MAKING MODERN LIVING POSSIBLE

Instruction Manual

VLT® HVAC Drive

VLT®
THE REAL DRIVE

Safety

Safety

⚠WARNING

HIGH VOLTAGE!

Frequency converters contain high voltage when connected to AC mains input 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.

High Voltage

Frequency converts are connected to hazardous mains voltages. 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 frequency converter is connected to AC mains, the motor may start at any time. The frequency converter, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the frequency converter is connected to AC mains could result in death, serious injury, equipment, or property damage.

Unintended Start

When the frequency converter is connected to the AC mains, the motor may be started by means of an external switch, a serial bus command, an input reference signal, or a cleared fault condition. Use appropriate cautions to guard against an unintended start.

⚠WARNING

DISCHARGE TIME!

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

Voltage (V)	Minimum Waiting Time (Minutes)	
	4	15
200–240	1.1–3.7 kW 1 1/2–5 hp	5.5–45 kW 7 1/2 - 60 hp
380–480	1.1 - 7.5 kW 1 1/2 - 10 hp	11–90 kW 15–120 hp
525–600	1.1 - 7.5 kW 1 1/2 - 10 hp	11–90 kW 15–120 hp
525–690	n/a	11–90 kW 15–120 hp
High voltage may be present even when the warning LEDs 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

Contents

1 Introduction

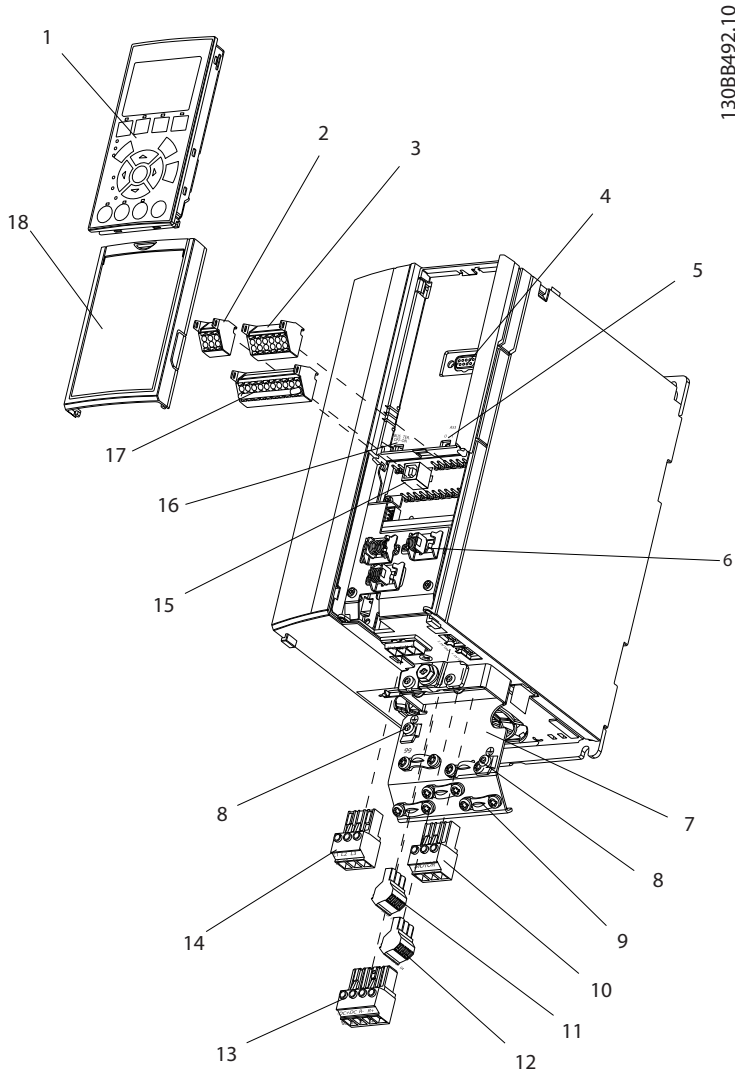

Figure 1.1 Exploded View A Size

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 24V power supply
9	Shielded cable grounding clamp and strain relief	18	Control cable coverplate

Table 1.1

1

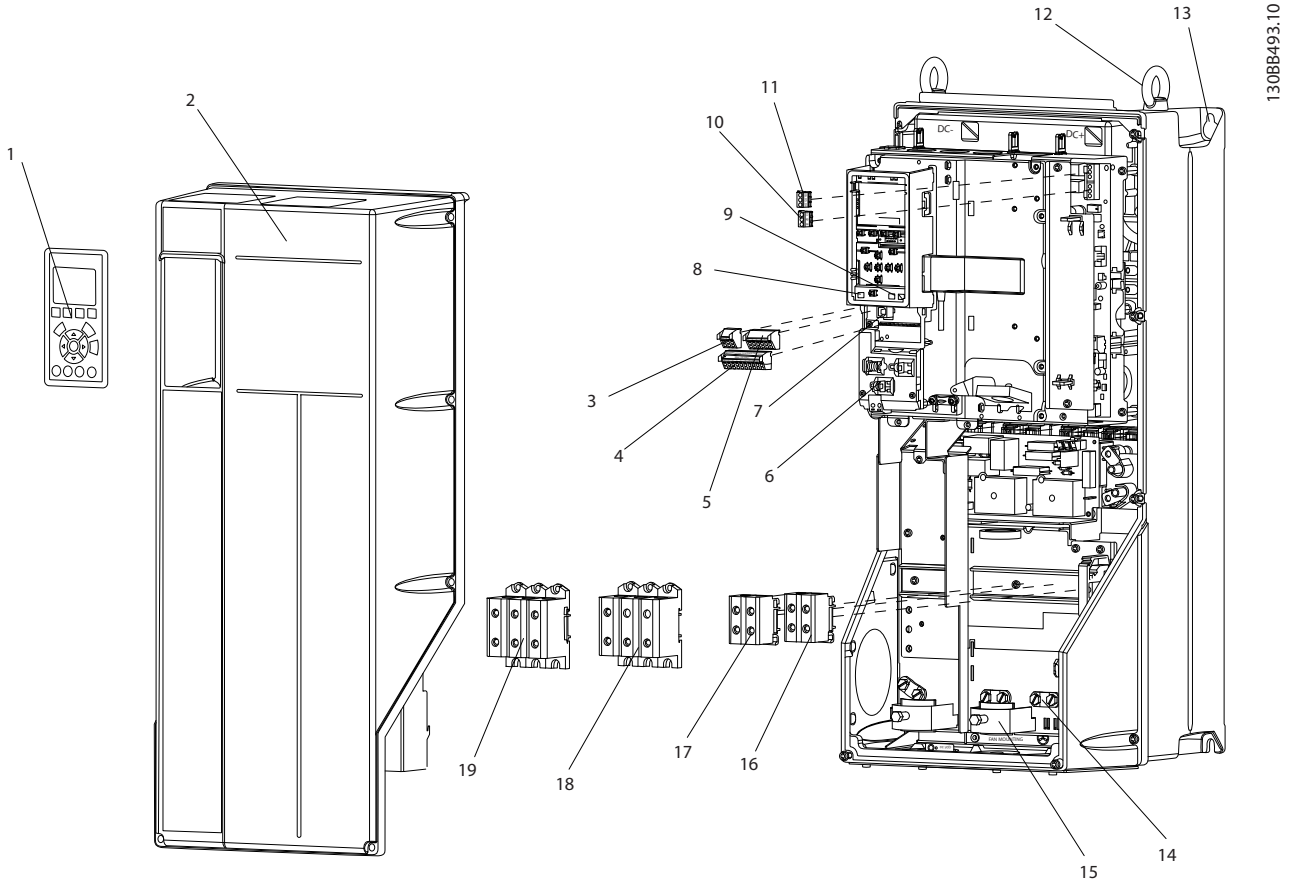

Figure 1.2 Exploded View B and C Sizes

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 24V 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

1.1 Purpose of the Manual

This manual is intended to provide detailed information for the installation and start-up of the adjustable frequency drive. *2 Installation* details the requirements for mechanical and electrical installation, including input, motor, control and serial communications wiring, and control terminal functions. *3 Start-up and Functional Testing* provides detailed procedures for start-up, basic operational programming, and functional testing. The remaining chapters provide supplementary details. These include user interface, detailed programming, application examples, start-up troubleshooting, and specifications.

1.2 Additional Resources

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

- The *VLT® Programming Guide, MG33MXYY* provides greater detail on working with parameters and many application examples.
- The *VLT® Design Guide, MG33BXYY* 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/DrivesSolutions/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 go to *http://www.danfoss.com/BusinessAreas/DrivesSolutions/Documentations/Technical+Documentation.htm* for downloads or additional information.

1.3 Product Overview

A 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 changing temperature or pressure for controlling fan, compressor, or pump motors. 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 Adjustable Frequency Drive Controller Functions

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

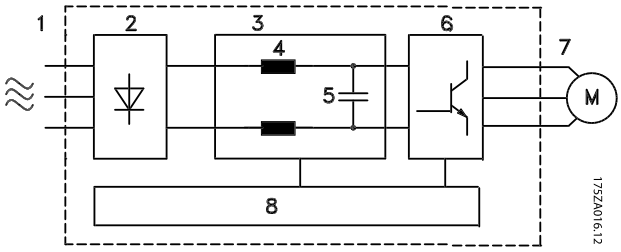

Figure 1.3 Adjustable Frequency Drive Block Diagram

1

Area	Title	Functions
1	Line power input	• Three-phase AC line power 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 Adjustable Frequency Drive Internal Components

1.5 Frame Sizes and Power Ratings

References to frames sizes used in this manual are defined in *Table 1.4*.

	Frame Size (HP/kW)											
Volts	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**C1**	**C2**	**C3**	**C4**
200–240	1.1–2.2	3.0–3.7	0.25–2.2	1.1–3.7	5.5–11	15	5.5–11	15–18.5	18.5–30	37–45	22–30	37–45
380–480	1.1–4.0	5.5–7.5	0.37–4.0	1.1–7.5	11–18.5	22–30	11–18.5	22–37	37–55	75–90	45–55	75–90
525–600	n/a	1.1–7.5	n/a	1.1–7.5	11–18.5	22–30	11–18.5	22–37	37–55	75–90	45–55	75–90
525–690	n/a	n/a	n/a	n/a	n/a	11–30	n/a	n/a	n/a	37–90	n/a	n/a

Table 1.4 Frames 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 limits on ambient air temperature for optimal operation
- Ensure that the installation location has sufficient support strength to mount the Adjustable frequency drive
- Keep the Adjustable frequency drive interior free from dust and dirt. Ensure that the components stay as clean as possible. In construction areas, provide a protective covering. Optional IP54 (NEMA 12) or IP66 (NEMA 4) enclosures may be necessary.
- 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
    - 1000 ft [300 m] for unshielded motor leads
    - 500 ft [150 m] for shielded cable.

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 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, 4–10 in [100–225 mm] is required. See *Figure 2.1* for clearance requirements
- Improper mounting can result in overheating and reduced performance.
- Derating for temperatures starting between 100°F (40°C) and 120°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.

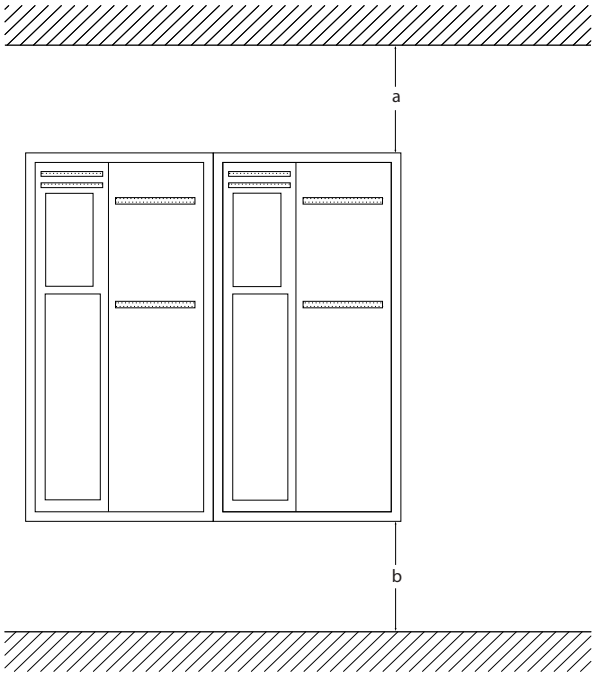

Figure 2.1 Top and Bottom Cooling Clearance

2

Enclosure	A2	A3	A4	A5	B1	B2
a/b (mm)	100	100	100	100	200	200
a/b (in)	4	4	4	4	8	8
Enclosure	**B3**	**B4**	**C1**	**C2**	**C3**	**C4**
a/b (mm)	200	200	200	225	200	225
a/b (in)	8	8	8	9	8	9

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, when 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 to a solid flat surface or to 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.

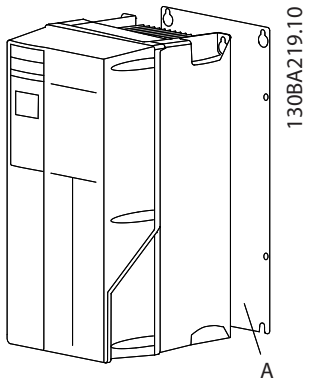

Figure 2.2 Proper Mounting with Backplate

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

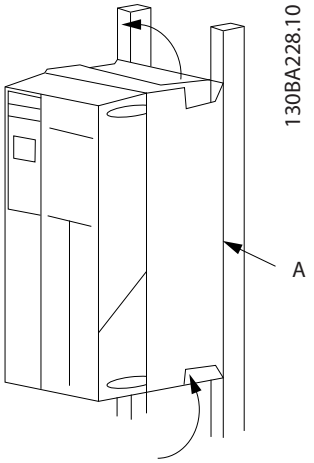

Figure 2.3 Proper Mounting with Railings

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 shows a basic electrical connection.

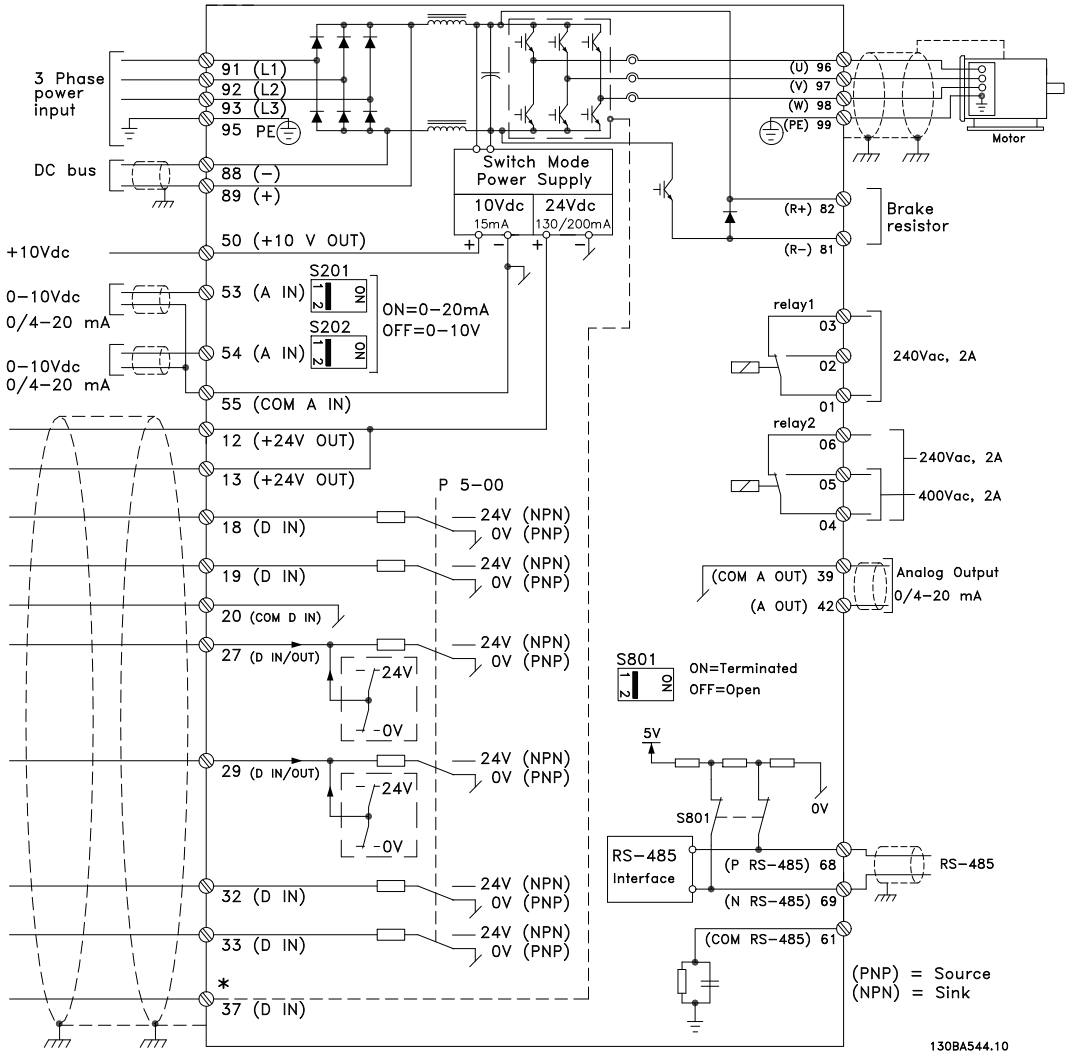

Figure 2.4 Basic Wiring Schematic Drawing.

