type 12, IP66/Type 4X
Enclosure type C3/C4	IP20/Chassis
Enclosure kit available ≤ enclosure type A	IP21/TYPE 1/IP4X top
Vibration test enclosure A/B/C	1.0 g
Max. relative humidity	5%–95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 721-3-3), uncoated	class 3C2
Aggressive environment (IEC 721-3-3), coated	class 3C3
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature	Max. 122 °F [50 °C]

Derating for high ambient temperature, see section on special conditions in the Design Guide.

Minimum ambient temperature during full-scale operation	32 °F [0 °C]
Minimum ambient temperature at reduced performance	14 °F [-10 °C]
Temperature during storage/transport	-13 to +149/158 °F [-25 to +65/70 °C]
Maximum altitude above sea level without derating	3300 ft [1000 m]
Maximum altitude above sea level with derating	10,000 ft [3000 m]

Derating for high altitude, see section on special conditions in the Design Guide.

EMC standards, Emission	EN 61800-3
EMC standards, Immunity	EN 61800-3

See section on special conditions in the Design Guide.

8.5 Cable Specifications

Cable lengths and cross-sections for control cables[1)]	
Max. motor cable length, shielded/armored	500 ft [150 m]
Max. motor cable length, non-shielded/unarmored	10,000 ft [300 m]
Max. cross-section to motor, line power, load sharing and brake *	
Maximum cross-section to control terminals, rigid wire	1.5 mm^2/16 AWG (2 x 0.75 mm^2)
Maximum cross-section to control terminals, flexible cable	1 mm^2/18 AWG
Maximum cross-section to control terminals, cable with enclosed core	0.5 mm^2/20 AWG
Minimum cross-section to control terminals	0.00039 in^2 [0.25 mm^2]

[1)] For power cables, see electrical data tables in chapter 8.1 Electrical Data.

** See electrical data tables in chapter 8.1 Electrical Data for more information!*

8.6 Control Input/Output and Control Data

Control card, RS-485 serial communication	
Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS-485 serial communication circuit is functionally seated from other central circuits and galvanically isolated from the supply voltage (PELV).

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	0 to +10 V (scaleable)
Input resistance, R_i	approx. 10 kΩ
Max. voltage	±20 V
Current mode	Switch S201/switch S202 = ON (I)
Current level	0/4 to 20 mA (scaleable)
Input resistance, R_i	approx. 200 Ω
Max. current	30 mA
Resolution for analog inputs	10 bit (+ sign)
Accuracy of analog inputs	Max. error 0.5% of full scale
Bandwidth	200 Hz

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

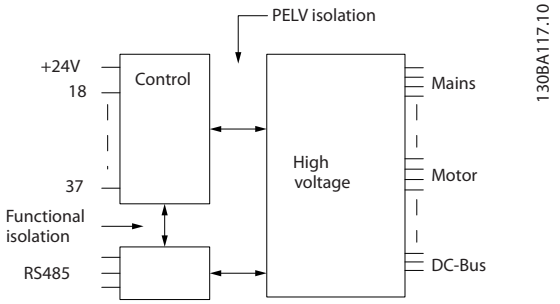


Figure 8.1 PELV Isolation of Analog Inputs

Analog output	
Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4–20 mA
Max. resistor load to common at analog output	500 Ω
Accuracy on analog output	Max. error: 0.8% of full scale
Resolution on analog output	8 bit

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

Digital inputs	
Programmable digital inputs	4 (6)
Terminal number	18, 19, 27 [1], 29 [1], 32, 33,
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic'0' PNP	<5 V DC
Voltage level, logic'1' PNP	>10 V DC
Voltage level, logic '0' NPN	>19 V DC
Voltage level, logic '1' NPN	<14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ

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

1) Terminals 27 and 29 can also be programmed as output.

Digital output	
Programmable digital/pulse outputs	2
Terminal number	27, 29 [1]
Voltage level at digital/frequency output	0–24 V
Max. output current (sink or source)	40 mA
Max. load at frequency output	1 kΩ
Max. 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	Max. error: 0.1% of full scale
Resolution of frequency outputs	12 bit

1) Terminal 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.

Pulse inputs	
Programmable pulse inputs	2
Terminal number pulse	29, 33
Max. frequency at terminal, 29, 33	110 kHz (push-pull driven)
Max. frequency at terminal, 29, 33	5 kHz (open collector)
Min. frequency at terminal 29, 33	4 Hz
Voltage level	see *chapter 8.6.1*
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Max. error: 0.1% of full scale
Control card, 24 V DC output	
Terminal number	12, 13
Max. load	200 mA

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

Relay outputs	
Programmable relay outputs	2
Relay 01 Terminal number	1-3 (break), 1-2 (make)
Max. terminal load (AC-1)[1] on 1-3 (NC), 1-2 (NO) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1] (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1] on 1-2 (NO), 1-3 (NC) (Resistive load)	60 V DC, 1 A
Max. terminal load (DC-13)[1] (Inductive load)	24 V DC, 0.1 A
Relay 02 Terminal number	4-6 (break), 4-5 (make)
Max. terminal load (AC-1)[1] on 4-5 (NO) (resistive load)[2][3]	400 V AC, 2 A
Max. terminal load (AC-15)[1] on 4-5 (NO) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1] on 4-5 (NO) (Resistive load)	80 V DC, 2 A
Max. terminal load (DC-13)[1] on 4-5 (NO) (Inductive load)	24 V DC, 0.1 A
Max. terminal load (AC-1)[1] on 4-6 (NC) (Resistive load)	240 V AC, 2 A
Max. terminal load (AC-15)[1] on 4-6 (NC) (Inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Max. terminal load (DC-1)[1] on 4-6 (NC) (Resistive load)	50 V DC, 2 A
Max. terminal load (DC-13)[1] on 4-6 (NC) (Inductive load)	24 V DC, 0.1 A
Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	overvoltage category III/pollution degree 2

1) IEC 60947 parts 4 and 5

The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).

