GE

AF-650 GP™
General Purpose Drive
(230V to 50HP, 460/575V to 100HP)
Instruction Manual

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Safety

Safety

WARNING

HIGH VOLTAGE!

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

High Voltage

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

WARNING

UNINTENDED START!

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

Unintended Start

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

WARNING

DISCHARGE TIME!

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

Voltage (V)	Minimum waiting time (minutes)	
	4	15
200–240	1/3–5 hp	7.5–50 hp
380–480	1/2–10 hp	15–100 hp
525–600	1/2–10 hp	15–100 hp
525–690		15–100 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

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1 Introduction

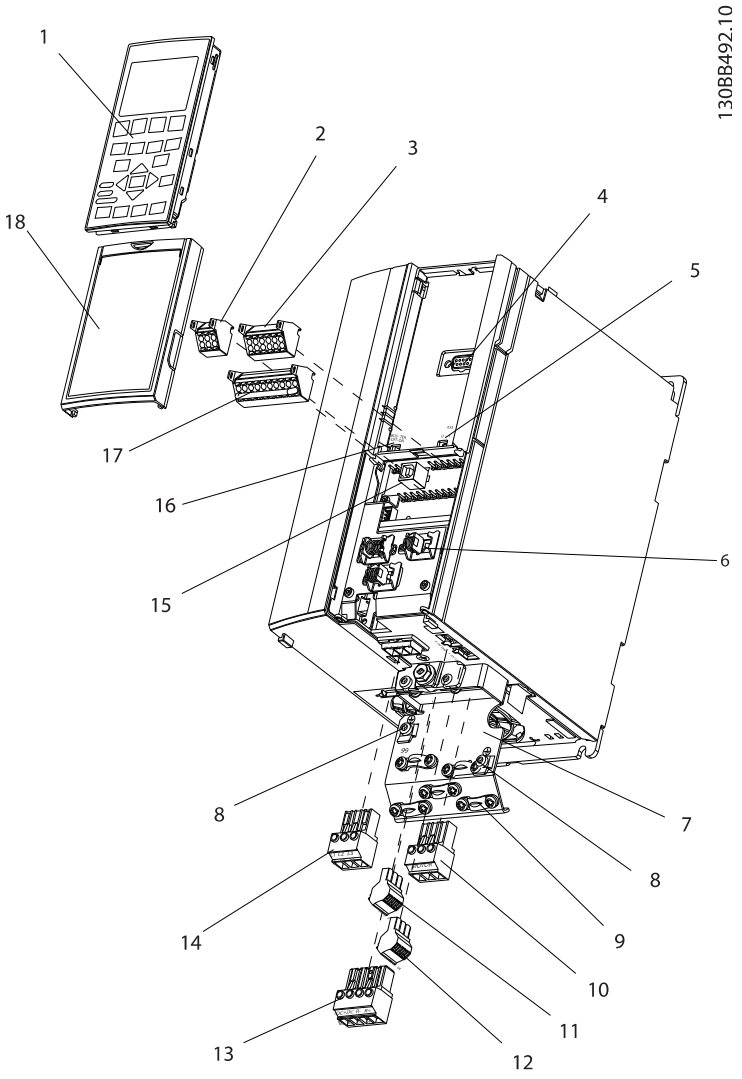


Figure 1.1 Exploded View Unit Sizes 12-13, IP20

1	Keypad	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	Keypad input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Line power input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable strain relief / PE ground	15	USB connector
7	Decoupling plate	16	Serial bus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V power supply
9	Shielded cable grounding clamp and strain relief	18	Control cable coverplate