* Terminal 37 is an option

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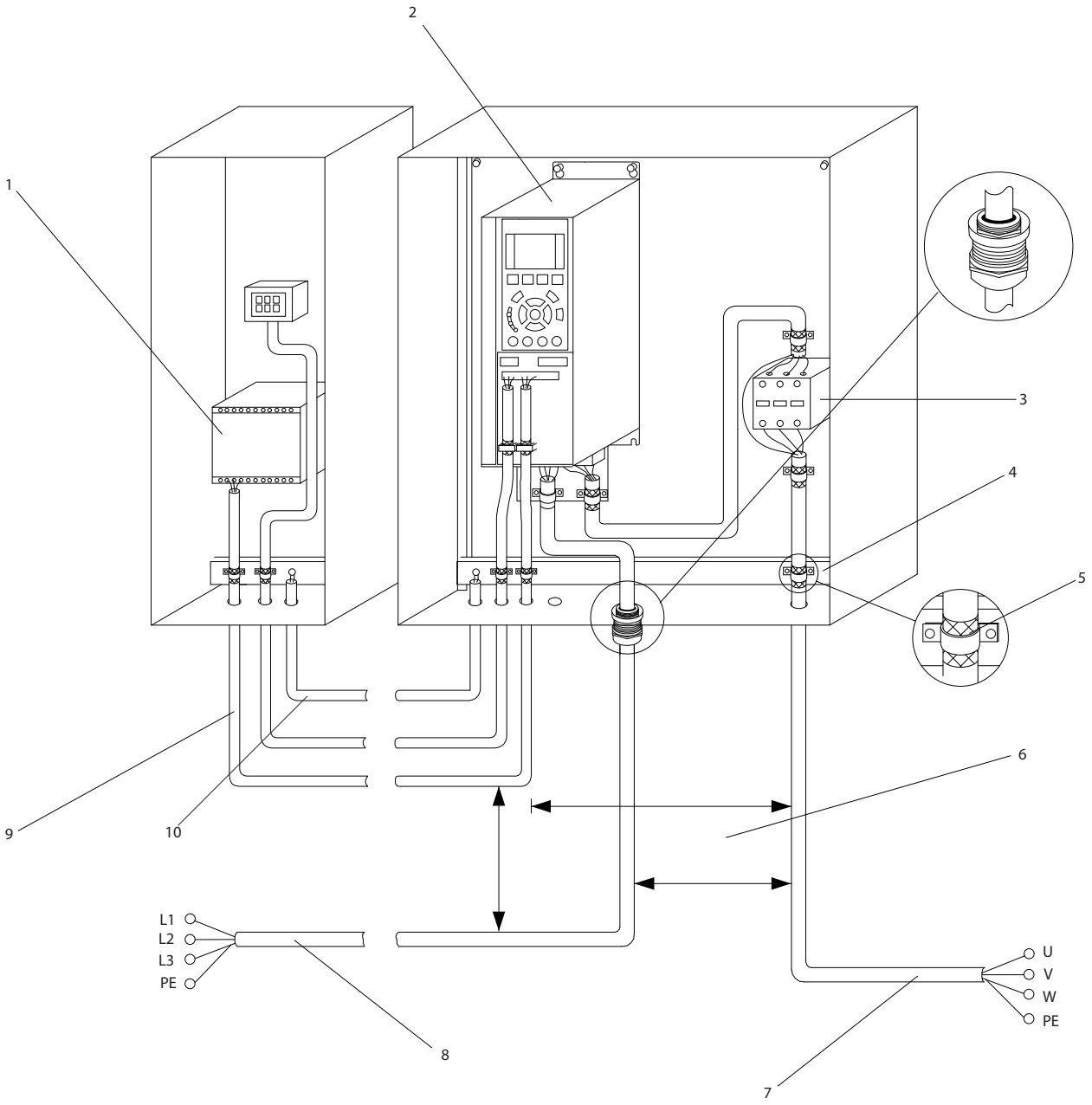

Figure 2.5 Typical Electrical Connection

1	PLC	6	Min. 8 in [200 mm] 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. 0.025 in^2 (16mm^2)

Table 2.2

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, startup, 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. See *Figure 2.6*.

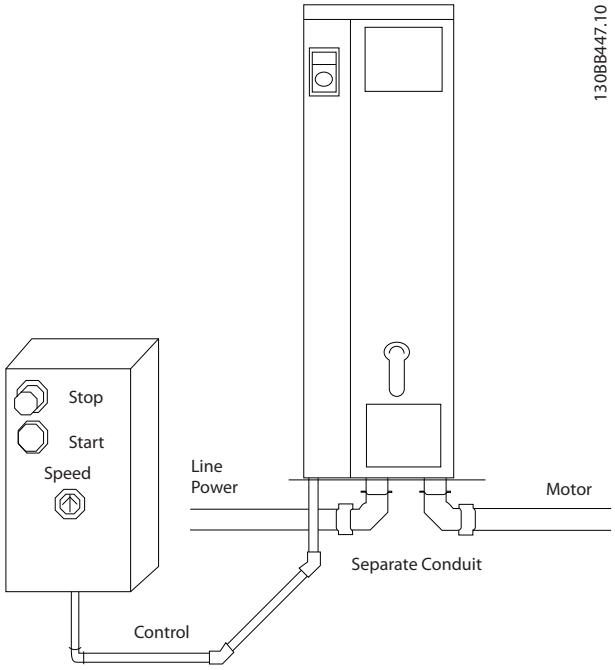

Figure 2.6 Proper Electrical Installation Using Conduit

- All adjustable frequency drives must be provided with short-circuit and overcurrent protection. Input fusing is required to provide this protection, see *Figure 2.7*. If not factory supplied, fuses must be provided by the installer as part of installation. See maximum fuse ratings in *10.3 Fuse Tables*.

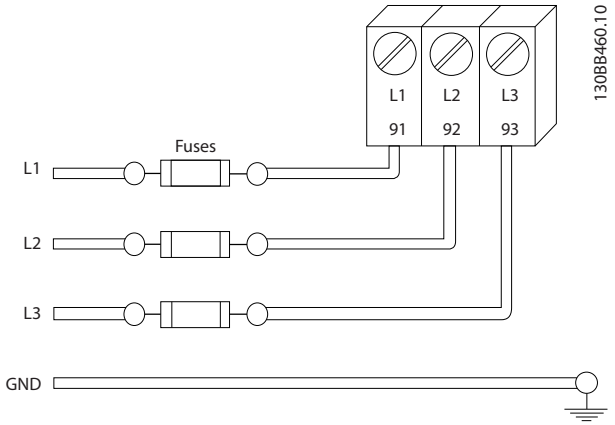

Figure 2.7 Adjustable frequency drive Fuses

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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 170°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 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 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.

- 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 dedicatedground wire is required for input power, motor power and control wiring
- Use the clamps provided on 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 3.5m A. Grounding must be reinforced in one of the following ways:

- Ground wire of at least 0.0155 in^2 [10mm^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 (ELCBs), are used, comply with the following:

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

Use RCDs with an inrush delay to prevent faults 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 2.8*).

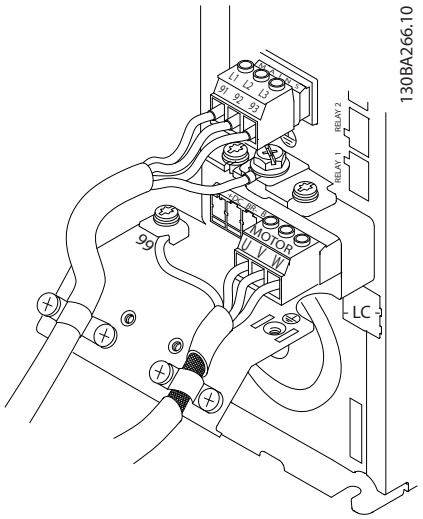

Figure 2.8 Grounding with Shielded Cable

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 *10.4.1 Connection Tightening Torques*
- Follow the motor manufacturer wiring requirements

The three following figures represent line power input, motor, and grounding for basic adjustable frequency drives. Actual configurations vary with unit types and optional equipment.

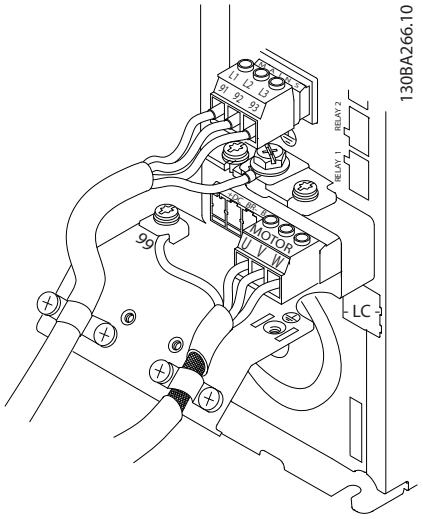

Figure 2.9 Motor, Line Power and Ground Wiring for A-Frame Sizes

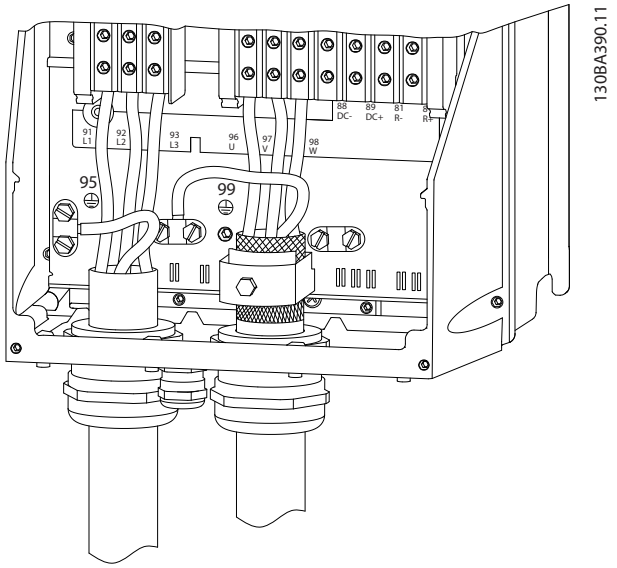

Figure 2.10 Motor, Line Power and Ground Wiring for B-Frame Sizes and Above Using Shielded Cable

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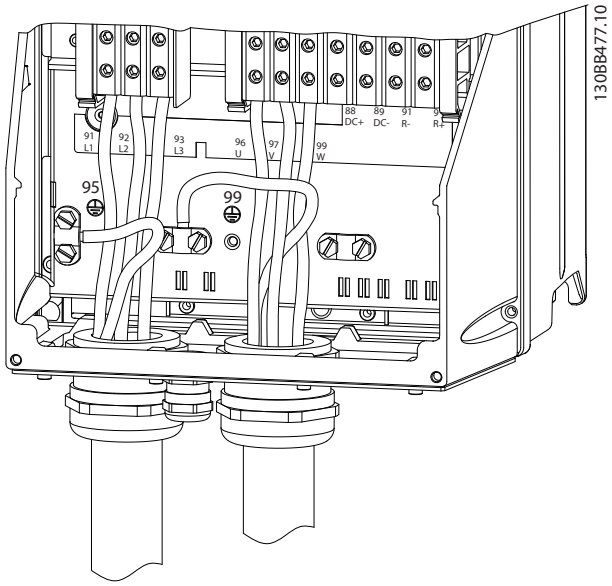

Figure 2.11 Motor, Line Power and Ground Wiring for B-Frame Sizes and Above Using Conduit

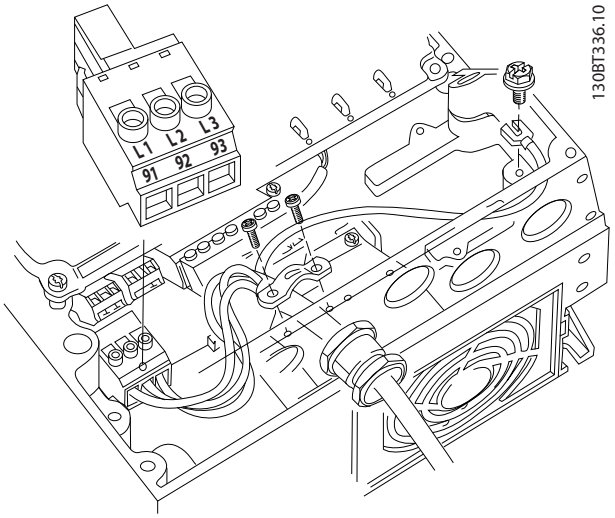

Figure 2.12 Connecting to AC Line Power

2.4.4 AC Line Power 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 2.12*).
- Depending on the configuration of the equipment, input power will be connected to the line power input terminals 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 or floating delta) or TT/TN-S power line with a grounded leg (grounded delta), set *14-50 RFI 1* to 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 coverplate with a screwdriver. See *Figure 2.13*.
- Or remove front cover by loosening attaching screws. See *Figure 2.14*.

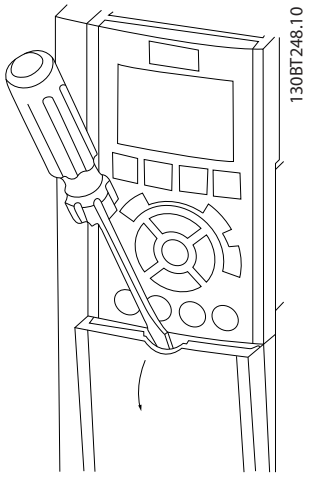

Figure 2.13 Control Wiring Access for A2, A3, B3, B4, C3 and C4 Enclosures

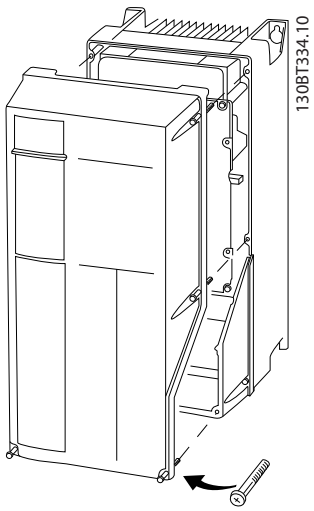

Figure 2.14 Control Wiring Access for A4, A5, B1, B2, C1 and C2 Enclosures

Please see *Table 2.3* before tightening the covers.

Frame	IP20	IP21	IP55	IP66
A4/A5	-	-	2	2
B1	-	*	2.2	2.2
B2	-	*	2.2	2.2
C1	-	*	2.2	2.2
C2	-	*	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

shows the removable Adjustable frequency drive connectors. Terminal functions and default settings are summarized in *Table 2.4*.

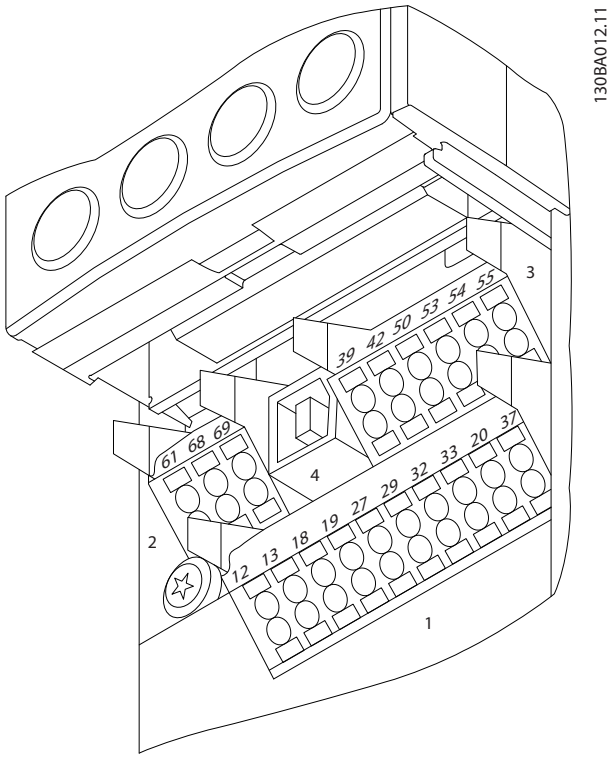

Figure 2.15 Control Terminal Locations

- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24V DC terminal supply voltage, and a common for optional customer supplied 24V DC voltage
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communications connection
- **Connector 3** provides two analog inputs, one analog output, 10V 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.

2

Terminal Description			
Digital Inputs/Outputs			
Terminal	Parameter	Default Setting	Description
12, 13	-	+24V DC	24V DC supply voltage. Maximum output current is 200mA total for all 24V loads. Useable for digital inputs and external transducers.
18	5-10	[8] Start	Digital inputs.
19	5-11	[0] No operation	
32	5-14	[0] No operation	
33	5-15	[0] No operation	
27	5-12	[2] Coast inverse	Selectable for either digital input or output. Default setting is input.
29	5-13	[14] JOG	
20	-		Common for digital inputs and 0V potential for 24V supply.
37	-	Safe Torque Off (STO)	(optional) Safe input. Used for STO
Analog Inputs/Outputs			
39	-		Common for analog output
42	6-50	Speed 0 - High Limit	Programmable analog output. The analog signal is 0–20mA or 4–20mA at a maximum of 500Ω
50	-	+10V DC	10V DC analog supply voltage. 15mA 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
Serial Communication			
61	-		Integrated RC filter for cable shield. 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] Alarm	Form C relay output. Usable for AC or DC voltage and resistive or inductive loads.
04, 05, 06	5-40 [1]	[0] Running	

Table 2.4 Terminal Description

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 2.16*.

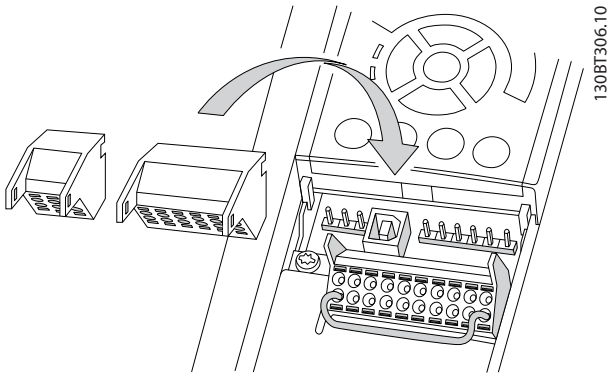

Figure 2.16 Unplugging Control Terminals

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Figure 2.17*.
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 Set-Up Examples* for typical control wiring connections.

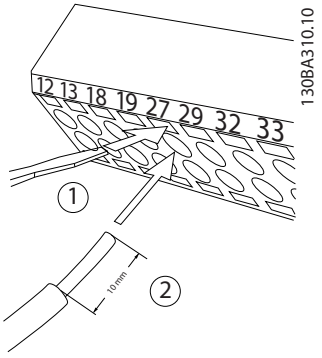

Figure 2.17 Connecting Control Wiring

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, electric 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$^{2)}$.

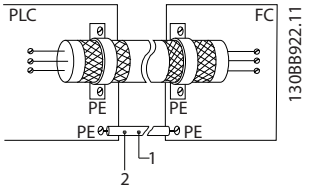

Figure 2.18

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).