2) Overvoltage Category II

3) UL applications 300 V AC 2 A

Control card, 10 V DC output	
Terminal number	50
Output voltage	10.5 V ±0.5 V
Max. load	25 mA

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

Control characteristics	
Resolution of output frequency at 0–590 Hz	±0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms
Speed control range (open-loop)	1:100 of synchronous speed
Speed accuracy (open-loop)	30–4000 rpm: Maximum error of ±8 RPM

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

Control card performance	
Scan interval	5 ms
Control card, USB serial communication	
USB standard	1.1 (Full speed)
USB plug	USB type B “device” plug

⚠CAUTION

Connection to PC is carried out via a standard host/device USB cable.

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

The USB connection is not galvanically isolated from ground protection. Use only isolated laptop/PC as connection to the USB connector on the adjustable frequency drive or an isolated USB cable/drive.

8.7 Connection Tightening Torques

	Torque (ft-lb [Nm])					
Enclosure	Line power	Motor	DC connection	Brake	Ground	Relay
A2	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	2.21 [3]	0.44 [0.6]
A3	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	2.21 [3]	0.44 [0.6]
A4	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	2.21 [3]	0.44 [0.6]
A5	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	2.21 [3]	0.44 [0.6]
B1	1.33 [1.8]	1.33 [1.8]	2 [1.5]	2 [1.5]	2.21 [3]	0.44 [0.6]
B2	3.32 [4.5]	3.32 [4.5]	2.73 [3.7]	2.73 [3.7]	2.21 [3]	0.44 [0.6]
B3	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	1.33 [1.8]	2.21 [3]	0.44 [0.6]
B4	3.32 [4.5]	3.32 [4.5]	3.32 [4.5]	3.32 [4.5]	2.21 [3]	0.44 [0.6]
C1	7.38 [10]	7.38 [10]	7.38 [10]	7.38 [10]	2.21 [3]	0.44 [0.6]
C2	10.33/17.7 [14/24][1)]	10.33/17.7 [14/24][1)]	10.33 [14]	10.33 [14]	2.21 [3]	0.44 [0.6]
C3	7.38 [10]	7.38 [10]	7.38 [10]	7.38 [10]	2.21 [3]	0.44 [0.6]
C4	10.33/17.7 [14/24][1)]	10.33/17.7 [14/24][1)]	10.33 [14]	10.33 [14]	2.21 [3]	0.44 [0.6]

Table 8.12 Tightening of Terminals

[1)] For different cable dimensions x/y, where x ≤ 4/0 AWG [95 mm^2] and y ≥ 4/0 AWG [95 mm^2].

8.8 Fuses and Circuit Breakers

Use recommended fuses and/or circuit breakers on the supply side as protection in case of component breakdown inside the adjustable frequency drive (first fault).

NOTICE!

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

Recommendations

- Fuses of the type gG.
- Circuit breakers of Moeller types. By use of other circuit breaker types, ensure that the energy into the adjustable frequency drive is equal to or lower than the energy provided by Moeller types.

If fuses/circuit breakers according to recommendations are chosen, possible damage on the adjustable frequency drive will mainly be limited to damage inside the unit. For further information, see *Application Note Fuses and Circuit Breakers, MN90T*.

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical), depending on the adjustable frequency drive voltage rating. With the proper fusing the adjustable frequency drive Short Circuit Current Rating (SCCR) is 100,000 Arms.