Table 1.1

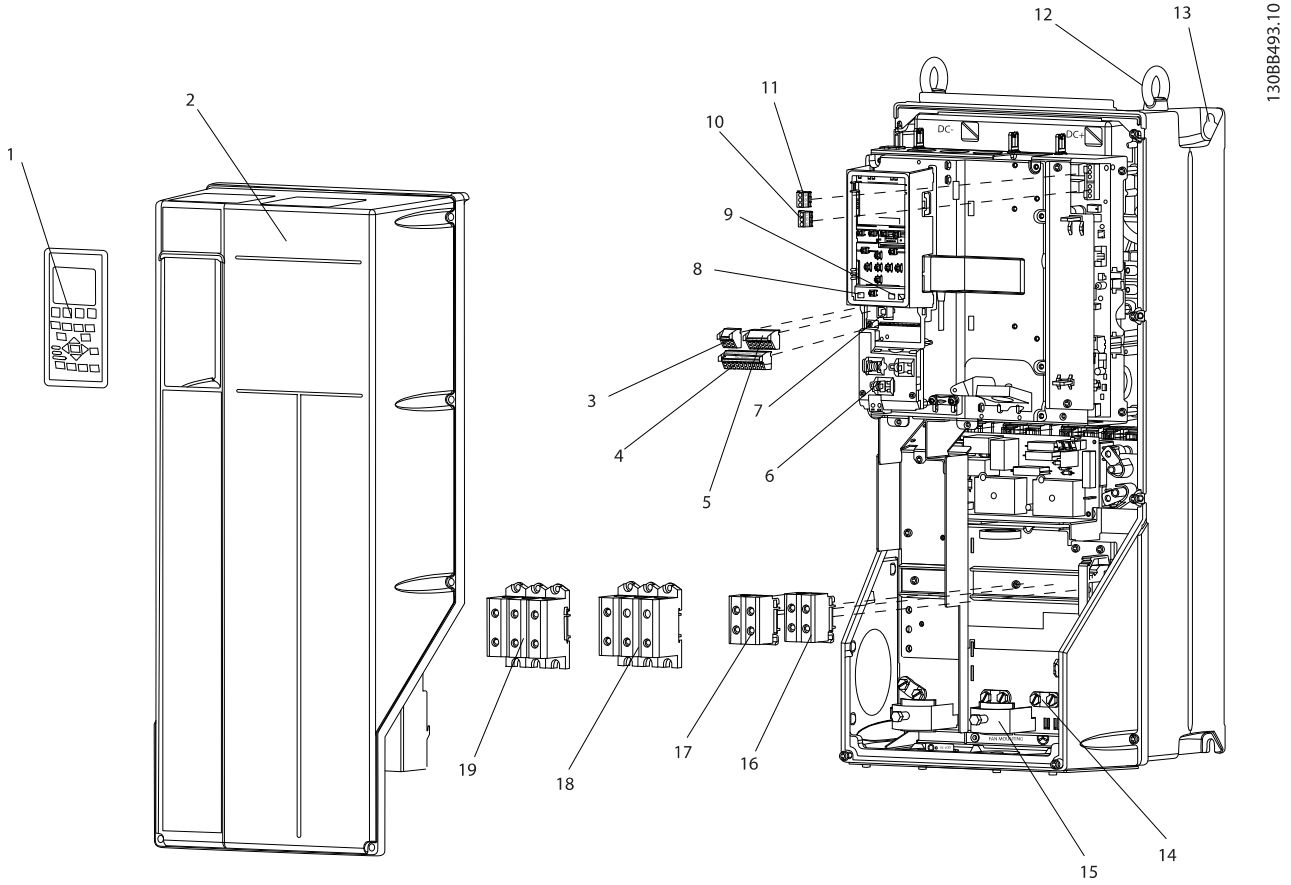


Figure 1.2 Exploded View Unit Sizes 2X and 3X, IP55/66

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

Table 1.2

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. Chapter 2 *Installation* provides requirements for mechanical and electrical installation, including input, motor, control and serial communications wiring, and control terminal functions. Chapter 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 drive functions and programming.

- The Programming Guide provides greater detail in how to work with parameters and many application examples.
- The Design Guide is intended to provide detailed capabilities and functionality to design motor control systems.
- Optional equipment is available that may change some of the procedures described. Be sure to see the instructions supplied with those options for specific requirements.

1.3 Product Overview

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

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

1.4 Internal Adjustable Frequency Drive Controller Functions

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

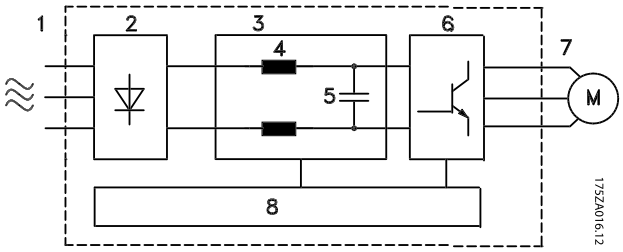


Figure 1.3 Block Diagram

Area	Title	Functions
1	Line power input	• Three-phase AC line power supply to the drive
2	Rectifier	• The rectifier bridge converts the AC input to DC current to supply inverter power
3	DC bus	• The adjustable frequency drive's 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

1

Area	Title	Functions
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 Internal Components

1.5 Unit Sizes and Power Ratings

	Unit sizes										
	IP20 / Open Chassis						IP55 / Nema 12 and IP66 / Nema 4/4X Indoor				
Volts	12	13	23	24	33	34	15	21	22	31	32
200–240	1/3–3 hp	5 hp	7.5–10 hp	15–20 hp	25–30 hp	40–50 hp	1/3–5 hp	7.5–10 hp	15 hp	20–30 hp	40–50 hp
380–480	1/2–5 hp	7.5–10 hp	15–20 hp	25–40 hp	150–60 hp	75–100 hp	1–10 hp	15–20 hp	25–30 hp	40–60 hp	75–100 hp
525–600	-	1–10 hp	15–20 hp	25–40 hp	50–60 hp	75–100 hp	1–10 hp	15–20 hp	25–30 hp	40–60 hp	75–100 hp
525–690	-	-	-	-	-	-	-	-	15–30 hp	-	40–100 hp