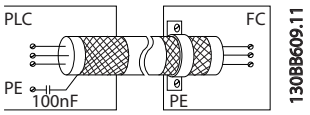

Figure 2.19

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:

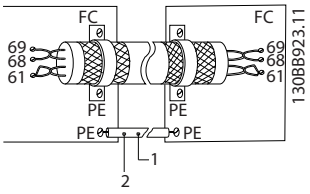

Figure 2.20

Alternatively, the connection to terminal 61 can be omitted:

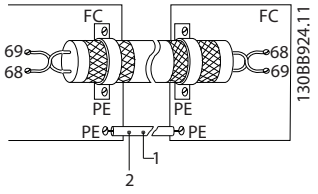

Figure 2.21

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 2.4* 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 24V 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 24V 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 COASTING or *Alarm 60 External Interlock* is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27.
- 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 (0 to 10V) or current (0/4–20mA) 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 2.22*). Note that 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*

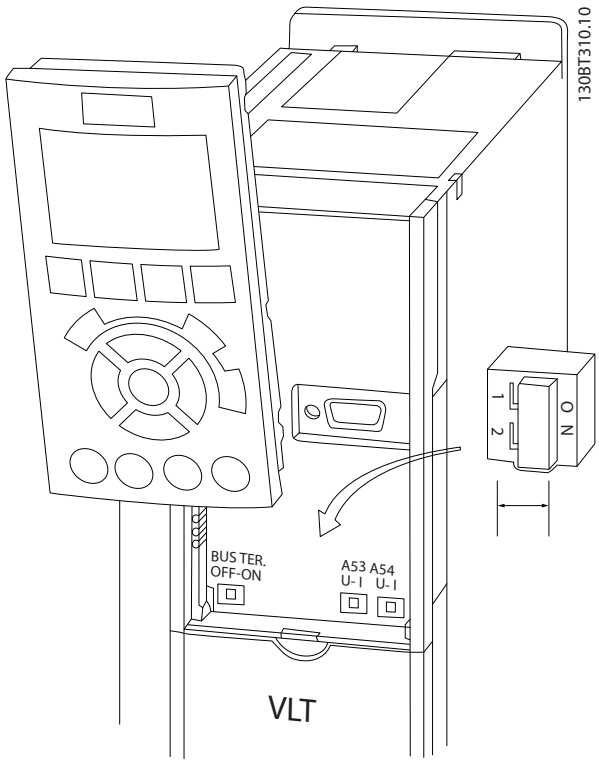

Figure 2.22 Location of Terminals 53 and 54 Switches

2.4.5.8 Terminal 37

Terminal 37 Safe Stop Function

The adjustable frequency drive is available with optional safe stop functionality via control terminal 37. Safe stop

disables the control voltage of the power semiconductors of the adjustable frequency drive output stage which 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 for stopping the adjustable frequency drive in emergency stop situations. In the normal operating mode when safe stop is not required, use the adjustable frequency drive's regular stop function instead. When automatic restart is used – the requirements according to ISO 12100-2 paragraph 5.3.2.5 must be fulfilled.

Liability Conditions

It is the responsibility of the user to ensure personnel installing and operating 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 *Design Guide*
- Have a good knowledge of the generic and safety standards applicable to the specific application

User is defined as: integrator, operator, servicing, maintenance staff.

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.

EN 954-1: 1996 Category 3

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

- Safety engineering systems may only be installed and commissioned by qualified and skilled personnel
- The unit must be installed in an IP54 cabinet or in an equivalent environment
- The cable between terminal 37 and the external safety device must be short circuit protected according to ISO 13849-2 table D.4
- If any external forces influence the motor axis (e.g., suspended loads), additional measures (e.g., a safety holding brake) are required in order to eliminate 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 under Safety in this manual. 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 will trip and stop by coasting. If this is not acceptable, i.e., causes danger, the adjustable frequency drive and machinery must be stopped using the appropriate stopping mode before using this function. Depending on the application, a mechanical brake may be required.
- Concerning synchronous and permanent magnet motor adjustable frequency drives in case of a multiple IGBT power semiconductor failure: In spite of the activation of the Safe torque off function, the adjustable frequency drive 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 adjustable frequency drive system or affected area of a machine only. It does not provide electrical safety. This function should not be used as a control for starting and/or stopping the adjustable frequency drive.

The following requirements have to be meet to perform a safe installation of the adjustable frequency drive:

2

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 2.23*.)
2. Connect an external Safety monitoring relay via a NO safety function (the instruction for the safety device must be followed) to terminal 37 (safe stop) and either terminal 12 or 13 (24V DC). The safety monitoring relay must comply with Category 3 (EN 954-1) / PL "d" (ISO 13849-1).

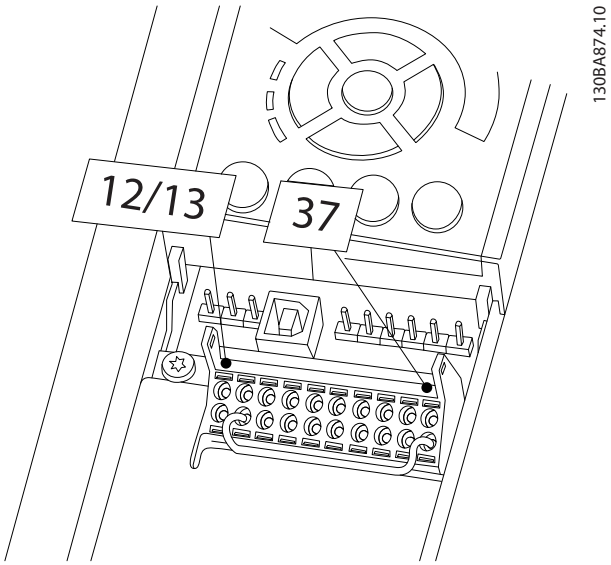

Figure 2.23 Jumper between Terminal 12/13 (24 V) and 37

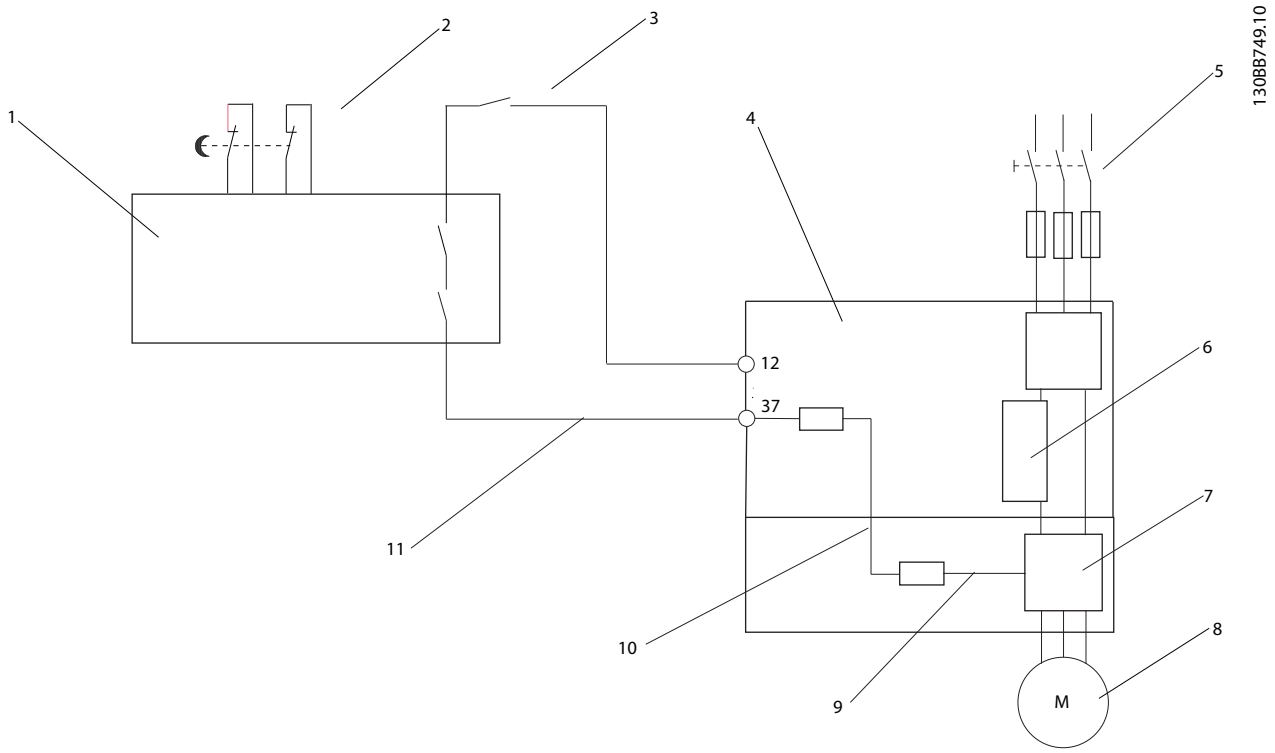

Figure 2.24 Installation to Achieve a Stopping Category 0 (EN 60204-1) with Safety Cat. 3 (EN 954-1) / PL "d" (ISO 13849-1).

1	Safety device Cat. 3 (circuit interrupt device, possibly with release input)	7	Inverter
2	Door contact	8	Motor
3	Contactor (Coast)	9	5 V DC
4	Adjustable frequency drive	10	Safe channel
5	Line power	11	Short-circuit protected cable (if not inside installation cabinet)
6	Control board		

Table 2.5

Safe Stop Commissioning Test
After installation and before first operation, perform a commissioning test of the installation making use of safe stop. Also, perform the test after each modification of the installation.

2.4.5.9 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, for example due to the load being too heavy.
- Select *Mechanical brake control* [32] 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.

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

2

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/lifting regulations.

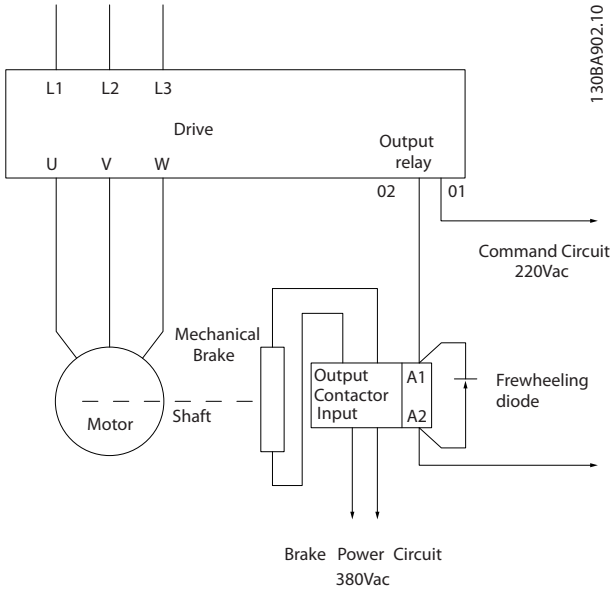

Figure 2.25 Connecting the Mechanical Brake to the Adjustable Frequency Drive

2.4.6 Serial Communication

RS-485 is a two-wire bus interface compatible with multi-drop network topology, i.e., nodes can be connected as a bus, or via drop cables from a common trunk line. A total of 32 nodes can be connected to one network segment. Repeaters divide network segments. Note that each repeater functions as a node within the segment in which it is installed. Each node connected within a given network must have a unique node address across all segments. Terminate each segment at both ends using either the termination switch (S801) of the adjustable frequency drives or a biased termination resistor network. Always use shielded twisted pair (STP) cable for bus cabling, and always follow good common installation practice. Low-impedance ground connection of the shield at every node is important, including at high frequencies. Thus, connect a large surface of the shield to ground, for example with a cable clamp or a conductive cable connector. It may be necessary to apply potential-equalizing cables to maintain the same ground potential throughout the network. particularly in installations with long cables.

To prevent impedance mismatch, always use the same type of cable throughout the entire network. When connecting a motor to the adjustable frequency drive, always use shielded motor cable.

Cable: Shielded twisted pair (STP)
Impedance: 120 Ω
Cable length: Max. 4,000 ft [1,200 m] (including drop lines)
Max. 1,650 ft [500 m] station-to-station

Table 2.6

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 through the same conduit, there is a 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	• Measure to 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 an ground wire(ground wire) from its chassis to the building ground. • Check for good ground connections(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	• Inspect to ensure 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 to the Adjustable Frequency Drive

⚠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.

⚠WARNING

UNINTENDED START!

When 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 COASTING or *Alarm 60 External Interlock* is displayed, this indicates that the unit is ready to operate but is missing an input signal on terminal 27. See *Figure 2.23* for details.

3.3 Basic Operational Programming

Adjustable Frequency require basic operational programming prior to running for best performance. Basic operational programming requires entering motor nameplate data for the motor being operated and the minimum and maximum motor speeds. Enter data in accordance with the following procedure. Parameter settings recommended are intended for startup and checkout purposes. Application settings may vary. See *4 User Interface* for detailed instructions on entering data through the LCP.

Enter data with power ON, but prior to operating the Adjustable frequency drive.

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

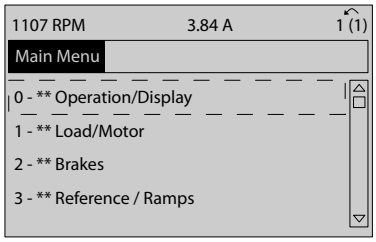

Figure 3.1

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

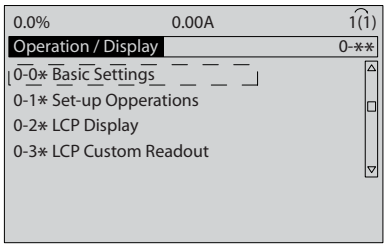

Figure 3.2

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

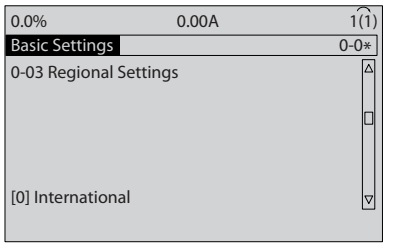

Figure 3.3

3

5. Use navigation keys to select *North America* or *International* as appropriate and press [OK]. (This changes the default settings for a number of basic parameters. See *5.4 International/North American Default Parameter Settings* for a complete list.)
6. Press [Quick Menu] on the LCP.
7. Use the navigation keys to scroll to parameter group *Q2 Quick Set-up* and press [OK].

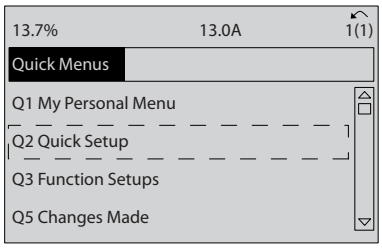

Figure 3.4

8. Select language and press [OK]. Then enter the motor data in parameters1-20/1-21 through 1-25 (induction motors only, for PM motors, skip these parameters for now). The information can be found on the motor nameplate. The entire quick menu is shown in *5.5.1 Quick Menu Structure*

   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

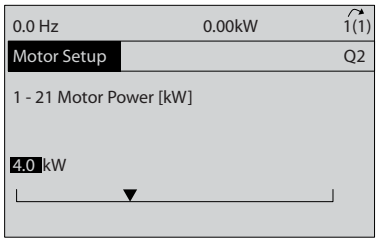

Figure 3.5

9. For best results, skip *1-28 Motor Rotation Check* at this time until basic programming is complete. This will be tested following basic set-up.
10. *3-41 Ramp 1 Ramp-up Time* is recommended as 60 seconds for fans or 10 seconds for pumps.
11. *3-42 Ramp 1 Ramp-down Time* is recommended as 60 seconds for fans or 10 seconds for pumps.
12. For *4-12 Motor Speed Low Limit [Hz]*, enter the application requirements. If these values are unknown at this time, the following values are recommended. These values will ensure initial Adjustable frequency drive operation. However, take any precautions necessary to prevent equipment damage. Make sure that the recommended values are safe to use for functional testing before starting the equipment.

    Fan = 20 Hz

    Pump = 20 Hz

    Compressor = 30 Hz
13. In *4-14 Motor Speed High Limit [Hz]*, enter the motor frequency from *1-23 Motor Frequency*.
14. Leave *3-11 Jog Speed [Hz]* (10 Hz) at the factory default (this is not used in initial programming).
15. 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 Danfoss bypass, no jumper wire is required.
16. *5-40 Function Relay*, leave at factory default.

This concludes the quick set-up procedure. Press [Status] to return to the operational display.

3.4 PM Motor Set-up

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 Danfoss 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 1000 RPM RMS (Line to Line Value)	This parameter gives back EMF across stator terminal of PM Motor at 1000 RPM mechanical speed specifically. It is defined between line to line and expressed in RMS Value. If the PM Motor specifications provide this value related to another motor speed, the voltage must be recalculated for 1000 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 note this voltage as related to nominal motor speed or to 1000 RPM measured between two lines.

3.5 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 to 1-25.
- 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

NOTE!

The AMA algorithm does not work when using PM motors.

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.

3.6 Check Motor Rotation

Prior to running the Adjustable frequency drive, check the motor rotation. The motor will run briefly at 5Hz or the minimum frequency set in *4-12 Motor Speed Low Limit [Hz]*.

1. Press [Quick Menu].
2. Scroll to *Q2 Quick Set-up*.
3. Press [OK].
4. Scroll to *1-28 Motor Rotation Check*.
5. Press [OK].
6. Scroll to *Enable*.

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

7. Press [OK].
8. Follow the on-screen instructions.

To change the direction of rotation, remove power to the Adjustable frequency drive and wait for power to discharge. Reverse the connection of any two of the three

motor cables on the motor or Adjustable frequency drive side of the connection.

3.7 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 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, [▲] and [▼] arrows on the LCP increase and decrease the speed output of the adjustable frequency drive. [◄] and [►] 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*.

NOTE!

The OVC algorithm does not work when using PM motors.

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

NOTE!

***3.1 Pre-start* through *3.7 Local Control Test* in this chapter concludes the procedures for applying power to the adjustable frequency drive, basic programming, set-up, and functional testing.**

3.8 System Start-up

The procedure in this section requires user-wiring and application programming to be completed. *6 Application Set-Up 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 is 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 is 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*.

3.9 Acoustic Noise or Vibration

If the motor or the equipment driven by the motor, e.g., a fan blade, is making noise or vibrations at certain frequencies, try the following:

- Speed Bypass, parameter group 4-6*
- Overmodulation, *14-03 Overmodulation* set to off
- Switching pattern and switching frequency parameter group 14-0*
- Resonance Dampening, *1-64 Resonance Dampening*

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 the up/down key.

4.1.1 LCP Layout

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

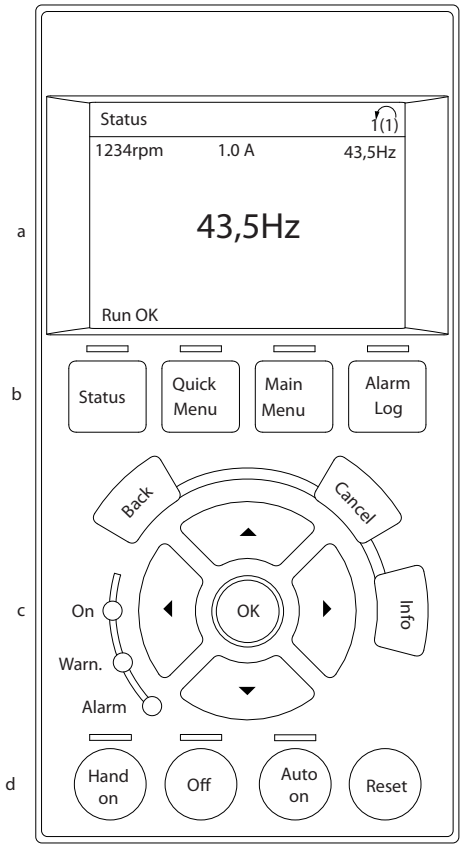

Figure 4.1 LCP

a. Display area.

b. Display menu keys for changing the display to show status options, programming, or error message history. Navigation keys for programming functions, moving the display cursor, and speed control in local operation. Also included are the status indicator lights.

c. 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 the quick menu *Q3-13 Display Settings*.
- Display 2 has an alternate larger display option.
- The adjustable frequency drive status at the bottom line of the display is generated automatically and is not selectable.

