MAKING MODERN LIVING POSSIBLE

Instruction Manual

VLT® AutomationDrive FC 300, 0.25–75 kW

VLT®
THE REAL DRIVE

Safety

⚠WARNING

HIGH VOLTAGE!

Adjustable frequency drives contain high voltage when connected to AC line power. Installation, startup, and maintenance should be performed by qualified personnel only. Failure to perform installation, startup, and maintenance by qualified personnel could result in death or serious injury.

High Voltage

Adjustable frequency drives are connected to hazardous AC line voltage. Extreme care should be taken to protect against shock. Only trained personnel familiar with electronic equipment should install, start, or maintain this equipment.

⚠WARNING

UNINTENDED START!

When the adjustable frequency drive is connected to AC line power, the motor may start at any time. The adjustable frequency drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the adjustable frequency drive is connected to AC line power could result in death, serious injury, equipment, or property damage.

Unintended Start

When the adjustable frequency drive is connected to AC line power, the motor may be started with an external switch, a serial bus command, an input reference signal, or a cleared fault condition. Use appropriate caution to guard against an unintended start.

⚠WARNING

DISCHARGE TIME!

Adjustable frequency drives contain DC link capacitors that can remain charged even when the adjustable frequency drive is not powered. To avoid electrical hazards, disconnect AC line power, any permanent magnet type motors, and any remote DC link power supplies, including battery backups, UPS and DC link connections to other adjustable frequency drives. Wait for the capacitors to fully discharge before performing any service or repair work. The wait time required is listed in the *Discharge Time* table. Failure to wait for the specified period of time after power has been removed to do service or repair could result in death or serious injury.

Voltage [V]	Minimum waiting time [minutes]	
	4	15
200–240	0-34-0.5 hp	7.5-50 hp
380–480	0.34-10 hp	15-100 hp
525–600	1.0-10 hp	15-100 hp
525–690		15-100 hp
High voltage may be present even when the warning LED indicator lights are off.		

Discharge Time

Symbols

The following symbols are used in this manual.

⚠WARNING

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

⚠CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices.

CAUTION

Indicates a situation that may result in equipment or property damage-only accidents.

NOTE!

Indicates highlighted information that should be observed in order to avoid mistakes or operate equipment at less than optimal performance.

Approvals

Table 1.2

NOTE!

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

From software version 6.72, the output frequency of the adjustable frequency drive is limited to 590 Hz. Software versions 6x.xx also limit the maximum output frequency to 590 Hz, but these versions cannot be flashed, i.e., neither downgraded nor upgraded.

Contents

1 Introduction

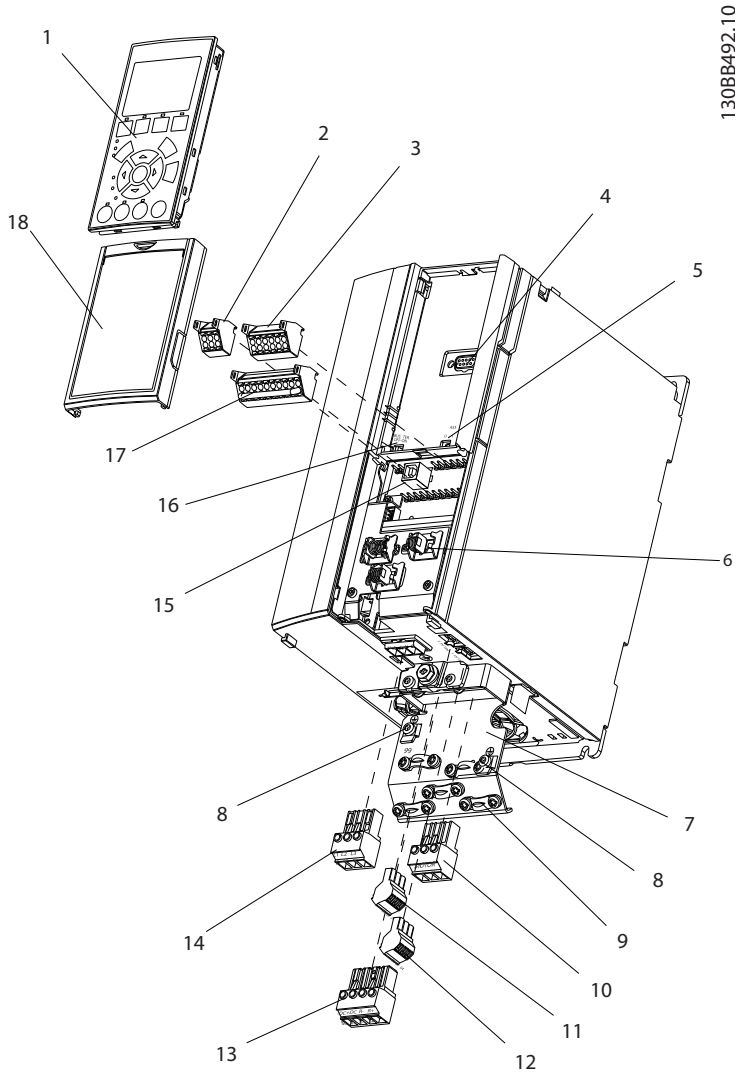


Figure 1.1 Exploded View A1-A3, IP20

1	LCP	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS-485 serial bus connector (+68, -69)	11	Relay 1 (01, 02, 03)
3	Analog I/O connector	12	Relay 2 (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 strain relief/PE ground	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	Control cable cover plate

Table 1.1 Legend to *Figure 1.1*

1

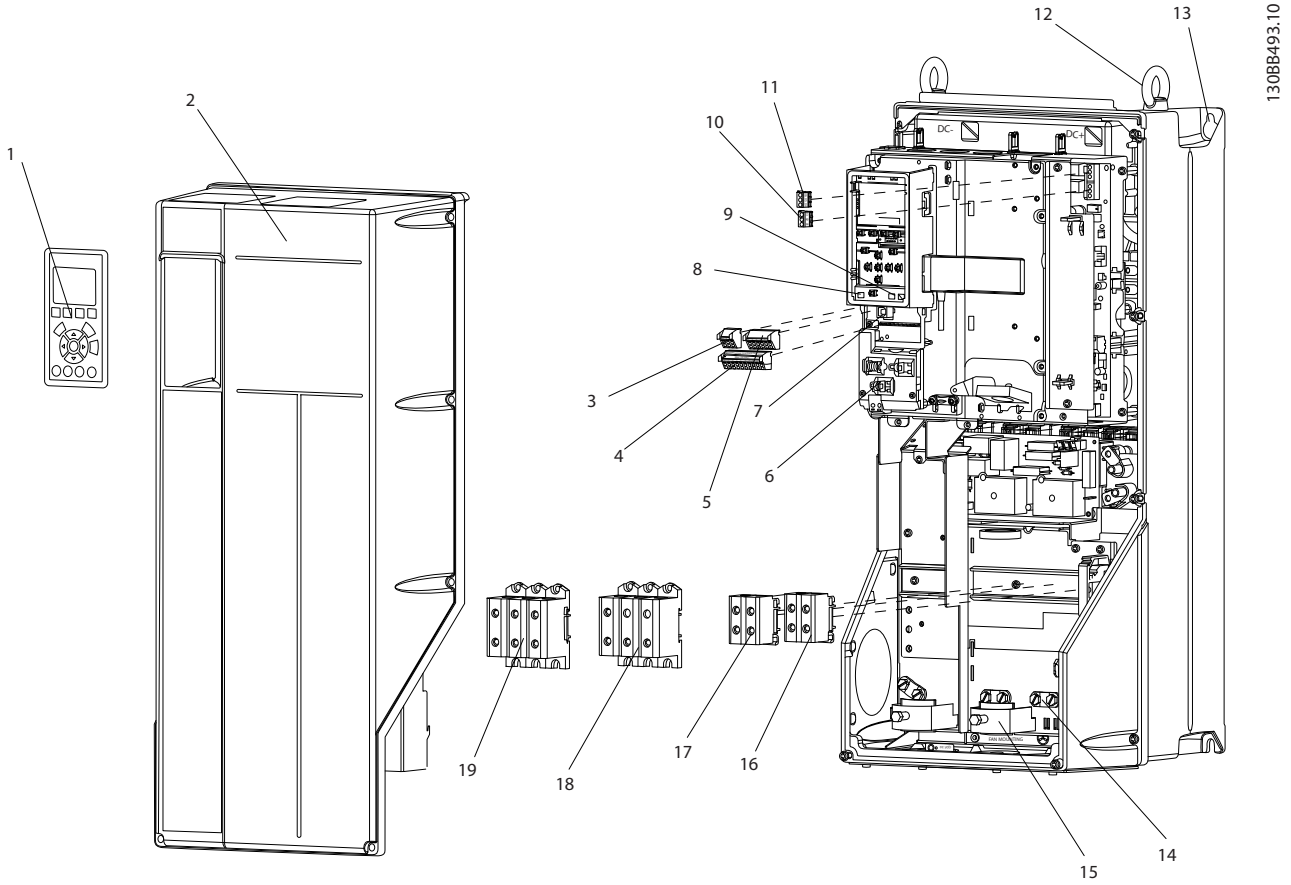


Figure 1.2 Exploded View B and C Sizes, IP55/66

1	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 strain relief/PE ground
6	Cable strain relief/PE ground	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)		

Table 1.2 Legend to *Figure 1.2*

1.1 Purpose of the Manual

This manual is intended to provide detailed information for the installation and startup of the adjustable frequency drive. provides requirements for mechanical and electrical installation, including input, motor, control and serial communications wiring and control terminal functions. provides detailed procedures for startup, basic operational programming, and functional testing. The remaining chapters provide supplementary details. These details include user interface, detailed programming, application examples, startup troubleshooting, and specifications.

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* is intended to provide detailed capabilities and functionality to design motor control systems.
- Supplementary publications and manuals are available from Danfoss.
  See *http://www.danfoss.com/BusinessAreas/Drives-Solutions/Documentations/Technical+Documentation.htm* for listings.
- Optional equipment is available that may change some of the procedures described. Reference the instructions supplied with those options for specific requirements. Contact the local Danfoss supplier or visit the Danfoss website: *http://www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm*, for downloads or additional information.

1.3 Product Overview

An adjustable frequency drive is an electronic motor controller that converts AC line power input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The adjustable frequency drive can vary the speed of the motor in response to system feedback, such as position sensors on a conveyor belt. The adjustable frequency drive can also regulate the motor by responding to remote commands from external controllers.

In addition, the adjustable frequency drive monitors the system and motor status, issues warnings or alarms for fault conditions, starts and stops the motor, optimizes energy efficiency, and offers many more control, monitoring, and efficiency functions. Operation and monitoring functions are available as status indications to an outside control system or serial communication network.

1.4 Internal Controller Functions

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

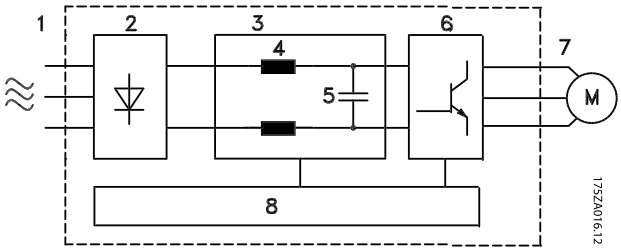


Figure 1.3 Adjustable Frequency Drive Block Diagram

1

Area	Title	Functions
1	Mains input	• Three-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 three-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 1.3 Legend to *Figure 1.3*

1.5 Frame Sizes and Power Ratings

	Frame size [hp]										
[Volts]	A1	A2	A3	A4	A5	B1	B2	C1	C2	C3	C4
200–240	0.34–2.0	0.34–3.0	4.00–5.00	0.34–3.0	0.34–5.0	7.5–10	15	20–30	40–50	25–30	40–50
380–480	0.5–2.0	0.5–5.0	7.5–10	0.5–5.0	0.5–10	15–20	25–30	40–60	75–100	50–60	75–100
525–600	N/A	N/A	1.0–10	N/A	1.0–10	15–20	25–30	40–60	75–125	50–60	75–125
525–690	N/A	N/A	1.5–10	N/A	N/A	N/A	15–30	N/A	40–100	50–60	N/A

Table 1.4 Frame Sizes and Power Ratings

1

2 Installation

2.1 Installation Site Checklist

- The adjustable frequency drive relies on the ambient air for cooling. Observe the limitations on ambient air temperature for optimal operation
- Ensure that the installation location has sufficient support strength to mount the adjustable frequency drive
- Keep the manual, drawings, and diagrams accessible for detailed installation and operation instructions. It is important that the manual is available for equipment operators.
- Locate equipment as near to the motor as possible. Keep motor cables as short as possible. Check the motor characteristics for actual tolerances. Do not exceed
    - 1,000 ft [300 m] for unshielded motor leads
    - 500 ft [150 m] for shielded cable.
- Ensure that the ingress protection rating of the adjustable frequency drive is suitable for the installation environment. IP55 (NEMA 12) or IP66 (NEMA 4) enclosures may be necessary.

⚠CAUTION

Ingress protection

IP54, IP55 and IP66 ratings can only be guaranteed if the unit is properly closed.

- **Ensure that all cable connectors and unused holes for connectors are properly sealed.**
- **Ensure that the unit cover is properly closed**

⚠CAUTION

Device damage through contamination

Do not leave the adjustable frequency drive uncovered.

For “spark-free” installations according to European Agreement concerning International Carriage of Dangerous Goods by Inland Waterways (ADN_2011 ###), refer to VLT® AutomationDrive FC 300 Design Guide.

2.2 Adjustable Frequency Drive and Motor Pre-installation Checklist

- Compare the model number of unit on the nameplate to what was ordered to verify the proper equipment
- Ensure each of the following are rated for the same voltage:

    Line power

    Adjustable frequency drive

    Motor
- Ensure that the adjustable frequency drive output current rating is equal to or greater than motor full load current for peak motor performance.

    Motor size and adjustable frequency drive power must match for proper overload protection

    If adjustable frequency drive rating is less than motor, full motor output cannot be achieved

2.3 Mechanical Installation

2.3.1 Cooling

- To provide cooling airflow, mount the unit to a solid flat surface or to the optional backplate (see *2.3.3 Mounting*)
- Top and bottom clearance for air cooling must be provided. Generally, 100–225 mm (4–10 in) is required. See *Figure 2.1* for clearance requirements
- Improper mounting can result in overheating and reduced performance
- Derating for temperatures starting between 104 °F [40 °C] and 122 °F [50 °C] and elevation 3,300 ft [1,000 m] above sea level must be considered. See the equipment Design Guide for detailed information.

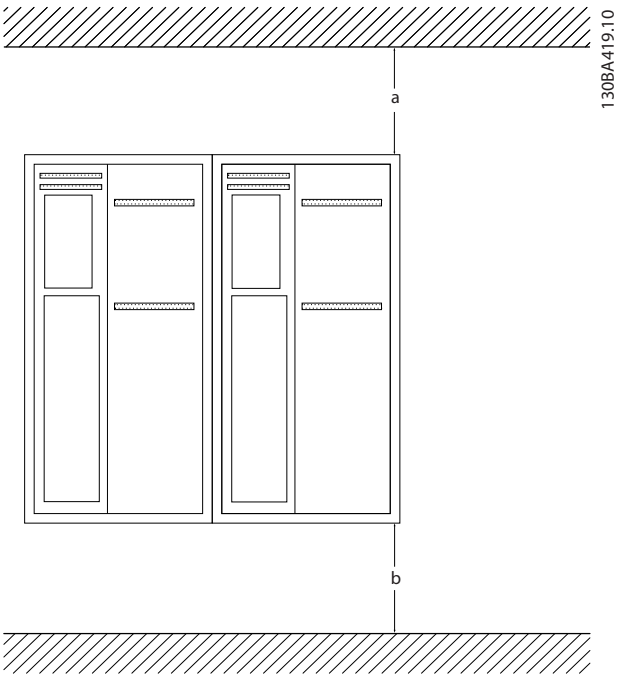


Figure 2.1 Top and Bottom Cooling Clearance

Enclosure	A1-A5	B1-B4	C1, C3	C2, C4
a/b (inch [mm])	3.94 [100]	7.87 [200]	7.87 [200]	8.86 [225]

Table 2.1 Minimum Airflow Clearance Requirements

2.3.2 Lifting

- Check the weight of the unit to determine a safe lifting method
- 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, where provided

2.3.3 Mounting

- Mount the unit vertically
- The adjustable frequency drive allows side by side installation
- Ensure that the strength of the mounting location will support the unit weight
- Mount the unit onto a solid flat surface or onto the optional backplate to provide cooling airflow (see *Figure 2.2* and *Figure 2.3*)
- Improper mounting can result in overheating and reduced performance
- Use the slotted mounting holes on the unit for wall mounting, when provided.

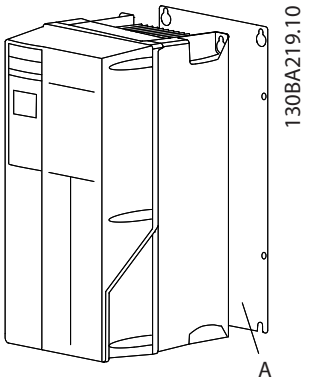


Figure 2.2 Proper Mounting with Backplate

Item A is a backplate properly installed for required airflow to cool the unit.

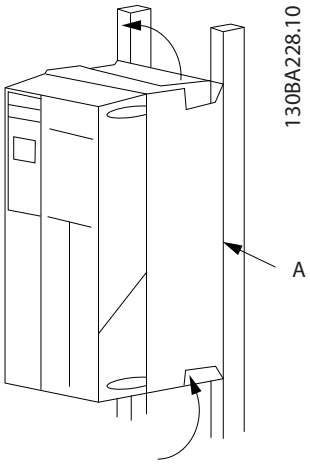


Figure 2.3 Proper Mounting with Railings

NOTE!

Backplate is needed when mounted on railings.

2.3.4 Tightening Torques

See *10.4 Connection Tightening Torques* for proper tightening specifications.

2.4 Electrical Installation

This section contains detailed instructions for wiring the adjustable frequency drive. The following tasks are described.

- Wiring the motor to the adjustable frequency drive output terminals
- Wiring the AC line power to the adjustable frequency drive input terminals
- Connecting control and serial communication wiring
- After power has been applied, checking input and motor power; programming control terminals for their intended functions

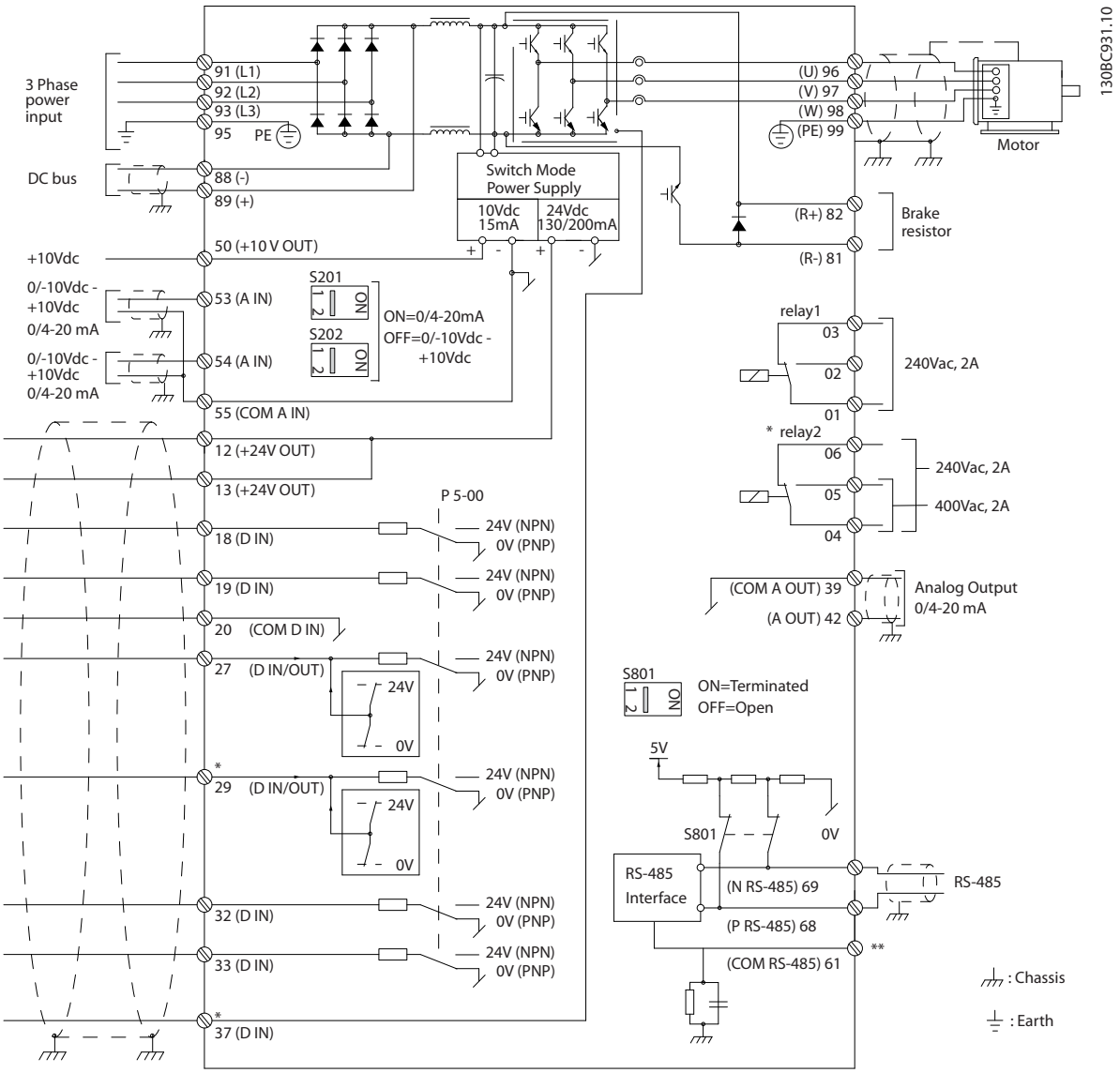


Figure 2.4 Basic Wiring Schematic Drawing

A=Analog, D=Digital

Terminal 37 is used for Safe Stop. For Safe Stop installation instructions, refer to the Design Guide.

* Terminal 37 is not included in FC 301 (except frame size A1). Relay 2 and terminal 29 have no function in FC 301.

** Do not connect cable screen.

2

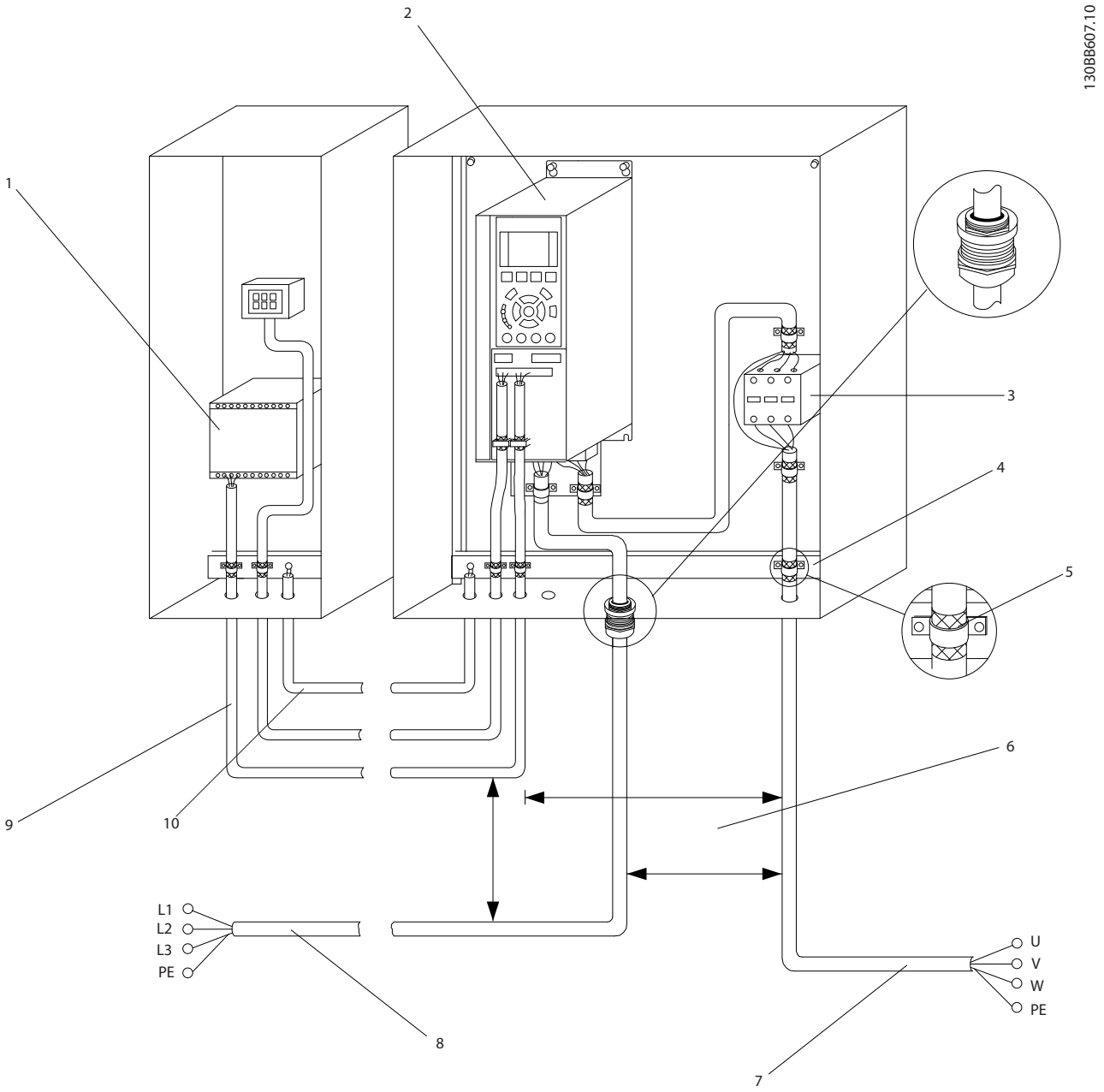


Figure 2.5 Typical Electrical Connection

1	PLC	6	Min. 200 mm (7.9 in) between control cables, motor and line power
2	Adjustable frequency drive	7	Motor, 3-phase and PE
3	Output contactor (Generally not recommended)	8	Line power, 3-phase and reinforced PE
4	Grounding rail (PE)	9	Control wiring
5	Cable insulation (stripped)	10	Equalizing min. 16 mm^2 (0.025 in^2)

Table 2.2 Legend to *Figure 2.5*

2.4.1 Requirements

WARNING

EQUIPMENT HAZARD!

Rotating shafts and electrical equipment can be hazardous. All electrical work must conform to national and local electrical codes. It is strongly recommended that installation, start-up, and maintenance be performed only by trained and qualified personnel. Failure to follow these guidelines could result in death or serious injury.

CAUTION

WIRING ISOLATION!

Run input power, motor wiring and control wiring in three separate metallic conduits or use separated shielded cable for high frequency noise isolation. Failure to isolate power, motor and control wiring could result in less than optimum adjustable frequency drive and associated equipment performance.

For your safety, comply with the following requirements.

- Electronic controls equipment is connected to hazardous AC line voltage. Extreme care should be taken to protect against electrical hazards when applying power to the unit.
- Run motor cables from multiple adjustable frequency drives separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out.