8.8.1 CE Compliance

200–240 V

Enclosure	Power [kW]	Recommended fuse size	Recommended max. fuse	Recommended circuit breaker Moeller	Max. trip level [A]
A2	0.34–3 [0.25–2.2]	gG-10 (0.34–2 [0.25–1.5]) gG-16 (3 [2.2])	gG-25	PKZM0-25	25
A3	4–5 [3.0–3.7]	gG-16 (4 [3]) gG-20 (5 [3.7])	gG-32	PKZM0-25	25
A4	0.34–3 [0.25–2.2]	gG-10 (0.34–2 [0.25–1.5]) gG-16 (3 [2.2])	gG-32	PKZM0-25	25
A5	0.34–5 [0.25–3.7]	gG-10 (0.34–2 [0.25–1.5]) gG-16 (3–4 [2.2–3]) gG-20 (5 [3.7])	gG-32	PKZM0-25	25
B1	7.5–15 [5.5–11]	gG-25 (7.5 [5.5]) gG-32 (10 [7.5])	gG-80	PKZM4-63	63
B2	15	gG-50	gG-100	NZMB1-A100	100
B3	7.5–15 [5.5–11]	gG-25	gG-63	PKZM4-50	50
B4	11–24 [15–18]	gG-32 (10 [7.5]) gG-50 (15 [11]) gG-63 (20 [15])	gG-125	NZMB1-A100	100
C1	25–40 [18.5–30]	gG-63 (20 [15]) gG-80 (25 [18.5]) gG-100 (30 [22])	gG-160 (20–25 [15-18.5]) aR-160 (30 [22])	NZMB2-A200	160
C2	50–60 [37–45]	aR-160 (40 [30]) aR-200 (50 [37])	aR-200 (40 [30]) aR-250 (50 [37])	NZMB2-A250	250
C3	30–40 [22–30]	gG-80 (25 [18.5]) aR-125 (30 [22])	gG-150 (25 [18.5]) aR-160 (30 [22])	NZMB2-A200	150
C4	50–60 [37–45]	aR-160 (40 [30]) aR-200 (50 [37])	aR-200 (40 [30]) aR-250 (50 [37])	NZMB2-A250	250

Table 8.13 200–240 V, Enclosure Types A, B and C

380–480 V

Enclosure	Power [kW]	Recommended fuse size	Recommended max. fuse	Recommended circuit breaker Moeller	Max. trip level [A]
A2	1.5–5 [1.1–4.0]	gG-10 (0.5–4 [0.37–3]) gG-16 (5 [4])	gG-25	PKZM0-25	25
A3	7.5–10 [5.5–7.5]	gG-16	gG-32	PKZM0-25	25
A4	1.5–5 [1.1–4.0]	gG-10 (0.5–4 [0.37–3]) gG-16 (5 [4])	gG-32	PKZM0-25	25
A5	1.5–10 [1.1–7.5]	gG-10 (0.5–4 [0.37–3]) gG-16 (5–10 [4–7.5])	gG-32	PKZM0-25	25
B1	15–25 [11–18.5]	gG-40	gG-80	PKZM4-63	63
B2	30–40 [22–30]	gG-50 (25 [18.5]) gG-63 (30 [22])	gG-100	NZMB1-A100	3.94 [100]
B3	15–25 [11–18]	gG-40	gG-63	PKZM4-50	50
B4	30–50 [22–37]	gG-50 (25 [18.5]) gG-63 (30 [22]) gG-80 (40 [30])	gG-125	NZMB1-A100	100
C1	50–75 [37–55]	gG-80 (40 [30]) gG-100 (50 [37]) gG-160 (60 [45])	gG-160	NZMB2-A200	160
C2	100–125 [75–90]	aR-200 (75 [55]) aR-250 (100 [75])	aR-250	NZMB2-A250	250
C3	60–75 [45–55]	gG-100 (50 [37]) gG-160 (60 [45])	gG-150 (50 [37]) gG-160 (60 [45])	NZMB2-A200	150
C4	100–125 [75–90]	aR-200 (75 [55]) aR-250 (100 [75])	aR-250	NZMB2-A250	250

Table 8.14 380–480 V, Enclosure Types A, B and C

525–600 V

Enclosure	Power [kW]	Recommended fuse size	Recommended max. fuse	Recommended circuit breaker Moeller	Max. trip level [A]
A2	1.5–5 [1.1–4.0]	gG-10	gG-25	PKZM0-25	25
A3	7.5–10 [5.5–7.5]	gG-10 (7.5 [5.5]) gG-16 (10 [7.5])	gG-32	PKZM0-25	25
A5	1.5–10 [1.1–7.5]	gG-10 (1–7.5 [0.75–5.5]) gG-16 (10 [7.5])	gG-32	PKZM0-25	25
B1	15–25 [11–18]	gG-25 (15 [11]) gG-32 (20 [15]) gG-40 (25 [18.5])	gG-80	PKZM4-63	63
B2	30–40 [22–30]	gG-50 (30 [22]) gG-63 (40 [30])	gG-100	NZMB1-A100	100
B3	15–25 [11–18.5]	gG-25 (15 [11]) gG-32 (20 [15])	gG-63	PKZM4-50	50
B4	30–50 [22–37]	gG-40 (25 [18.5]) gG-50 (30 [22]) gG-63 (40 [30])	gG-125	NZMB1-A100	100
C1	50–75 [37–55]	gG-63 (50 [37]) gG-100 (60 [45]) aR-160 (75 [55])	gG-160 (50–60 [37–45]) aR-250 (75 [55])	NZMB2-A200	160
C2	100–125 [75–90]	aR-200 (100 [75])	aR-250	NZMB2-A250	250
C3	60–75 [45–55]	gG-63 (50 [37]) gG-100 (60 [45])	gG-150	NZMB2-A200	150
C4	100–125 [75–90]	aR-160 (75 [55]) aR-200 (100 [75])	aR-250	NZMB2-A250	250