Table 1.4

2 Installation

2.1 Installation Site Checklist

- The drive relies on the ambient air for cooling. Observe the limitations on ambient air temperature for optimal operation
- Ensure that the installation location has sufficient support strength to mount the drive
- Keep the drive interior free from dust and dirt. Ensure that the components stay as clean as possible. In construction areas, provide a protective covering. Optional IP55 (NEMA 12) 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

    Drive

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

    Motor size and drive power must match for proper overload protection.

    If 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 104°F [40°C]) and 122°F [50°C] and elevation 3,300 ft [1,000 m] above sea level must be considered. See the equipment Design Guide for detailed information.

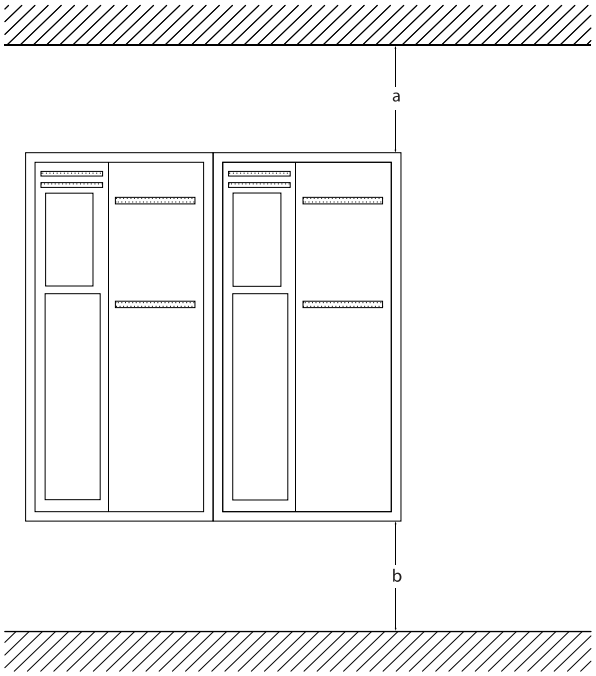


Figure 2.1 Top and Bottom Cooling Clearance

Size	12-15	21-24	31, 33	32, 34
a/b (in / mm)	3.94 / 100	7.87 / 200	7.87 / 200	8.86 / 225

Table 2.1 Minimum Airflow Clearance Requirements

2

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 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.

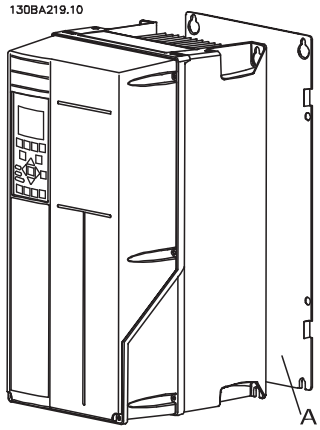


Figure 2.2 Proper Mounting with Backplate

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

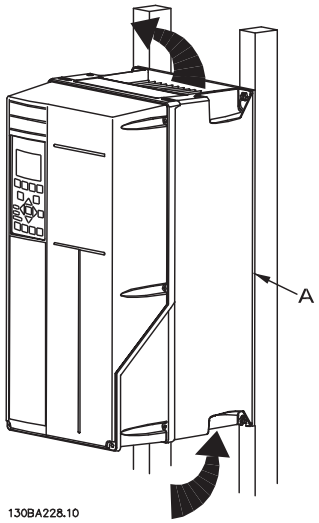


Figure 2.3 Proper Mounting with Railings

NOTE!

Backplate is needed when mounted on railings.

2.3.4 Tightening Torques

See *10.4.1 Connection Tightening Torques* for proper tightening specifications.