Display	Parameter number	Default setting
1.1	0-20	Motor RPMs
1.2	0-21	Motor current
1.3	0-22	Motor power (kW)
2	0-23	Motor frequency
3	0-24	Reference in percent

Table 4.1

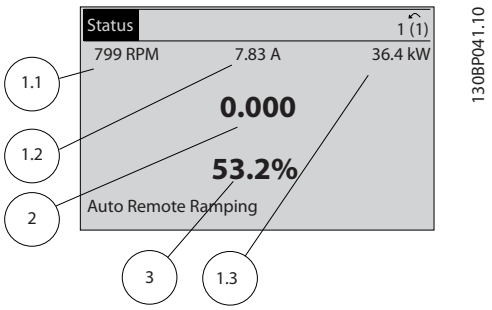

Figure 4.2

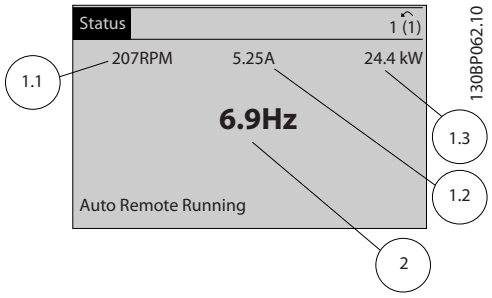

Figure 4.3

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

Key	Function
Status	Shows operational information. • In auto mode, press to toggle between status readout displays. • Press repeatedly to scroll through each status display. • Press [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 to enter a parameter number for direct access to that parameter.
Alarm Log	Displays a list of current warnings, the last 10 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

4.1.4 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.

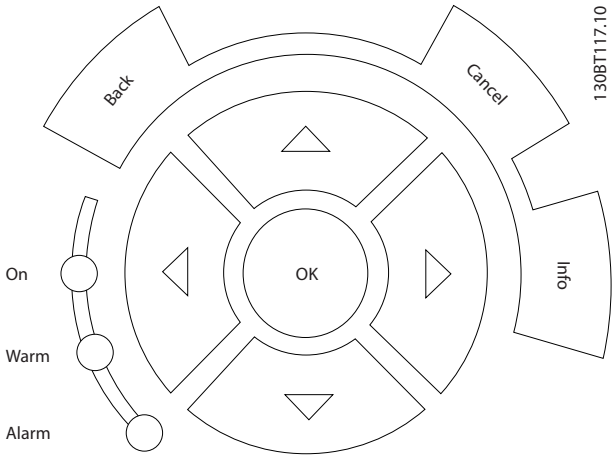

Figure 4.5

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 arrows to move between items in the menu.
OK	Use to access parameter groups or to enable a choice.

Table 4.3

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	WARN	When warning conditions are met, the yellow WARN 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

4.1.5 Operation Keys

Operation keys are found at the bottom of the LCP.

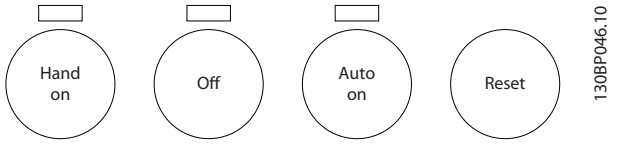

Figure 4.6

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

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 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. Parameter 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 Remote Programming with*).

The quick menu is intended for initial startup (*Q2-** Quick Set-up*) and detailed instructions for common Adjustable frequency drive applications (*Q3-** Function Set-up*). Step-by-step instructions are provided. These instructions enable the user to walk through the parameters used for programming applications in their proper sequence. Data entered in a parameter can change the options available in the parameters following that entry. The quick menu presents easy guidelines for getting most systems up and running.

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*

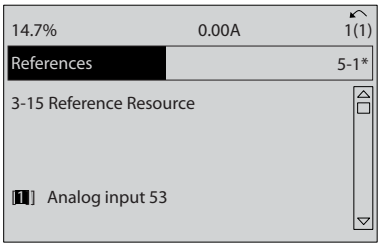

Figure 5.1

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.)

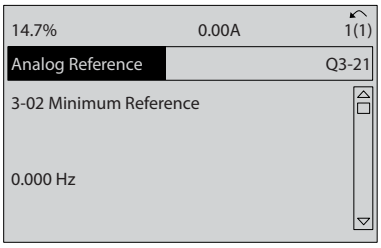

Figure 5.2

3. *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.)

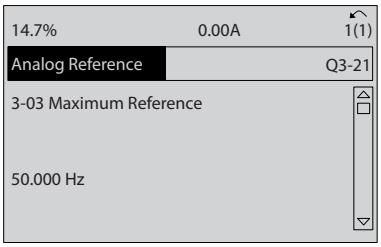

Figure 5.3

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.)

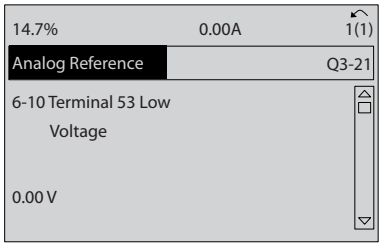

Figure 5.4

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.)

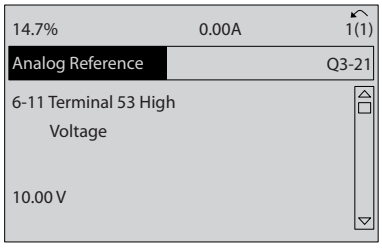

Figure 5.5

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

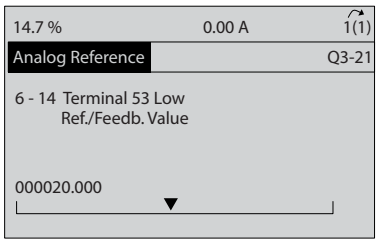

Figure 5.6

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.)

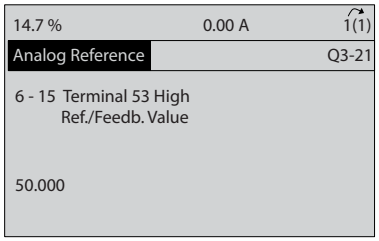

Figure 5.7

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 that the scroll bar on the right in the last figure of the display is at the bottom, indicating the procedure is complete.

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

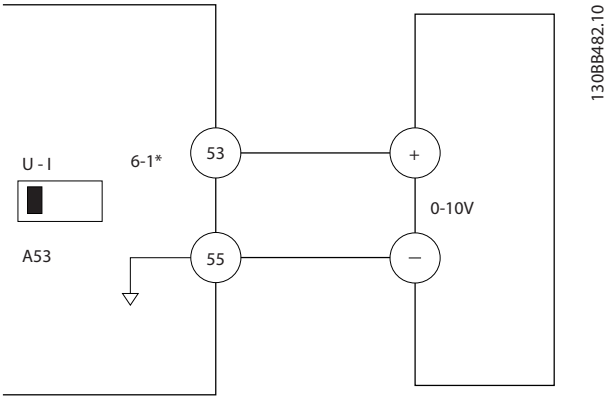

Figure 5.8 Wiring Example for External Device Providing 0–10 V Control Signal (adjustable frequency drive left, external device right)

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.
- For proper Adjustable frequency drive functioning, the control terminals must be

  Wired properly

  Programmed for the intended function

  Receiving a signal

See *Table 2.4* 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 Parameter Data Set* and press [OK].

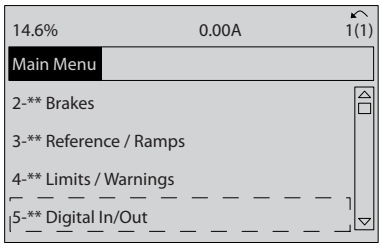

Figure 5.9

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

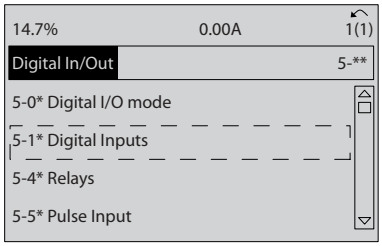

Figure 5.10

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

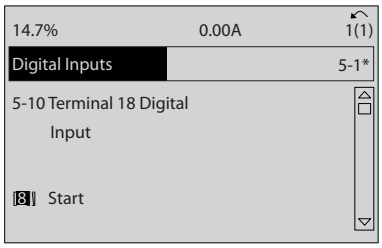

Figure 5.11

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 effected.

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	1500 PM	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 are 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].

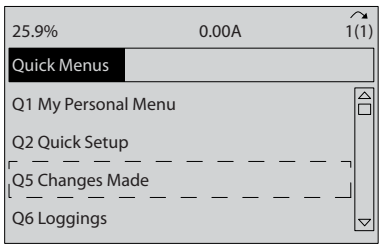

Figure 5.12

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

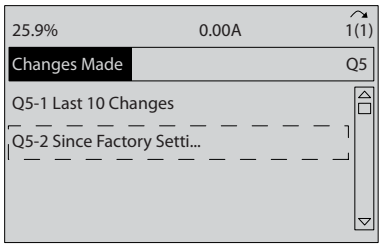

Figure 5.13

5.4.1 Parameter Data Check

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

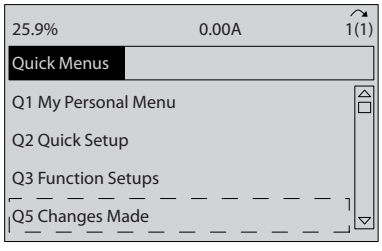

Figure 5.14

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

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 Set-Up Examples*

Q3-1 General Settings	0-24 Display Line 3 Large	1-00 Configuration Mode	**Q3-31 Single Zone Ext. Setpoint**	20-70 Closed-loop Type
Q3-10 Adv. Motor Settings	0-37 Display Text 1	20-12 Reference/Feedback Unit	1-00 Configuration Mode	20-71 PID Performance
1-90 Motor Thermal Protection	0-38 Display Text 2	20-13 Minimum Reference/Feedb.	20-12 Reference/Feedback Unit	20-72 PID Output Change
1-93 Thermistor Source	0-39 Display Text 3	20-14 Maximum Reference/Feedb.	20-13 Minimum Reference/Feedb.	20-73 Minimum Feedback Level
1-29 Automatic Motor Adaptation (AMA)	*Q3-2 Open-loop Settings*	6-22 Terminal 54 Low Current	20-14 Maximum Reference/Feedb.	20-74 Maximum Feedback Level
14-01 Switching Frequency	**Q3-20 Digital Reference**	6-24 Terminal 54 Low Ref./Feedb. Value	6-10 Terminal 53 Low Voltage	20-79 PID Autotuning
4-53 Warning Speed High	3-02 Minimum Reference	6-25 Terminal 54 High Ref./Feedb. Value	6-11 Terminal 53 High Voltage	**Q3-32 Multi Zone / Adv**
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0-70 Date and Time	**Q3-21 Analog Reference**	20-81 PID Normal/ Inverse Control	6-24 Terminal 54 Low Ref./Feedb. Value	20-02 Feedback 1 Source Unit
0-71 Date Format	3-02 Minimum Reference	20-82 PID Start Speed [RPM]	6-25 Terminal 54 High Ref./Feedb. Value	20-03 Feedback 2 Source
0-72 Time Format	3-03 Maximum Reference	20-83 PID Start Speed [Hz]	6-26 Terminal 54 Filter Time Constant	20-04 Feedback 2 Conversion
0-74 DST/Summertime	6-10 Terminal 53 Low Voltage	20-93 PID Proportional Gain	6-27 Terminal 54 Live Zero	20-05 Feedback 2 Source Unit
0-76 DST/Summertime Start	6-11 Terminal 53 High Voltage	20-94 PID Integral Time	6-00 Live Zero Timeout Time	20-06 Feedback 3 Source
0-77 DST/Summertime End	6-12 Terminal 53 Low Current	20-70 Closed-loop Type	6-01 Live Zero Timeout Function	20-07 Feedback 3 Conversion
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Table 5.2

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6-12 Terminal 53 Low Current	20-22 Setpoint 2	22-23 No-Flow Function	22-22 Low Speed Detection	22-88 Pressure at Rated Speed
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6-17 Terminal 53 Live Zero	20-94 PID Integral Time	22-43 Wake-up Speed [Hz]	22-42 Wake-up Speed [RPM]	**Q3-42 Compressor Functions**
6-20 Terminal 54 Low Voltage	20-70 Closed-loop Type	22-44 Wake-up Ref./FB Difference	22-43 Wake-up Speed [Hz]	1-03 Torque Characteristics
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20-20 Feedback Function	1-03 Torque Characteristics	22-20 Low Power Auto Set-up	22-86 Speed at Design Point [Hz]	1-87 Trip Speed Low [Hz]

Table 5.3

5.5.2 Main menu structure

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0-04 Operating State at Power-up
0-05 Local Mode Unit
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0-12 This Set-up Linked to
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0-14 Readout: Prog. Set-ups / Channel
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1-24 Motor Current
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1-28 Motor Rotation Check
1-29 Automatic Motor Adaptation (AMA)
1-3* Adv. Motor Data
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1-39 Motor Poles
1-40 Back EMF at 1,000 RPM
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1-50 Motor Magnetization at Zero Speed
1-51 Min Speed Normal Magnetizing [RPM]
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1-65 Resonance Dampening Time Constant
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1-71 Start Delay
1-72 Start Function
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1-79 Compressor Start Max Time to Trip
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1-80 Function at Stop
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4-17 Torque Limit Generator Mode
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8-70 BACnet Device Instance
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8-74 "I-Am" Service
8-75 Initialization Password
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8-82 Slave Messages Rcvd
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8-94 Bus Feedback 1
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15-59 CSIV Filename
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15-60 Option Mounted
15-61 Option SW Version
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15-70 Option in Slot A
15-71 Slot A Option SW Version
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16-13 Frequency
16-14 Motor Current
16-15 Frequency [%]
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16-17 Speed [RPM]
16-18 Motor Thermal
16-22 Torque [%]
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16-64 Analog Input 54
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16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
16-95 Ext. Status Word 2
16-96 Maintenance Word
18- Info & Readouts**
18-0* Maintenance Log
18-00 Maintenance Log: Item
18-01 Maintenance Log: Action
18-02 Maintenance Log: Time
18-03 Maintenance Log: Date and Time
18-1* Fire Mode Log
18-10 Fire Mode Log: Event
18-11 Fire Mode Log: Time
18-12 Fire Mode Log: Date and Time
18-3* Inputs & Outputs
18-30 Analog Input X42/1
18-31 Analog Input X42/3
18-32 Analog Input X42/5
18-33 Analog Out X42/7 [V]
18-34 Analog Out X42/9 [V]
18-35 Analog Out X42/11 [V]
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
18-5* Ref. & Feedb.
18-50 Sensorless Readout [unit]
20- Drive Closed-loop**
20-0* Feedback
20-00 Feedback 1 Source
20-01 Feedback 1 Conversion
20-02 Feedback 1 Source Unit
20-03 Feedback 2 Source
20-04 Feedback 2 Conversion
20-05 Feedback 2 Source Unit
20-06 Feedback 3 Source
20-07 Feedback 3 Conversion
20-08 Feedback 3 Source Unit
20-12 Reference/Feedback Unit
20-13 Minimum Reference/Feedb.
20-14 Maximum Reference/Feedb.
20-2* Feedback/Setpoint
20-20 Feedback Function
20-21 Setpoint 1
20-22 Setpoint 2
20-23 Setpoint 3
20-3* Feedb. Adv. Conv.
20-30 Refrigerant
20-31 User-defined Refrigerant A1
20-32 User-defined Refrigerant A2
20-33 User-defined Refrigerant A3
20-34 Duct 1 Area [m2]
20-35 Duct 1 Area [in2]
20-36 Duct 2 Area [m2]
20-37 Duct 2 Area [in2]
20-38 Air Density Factor [%]
20-6* Sensorless
20-60 Sensorless Unit
20-69 Sensorless Information
20-7* PID Autotuning
20-70 Closed-loop Type
20-71 PID Performance
20-72 PID Output Change
20-73 Minimum Feedback Level
20-74 Maximum Feedback Level
20-79 PID Autotuning
20-8* PID Basic Settings
20-81 PID Normal/ Inverse Control
20-82 PID Start Speed [RPM]
20-83 PID Start Speed [Hz]
20-84 On Reference Bandwidth
20-9* PID Controller
20-91 PID Anti Windup
20-93 PID Proportional Gain
20-94 PID Integral Time
20-95 PID Differentiation Time
20-96 PID Diff. Gain Limit
21- Ext. Closed-Loop**
21-0* Ext. CL Autotuning
21-00 Closed-loop Type
21-01 PID Performance
21-02 PID Output Change
21-03 Minimum Feedback Level
21-04 Maximum Feedback Level
21-09 PID Autotuning
21-1* Ext. CL 1 Ref./Fb.
21-10 Ext. 1 Ref./Feedback Unit
21-11 Ext. 1 Minimum Reference
21-12 Ext. 1 Maximum Reference
21-13 Ext. 1 Reference Source
21-14 Ext. 1 Feedback Source
21-15 Ext. 1 Setpoint
21-17 Ext. 1 Reference [Unit]
21-18 Ext. 1 Feedback [Unit]
21-19 Ext. 1 Output [%]
21-2* Ext. CL 1 PID
21-20 Ext. 1 Normal/Inverse Control
21-21 Ext. 1 Proportional Gain
21-22 Ext. 1 Integral Time
21-23 Ext. 1 Differentiation Time
21-24 Ext. 1 Dif. Gain Limit
21-3* Ext. CL 2 Ref./Fb.
21-30 Ext. 2 Ref./Feedback Unit
21-31 Ext. 2 Minimum Reference
21-32 Ext. 2 Maximum Reference
21-33 Ext. 2 Reference Source
21-34 Ext. 2 Feedback Source
21-35 Ext. 2 Setpoint
21-37 Ext. 2 Reference [Unit]
21-38 Ext. 2 Feedback [Unit]
21-39 Ext. 2 Output [%]
21-4* Ext. CL 2 PID
21-40 Ext. 2 Normal/Inverse Control
21-41 Ext. 2 Proportional Gain
21-42 Ext. 2 Integral Time
21-43 Ext. 2 Differentiation Time
21-44 Ext. 2 Dif. Gain Limit
21-5* Ext. CL 3 Ref./Fb.
21-50 Ext. 3 Ref./Feedback Unit
21-51 Ext. 3 Minimum Reference
21-52 Ext. 3 Maximum Reference
21-53 Ext. 3 Reference Source
21-54 Ext. 3 Feedback Source
21-55 Ext. 3 Setpoint
21-57 Ext. 3 Reference [Unit]
21-58 Ext. 3 Feedback [Unit]
21-59 Ext. 3 Output [%]
21-6* Ext. CL 3 PID
21-60 Ext. 3 Normal/Inverse Control
21-61 Ext. 3 Proportional Gain
21-62 Ext. 3 Integral Time
21-63 Ext. 3 Differentiation Time
21-64 Ext. 3 Dif. Gain Limit
22- Appl. Functions**
22-0* Miscellaneous
22-00 External Interlock Delay
22-01 Power Filter Time
22-2* No-Flow Detection
22-20 Low Power Auto Set-up
22-21 Low Power Detection
22-22 Low Speed Detection
22-23 No-Flow Function
22-24 No-Flow Delay
22-26 Dry Pump Function
22-27 Dry Pump Delay
22-3* No-Flow Power Tuning
22-30 No-Flow Power
22-31 Power Correction Factor
22-32 Low Speed [RPM]
22-33 Low Speed [Hz]
22-34 Low Speed Power [kW]
22-35 Low Speed Power [HP]
22-36 High Speed [RPM]
22-37 High Speed [Hz]
22-38 High Speed Power [kW]
22-39 High Speed Power [HP]
22-4* Sleep Mode
22-40 Minimum Run Time
22-41 Minimum Sleep Time
22-42 Wake-up Speed [RPM]
22-43 Wake-up Speed [Hz]
22-44 Wake-up Ref./FB Difference
22-45 Setpoint Boost
22-46 Maximum Boost Time
22-5* End of Curve
22-50 End of Curve Function
22-51 End of Curve Delay
22-6* Broken Belt Detection
22-60 Broken Belt Function
22-61 Broken Belt Torque
22-62 Broken Belt Delay
22-7* Short Cycle Protection
22-75 Short Cycle Protection
22-76 Interval between Starts
22-77 Minimum Run Time
22-78 Minimum Run Time Override
22-79 Minimum Run Time Override Value
22-8* Flow Compensation
22-80 Flow Compensation
22-81 Square-linear Curve Approximation
22-82 Work Point Calculation
22-83 Speed at No-Flow [RPM]
22-84 Speed at No-Flow [Hz]
22-85 Speed at Design Point [RPM]
22-86 Speed at Design Point [Hz]
22-87 Pressure at No-Flow Speed
22-88 Pressure at Rated Speed
22-89 Flow at Design Point
22-90 Flow at Rated Speed
23- Time-based Functions**
23-0* Timed Actions
23-00 ON Time
23-01 ON Action
23-02 OFF Time
23-03 OFF Action
23-04 Occurrence
23-0* Timed Actions Set.
23-08 Timed Actions Mode
23-09 Timed Actions Reactivation
23-1* Maintenance
23-10 Maintenance Item
23-11 Maintenance Action
23-12 Maintenance Time Base
23-13 Maintenance Time Interval
23-14 Maintenance Date and Time
23-1* Maintenance Reset
23-15 Reset Maintenance Word
23-16 Maintenance Text
23-5* Energy Log
23-50 Energy Log Resolution