Table 8.15 525–600 V, Enclosure Types A, B and C

525–690 V

Enclosure	Power [kW]	Recommended fuse size	Recommended max. fuse	Recommended circuit breaker Danfoss	Max. trip level [A]
A3	1.5 [1.1]	gG-6	gG-25	CTI25M 10-16	16
	2 [1.5]	gG-6	gG-25	CTI25M 10-16	16
	3 [2.2]	gG-6	gG-25	CTI25M 10-16	16
	4 [3]	gG-10	gG-25	CTI25M 10-16	16
	5 [4]	gG-10	gG-25	CTI25M 10-16	16
	7.5 [5.5]	gG-16	gG-25	CTI25M 10-16	16
	10 [7.5]	gG-16	gG-25	CTI25M 10-16	16
B2	15 [11]	gG-25	gG-63		
	15	gG-25	gG-63		
	24 [18]	gG-32			
	30 [22]	gG-32			
C2	40 [30]	gG-40			
	50 [37]	gG-63	gG-80		
	60 [45]	gG-63	gG-100		
	75 [55]	gG-80	gG-125		
	100 [75]	gG-100	gG-160		
C3	50 [37]	gG-100	gG-125		
	60 [45]	gG-125	gG-160		

Table 8.16 525–690 V, Enclosure Types A, B, C

8.8.2 UL Compliance

1x200–240 V

Recommended max. fuse													
Power [kW]	Max. pre-fuse size [A]	Buss-mann JFHR2	Buss-mann RK1	Buss-mann J	Buss-mann T	Buss-mann CC	Buss-mann CC	Buss-mann CC	SIBA RK1	Littelfuse RK1	Ferraz-Shawmut CC	Ferraz-Shawmut RK1	Ferraz-Shawmut J
1.5 [1.1]	15	FWX-15	KTN-R15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15	5017906-016	KLN-R15	ATM-R15	A2K-15R	HSJ15
2 [1.5]	20	FWX-20	KTN-R20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLN-R20	ATM-R20	A2K-20R	HSJ20
3 [2.2]	30*	FWX-30	KTN-R30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30	5012406-032	KLN-R30	ATM-R30	A2K-30R	HSJ30
4 [3.0]	35	FWX-35	KTN-R35	JKS-35	JJN-35				---	KLN-R35	---	A2K-35R	HSJ35
5 [3.7]	50	FWX-50	KTN-R50	JKS-50	JJN-50				5014006-050	KLN-R50	---	A2K-50R	HSJ50
7.5 [5.5]	60**	FWX-60	KTN-R60	JKS-60	JJN-60				5014006-063	KLN-R60	---	A2K-60R	HSJ60
10 [7.5]	80	FWX-80	KTN-R80	JKS-80	JJN-80				5014006-080	KLN-R80	---	A2K-80R	HSJ80
20 [15]	150	FWX-150	KTN-R150	JKS-150	JJN-150				2028220-150	KLN-R150		A2K-150R	HSJ150
30 [22]	200	FWX-200	KTN-R200	JKS-200	JJN-200				2028220-200	KLN-R200		A2K-200R	HSJ200

Table 8.17 1x200–240 V, Enclosure Types A, B and C

** Siba allowed up to 32 A.*

*** Siba allowed up to 63 A.*

1x380–500 V

Recommended max. fuse													
Power [kW]	Max. pre-fuse size [A]	Buss-mann JFHR2	Buss-mann RK1	Buss-mann J	Buss-mann T	Buss-mann CC	Buss-mann CC	Buss-mann CC	SIBA RK1	Littelfuse RK1	Ferraz-Shawmut CC	Ferraz-Shawmut RK1	Ferraz-Shawmut J
10 [7.5]	60	FWH-60	KTS-R60	JKS-60	JJS-60				5014006-063	KLS-R60	-	A6K-60R	HSJ60
15 [11]	80	FWH-80	KTS-R80	JKS-80	JJS-80				2028220-100	KLS-R80	-	A6K-80R	HSJ80
30 [22]	150	FWH-150	KTS-R150	JKS-150	JJS-150				2028220-160	KLS-R150	-	A6K-150R	HSJ150
50 [37]	200	FWH-200	KTS-R200	JKS-200	JJS-200				2028220-200	KLS-200		A6K-200R	HSJ200

Table 8.18 1x380–500 V, Enclosure Types B and C

KTS fuses from Bussmann may substitute KTN for 240 V adjustable frequency drives.

FWH fuses from Bussmann may substitute FWX for 240 V adjustable frequency drives.

JJS fuses from Bussmann may substitute JJN for 240 V adjustable frequency drives.
KLSR fuses from Littelfuse may substitute KLNR fuses for 240 V adjustable frequency drives.
A6KR fuses from Ferraz-Shawmut may substitute A2KR for 240 V adjustable frequency drives.