2.4 Electrical Installation

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

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

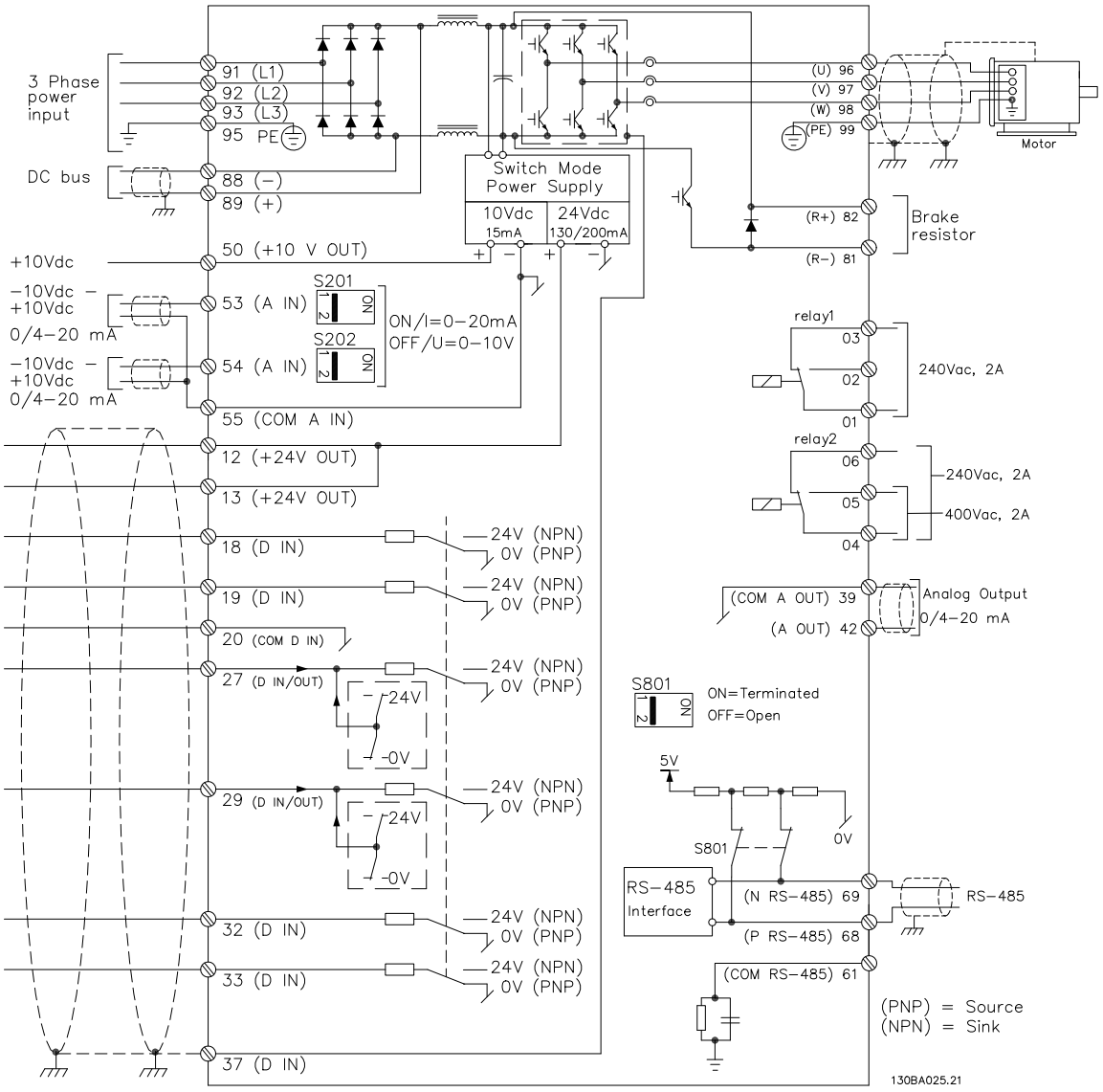


Figure 2.4 Basic Wiring Schematic Drawing.

A=Analog, D=Digital
Terminal 37 is used for Safe Stop. For Safe Stop installation instructions, refer to the Design Guide.

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, start-up, and maintenance be performed only by trained and qualified personnel. Failure to follow these guidelines could result in death or serious injury.

CAUTION

WIRING ISOLATION!

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

For your safety, comply with the following requirements.

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

Overload and Equipment Protection

- An electronically activated function within the adjustable frequency drive provides overload protection for the motor. The overload calculates the level of increase to activate timing for the trip (controller output stop) function. The higher the current draw, the quicker the trip response. The overload provides Class 20 motor protection. See *8 Warnings and Alarms* for details on the trip function.
- Because the motor wiring carries high frequency current, it is important that wiring for line power, motor power, and control is run separately. Use metallic conduit or separated shielded wire. Failure to isolate power, motor, and control wiring could result in less than optimum equipment performance.
- All adjustable frequency drives must be provided with short-circuit and overcurrent protection.

Input fusing is required to provide this protection, see *Figure 2.5*. Fuses must be provided by the installer as part of installation. See maximum fuse ratings in *10.3 Fuse Tables*.