Overload and Equipment Protection

- An electronically activated function within the adjustable frequency drive provides overload protection for the motor. The overload calculates the level of increase to activate timing for the trip (controller output stop) function. The higher the current draw, the quicker the trip response. The overload provides Class 20 motor protection. See *8 Warnings and Alarms* for details on the trip function.
- Because the motor wiring carries high frequency current, it is important that wiring for line power, motor power, and control is run separately. Use metallic conduit or separated shielded wire. Failure to isolate power, motor, and control wiring could result in less than optimum equipment performance.
- All adjustable frequency drives must be provided with short-circuit and overcurrent protection. Input fusing is required to provide this protection, see *Figure 2.6*. If not factory supplied, fuses must be provided by the installer as part of installation. See maximum fuse ratings in *10.3 Fuse Specifications*.

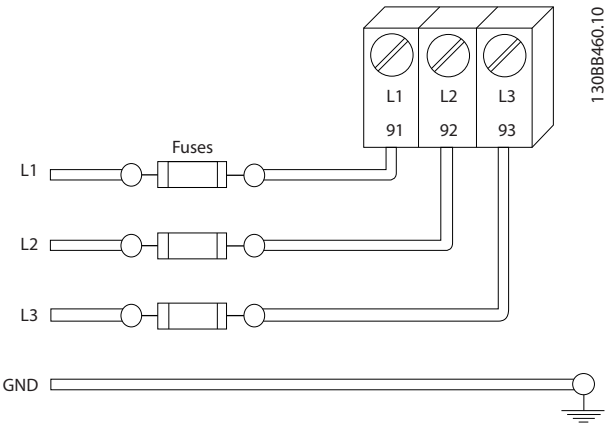


Figure 2.6 Adjustable Frequency Drive Fuses

Wire Type and Ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- Danfoss recommends that all power connections be made with a minimum 167 °F [75 °C] rated copper wire.
- See *10.1 Power-dependent Specifications* for recommended wire sizes.

2.4.2 Grounding Requirements

WARNING

GROUNDING HAZARD!

For operator safety, it is important to ground the adjustable frequency drive properly in accordance with national and local electrical codes, as well as instructions contained within these instructions. Ground currents are higher than 3.5 mA. Failure to ground the adjustable frequency drive properly could result in death or serious injury.

NOTE!

It is the responsibility of the user or certified electrical installer to ensure correct grounding of the equipment in accordance with national and local electrical codes and standards.

2

- Follow all local and national electrical codes to ground electrical equipment properly.
- Proper protective grounding for equipment with ground currents higher than 3.5 mA must be established, see *Leakage Current (>3,5 mA)*
- A dedicated ground wire is required for input power, motor power and control wiring
- Use the clamps provided with the equipment for proper ground connections
- Do not ground one adjustable frequency drive to another in a "daisy chain" fashion
- Keep the ground wire connections as short as possible
- Use of high strand wire to reduce electrical noise is recommended
- Follow the motor manufacturer wiring requirements

2.4.2.1 Leakage Current (>3.5 mA)

Follow national and local codes regarding protective grounding of equipment with a leakage current > 3.5 mA. Adjustable frequency drive technology implies high frequency switching at high power. This will generate a leakage current in the ground connection. A fault current in the adjustable frequency drive at the output power terminals might contain a DC component which can charge the filter capacitors and cause a transient ground current. The ground leakage current depends on various system configurations including RFI filtering, shielded motor cables, and adjustable frequency drive power.

EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care if the leakage current exceeds 3.5 mA. Grounding must be reinforced in one of the following ways:

- Ground wire of at least 0.0155 in^2 [10 mm^2]
- Two separate ground wires both complying with the dimensioning rules

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

Using RCDs

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

Use RCDs of type B only which are capable of detecting AC and DC currents

Use RCDs with an inrush delay to prevent faults due to transient ground currents

Dimension RCDs according to the system configuration and environmental considerations

2.4.2.2 Grounding Using Shielded Cable

Grounding clamps are provided for motor wiring (see *Figure 2.7*).

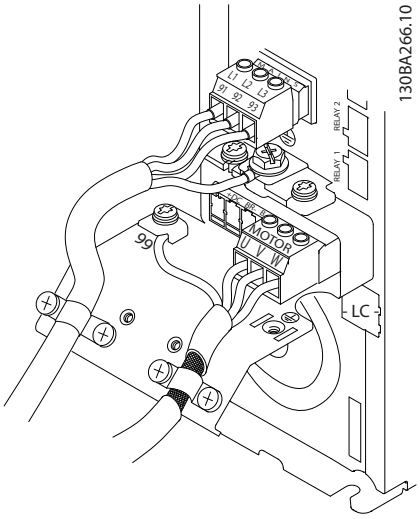


Figure 2.7 Grounding with Shielded Cable

2.4.3 Motor Connection

⚠WARNING

INDUCED VOLTAGE!

Run output motor cables from multiple adjustable frequency drives separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately could result in death or serious injury.

- For maximum wire sizes, see *10.1 Power-dependent Specifications*
- Comply with local and national electrical codes for cable sizes.
- Motor wiring knockouts or access panels are provided at the base of IP21 and higher (NEMA1/12) units
- Do not install power factor correction capacitors between the adjustable frequency drive and the motor
- Do not wire a starting or pole-changing device between the adjustable frequency drive and the motor.
- Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W).

- Ground the cable in accordance with grounding instructions provided.
- Torque terminals in accordance with the information provided in
- Follow the motor manufacturer wiring requirements

Figure 2.8 represents line power input, motor, and grounding for basic adjustable frequency drives. Actual configurations vary with unit types and optional equipment.

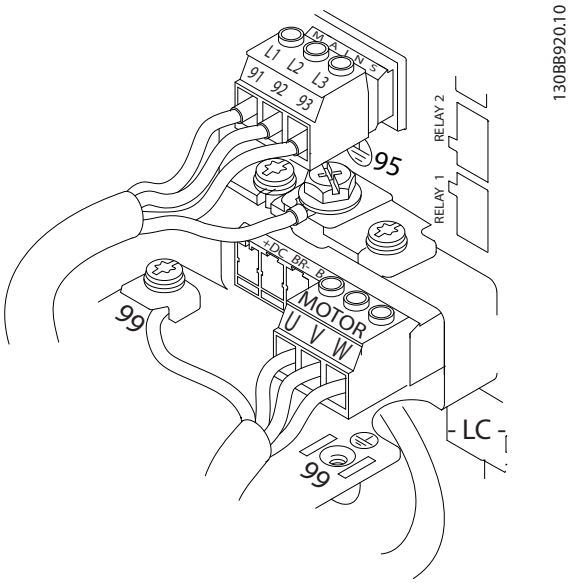


Figure 2.8 Example of Motor, Line Power and Ground Wiring

2.4.4 AC Line Input Connection

- Size wiring based upon the input current of the adjustable frequency drive. For maximum wire sizes, see *10.1 Power-dependent Specifications*.
- Comply with local and national electrical codes for cable sizes.
- Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Figure 2.8*).
- Depending on the configuration of the equipment, input power will be connected to the line input power or the input disconnect.
- Ground the cable in accordance with grounding instructions provided in *2.4.2 Grounding Requirements*
- All adjustable frequency drives may be used with an isolated input source as well as with ground reference power lines. 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), set *14-50 RFI 1* to *[0] Off*. When off, the internal RFI filter capacitors between the chassis and the intermediate circuit are isolated to avoid damage to the intermediate circuit and to reduce ground capacity currents in accordance with IEC 61800-3.

2.4.5 Control Wiring

- Isolate control wiring from high power components in the adjustable frequency drive.
- If the adjustable frequency drive is connected to a thermistor, for PELV isolation, optional thermistor control wiring must be reinforced/ double insulated. A 24 V DC supply voltage is recommended.

2.4.5.1 Access

- Remove access cover plate with a screw driver. See *Figure 2.9*.
- Or remove front cover by loosening attaching screws. See *Figure 2.10*.

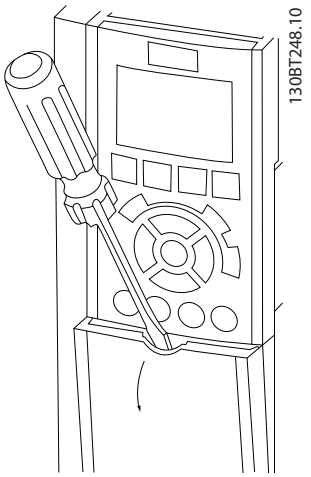


Figure 2.9 Control Wiring Access for A2, A3, B3, B4, C3 and C4 Enclosures

2

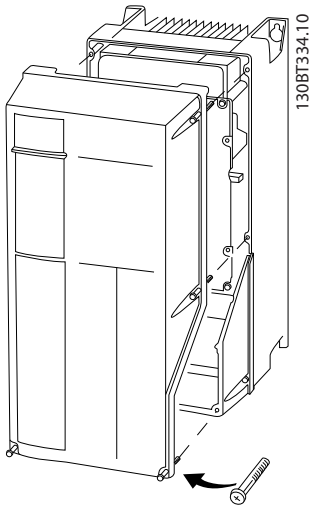


Figure 2.10 Control Wiring Access for A4, A5, B1, B2, C1 and C2 Enclosures

See *Table 2.3* before tightening the covers.

Frame	IP20	IP21	IP55	IP66
A3/A4/A5	-	-	2	2
B1/B2	-	*	2.2	2.2
C1/C2/C3/C4	-	*	2.2	2.2
* No screws to tighten - Does not exist				

Table 2.3 Tightening Torques for Covers (Nm)

2.4.5.2 Control Terminal Types

Figure 2.11 and shows the removable adjustable frequency drive connectors. Terminal functions and default settings are summarized in *Table 2.5*.

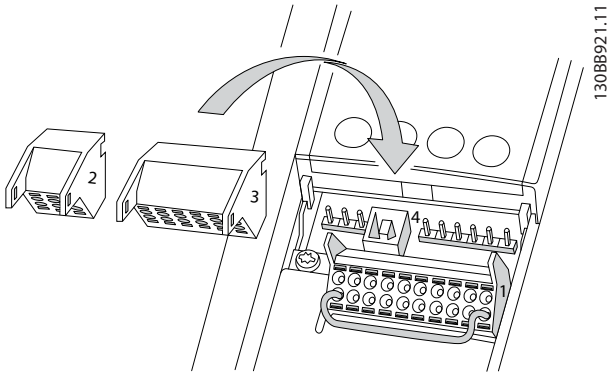


Figure 2.11 Control Terminal Locations

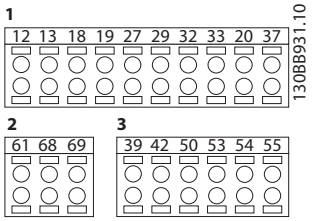


Figure 2.12 Terminal Numbers

- **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. FC 302 and FC 301 (optional in A1 enclosure) also provide a digital input for STO (Safe Torque Off) function.
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communications 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
- Also provided are two Form C relay outputs that are in various locations depending upon the adjustable frequency drive configuration and size
- Some options available for ordering with the unit may provide additional terminals. See the manual provided with the equipment option.

See *10.2 General Technical Data* for terminal ratings details.

Terminal description			
Terminal	**Parameter**	**Default setting**	**Description**
Digital inputs/outputs			
12, 13	-	+24 V DC	24 V DC supply voltage. Maximum output current is 200 mA total (130 mA for FC 301) for all 24 V loads. Usable for digital inputs and external transducers.
18	5-10	[8] Start	Digital inputs.
19	5-11	[10] Reversing	
32	5-14	[0] No operation	
33	5-15	[0] No operation	

Terminal description			
Terminal	Parameter	Default setting	Description
27	5-12	[2] Coast inverse	Selectable for either 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. Used for STO.
Analog inputs/outputs			
39	-		Common for analog output
42	6-50	[0] No operation	Programmable analog output. The analog signal is 0–20 mA or 4–20 mA at a maximum of 500 Ω
50	-	+10 V DC	10 V DC analog supply voltage. 15 mA maximum commonly used for potenti-ometer or thermistor.
53	6-1*	Reference	Analog input. Selectable for voltage or current. Switches A53 and A54 select mA or V.
54	6-2*	Feedback	
55	-		Common for analog input

Table 2.4 Terminal Description Digital Inputs/Outputs, Analog Inputs/Outputs

Terminal description			
Terminal	Parameter	Default setting	Description
Serial communication			
61	-		Integrated RC filter for cable screen. ONLY for connecting the shield when experiencing EMC problems.
68 (+)	8-3*		RS-485 Interface. A control card switch is provided for termination resistance.
69 (-)	8-3*		
Relays			
01, 02, 03	5-40 [0]	[0] No operation	Form C relay output. Usable for AC or DC voltage and resistive or inductive loads.
04, 05, 06	5-40 [1]	[0] No operation	

Table 2.5 Terminal Description Serial Communication

2.4.5.3 Wiring to Control Terminals

Control terminal connectors can be unplugged from the adjustable frequency drive for ease of installation, as shown in *Figure 2.11*.

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Figure 2.13*.
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 *10.1 Power-dependent Specifications* for control terminal wiring sizes.

See *6 Application Examples* for typical control wiring connections.

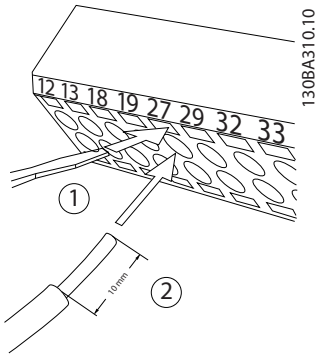


Figure 2.13 Connecting Control Wiring

2

2.4.5.4 Using Shielded Control Cables

Correct shielding

The preferred method in most cases is to secure control and serial communication cables with shielding clamps provided at both ends to ensure best possible high frequency cable contact.

If the ground potential between the adjustable frequency drive and the PLC is different, electrical noise may occur that will disturb the entire system. Solve this problem by fitting an equalizing cable next to the control cable.

Minimum cable cross-section: 0.025 in^2 [16 mm^2].

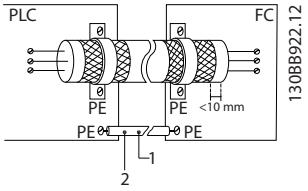


Figure 2.14 Correct Shielding

1	Min. 0.025 in^2 [16 mm^2]
2	Equalizing cable

Table 2.6 Legend to *Figure 2.14*

50/60 Hz ground loops

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

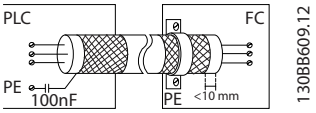


Figure 2.15 50/60 Hz Ground Loops

Avoid EMC noise on serial communication

This terminal is grounded via an internal RC link. Use twisted-pair cables to reduce interference between conductors. The recommended method is shown below:

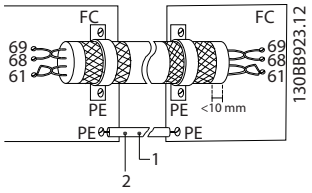


Figure 2.16 Twisted-pair Cables

1	Min. 0.025 in^2 [16 mm^2]
2	Equalizing cable

Table 2.7 Legend to *Figure 2.16*

Alternatively, the connection to terminal 61 can be omitted:

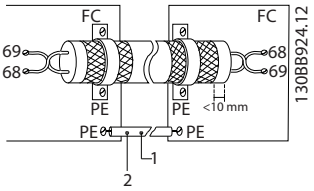


Figure 2.17 Twisted-pair Cables without Terminal 61

1	Min. 0.025 in^2 [16 mm^2]
2	Equalizing cable

Table 2.8 Legend to *Figure 2.17*

2.4.5.5 Control Terminal Functions

Adjustable frequency drive functions are commanded by receiving control input signals.

- Each terminal must be programmed for the function it will be supporting in the parameters associated with that terminal. See *Table 2.5* for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See *4 User Interface* for details on accessing parameters and *5 About Adjustable Frequency Drive Programming* for details on programming.
- The default terminal programming is intended to initiate adjustable frequency drive functioning in a typical operational mode.

2.4.5.6 Jumper Terminals 12 and 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.

- No signal present prevents the unit from operating.
- 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

2.4.5.7 Terminal 53 and 54 Switches

- Analog input terminals 53 and 54 can select either voltage (-10 to 10 V) or current (0/4–20 mA) input signals
- Remove power to the adjustable frequency drive before changing switch positions.
- Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.
- The switches are accessible when the LCP has been removed (see *Figure 2.18*).

NOTE!

Some option cards available for the unit may cover these switches and must be removed to change switch settings. Always remove power to the unit before removing option cards.

- Terminal 53 default is for a speed reference signal in open-loop set in *16-61 Terminal 53 Switch Setting*
- Terminal 54 default is for a feedback signal in closed-loop set in *16-63 Terminal 54 Switch Setting*

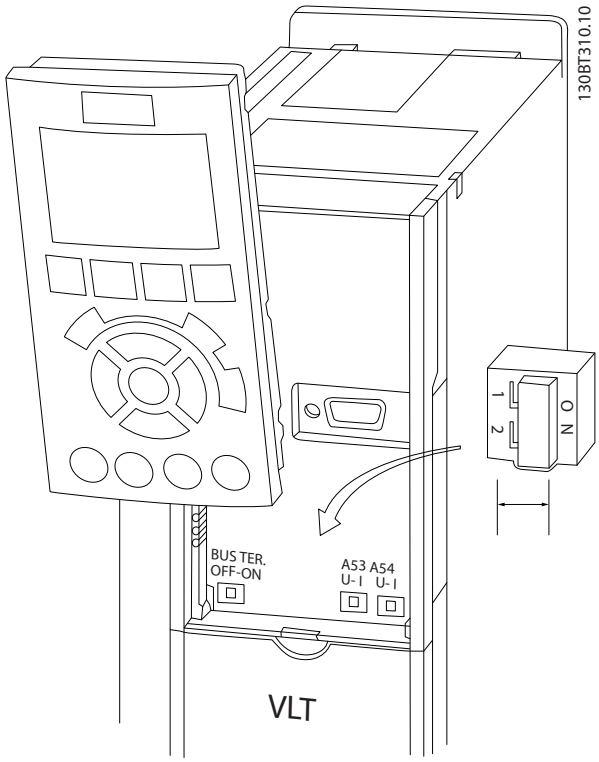


Figure 2.18 Location of Terminals 53 and 54 Switches and Bus Termination Switch

2.4.5.8 Mechanical Brake Control

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

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

2

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

In the vertical movement, the key point is that the load must be held, stopped, controlled (raised, lowered) in a perfectly safe mode during the entire operation. Because the adjustable frequency drive is not a safety device, the crane/lift designer (OEM) must decide on the type and number of safety devices (e.g. speed switch, emergency brakes, etc.) to be used, in order to be able to stop the load in case of emergency or malfunction of the system, according to relevant national crane/lift regulations.

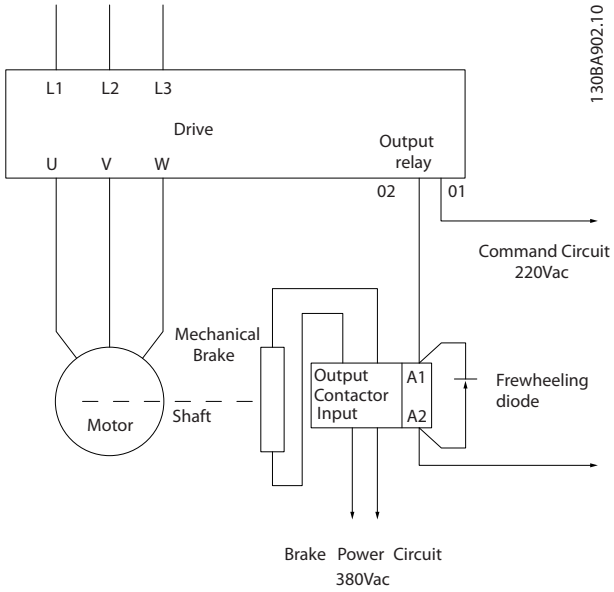


Figure 2.19 Connecting the Mechanical Brake to the Adjustable Frequency Drive

2.4.6 Serial Communication

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

- A shielded serial communication cable is recommended
- See *2.4.2 Grounding Requirements* for proper grounding

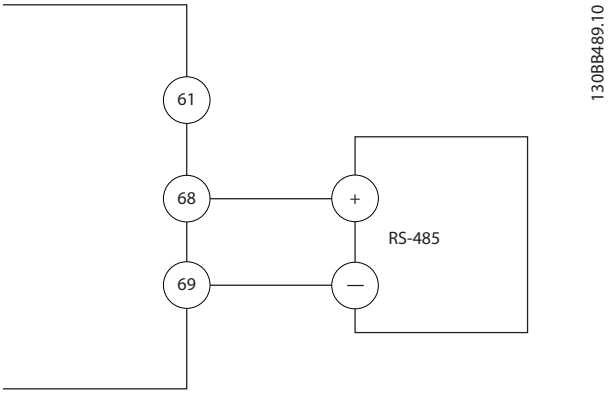


Figure 2.20 Serial Communication Wiring Diagram

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. Follow the motor manufacturer wiring requirements.

  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

2.5 Safe Stop

The adjustable frequency drive can perform the safety function *Safe Torque Off* (STO, as defined by EN IEC 61800-5-2[1]) and *Stop Category 0* (as defined in EN 60204-1[2]).
Danfoss has named this functionality *Safe Stop*. Before integration and use of Safe Stop in an installation, perform a thorough risk analysis to determine whether the Safe

Stop functionality and safety levels are appropriate and sufficient. Safe Stop is designed and approved suitable for the requirements of:

- Safety Category 3 according to EN ISO 13849-1
- Performance Level "d" according to EN ISO 13849-1:2008
- SIL 2 Capability according to IEC 61508 and EN 61800-5-2
- SILCL 2 according to EN 62061

[1] Refer to EN IEC 61800-5-2 for details of Safe torque off (STO) function.
[2] Refer to EN IEC 60204-1 for details of stop category 0 and 1.

Activation and Termination of Safe Stop
The Safe Stop (STO) function is activated by removing the voltage at Terminal 37 of the Safe Inverter. By connecting the Safe Inverter to external safety devices providing a safe delay, an installation for a safe Stop Category 1 can be obtained. The Safe Stop function can be used for asynchronous, synchronous, and permanent magnet motors.

⚠WARNING

After installation of Safe Stop (STO), a commissioning test as specified in *2.5.2 Safe Stop Commissioning Test* must be performed. A passed commissioning test is mandatory after first installation and after each change to the safety installation.

Safe Stop Technical Data
The following values are associated to the different types of safety levels:

Reaction time for T37
- Maximum reaction time: 10 ms

Reaction time = delay between de-energizing the STO input and switching off the adjustable frequency drive output bridge.

Data for EN ISO 13849-1
- Performance Level "d"
- $MTTF_d$ (Mean Time To Dangerous Failure): 14,000 years
- DC (Diagnostic Coverage): 90%
- Category 3
- Lifetime 20 years

Data for EN IEC 62061, EN IEC 61508, EN IEC 61800-5-2
- SIL 2 Capability, SILCL 2
- PFH (Probability of Dangerous failure per Hour)=1e-10FIT=7e-19/h-9/h>90%
- SFF (Safe Failure Fraction) >99%
- HFT (Hardware Fault Tolerance)=0 (1001 architecture)
- Lifetime 20 years

Data for EN IEC 61508 low demand
- PFDavg for one year proof test: 1E-10
- PFDavg for three year proof test: 1E-10
- PFDavg for five year proof test: 1E-10

No maintenance of the STO functionality is needed.

Security measures have to be taken by the user, e.g., installation in a closed cabinet that is only accessible for skilled personnel.

SISTEMA Data
Functional safety data is available via a data library for use with the SISTEMA calculation tool from the IFA (Institute for Occupational Safety and Health of the German Social Accident Insurance) and data for manual calculation. The library is complete and continually extended.

2.5.1 Terminal 37 Safe Stop Function

The adjustable frequency drive is available with safe stop functionality via control terminal 37. Safe stop disables the control voltage of the power semiconductors of the adjustable frequency drive output stage. This in turn prevents generating the voltage required to rotate the motor. When the Safe Stop (T37) is activated, the adjustable frequency drive issues an alarm, trips the unit, and coasts the motor to a stop. Manual restart is required. The safe stop function can be used as an emergency stop for the adjustable frequency drive. In normal operating mode when safe stop is not required, use the regular stop function instead. When automatic restart is used, ensure the requirements of ISO 12100-2 paragraph 5.3.2.5 are fulfilled.

Liability Conditions
It is the responsibility of the user to ensure that qualified personnel installs and operates the safe stop function:

- Read and understand the safety regulations concerning health and safety/accident prevention
- Understand the generic and safety guidelines given in this description and the extended description in the relevant *Design Guide*
- Have a good knowledge of the generic and safety standards applicable to the specific application

User is defined as: integrator, operator, service technician, maintenance technician.

2

Standards

Use of safe stop on terminal 37 requires that the user satisfies all provisions for safety including relevant laws, regulations and guidelines. The optional safe stop function complies with the following standards.

- IEC 60204-1: 2005 category 0 – uncontrolled stop
- IEC 61508: 1998 SIL2
- IEC 61800-5-2: 2007 – safe torque off (STO) function
- IEC 62061: 2005 SIL CL2
- ISO 13849-1: 2006 Category 3 PL d
- ISO 14118: 2000 (EN 1037) – prevention of unexpected start-up

The information and instructions of the instruction manual are not sufficient for a proper and safe use of the safe stop functionality. The related information and instructions of the relevant *Design Guide* must be followed.

Protective Measures

- Qualified and skilled personnel are required for installation and commissioning of safety engineering systems
- The unit must be installed in an IP54 cabinet or in an equivalent environment. In special applications, a higher IP degree is required
- The cable between terminal 37 and the external safety device must be short circuit protected according to ISO 13849-2 table D.4
- When external forces influence the motor axis (for example, suspended loads), additional measures are required (for example, a safety holding brake) to eliminate potential hazards

Safe Stop Installation and Set-up

⚠WARNING

SAFE STOP FUNCTION!

The safe stop function does NOT isolate AC line voltage to the adjustable frequency drive or auxiliary circuits. Perform work on electrical parts of the adjustable frequency drive or the motor only after isolating the AC line voltage supply and waiting the length of time specified in *Table 1.1*. Failure to isolate the AC line voltage supply from the unit and waiting the time specified could result in death or serious injury.

- It is not recommended to stop the adjustable frequency drive by using the Safe Torque Off function. If a running adjustable frequency drive is stopped by using the function, the unit trips and stops by coasting. If unacceptable or dangerous, use another stopping mode to stop the adjustable frequency drive and machinery, before using this function. Depending on the application, a mechanical brake can be required.
- For synchronous and permanent magnet motor adjustable frequency drives, in a multiple IGBT power semiconductor failure: In spite of the activation of the Safe Torque Off function, the system can produce an alignment torque which maximally rotates the motor shaft by 180/p degrees. p denotes the pole pair number.
- This function is suitable for performing mechanical work on the system or affected area of a machine only. It does not provide electrical safety. Do not use this function as a control for starting and/or stopping the adjustable frequency drive.

Follow these steps to perform a safe installation of the adjustable frequency drive:

1. Remove the jumper wire between control terminals 37 and 12 or 13. Cutting or breaking the jumper is not sufficient to avoid short-circuiting. (See jumper on *Figure 2.21*.)
2. Connect an external Safety monitoring relay via a NO safety function to terminal 37 (safe stop) and either terminal 12 or 13 (24 V DC). Follow the instructions for the safety device. The Safety monitoring relay must comply with Category 3 /PL “d” (ISO 13849-1) or SIL 2 (EN 62061).