3x200–240 V

	Recommended max. fuse					
Power [kW]	**Bussmann Type RK1** [1]	**Bussmann Type J**	**Bussmann Type T**	**Bussmann Type CC**	**Bussmann**	**Bussmann Type CC**
0.34–5 [0.25–0.37]	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
0.75–1.5 [0.55–1.1]	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
2 [1.5]	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
3 [2.2]	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
4 [3.0]	KTN-R-25	JKS-25	JJN-25	FNQ-R-25	KTK-R-25	LP-CC-25
5 [3.7]	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
7.5–10 [5.5–7.5]	KTN-R-50	KS-50	JJN-50	-	-	-
15 [11]	KTN-R-60	JKS-60	JJN-60	-	-	-
20 [15]	KTN-R-80	JKS-80	JJN-80	-	-	-
25–30 [18.5–22]	KTN-R-125	JKS-125	JJN-125	-	-	-
40 [30]	KTN-R-150	JKS-150	JJN-150	-	-	-
50 [37]	KTN-R-200	JKS-200	JJN-200	-	-	-
60 [45]	KTN-R-250	JKS-250	JJN-250	-	-	-

Table 8.19 3x200–240 V, Enclosure Types A, B and C

	Recommended max. fuse							
Power [kW]	**SIBA Type RK1**	**Littelfuse Type RK1**	**Ferraz-Shawmut Type CC**	**Ferraz-Shawmut Type RK1**[3]	**Bussmann Type JFHR2**[2]	**Littelfuse JFHR2**	**Ferraz-Shawmut JFHR2**[4]	**Ferraz-Shawmut J**
0.34–5 [0.25–0.37]	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R	FWX-5	-	-	HSJ-6
0.75–1.5 [0.55–1.1]	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R	FWX-10	-	-	HSJ-10
2 [1.5]	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R	FWX-15	-	-	HSJ-15
3 [2.2]	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R	FWX-20	-	-	HSJ-20
4 [3.0]	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R	FWX-25	-	-	HSJ-25
5 [3.7]	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R	FWX-30	-	-	HSJ-30
7.5–10 [5.5–7.5]	5014006-050	KLN-R-50	-	A2K-50-R	FWX-50	-	-	HSJ-50
15 [11]	5014006-063	KLN-R-60	-	A2K-60-R	FWX-60	-	-	HSJ-60
20 [15]	5014006-080	KLN-R-80	-	A2K-80-R	FWX-80	-	-	HSJ-80
25–30 [18.5–22]	2028220-125	KLN-R-125	-	A2K-125-R	FWX-125	-	-	HSJ-125
40 [30]	2028220-150	KLN-R-150	-	A2K-150-R	FWX-150	L25S-150	A25X-150	HSJ-150
50 [37]	2028220-200	KLN-R-200	-	A2K-200-R	FWX-200	L25S-200	A25X-200	HSJ-200
60 [45]	2028220-250	KLN-R-250	-	A2K-250-R	FWX-250	L25S-250	A25X-250	HSJ-250

Table 8.20 3x200–240 V, Enclosure Types A, B and C

1) KTS fuses from Bussmann may substitute KTN for 240 V adjustable frequency drives.
2) FWH fuses from Bussmann may substitute FWX for 240 V adjustable frequency drives.
3) A6KR fuses from Ferraz-Shawmut may substitute A2KR for 240 V adjustable frequency drives.

4) A50X fuses from Ferraz-Shawmut may substitute A25X for 240 V adjustable frequency drives.

3x380–480 V

	Recommended max. fuse					
Power (hp [kW])	**Bussmann Type RK1**	**Bussmann Type J**	**Bussmann Type T**	**Bussmann Type CC**	**Bussmann Type CC**	**Bussmann Type CC**
-	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.5–3 [1.1–2.2]	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
4 [3]	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
5 [4]	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
7.5 [5.5]	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
10 [7.5]	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
15 [11]	KTS-R-40	JKS-40	JJS-40	-	-	-
20 [15]	KTS-R-50	JKS-50	JJS-50	-	-	-
30 [22]	KTS-R-60	JKS-60	JJS-60	-	-	-
40 [30]	KTS-R-80	JKS-80	JJS-80	-	-	-
50 [37]	KTS-R-100	JKS-100	JJS-100	-	-	-
60 [45]	KTS-R-125	JKS-125	JJS-125	-	-	-
75 [55]	KTS-R-150	JKS-150	JJS-150	-	-	-
100 [75]	KTS-R-200	JKS-200	JJS-200	-	-	-
125 [90]	KTS-R-250	JKS-250	JJS-250	-	-	-

Table 8.21 3x380–480 V, Enclosure Types A, B and C

	Recommended max. fuse							
Power [kW]	**SIBA Type RK1**	**Littelfuse Type RK1**	**Ferraz-Shawmut Type CC**	**Ferraz-Shawmut Type RK1**	**Bussmann JFHR2**	**Ferraz-Shawmut J**	**Ferraz-Shawmut JFHR2[1)]**	**Littelfuse JFHR2**
-	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R	FWH-6	HSJ-6	-	-
1.5–3 [1.1–2.2]	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R	FWH-10	HSJ-10	-	-
4 [3]	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R	FWH-15	HSJ-15	-	-
5 [4]	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R	FWH-20	HSJ-20	-	-
7.5 [5.5]	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R	FWH-25	HSJ-25	-	-
10 [7.5]	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R	FWH-30	HSJ-30	-	-
15 [11]	5014006-040	KLS-R-40	-	A6K-40-R	FWH-40	HSJ-40	-	-
20 [15]	5014006-050	KLS-R-50	-	A6K-50-R	FWH-50	HSJ-50	-	-
30 [22]	5014006-063	KLS-R-60	-	A6K-60-R	FWH-60	HSJ-60	-	-
40 [30]	2028220-100	KLS-R-80	-	A6K-80-R	FWH-80	HSJ-80	-	-
50 [37]	2028220-125	KLS-R-100	-	A6K-100-R	FWH-100	HSJ-100	-	-
60 [45]	2028220-125	KLS-R-125	-	A6K-125-R	FWH-125	HSJ-125	-	-
75 [55]	2028220-160	KLS-R-150	-	A6K-150-R	FWH-150	HSJ-150	-	-
100 [75]	2028220-200	KLS-R-200	-	A6K-200-R	FWH-200	HSJ-200	A50-P-225	L50-S-225
125 [90]	2028220-250	KLS-R-250	-	A6K-250-R	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 8.22 3x380–480 V, Enclosure Types A, B and C