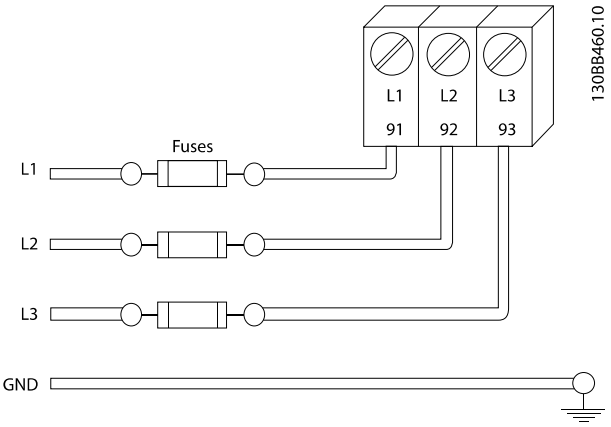


Figure 2.5 Fuses

Wire Type and Ratings

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

2.4.2 Grounding Requirements

WARNING

GROUNDING HAZARD!

For operator safety, it is important to ground 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 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 with on the equipment for proper ground connections
- Do not ground one 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 (>3.5mA)

Follow national and local codes regarding protective grounding of equipment with a leakage current > 3.5mA. Drive technology implies high frequency switching at high power. This will generate a leakage current in the ground connection. A fault current in the 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 drive power.

EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care if the leakage current exceeds 3.5mA. 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 2.6*).

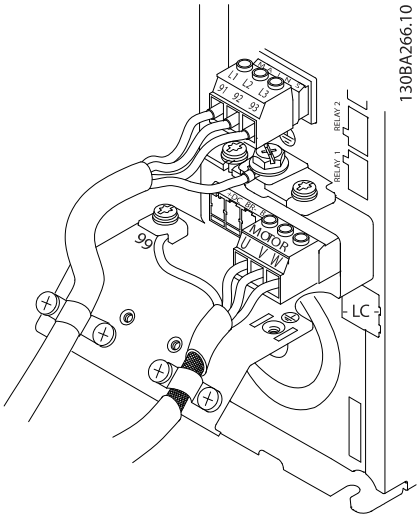


Figure 2.6 Grounding with Shielded Cable

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 (Nema 1, 12, and 4/4X Indoor) 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).

2

- 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

Figure 2.7 represents line power input, motor, and ground grounding for basic adjustable frequency drives. Actual configurations vary with unit types and optional equipment.

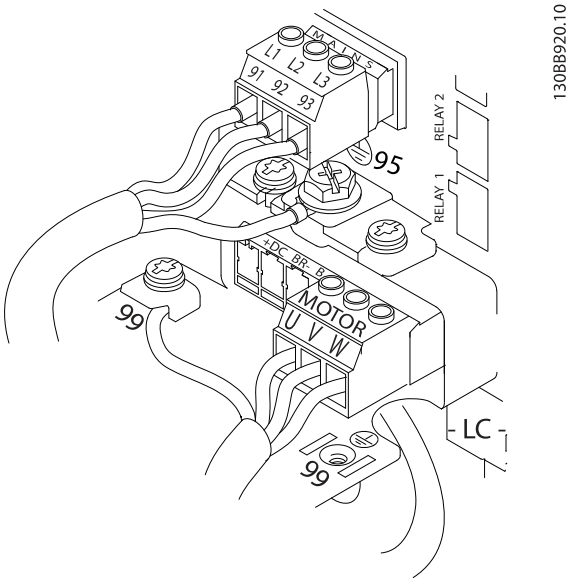


Figure 2.7 Example of Motor, Line Power and Ground Wiring

2.4.4 AC Line Power Connection

- Size wiring based upon the input current of the 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 2.7*).
- 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 power or floating delta) or TT/TN-S line power with a grounded leg (grounded delta), set *SP-50 RFI Filter* 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 VDC supply voltage is recommended.

2.4.5.1 Access

- Remove access coverplate with a screwdriver. See *Figure 2.8*.
- Or remove front cover by loosening attaching screws. See *Figure 2.9*.
  Tightening torque for front cover is 2.0Nm for unit size 15 and 2.2Nm for unit sizes 2X and 3X.

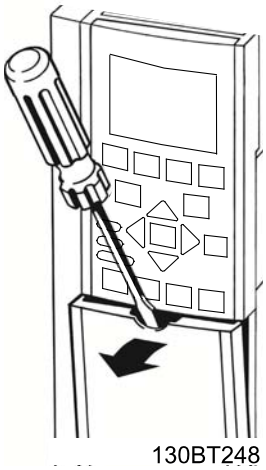


Figure 2.8 Control Wiring Access for IP20 / Open chassis enclosures

Figure 2.9 Control Wiring Access for IP55 / Nema 12 and IP66 / Nema 4/4X Indoor

2.4.5.2 Control Terminal Types

Figure 2.10 and shows the removable adjustable frequency drive connectors. Terminal functions and default settings are summarized in *Table 2.3*.