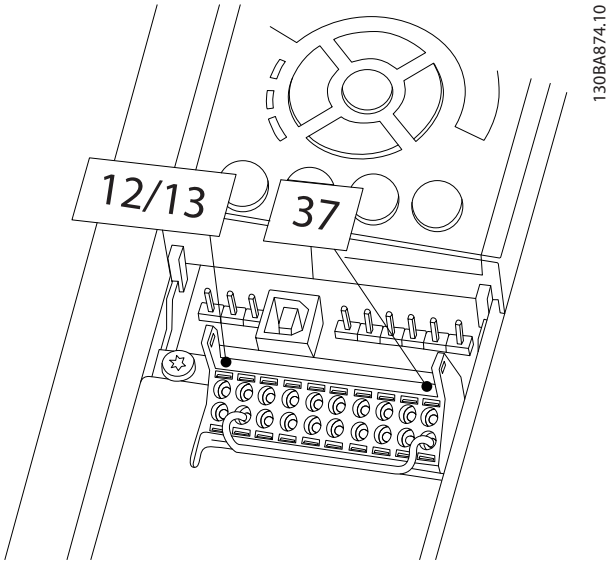


Figure 2.21 Jumper between Terminal 12/13 (24 V) and 37

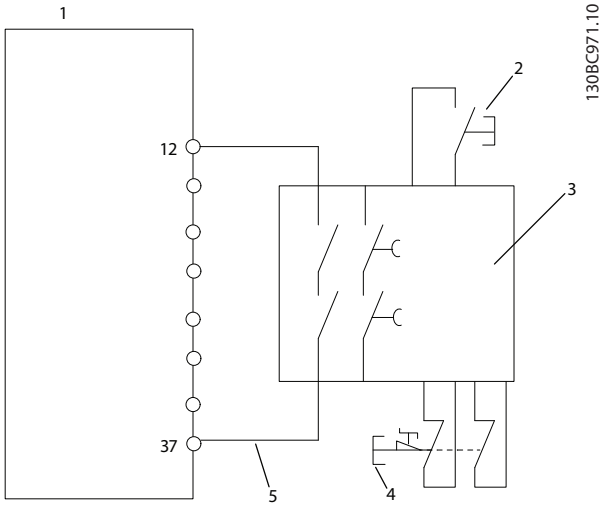


Figure 2.22 Installation to Achieve a Stopping Category 0 (EN 60204-1) with Cat. 3 /PL "d" (ISO 13849-1) or SIL 2 (EN 62061).

1	Adjustable frequency drive
2	[Reset] key
3	Safety relay (cat. 3, PL d or SIL2
4	Emergency stop button
5	Short-circuit protected cable (if not inside installation IP54 cabinet)

Table 2.9 Legend to *Figure 2.22*

Safe Stop Commissioning Test

After installation and before first operation, perform a commissioning test of the installation using safe stop. Also, perform the test after each modification of the installation.

⚠WARNING

Safe Stop activation (that is removal of 24 V DC voltage supply to terminal 37) does not provide electrical safety. The Safe Stop function itself is therefore not sufficient to implement the Emergency-Off function as defined by EN 60204-1. Emergency-Off requires measures of electrical isolation, for example, by switching off line power via an additional contactor.

1. Activate the Safe Stop function by removing the 24 V DC voltage supply to the terminal 37.
2. After activation of Safe Stop (that is, after the response time), the adjustable frequency drive coasts (stops creating a rotational field in the motor). The response time is typically less than 10 ms.

The adjustable frequency drive is guaranteed not to restart creation of a rotational field by an internal fault (in accordance with Cat. 3 PL d acc. EN ISO 13849-1 and SIL 2 acc. EN 62061). After activation of Safe Stop, the display shows the text "Safe Stop activated". The associated help text says, "Safe Stop has been activated". This means that the Safe Stop has been activated, or that normal operation has not been resumed yet after Safe Stop activation.

NOTE!

The requirements of Cat. 3 /PL "d" (ISO 13849-1) are only fulfilled while 24 V DC supply to terminal 37 is kept removed or low by a safety device which itself fulfills Cat. 3 PL "d" (ISO 13849-1). If external forces act on the motor, it must not operate without additional measures for fall protection. External forces can arise for example, in the event of vertical axis (suspended loads) where an unwanted movement, for example caused by gravity, could cause a hazard. Fall protection measures can be additional mechanical brakes.

By default the Safe Stop function is set to an Unintended Restart Prevention behavior. Therefore, to resume operation after activation of Safe Stop,

1. reapply 24 V DC voltage to terminal 37 (text Safe Stop activated is still displayed)
2. create a reset signal (via bus, digital I/O, or [Reset] key.

The Safe Stop function can be set to an Automatic Restart behavior. Set the value of *5-19 Terminal 37 Safe Stop* from default value [1] to value [3].
Automatic Restart means that Safe Stop is terminated, and normal operation is resumed, as soon as the 24 V DC are applied to Terminal 37. No Reset signal is required.

⚠WARNING

Automatic Restart Behavior is permitted in one of the two situations:

1. **Unintended restart prevention is implemented by other parts of the safe stop installation.**
2. **A presence in the hazard zone can be physically excluded when safe stop is not activated. In particular, paragraph 5.3.2.5 of ISO 12100-2 2003 must be observed**

2.5.2 Safe Stop Commissioning Test

After installation and before first operation, perform a commissioning test of an installation or application, using Safe Stop.
Perform the test again after each modification of the installation or application involving the Safe Stop.

NOTE!

A passed commissioning test is mandatory after first installation and after each change to the safety installation.

The commissioning test (select one of cases 1 or 2 as applicable):

Case 1: Restart prevention for Safe Stop is required (that is Safe Stop only where *5-19 Terminal 37 Safe Stop* is set to default value [1], or combined Safe Stop and MCB 112 where *5-19 Terminal 37 Safe Stop* is set to *[6] PTC 1 & Relay A* or *[9] PTC 1 & Relay W/A*):

1.1 Remove the 24 V DC voltage supply to terminal 37 using the interrupt device while the adjustable frequency drive drives the motor (that is line power supply is not interrupted). The test step is passed when

- the motor reacts with a coast, and
- the mechanical brake is activated (if connected)
- the alarm "Safe Stop [A68]" is displayed in the LCP, if mounted

1.2 Send Reset signal (via bus, digital I/O, or [Reset] key). The test step is passed if the motor remains in the safe stop state, and the mechanical brake (if connected) remains activated.

1.3 Reapply 24 V DC to terminal 37. The test step is passed if the motor remains in the coasted state, and the mechanical brake (if connected) remains activated.

1.4 Send Reset signal (via bus, digital I/O, or [Reset] key). The test step is passed when the motor becomes operational again.

The commissioning test is passed if all four test steps 1.1, 1.2, 1.3 and 1.4 are passed.

Case 2: Automatic Restart of Safe Stop is wanted and allowed (that is, Safe Stop only where *5-19 Terminal 37 Safe Stop* is set to [3], or combined Safe Stop and MCB 112 where *5-19 Terminal 37 Safe Stop* is set to *[7] PTC 1 & Relay W* or *[8] PTC 1 & Relay A/W*):

2.1 Remove the 24 V DC voltage supply to terminal 37 by the interrupt device while the adjustable frequency drive drives the motor (that is line power supply is not interrupted). The test step is passed when

- the motor reacts with a coast, and
- the mechanical brake is activated (if connected)
- the alarm "Safe Stop [A68]" is displayed in the LCP, if mounted

2.2 Reapply 24 V DC to terminal 37.

The test step is passed if the motor becomes operational again. The commissioning test is passed if both test steps 2.1 and 2.2 are passed.

NOTE!

See warning on the restart behavior in *2.5.1 Terminal 37 Safe Stop Function*

⚠WARNING

The Safe Stop function can be used for asynchronous, synchronous and permanent magnet motors. Two faults can occur in the power semiconductor of the adjustable frequency drive. When using synchronous or permanent magnet motors a residual rotation can result from the faults. The rotation can be calculated to Angle = 360/ (Number of Poles). The application using synchronous or permanent magnet motors must take this residual rotation into consideration and ensure that it does not pose a safety risk. This situation is not relevant for asynchronous motors.

3 Start-up and Functional Testing

3.1 Pre-start

3.1.1 Safety Inspection

⚠WARNING

HIGH VOLTAGE!

If input and output connections have been connected improperly, there is potential for high voltage on these terminals. If power leads for multiple motors are improperly run in same conduit, there is potential for leakage current to charge capacitors within the adjustable frequency drive, even when disconnected from line power input. For initial start-up, make no assumptions about power components. Follow pre-start procedures. Failure to follow pre-start procedures could result in personal injury or damage to equipment.

1. Input power to the unit must be OFF and locked out. Do not rely on the adjustable frequency drive disconnect switches for input power isolation.
2. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase and phase-to-ground,
3. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase and phase-to-ground.
4. Confirm continuity of the motor by measuring ohm values on U-V (96-97), V-W (97-98), and W-U (98-96).
5. Check for proper grounding of the adjustable frequency drive as well as the motor.
6. Inspect the adjustable frequency drive for loose connections on terminals.
7. Record the following motor nameplate data: power, voltage, frequency, full load current, and nominal speed. These values are needed to program motor nameplate data later.
8. Confirm that the supply voltage matches voltage of adjustable frequency drive and motor.

CAUTION

Before applying power to the unit, inspect the entire installation as detailed in *Table 3.1*. Check mark those 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 power factor correction caps on motor(s), if present	
Cable routing	• Ensure that input power, motor wiring and control wiring are separated or in three separate metallic conduits for high frequency noise 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	• Make sure that the top and bottom clearance is adequate to ensure proper airflow for cooling.	
EMC considerations	• Check for proper installation regarding electromagnetic compatibility.	
Environmental considerations	• See equipment label for the maximum ambient operating temperature limits. • Humidity levels must be 5%–95% non-condensing.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position.	
Grounding	• The unit requires a ground wire from its chassis to the building ground • Check for good ground connections that are tight and free of oxidation • Grounding to conduit or mounting the back panel to a metal surface is not a suitable ground	
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.	
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 3.1 Start-up Check List

3.2 Applying Power

⚠WARNING

HIGH VOLTAGE!

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

⚠WARNING

UNINTENDED START!

When the adjustable frequency drive is connected to AC line power, the motor may start at any time. The adjustable frequency drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the adjustable frequency drive is connected to AC line power could result in death, serious injury, equipment, or property damage.

1. Confirm input voltage is balanced within 3%. If not, correct input voltage imbalance before proceeding. Repeat procedure after voltage correction.
2. Ensure optional equipment wiring, if present, matches installation application.
3. Ensure that all operator devices are in the OFF position. Panel doors 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.

NOTE!

If 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.

3.3 Basic Operational Programming

Programming

For best performance, adjustable frequency drives require basic operational programming before running. Basic operational programming requires entering motor nameplate data for the motor being operated and the minimum and maximum motor speeds. The recommended parameter settings are intended for start-up and checkout purposes. Application settings may vary. See *4.1 Local Control Panel* for detailed instructions on entering data through the LCP.

Enter data with power ON, but before operating the adjustable frequency drive. There are two ways of programming the adjustable frequency drive: either by using the Smart Application Set-up (SAS) or by using the procedure described further down. The SAS is a quick wizard for setting up the most commonly used applications. At first power-up and after a reset, the SAS appears on the LCP. Follow the instructions that appear on the successive screens for setting up the applications listed. SAS can also be found under the Quick Menu. [Info] can be used throughout the Smart Set-up to see help information for various selections, settings and messages.

NOTE!

The start conditions will be ignored while in the wizard.

NOTE!

If no action is taken after first power-up or reset, the SAS screen will automatically disappear after 10 minutes.

When not using the SAS, enter data in accordance with the following procedure.

1. Press [Main Menu] twice on the LCP.
2. Press the navigation keys to scroll to parameter group Q2 Quick Set-up and press [OK].

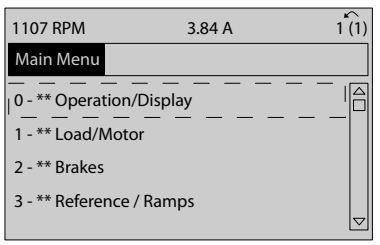


Figure 3.1 0- Operation/Display**

3

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

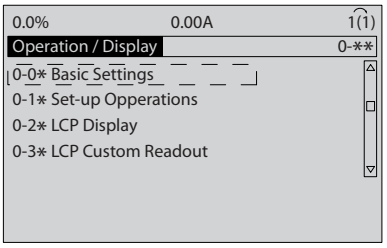


Figure 3.2 0-0* Basic Settings

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

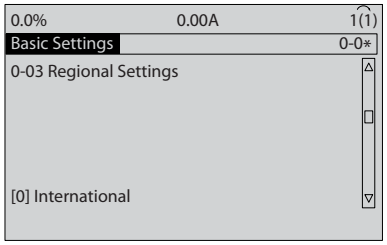


Figure 3.3 0-03 Regional Settings

5. Press the navigation keys to select *International* or *North America* as appropriate and press [OK]. (This changes the default settings for a number of basic parameters. See for a complete list.)
6. Press [Quick Menu] on the LCP.
7. Press the navigation keys to scroll to parameter group *Q2 Quick Set-up* and press [OK].

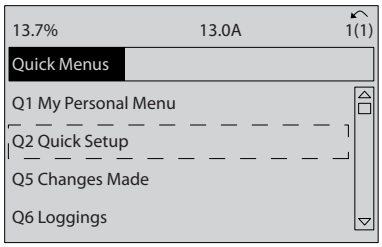


Figure 3.4 Q2 Quick Set-up

8. Select language and press [OK].

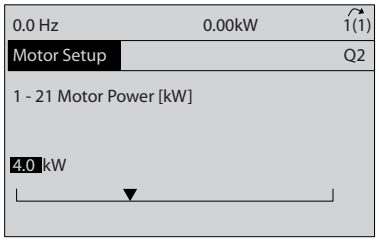


Figure 3.5 Select Language

9. A jumper wire should be in place between control terminals 12 and 27. If this is the case, leave *5-12 Terminal 27 Digital Input* at factory default. Otherwise select *No Operation*. For adjustable frequency drives with an optional bypass, no jumper wire is required.
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.

3.4 Asynchronous Motor Set-up

Enter the motor data in parameters 1-20/1-21 to 1-25. The information can be found on the motor nameplate.

1. *1-20 Motor Power [kW]* or *1-21 Motor Power [HP]*

   1-22 Motor Voltage

   1-23 Motor Frequency

   1-24 Motor Current

   1-25 Motor Nominal Speed

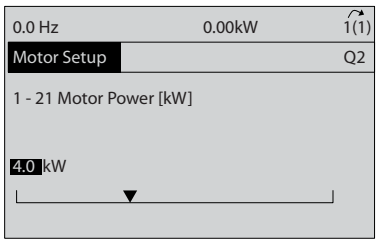


Figure 3.6 Motor Setup

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

This section is only relevant when using a PM motor.

Set up the basic motor parameters:

- *1-10 Motor Construction*
- *1-14 Damping Gain*
- *1-15 Low Speed Filter Time Const.*
- *1-16 High Speed Filter Time Const.*
- *1-17 Voltage filter time const.*
- *1-24 Motor Current*
- *1-25 Motor Nominal Speed*
- *1-26 Motor Cont. Rated Torque*
- *1-30 Stator Resistance (Rs)*
- *1-37 d-axis Inductance (Ld)*
- *1-39 Motor Poles*
- *1-40 Back EMF at 1000 RPM*
- *1-66 Min. Current at Low Speed*
- *4-13 Motor Speed High Limit [RPM]*
- *4-19 Max Output Frequency*

Note concerning advanced motor data:
Stator resistance and d-axis inductance values are often described differently in technical specifications. For programming resistance and d-axis inductance values in adjustable frequency drives, always use line to common (starpoint) values. This is valid for both asynchronous and PM motors.

Par. 1-30	Stator Resistance (Line to common)	This parameter gives stator winding resistance (Rs) similar to asynchronous motor stator resistance. When line-line data (where stator resistance is measured between any two lines) are available, you need to divide it with 2.
Par. 1-37	d-axis Inductance (Line to common)	This parameter gives direct axis inductance of the PM motor. When line-line data are available, you need to divide it with 2.
Par. 1-40	Back EMF at 1,000 RPM RMS (Line to Line Value)	This parameter gives back EMF across stator terminal of PM Motor at 1,000 RPM mechanical speed specifically. It is defined between line to line and expressed in RMS Value. In case the PM Motor specifications provides this value related to another motor speed, the voltage must be recalculated for 1,000 RPM.

Table 3.2

Note concerning back EMF:
Back EMF is the voltage generated by a PM motor when no drive is connected and the shaft is turned externally. Technical specifications usually notes this voltage related to nominal motor speed or to 1,000 RPM measured between two lines.

3.6 Automatic Motor Adaptation

Automatic motor adaptation (AMA) is a test procedure that measures the electrical characteristics of the motor to optimize 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 Motor Power [kW]* to *1-25 Motor Nominal Speed*.
- It does not cause the motor to run or harm to the motor
- Some motors may be unable to run the complete version of the test. In that case, select *Enable reduced AMA*
- If an output filter is connected to the motor, select *Enable reduced AMA*
- If warnings or alarms occur, see *8 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*.
3. Press [OK].
4. Scroll to parameter group *1-2* Motor Data*.
5. Press [OK].
6. Scroll to *1-29 Automatic Motor Adaptation (AMA)*.
7. Press [OK].
8. Select *Enable complete AMA*.
9. Press [OK].
10. Follow on-screen instructions.
11. The test will run automatically and indicate when it is complete.

3.7 Check Motor Rotation

Before running the adjustable frequency drive, check the motor rotation.

1. Press [Hand On].
2. Press [►] for positive speed reference.
3. Check that the speed displayed is positive.

When *1-06 Clockwise Direction* is set to *[0] Normal* (default clockwise):

4a. Verify that the motor turns clockwise.

5a. Verify that the LCP direction arrow is clockwise.

When *1-06 Clockwise Direction* is set to *[1] Inverse* (counter-clockwise):

4b. Verify that the motor turns counter-clockwise.

5b. Verify that the LCP direction arrow is counter-clockwise.

3.8 Check Encoder Rotation

Check encoder rotation only if encoder feedback is used. Check encoder rotation in default open-loop control.

1. Verify that the encoder connection is according to *Figure 3.7*:

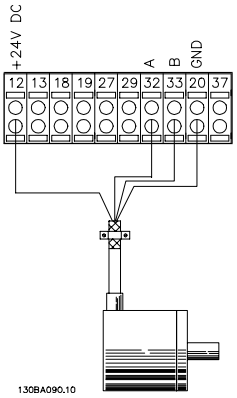


Figure 3.7 Wiring Diagram

NOTE!

When using an encoder option, refer to the option manual.

2. Enter the speed PID feedback source in *7-00 Speed PID Feedback Source*.
3. Press [Hand On].
4. Press [►] for positive speed reference (*1-06 Clockwise Direction* at *[0] Normal*).
5. Check in *16-57 Feedback [RPM]* that the feedback is positive.

NOTE!

If the feedback is negative, the encoder connection is wrong!

3.9 Local Control Test

⚠CAUTION

MOTOR START!

Ensure that the motor, system, and any attached equipment are ready for start. It is the responsibility of the user to ensure safe operation under any operational condition. Failure to ensure that the motor, system, and any attached equipment are ready for start could result in personal injury or equipment damage.

NOTE!

The Hand on key on the LCP provides a local start command to the adjustable frequency drive. The [Off] key provides the stop function.
When operating in local mode, the up and down arrows on the LCP increase and decrease the speed output of the LCP. The left and right arrow keys move the display cursor in the numeric display.

1. Press [Hand On].
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].
5. Note any deceleration problems.

If acceleration problems were encountered

- If warnings or alarms occur, see *8 Warnings and Alarms*
- Check that motor data is 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*

If deceleration problems were encountered

- If warnings or alarms occur, see *8 Warnings and Alarms*
- Check that motor data is entered correctly
- Increase the ramp-down time in *3-42 Ramp 1 Ramp-down Time*
- Enable overvoltage control in *2-17 Over-voltage Control*

See *8.4 Warning and Alarm Definitions* for resetting the adjustable frequency drive after a trip.

NOTE!

***3.1 Pre-start* through *3.9 Local Control Test* in this chapter conclude the procedures for applying power to the adjustable frequency drive, basic programming, set-up, and functional testing.**

3.10 System Start-up

The procedure in this section requires user-wiring and application programming to be completed. *6 Application Examples* is intended to help with this task. Other aids to application set-up are listed in *1.2 Additional Resources*. The following procedure is recommended after application set-up by the user is completed.

⚠CAUTION

MOTOR START!

Ensure that the motor, system, and any attached equipment are ready for start. It is the responsibility of the user to ensure safe operation under any operational condition. Failure to ensure that the motor, system, and any attached equipment are ready for start could result in personal injury or equipment damage.

1. Press [Auto On].
2. Ensure that external control functions are properly wired to the adjustable frequency drive and all programming completed.
3. Apply an external run command.
4. Adjust the speed reference throughout the speed range.
5. Remove the external run command.
6. Note any problems.

If warnings or alarms occur, see *8 Warnings and Alarms*.

3

4 User Interface

4.1 Local Control Panel

The local control panel (LCP) is the combined display and keypad on the front of the unit. The LCP is the user interface to the adjustable frequency drive.

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.

NOTE!

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

4.1.1 LCP Layout

The LCP is divided into four functional groups (see *Figure 4.1*).

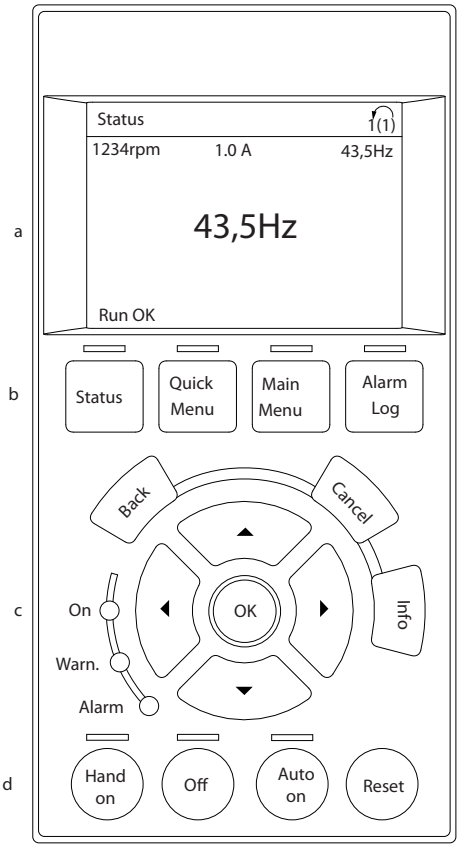


Figure 4.1 LCP

a. Display area.

b. Display menu keys for changing the display to show status options, programming, or error message history.

c. Navigation keys for programming functions, moving the display cursor, and speed control in local operation. Also included are the status indicator lights.

d. Operational mode keys and reset.

4

4.1.2 Setting LCP Display Values

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 supply.

The information displayed on the LCP can be customized for user application.

- Each display readout has a parameter associated with it.
- Options are selected in main menu *0-2* LCP Display*
- The adjustable frequency drive status at the bottom line of the display is generated automatically and is not selectable. See *7 Status Messages* for definitions and details.

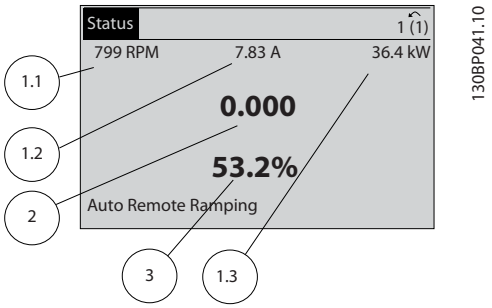


Figure 4.2 Display Readouts

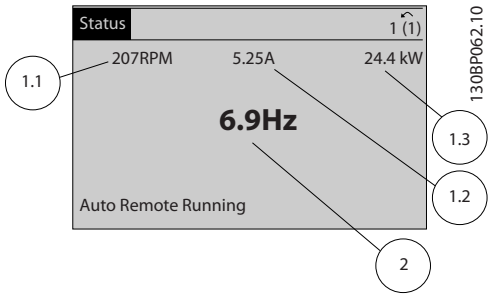


Figure 4.3 Display Readouts

Display	Parameter number	Default setting
1.1	0-20	Speed [RPM]
1.2	0-21	Motor Current
1.3	0-22	Power [kW]
2	0-23	Frequency
3	0-24	Reference [%]

Table 4.1 Legend to *Figure 4.2* and *Figure 4.3*

4.1.3 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.

Figure 4.4 Menu Keys

Key	Function
Status	Press to show operational information. • In Auto mode, press and hold to toggle between status readout displays • Press repeatedly to scroll through each status display. • Press and hold [Status] plus [▲] or [▼] to adjust the display brightness • The symbol in the upper right corner of the display shows the direction of motor rotation and which set-up is active. This is not programmable.
Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions. • Press to access *Q2 Quick Setup* for sequenced instructions to program the basic frequency controller set up • Follow the sequence of parameters as presented for the function set-up
Main Menu	Allows access to all programming parameters. • Press twice to access top-level index • Press once to return to the last location accessed. • Press and hold to enter a parameter number for direct access to that parameter.
Alarm Log	Displays a list of current warnings, the last 5 alarms, and the maintenance log. • For details about the adjustable frequency drive before it entered the alarm mode, select the alarm number using the navigation keys and press [OK].

Table 4.2 Legend to *Figure 4.4*

4.1.4 Navigation Keys

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. Three adjustable frequency drive status indicators are also located in this area.

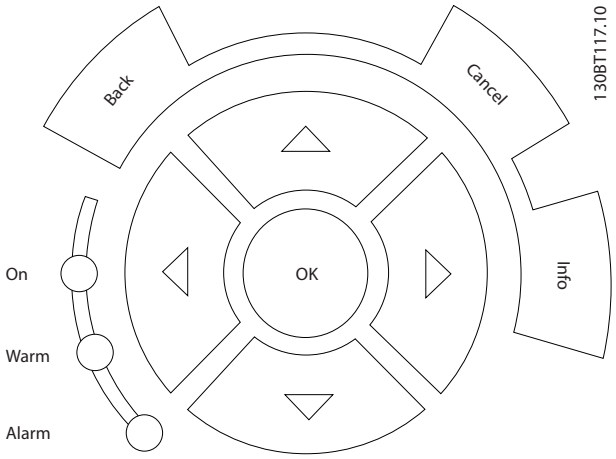


Figure 4.5 Navigation Keys

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

Table 4.3 Navigation Keys Functions

Light	Indicator	Function
Green	ON	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.
Yellow	WARNING	When warning conditions are met, the yellow WARNING light comes on and text appears in the display area identifying the problem.
Red	ALARM	A fault condition causes the red alarm light to flash and an alarm text is displayed.

Table 4.4 Indicator Lights Functions

4.1.5 Operation Keys

Operation keys are found at the bottom of the LCP.