23-51 Period Start
23-53 Energy Log
23-54 Reset Energy Log
23-6* Trending
23-60 Trend Variable
23-61 Continuous Bin Data
23-62 Timed Bin Data
23-63 Timed Period Start
23-64 Timed Period Stop
23-65 Minimum Bin Value
23-66 Reset Continuous Bin Data
23-67 Reset Timed Bin Data
23-8* Payback Counter
23-80 Power Reference Factor
23-81 Energy Cost
23-82 Investment
23-83 Energy Savings
23-84 Cost Savings
24- Appl. Functions 2**
24-0* Fire Mode
24-00 Fire Mode Function
24-01 Fire Mode Configuration
24-02 Fire Mode Unit
24-03 Fire Mode Min Reference
24-04 Fire Mode Max Reference
24-05 Fire Mode Preset Reference
24-06 Fire Mode Reference Source
24-07 Fire Mode Feedback Source
24-09 Fire Mode Alarm Handling
24-1* Drive Bypass
24-10 Drive Bypass Function
24-11 Drive Bypass Delay Time
24-9* Multi-Motor Funct.
24-90 Missing Motor Function
24-91 Missing Motor Coefficient 1
24-92 Missing Motor Coefficient 2
24-93 Missing Motor Coefficient 3
24-94 Missing Motor Coefficient 4
24-95 Locked Rotor Function
24-96 Locked Rotor Coefficient 1
24-97 Locked Rotor Coefficient 2
24-98 Locked Rotor Coefficient 3
24-99 Locked Rotor Coefficient 4
25- Cascade Controller**
25-0* System Settings
25-00 Cascade Controller
25-02 Motor Start
25-04 Pump Cycling
25-05 Fixed Lead Pump
25-06 Number of Pumps
25-2* Bandwidth Settings
25-20 Staging Bandwidth
25-21 Override Bandwidth
25-22 Fixed Speed Bandwidth
25-23 SBW Staging Delay
25-24 SBW De-staging Delay
25-25 OBW Time
25-26 Destage At No-Flow
25-27 Stage Function
25-28 Stage Function Time
25-29 Destage Function
25-30 Destage Function Time
25-4* Staging Settings
25-40 Ramp-down Delay
25-41 Ramp-up Delay
25-42 Staging Threshold
25-43 De-staging Threshold
25-44 Staging Speed [RPM]
25-45 Staging Speed [Hz]
25-46 De-staging Speed [RPM]
25-47 De-staging Speed [Hz]
25-5* Alternation Settings
25-50 Lead Pump Alternation
25-51 Alternation Event
25-52 Alternation Time Interval
25-53 Alternation Timer Value
25-54 Alternation Predefined Time
25-55 Alternate if Load < 50%
25-56 Staging Mode at Alternation
25-58 Run Next Pump Delay
25-59 Run-on Line Delay
25-8* Status
25-80 Cascade Status
25-81 Pump Status
25-82 Lead Pump
25-83 Relay Status
25-84 Pump ON Time
25-85 Relay ON Time
25-86 Reset Relay Counters
25-9* Service
25-90 Pump Interlock
25-91 Manual Alternation
26- Analog I/O Option**
26-0* Analog I/O Mode
26-00 Terminal X42/1 Mode
26-01 Terminal X42/3 Mode
26-02 Terminal X42/5 Mode
26-1* Analog Input X42/1
26-10 Terminal X42/1 Low Voltage
26-11 Terminal X42/1 High Voltage
26-14 Term. X42/1 Low Ref./Feedb. Value
26-15 Term. X42/1 High Ref./Feedb. Value
26-16 Term. X42/1 Filter Time Constant
26-17 Term. X42/1 Live Zero
26-2* Analog Input X42/3
26-20 Terminal X42/3 Low Voltage
26-21 Terminal X42/3 High Voltage
26-24 Term. X42/3 Low Ref./Feedb. Value
26-25 Term. X42/3 High Ref./Feedb. Value
26-26 Term. X42/3 Filter Time Constant
26-27 Term. X42/3 Live Zero
26-3* Analog Input X42/5
26-30 Terminal X42/5 Low Voltage
26-31 Terminal X42/5 High Voltage
26-34 Term. X42/5 Low Ref./Feedb. Value
26-35 Term. X42/5 High Ref./Feedb. Value
26-36 Term. X42/5 Filter Time Constant
26-37 Term. X42/5 Live Zero
26-4* Analog Out X42/7
26-40 Terminal X42/7 Output
26-41 Terminal X42/7 Min. Scale
26-42 Terminal X42/7 Max. Scale
26-43 Terminal X42/7 Bus Control
26-44 Terminal X42/7 Timeout Preset
26-5* Analog Out X42/9
26-50 Terminal X42/9 Output
26-51 Terminal X42/9 Min. Scale
26-52 Terminal X42/9 Max. Scale
26-53 Terminal X42/9 Bus Control
26-54 Terminal X42/9 Timeout Preset
26-6* Analog Out X42/11
26-60 Terminal X42/11 Output
26-61 Terminal X42/11 Min. Scale
26-62 Terminal X42/11 Max. Scale
26-63 Terminal X42/11 Bus Control
26-64 Terminal X42/11 Timeout Preset
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
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
35-47 Term. X48/2 Live Zero
99-* Devel support
99-00 DAC 1 selection
99-01 DAC 2 selection
99-02 DAC 3 selection
99-03 DAC 4 selection
99-04 DAC 1 scale
99-05 DAC 2 scale
99-06 DAC 3 scale
99-07 DAC 4 scale
99-08 Test param 1
99-09 Test param 2
99-10 DAC Option Slot
99-11 RFI 2
99-12 Fan
99-13 Idle time
99-14 Paramdb requests in queue
99-15 Secondary Timer at Inverter Fault
99-16 No. of Current Sensors
99-20 HS Temp. (PC1)
99-21 HS Temp. (PC2)
99-22 HS Temp. (PC3)
99-23 HS Temp. (PC4)
99-24 HS Temp. (PC5)
99-25 HS Temp. (PC6)
99-26 HS Temp. (PC7)
99-27 HS Temp. (PC8)
99-29 Platform Version
99-40 StartupWizardState
99-90 Options present
99-91 Motor Power Internal
99-92 Motor Voltage Internal
99-93 Motor Frequency Internal
99-94 Imbalance derate [%]
99-95 Temperature derate [%]
99-96 Overload derate [%]

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 offline and simply downloaded to theAdjustable 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 are 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. A user's manual provides detailed instructions for operation.

6 Application Set-Up Examples

6.1 Introduction

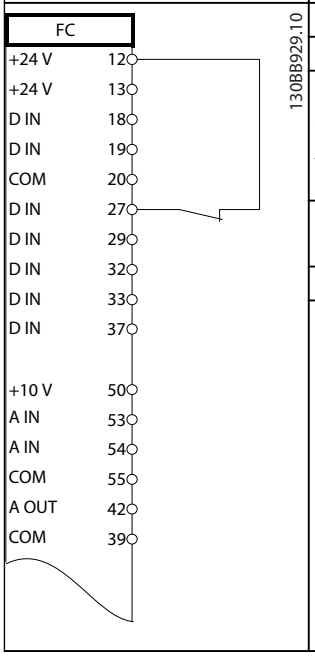
NOTE!

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.

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

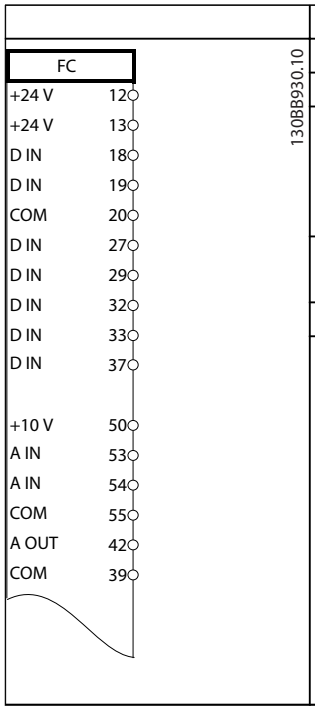
- Parameter settings are the regional default values unless otherwise indicated (selected in *0-03 Regional Settings*)
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Where switch settings for analog terminals A53 or A54 are required, these are also shown.

6.2 Application Examples



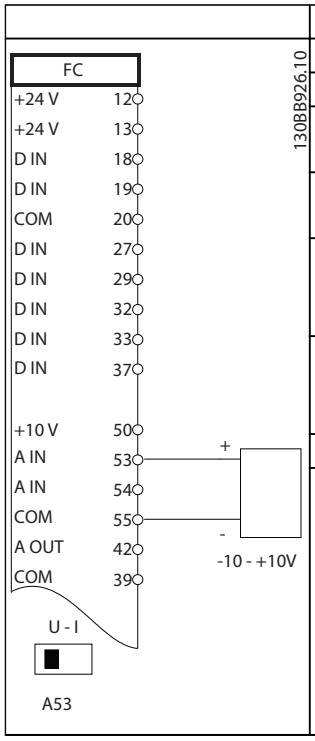
Parameters	
Function	**Setting**
1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
5-12 Terminal 27 Digital Input	[2]* Coast inverse
* = Default Value	
Notes/comments: Parameter group 1-2* must be set according to motor	

Table 6.1 AMA with T27 Connected



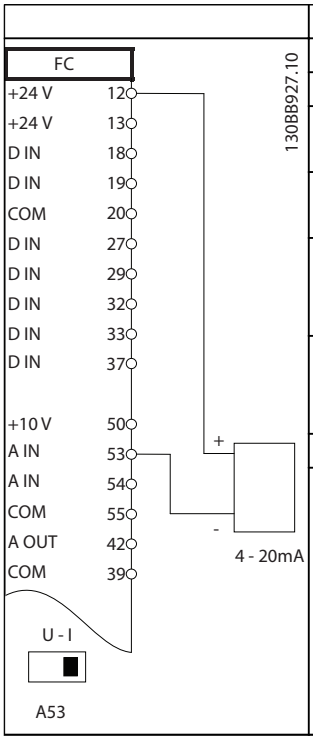
Parameters	
Function	**Setting**
1-29 Automatic Motor Adaptation (AMA)	[1] Enable complete AMA
5-12 Terminal 27 Digital Input	[0] No operation
* = Default Value	
Notes/comments: Parameter group 1-2* must be set according to motor	

Table 6.2 AMA without T27 Connected



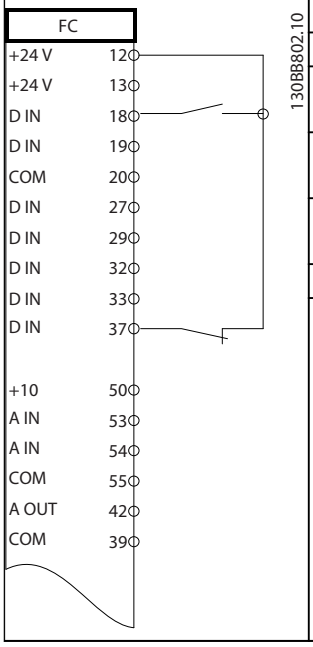
Parameters	
Function	**Setting**
6-10 Terminal 53 Low Voltage	0.07V*
6-11 Terminal 53 High Voltage	10 V*
6-14 Terminal 53 Low Ref./Feedb. Value	0 RPM
6-15 Terminal 53 High Ref./Feedb. Value	1,500 RPM
* = Default Value	
Notes/comments:	

Table 6.3 Analog Speed Reference (Voltage)



	Parameters	
	Function	**Setting**
	6-12 Terminal 53 Low Current	4mA*
	6-13 Terminal 53 High Current	20mA*
	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

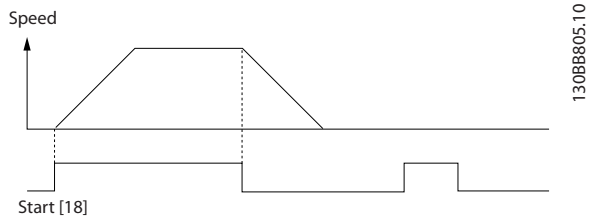
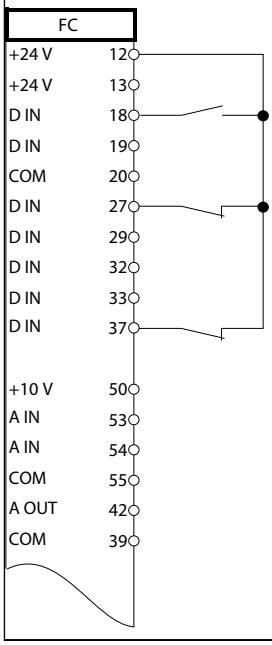


Figure 6.1



	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

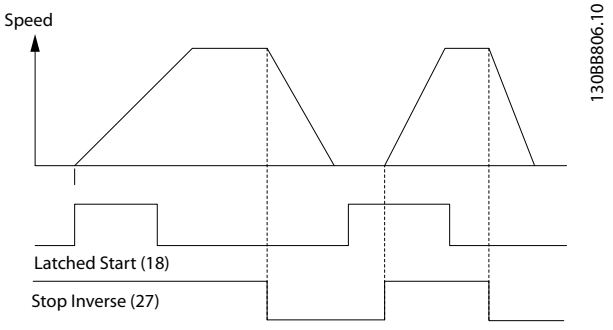
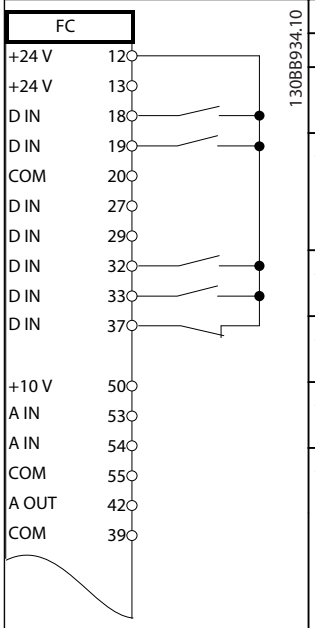
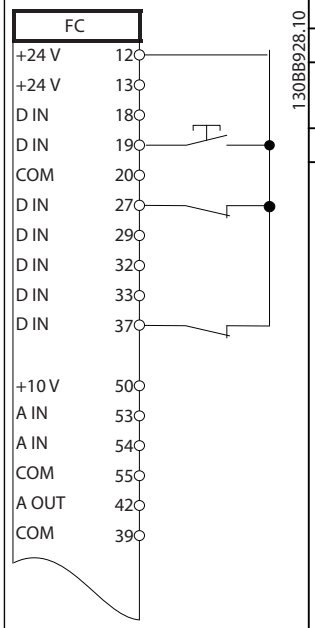