1) Ferraz-Shawmut A50QS fuses may substitute A50P fuses.

3x525–600 V

	Recommended max. fuse									
Power [kW]	**Bussmann Type RK1**	**Bussmann Type J**	**Bussmann Type T**	**Bussmann Type CC**	**Bussmann Type CC**	**Bussmann Type CC**	**SIBA Type RK1**	**Littelfuse Type RK1**	**Ferraz-Shawmut Type RK1**	**Ferraz-Shawmut J**
1–1.5 [0.75–1.1]	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
2–3 [1.5–2.2]	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
4 [3]	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15	5017906-016	KLS-R-015	A6K-15-R	HSJ-15
5 [4]	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
7.5 [5.5]	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
10 [7.5]	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
15–20 [11–15]	KTS-R-35	JKS-35	JJS-35	-	-	-	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
24 [18]	KTS-R-45	JKS-45	JJS-45	-	-	-	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
30 [22]	KTS-R-50	JKS-50	JJS-50	-	-	-	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
40 [30]	KTS-R-60	JKS-60	JJS-60	-	-	-	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
50 [37]	KTS-R-80	JKS-80	JJS-80	-	-	-	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
60 [45]	KTS-R-100	JKS-100	JJS-100	-	-	-	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
75 [55]	KTS-R-125	JKS-125	JJS-125	-	-	-	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
75	KTS-R-150	JKS-150	JJS-150	-	-	-	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
125 [90]	KTS-R-175	JKS-175	JJS-175	-	-	-	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 8.23 3x525–600 V, Enclosure Types A, B and C

1) 170M fuses shown from Bussmann use the -/80 visual indicator. –TN/80 Type T, -/110 or TN/110 Type T indicator fuses of the same size and amperage may be substituted.

3x525–690 V

	Recommended max. fuse							
Power [kW]	**Max. prefuse [A]**	**Bussmann E52273 RK1/JDDZ**	**Bussmann E4273 J/JDDZ**	**Bussmann E4273 T/JDDZ**	**SIBA E180276 RK1/JDDZ**	**LittelFuse E81895 RK1/JDDZ**	**Ferraz-Shawmut E163267/E2137 RK1/JDDZ**	**Ferraz-Shawmut E2137 J/HSJ**
15–20 [11–15]	30	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
30 [22]	45	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
40 [30]	60	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
50 [37]	80	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
60 [45]	90	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
75 [55]	100	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
100 [75]	125	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
125 [90]	150	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150

Table 8.24 3x525–690 V, Enclosure Types B and C

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8.9 Power Ratings, Weight and Dimensions