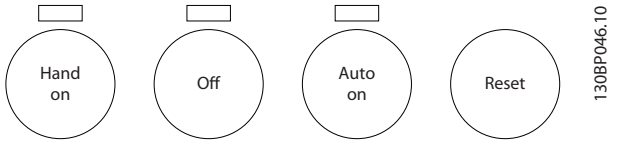


Figure 4.6 Operation Keys

Key	Function
Hand On	Starts the adjustable frequency drive in local control. • Use the navigation keys to control adjustable frequency drive speed. • An external stop signal by control input or serial communication overrides the local hand on
Off	Stops the motor but does not remove power to the adjustable frequency drive.
Auto On	Puts the system in remote operational mode. • Responds to an external start command by control terminals or serial communication • Speed reference is from an external source
Reset	Resets the adjustable frequency drive manually after a fault has been cleared.

Table 4.5 Operation Keys Functions

4.2 Backup and Copying Parameter Settings

Programming data is stored internally in the adjustable frequency drive.

- The data can be uploaded into the LCP memory as a storage backup.
- Once stored in the LCP, the data can be downloaded back into the adjustable frequency drive.
- Data can also be downloaded into other adjustable frequency drives by connecting the LCP into those units and downloading the stored settings. (This is a quick way to program multiple units with the same settings).
- Initialization of the adjustable frequency drive to restore factory default settings does not change data stored in the LCP memory.

⚠WARNING

UNINTENDED START!

When the adjustable frequency drive is connected to AC line power, the motor may start at any time. The adjustable frequency drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the adjustable frequency drive is connected to AC line power could result in death, serious injury, or equipment or property damage.

4

4.2.1 Uploading Data to the LCP

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

4.2.2 Downloading Data from the LCP

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

4.3 Restoring Default Settings

CAUTION

Initialization restores the unit to factory default settings. Any programming, motor data, localization, and monitoring records will be lost. Uploading data to the LCP provides a backup before initialization.

Restoring the adjustable frequency drive parameter settings back to default values is done by initialization of the adjustable frequency drive. Initialization can be through *14-22 Operation Mode* or manually.

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

4.3.1 Recommended Initialization

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

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

8. Alarm 80 is displayed.
9. Press [Reset] to return to operation mode.

4.3.2 Manual Initialization

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 and apply power to the unit.

Factory default parameter settings are restored during startup. This may take slightly longer than normal.

Manual initialization does not change the following adjustable frequency drive information

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

5 About Adjustable Frequency Drive Programming

5.1 Introduction

The adjustable frequency drive is programmed for its application functions using parameters. Parameters are accessed by pressing either [Quick Menu] or [Main Menu] on the LCP. (See *4 User Interface* for details on using the LCP function keys.) Parameters may also be accessed through a PC using the MCT 10 Set-up Software (see *5.6.1 Remote Programming with MCT 10 Set-up Software*).

The quick menu is intended for initial start-up (*Q2-** Quick Set-up*). Data entered in a parameter can change the options available in the parameters following that entry.

The main menu accesses all parameters and allows for advanced adjustable frequency drive applications.

5.2 Programming Example

Here is an example for programming the adjustable frequency drive for a common application in open-loop using the quick menu.

- This procedure programs the adjustable frequency drive to receive a 0–10 V DC analog control signal on input terminal 53
- The adjustable frequency drive will respond by providing 6-60 Hz output to the motor proportional to the input signal (0–10 V DC = 6–60 Hz)

Select the following parameters using the navigation keys to scroll to the titles and press [OK] after each action.

1. *3-15 Reference Resource 1*

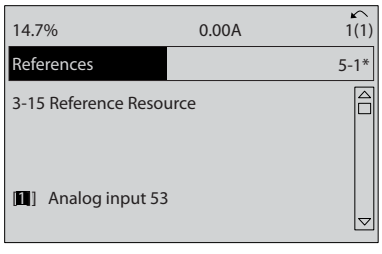


Figure 5.1 *3-15 Reference Resource 1*

2. *3-02 Minimum Reference*. Set minimum internal adjustable frequency drive reference to 0 Hz. (This sets the minimum adjustable frequency drive speed at 0 Hz.)

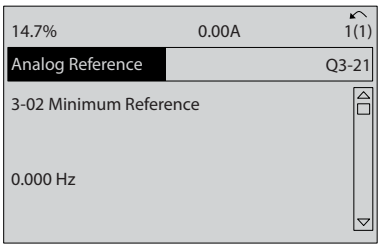


Figure 5.2 *3-02 Minimum Reference*

3. *3-03 Maximum Reference*. Set maximum internal adjustable frequency drive reference to 60 Hz. (This sets the maximum adjustable frequency drive speed at 60 Hz. Note that 50/60 Hz is a regional variation.)

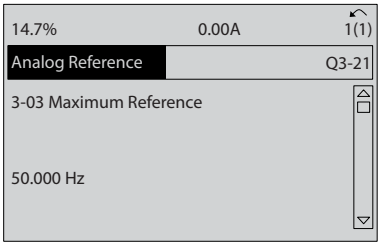


Figure 5.3 *3-03 Maximum Reference*

4. *6-10 Terminal 53 Low Voltage*. Set minimum external voltage reference on Terminal 53 at 0 V (this sets the minimum input signal at 0 V).

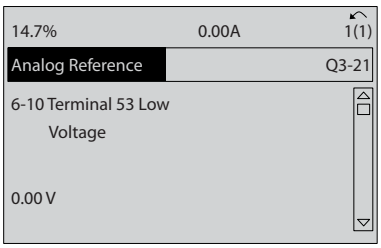


Figure 5.4 *6-10 Terminal 53 Low Voltage*

5. *6-11 Terminal 53 High Voltage*. Set maximum external voltage reference on Terminal 53 at 10 V (this sets the maximum input signal at 10 V).

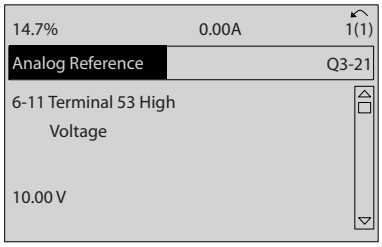


Figure 5.5 *6-11 Terminal 53 High Voltage*

6. *6-14 Terminal 53 Low Ref./Feedb. Value*. Set minimum speed reference on Terminal 53 at 6 Hz (this tells the adjustable frequency drive that the minimum voltage received on Terminal 53 (0 V) equals 6 Hz output).

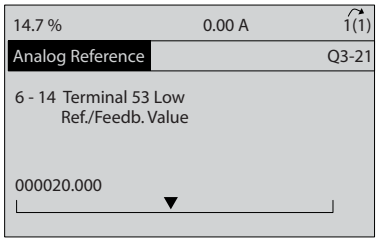


Figure 5.6 *6-14 Terminal 53 Low Ref./Feedb. Value*

7. *6-15 Terminal 53 High Ref./Feedb. Value*. Set maximum speed reference on Terminal 53 at 60 Hz (this tells the adjustable frequency drive that the maximum voltage received on Terminal 53 (10 V) equals 60 Hz output).

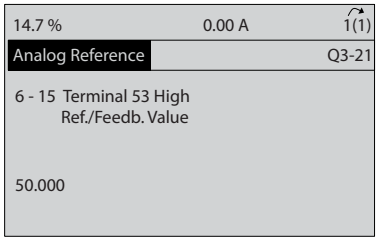


Figure 5.7 *6-15 Terminal 53 High Ref./Feedb. Value*

With an external device providing a 0–10 V control signal connected to adjustable frequency drive terminal 53, the system is now ready for operation.

NOTE!

When the procedure is complete, the scroll bar is at the bottom.

Figure 5.8 shows the wiring connections used to enable this set-up.

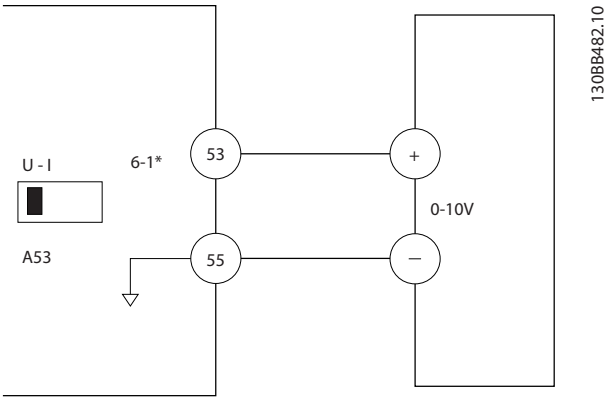


Figure 5.8 Wiring Example for External Device Providing 0–10 V Control Signal (adjustable frequency drive left, external device right)

5.3 Control Terminal Programming Examples

Control terminals can be programmed.

- Each terminal has specified functions it is capable of performing.
- Parameters associated with the terminal enable the function.

See *Table 2.5* for control terminal parameter number and default setting. (Default setting can change based on the selection in *0-03 Regional Settings*.)

The following example shows accessing Terminal 18 to see the default setting.

1. Press [Main Menu] twice, scroll to parameter group 5-** *Digital In/Out* and press [OK].

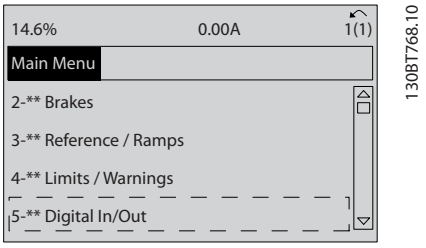


Figure 5.9

2. Scroll to parameter group 5-1* *Digital Inputs* and press [OK].

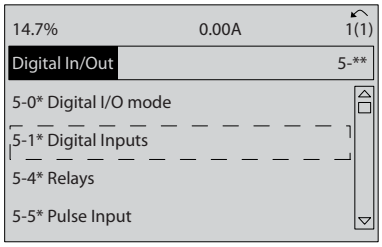


Figure 5.10

3. Scroll to *5-10 Terminal 18 Digital Input*. Press [OK] to access function choices. The default setting *Start* is shown.

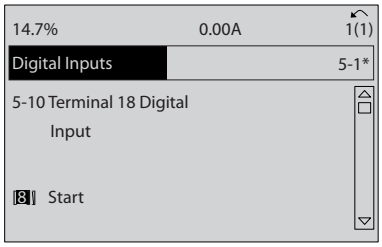


Figure 5.11

5.4 International/North American Default Parameter Settings

Setting *0-03 Regional Settings* to [0] *International* or [1] *North America* changes the default settings for some parameters. *Table 5.1* lists those parameters that are affected.

Parameter	International default parameter value	North American default parameter value
0-03 Regional Settings	International	North America
1-20 Motor Power [kW]	See Note 1	See Note 1
1-21 Motor Power [HP]	See Note 2	See Note 2
1-22 Motor Voltage	230 V/400 V/575 V	208 V/460 V/575 V
1-23 Motor Frequency	50 Hz	60 Hz
3-03 Maximum Reference	50 Hz	60 Hz
3-04 Reference Function	Sum	External/Preset
4-13 Motor Speed High Limit [RPM] See Note 3 and 5	1,500 RPM	1,800 RPM
4-14 Motor Speed High Limit [Hz] See Note 4	50 Hz	60 Hz
4-19 Max Output Frequency	132 Hz	120 Hz
4-53 Warning Speed High	1,500 RPM	1,800 RPM
5-12 Terminal 27 Digital Input	Coast inverse	External interlock
5-40 Function Relay	No operation	No alarm
6-15 Terminal 53 High Ref./Feedb. Value	50	60
6-50 Terminal 42 Output	No operation	Speed 4–20 mA
14-20 Reset Mode	Manual reset	Infinite auto reset

Table 5.1 International/North American Default Parameter Settings

Note 1: 1-20 Motor Power [kW] is only visible when 0-03 Regional Settings is set to [0] International.
Note 2:1-21 Motor Power [HP], is only visible when 0-03 Regional Settings is set to [1] North America.
Note 3: This parameter is only visible when 0-02 Motor Speed Unit is set to [0] RPM.
Note 4: This parameter is only visible when 0-02 Motor Speed Unit is set to [1] Hz.
Note 5: The default value depends on the number of motor poles. For a 4 poled motor the international default value is 1,500 RPM and for a 2 poled motor 3,000 RPM. The corresponding values for North America is 1,800 and 3,600 RPM, respectively.

Changes made to default settings are stored and available for viewing in the quick menu along with any programming entered into parameters.

1. Press [Quick Menu].
2. Scroll to *Q5 Changes Made* and press [OK].

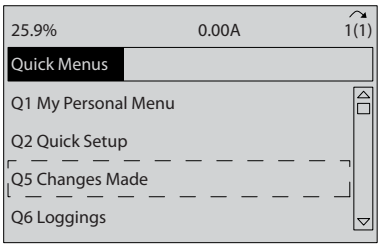


Figure 5.12 ***Q5 Changes Made***

3. Select Q5-2 *Since Factory Setting* to view all programming changes or Q5-1 *Last 10 Changes* for the most recent.

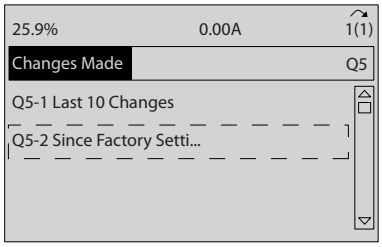


Figure 5.13 *Q5-2 Since Factory Setting*

5

5.5 Parameter Menu Structure

Establishing the correct programming for applications often requires setting functions in several related parameters. These parameter settings provide the adjustable frequency drive with system details for the adjustable frequency drive to operate properly. System details may include such things as input and output signal types, programming terminals, minimum and maximum signal ranges, custom displays, automatic restart, and other features.

- See the LCP display to view detailed parameter programming and setting options.
- Press [Info] in any menu location to view additional details for that function.
- Press and hold [Main Menu] to enter a parameter number for direct access to that parameter.
- Details for common application set-ups are provided in *6 Application Examples*.

5.5.1 Main 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 (Hand)
0-09 Performance Monitor
0-1* Set-up Operations
0-10 Active Set-up
0-11 Edit Set-up
0-12 This Set-up Linked to
0-13 Readout: Linked Set-ups
0-14 Readout: Edit Set-ups / Channel
0-15 Readout: actual setup
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 Unit for User-defined Readout
0-31 Min Value of User-defined Readout
0-32 Max Value of User-defined Readout
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 Quick Menu Password
0-66 Access to Quick Menu w/o Password
0-67 Bus Password Access
0-68 Safety Parameters Password
0-69 Password Protection of Safety Parameters

1- Load and Motor**
1-0* General Settings
1-00 Configuration Mode
1-01 Motor Control Principle
1-02 Flux Motor Feedback Source
1-03 Torque Characteristics
1-04 Overload Mode
1-05 Local Mode Configuration
1-06 Clockwise Direction
1-07 Motor Angle Offset Adjust
1-1* Special Settings
1-10 Motor Construction
1-11 Motor Model
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
1-29 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)
1-38 q-axis Inductance (Lq)
1-39 Motor Poles
1-40 Back EMF at 1000 RPM
1-41 Motor Angle Offset
1-44 d-axis Inductance Sat. (LdSat)
1-45 q-axis Inductance Sat. (LqSat)
1-46 Position Detection Gain
1-47 Low Speed Torque Calibration
1-48 Inductance Sat. Point
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]
1-53 Model Shift Frequency
1-54 Voltage reduction in fieldweakening
1-55 U/f Characteristic - U
1-56 U/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
1-67 Load Type
1-68 Minimum Inertia
1-69 Maximum Inertia
1-7* Start Adjustments
1-70 PM Start Mode
1-71 Start Delay
1-72 Start Function
1-73 Flying Start
1-74 Start Speed [RPM]
1-75 Start Speed [Hz]
1-76 Start Current
1-8* Stop Adjustments
1-80 Function at Stop
1-81 Min Speed for Function at Stop [RPM]
1-82 Min Speed for Function at Stop [Hz]
1-83 Precise Stop Function
1-84 Precise Stop Counter Value
1-85 Precise Stop Speed Compensation Delay
1-9* Motor Temperature
1-90 Motor Thermal Protection
1-91 Motor External Fan
1-93 Thermistor Resource
1-94 ATEX ETR cur.lim. speed reduction
1-95 KTY Sensor Type
1-96 KTY Thermistor Resource
1-97 KTY Threshold level
1-98 ATEX ETR interpol. points freq.
1-99 ATEX ETR interpol points current

2- Brakes**
2-0* DC Brake
2-00 DC Hold Current
2-01 DC Brake Current
2-02 DC Braking Time
2-03 DC Brake Cut-in Speed [RPM]
2-04 DC Brake Cut-in Speed [Hz]
2-05 Maximum Reference
2-06 Parking Current
2-07 Parking Time
2-1* Brake Energy Funct.
2-10 Brake Function
2-11 Brake Resistor (ohm)
2-12 Brake Power Limit (kW)
2-13 Brake Power Monitoring
2-15 Brake Check
2-16 AC Brake Max. Current
2-17 Over-voltage Control
2-18 Brake Check Condition
2-19 Over-voltage Gain
2-2* Mechanical Brake
2-20 Release Brake Current
2-21 Activate Brake Speed [RPM]
2-22 Activate Brake Speed [Hz]
2-23 Activate Brake Delay
2-24 Stop Delay
2-25 Brake Release Time
2-26 Torque Ref
2-27 Torque Ramp Time
2-28 Gain Boost Factor

3- Reference / Ramps**
3-0* Reference Limits
3-00 Reference Range
3-01 Reference/Feedback Unit
3-02 Minimum Reference
3-03 Maximum Reference
3-04 Reference Function
3-1* References
3-10 Preset Reference
3-11 Jog Speed [Hz]
3-12 Catch up/slow-down value
3-13 Reference Site
3-14 Preset Relative Reference
3-15 Reference Resource 1
3-16 Reference Resource 2
3-17 Reference Resource 3
3-18 Relative Scaling Reference Resource
3-19 Jog Speed [RPM]
3-4* Ramp 1
3-40 Ramp 1 Type
3-41 Ramp 1 Ramp-up Time
3-42 Ramp 1 Ramp-down Time
3-45 Ramp 1 S-ramp Ratio at Accel. Start
3-46 Ramp 1 S-ramp Ratio at Accel. End
3-47 Ramp 1 S-ramp Ratio at Decel. Start
3-48 Ramp 1 S-ramp Ratio at Decel. End
3-5* Ramp 2
3-50 Ramp 2 Type
3-51 Ramp 2 Ramp-up Time
3-52 Ramp 2 Ramp-down Time
3-55 Ramp 2 S-ramp Ratio at Accel. Start
3-56 Ramp 2 S-ramp Ratio at Accel. End
3-57 Ramp 2 S-ramp Ratio at Decel. Start
3-58 Ramp 2 S-ramp Ratio at Decel. End
3-6* Ramp 3
3-60 Ramp 3 Type
3-61 Ramp 3 Ramp-up Time
3-62 Ramp 3 Ramp-down Time
3-65 Ramp 3 S-ramp Ratio at Accel. Start
3-66 Ramp 3 S-ramp Ratio at Accel. End
3-67 Ramp 3 S-ramp Ratio at Decel. Start
3-68 Ramp 3 S-ramp Ratio at Decel. End
3-7* Ramp 4
3-70 Ramp 4 Type
3-71 Ramp 4 Ramp-up Time
3-72 Ramp 4 Ramp-down Time
3-75 Ramp 4 S-ramp Ratio at Accel. Start
3-76 Ramp 4 S-ramp Ratio at Accel. End
3-77 Ramp 4 S-ramp Ratio at Decel. Start
3-78 Ramp 4 S-ramp Ratio at Decel. End
3-8* Other Ramps
3-80 Jog Ramp Time
3-81 Quick Stop Ramp Time
3-82 Quick Stop Ramp Type
3-83 Quick Stop S-ramp Ratio at Decel. Start
3-84 Quick Stop S-ramp Ratio at Decel. End
3-9* Digital Pot. meter
3-90 Step Size
3-91 Ramp Time
3-92 Power Restore
3-93 Maximum Limit
3-94 Minimum Limit
3-95 Ramp Delay

4- Limits / Warnings**
4-1* Motor Limits
4-10 Motor Speed Direction
4-11 Motor Speed Low Limit [RPM]
4-12 Motor Speed Low Limit [Hz]
4-13 Motor Speed High Limit [RPM]
4-14 Motor Speed High Limit [Hz]
4-16 Torque Limit Motor Mode
4-17 Torque Limit Generator Mode
4-18 Current Limit
4-19 Max Output Frequency
4-2* Limit Factors
4-20 Torque Limit Factor Source
4-21 Speed Limit Factor Source
4-3* Motor Speed Mon.
4-30 Motor Feedback Loss Function
4-31 Motor Feedback Speed Error
4-32 Motor Feedback Loss Timeout
4-34 Tracking Error Function
4-35 Tracking Error
4-36 Tracking Error Timeout
4-37 Tracking Error Ramping
4-38 Tracking Error Ramping Timeout
4-39 Tracking Error After Ramping Timeout
4-5* Adj. Warnings
4-50 Warning Current Low
4-51 Warning Current High
4-52 Warning Speed Low
4-53 Warning Speed High
4-54 Warning Reference Low
4-55 Warning Reference High
4-56 Warning Feedback Low
4-57 Warning Feedback High
4-58 Missing Motor Phase Function
4-6* Speed Bypass
4-60 Bypass Speed From [RPM]
4-61 Bypass Speed From [Hz]
4-62 Bypass Speed to [RPM]
4-63 Bypass Speed To [Hz]

5- Digital In/Out**
5-0* Digital I/O mode
5-00 Digital I/O Mode
5-01 Terminal 27 Mode
5-02 Terminal 29 Mode
5-1* Digital Inputs
5-10 Terminal 18 Digital Input
5-11 Terminal 19 Digital Input
5-12 Terminal 27 Digital Input
5-13 Terminal 29 Digital Input
5-14 Terminal 32 Digital Input
5-15 Terminal 33 Digital Input
5-16 Terminal X30/2 Digital Input
5-17 Terminal X30/3 Digital Input
5-18 Terminal X30/4 Digital Input
5-19 Terminal 37 Safe Stop

5-20	Terminal X46/1 Digital Input
5-21	Terminal X46/3 Digital Input
5-22	Terminal X46/5 Digital Input
5-23	Terminal X46/7 Digital Input
5-24	Terminal X46/9 Digital Input
5-25	Terminal X46/11 Digital Input
5-26	Terminal X46/13 Digital Input
5-3*	**Digital Outputs**
5-30	Terminal 27 Digital Output
5-31	Terminal 29 Digital Output
5-32	Term X30/6 Digi Out (MCB 101)
5-33	Term X30/7 Digi Out (MCB 101)
5-4*	**Relays**
5-40	Function Relay
5-41	On Delay, Relay
5-42	Off Delay, Relay
5-5*	**Pulse Input**
5-50	Term. 29 Low Frequency
5-51	Term. 29 High Frequency
5-52	Term. 29 Low Ref./Feedb. Value
5-53	Term. 29 High Ref./Feedb. Value
5-54	Pulse Filter Time Constant #29
5-55	Term. 33 Low Frequency
5-56	Term. 33 High Frequency
5-57	Term. 33 Low Ref./Feedb. Value
5-58	Term. 33 High Ref./Feedb. Value
5-59	Pulse Filter Time Constant #33
5-6*	**Pulse Output**
5-60	Terminal 27 Pulse Output Variable
5-62	Pulse Output Max Freq #27
5-63	Terminal 29 Pulse Output Variable
5-65	Pulse Output Max Freq #29
5-66	Terminal X30/6 Pulse Output Variable
5-68	Pulse Output Max Freq #X30/6
5-7*	**24V Encoder Input**
5-70	Term 32/33 Pulses Per Revolution
5-71	Term 32/33 Encoder Direction
5-8*	**I/O Options**
5-80	AHF Cap Reconnect Delay
5-9*	**Bus Controlled**
5-90	Digital & Relay Bus Control
5-93	Pulse Out #27 Bus Control
5-94	Pulse Out #27 Timeout Preset
5-95	Pulse Out #29 Bus Control
5-96	Pulse Out #29 Timeout Preset
5-97	Pulse Out #X30/6 Bus Control
5-98	Pulse Out #X30/6 Timeout Preset
6-**	**Analog In/Out**
6-0*	**Analog I/O Mode**
6-00	Live Zero Timeout Time
6-01	Live Zero Timeout Function
6-1*	**Analog Input 1**
6-10	Terminal 53 Low Voltage
6-11	Terminal 53 High Voltage
6-12	Terminal 53 Low Current
6-13	Terminal 53 High Current
6-14	Terminal 53 Low Ref./Feedb. Value
6-15	Terminal 53 High Ref./Feedb. Value
6-16	Terminal 53 Filter Time Constant
6-2*	**Analog Input 2**
6-20	Terminal 54 Low Voltage
6-21	Terminal 54 High Voltage
6-22	Terminal 54 Low Current
6-23	Terminal 54 High Current
6-24	Terminal 54 Low Ref./Feedb. Value
6-25	Terminal 54 High Ref./Feedb. Value
6-26	Terminal 54 Filter Time Constant
6-3*	**Analog Input 53**
6-30	Terminal X30/11 Low Voltage
6-31	Terminal X30/11 High Voltage
6-34	Term. X30/11 Low Ref./Feedb. Value
6-35	Term. X30/11 High Ref./Feedb. Value
6-36	Term. X30/11 Filter Time Constant
6-4*	**Analog Input 4**
6-40	Terminal X30/12 Low Voltage
6-41	Terminal X30/12 High Voltage
6-44	Term. X30/12 Low Ref./Feedb. Value
6-45	Term. X30/12 High Ref./Feedb. Value
6-46	Term. X30/12 Filter Time Constant
6-5*	**Analog Output 1**
6-50	Terminal 42 Output
6-51	Terminal 42 Output Min Scale
6-52	Terminal 42 Output Max Scale
6-53	Term 42 Output Bus Ctrl
6-54	Terminal 42 Output Timeout Preset
6-55	Analog Output Filter
6-6*	**Analog Output 2**
6-60	Terminal X30/8 Output
6-61	Terminal X30/8 Min. Scale
6-62	Terminal X30/8 Max. Scale
6-63	Terminal X30/8 Bus Control
6-64	Terminal X30/8 Output Timeout Preset
6-7*	**Analog Output 3**
6-70	Terminal X45/1 Output
6-71	Terminal X45/1 Min. Scale
6-72	Terminal X45/1 Max. Scale
6-73	Terminal X45/1 Bus Control
6-74	Terminal X45/1 Output Timeout Preset
6-8*	**Analog Output 4**
6-80	Terminal X45/3 Output
6-81	Terminal X45/3 Min. Scale
6-82	Terminal X45/3 Max. Scale
6-83	Terminal X45/3 Bus Control
6-84	Terminal X45/3 Output Timeout Preset
7-**	**Controllers**
7-0*	**Speed PID Ctrl.**
7-00	Speed PID Feedback Source
7-02	Speed PID Proportional Gain
7-03	Speed PID Integral Time
7-04	Speed PID Differentiation Time
7-05	Speed PID Diff. Gain Limit
7-06	Speed PID Lowpass Filter Time
7-07	Speed PID Feedback Gear Ratio
7-08	Speed PID Feed Forward Factor
7-09	Speed PID Error Correction w/ Ramp
7-1*	**Torque PI Ctrl.**
7-12	Torque PI Proportional Gain
7-13	Torque PI Integration Time
7-2*	**Process Ctrl. Feedb**
7-20	Process CL Feedback 1 Resource
7-22	Process CL Feedback 2 Resource
7-3*	**Process PID Ctrl.**
7-30	Process PID Normal/Inverse Control
7-31	Process PID Anti Windup
7-32	Process PID Controller Start Value
7-33	Process PID Proportional Gain
7-34	Process PID Integral Time
7-35	Process PID Differentiation Time
7-36	Process PID Differentiation Gain Limit
7-38	Process PID Feed Forward Factor
7-39	On Reference Bandwidth
7-4*	**Adv. Process PID I**
7-40	Process PID I-part Reset
7-41	Process PID Output Neg. Clamp
7-42	Process PID Output Pos. Clamp
7-43	Process PID Gain Scale at Min. Ref.
7-44	Process PID Gain Scale at Max. Ref.
7-45	Process PID Feed Fwd Resource
7-46	Process PID Feed Fwd Normal/ Inv. Ctrl.
7-48	PCD Feed Forward
7-49	Process PID Output Normal/ Inv. Ctrl.
7-5*	**Adv. Process PID II**
7-50	Process PID Extended PID
7-51	Process PID Feed Fwd Gain
7-52	Process PID Feed Fwd Ramp-up
7-53	Process PID Feed Fwd Ramp-down
7-56	Process PID Ref. Filter Time
7-57	Process PID Fb. Filter Time
8-**	**Comm. and Options**
8-0*	**General Settings**
8-01	Control Site
8-02	Control Word Source
8-03	Control Word Timeout Time
8-04	Control Word Timeout Function
8-05	End-of-Timeout Function
8-06	Reset Control Word Timeout
8-07	Diagnosis Trigger
8-08	Readout Filtering
8-1*	**Ctrl. Word Settings**
8-10	Control Word Profile
8-13	Configurable Status Word STW
8-14	Configurable Control Word CTW
8-19	Product Code
8-3*	**FC Port Settings**
8-30	Protocol
8-31	Address
8-32	FC Port Baud Rate
8-33	Parity / Stop Bits
8-34	Estimated cycle time
8-35	Minimum Response Delay
8-36	Max Response Delay
8-37	Max Inter-Char Delay
8-4*	**FC MC protocol set**
8-40	Telegram selection
8-41	Parameters for Signals
8-42	PCD Write Configuration
8-43	PCD Read Configuration
8-5*	**Digital/Bus**
8-50	Coasting Select
8-51	Quick Stop Select
8-52	DC Brake Select
8-53	Start Select
8-54	Reverse Select
8-55	Set-up Select
8-56	Preset Reference Select
8-57	Profidrive OFF2 Select
8-58	Profidrive OFF3 Select
8-8*	**AFD Port Diagnostics**
8-80	Bus Message Count
8-81	Bus Error Count
8-82	Slave Messages Rcvd
8-83	Slave Error Count
8-9*	**Bus Jog**
8-90	Bus Jog 1 Speed
8-91	Bus Jog 2 Speed
9-**	**PROFIdrive**
9-00	Setpoint
9-07	Actual Value
9-15	PCD Write Configuration
9-16	PCD Read Configuration
9-18	Node Address
9-22	Telegram Selection
9-23	Parameters for Signals
9-27	Parameter Edit
9-28	Process Control
9-44	Fault Message Counter
9-45	Fault Code
9-47	Fault Number
9-52	Fault Situation Counter
9-53	Profibus Warning Word
9-63	Actual Baud Rate
9-64	Device Identification
9-65	Profile Number
9-67	Control Word 1
9-68	Status Word 1
9-71	Profibus Save Data Values
9-72	ProfibusDriveReset
9-75	DO Identification
9-80	Defined Parameters (1)
9-81	Defined Parameters (2)
9-82	Defined Parameters (3)
9-83	Defined Parameters (4)
9-84	Defined Parameters (5)
9-90	Changed Parameters (1)
9-91	Changed Parameters (2)
9-92	Changed Parameters (3)
9-93	Changed parameters (4)
9-94	Changed parameters (5)
9-99	Profibus Revision Counter
10-**	**CAN Fieldbus**
10-0*	**Common Settings**
10-00	CAN Protocol
10-01	Baud Rate Select
10-02	MAC ID
10-05	Readout Transmit Error Counter
10-06	Readout Receive Error Counter
10-07	Readout Bus Off Counter
10-1*	**DeviceNet**
10-10	Process Data Type Selection
10-11	Process Data Config Write
10-12	Process Data Config Read
10-13	Warning Parameter
10-14	Net Reference
10-15	Net Control
10-2*	**COS Filters**
10-20	COS Filter 1
10-21	COS Filter 2
10-22	COS Filter 3
10-23	COS Filter 4
10-3*	**Parameter Access**
10-30	Array Index
10-31	Store Data Values
10-32	Devicenet Revision
10-33	Store Always
10-34	DeviceNet Product Code
10-39	Devicenet F Parameters
10-5*	**CANopen**
10-50	Process Data Config Write.
10-51	Process Data Config Read.
12-**	**Ethernet**
12-0*	**IP Settings**
12-00	IP Address Assignment
12-01	IP Address
12-02	Subnet Mask
12-03	Default Gateway
12-04	DHCP Server
12-05	Lease Expires
12-06	Name Servers
12-07	Domain Name
12-08	Host Name
12-09	Physical Address
12-1*	**Eth link par**
12-10	Link Status
12-11	Link Duration
12-12	Auto Negotiation
12-13	Link Speed
12-14	Link Duplex
12-2*	**Process Data**
12-20	Control Instance
12-21	Process Data Config Write
12-22	Process Data Config Read
12-23	Process Data Config Write Size
12-24	Process Data Config Read Size
12-27	Master Address
12-28	Store Data Values
12-29	Store Always
12-3*	**EtherNet/IP**
12-30	Warning Parameter
12-31	Net Reference
12-32	Net Control
12-33	CIP Revision