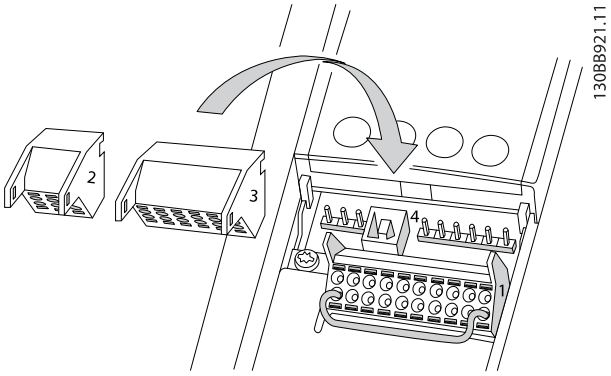


Figure 2.10 Control Terminal Locations

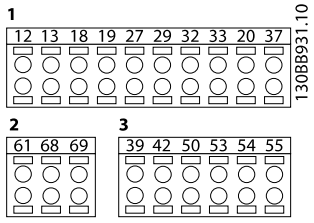


Figure 2.11 Terminal Numbers

- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, 24 V DC terminal supply voltage, and a common, optional, customer-supplied 24 V DC voltage. A digital input for STO (Safe Torque Off) function.
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communications connection
- **Connector 3** provides two analog inputs, one analog output, 10 V DC supply voltage, and commons for the inputs and output
- **Connector 4** is a USB port available for use with the
- Also provided are two Form C relay outputs that are in various locations depending upon the adjustable frequency drive configuration and size
- Some options available for ordering with the unit may provide additional terminals. See the manual provided with the equipment option.

See 10.2 General Technical Data for terminal ratings details.

Terminal description			
Terminal	**Parameter**	**Default setting**	**Description**
Digital inputs/outputs			
12, 13	-	+24 V DC	24 V DC supply voltage. Maximum output current is 200 mA total for all 24 V loads. Useable for digital inputs and external transducers.
18	E-01	[8] Start	Digital inputs.
19	E-02	[10] Reversing	
32	E-05	[0] No operation	
33	E-06	[0] No operation	
27	E-03	[0] No operation	Selectable for either digital input or output. Default setting is input.
29	E-04	[14] JOG	
20	-		Common for digital inputs and 0 V potential for 24 V supply.
37	-	Safe Torque Off (STO)	Safe input. Used for STO.
Analog inputs/outputs			
39	-		Common for analog output

2

Terminal description			
Terminal	Parameter	Default setting	Description
42	AN-50	[0] No operation	Programmable analog output. The analog signal is 0–20 mA or 4–20 mA at a maximum of 500Ω
50	-	+10 V DC	10 V DC analog supply voltage. 15 mA maximum commonly used for potenti-ometer or thermistor.
53	AN-1#	Reference	Analog input. Selectable for voltage or current. Switches A53 and A54 select mA or V.
54	AN-2#	Feedback	
55	-		Common for analog input

Table 2.2

Terminal description			
Terminal	Parameter	Default setting	Description
Serial communication			
61	-		Integrated RC filter for cable screen. ONLY for connecting the shield when experiencing EMC problems.
68 (+)	O-3#		RS-485 Interface. A control card switch is provided for termination resistance.
69 (-)	O-3#		
Relays			
01, 02, 03	E-24	[0] No operation	Form C relay output. Usable for AC or DC voltage and resistive or inductive loads.
04, 05, 06	E-24	[0] No operation	

Table 2.3 Terminal Description

2.4.5.3 Wiring to Control Terminals

Control terminal connectors can be unplugged from the drive for ease of installation, as shown in *Figure 2.10*.

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Figure 2.12*.
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.

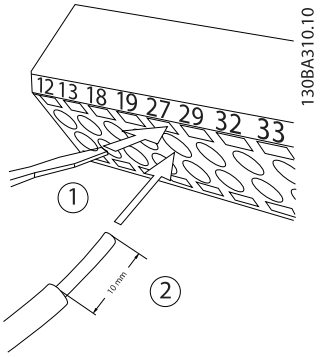


Figure 2.12 Connecting Control Wiring

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: 16 mm^2.

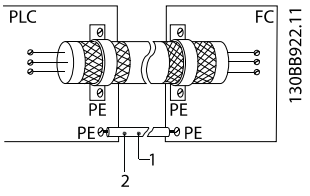


Figure 2.13

50/60Hz 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 100nF capacitor (keeping leads short).

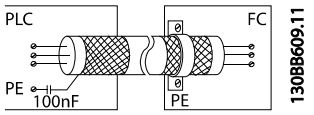


Figure 2.14

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:

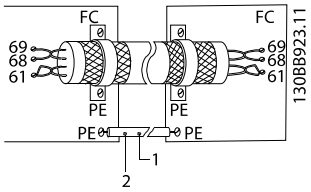


Figure 2.15

Alternatively, the connection to terminal 61 can be omitted:

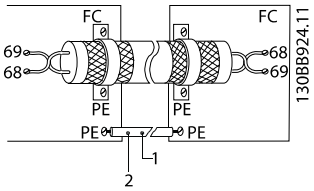


Figure 2.16

2.4.5.5 Control Terminal Functions

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 2.3* 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 for details on programming.
- The default terminal programming is intended to initiate drive functioning in a typical operational mode.