Enclosure Type (hp [kW])		A2		A3		A4	A5	B1	B2	B3	B4	C1	C2	C3	C4
1x200–240 V	S2	-		1.5 [1.1]		1.5–3 [1.1–2.2]	1.5 [1.1]	2–5 [1.5–3.7]	10 [7.5]	-	-	20 [15]	30 [22]	-	-
3x200–240 V	T2	0.34–4 [0.25–3.0]		5 [3.7]		0.34–3 [0.25–2.2]	0.34–5 [0.25–3.7]	7.5 [5.5]	20 [15]	7.5–15 [5.5–11]	-	25–40 [18.5–30]	50–60 [37–45]	30 [22]	50–60 [37–45]
1x380–480 V	S4	-		-		1.5–5 [1.1–4.0]	-	10 [7.5]	15 [11]	-	-	24 [18]	50 [37]	-	-
3x380–480 V	T4	5 [0.37–4.0]		7.5–10 [5.5–7.5]		5 [0.37–4.0]	0.5–10 [0.37–7.5]	15–25 [11–18.5]	30–40 [22–30]	15–25 [11–18.5]	30–50 [22–37]	50–75 [37–55]	100–125 [75–90]	60–75 [45–60]	100–125 [75–90]
3x525–600 V	T6	-		1–10 [0.75–7.5]		5 [0.37–4.0]	1–10 [0.75–7.5]	15–25 [11–18.5]	30–40 [22–30]	15–25 [11–18.5]	30–50 [22–37]	50–75 [37–55]	100–125 [75–90]	60–75 [45–60]	100–125 [75–90]
3x525–690 V	T7	-		-		-	-	-	15–40 [11–30]	-	-	-	50–125 [37–90]	-	-
IP		20	21	20	21	55/66	55/66	21/55/66	21/55/66	20	20	21/55/66	21/55/66	20	20
NEMA		Chas-sis	Type 1	Chas-sis	Type 1	Type 12/4X	Type 12/4X	Type 1/12/4X	Type 1/12/4X	Chas-sis	Chas-sis	Type 1/12/4X	Type 1/12/4X	Chas-sis	Chas-sis
Height (in [mm])															
Height of backplate	A*	10.6 [268]	14.8 [375]	10.6 [268]	14.8 [375]	15.35 [390]	16.54 [420]	18.9 [480]	25.6 [650]	15.71 [399]	20.5 [520]	26.8 [680]	30.32 [770]	21.65 [550]	25.98 [660]
Height with decoupling plate for serial communication bus cables	A	14.72 [374]	-	14.72 [374]	-	-	-	-	-	16.5 [419]	23.43 [595]	-	-	24.8 [630]	31.5 [800]
Distance between mounting holes	a	10.12 [257]	13.8 [350]	10.12 [257]	13.8 [350]	15.8 [401]	15.83 [402]	17.87 [454]	24.6 [624]	14.96 [380]	19.5 [495]	25.51 [648]	29.1 [739]	20.51 [521]	24.84 [631]
Width (in [mm])															
Width of backplate	B	3.54 [90]	3.54 [90]	5.12 [130]	5.12 [130]	7.87 [200]	9.53 [242]	9.53 [242]	9.53 [242]	6.5 [165]	9.1 [231]	12.13 [308]	14.57 [370]	12.13 [308]	14.57 [370]
Width of backplate with one C option	B	5.12 [130]	5.12 [130]	6.7 [170]	6.7 [170]	-	9.53 [242]	9.53 [242]	9.53 [242]	8.07 [205]	9.1 [231]	12.13 [308]	14.57 [370]	12.13 [308]	14.57 [370]
Width of backplate with two C option	B	3.54 [90]	3.54 [90]	5.12 [130]	5.12 [130]	-	9.53 [242]	9.53 [242]	9.53 [242]	6.5 [165]	9.1 [231]	12.13 [308]	14.57 [370]	12.13 [308]	14.57 [370]
Distance between mounting holes	b	2.76 [70]	2.76 [70]	4.33 [110]	4.33 [110]	6.73 [171]	8.47 [215]	8.27 [210]	8.27 [210]	5.51 [140]	7.87 [200]	10.71 [272]	13.15 [334]	10.63 [270]	13 [330]

Enclosure Type (hp [kW])		A2		A3		A4	A5	B1	B2	B3	B4	C1	C2	C3	C4
Depth (in [mm])**															
Without option A/B	C	8.07 [205]	8.07 [205]	8.07 [205]	8.07 [205]	6.9 [175]	7.87 [200]	10.24 [260]	10.24 [260]	9.76 [248]	9.53 [242]	12.21 [310]	13.2 [335]	12.99 [333]	12.99 [333]
With option A/B	C	8.7 [220]	8.7 [220]	8.7 [220]	8.7 [220]	6.9 [175]	7.87 [200]	10.24 [260]	10.24 [260]	10.32 [262]	9.53 [242]	12.21 [310]	13.2 [335]	12.99 [333]	12.99 [333]
Screw holes (in [mm])															
	c	0.32 [8.0]	0.32 [8.0]	0.32 [8.0]	0.32 [8.0]	0.33 [8.25]	0.32 [8.2]	0.47 [12]	0.47 [12]	0.32 [8]	-	0.47 [12]	0.47 [12]	-	-
	d	ø0.43 [ø11]	ø0.43 [ø11]	ø0.43 [ø11]	ø0.43 [ø11]	ø0.47 [ø12]	ø0.47 [ø12]	ø0.75 [ø19]	ø0.75 [ø19]	0.47 [12]	-	ø0.75 [ø19]	ø0.75 [ø19]	-	-
	e	ø0.22 [ø5.5]	ø0.22 [ø5.5]	ø0.22 [ø5.5]	ø0.22 [ø5.5]	ø0.26 [ø6.5]	ø0.26 [ø6.5]	ø0.35 [ø9]	ø0.35 [ø9]	0.27 [6.8]	0.34 [8.5]	ø0.35 [ø9.0]	ø0.35 [ø9.0]	0.34 [8.5]	0.34 [8.5]
	f	0.35 [9]	0.35 [9]	0.35 [9]	0.35 [9]	19.69 [6]	0.35 [9]	0.35 [9]	0.35 [9]	0.31 [7.9]	0.59 [15]	0.39 [9.8]	0.39 [9.8]	0.67 [17]	0.67 [17]
Max weight (lbs [kg])		10.8 [4.9]	11.7 [5.3]	14.6 [6.6]	15.43 [7.0]	21.5 [9.7]	30.9 [14]	50.71 [23]	59.53 [27]	26.46 [12]	52 [23.5]	99.21 [45]	143.3 [65]	77.2 [35]	110.23 [50]

* See *Figure 3.4* and *Figure 3.5* for top and bottom mounting holes.