12-34 CIP Product Code
12-35 EDS Parameter
12-37 COS Inhibit Timer
12-38 COS Filter
12-4* Modbus TCP
12-40 Status Parameter
12-41 Slave Message Count
12-42 Slave Exception Message Count
12-5* EtherCAT
12-50 Configured Station Alias
12-51 Configured Station Address
12-59 EtherCAT Status
12-6* Ethernet PowerLink
12-60 Node ID
12-62 SDO Timeout
12-63 Basic Ethernet Timeout
12-66 Threshold
12-67 Threshold Counters
12-68 Cumulative Counters
12-69 Ethernet PowerLink Status
12-8* Oth. Ethernet services
12-80 FTP Server
12-81 HTTP Server
12-82 SMTP Service
12-89 Transparent Socket Channel Port
12-9* Adv. Eth. services
12-90 Cable Diagnostic
12-91 Auto Cross Over
12-92 IGMP Snooping
12-93 Cable Error Length
12-94 Broadcast Storm Protection
12-95 Broadcast Storm Filter
12-96 Port Config
12-98 Interface Counters
12-99 Media Counters
13- Smart Logic**
13-0* SLC Settings
13-00 SL Controller Mode
13-01 Start Event
13-02 Stop Event
13-03 Reset SLC
13-1* Comparators
13-10 Comparator Operand
13-11 Comparator Operator
13-12 Comparator Value
13-1* RS Flip Flops
13-15 RS-FF Operand S
13-16 RS-FF Operand R
13-2* Timers
13-20 SL Controller Timer
13-4* Logic Rules
13-40 Logic Rule Boolean 1
13-41 Logic Rule Operator 1
13-42 Logic Rule Boolean 2
13-43 Logic Rule Operator 2
13-44 Logic Rule Boolean 3
13-5* States
13-51 SL Controller Event
13-52 SL Controller Action

14- Special Functions**
14-0* Inverter Switching
14-00 Switching Pattern
14-01 Switching Frequency
14-03 Overmodulation
14-04 PWM Random
14-06 Dead Time Compensation
14-1* Mains On/Off
14-10 Line Failure
14-11 Line Voltage at Line Fault
14-12 Function at Mains Imbalance
14-13 Line Failure Step Factor
14-14 Kin. Backup Time Out
14-15 Kin. Backup Trip Recovery Level
14-2* Trip Reset
14-20 Reset Mode
14-21 Automatic Restart Time
14-22 Operation Mode
14-23 Typecode Setting
14-24 Trip Delay at Current Limit
14-25 Trip Delay at Torque Limit
14-26 Trip Delay at Inverter Fault
14-28 Production Settings
14-29 Service Code
14-3* Current Limit Ctrl.
14-30 Current Lim Ctrl, Proportional Gain
14-31 Current Lim Ctrl, Integration Time
14-32 Current Lim Ctrl, Filter Time
14-35 Stall Protection
14-4* Energy Optimizing
14-40 VT Level
14-41 AEO Minimum Magnetization
14-42 Minimum AEO Frequency
14-43 Motor Cos-Phi
14-5* Environment
14-50 RFI 1
14-51 DC Link Compensation
14-52 Fan Control
14-53 Fan Monitor
14-55 Output Filter
14-56 Capacitance Output Filter
14-57 Inductance Output Filter
14-59 Actual Number of Inverter Units
14-7* Compatibility
14-72 VLT Alarm Word
14-73 VLT Warning Word
14-74 Leg. Ext. Status Word
14-8* Options
14-80 Option Supplied by External 24VDC
14-89 Option Detection
14-9* Fault Settings
14-90 Fault Level
15- Drive Information**
15-0* Operating Data
15-00 Operating hours
15-01 Running Hours
15-02 kWh Counter
15-03 Power-ups
15-04 Over Temps
15-05 Over Volts
15-06 Reset kWh Counter
15-07 Reset Running Hours Counter
15-1* Data Log Settings
15-10 Logging Source
15-11 Logging Interval
15-12 Trigger Event
15-13 Logging Mode
15-14 Samples Before Trigger
15-2* Historic Log
15-20 Historic Log: Event
15-21 Historic Log: Value
15-22 Historic Log: Time
15-3* Fault Log
15-30 Fault Log: Error Code
15-31 Fault Log: Value
15-32 Fault Log: Time
15-4* Drive Identification
15-40 FC Type
15-41 Power Section
15-42 Voltage
15-43 Software Version
15-44 Ordered Typecode String
15-45 Actual Typecode String
15-46 Adj Freq Dr Ordering No.
15-47 Power Card Ordering No.
15-48 LCP ID Num.
15-49 SW ID Control Card
15-50 SW ID Power Card
15-51 Adj Freq Dr Serial No.
15-53 Power Card Serial Number
15-58 Smart Setup Filename
15-59 CSIV Filename
15-6* Option Ident
15-60 Option Mounted
15-61 Option SW Version
15-62 Option Ordering No
15-63 Option Serial No
15-70 Option in Slot A
15-71 Slot A Option SW Version
15-72 Option in Slot B
15-73 Slot B Option SW Version
15-74 Option in Slot C0
15-75 Slot C0/E0 Option SW Version
15-76 Option in Slot C1
15-77 Slot C1/E1 Option SW Version
15-8* Operating Data II
15-80 Fan Running Hours
15-81 Preset Fan Running Hours
15-89 Configuration Change Counter
15-9* Parameter Info
15-92 Defined Parameters
15-93 Modified Parameters
15-98 Drive Identification
15-99 Parameter Metadata
16- Data Readouts**
16-0* General Status
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference %
16-03 Status Word
16-05 Main Actual Value [%]
16-09 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor voltage
16-13 Frequency
16-14 Motor current
16-15 Frequency [%]
16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 KTY sensor temperature
16-20 Motor Angle
16-21 Torque [%] High Res.
16-22 Torque [%]
16-25 Torque [Nm] High
16-3* Drive Status
16-30 DC Link Voltage
16-32 Brake Energy /s
16-33 Brake Energy /2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-36 Inv. Nom. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 LCP Bottom Statusline
16-48 Speed Ref. After Ramp [RPM]
16-49 Current Fault Source
16-5* Ref. & Feedb.
16-50 External Reference
16-51 Pulse Reference
16-52 Feedback [Unit]
16-53 Digi Pot Reference
16-57 Feedback [RPM]
16-6* Inputs & Outputs
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Freq. Input #29 [Hz]
16-68 Freq. Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-71 Relay Output [bin]
16-72 Counter A
16-73 Counter B
16-74 Prec. Stop Counter
16-75 Analog In X30/11
16-76 Analog In X30/12
16-77 Analog Out X30/8 [mA]
16-78 Analog Out X45/1 [mA]
16-79 Analog Out X45/3 [mA]
16-8* Fieldbus & FC Port
16-80 Fieldbus CTW 1
16-82 Fieldbus REF 1
16-84 Comm. Option Status
16-85 FC Port CTW 1
16-86 FC Port REF 1
16-87 Comm. Option Status
16-9* Diagnosis Readouts
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
17- Feedback Option**
17-1* Inc. Enc. Interface
17-10 Signal Type
17-11 Resolution (PPR)
17-2* Abs. Enc. Interface
17-20 Protocol Selection
17-21 Resolution (Positions/Rev)
17-24 SSI Data Length
17-25 Clock Rate
17-26 SSI Data Format
17-34 HIPERFACE Baud rate
17-5* Resolver Interface
17-50 Poles
17-51 Input Voltage
17-52 Input Frequency
17-53 Transformation Ratio
17-56 Encoder Sim. Resolution
17-59 Resolver Interface
17-6* Monitoring and App.
17-60 Feedback Direction
17-61 Feedback Signal Monitoring
18- Data Readouts 2**
18-3* Analog Readouts
18-36 Analog Input X48/2 [mA]
18-37 Temp. Input X48/4
18-38 Temp. Input X48/7
18-39 Temp. Input X48/10
18-6* Inputs & Outputs 2
18-60 Digital Input 2
18-9* PID Readouts
18-90 Process PID Error
18-91 Process PID Output
18-92 Process PID Clamped Output
18-93 Process PID Gain Scaled Output
30- Special Features**
30-0* Wobbler
30-00 Wobble Mode
30-01 Wobble Delta Frequency [Hz]
30-02 Wobble Delta Frequency [%]
30-03 Wobble Delta Freq. Scaling Resource
30-04 Wobble Jump Frequency [Hz]
30-05 Wobble Jump Frequency [%]
30-06 Wobble Jump Time
30-07 Wobble Sequence Time
30-08 Wobble Up/Down Time

30-09 Wobble Random Function
30-10 Wobble Ratio
30-11 Wobble Random Ratio Max.
30-12 Wobble Random Ratio Min.
30-19 Wobble Delta Freq. Scaled
30-2* Adv. Start Adjust
30-20 High Starting Torque Time [s]
30-21 High Starting Torque Current [%]
30-22 Locked Rotor Protection
30-23 Locked Rotor Detection Time [s]
30-8* Compatibility (I)
30-80 d-axis inductance (Ld)
30-81 Brake Resistor (ohm)
30-83 Speed PID Proportional Gain
30-84 Process PID Proportional Gain
31- Bypass Option**
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation
32- MCO Basic Settings**
32-0* Encoder 2
32-00 Incremental Signal Type
32-01 Incremental Resolution
32-02 Absolute Protocol
32-03 Absolute Resolution
32-04 Absolute Encoder Baudrate X55
32-05 Absolute Encoder Data Length
32-06 Absolute Encoder Clock Frequency
32-07 Absolute Encoder Clock Generation
32-08 Absolute Encoder Cable Length
32-09 Encoder Monitoring
32-10 Rotational Direction
32-11 User Unit Denominator
32-12 User Unit Numerator
32-13 Enc.2 Control
32-14 Enc.2 node ID
32-15 Enc.2 CAN guard
32-3* Encoder 1
32-30 Incremental Signal Type
32-31 Incremental Resolution
32-32 Absolute Protocol
32-33 Absolute Resolution
32-35 Absolute Encoder Data Length
32-36 Absolute Encoder Clock Frequency
32-37 Absolute Encoder Clock Generation
32-38 Absolute Encoder Cable Length
32-39 Encoder Monitoring
32-40 Encoder Termination
32-43 Enc.1 Control
32-44 Enc.1 node ID
32-45 Enc.1 CAN guard
32-5* Feedback Source
32-50 Source Slave
32-51 MCO 302 Last Will
32-52 Source Master
32-6* PID Controller
32-60 Proportional factor
32-61 Derivative factor
32-62 Integral factor
32-63 Limit Value for Integral Sum
32-64 PID Bandwidth
32-65 Velocity Feed-Forward
32-66 Acceleration Feed-Forward
32-67 Max. Tolerated Position Error
32-68 Reverse Behavior for Slave
32-69 Sampling Time for PID Control
32-70 Scan Time for Profile Generator
32-71 Size of the Control Window (Activation)
32-72 Size of the Control Window (Deactiv.)
32-73 Integral limit filter time
32-74 Position error filter time
32-8* Velocity & Accel.
32-80 Maximum Velocity (Encoder)
32-81 Shortest Ramp
32-82 Ramp Type
32-83 Velocity Resolution
32-84 Default Velocity
32-85 Default Acceleration
32-86 Acc. up for limited jerk
32-87 Acc. down for limited jerk
32-88 Dec. up for limited jerk
32-89 Dec. down for limited jerk
32-9* Development
32-90 Debug Source
33- MCO Adv. Settings**
33-0* Home Motion
33-00 Force HOME
33-01 Zero Point Offset from Home Pos.
33-02 Ramp for Home Motion
33-03 Velocity of Home Motion
33-04 Behavior during Home Motion
33-1* Synchronization
33-10 Sync Factor Master
33-11 Sync Factor Slave
33-12 Position Offset for Synchronization
33-13 Accuracy Window for Position Sync.
33-14 Relative Slave Velocity Limit
33-15 Marker Number for Master
33-16 Marker Number for Slave
33-17 Master Marker Distance
33-18 Slave Marker Distance
33-19 Master Marker Type
33-20 Slave Marker Type
33-21 Master Marker Tolerance Window
33-22 Slave Marker Tolerance Window
33-23 Start Behavior for Marker Sync
33-24 Marker Number for Fault
33-25 Marker Number for Ready
33-26 Velocity Filter
33-27 Offset Filter Time
33-28 Marker Filter Configuration
33-29 Filter Time for Marker Filter
33-30 Maximum Marker Correction
33-31 Synchronization Type
33-32 Feed Forward Velocity Adaptation
33-33 Velocity Filter Window
33-34 Slave Marker filter time
33-4* Limit Handling
33-40 Behavior at End Limit Switch
33-41 Negative Software End Limit
33-42 Positive Software End Limit
33-43 Negative Software End Limit Active
33-44 Positive Software End Limit Active
33-45 Time in Target Window
33-46 Target Window LimitValue
33-47 Size of Target Window
33-5* I/O Configuration
33-50 Terminal X57/1 Digital Input
33-51 Terminal X57/2 Digital Input
33-52 Terminal X57/3 Digital Input
33-53 Terminal X57/4 Digital Input
33-54 Terminal X57/5 Digital Input
33-55 Terminal X57/6 Digital Input
33-56 Terminal X57/7 Digital Input
33-57 Terminal X57/8 Digital Input
33-58 Terminal X57/9 Digital Input
33-59 Terminal X57/10 Digital Input
33-60 Terminal X59/1 and X59/2 Mode
33-61 Terminal X59/1 Digital Input
33-62 Terminal X59/2 Digital Input
33-63 Terminal X59/1 Digital Output
33-64 Terminal X59/2 Digital Output
33-65 Terminal X59/3 Digital Output
33-66 Terminal X59/4 Digital Output
33-67 Terminal X59/5 Digital Output
33-68 Terminal X59/6 Digital Output
33-69 Terminal X59/7 Digital Output
33-70 Terminal X59/8 Digital Output
33-8* Global Parameters
33-80 Activated Program Number
33-81 Power-up State
33-82 Drive Status Monitoring
33-83 Behavior After Error
33-84 Behavior afterEsc.
33-85 MCO Supplied by External 24VDC
33-86 Terminal at alarm
33-87 Terminal state at alarm
33-88 Status word at alarm
33-9* MCO Port Settings
33-90 X62 MCO CAN node ID
33-91 X62 MCO CAN baud rate
33-94 X60 MCO RS485 serial termination
33-95 X60 MCO RS485 serial baud rate
34- MCO Data Readouts**
34-0* PCD Write Par.
34-01 PCD 1 Write to MCO
34-02 PCD 2 Write to MCO
34-03 PCD 3 Write to MCO
34-04 PCD 4 Write to MCO
34-05 PCD 5 Write to MCO
34-06 PCD 6 Write to MCO
34-07 PCD 7 Write to MCO
34-08 PCD 8 Write to MCO
34-09 PCD 9 Write to MCO
34-10 PCD 10 Write to MCO
34-2* PCD Read Par.
34-21 PCD 1 Read from MCO
34-22 PCD 2 Read from MCO
34-23 PCD 3 Read from MCO
34-24 PCD 4 Read from MCO
34-25 PCD 5 Read from MCO
34-26 PCD 6 Read from MCO
34-27 PCD 7 Read from MCO
34-28 PCD 8 Read from MCO
34-29 PCD 9 Read from MCO
34-30 PCD 10 Read from MCO
34-4* Inputs & Outputs
34-40 Digital Inputs
34-41 Digital Outputs
34-5* Process Data
34-50 Actual Position
34-51 Commanded Position
34-52 Actual Master Position
34-53 Slave Index Position
34-54 Master Index Position
34-55 Curve Position
34-56 Track Error
34-57 Synchronizing Error
34-58 Actual Velocity
34-59 Actual Master Velocity
34-60 Synchronizing Status
34-61 Axis Status
34-62 Program Status
34-64 MCO 302 Status
34-65 MCO 302 Control
34-7* Diagnosis readouts
34-70 MCO Alarm Word 1
34-71 MCO Alarm Word 2
35- Sensor Input Option**
35-0* Temp. Input Mode
35-00 Term. X48/4 Temp. Unit
35-01 Term. X48/4 Input Type
35-02 Term. X48/7 Temp. Unit
35-03 Term. X48/7 Input Type
35-04 Term. X48/10 Temp. Unit
35-05 Term. X48/10 Input Type
35-06 Temperature Sensor Alarm Function
35-1* Temp. Input X48/4
35-14 Term. X48/4 Filter Time Constant
35-15 Term. X48/4 Temp. Monitor
35-16 Term. X48/4 Low Temp. Limit
35-17 Term. X48/4 High Temp. Limit
35-2* Temp. Input X48/7
35-24 Term. X48/7 Filter Time Constant
35-25 Term. X48/7 Temp. Monitor
35-26 Term. X48/7 Low Temp. Limit
35-27 Term. X48/7 High Temp. Limit
35-3* Temp. Input X48/10
35-34 Term. X48/10 Filter Time Constant
35-35 Term. X48/10 Temp. Monitor
35-36 Term. X48/10 Low Temp. Limit
35-37 Term. X48/10 High Temp. Limit
35-4* Analog Input X48/2
35-42 Term. X48/2 Low Current
35-43 Term. X48/2 High Current
35-44 Term. X48/2 Low Ref./Feedb. Value
35-45 Term. X48/2 High Ref./Feedb. Value
35-46 Term. X48/2 Filter Time Constant
42- Safety Functions**
42-1* Speed Monitoring
42-10 Measured Speed Source
42-11 Encoder Resolution
42-12 Encoder Direction
42-13 Gear Ratio
42-14 Feedback Type
42-15 Feedback Filter
42-17 Tolerance Error
42-18 Zero Speed Timer
42-19 Zero Speed Limit
42-2* Safe Input
42-20 Safe Function
42-21 Type
42-22 Discrepancy Time
42-23 Stable Signal Time
42-24 Restart Behaviour
42-3* General
42-30 External Failure Reaction
42-31 Reset Source
42-33 Parameter Set Name
42-35 S-CRC Value
42-36 Level 1 Password
42-4* SS1
42-40 Type
42-41 Ramp Profile
42-42 Delay Time
42-43 Delta T
42-44 Deceleration Rate
42-45 Delta V
42-46 Zero Speed
42-47 Ramp Time
42-48 S-ramp Ratio at Decel. Start
42-49 S-ramp Ratio at Decel. End
42-5* SLS
42-50 Cut Off Speed
42-51 Speed Limit
42-52 Fail Safe Reaction
42-53 Start Ramp
42-54 Ramp Down Time
42-8* Status
42-80 Safe Option Status
42-81 Safe Option Status 2
42-85 Active Safe Func.
42-86 Safe Option Info
42-89 Customization File Version
42-9* Special
42-90 Restart Safe Option

5.6 Remote Programming with MCT 10 Set-up Software

Danfoss has a software program available for developing, storing, and transferring adjustable frequency drive programming. The MCT 10 Set-up Software allows the user to connect a PC to the adjustable frequency drive and perform live programming rather than using the LCP. Additionally, all adjustable frequency drive programming can be done off-line and simply downloaded to the adjustable frequency drive. Or the entire adjustable frequency drive profile can be loaded onto the PC for backup storage or analysis.

The USB connector or RS-485 terminal is available for connecting to the adjustable frequency drive.

MCT 10 Set-up Software is available for free download at www.VLT-software.com. A CD is also available by requesting part number 130B1000. For further information, see the Instruction Manual.

5

6 Application Examples

6.1 Introduction

NOTE!

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.

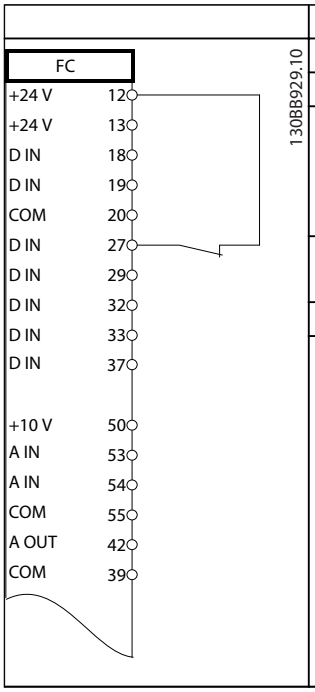
The examples in this section are intended as a quick reference for common applications.

- 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.

6.2 Application Examples

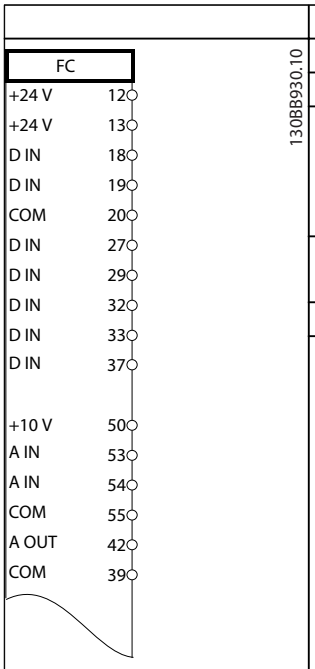
CAUTION

Thermistors must use reinforced or double insulation to meet PELV insulation requirements.