Figure 6.2



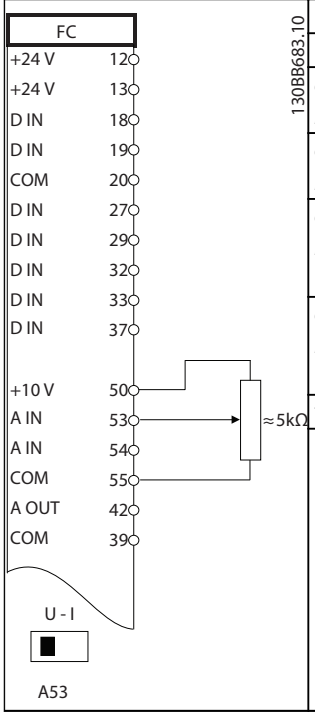
Parameters	
Function	**Setting**
5-10 Terminal 18 Digital Input	[8] Start
5-11 Terminal 19 Digital Input	[10] Reversing*
5-12 Terminal 27 Digital Input	[0] No operation
5-14 Terminal 32 Digital Input	[16] Preset ref bit 0
5-15 Terminal 33 Digital Input	[17] Preset ref bit 1
3-10 Preset Reference	
Preset 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



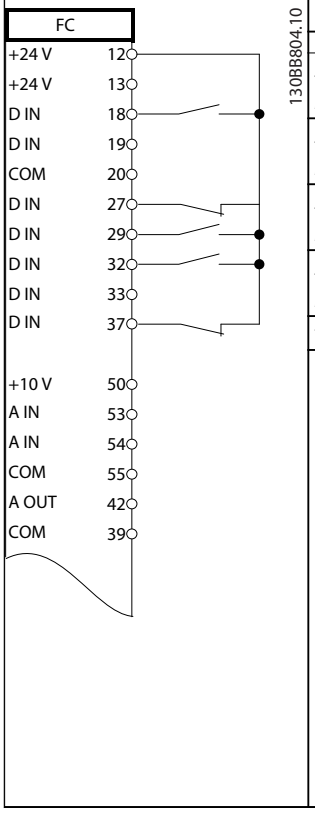
Parameters	
Function	**Setting**
5-11 Terminal 19 Digital Input	[1] Reset
* = Default Value	
Notes/comments:	

Table 6.8 External Alarm Reset



Parameters	
Function	**Setting**
6-10 Terminal 53 Low Voltage	0.07V*
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

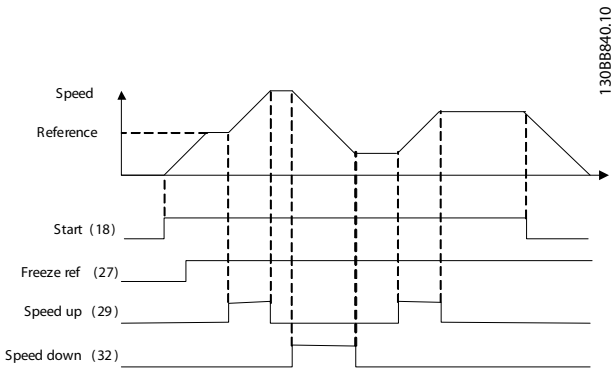
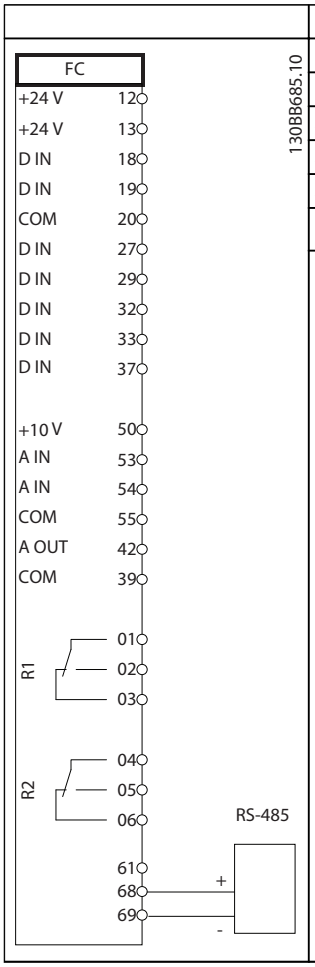


Figure 6.3

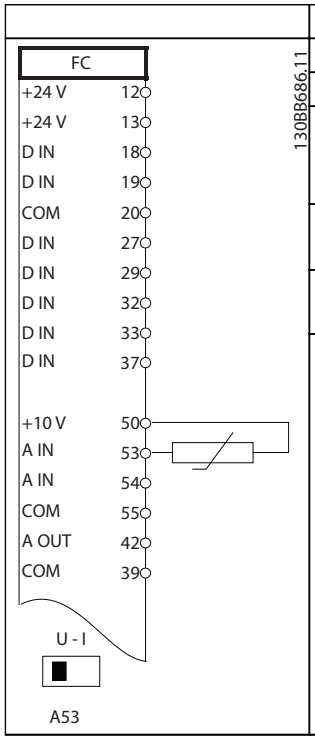


Parameters	
Function	**Setting**
8-30 Protocol	FC*
8-31 Address	1*
8-32 Baud Rate	9600*
* = Default Value	
Notes/comments: Select protocol, address and baud rate in the above mentioned parameters.	

Table 6.11 RS-485 Network Connection

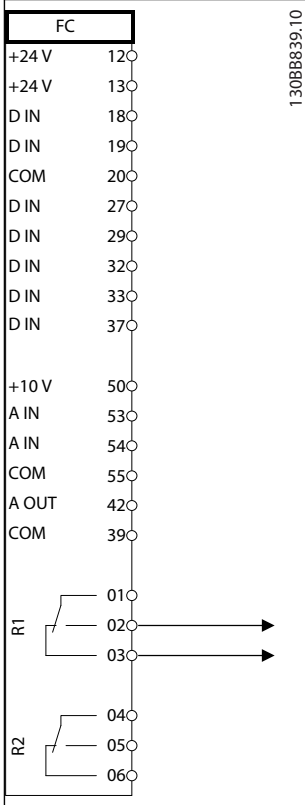
CAUTION

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



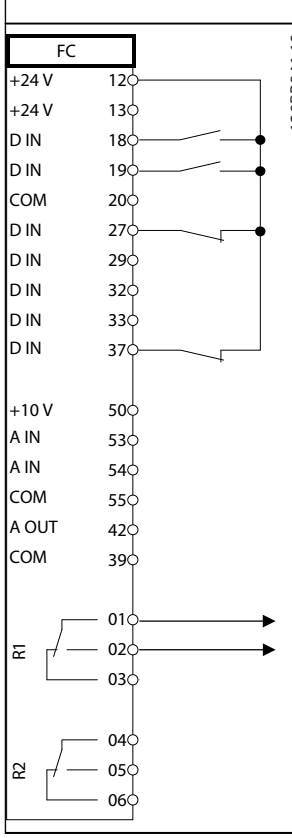
Parameters	
Function	**Setting**
1-90 Motor Thermal Protection	[2] Thermistor trip
1-93 Thermistor Source	[1] Analog input 53
* = Default Value	
Notes/comments: If only a warning is desired, *1-90 Motor Thermal Protection* should be set to [1] *Thermistor warning*.	

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 sec
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 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	Im,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

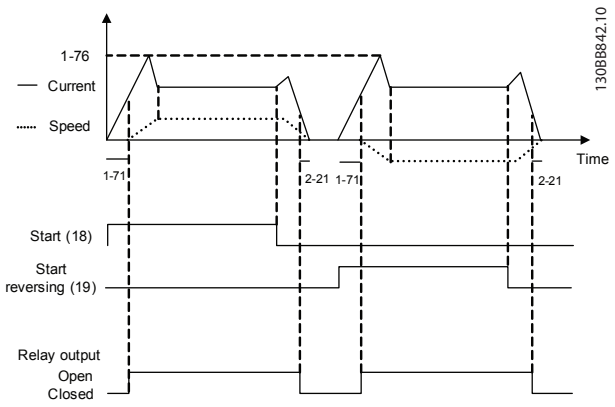


Figure 6.4

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*.)

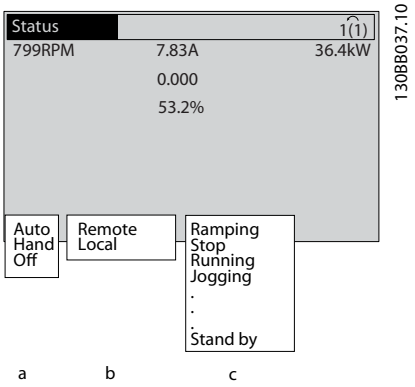


Figure 7.1 Status Display

a. The first word on the status line indicates where the stop/start command originates.

b. The second word on 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

The next three tables define the meaning of the status message display words.

	Operation Mode
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

	Reference Site
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

	Operation Status
AC Brake	AC Brake was selected in *2-10 Brake Function*. The AC brake overmagnetizes the motor to achieve a controlled slow-down.
AMA finish OK	Automatic motor adaptation (AMA) was carried out successfully.
AMA ready	AMA is ready to start. Press [Hand On] to start.
AMA running	AMA process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in *2-12 Brake Power Limit (kW)* is reached.
Coast	• Coast inverse was selected as a function for a digital input (parameter group 5-1*). The corresponding terminal is not connected. • Coast activated by serial communication

7

	Operation Status
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*). 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 (Group 5-1*). 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.

	Operation Status
Freeze ref.	*Freeze Reference* was chosen as a function for a digital input (parameter group 5-1*). 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*). 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. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the Adjustable frequency drive from tripping.
PowerUnit Off	(For adjustable frequency drives with an external 24V power supply installed only.) Line power supply to the Adjustable frequency drive is removed, but the control card is supplied by the external 24V.
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 4kHz. • If possible, protection mode ends after approximately 10sec. • Protection mode can be restricted in *14-26 Trip Delay at Inverter Fault*

	Operation Status
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*). 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.
Sleep Mode	The energy saving function is enabled. This means that at present the motor has stopped, but that it will restart automatically when required.
Speed high	Motor speed is above the value set in *4-53 Warning Speed High*.
Speed low	Motor speed is below the value set in *4-52 Warning Speed Low*.
Standby	In Auto On mode, the Adjustable frequency drive 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*). 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

7

7

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 4 ways:

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

Trip lock
An alarm that causes the Adjustable frequency drive to trip-lock requires that input power be 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

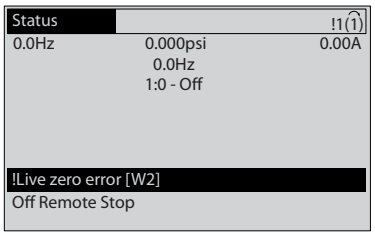


Figure 8.1

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

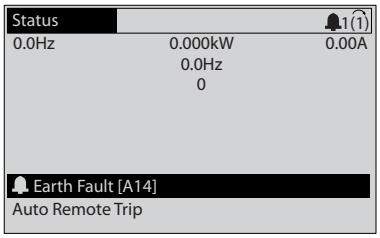


Figure 8.2

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

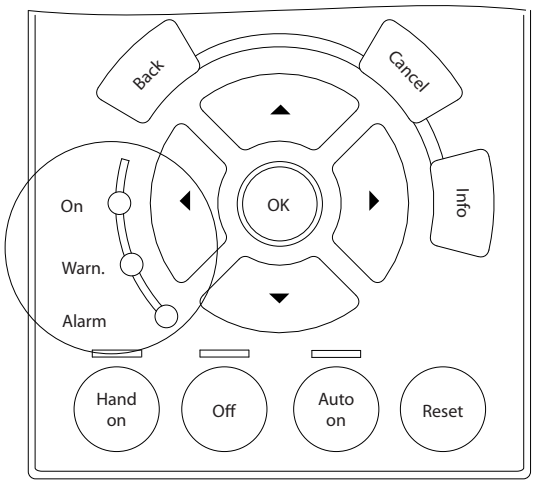


Figure 8.3

	Warn. LED	Alarm LED
Warning	ON	OFF
Alarm	OFF	ON (Flashing)
Trip Lock	ON	ON (Flashing)

Table 8.1

8.4 Warning and Alarm Definitions

Table 8.2 defines whether a warning is issued before an alarm, and whether the alarm trips the unit or trip locks the unit.

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		6-01 Live Zero Timeout Function
4	Mains phase loss	(X)	(X)	(X)	14-12 Function at Mains Imbalance
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC overvoltage	X	X		
8	DC undervoltage	X	X		
9	Inverter overloaded	X	X		
10	Motor ETR over temperature	(X)	(X)		1-90 Motor Thermal Protection
11	Motor thermistor over temperature	(X)	(X)		1-90 Motor Thermal Protection
12	Torque limit	X	X		
13	Overcurrent	X	X	X	
14	Ground fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short-circuit		X	X	
17	Control word timeout	(X)	(X)		8-04 Control Timeout Function
18	Start Failed				
23	Internal Fan Fault	X			
24	External Fan Fault	X			14-53 Fan Monitor
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		2-13 Brake Power Monitoring
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		2-15 Brake Check
29	Drive over temperature	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
31	Motor phase V missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
32	Motor phase W missing	(X)	(X)	(X)	4-58 Missing Motor Phase Function
33	Inrush fault		X	X	
34	Fieldbus communication fault	X	X		
35	Out of frequency range	X	X		
36	Mains failure	X	X		
37	Phase Imbalance	X	X		
38	Internal fault		X	X	

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			5-00 Digital I/O Mode, 5-01 Terminal 27 Mode
41	Overload of Digital Output Terminal 29	(X)			5-00 Digital I/O Mode, 5-02 Terminal 29 Mode
42	Overload of Digital Output On X30/6	(X)			5-32 Term X30/6 Digi Out (MCB 101)
42	Overload of Digital Output On X30/7	(X)			5-33 Term X30/7 Digi Out (MCB 101)
46	Pwr. card supply		X	X	
47	24 V supply low	X	X	X	
48	1.8 V supply low		X	X	
49	Speed limit	X	(X)		1-86 Trip Speed Low [RPM]
50	AMA calibration failed		X		
51	AMA check Unom and Inom		X		
52	AMA low I_{nom}		X		
53	AMA motor too big		X		
54	AMA motor too small		X		
55	AMA Parameter out of range		X		
56	AMA interrupted by user		X		
57	AMA timeout		X		
58	AMA internal fault	X	X		
59	Current limit	X			
60	External Interlock	X			
62	Output Frequency at Maximum Limit	X			
64	Voltage Limit	X			
65	Control Board Over Temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Configuration has Changed		X		
69	Pwr. Card Temp		X	X	
70	Illegal FC configuration			X	
71	PTC 1 Safe Stop	X	X[1)]		
72	Dangerous Failure			X[1)]	
73	Safe Stop Auto Restart				
76	Power Unit Setup	X			
77	Red. Pwr Mode				
79	Illegal PS config		X	X	
80	Drive Initialized to Default Value		X		
91	Analog input 54 wrong settings			X	
92	No-flow	X	X		22-2*
93	Dry Pump	X	X		22-2*
94	End of Curve	X	X		22-5*
95	Broken Belt	X	X		22-6*
96	Start Delayed	X			22-7*
97	Stop Delayed	X			22-7*
98	Clock Fault	X			0-7*
0.270 [201]	Fire M was Active				
202	Fire M Limits Exceeded				
203	Missing Motor				

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
204	Locked Rotor				
243	Brake IGBT	X	X		
244	Heatsink temp	X	X	X	
245	Heatsink sensor		X	X	
246	Pwr.card supply		X	X	
247	Pwr.card temp		X	X	
248	Illegal PS config		X	X	
250	New spare parts			X	
251	New Type Code		X	X	

Table 8.2 Alarm/Warning Code List

(X) Dependent on parameter

1) Cannot be Auto reset via 14-20 Reset Mode

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 will only appear 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. This condition can be caused by broken wiring or faulty device sending the signal.

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

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

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

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

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

Troubleshooting

Connect a brake resistor

Extend the ramp time

Change the ramp type

Activate the functions in *2-10 Brake Function*

Increase *14-26 Trip Delay at Inverter Fault*

WARNING/ALARM 8, DC undervoltage
If the intermediate circuit voltage (DC link) drops below the under voltage 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 gives a warning at 98% and trips at 100%, while giving an alarm. The adjustable frequency drive *cannot* be reset until the counter is below 90%.

The fault is that the adjustable frequency drive is overloaded by more than 100% for too long.

Troubleshooting

Compare the output current shown on the LCP with the adjustable frequency drive rated current.

Compare the output current shown on the LCP with measured motor current.

Display the Thermal Drive Load on the LCP and monitor the value. When running above the adjustable frequency drive continuous current rating, the counter should increase. When running below the adjustable frequency drive continuous current rating, the counter should decrease.

WARNING/ALARM 10, Motor overload temperature

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

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded.

Check that the motor current set in *1-24 Motor Current* is correct.

Ensure that Motor data in parameters 1-20 through 1-25 are set correctly.

If an external fan is in use, check in *1-91 Motor External Fan* that it is selected.

Running AMA in *1-29 Automatic Motor Adaptation (AMA)* tunes the adjustable frequency drive to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor over temp

The thermistor might be disconnected. Select whether the Adjustable frequency drive gives a warning or an alarm in *1-90 Motor Thermal Protection*.

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded.

When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10V 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. Check *1-93 Thermistor Source* selects terminal 18 or 19.

WARNING/ALARM 12, Torque limit

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

Troubleshooting

If the motor torque limit is exceeded during ramp-up, extend the ramp-up time.

If the generator torque limit is exceeded during ramp-down, extend the ramp-down time.

If torque limit occurs while running, possibly increase the torque limit. Be sure the system can operate safely at a higher torque.

Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Overcurrent

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

Troubleshooting

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

Make sure that the motor size matches the adjustable frequency drive.

Check parameters 1-20 through 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.

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 stops 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.

ALARM 18, Start failed
The speed has not been able to exceed *AP-70 Compressor Start Max Speed [RPM]* during start within the allowed time. (set in *AP-72 Compressor Start Max Time to Trip*). This may be caused by a blocked motor.

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).

For the D, E, and F Frame filters, the regulated voltage to the fans is monitored.

Troubleshooting

Check for proper fan operation.

Cycle power to the Adjustable frequency drive and make sure that the fan operates briefly at start-up.

Check the sensors on the heatsink and control card.

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 for proper fan operation.

Cycle power to the Adjustable frequency drive and make sure that the fan operates briefly at start-up.

Check the sensors on the heatsink and control card.

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 seconds 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 *Trip* [2] is selected in *2-13 Brake Power Monitoring*, the Adjustable frequency drive will trip when the dissipated braking energy reaches 100%.

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.

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.

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, communication fault
The serial communication bus on the communication option card is not working.

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

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in the table below 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
512-519	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.
783	Parameter value outside of min/max limits
1024-1284	Internal fault. Contact your Danfoss supplier or the Danfoss Service Department.
1299	Option SW in slot A is too old
1300	Option SW in slot B 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)
1318	Option SW in slot C1 is not supported (not allowed)
1379-2819	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.
2820	LCP stack overflow
2821	Serial port overflow
2822	USB port overflow
3072-5122	Parameter value is outside its limits
5123	Option in slot A: Hardware incompatible with 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	Internal fault. Contact your Danfoss supplier or Danfoss Service Department.