2.4.5.6 Terminal 53 and 54 Switches

- Analog input terminals 53 and 54 can select either voltage (-10–10V) or current (0/4–20mA) input signals
- Remove power to the 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 Keypad has been removed (see *Figure 2.17*). 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 *DR-61 Terminal 53 Switch Setting*
- Terminal 54 default is for a feedback signal in closed-loop set in *DR-63 Terminal 54 Switch Setting*

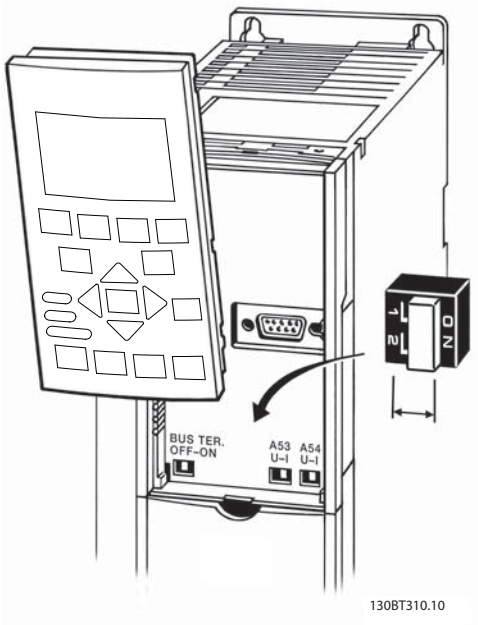


Figure 2.17 Location of Terminals 53 and 54 Switches and Bus Termination Switch

2.4.5.7 Terminal 37

Terminal 37 Safe Stop Function
The AF-650 GP and is available with safe stop functionality via control terminal 37. Safe stop disables the control voltage of the power semiconductors of the drive output

2

stage which in turn prevents generating the voltage required to rotate the motor. When the Safe Stop (T37) is activated, the 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 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 drive or auxiliary circuits. Perform work on electrical parts of the 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 drive by using the Safe Torque Off function. If a running drive is stopped by using the function, the unit will trip and stop by coasting. If this is not acceptable, e.g., causes danger, the 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 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 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 drive.

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

1. Remove the jumper wire between control terminals 37 and 12 or 13. Cutting or breaking the jumper is not sufficient to avoid short-circuiting. (See jumper on *Figure 2.18*.)
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 (24 V DC). The safety monitoring relay must comply with Category 3 (EN 954-1) / PL “d” (ISO 13849-1).