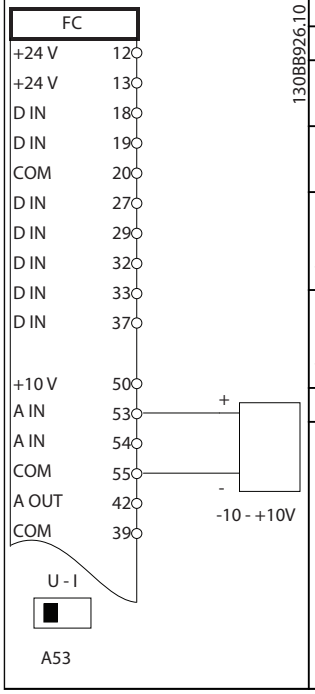
	Parameters	
	Function	**Setting**
1-29 Automatic Motor Adaptation (AMA)		[1] Enable complete AMA
5-12 Terminal 27 Digital Input		[2]* Coast inverse
*=Default Value		
Notes/comments: Parameter group *1-2* Motor Data* must be set according to motor		

Table 6.1 AMA with T27 Connected



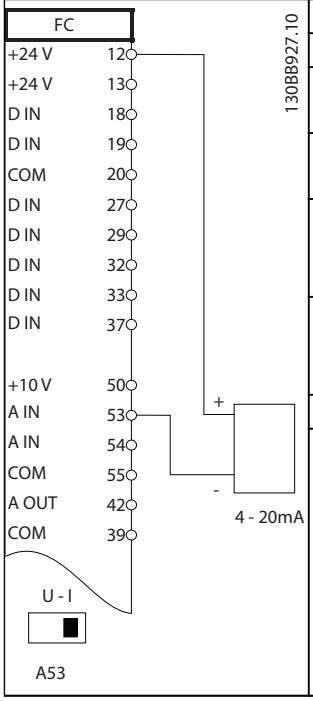
	Parameters	
	Function	**Setting**
1-29 Automatic Motor Adaptation (AMA)		[1] Enable complete AMA
5-12 Terminal 27 Digital Input		[0] No operation
*=Default Value		
Notes/comments: Parameter group *1-2* Motor Data* must be set according to motor		

Table 6.2 AMA without T27 Connected



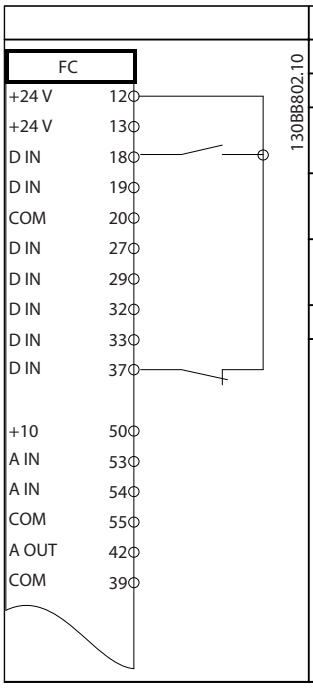
	Parameters	
	Function	**Setting**
6-10 Terminal 53 Low Voltage		0.07 V*
6-11 Terminal 53 High Voltage		10 V*
6-14 Terminal 53 Low Ref./Feedb. Value		0 RPM
6-15 Terminal 53 High Ref./Feedb. Value		1,500 RPM
*=Default Value		
Notes/comments:		

Table 6.3 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	1,500 RPM
*=Default Value		
Notes/comments:		

Table 6.4 Analog Speed Reference (Current)



	Parameters	
	Function	**Setting**
	5-10 Terminal 18 Digital Input	[8] Start*
	5-12 Terminal 27 Digital Input	[0] No operation
	5-19 Terminal 37 Safe Stop	[1] Safe Stop Alarm
*=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.		

Table 6.5 Start/Stop Command with Safe Stop

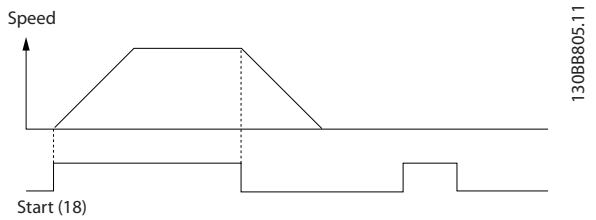
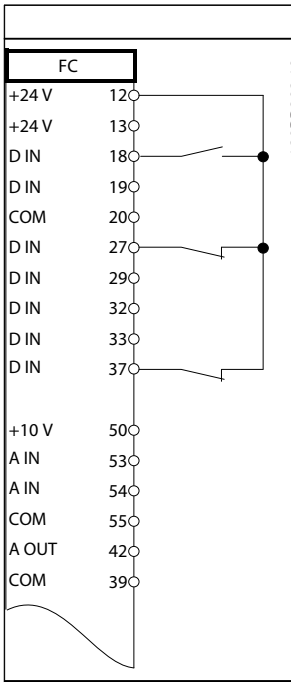


Figure 6.1 Start/Stop with Safe Stop



	Parameters	
	Function	**Setting**
	5-10 Terminal 18 Digital Input	[9] Latched Start
	5-12 Terminal 27 Digital Input	[6] Stop Inverse
*=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.		

Table 6.6 Pulse Start/Stop

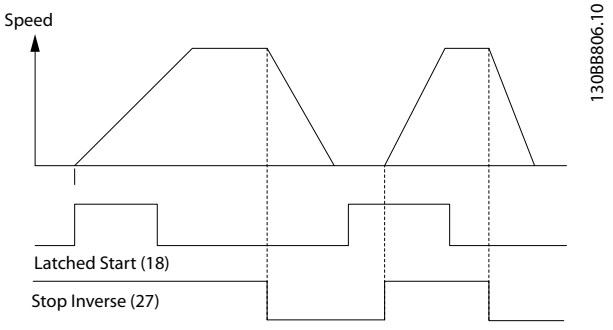
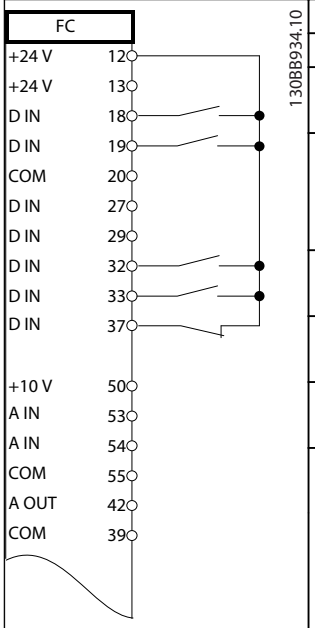
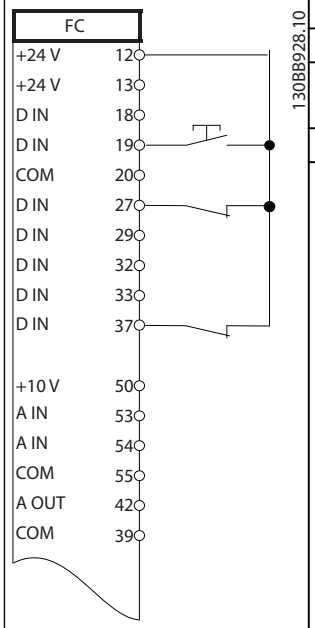


Figure 6.2 Latched Start/Stop Inverse



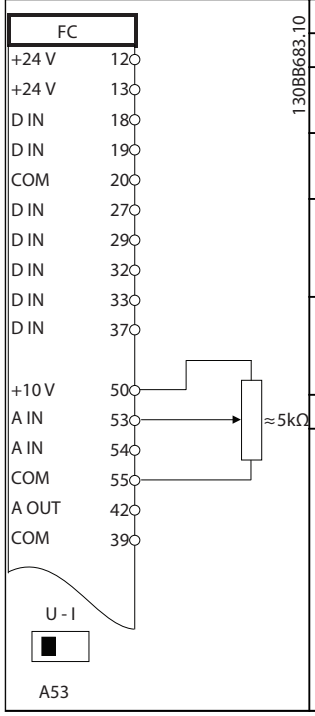
Parameters	
Function	**Setting**
5-10 Terminal 18 Digital Input	[8] Start
5-11 Terminal 19 Digital Input	[10] Reversing*
5-12 Terminal 27 Digital Input	[0] No operation
5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
3-10 Preset Reference	
Preset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

Table 6.7 Start/Stop with Reversing and Four Preset Speeds



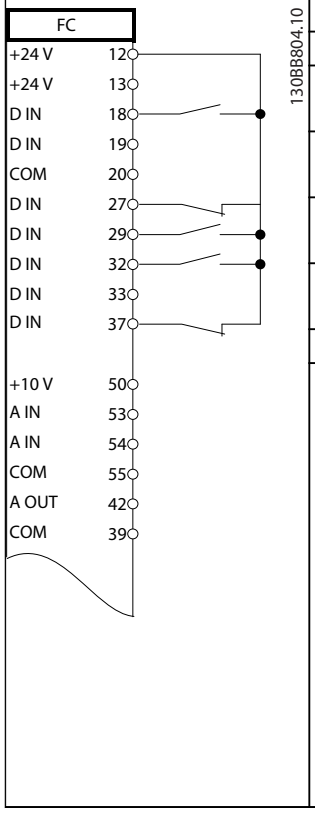
Parameters	
Function	**Setting**
5-11 Terminal 19 Digital Input	[1] Reset
*=Default Value	
Notes/comments:	

Table 6.8 External Alarm Reset



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	1,500 RPM
*=Default Value	
Notes/comments:	

Table 6.9 Speed Reference (using a Manual Potentiometer)



Parameters	
Function	**Setting**
5-10 Terminal 18 Digital Input	[8] Start*
5-12 Terminal 27 Digital Input	[19] Freeze Reference
5-13 Terminal 29 Digital Input	[21] Speed Up
5-14 Terminal 32 Digital Input	[22] Slow
*=Default Value	
Notes/comments:	

Table 6.10 Speed Up/Down

6

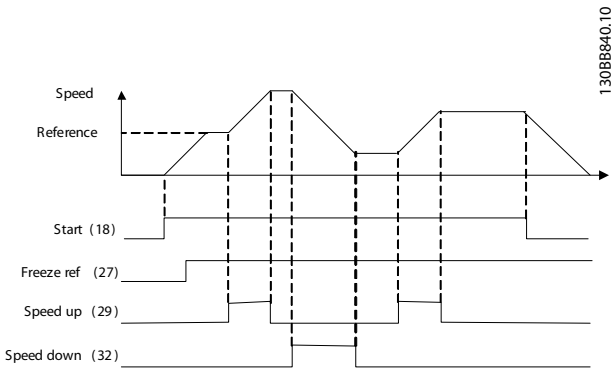
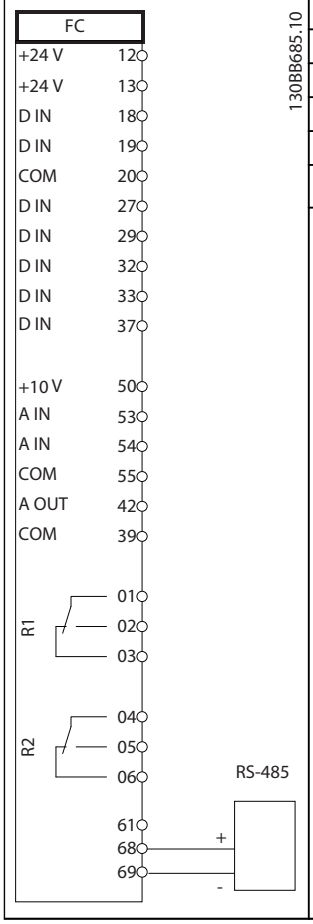
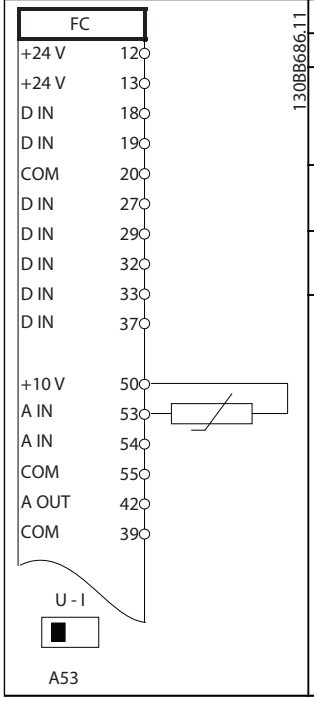


Figure 6.3 Speed Up/Down



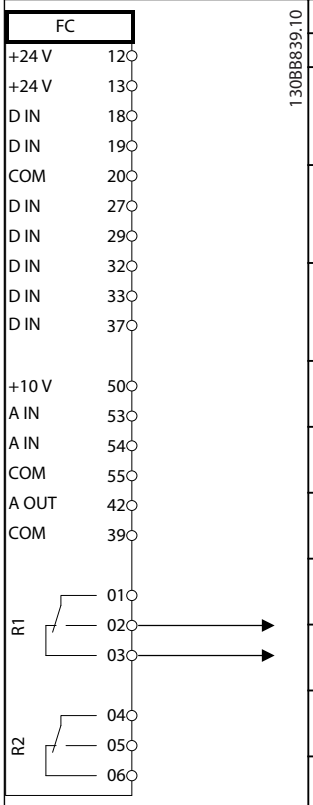
Parameters	
Function	**Setting**
8-30 Protocol	FC*
8-31 Address	1*
8-32 Baud Rate	9600*
*=Default Value	
Notes/comments: Select protocol, address and baud rate in the above mentioned parameters.	

Table 6.11 RS-485 Network Connection



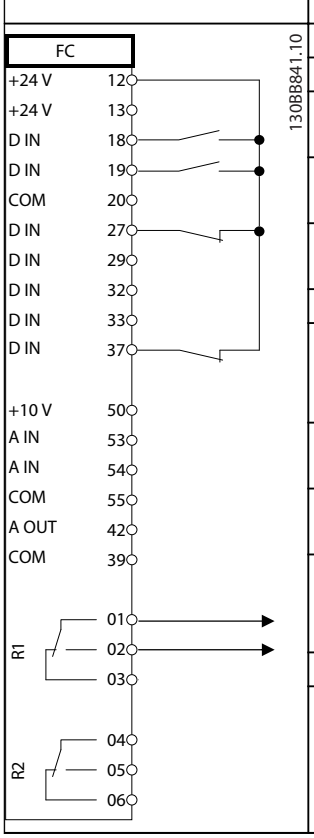
Parameters	
Function	**Setting**
1-90 Motor Thermal Protection	[2] Thermistor trip
1-93 Thermistor Source	[1] Analog input 53
*=Default Value	
Notes/comments: If only a warning is desired, *1-90 Motor Thermal Protection* should be set to *[1] Thermistor warning*.	

Table 6.12 Motor Thermistor



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

Table 6.13 Using SLC to Set a Relay



Parameters	
Function	**Setting**
5-40 Function Relay	[32] Mech. brake ctrl.
5-10 Terminal 18 Digital Input	[8] Start*
5-11 Terminal 19 Digital Input	[11] Start reversing
1-71 Start Delay	0.2
1-72 Start Function	[5] VVC^{plus}/ FLUX Clockwise
1-76 Start Current	$I_{m,n}$
2-20 Release Brake Current	App. dependent
2-21 Activate Brake Speed [RPM]	Half of nominal slip of the motor
*=Default Value	
Notes/comments:	

Table 6.14 Mechanical Brake Control

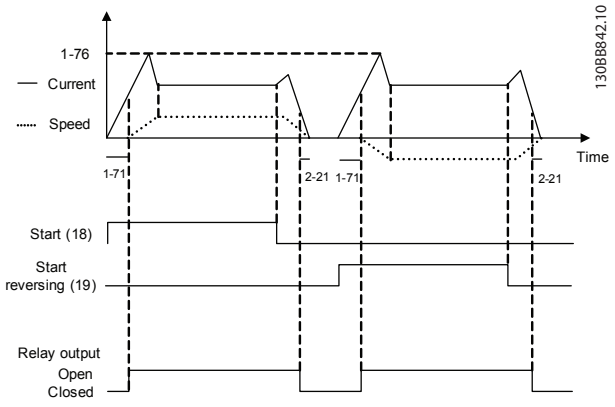


Figure 6.4 Mechanical Brake Control

6

7 Status Messages

7.1 Status Display

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

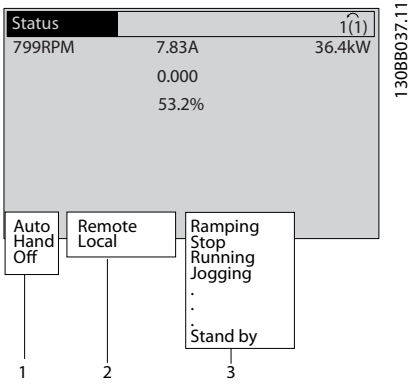


Figure 7.1 Status Display

a. The first part of the status line indicates where the stop/start command originates.

b. The second part of the status line indicates where the speed control originates.

c. The last part of the status line gives the present adjustable frequency drive status. These show the operational mode the adjustable frequency drive is in.

NOTE!

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

7.2 Status Message Definitions Table

Table 7.1, *Table 7.2* and *Table 7.3* define the meaning of the status message display words.

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.
Hand on	The adjustable frequency drive can be controlled by the navigation keys on the LCP. Stop commands, reset, reversing, DC brake, and other signals applied to the control terminals can 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 over-magnetizes 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)* is 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 has been given, but the motor will remain stopped until a run permissive signal is received.
Freeze ref.	*Freeze Reference* was chosen 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 has been given, but the motor will be 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*. The connected motor is supplying the adjustable frequency drive with generative energy. 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	(For adjustable frequency drives with an external 24 V power supply installed only). Line power supply to the adjustable frequency drive is removed, but the control card is supplied by the external 24 V.
Protection md	Protection mode is active. The unit has detected a critical status (an 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 chosen 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 has been given, but the motor is stopped until a run permissive signal is received via digital input.
Running	The motor is driven by the adjustable frequency drive.
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 Auto mode, the adjustable frequency drive will start 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 will start 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 will start 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

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8 Warnings and Alarms

8.1 System Monitoring

The adjustable frequency drive monitors the condition of its input power, output, and motor factors as well as other system performance indicators. A warning or alarm may not necessarily indicate a problem internal to the adjustable frequency drive itself. In many cases, it indicates failure conditions from input voltage, motor load or temperature, external signals, or other areas monitored by the adjustable frequency drive's internal logic. Be sure to investigate those areas exterior to the adjustable frequency drive as indicated in the alarm or warning.

8.2 Warning and Alarm Types

Warnings

A warning is issued when an alarm condition is impending or when an abnormal operating condition is present and may result in the 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, that is, the adjustable frequency drive suspends operation to prevent adjustable frequency drive or system damage. The motor will coast to a stop. The adjustable frequency drive logic will continue to operate and monitor the adjustable frequency drive status. After the fault condition is remedied, the adjustable frequency drive can be reset. It will then be ready to start operation again.

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

An alarm that causes the adjustable frequency drive to trip-lock requires that input power is cycled. The motor will coast to a stop. The adjustable frequency drive logic will continue to operate and monitor the adjustable frequency drive status. Remove input power to the adjustable frequency drive and correct the cause of the fault, then restore power. This action puts the adjustable frequency drive into a trip condition as described above and may be reset in any of those four ways.

8.3 Warning and Alarm Displays

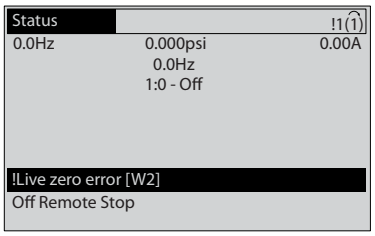

Figure 8.1 Warning Display

An alarm or trip lock alarm will flash on display along with the alarm number.

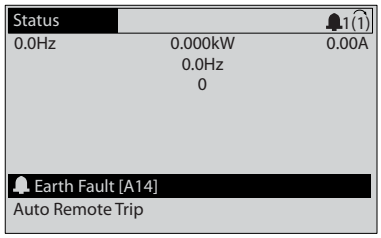

Figure 8.2 Alarm Display

In addition to the text and alarm code on the adjustable frequency drive LCP, there are three status indicator lights.

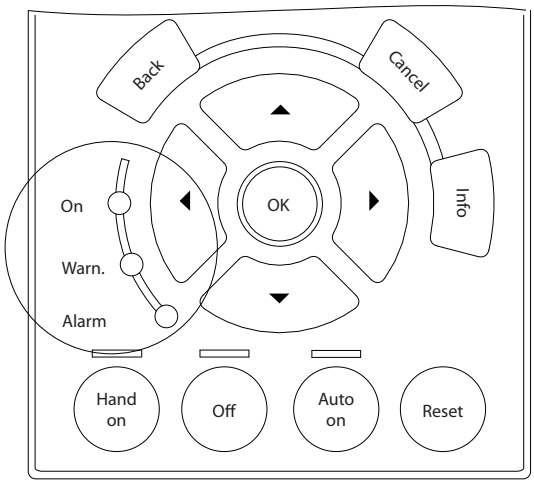

Figure 8.3 Status Indicator Lights

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

Table 8.1 Status Indicator Lights Explanations

8.4 Warning and Alarm Definitions

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*

If the alarm/warning occurs during a power sag, the solution is to use kinetic backup (*14-10 Line Failure*)

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 (current too high for too long). The counter for electronic, thermal inverter protection issues 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 has run with more than 100% overload 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 increases. When running below the adjustable frequency drive continuous current rating, the counter decreases.

WARNING/ALARM 10, Motor overload temperature

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

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded.

Check that the motor current set in *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 overtemp

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 if *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. Make sure that 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 can be caused by shock loading or quick acceleration with high inertia loads. It can also appear after kinetic backup if the acceleration during ramp-up is quick. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting

Remove power and check if the motor shaft can be turned.

Make sure 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.

8

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 your 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 will only be active when *8-04 Control Word Timeout Function* is NOT set to *[Off]*.

If *8-04 Control Word 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 Word 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 is higher than 90% of the brake resistance power. If *[2] Trip* is selected in *2-13 Brake Power Monitoring*, the adjustable frequency drive will trip 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 section *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 will not reset until the temperature falls 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.

For the D, E, and F Frame sizes, this alarm is based on the temperature measured by the heatsink sensor mounted inside the IGBT modules. For the F Frame sizes, this alarm can also be caused by the thermal sensor in the rectifier module.

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 *Table 8.2* is displayed.

Troubleshooting

Cycle power

Check that the option is properly installed

Check for loose or missing wiring

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

No.	Text
0	Serial port cannot be initialized. Contact your Danfoss 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 time out reading EEPROM data
514	Communication time out 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
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)

No.	Text
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 8.2 Internal Fault, Code Numbers

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 will trip.

ALARM 50, AMA calibration failed
Contact your 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 Rs and Rr are increased. In most cases, however, this is not critical.

ALARM 58, AMA internal fault
Contact your 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/ALARM 61, Tracking error
An error between calculated motor speed and speed measurement from feedback device. The function Warning/ Alarm/Disable is set in *4-30 Motor Feedback Loss Function*. Accepted error setting in *4-31 Motor Feedback Speed Error* and the allowed time the error occur setting in *4-32 Motor Feedback Loss Timeout*. During a commissioning procedure the function may be effective.

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 cutout temperature of the control card is 176° F [80°C].

Troubleshooting

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

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 the reset key).

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.

Make sure that the filters for the door fans are not blocked.

Check that the connector plate is properly installed on IP21/IP 54 (NEMA 1/12) adjustable frequency drives.

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ALARM 70, Illegal adjustable frequency drive configuration
The control card and power card are incompatible. Contact your 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 T-37 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 is be sent (via Bus, Digital I/O, or by pressing [Reset]). Note that 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.

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 will be generated on power cycle when the adjustable frequency drive is set to run with fewer inverters and will remain 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 file has syntax errors.

ALARM 82, CSIV par. err.
CSIV failed to init a parameter.

ALARM 85, Dang fail PB:
Profibus/Profisafe Error.

WARNING/ALARM 104, Mixing fan fault
The fan monitor checks that the fan is spinning at 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.

ALARM 243, Brake IGBT
This alarm is only for F Frame adjustable frequency drives. It is equivalent to Alarm 27. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in F12 or F3 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 244, Heatsink temperature
This alarm is only for F Frame adjustable frequency drives. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in F12 or F3 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 245, Heatsink sensor
This alarm is only for F Frame adjustable frequency drives. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in F12 or F3 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 246, Power card supply
This alarm is only for F Frame adjustable frequency drive. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in F12 or F3 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 247, Power card temperature
This alarm is only for F Frame adjustable frequency drive. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in F12 or F3 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

ALARM 248, Illegal power section configuration
This alarm is only for F Frame adjustable frequency drives. It is equivalent to Alarm 79. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in F12 or F3 frame sizes.

2 = right inverter module in F10 or F11 frame sizes.

2 = second adjustable frequency drive from the left inverter module in F14 frame size.

3 = right inverter module in F12 or F13 frame sizes.

3 = third from the left inverter module in F14 frame size.

4 = far right inverter module in F14 frame size.

5 = rectifier module.

6 = right rectifier module in F14 frame size.

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.

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9 Basic Troubleshooting

9.1 Start Up and Operation

NOTE!

See *Alarm Log* in *Table 4.2*.

Symptom	Possible Cause	Test	Solution
Display dark/No function	Missing input power	See *Table 3.1*.	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 terminal 12/13 to 20–39 or 10 V supply for terminal 50 to 55.	Wire the terminals properly.
	Wrong 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 shorts or incorrect connections. If the display continues to cut out, follow the procedure for display dark.

Symptom	Possible Cause	Test	Solution
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 your 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 Terminal 27 Digital Input* 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 *3.7 Check Motor Rotation* in this manual.
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 parameter group *6-* Analog I/O mode* and parameter group *3-1* References*.	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* Analog I/O mode*. For closed-loop operation, check settings in parameter group 20-0* Feedback.
Motor runs rough	Possible over-magnetization	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups *1-2* Motor data 1-3* Adv 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*.

Symptom	Possible Cause	Test	Solution
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 shorts 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-startup check for loose connections.	Tighten loose connections.
Line power current imbalance greater than 3%	Problem with line power (See *Alarm 4 Line phase loss* description)	Rotate input power leads into the 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 unit	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 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 adjustable frequency drive unit	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 supplier.

Table 9.1 Troubleshooting

9

10 Specifications

10.1 Power-dependent Specifications

	PK25	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P3K7
Typical Shaft Output (hp [kW])	0.34 [0.25]	0.5 [0.37]	0.75 [0.55]	1 [0.75]	1.5 [1.1]	2 [1.5]	3 [2.2]	4 [3]	5 [3.7]
Enclosure IP20/IP21	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure IP20 (FC 301 only)	A1	A1	A1	A1	A1	A1	-	-	-
Enclosure IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/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]	2.9	3.8	5.6	7.4	10.6	12.0	17.0	20.0	26.7
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]	2.6	3.5	5.1	6.6	9.4	10.9	15.2	18.1	24.0
Additional specifications									
IP20, IP21 max. cable cross-section[5] (line power, motor, brake and load sharing) [mm² (AWG)][2]	4,4,4 (12,12,12) (min. 0.2 (24))								
IP55, IP66 max. cable cross-section[5] (line power, motor, brake and load sharing) [mm² (AWG)]	4,4,4 (12,12,12)								
Max. cable cross-section[5] with disconnect	6,4,4 (10,12,12)								
Estimated power loss at rated max. load [W] [4]	21	29	42	54	63	82	116	155	185
Weight, enclosure IP20 (lbs [kg])	10.36 [4.7]	10.36 [4.7]	10.58 [4.8]	10.58 [4.8]	10.8 [4.9]	10.8 [4.9]	10.8 [4.9]	14.55 [6.6]	14.55 [6.6]
A1 (IP20)	2.7	2.7	2.7	2.7	2.7	2.7	-	-	-
A5 (IP55, IP66)	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
Efficiency [4]	0.94	0.94	0.95	0.95	0.96	0.96	0.96	0.96	0.96
0.34–5 hp [0.25–3.7 kW] only available as 160% high overload.									