Table 8.3

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*.

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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 45, Earth fault 2
Ground fault on start-up.

Troubleshooting

Check for proper grounding and loose connections.

Check for proper wire size.

Check motor cables for short-circuits or leakage currents.

8

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: 24V, 5V, +/- 18V. When powered with 24V DC with the MCB 107 option, only the 24V and 5V supplies are monitored. When powered with three phase AC line voltage, all three supplies are monitored.

Troubleshooting

Check for a defective power card.

Check for a defective control card.

Check for a defective option card.

If a 24V DC power supply is used, verify proper supply power.

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 your 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 Unom and Inom
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.

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

ALARM 57, AMA internal fault
Try to restart AMA again. Repeated restarts may overheat the motor.

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 through 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
A digital input signal is indicating a fault condition external to the Adjustable frequency drive. An external interlock has commanded the Adjustable frequency drive to trip. Clear the external fault condition. To resume normal operation, apply 24V DC to the terminal programmed for external interlock. Reset the Adjustable frequency drive.

WARNING 62, Output frequency at maximum limit
The output frequency has reached the value set in *4-19 Max Output Frequency*. Check the application to determine the cause. Possibly increase the output frequency limit. Be sure the system can operate safely at a higher output frequency. The warning will clear when the output drops below the maximum limit.

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*

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
Loss of the 24V DC signal on terminal 37 has caused the filter to trip. To resume normal operation, apply 24V DC to terminal 37 and reset the filter.

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

Troubleshooting

Check that the ambient operating temperature is within limits.

Check for clogged filters.

Check fan operation.

Check the power card.

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

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

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

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

ALARM 96, Start delayed
Motor start has been delayed due to short-cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the Adjustable frequency drive after the fault has been cleared.

WARNING 97, Stop delayed
Stopping the motor has been delayed due to short cycle protection. *22-76 Interval between Starts* is enabled. Troubleshoot the system and reset the Adjustable frequency drive after the fault has been cleared.

WARNING 98, Clock fault
Time is not set or the RTC clock has failed. Reset the clock in *0-70 Date and Time*.

WARNING 200, Fire mode
This indicates the Adjustable frequency drive is operating in fire mode. The warning clears when fire mode is removed. See the fire mode data in the alarm log.

WARNING 201, Fire Mode was Active
This indicates the Adjustable frequency drive had entered fire mode. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 202, Fire mode limits exceeded
While operating in fire mode one or more alarm conditions have been ignored which would normally trip the unit. Operating in this condition voids unit warranty. Cycle power to the unit to remove the warning. See the fire mode data in the alarm log.

WARNING 203, Missing motor
With a Adjustable frequency drive operating multi-motors, an underload condition was detected. This could indicate a missing motor. Inspect the system for proper operation.

WARNING 204, Locked rotor
With a Adjustable frequency drive operating multi-motors, an overload condition was detected. This could indicate a locked rotor. Inspect the motor for proper operation.

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.

9 Basic Troubleshooting

9.1 Start-up and Operation

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 operation mode) to run the motor.
	Missing start signal (Standby)	Check *5-10 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting)	Check *5-12 Coast inv.* for correct setting for terminal 27 (use default setting).	Apply 24 V on terminal 27 or program this terminal to *No operation.*
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check *3-13 Reference Site*. Set preset reference active in parameter group *3-1* References*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit	Check that *4-10 Motor Speed Direction* is programmed correctly.	Program correct settings.
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group *5-1* Digital inputs.*	Deactivate reversing signal.
	Wrong motor phase connection		See 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 *6-* Analog I/O mode* and parameter group *3-1* References.* Reference limits in parameter group 3-0*.	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 adjustable frequency drive one position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check line power supply.
	Problem with the adjustable frequency drive	Rotate input power leads into the adjustable frequency drive one position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with the adjustable frequency drives	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier.
Acoustic noise or vibration (e.g., a fan blade is making noise or vibrations at certain frequencies)	Resonances, e.g., in the motor/fan system	Bypass critical frequencies by using parameters in parameter group 4-6*.	Check if noise and/or vibration have been reduced to an acceptable limit.
		Turn off overmodulation in *14-03 Overmodulation*.	
		Change switching pattern and frequency in parameter group 14-0*.	
		Increase Resonance Dampening in *1-64 Resonance Dampening*.	

Table 9.1

9

9

10 Specifications

10.1 Power-dependent Specifications

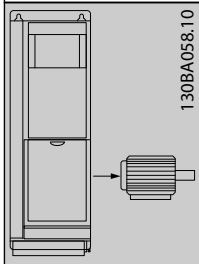
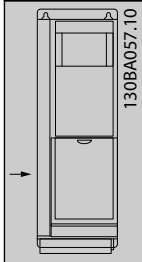
Line power supply 200–240V AC - Normal overload 110% for 1 minute						
Adjustable frequency drive		P1K1	P1K5	P2K2	P3K0	P3K7
Typical Shaft Output [kW]		1.1	1.5	2.2	3	3.7
IP20/Chassis (A2+A3 may be converted to IP21 using a conversion kit. (Please also see *Mechanical mounting* and *IP21/Type 1 Enclosure kit* in the Design Guide.))		A2	A2	A2	A3	A3
IP55/Type 12		A4/A5	A4/A5	A4/A5	A5	A5
IP66/NEMA 4X		A4/A5	A4/A5	A4/A5	A5	A5
Typical Shaft Output [HP] at 208 V		1.5	2.0	2.9	4.0	4.9
Output current						
 130BA058.10	Continuous (3 x 200–240V) [A]	6.6	7.5	10.6	12.5	16.7
	Intermittent (3 x 200–240V) [A]	7.3	8.3	11.7	13.8	18.4
	Continuous kVA (208 V AC) [kVA]	2.38	2.70	3.82	4.50	6.00
Max. input current						
 130BA057.10	Continuous (3 x 200–240V) [A]	5.9	6.8	9.5	11.3	15.0
	Intermittent (3 x 200–240V) [A]	6.5	7.5	10.5	12.4	16.5
Additional specifications						
	Estimated power loss at rated max. load [W] [4]	63	82	116	155	185
	Max. cable size (line power, motor, brake) [mm² /AWG] [2]			4/10		
	Weight enclosure IP20 [lb][kg]	10.8/4.9	10.8/4.9	10.8/4.9	14.6/6.6	14.6/6.6
	Weight enclosure IP21 [lb][kg]	12.2/5.5	12.2/5.5	12.2/5.5	16.5/7.5	16.5/7.5
	Weight enclosure IP55 [lb][kg] (A4/A5)	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	29.8/13.5	29.8/13.5
	Weight enclosure IPø66 [lb][kg] (A4/A5)	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	29.8/13.5	29.8/13.5
	Efficiency [3]	0.96	0.96	0.96	0.96	0.96

Table 10.1 Line Power Supply 200–240V AC

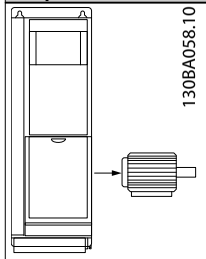
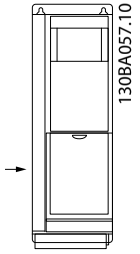
Line Power Supply 3x200–240V AC - Normal overload 110% for 1 minute										
IP20/Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit. (Please see also items *Mechanical mounting* and *IP21/Type 1 Enclosure kit* in the Design Guide.))		B3	B3	B3	B4	B4	C3	C3	C4	C4
IP21/NEMA 1		B1	B1	B1	B2	C1	C1	C1	C2	C2
IP55/Type 12		B1	B1	B1	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X		B1	B1	B1	B2	C1	C1	C1	C2	C2
Adjustable frequency drive		P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K
Typical Shaft Output [kW]		5.5	7.5	11	15	18.5	22	30	37	45
Typical Shaft Output [HP] at 208 V		7.5	10	15	20	25	30	40	50	60
Output current										
 130BA058.10	Continuous (3 x 200–240V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	115	143	170
	Intermittent (3 x 200–240V) [A]	26.6	33.9	50.8	65.3	82.3	96.8	127	157	187
	Continuous kVA (208 V AC) [kVA]	8.7	11.1	16.6	21.4	26.9	31.7	41.4	51.5	61.2
Max. input current										
 130BA057.10	Continuous (3 x 200–240V) [A]	22.0	28.0	42.0	54.0	68.0	80.0	104.0	130.0	154.0
	Intermittent (3 x 200–240V) [A]	24.2	30.8	46.2	59.4	74.8	88.0	114.0	143.0	169.0
Additional Specifications										
	Estimated power loss at rated max. load [W] [4]	269	310	447	602	737	845	1140	1353	1636
	Max. cable size (line power, motor, brake) [mm² /AWG] [2]		10/7		35/2		50/1/0 (B4=35/2)		95/4/0	120/250 MCM
	With line power disconnect switch included:		16/6		35/2		35/2		70/3/0	185/ kcmil350
	Weight enclosure IP20 [lb][kg]	26.5/12	26.5/12	26.5/12	51.8/23.5	51.8/23.5	77.2/35	77.2/35	110.2/50	110.2/50
	Weight enclosure IP21 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Weight enclosure IP55 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Weight enclosure IP66 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Efficiency [3]	0.96	0.96	0.96	0.96	0.96	0.97	0.97	0.97	0.97

Table 10.2 Line Power Supply 3x200–240V AC

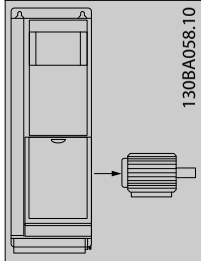
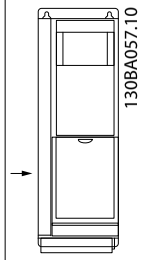
Line Power Supply 3 x 380–480V AC - Normal overload 110% for 1 minute								
Adjustable frequency drive		P1K1	P1K5	P2K2	P3K0	P4K0	P5K5	P7K5
Typical Shaft Output [kW]		1.1	1.5	2.2	3	4	5.5	7.5
Typical Shaft Output [HP] at 460V		1.5	2.0	2.9	4.0	5.0	7.5	10
IP 20 / Chassis (A2+A3 may be converted to IP21 using a conversion kit. (Please see also items *Mechanical mounting* and *IP 21/Type 1 Enclosure kit* in the Design Guide.))		A2	A2	A2	A2	A2	A3	A3
IP 55 / Type 12		A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
IP 66 / NEMA 4X		A4/A5	A4/A5	A4/A5	A4/A5	A4/A5	A5	A5
Output current								
 130BA058.10	Continuous (3 x 380–440V) [A]	3	4.1	5.6	7.2	10	13	16
	Intermittent (3 x 380–440V) [A]	3.3	4.5	6.2	7.9	11	14.3	17.6
	Continuous (3 x 441–480V) [A]	2.7	3.4	4.8	6.3	8.2	11	14.5
	Intermittent (3 x 441–480V) [A]	3.0	3.7	5.3	6.9	9.0	12.1	15.4
	Continuous kVA (400V AC) [kVA]	2.1	2.8	3.9	5.0	6.9	9.0	11.0
	Continuous kVA (460V AC) [kVA]	2.4	2.7	3.8	5.0	6.5	8.8	11.6
Max. input current								
 130BA057.10	Continuous (3 x 380–440V) [A]	2.7	3.7	5.0	6.5	9.0	11.7	14.4
	Intermittent (3 x 380–440V) [A]	3.0	4.1	5.5	7.2	9.9	12.9	15.8
	Continuous (3 x 441–480V) [A]	2.7	3.1	4.3	5.7	7.4	9.9	13.0
	Intermittent (3 x 441–480V) [A]	3.0	3.4	4.7	6.3	8.1	10.9	14.3
Additional specifications								
	Estimated power loss at rated max. load [W] [4]	58	62	88	116	124	187	255
	(line power, motor, brake) [[mm²/AWG] [2]				4/10			
	Weight enclosure IP20 [lb][kg]	10.6/4.8	10.8/4.9	10.8/4.9	10.8/4.9	10.8/4.9	14.6/6.6	14.6/6.6
	Weight enclosure IPø21 [lb][kg]							
	Weight enclosure IPø55 [lb][kg] (A4/A5)	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	31.3/14.2	31.3/14.2
	Weight enclosure IPø66 [lb][kg] (A4/A5)	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	21.4/9.7/13.5	31.3/14.2	31.3/14.2
	Efficiency [3]	0.96	0.97	0.97	0.97	0.97	0.97	0.97

Table 10.3 Line Power Supply 3 x 380–480V AC

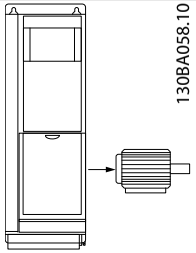
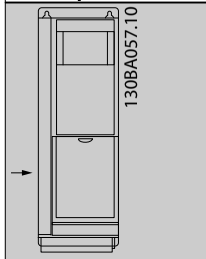
Line Power Supply 3 x 380–480V AC - Normal overload 110% for 1 minute											
Adjustable frequency drive		P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]		11	15	18.5	22	30	37	45	55	75	90
Typical Shaft Output [HP] at 460V		15	20	25	30	40	50	60	75	100	125
IP20/Chassis (B3+4 and C3+4 may be converted to IP21 using a conversion kit (Please contact Danfoss)		B3	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/NEMA 1		B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP55/Type 12		B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X		B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
Output current											
 130BA058.10	Continuous (3 x 380–439 V) [A]	24	32	37.5	44	61	73	90	106	147	177
	Intermittent (3 x 380–439 V) [A]	26.4	35.2	41.3	48.4	67.1	80.3	99	117	162	195
	Continuous (3 x 440–480V) [A]	21	27	34	40	52	65	80	105	130	160
	Intermittent (3 x 440–480V) [A]	23.1	29.7	37.4	44	61.6	71.5	88	116	143	176
	Continuous kVA (400V AC) [kVA]	16.6	22.2	26	30.5	42.3	50.6	62.4	73.4	102	123
	Continuous kVA 460V AC) [kVA]	16.7	21.5	27.1	31.9	41.4	51.8	63.7	83.7	104	128
Max. input current											
 130BA057.10	Continuous (3 x 380–439 V) [A]	22	29	34	40	55	66	82	96	133	161
	Intermittent (3 x 380–439 V) [A]	24.2	31.9	37.4	44	60.5	72.6	90.2	106	146	177
	Continuous (3 x 440–480V) [A]	19	25	31	36	47	59	73	95	118	145
	Intermittent (3 x 440–480V) [A]	20.9	27.5	34.1	39.6	51.7	64.9	80.3	105	130	160
Additional specifications											
	Estimated power lossat rated max. load [W] [4]	278	392	465	525	698	739	843	1083	1384	1474
	Max. cable size (line power, motor, brake) [mm²/ AWG] [2]		10/7			35/2		50/1/0 (B4=35/2)		95/ 4/0	120/ MCM250
	With line power disconnect switch included:			16/6			35/2		35/2	70/3/0	185/ kcmil350
	Weight enclosure IP20 [lb][kg]	26.5/12	26.5/12	26.5/12	51.8/23.5	51.8/23.5	51.8/23.5	77.2/35	77.2/35	110.2/50	110.2/50
	Weight enclosure IP21 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Weight enclosure IP55 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Weight enclosure IP66 [lb][kg]	50.7/23	50.7/23	50.7/23	59.5/27	59.5/27	99.2/45	99.2/45	99.2/45	143.3/65	143.3/65
	Efficiency [3]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.99

Table 10.4 Line Power Supply 3 x 380–480V AC

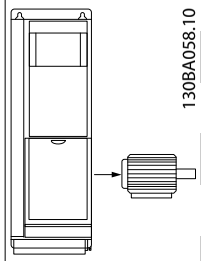
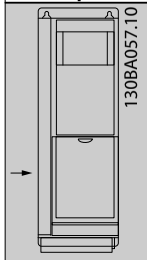
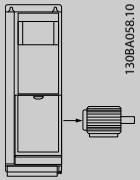
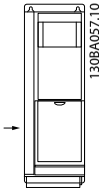
Line power supply 3 x 525–600V ACNormal overload 110% for 1 minute																			
Size:		P1K1	P1K5	P2K2	P3K0	P3K7	P4K0	P5K5	P7K5	P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]		1.1	1.5	2.2	3	3.7	4	5.5	7.5	11	15	18.5	22	30	37	45	55	75	90
IP20/Chassis		A3	A3	A3	A3	A2	A3	A3	A3	B3	B3	B3	B4	B4	B4	C3	C3	C4	C4
IP21/NEMA 1		A3	A3	A3	A3	A2	A3	A3	A3	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP55/Type 12		A5	A5	A5	A5	A5	A5	A5	A5	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
IP66/NEMA 4X		A5	A5	A5	A5	A5	A5	A5	A5	B1	B1	B1	B2	B2	C1	C1	C1	C2	C2
Output current																			
 130BA058.10	Continuous (3 x 525–550V) [A]	2.6	2.9	4.1	5.2	-	6.4	9.5	11.5	19	23	28	36	43	54	65	87	105	137
	Intermittent (3 x 525–550V) [A]	2.9	3.2	4.5	5.7	-	7.0	10.5	12.7	21	25	31	40	47	59	72	96	116	151
	Continuous (3 x 525–600V) [A]	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0	18	22	27	34	41	52	62	83	100	131
	Intermittent (3 x 525–600V) [A]	2.6	3.0	4.3	5.4	-	6.7	9.9	12.1	20	24	30	37	45	57	68	91	110	144
	Continuous kVA (525V AC) [kVA]	2.5	2.8	3.9	5.0	-	6.1	9.0	11.0	18.1	21.9	26.7	34.3	41	51.4	61.9	82.9	100	130.5
	Continuous kVA (575V AC) [kVA]	2.4	2.7	3.9	4.9	-	6.1	9.0	11.0	17.9	21.9	26.9	33.9	40.8	51.8	61.7	82.7	99.6	130.5
Max. input current																			
 130BA057.10	Continuous (3 x 525–600V) [A]	2.4	2.7	4.1	5.2	-	5.8	8.6	10.4	17.2	20.9	25.4	32.7	39	49	59	78.9	95.3	124.3
	Intermittent (3 x 525–600V) [A]	2.7	3.0	4.5	5.7	-	6.4	9.5	11.5	19	23	28	36	43	54	65	87	105	137
Additional specifications																			
	Estim. power loss at rated max. load [W] [4]	50	65	92	122	-	145	195	261	300	400	475	525	700	750	850	1100	1400	1500
	Max. cable size, IP21/55/66 (line power, motor, brake) [mm²]/[AWG] [2]	4/10								10/7				25/4		50/1/0		95/4/0	120/ MCM250
	Max. cable size, IP 20 (line power, motor, brake) [mm²]/[AWG] [2]	4/10								16/6				35/2		50/1/0		95/4/0	150/ MCM250 [5]
	Line power disconnect switch included:	4/10								16/6						35/2		70/3/0	185/ kcmil350
	Weight IP20 [lb][kg]	14.3/ 6.5	14.3/ 6.5	14.3/ 6.5	14.3/ 6.5	-	14.3/6. 5	14.6/6 .6	14.6/ 6.6	26.5/1 2	26.5/12	26.5/1 2	51.8/23 .5	51.8/23. 5	51.8/ 23.5	77.2/35	77.2/3 5	110.2/50	110.2/50
	Weight IP21/55 [lb] [kg]	29.8/ 13.5	29.8/ 13.5	29.8/ 13.5	29.8/ 13.5	29.8/1 3.5	29.8/13 .5	31.3/1 4.2	31.3/ 14.2	50.7/2 3	50.7/23	50.7/2 3	59.5/27	59.5/27	59.5/ 27	99.2/45	99.2/4 5	143.3/65	143.3/65
	Efficiency [4]	0.97	0.97	0.97	0.97	-	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