** Depth of enclosure will vary with different options installed.

Table 8.25 Power Ratings, Weight and Dimensions

9 Appendix

9.1 Symbols, Abbreviations and Conventions

AC	Alternating Current
AEO	Automatic Energy Optimization
AWG	American Wire Gauge
AMA	Automatic Motor Adaptation
°C	Degrees Celsius
DC	Direct Current
EMC	Electro Magnetic Compatibility
ETR	Electronic Thermal Relay
FC	Adjustable Frequency Drive
LCP	Local Control Panel
MCT	Motion Control Tool
IP	Ingress Protection
$I_{M,N}$	Nominal Motor Current
$f_{M,N}$	Nominal Motor Frequency
$P_{M,N}$	Nominal Motor Power
$U_{M,N}$	Nominal Motor Voltage
PM Motor	Permanent Magnet Motor
PELV	Protective Extra Low Voltage
PCB	Printed Circuit Board
PWM	Pulse Width Modulated
I_{LIM}	Current Limit
I_{INV}	Rated Inverter Output Current
RPM	Revolutions Per Minute
Regen	Regenerative Terminals
n_s	Synchronous Motor Speed
T_{LIM}	Torque Limit
$I_{VLT,MAX}$	The Maximum Output Current
$I_{VLT,N}$	The Rated Output Current Supplied by the Adjustable Frequency Drive

Table 9.1 Symbols and Abbreviations

Conventions

Numbered lists indicate procedures.

Bullet lists indicate other information and description of figures.

Italicized text indicates

- cross reference
- link
- parameter name

9.2 Parameter Menu Structure

0- **	**Operation/Display**
0-0*	**Basic Settings**
0-01	Language
0-02	Motor Speed Unit
0-03	Regional Settings
0-04	Operating State at Power-up
0-05	Local Mode Unit
0-1*	**Set-up Operations**
0-10	Active Set-up
0-11	Programming Set-up
0-12	This Set-up Linked to
0-13	Readout: Linked Set-ups
0-14	Readout: Prog. Set-ups / Channel
0-2*	**LCP Display**
0-20	Display Line 1.1 Small
0-21	Display Line 1.2 Small
0-22	Display Line 1.3 Small
0-23	Display Line 2 Large
0-24	Display Line 3 Large
0-25	My Personal Menu
0-3*	**LCP Cust. Readout**
0-30	Custom Readout Unit
0-31	Custom Readout Min Value
0-32	Custom Readout Max Value
0-37	Display Text 1
0-38	Display Text 2
0-39	Display Text 3
0-4*	**LCP Keypad**
0-40	[Hand on] Key on LCP
0-41	[Off] Key on LCP
0-42	[Auto on] Key on LCP
0-43	[Reset] Key on LCP
0-44	[Off/Reset] Key on LCP
0-45	[Drive Bypass] Key on LCP
0-5*	**Copy/Save**
0-50	LCP Copy
0-51	Set-up Copy
0-6*	**Password**
0-60	Main Menu Password
0-61	Access to Main Menu w/o Password
0-65	Personal Menu Password
0-66	Access to Personal Menu w/o Password
0-67	Bus Password Access
0-7*	**Clock Settings**
0-70	Date and Time
0-71	Date Format
0-72	Time Format
0-74	DST/Summertime
0-76	DST/Summertime Start
0-77	DST/Summertime End
0-79	Clock Fault
0-81	Working Days
0-82	Additional Working Days
0-83	Additional Non-Working Days
0-89	Date and Time Readout
1- **	**Load and Motor**
1-0*	**General Settings**
1-00	Configuration Mode
1-01	Motor Control Principle
1-03	Torque Characteristics
1-06	Clockwise Direction
1-1*	**Motor Selection**
1-10	Motor Construction
1-1*	**VVC+ PM**
1-14	Damping Gain
1-15	Low Speed Filter Time Const.
1-16	High Speed Filter Time Const.
1-17	Voltage filter time const.
1-2*	**Motor Data**
1-20	Motor Power [kW]
1-21	Motor Power [HP]
1-22	Motor Voltage
1-23	Motor Frequency
1-24	Motor Current
1-25	Motor Nominal Speed
1-26	Motor Cont. Rated Torque
1-28	Motor Rotation Check
1-29	Automatic Motor Adaptation (AMA)
1-3*	**Addl. Motor Data**
1-30	Stator Resistance (Rs)
1-31	Rotor Resistance (Rr)
1-33	Stator Leakage Reactance (X1)
1-34	Rotor Leakage Reactance (X2)
1-35	Main Reactance (Xh)
1-36	Iron Loss Resistance (Rfe)
1-37	d-axis Inductance (Ld)
1-39	Motor Poles
1-40	Back EMF at 1000 RPM
1-46	Position Detection Gain
1-5*	**Load-Indep. Setting**
1-50	Motor Magnetization at Zero Speed
1-51	Min Speed Normal Magnetizing [RPM]
1-52	Min Speed Normal Magnetizing [Hz]
1-55	V/f Characteristic - V
1-56	V/f Characteristic - f
1-58	Flystart Test Pulses Current
1-59	Flystart Test Pulses Frequency
1-6*	**Load-Depend. Settg.**
1-60	Low Speed Load Compensation
1-61	High Speed Load Compensation
1-62	Slip Compensation
1-63	Slip Compensation Time Constant
1-64	Resonance Dampening
1-65	Resonance Dampening Time Constant
1-66	Min. Current at Low Speed
1-7*	**Start Adjustments**
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