Table 10.1 Line Power Supply 3x200–240 V AC

10

	P5K5		P7K5		P11K	
High/ Normal Load[1]	HO	NO	HO	NO	HO	NO
Typical Shaft Output (hp [kW])	7.5 [5.5]	10 [7.5]	10 [7.5]	15 [11]	15 [11]	20 [15]
Enclosure IP20	B3		B3		B4	
Enclosure IP21	B1		B1		B2	
Enclosure IP55, IP66	B1		B1		B2	
Output current						
Continuous (3x200–240 V) [A]	24.2	30.8	30.8	46.2	46.2	59.4
Intermittent (60 s overload) (3x200–240 V) [A]	38.7	33.9	49.3	50.8	73.9	65.3
Continuous kVA (208 V AC) [kVA]	8.7	11.1	11.1	16.6	16.6	21.4
Max. input current						
Continuous (3x200–240 V) [A]	22	28	28	42	42	54
Intermittent (60 s overload) (3x200–240 V) [A]	35.2	30.8	44.8	46.2	67.2	59.4
Additional specifications						
IP21 max. cable cross-section[5] (line power, brake, load sharing) [AWG (mm^2)] [2]	16,10, 16 (6,8,6)		16,10, 16 (6,8,6)		35,-,- (2,-,-)	
IP21 max. cable cross-section[5] (motor) [AWG (mm^2)] [2]	10,10,- (8,8,-)		10,10,- (8,8,-)		35,25,25 (2,4,4)	
IP20 max. cable cross-section[5] (line power, brake, motor and load sharing)	10,10,- (8,8,-)		10,10,- (8,8,-)		35,-,- (2,-,-)	
Max. cable cross-section with disconnect [AWG (mm^2)] [2]	16,10,10 (6,8,8)					
Estimated power loss at rated max. load [W] [4]	239	310	371	514	463	602
Weight, enclosure IP21, IP55, IP66 (lbs [kg])	50.71 [23]		50.71 [23]		59.53 [27]	
Efficiency[4]	0.964		0.959		0.964	

Table 10.2 Line Power Supply 3x200–240 V AC

10

	P15K		P18K		P22K		P30K		P37K	
High/Normal Load[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft Output (hp [kW])	20 [15]	25 [18.5]	25 [18.5]	30 [22]	30 [22]	40 [30]	40 [30]	50 [37]	50 [37]	60 [45]
Enclosure IP20	B4		C3		C3		C4		C4	
Enclosure IP21	C1		C1		C1		C2		C2	
Enclosure IP55, IP66	C1		C1		C1		C2		C2	
Output current										
Continuous (3x200–240 V) [A]	59.4	74.8	74.8	88	88	115	115	143	143	170
Intermittent (60 s overload) (3x200–240 V) [A]	89.1	82.3	112	96.8	132	127	173	157	215	187
Continuous kVA (208 V AC) [kVA]	21.4	26.9	26.9	31.7	31.7	41.4	41.4	51.5	51.5	61.2
Max. input current										
Continuous (3x200–240 V) [A]	54	68	68	80	80	104	104	130	130	154
Intermittent (60 s overload) (3x200–240 V) [A]	81	74.8	102	88	120	114	156	143	195	169
Additional specifications										
IP20 max. cable cross-section[5] (line power, brake, motor and load sharing)	35 (2)		50 (1)		50 (1)		300MCM (150)		300MCM (150)	
IP21, IP55, IP66 max. cable cross-section[5] (line power, motor) [mm² (AWG)] [2]	50 (1)		50 (1)		50 (1)		300MCM (150)		300MCM (150)	
IP21, IP55, IP66 max. cable cross-section[5] (brake, load sharing) [mm² (AWG)] [2]	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Max. cable size with line power disconnect [AWG (mm²)] [2]	50, 35, 35 (1, 2, 2)						95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350MCM, 300MCM, 4/0)	
Estimated power loss at rated max. load [W] [4]	624	737	740	845	874	1140	1143	1353	1400	1636
Weight, enclosure IP21, IP55/IP66 (lbs [kg])	99.21 [45]		99.21 [45]		99.21 [45]		143.3 [65]		143.3 [65]	
Efficiency[4]	0.96		0.97		0.97		0.97		0.97	

Table 10.3 Line Power Supply 3x200–240 V AC

For fuse ratings, see 10.3.1 Fuses

1) High overload = 160% torque during 60 s. Normal overload = 110% torque during 60 s.

2) American Wire Gauge.

3) Measured using 16.5 ft. [5 m] shielded motor cables at rated load and rated frequency.

4) The typical power loss is at nominal load conditions and expected to be within ±15% (tolerance relates to variances in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Motors with lower efficiency will also add to the power loss in the adjustable frequency drive and vice-versa.
If the switching frequency is increased compared to the default setting, the power losses may rise significantly.
LCP and typical control card power consumption values are included. Further options and customer load may add up to 30 W to the losses. (Though typical only 4 W extra for a fully loaded control card, or options for slot A or slot B, each).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (±5%).

5) The three values for the max. cable cross-section are for single core, flexible wire and flexible wire with sleeve, respectively.

	PK37	PK55	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output (hp [kW])	0.5 [0.37]	0.75 [0.55]	1 [0.75]	1.5 [1.1]	2 [1.5]	3 [2.2]	4 [3]	5 [4]	7.5 [5.5]	10 [7.5]
Enclosure IP20/IP21	A2	A2	A2	A2	A2	A2	A2	A2	A3	A3
Enclosure IP20 (FC 301 only)	A1	A1	A1	A1	A1					
Enclosure IP55, IP66	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current										
High overload 160% for 1 min.										
Shaft output [hp, kW]	0.5 [0.37]	0.75 [0.55]	1 [0.75]	1.5 [1.1]	2 [1.5]	3 [2.2]	4 [3]	5 [4]	7.5 [5.5]	10 [7.5]
Continuous (3x380–440 V) [A]	1.3	1.8	2.4	3	4.1	5.6	7.2	10	13	16
Intermittent (3x380–440 V) [A]	2.1	2.9	3.8	4.8	6.6	9.0	11.5	16	20.8	25.6
Continuous (3x441–500 V) [A]	1.2	1.6	2.1	2.7	3.4	4.8	6.3	8.2	11	14.5
Intermittent (3x441–500 V) [A]	1.9	2.6	3.4	4.3	5.4	7.7	10.1	13.1	17.6	23.2
Continuous kVA (400 V 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]	1.9	2.6	3.5	4.3	5.9	8.0	10.4	14.4	18.7	23.0
Continuous (3x441–500 V) [A]	1.0	1.4	1.9	2.7	3.1	4.3	5.7	7.4	9.9	13.0
Intermittent (3x441–500 V) [A]	1.6	2.2	3.0	4.3	5.0	6.9	9.1	11.8	15.8	20.8
Additional specifications										
IP20, IP21 max. cable-cross section[5] (line power, motor, brake and load sharing) [mm² (AWG)][2]	4,4,4 (12,12,12) (min. 0.2(24))									
IP55, IP66 max. cable cross-section[5] (line power, motor, brake and load sharing) [mm² (AWG)]	4,4,4 (12,12,12)									
Max. cable cross-section[5] with disconnect	6,4,4 (10,12,12)									
Estimated power loss at rated max. load [W] [4]	35	42	46	58	62	88	116	124	187	255
Weight, enclosure IP20 (lb [kg])	10.36 [4.7]	10.36 [4.7]	10.58 [4.8]	10.58 [4.8]	10.8 [4.9]	10.8 [4.9]	10.8 [4.9]	10.8 [4.9]	14.55 [6.6]	14.55 [6.6]
Enclosure IP55, IP66	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	14.2	14.2
Efficiency [4]	0.93	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.97	0.97
0.5–10 hp [0.37–7.5 kW] only available as 160% high overload.										

Table 10.4 Line Power Supply 3x380–500 V AC (FC 302), 3x380–480 V AC (FC 301)

	P11K		P15K		P18K		P22K	
High/Normal Load[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output hp [kW]	15 [11]	20 [15]	20 [15]	25 [18.5]	25 [18.5]	30 [22.0]	30 [22.0]	40 [30.0]
Enclosure IP20	B3		B3		B4		B4	
Enclosure IP21	B1		B1		B2		B2	
Enclosure IP55, IP66	B1		B1		B2		B2	
Output current								
Continuous (3x380–440 V) [A]	24	32	32	37.5	37.5	44	44	61
Intermittent (60 s overload) (3x380–440 V) [A]	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1
Continuous (3x441–500 V) [A]	21	27	27	34	34	40	40	52
Intermittent (60 s overload) (3x441–500 V) [A]	33.6	29.7	43.2	37.4	54.4	44	64	57.2
Continuous kVA (400 V AC) [kVA]	16.6	22.2	22.2	26	26	30.5	30.5	42.3
Continuous kVA (460 V AC) [kVA]		21.5		27.1		31.9		41.4
Max. input current								
Continuous (3x380–440 V) [A]	22	29	29	34	34	40	40	55
Intermittent (60 s overload) (3x380–440 V) [A]	35.2	31.9	46.4	37.4	54.4	44	64	60.5
Continuous (3x441–500 V) [A]	19	25	25	31	31	36	36	47
Intermittent (60 s overload) (3x441–500 V) [A]	30.4	27.5	40	34.1	49.6	39.6	57.6	51.7
Additional specifications								
IP21, IP55, IP66 max. cable cross-section[5)] (line power, brake, load sharing) [mm^2 (AWG)] [2)]	16, 10, 16 (6, 8, 6)		16, 10, 16 (6, 8, 6)		35,-,-(2,-,-)		35,-,-(2,-,-)	
IP21, IP55, IP66 max. cable cross-section[5)] (motor) [mm^2 (AWG)] [2)]	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35, 25, 25 (2, 4, 4)		35, 25, 25 (2, 4, 4)	
IP20 max. cable cross-section[5)] (line power, brake, motor and load sharing)	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,-(2,-,-)		35,-,-(2,-,-)	
Max. cable cross-section with disconnect [AWG (mm^2)] [2)]	16, 10, 10 (6, 8, 8)							
Estimated power loss at rated max. load [W] [4)]	291	392	379	465	444	525	547	739
Weight, enclosure IP20 (lbs [kg])	26.46 [12]		26.46 [12]		51.81 [23.5]		51.81 [23.5]	
Weight, enclosure IP21, IP55, 66 (lbs [kg])	50.71 [23]		50.71 [23]		59.53 [27]		59.53 [27]	
Efficiency[4)]	0.98		0.98		0.98		0.98	

Table 10.5 Line Power Supply 3x380–500 V AC (FC 302), 3x380–480 V AC (FC 301)

10

	P30K		P37K		P45K		P55K		P75K	
High/Normal Load[1]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output hp [kW]	40 [30]	50 [37]	50 [37]	60 [45]	60 [45]	75 [55]	75 [55]	100 [75]	100 [75]	125 [90]
Enclosure IP20	B4		C3		C3		C4		C4	
Enclosure IP21	C1		C1		C1		C2		C2	
Enclosure IP55, IP66	C1		C1		C1		C2		C2	
Output current										
Continuous (3x380–440 V) [A]	61	73	73	90	90	106	106	147	147	177
Intermittent (60 s overload) (3x380–440 V) [A]	91.5	80.3	110	99	135	117	159	162	221	195
Continuous (3x441–500 V) [A]	52	65	65	80	80	105	105	130	130	160
Intermittent (60 s overload) (3x441–500 V) [A]	78	71.5	97.5	88	120	116	158	143	195	176
Continuous kVA (400 V AC) [kVA]	42.3	50.6	50.6	62.4	62.4	73.4	73.4	102	102	123
Continuous kVA (460 V AC) [kVA]		51.8		63.7		83.7		104		128
Max. input current										
Continuous (3x380–440 V) [A]	55	66	66	82	82	96	96	133	133	161
Intermittent (60 s overload) (3x380–440 V) [A]	82.5	72.6	99	90.2	123	106	144	146	200	177
Continuous (3x441–500 V) [A]	47	59	59	73	73	95	95	118	118	145
Intermittent (60 s overload) (3x441–500 V) [A]	70.5	64.9	88.5	80.3	110	105	143	130	177	160
Additional specifications										
IP20 max. cable cross-section[5] (line power and motor)	35 (2)		50 (1)		50 (1)		150 (300 MCM)		150 (300 MCM)	
IP20 max. cable cross-section[5] (brake and load sharing)	35 (2)		50 (1)		50 (1)		95 (4/0)		95 (4/0)	
IP21, IP55, IP66 max. cable cross-section[5] (line power, motor) [mm² (AWG)] [2]	50 (1)		50 (1)		50 (1)		150 (300 MCM)		300MCM (150)	
IP21, IP55, IP66 max. cable cross-section[5] (brake, load sharing) [mm² (AWG)] [2]	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
Max. cable size with line power disconnect [AWG (mm²)] [2]	50, 35, 35 (1, 2, 2)						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]	570	698	697	843	891	1083	1022	1384	1232	1474
Weight, enclosure IP21, IP55, IP66 (lbs [kg])	99.21 [45]		99.21 [45]		99.21 [45]		143.3 [65]		143.3 [65]	
Efficiency[4]	0.98		0.98		0.98		0.98		0.99	

Table 10.6 Line Power Supply 3x380–500 V AC (FC 302), 3x380–480 V AC (FC 301)

For fuse ratings, see 10.3.1 Fuses

1) High overload = 160% torque during 60 s. Normal overload = 110% torque during 60 s.

2) American Wire Gauge.

3) Measured using 16.5 ft. [5 m] shielded motor cables at rated load and rated frequency.

4) The typical power loss is at nominal load conditions and expected to be within ±15% (tolerance relates to variances in voltage and cable conditions).

Values are based on a typical motor efficiency (eff2/eff3 border line). Motors with lower efficiency will also add to the power loss in the adjustable frequency drive and vice-versa.
If the switching frequency is increased compared to the default setting, the power losses may rise significantly.
LCP and typical control card power consumption values are included. Further options and customer load may add up to 30 W to the losses. (Though typical, only 4 W extra for a fully loaded control card, or options for slot A or slot B, each).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (± 5%).

5) The three values for the max. cable cross-section are for single core, flexible wire and flexible wire with sleeve, respectively.

	PK75	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output (hp [kW])	1 [0.75]	1.5 [1.1]	2 [1.5]	3 [2.2]	4 [3]	5 [4]	7.5 [5.5]	10 [7.5]
Enclosure IP20, IP21	A3	A3	A3	A3	A3	A3	A3	A3
Enclosure IP55	A5	A5	A5	A5	A5	A5	A5	A5
Output current								
Continuous (3x525–550 V) [A]	1.8	2.6	2.9	4.1	5.2	6.4	9.5	11.5
Intermittent (3x525–550 V) [A]	2.9	4.2	4.6	6.6	8.3	10.2	15.2	18.4
Continuous (3x551–600 V) [A]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0
Intermittent (3x551–600 V) [A]	2.7	3.8	4.3	6.2	7.8	9.8	14.4	17.6
Continuous kVA (525 V AC) [kVA]	1.7	2.5	2.8	3.9	5.0	6.1	9.0	11.0
Continuous kVA (575 V AC) [kVA]	1.7	2.4	2.7	3.9	4.9	6.1	9.0	11.0
Max. input current								
Continuous (3x525–600 V) [A]	1.7	2.4	2.7	4.1	5.2	5.8	8.6	10.4
Intermittent (3x525–600 V) [A]	2.7	3.8	4.3	6.6	8.3	9.3	13.8	16.6
Additional specifications								
IP20, IP21 max. cable-cross section[5] (line power, motor, brake and load sharing) [mm² (AWG)][2]	4,4,4 (12,12,12) (min. 0.2 (24))							
IP55, IP66 max. cable cross-section[5] (line power, motor, brake and load sharing) [mm² (AWG)]	4,4,4 (12,12,12)							
Max. cable cross-section[5] with disconnect	6,4,4 (10,12,12)							
Estimated power loss at rated max. load [W] [4]	35	50	65	92	122	145	195	261
Weight, Enclosure IP20 (lb [kg])	14.33 [6.5]	14.33 [6.5]	14.33 [6.5]	14.33 [6.5]	14.33 [6.5]	14.33 [6.5]	14.55 [6.6]	14.55 [6.6]
Weight, enclosure IP55 (lb [kg])	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	31.31 [14.2]	31.31 [14.2]
Efficiency [4]	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97

Table 10.7 Line Power Supply 3x525–600 V AC (FC 302 only)

10

	P11K		P15K		P18K		P22K		P30K	
High/Normal Load[1)]	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft Output (hp [kW])	15 [11]	20 [15]	20 [15]	25 [18.5]	25 [18.5]	30 [22]	30 [22]	40 [30]	40 [30]	50 [37]
Enclosure IP21, IP55, IP66	B1		B1		B2		B2		C1	
Enclosure IP20	B3		B3		B4		B4		B4	
Output current										
Continuous (3x525–550 V) [A]	19	23	23	28	28	36	36	43	43	54
Intermittent (3x525–550 V) [A]	30	25	37	31	45	40	58	47	65	59
Continuous (3x525–600 V) [A]	18	22	22	27	27	34	34	41	41	52
Intermittent (3x525–600 V) [A]	29	24	35	30	43	37	54	45	62	57
Continuous kVA (550 V AC) [kVA]	18.1	21.9	21.9	26.7	26.7	34.3	34.3	41.0	41.0	51.4
Continuous kVA (575 V AC) [kVA]	17.9	21.9	21.9	26.9	26.9	33.9	33.9	40.8	40.8	51.8
Max. input current										
Continuous at 550 V [A]	17.2	20.9	20.9	25.4	25.4	32.7	32.7	39	39	49
Intermittent at 550 V [A]	28	23	33	28	41	36	52	43	59	54
Continuous at 575 V [A]	16	20	20	24	24	31	31	37	37	47
Intermittent at 575 V [A]	26	22	32	27	39	34	50	41	56	52
Additional specifications										
IP21, IP55, IP66 max. cable cross-section[5)] (line power, brake, load sharing) [mm² (AWG)] [2)]	16, 10, 10 (6, 8, 8)		16, 10, 10 (6, 8, 8)		35,-,-(2,-,-)		35,-,-(2,-,-)		50,-,- (1,-,-)	
IP21, IP55, IP66 max. cable cross-section[5)] (motor) [mm² (AWG)] [2)]	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35, 25, 25 (2, 4, 4)		35, 25, 25 (2, 4, 4)		50,-,- (1,-,-)	
IP20 max. cable cross-section[5)] (line power, brake, motor and load sharing)	10, 10,- (8, 8,-)		10, 10,- (8, 8,-)		35,-,-(2,-,-)		35,-,-(2,-,-)		35,-,-(2,-,-)	
Max. cable cross-section with disconnect [AWG (mm²)] [2)]	16, 10, 10 (6, 8, 8)								50, 35, 35 (1,2, 2)	
Estimated power loss at rated max. load [W] [4)]	225		285		329		700		700	
Weight, enclosure IP21, (lbs [kg])	50.71 [23]		50.71 [23]		59.53 [27]		59.53 [27]		59.53 [27]	
Weight, enclosure IP20 (lbs [kg])	26.46 [12]		26.46 [12]		51.81 [23.5]		51.81 [23.5]		51.81 [23.5]	
Efficiency [4)]	0.98		0.98		0.98		0.98		0.98	

Table 10.8 Line Power Supply 3x525–600 V AC (FC 302 only)

10

	P37K		P45K		P55K		P75K	
High/Normal Load[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft Output (hp [kW])	50 [37]	60 [45]	60 [45]	75 [55]	75 [55]	100 [75]	100 [75]	125 [90]
Enclosure IP21, IP55, IP66	C1	C1	C1		C2		C2	
Enclosure IP20	C3	C3	C3		C4		C4	
Output current								
Continuous (3x525–550 V) [A]	54	65	65	87	87	105	105	137
Intermittent (3x525–550 V) [A]	81	72	98	96	131	116	158	151
Continuous (3x525–600 V) [A]	52	62	62	83	83	100	100	131
Intermittent (3x525–600 V) [A]	78	68	93	91	125	110	150	144
Continuous kVA (550 V AC) [kVA]	51.4	61.9	61.9	82.9	82.9	100.0	100.0	130.5
Continuous kVA (575 V AC) [kVA]	51.8	61.7	61.7	82.7	82.7	99.6	99.6	130.5
Max. input current								
Continuous at 550 V [A]	49	59	59	78.9	78.9	95.3	95.3	124.3
Intermittent at 550 V [A]	74	65	89	87	118	105	143	137
Continuous at 575 V [A]	47	56	56	75	75	91	91	119
Intermittent at 575 V [A]	70	62	85	83	113	100	137	131
Additional specifications								
IP20 max. cable cross-section[5)] (line power and motor)	50 (1)				150 (300 MCM)			
IP20 max. cable cross-section[5)] (brake and load sharing)	50 (1)				95 (4/0)			
IP21, IP55, IP66 max. cable cross-section[5)] (line power, motor) [mm^2 (AWG)] [2)]	50 (1)				150 (300 MCM)			
IP21, IP55, IP66 max. cable cross-section[5)] (brake, load sharing) [mm^2 (AWG)] [2)]	50 (1)				95 (4/0)			
Max. cable size with line power disconnect [AWG (mm^2)] [2)]	50, 35, 35 (1, 2, 2)				95, 70, 70 (3/0, 2/0, 2/0)		185, 150, 120 (350MCM, 300MCM, 4/0)	
Estimated power loss at rated max. load [W] [4)]	850		1100		1400		1500	
Weight, enclosure IP20 (lbs [kg])	77.16 [35]		77.16 [35]		165 [50]		165 [50]	
Weight, enclosure IP21, IP55 (lbs [kg])	99.21 [45]		99.21 [45]		143.3 [65]		143.3 [65]	
Efficiency [4)]	0.98		0.98		0.98		0.98	

Table 10.9 Line Power Supply 3x525–600 V AC (FC 302 only)

10

	P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output (hp [kW])	1.5 [1.1]	2 [1.5]	3 [2.2]	4 [3]	5 [4]	7.5 [5.5]	10 [7.5]
Enclosure IP20 (only)	A3	A3	A3	A3	A3	A3	A3
Output Current High Overload 160% for 1 min							
Continuous (3x525–550 V) [A]	2.1	2.7	3.9	4.9	6.1	9	11
Intermittent (3x525–550 V) [A]	3.4	4.3	6.2	7.8	9.8	14.4	17.6
Continuous kVA (3x551–690 V) [A]	1.6	2.2	3.2	4.5	5.5	7.5	10
Intermittent kVA (3x551–690 V) [A]	2.6	3.5	5.1	7.2	8.8	12	16
Continuous kVA 525 V AC	1.9	2.5	3.5	4.5	5.5	8.2	10
Continuous kVA 690 V AC	1.9	2.6	3.8	5.4	6.6	9	12
Max. input current							
Continuous (3x525–550 V) [A]	1.9	2.4	3.5	4.4	5.5	8	10
Intermittent (3x525–550 V) [A]	3.0	3.9	5.6	7.1	8.8	13	16
Continuous kVA (3x551–690 V) [A]	1.4	2.0	2.9	4.0	4.9	6.7	9
Intermittent kVA (3x551–690 V) [A]	2.3	3.2	4.6	6.5	7.9	10.8	14.4
Additional specifications							
IP20 max. cable cross-section[5] (line power, motor, brake and load sharing) [mm^2 (AWG)]	0.2–4 (24–12)						
Estimated power loss at rated max. load [W] [4]	44	60	88	120	160	220	300
Weight, enclosure IP20 (lbs [kg])	14.55 [6.6]	14.55 [6.6]	14.55 [6.6]	14.55 [6.6]	14.55 [6.6]	14.55 [6.6]	14.55 [6.6]
Efficiency[4]	0.96	0.96	0.96	0.96	0.96	0.96	0.96

Table 10.10 A3 Frame,
Line Power Supply 3x525–690 V AC IP20/Protected Chassis

10

	P11K		P15K		P18K		P22K	
High/Normal Load[1)]	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output at 550 V (hp [kW])	10 [7.5]	15 [11]	15 [11]	20 [15]	20 [15]	25 [18.5]	25 [18.5]	30 [22]
Typical Shaft output at 575 V [hp]	11	15	15	20	20	25	25	30
Typical Shaft output at 690 V (hp [kW])	15 [11]	20 [15]	20 [15]	25 [18.5]	25 [18.5]	30 [22]	30 [22]	40 [30]
Enclosure IP21, IP55	B2		B2		B2		B2	
Output current								
Continuous (3x525–550 V) [A]	14	19	19	23	23	28	28	36
Intermittent (60 s overload) (3x525–550 V) [A]	22.4	20.9	30.4	25.3	36.8	30.8	44.8	39.6
Continuous (3x551–690 V) [A]	13	18	18	22	22	27	27	34
Intermittent (60 s overload) (3x551–690 V) [A]	20.8	19.8	28.8	24.2	35.2	29.7	43.2	37.4
Continuous KVA (at 550 V) [KVA]	13.3	18.1	18.1	21.9	21.9	26.7	26.7	34.3
Continuous KVA (at 575 V) [KVA]	12.9	17.9	17.9	21.9	21.9	26.9	26.9	33.9
Continuous KVA (at 690 V) [KVA]	15.5	21.5	21.5	26.3	26.3	32.3	32.3	40.6
Max. input current								
Continuous (3x525–690 V) [A]	15	19.5	19.5	24	24	29	29	36
Intermittent (60 s overload) (3x525–690 V) [A]	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Additional specifications								
Max. cable cross-section (line power, load share and brake) [AWG (mm^2)]	35,-,- (2,-,-)							
Max. cable cross-section (motor) [AWG (mm^2)]	35, 25, 25 (2, 4, 4)							
Max. cable size with line power disconnect [AWG (mm^2)] [2)]	16,10,10 (6,8, 8)							
Estimated power loss at rated max. load [W][4)]	228		285		335		375	
Weight, enclosure IP21, IP55 (lbs [kg])	59.53 [27]							
Efficiency[4)]	0.98		0.98		0.98		0.98	

Table 10.11 B2 Frame,
Line Power Supply 3x525–690 V AC IP21/IP55 - NEMA 1/NEMA 12 (FC 302 only)

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	P30K		P37K		P45K		P55K		P75K	
High/Normal Load*	HO	NO	HO	NO	HO	NO	HO	NO	HO	NO
Typical Shaft output at 550 V (hp [kW])	30 [22]	40 [30]	40 [30]	50 [37]	50 [37]	60 [45]	60 [45]	75 [55]	75 [55]	100 [75]
Typical Shaft output at 575 V [hp]	30	40	40	50	50	60	60	75	75	100
Typical Shaft output at 690 V (hp [kW])	40 [30]	50 [37]	50 [37]	60 [45]	60 [45]	75 [55]	75 [55]	100 [75]	100 [75]	125 [90]
Enclosure IP21, IP55	C2		C2		C2		C2		C2	
Output current										
Continuous (3x525–550 V) [A]	36	43	43	54	54	65	65	87	87	105
Intermittent (60 s overload) (3x525–550 V) [A]	54	47.3	64.5	59.4	81	71.5	97.5	95.7	130.5	115.5
Continuous (3x551–690 V) [A]	34	41	41	52	52	62	62	83	83	100
Intermittent (60 s overload) (3x551–690 V) [A]	51	45.1	61.5	57.2	78	68.2	93	91.3	124.5	110
Continuous KVA (at 550 V) [KVA]	34.3	41.0	41.0	51.4	51.4	61.9	61.9	82.9	82.9	100.0
Continuous KVA (at 575 V) [KVA]	33.9	40.8	40.8	51.8	51.8	61.7	61.7	82.7	82.7	99.6
Continuous KVA (at 690 V) [KVA]	40.6	49.0	49.0	62.1	62.1	74.1	74.1	99.2	99.2	119.5
Max. input current										
Continuous (at 550 V) [A]	36	49	49	59	59	71	71	87	87	99
Continuous (at 575 V) [A]	54	53.9	72	64.9	87	78.1	105	95.7	129	108.9
Additional specifications										
Max. cable cross-section (line power and motor) [AWG (mm^2)]	150 (300 MCM)									
Max. cable cross-section (load share and brake) [mm^2 (AWG)]	95 (3/0)									
Max. cable size with line power disconnect [AWG (mm^2)] [2]	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]	480		592		720		880		1200	
Weight, enclosure IP21, IP55 (lbs [kg])	143.3 [65]									
Efficiency[4]	0.98		0.98		0.98		0.98		0.98	

Table 10.12 C2 Frame,
Line Power Supply 3x525–690 V AC IP21/IP55 - NEMA 1/NEMA 12 (FC 302 only)

	P37K		P45K	
High/Normal Load[1)]	HO	NO	HO	NO
Typical Shaft output at 550 V (hp [kW])	40 [30]	50 [37]	50 [37]	60 [45]
Typical Shaft output at 575 V [hp]	40	50	50	60
Typical Shaft output at 690 V (hp [kW])	50 [37]	60 [45]	60 [45]	75 [55]
Enclosure IP20 only	C3		C3	
Output current 150% for 1 min (HO), 110% for 1 min (NO)				
Continuous (3x525–550 V) [A]	43	54	54	65
Intermittent (60 s overload) (3x525–550 V) [A]	64.5	59.4	81	71.5
Continuous (3x551–690 V) [A]	41	52	52	62
Intermittent (60 s overload) (3x551–690 V) [A]	61.5	57.2	78	68.2
Continuous KVA (at 550 V) [KVA]	41	51.4	51.4	62
Continuous KVA (at 690 V) [KVA]	49	62.2	62.2	74.1
Max. input current				
Continuous (at 550 V) [A]	41.5	52.1	52.1	62.7
Intermittent (at 550 V) [A]	62.2	57.3	78.1	68.9
Continuous (at 690 V) [A]	39.5	50.1	50.1	59.8
Intermittent (at 690 V) [A]	59.3	55.1	75.2	65.8
Additional specifications				
Max. cable cross-section (line power, load share and brake) [AWG (mm^2)]	50 (1)			
Max. cable cross-section (motor) [AWG (mm^2)]	50 (1)			
Estimated power loss at rated max. load [W] [4)]	592		720	
Weight, enclosure IP20 (lbs [kg])	77.16 [35]		77.16 [35]	
Efficiency[4)]	0.98		0.98	

Table 10.13 C3 Frame,
Line Power Supply 3x525–690 V AC IP20/Protected Chassis (FC 302 only)

For fuse ratings, see 10.3.1 Fuses

[1)] High overload=160% torque during 60 s. Normal overload=110% torque during 60 s.