Table 10.5 [5] With brake and load sharing 95/ 4/0

Normal overload 110% for 1 minute											
Size:		P11K	P15K	P18K	P22K	P30K	P37K	P45K	P55K	P75K	P90K
Typical Shaft Output [kW]		11	15	18.5	22	30	37	45	55	75	90
Typical Shaft Output [HP] at 575V		10	16.4	20.1	24	33	40	50	60	75	100
IP21 / NEMA 1		B2	B2	B2	B2	B2	C2	C2	C2	C2	C2
IP55 / NEMA 12		B2	B2	B2	B2	B2	C2	C2	C2	C2	C2
Output current											
 130BA058.10	Continuous (3 x 525–550 V) [A]	14	19	23	28	36	43	54	65	87	105
	Intermittent (3 x 525–550 V) [A]	15.4	20.9	25.3	30.8	39.6	47.3	59.4	71.5	95.7	115.5
	Continuous (3 x 551–690 V) [A]	13	18	22	27	34	41	52	62	83	100
	Intermittent (3 x 551–690V) [A]	14.3	19.8	24.2	29.7	37.4	45.1	57.2	68.2	91.3	110
	Continuous kVA (550V AC) [kVA]	13.3	18.1	21.9	26.7	34.3	41	51.4	61.9	82.9	100
	Continuous kVA (575V AC) [kVA]	12.9	17.9	21.9	26.9	33.8	40.8	51.8	61.7	82.7	99.6
	Continuous kVA (690V AC) [kVA]	15.5	21.5	26.3	32.3	40.6	49	62.1	74.1	99.2	119.5
	Max. cable size (line power, motor, brake) [mm²]/[AWG] [2]			35 1/0					95 4/0		
Max. input current											
 130BA057.10	Continuous (3 x 525–690 V) [A]	15	19.5	24	29	36	49	59	71	87	99
	Intermittent (3 x 525–690V) [A]	16.5	21.5	26.4	31.9	39.6	53.9	64.9	78.1	95.7	108.9
	Max. pre-fuses[1] [A]	63	63	63	63	80	100	125	160	160	160
	Environment:										
	Estimated power loss at rated max. load [W, hp] [4]	201, 0.27	285, 0.38	335, 0.45	375, 0.50	430, 0.58	592, 0.79	720, 0.97	880, 1.18	1200, 1.61	1440, 1.93
	Weight:										
	IP21 (lb [kg])	59.5 [27]	59.5 [27]	59.5 [27]	59.5 [27]	59.5 [27]	143.3 [65]	143.3 [65]	143.3 [65]	143.3 [65]	143.3 [65]
	IP55 (lb [kg])	59.5 [27]	59.5 [27]	59.5 [27]	59.5 [27]	59.5 [27]	143.3 [65]	143.3 [65]	143.3 [65]	143.3 [65]	143.3 [65]
	Efficiency [4]	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98

[1] For type of fuse see
[2] American Wire Gauge
[3] Measured using 16 ft [5 m] shielded motor cables at rated load and rated frequency
[4] The typical power loss is at normal 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). Lower efficiency motors will also add to the power loss in the Adjustable frequency drive and vice versa.
If the switching frequency is raised from nominal, the power losses may rise significantly.
LCP and typical control card power consumptions are included. Further options and customer load may add up to 0.04 hp [30 Watts] to the losses. (Though typically only 0.005 hp [4 Watts] 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] Motor and line cable: 300MCM/150mm²

Table 10.6 Line Power Supply 3 x 525–690V AC

10.2 General Technical Data

Line power supply (L1, L2, L3):	
Supply voltage	200–240V ±10%, 380–480V ±10%, 525–690V ±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 lowest rated supply voltage. Power-up and full torque cannot be expected at AC line voltage lower than 10% below the adjustable frequency lowest rated supply voltage.

Supply frequency	50/60Hz ±5%
Max. imbalance temporary between line phases	3.0% of rated supply voltage
True Power Factor ()	≥ 0.9 nominal at rated load
Displacement Power Factor (cos) near unity	(> 0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤ enclosure type A	maximum twice/min.
Switching on input supply L1, L2, L3 (power-ups) ≥ enclosure type B, C	maximum once/min.
Switching on input supply L1, L2, L3 (power-ups) ≥ enclosure type D, E, F	maximum once/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, 480/600V maximum.

Motor output (U, V, W):	
Output voltage	0–100% of supply voltage
Output frequency	0–1000 Hz*
Switching on output	Unlimited
Ramp times	1–3600 sec.

** Dependent on power size.*

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

**Percentage relates to the adjustable frequency drive's nominal torque.*

Cable lengths and cross-sections:	
Max. motor cable length, shielded/armored	VLT® HVAC Drive: 492 ft [150 m]
Max. motor cable length, unshielded/unarmored	VLT® HVAC Drive: 984 ft [300 m]
Max. cross-section to motor, line power, load sharing and brake *	
Maximum cross-section to control terminals, rigid wire	0.0023 in^2 [1.5 mm^2]/16 AWG (2 x 0.00112^2 in [0.75 mm^2])
Maximum cross-section to control terminals, flexible cable	0.0016 in^2 [1 mm^2]/18 AWG
Maximum cross-section to control terminals, cable with enclosed core	0.0008 in^2 [0.5 mm^2]/20 AWG
Minimum cross-section to control terminals	0.039 in2 [0.25 mm2]

** See 10.1 Power-dependent Specifications for more information!*

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

Input resistance, R_i	approx. 4kΩ

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.

Analog inputs:	
Number of analog inputs	2
Terminal number	53, 54
Modes	Voltage or current
Mode select	Switches A53 and A54
Voltage mode	Switch A53/A54 = (U)
Voltage level	0 to + 10V (scaleable)
Input resistance, R_i	approx. 10 kΩ
Max. voltage	± 20 V
Current mode	Switch A53/A54 = (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	200Hz

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

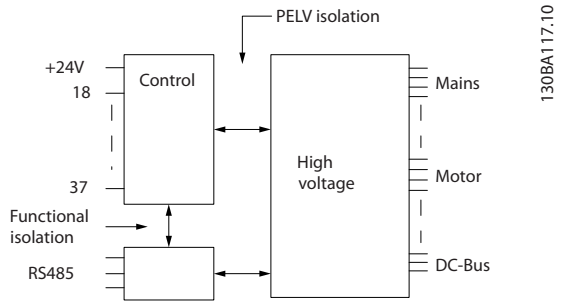


Figure 10.1

Pulse inputs:	
Programmable pulse inputs	2
Terminal number pulse	29, 33
Max. frequency at terminal, 29, 33	110 kHz (push-pull driven)
Max. frequency at terminal, 29, 33	5 kHz (open collector)
Min. frequency at terminal 29, 33	4 Hz
Voltage level	see 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
Analog output:	
Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4 - 20 mA
Max. resistor load to common at analog output	500 Ω
Accuracy on analog output	Max. error: 0.8% of full scale
Resolution on analog output	8 bit

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

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

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

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.

Control card, 24 V DC output:	
Terminal number	12, 13
Max. load	200mA

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

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

1) IEC 60947 t 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 300V AC 2A

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

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

Control characteristics:	
Resolution of output frequency at 0–1000 Hz	+/- 0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms
Speed control range (open-loop)	1:100 of synchronous speed
Speed accuracy (open-loop)	30–4000 rpm: Maximum error of ±8 rpm

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

Surroundings:	
Enclosure type A	IP 20/Chassis, IP 21kit/Type 1, IP55/Type12, IP 66/Type12
Enclosure type B1/B2	IP 21/Type 1, IP55/Type12, IP 66/12
Enclosure type B3/B4	IP20/Chassis
Enclosure type C1/C2	IP 21/Type 1, IP55/Type 12, IP66/12
Enclosure type C3/C4	IP20/Chassis
Enclosure type D1/D2/E1	IP21/Type 1, IP54/Type12
Enclosure type D3/D4/E2	IP00/Chassis
Enclosure type F1/F3	IP21, 54/Type1, 12
Enclosure type F2/F4	IP21, 54/Type1, 12
Enclosure kit available ≤ enclosure type D	IP21/NEMA 1/IP 4X on top of enclosure
Vibration test all enclosure types	1.0g
Relative humidity	5–95% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class Kd
Test method according to IEC 60068-2-43 H2S (10 days)	
Ambient temperature (at 60 AVM switching mode)	
- with derating	max. 131°F [55°C][1)]
- with full output power of typical EFF2 motors (up to 90% output current)	max. 122°F [50°C][1)]
- at full continuous FC output current	max. 113°F [45°C][1)]

1) For more information on derating see the Design Guide, section on Special Conditions.

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°–+149°/158°F [-25°–+65°/70°°C]
Maximum altitude above sea level without derating	3281 ft [1000 m]
Maximum altitude above sea level with derating	9843 ft [3000 m]

Derating for high altitude, see section on special conditions

EMC standards, Emission	EN 61800-3, EN 61000-6-3/4, EN 55011, IEC 61800-3
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!

Control card performance:	
Scan interval	5 ms

Control Card, USB Serial Communication:	
USB standard	1.1 (Full speed)
USB plug	USB type B “device” plug

⚠CAUTION

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

Protection and Features:

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the Adjustable frequency drive trips if the temperature reaches 203°F ± 9°F [95°C ± 5°C]. An overload temperature cannot be reset until the temperature of the heatsink is below 158°F ± 9°F [70°C ± 5°C] (Guideline - these temperatures may vary for different power sizes, enclosures, etc.). The Adjustable frequency drive has an auto derating function to avoid it's heatsink reaching 203°F [95°C].
- The Adjustable frequency drive is protected against short-circuits on motor terminals U, V, W.
- If a line phase is missing, the Adjustable frequency drive trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the Adjustable frequency drive trips if the intermediate circuit voltage is too low or too high.
- The Adjustable frequency drive is protected against ground faults on motor terminals U, V, W.

10.3 Fuse Tables

10.3.1 Branch Circuit Protection Fuses

For compliance with IEC/EN 61800-5-1 electrical standards, the following fuses are recommended.

Adjustable frequency drive	Maximum fuse size	Voltage	Type
200–240 V - T2			
1K1-1K5	16A[1]	200–240	type gG
2K2	25A[1]	200–240	type gG
3K0	25A[1]	200–240	type gG
3K7	35A[1]	200–240	type gG
5K5	50A[1]	200–240	type gG
7K5	63A[1]	200–240	type gG
11K	63A[1]	200–240	type gG
15K	80A[1]	200–240	type gG
18K5	125A[1]	200–240	type gG
22K	125A[1]	200–240	type gG
30K	160A[1]	200–240	type gG
37K	200A[1]	200–240	type aR
45K	250A[1]	200–240	type aR
380–480 V - T4			
1K1-1K5	10A[1]	380–500	type gG
2K2-3K0	16A[1]	380–500	type gG
4K0-5K5	25A[1]	380–500	type gG
7K5	35A[1]	380–500	type gG
11K–15K	63A[1]	380–500	type gG
18K	63A[1]	380–500	type gG
22K	63A[1]	380–500	type gG
30K	80A[1]	380–500	type gG
37K	100A[1]	380–500	type gG
45K	125A[1]	380–500	type gG
55K	160A[1]	380–500	type gG
75K	250A[1]	380–500	type aR
90K	250A[1]	380–500	type aR
1) Max. fuses - see national/international regulations for selecting an applicable fuse size.			

Table 10.7 EN50178 fuses 200 V to 480 V

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10.3.2 UL and cUL Branch Circuit Protection Fuses

For compliance with UL and cUL electrical standards, the following fuses or UL/cUL approved substitutions are required. Maximum fuse ratings are listed.

Adjustable frequency drive	Bussmann	Bussmann	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
200-240 V							
kW	Type RK1	Type J	Type T	Type RK1	Type RK1	Type CC	Type RK1
K25-K37	KTN-R05	JKS-05	JJN-05	5017906-005	KLN-R005	ATM-R05	A2K-05R
K55-1K1	KTN-R10	JKS-10	JJN-10	5017906-010	KLN-R10	ATM-R10	A2K-10R
1K5	KTN-R15	JKS-15	JJN-15	5017906-015	KLN-R15	ATM-R15	A2K-15R
2K2	KTN-R20	JKS-20	JJN-20	5012406-020	KLN-R20	ATM-R20	A2K-20R
3K0	KTN-R25	JKS-25	JJN-25	5012406-025	KLN-R25	ATM-R25	A2K-25R
3K7	KTN-R30	JKS-30	JJN-30	5012406-030	KLN-R30	ATM-R30	A2K-30R
5K5	KTN-R50	JKS-50	JJN-50	5012406-050	KLN-R50	-	A2K-50R
7K5	KTN-R50	JKS-60	JJN-60	5012406-050	KLN-R60	-	A2K-50R
11K	KTN-R60	JKS-60	JJN-60	5014006-063	KLN-R60	A2K-60R	A2K-60R
15K	KTN-R80	JKS-80	JJN-80	5014006-080	KLN-R80	A2K-80R	A2K-80R
18K5	KTN-R125	JKS-150	JJN-125	2028220-125	KLN-R125	A2K-125R	A2K-125R
22K	KTN-R125	JKS-150	JJN-125	2028220-125	KLN-R125	A2K-125R	A2K-125R
30K	FWX-150	-	-	2028220-150	L25S-150	A25X-150	A25X-150
37K	FWX-200	-	-	2028220-200	L25S-200	A25X-200	A25X-200
45K	FWX-250	-	-	2028220-250	L25S-250	A25X-250	A25X-250
380–480 V, 525–600 V							
kW	Type RK1	Type J	Type T	Type RK1	Type RK1	Type CC	Type RK1
K37-1K1	KTS-R6	JKS-6	JJS-6	5017906-006	KLS-R6	ATM-R6	A6K-6R
1K5-2K2	KTS-R10	JKS-10	JJS-10	5017906-010	KLS-R10	ATM-R10	A6K-10R
3K0	KTS-R15	JKS-15	JJS-15	5017906-016	KLS-R16	ATM-R16	A6K-16R
4K0	KTS-R20	JKS-20	JJS-20	5017906-020	KLS-R20	ATM-R20	A6K-20R
5K5	KTS-R25	JKS-25	JJS-25	5017906-025	KLS-R25	ATM-R25	A6K-25R
7K5	KTS-R30	JKS-30	JJS-30	5012406-032	KLS-R30	ATM-R30	A6K-30R
11K	KTS-R40	JKS-40	JJS-40	5014006-040	KLS-R40	-	A6K-40R
15K	KTS-R40	JKS-40	JJS-40	5014006-040	KLS-R40	-	A6K-40R
18K	KTS-R50	JKS-50	JJS-50	5014006-050	KLS-R50	-	A6K-50R
22K	KTS-R60	JKS-60	JJS-60	5014006-063	KLS-R60	-	A6K-60R
30K	KTS-R80	JKS-80	JJS-80	2028220-100	KLS-R80	-	A6K-80R
37K	KTS-R100	JKS-100	JJS-100	2028220-125	KLS-R100		A6K-100R
45K	KTS-R125	JKS-150	JJS-150	2028220-125	KLS-R125		A6K-125R
55K	KTS-R150	JKS-150	JJS-150	2028220-160	KLS-R150		A6K-150R
75K	FWH-220	-	-	2028220-200	L50S-225		A50-P225
90K	FWH-250	-	-	2028220-250	L50S-250		A50-P250

Table 10.8 UL fuses, 200–240 V and 380–600 V

10.3.3 Substitute Fuses for 240 V

Original fuse	Manufacturer	Substitute fuses
KTN	Bussmann	KTS
FWX	Bussmann	FWH
KLNR	LITTEL FUSE	KLSR
L50S	LITTEL FUSE	L50S
A2KR	FERRAZ SHAWMUT	A6KR
A25X	FERRAZ SHAWMUT	A50X

Table 10.9

10.4 Connection Tightening Torques

	Power (kW)				Torque (Nm)					
Enclosure	200–240V	380–480V	525–600V	525–690V	Line power	Motor	DC connection	Brake	Ground	Relay
A2	1.1 - 3.0	1.1 - 4.0	1.1 - 4.0		1.8	1.8	1.8	1.8	3	0.6
A3	3.7	5.5–7.5	5.5–7.5		1.8	1.8	1.8	1.8	3	0.6
A4	1.1–2.2	1.1–4.0			1.8	1.8	1.8	1.8	3	0.6
A5	1.1–3.7	1.1–7.5	1.1–7.5		1.8	1.8	1.8	1.8	3	0.6
B1	5.5–11	11–18.5	11–18.5	-	1.8	1.8	1.5	1.5	3	0.6
B2	- 15	22 30	22 30	11 30	4.5 4.5[2)]	4.5 4.5[2)]	3.7 3.7	3.7 3.7	3 3	0.6 0.6
B3	5.5–11	11–18.5	11–18.5	-	1.8	1.8	1.8	1.8	3	0.6
B4	15–18.5	22–37	22–37	-	4.5	4.5	4.5	4.5	3	0.6
C1	18.5–30	37–55	37–55	-	10	10	10	10	3	0.6
C2	37–45	75–90	75–90	30 90	14/24[1)]	14/24[1)]	14	14	3	0.6
C3	22–30	45–55	45–55	-	10	10	10	10	3	0.6
C4	37–45	75–90	75–90	-	14/24 [1)]	14/24 [1)]	14	14	3	0.6

Table 10.10 Tightening of Terminals

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

2) Cable dimensions above 25 hp [18.5 kW] ≥ 0.0543 in² [35 mm²] and below 30 hp [22 kW] ≤ ≤ 0.0155 in² [10 mm²].

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