[2)] American Wire Gauge.

[3)] Measured using 16.5 ft. [5 m] shielded motor cables at rated load and rated frequency.

[4)] The typical power loss is at nominal load conditions and expected to be within ±15% (tolerance relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line). Motors with lower efficiency will also add to the power loss in the adjustable frequency drive and vice-versa.
If the switching frequency is increased compared to the default setting, the power losses may rise significantly.
LCP and typical control card power consumption values are included. Further options and customer load may add up to 30 W to the losses. (Though typical only 4 W extra for a fully loaded control card, or options for slot A or slot B, each).
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (± 5%).

[5)] The three values for the max. cable cross-section are for single core, flexible wire and flexible wire with sleeve, respectively.

10.2 General Technical Data

Line power supply	
Supply Terminals (6-pulse)	L1, L2, L3
Supply Terminals (12-pulse)	L1-1, L2-1, L3-1, L1-2, L2-2, L3-2
Supply voltage	200–240 V ±10%
Supply voltage	FC 301: 380–480 V/FC 302: 380–500 V ±10%
Supply voltage	FC 302: 525–600 V ±10%
Supply voltage	FC 302: 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 adjustable frequency drive's lowest rated supply voltage. Power-up and full torque cannot be expected at AC line voltage lower than 10% below the adjustable frequency drive's lowest rated supply voltage.

Supply frequency	50/60 Hz ±5%
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 (cos ϕ)	near unity (> 0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤ 10 hp [7.5 kW]	maximum 2 times/min.
Switching on input supply L1, L2, L3 (power-ups) 15–100 hp [11–75 kW]	maximum 1 time/min.
Switching on input supply L1, L2, L3 (power-ups) ≥ 125 hp [90 kW]	maximum 1 time/2 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, 240/500/600/ 690 V maximum.

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Motor output (U, V, W)	
Output voltage	0–100% of supply voltage
Output frequency (0.33–10 hp [0.25–75 kW])	FC 301: 0.2–590 Hz/FC 302: 0–590 Hz
Output frequency (125–1,350 hp [90–1,000 kW])	0–590[1)] Hz
Output frequency in flux mode (FC 302 only)	0–300 Hz
Switching on output	Unlimited
Ramp times	0.01–3,600 s

[1)] Voltage and power dependent

Torque characteristics	
Starting torque (constant torque)	maximum 160% for 60 s[1)]
Starting torque	maximum 180% up to 0.5 s[1)]
Overload torque (constant torque)	maximum 160% for 60 s[1)]
Starting torque (variable torque)	maximum 110% for 60 s[1)]
Overload torque (variable torque)	maximum 110% for 60 s
Torque rise time in VVC^{plus} (independent of fsw)	10 ms
Torque rise time in FLUX (for 5 kHz fsw)	1 ms

[1)] Percentage relates to the nominal torque.
[2)] The torque response time depends on application and load but as a general rule, the torque step from 0 to reference is 4–5 x torque rise time.

Digital inputs	
Programmable digital inputs	FC 301: 4 (5)[1)]/FC 302: 4 (6)[1)]
Terminal number	18, 19, 27[1)], 29[1)], 32, 33,
Logic	PNP or NPN
Voltage level	0–24 V DC
Voltage level, logic'0' PNP	< 5 V DC

Voltage level, logic'1' PNP	> 10 V DC
Voltage level, logic '0' NPN[2)]	> 19 V DC
Voltage level, logic '1' NPN[2)]	< 14 V DC
Maximum voltage on input	28 V DC
Pulse frequency ranges	0–110 kHz
(Duty cycle) Min. pulse width	4.5 ms
Input resistance, R_i	approx. 4 kΩ

Safe stop Terminal 37[3, 4)] (Terminal 37 is fixed PNP logic)	
Voltage level	0–24 V DC
Voltage level, logic'0' PNP	<4 V DC
Voltage level, logic'1' PNP	>20 V DC
Maximum voltage on input	28 V DC
Typical input current at 24 V	50 mA rms
Typical input current at 20 V	60 mA rms
Input capacitance	400 nF

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

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

[2)] Except safe stop input Terminal 37.

[3)] See 2.5 Safe Stop for further information about terminal 37 and Safe Stop.

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

Analog inputs	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switch S201 and switch S202
Voltage mode	Switch S201/switch S202 = OFF (U)
Voltage level	FC 301: 0 to +10/FC 302: -10 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	FC 301: 20 Hz/FC 302: 100 Hz

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

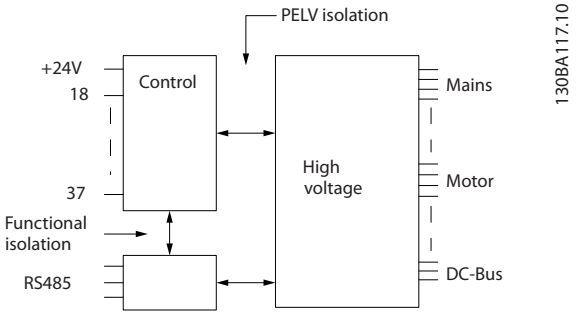

Figure 10.1

Pulse/encoder inputs	
Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29[1], 33[2] / 32[3], 33[3]
Max. frequency at terminal 29, 32, 33	110 kHz (push-pull driven)
Max. frequency at terminal 29, 32, 33	5 kHz (open collector)
Min. frequency at terminal 29, 32, 33	4 Hz
Voltage level	see section on Digital input
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
Encoder input accuracy (1–11 kHz)	Max. error: 0.05% of full scale

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

1) FC 302 only

2) Pulse inputs are 29 and 33

3) Encoder inputs: 32 = A, and 33 = B

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.

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

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

Control card, 24 V DC output	
Terminal number	12, 13
Output voltage	24 V +1, -3 V
Max. load	FC 301: 130mA/FC 302: 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.

Control card, 10 V DC output	
Terminal number	±50
Output voltage	10.5 V ±0.5 V
Max. load	15 mA

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

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 separated from other central circuits and galvanically isolated from the supply voltage (PELV).

Control card, USB serial communication	
USB standard	1.1 (Full speed)
USB plug	USB type B "device" plug

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

Relay outputs	
Programmable relay outputs	FC 301all kW: 1/FC 302 all kW: 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, 2A
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, 1A
Max. terminal load (DC-13)[1] (Inductive load)	24 V DC, 0.1A
Relay 02 (FC 302 only) Terminal number	4-6 (break), 4-5 (make)
Max. terminal load (AC-1)[1] on 4-5 (NO) (Resistive load)[2][3] Overvoltage cat. II	400 V AC, 2A
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, 2A
Max. terminal load (DC-13)[1] on 4-5 (NO) (inductive load)	24 V DC, 0.1A
Max. terminal load (AC-1)[1] on 4-6 (NC) (resistive load)	240 V AC, 2A
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, 2A
Max. terminal load (DC-13)[1] on 4-6 (NC) (inductive load)	24 V DC, 0.1A
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 part 4 and 5
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).
[2] Overvoltage Category II
[3] UL applications 300 V AC2A

Cable lengths and cross-sections for control cables1)	
Max. motor cable length, shielded	FC 301: 165 ft [50 m]/FC 301 (Frame size A1): 80 ft [25 m]/FC 302: 500 ft [150 m]
Max. motor cable length, non-shielded	FC 301: 250 ft [75 m]/FC 301 (Frame size A1): 165 ft [50 m]/FC 302: 1,000 ft [300 m]
Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	0.0023 in^2 [1.5 mm^2]/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	0.0016 in^2 [1 mm^2]/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.0008 in^2 [0.5 mm^2]/20 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 AWG

[1)]For power cables, see 10.1 Power-dependent Specifications.

Control card performance	
Scan interval	FC 301: 5 ms/FC 302: 1 ms

Control characteristics	
Resolution of output frequency at 0–590 Hz	±0.003 Hz
Repeat accuracy of Precise start/stop (terminals 18, 19)	≤±0.1 ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms

Speed control range (open-loop)	1:100 of synchronous speed
Speed control range (closed-loop)	1:1,000 of synchronous speed
Speed accuracy (open-loop)	30–4,000 rpm: error ±8 rpm
Speed accuracy (closed-loop), depending on resolution of feedback device	0–6,000 rpm: error ±0.15 rpm
Torque control accuracy (speed feedback)	max error ±5% of rated torque

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

Environment	
Enclosure	IP20[1)]/Type 1, IP21[2)]/Type 1, IP55/Type 12, IP66
Vibration test	1.0 g
Max. THVD	10%
Max. relative humidity	5%–93% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class Kd
Ambient temperature[3)]	Max. 122 °F [50 °C] (24-hour average maximum 113 °F [45 °C])

[1)] Only for ≤ 3.7 kW/5 HP (200–240 V), ≤ 7.5 kW/10 HP (400–480/500 V)

[2)] As enclosure kit for ≤ 3.7 kW/5 HP (200–240 V), ≤ 7.5 kW/10 HP (400–480/500 V)

[3)] Derating for high ambient temperature, see 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	3,300 ft [1,000 m]

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

EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011
EMC standards, Immunity	EN 61800-3, EN 61000-6-1/2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN 61000-4-5, EN 61000-4-6

See section on special conditions in the Design Guide.

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10.3 Fuse Specifications

10.3.1 Fuses

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

NOTE!

This is mandatory in order to ensure compliance with IEC 60364 for CE or NEC 2009 for UL.

WARNING

Personnel and property must be protected against the consequence of component breakdown internally in the adjustable frequency drive.

Branch Circuit Protection

In order to protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines etc., must be protected against short-circuit and overcurrent according to national/international regulations.

NOTE!

The recommendations given do not cover branch circuit protection for UL.

Short-circuit protection

Danfoss recommends using the fuses/circuit breakers mentioned below to protect service personnel and property in case of component breakdown in the adjustable frequency drive.

10.3.2 Recommendations

WARNING

In case of malfunction, not following the recommendation may result in risk to personnel and damage to the adjustable frequency drive and other equipment.

The following tables list the recommended rated current. Recommended fuses are of the type gG for small to medium power sizes. For larger powers, aR fuses are recommended. For circuit breakers, Moeller types have been tested to have a recommendation. Other types of circuit breakers may be used provided they limit the energy into the adjustable frequency drive to a level equal to or lower than the Moeller types.

If fuses/circuit breakers according to recommendations are chosen, possible damage to the adjustable frequency drive will mainly be limited to damage inside the unit.

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

10.3.3 CE Compliance

Fuses or circuit breakers are mandatory to comply with IEC 60364. Danfoss recommend using a selection of the following.

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical), 240 V, 480 V, 500 V, 600 V, or 690 V 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.

The following UL-listed fuses are suitable:

- UL248-4 class CC fuses
- UL248-8 class J fuses
- UL248-12 class R fuses (RK1)
- UL248-15 class T fuses

The following max. fuse size and type have been tested:

Enclosure size	Power (hp [kW])	Recommended fuse size	Recommended Max. fuse	Recommended circuit breaker Moeller	Max trip level [A]
A1	0.34–2 [0.25–1.5]	gG-10	gG-25	PKZM0-16	16
A2	0.34–3 [0.25–2.2]	gG-10 (0.25–1.5) gG-16 (2.2)	gG-25	PKZM0-25	25
A3	4–5 [3.0–3.7]	gG-16 (3) gG-20 (3.7)	gG-32	PKZM0-25	25
B3	7.5 [5.5]	gG-25	gG-63	PKZM4-50	50
B4	10–20 [7.5–15]	gG-32 (7.5) gG-50 (11) gG-63 (15)	gG-125	NZMB1-A100	100
C3	25–30 [18.5–22]	gG-80 (18.5) aR-125 (22)	gG-150 (18.5) aR-160 (22)	NZMB2-A200	150
C4	40–50 [30–37]	aR-160 (30) aR-200 (37)	aR-200 (30) aR-250 (37)	NZMB2-A250	250
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	7.5–10 [5.5–7.5]	gG-25 (7.5) [5.5] gG-32 (10) [7.5]	gG-80	PKZM4-63	63
B2	15 [11]	gG-50	gG-100	NZMB1-A100	100
C1	20–30 [15–22]	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	40–50 [30–37]	aR-160 (40) [30] aR-200 (50) [37]	aR-200 (40) [30] aR-250 (50) [37]	NZMB2-A250	250

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Table 10.14 200–240 V, Frame Sizes A, B and C

Enclosure size	Power [kW]	Recommended fuse size	Recommended Max. fuse	Recommended circuit breaker Moeller	Max trip level [A]
A1	0.37–1.5	gG-10	gG-25	PKZM0-16	16
A2	0.37–4.0	gG-10 (0.37–3) gG-16 (4)	gG-25	PKZM0-25	25
A3	5.5–7.5	gG-16	gG-32	PKZM0-25	25
B3	11–15	gG-40	gG-63	PKZM4-50	50
B4	18.5–30	gG-50 (18.5) gG-63 (22) gG-80 (30)	gG-125	NZMB1-A100	100
C3	37–45	gG-100 (37) gG-160 (45)	gG-150 (37) gG-160 (45)	NZMB2-A200	150
C4	55–75	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250
A4	0.37–4	gG-10 (0.37–3) gG-16 (4)	gG-32	PKZM0-25	25
A5	0.37–7.5	gG-10 (0.37–3) gG-16 (4–7.5)	gG-32	PKZM0-25	25
B1	11–15	gG-40	gG-80	PKZM4-63	63
B2	18.5–22	gG-50 (18.5) gG-63 (22)	gG-100	NZMB1-A100	100
C1	30–45	gG-80 (30) gG-100 (37) gG-160 (45)	gG-160	NZMB2-A200	160
C2	55–75	aR-200 (55) aR-250 (75)	aR-250	NZMB2-A250	250

Table 10.15 380–500 V, Frame Sizes A, B and C

Enclosure size	Power [kW]	Recommended fuse size	Recommended Max. fuse	Recommended circuit breaker Moeller	Max trip level [A]
A2	0-75–4.0	gG-10	gG-25	PKZM0-25	25
A3	5.5–7.5	gG-10 (5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B3	11–15	gG-25 (11) gG-32 (15)	gG-63	PKZM4-50	50
B4	18.5–30	gG-40 (18.5) gG-50 (22) gG-63 (30)	gG-125	NZMB1-A100	100
C3	37–45	gG-63 (37) gG-100 (45)	gG-150	NZMB2-A200	150
C4	55–75	aR-160 (55) aR-200 (75)	aR-250	NZMB2-A250	250
A5	0.75–7.5	gG-10 (0.75–5.5) gG-16 (7.5)	gG-32	PKZM0-25	25
B1	11–18	gG-25 (11) gG-32 (15) gG-40 (18.5)	gG-80	PKZM4-63	63
B2	22–30	gG-50 (22) gG-63 (30)	gG-100	NZMB1-A100	100
C1	37–55	gG-63 (37) gG-100 (45) aR-160 (55)	gG-160 (37–45) aR-250 (55)	NZMB2-A200	160
C2	75	aR-200 (75)	aR-250	NZMB2-A250	250

Table 10.16 525–600 V, Frame Sizes A, B and C

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

Table 10.17 525–690 V, Frame Sizes A, B and C

UL Compliance

Fuses or Circuit Breakers must comply with NEC 2009. Danfoss recommends using a selection of the following

The fuses below are suitable for use on a circuit capable of delivering 100,000 Arms (symmetrical), 240 V, or 480 V, or 500 V, or 600 V depending on the adjustable frequency drive voltage rating. With the proper fusing, the drive Short Circuit Current Rating (SCCR) is 100,000 Arms.

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

Table 10.18 200–240 V, Frame Sizes A, B and C

	Recommended max. fuse			
Power [kW]	SIBA Type RK1	Littel fuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1[3)]
0.25–0.37	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R
0.55–1.1	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R
1.5	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R
2.2	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R
3.0	5017906-025	KLN-R-25	ATM-R-25	A2K-25-R
3.7	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R
5.5	5014006-050	KLN-R-50	-	A2K-50-R
7.5	5014006-063	KLN-R-60	-	A2K-60-R
11	5014006-080	KLN-R-80	-	A2K-80-R
15–18.5	2028220-125	KLN-R-125	-	A2K-125-R
22	2028220-150	KLN-R-150	-	A2K-150-R
30	2028220-200	KLN-R-200	-	A2K-200-R
37	2028220-250	KLN-R-250	-	A2K-250-R

Table 10.19 200–240 V, Frame Sizes A, B and C

	Recommended max. fuse			
Power [kW]	Bussmann Type JFHR2[2)]	Littel fuse JFHR2	Ferraz-Shawmut JFHR2[4)]	Ferraz-Shawmut J
0.25–0.37	FWX-5	-	-	HSJ-6
0.55–1.1	FWX-10	-	-	HSJ-10
1.5	FWX-15	-	-	HSJ-15
2.2	FWX-20	-	-	HSJ-20
3.0	FWX-25	-	-	HSJ-25
3.7	FWX-30	-	-	HSJ-30
5.5	FWX-50	-	-	HSJ-50
7.5	FWX-60	-	-	HSJ-60
11	FWX-80	-	-	HSJ-80
15–18.5	FWX-125	-	-	HSJ-125
22	FWX-150	L25S-150	A25X-150	HSJ-150
30	FWX-200	L25S-200	A25X-200	HSJ-200
37	FWX-250	L25S-250	A25X-250	HSJ-250

Table 10.20 200–240 V, Frame Sizes A, B and C

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

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

3) A6KR fuses from FERRAZ SHAWMUT may substitute for A2KR for 240 V adjustable frequency drives.

4) A50X fuses from FERRAZ SHAWMUT may substitute for A25X for 240 V adjustable frequency drives.

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	Recommended max. fuse					
Power [kW]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
0.37–1.1	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.5–2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R-15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11	KTS-R-40	JKS-40	JJS-40	-	-	-
15	KTS-R-50	JKS-50	JJS-50	-	-	-
18	KTS-R-60	JKS-60	JJS-60	-	-	-
22	KTS-R-80	JKS-80	JJS-80	-	-	-
30	KTS-R-100	JKS-100	JJS-100	-	-	-
37	KTS-R-125	JKS-125	JJS-125	-	-	-
45	KTS-R-150	JKS-150	JJS-150	-	-	-
55	KTS-R-200	JKS-200	JJS-200	-	-	-
75	KTS-R-250	JKS-250	JJS-250	-	-	-

Table 10.21 380–500 V, Frame Sizes A, B and C

	Recommended max. fuse			
Power [kW]	SIBA Type RK1	Littel fuse Type RK1	Ferraz-Shawmut Type CC	Ferraz-Shawmut Type RK1
0.37–1.1	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R
1.5–2.2	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R
3	5017906-016	KLS-R-15	ATM-R-15	A6K-15-R
4	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R
5.5	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R
7.5	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R
11	5014006-040	KLS-R-40	-	A6K-40-R
15	5014006-050	KLS-R-50	-	A6K-50-R
18	5014006-063	KLS-R-60	-	A6K-60-R
22	2028220-100	KLS-R-80	-	A6K-80-R
30	2028220-125	KLS-R-100	-	A6K-100-R
37	2028220-125	KLS-R-125	-	A6K-125-R
45	2028220-160	KLS-R-150	-	A6K-150-R
55	2028220-200	KLS-R-200	-	A6K-200-R
75	2028220-250	KLS-R-250	-	A6K-250-R

Table 10.22 380–500 V, Frame Sizes A, B and C

	Recommended max. fuse			
Power [kW]	Bussmann JFHR2	Ferraz-Shawmut J	Ferraz-Shawmut JFHR2[1)]	Littel fuse JFHR2
0.37–1.1	FWH-6	HSJ-6	-	-
1.5–2.2	FWH-10	HSJ-10	-	-
3	FWH-15	HSJ-15	-	-
4	FWH-20	HSJ-20	-	-
5.5	FWH-25	HSJ-25	-	-
7.5	FWH-30	HSJ-30	-	-
11	FWH-40	HSJ-40	-	-
15	FWH-50	HSJ-50	-	-
18	FWH-60	HSJ-60	-	-
22	FWH-80	HSJ-80	-	-
30	FWH-100	HSJ-100	-	-
37	FWH-125	HSJ-125	-	-
45	FWH-150	HSJ-150	-	-
55	FWH-200	HSJ-200	A50-P-225	L50-S-225
75	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 10.23 380–500 V, Frame Sizes A, B and C

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

	Recommended max. fuse					
Power [kW]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
0.75–1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5–2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11	KTS-R-35	JKS-35	JJS-35	-	-	-
15	KTS-R-45	JKS-45	JJS-45	-	-	-
18	KTS-R-50	JKS-50	JJS-50	-	-	-
22	KTS-R-60	JKS-60	JJS-60	-	-	-
30	KTS-R-80	JKS-80	JJS-80	-	-	-
37	KTS-R-100	JKS-100	JJS-100	-	-	-
45	KTS-R-125	JKS-125	JJS-125	-	-	-
55	KTS-R-150	JKS-150	JJS-150	-	-	-
75	KTS-R-175	JKS-175	JJS-175	-	-	-

Table 10.24 525–600 V, Frame Sizes A, B and C

	Recommended max. fuse			
Power [kW]	SIBA Type RK1	Littel fuse Type RK1	Ferraz-Shawmut Type RK1	Ferraz-Shawmut J
0.75–1.1	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5–2.2	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3	5017906-016	KLS-R-015	A6K-15-R	HSJ-15
4	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
15	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
18	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
22	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
30	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
37	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
45	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
55	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
75	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 10.25 525–600 V, Frame Sizes 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.

	Recommended max. fuse					
Power [kW]	Bussmann Type RK1	Bussmann Type J	Bussmann Type T	Bussmann Type CC	Bussmann Type CC	Bussmann Type CC
[kW]						
1.1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5–2.2	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3	KTS-R15	JKS-15	JJS-15	FNQ-R-15	KTK-R-15	LP-CC-15
4	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11	KTS-R-35	JKS-35	JJS-35	-	-	-
15	KTS-R-45	JKS-45	JJS-45	-	-	-
18	KTS-R-50	JKS-50	JJS-50	-	-	-
22	KTS-R-60	JKS-60	JJS-60	-	-	-
30	KTS-R-80	JKS-80	JJS-80	-	-	-
37	KTS-R-100	JKS-100	JJS-100	-	-	-
45	KTS-R-125	JKS-125	JJS-125	-	-	-
55	KTS-R-150	JKS-150	JJS-150	-	-	-
75	KTS-R-175	JKS-175	JJS-175	-	-	-

Table 10.26 525–690 V, Frame Sizes A, B and C

	Recommended max. fuse							
Power [kW]	Max. prefuse	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
11	30 A	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
15–18.5	45 A	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
22	60 A	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
30	80 A	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
37	90 A	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
45	100 A	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
55	125 A	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
75	150 A	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150
* UL compliance only 525–600 V								

Table 10.27 525–690 V*, Frame Sizes B and C

10.4 Connection Tightening Torques

	Power hp [KW]			Torque [Nm]					
Enclo-sure	200–240 V	380–480/500 V	525–600 V	525–690 V	Line power	Motor	DC connection	Brake	Ground	Relay
A2	0.34–3 [0.25–2.2]	0.5–5 [0.37–4.0]			1.8	1.8	1.8	1.8	3	0.6
A3	4–5 [3.0–3.7]	7.5–10 [5.5–7.5]	1–10 [0.75–7.5]	1.5–10 [1.1–7.5]	1.8	1.8	1.8	1.8	3	0.6
A4	0.34–3 [0.25–2.2]	0.5–5 [0.37–4.0]			1.8	1.8	1.8	1.8	3	0.6
A5	0.34–5 [0.25–3.7]	0.5–10 [0.37–7.5]	1–10 [0.75–7.5]		1.8	1.8	1.8	1.8	3	0.6
B1	7.5–10 [5.5–7.5]	15–20 [11–15]	15–20 [11–15]		1.8	1.8	1.5	1.5	3	0.6
B2	11	18 22	18 22	11 22	4.5 4.5	4.5 4.5	3.7 3.7	3.7 3.7	3 3	0.6 0.6
B3	7.5–10 [5.5–7.5]	15–20 [11–15]	15–20 [11–15]		1.8	1.8	1.8	1.8	3	0.6
B4	15–20 [11–15]	25–40 [18–30]	25–40 [18–30]		4.5	4.5	4.5	4.5	3	0.6
C1	20–30 [15–22]	40–60 [30–45]	40–60 [30–45]		10	10	10	10	3	0.6
C2	40–50 [30–37]	7.5–10 [5.5–7.5]	75–100 [55–75]	40–100 [30–75]	14/24[1)]	14/24[1)]	14	14	3	0.6
C3	25–30 [18–22]	50–60 [37–45]	50–60 [37–45]	50–75 [45–55]	10	10	10	10	3	0.6
C4	40–50 [30–37]	75–100 [55–75]	75–100 [55–75]		14/24 [1)]	14/24 [1)]	14	14	3	0.6

Table 10.28 Tightening of Terminals

[1)] For different cable dimensions x/y, where x ≤ 0.147 in² [95 mm²] and y ≥ 0.147 in² [95 mm²].

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