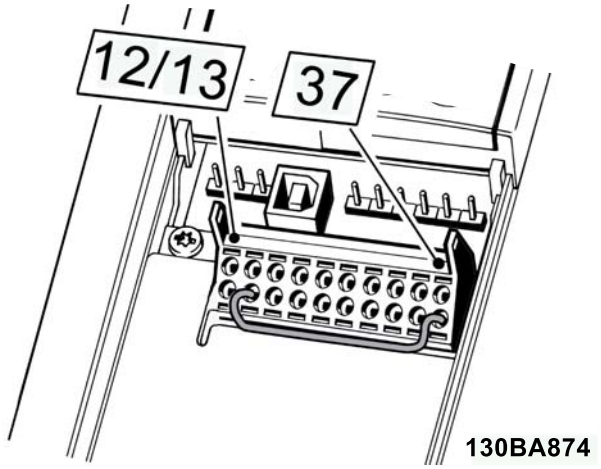


Figure 2.18 Jumper between Terminal 12/13 (24 V) and 37

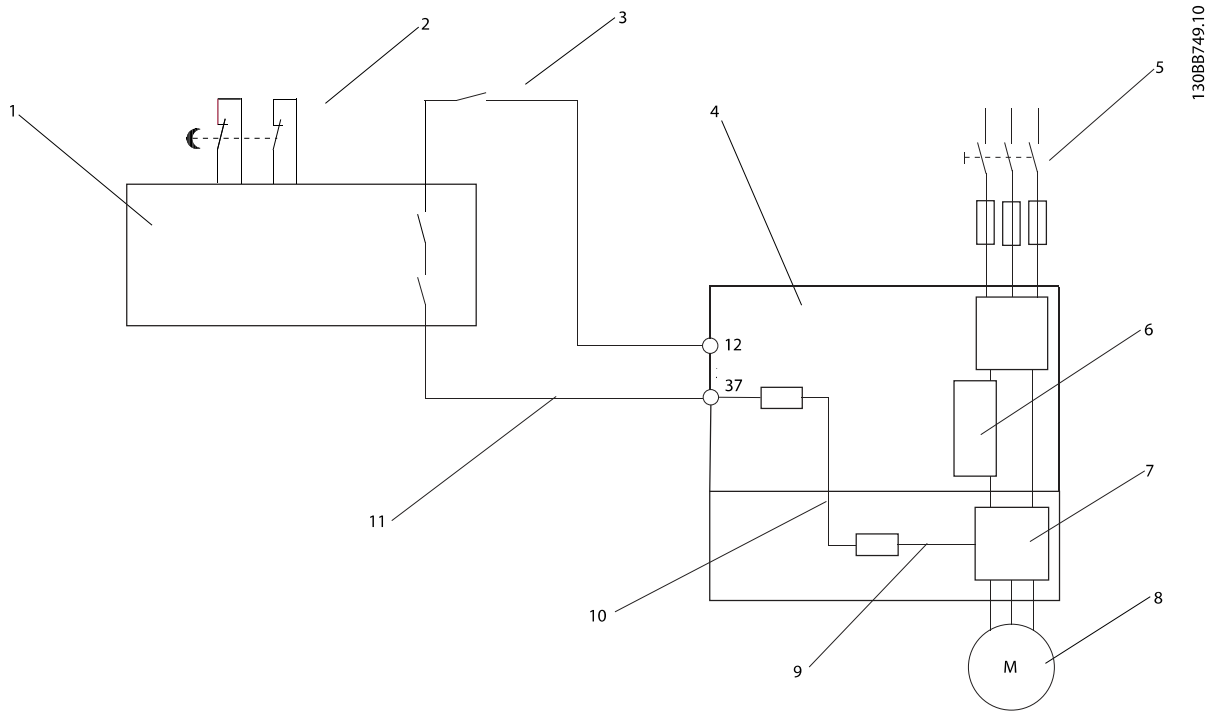


Figure 2.19 Installation to Achieve a Stopping Category 0 (EN 60204-1) with Safety Cat. 3 (EN 954-1) / PL "d" (ISO 13849-1).

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	Drive	10	Safe channel
5	Line power	11	Short-circuit protected cable (if not inside installation cabinet)
6	Control board		

Table 2.4

Safe Stop Commissioning Test

After installation and before first operation, perform a commissioning test of the installation making use of safe stop. Moreover, perform the test after each modification of the installation.

2.4.6 Serial Communication

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

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

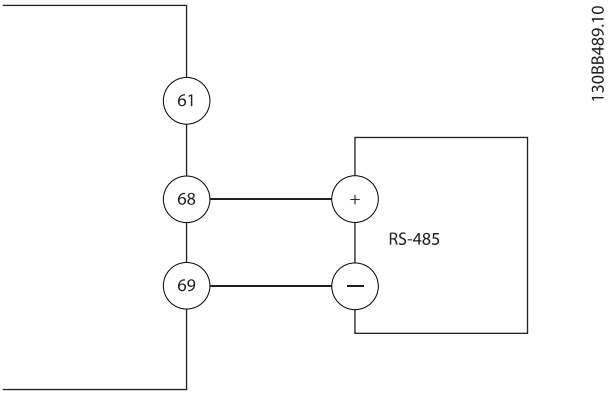


Figure 2.20 Serial Communication Wiring Diagram

For basic serial communication set-up, select the following

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

- Two communication protocols are internal to the drive.

  Drive profile

  Modbus RTU

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

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 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 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 drive as well as the motor.
6. Inspect the 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 drive and motor.

3.1.2 Start-up Check List

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 input power side of drive or output side to motor. Examine their operational readiness and ensure that they are ready in all respects for operation at full speed. • Check function and installation of any sensors used for feedback to drive. • Remove power factor correction caps on motor(s), if present	
Cable routing	• Ensure that input power, motor wiring, and control wiring are separated or in three separate metallic conduits for high frequency noise isolation.	
Control wiring	• Check for broken or damaged wires and loose connections. • Check that control wiring is isolated from power and motor wiring for noise immunity. • Check the voltage source of the signals, if necessary. • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.	
Cooling clearance	• Make sure that the top and bottom clearance is adequate to ensure proper airflow for cooling.	
EMC considerations	• Check for proper installation regarding electromagnetic compatibility.	
Environmental considerations	• See equipment label for the maximum ambient operating temperature limits. • Humidity levels must be 5%–95% non-condensing.	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers. • Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position.	
Grounding	• The unit requires a ground wire from its chassis to the building ground. • Check for good ground connections that are tight and free of oxidation. • Grounding to conduit or mounting the back panel to a metal surface is not a suitable ground.	
Input and output power wiring	• Check for loose connections. • Check that motor and line power are in separate conduit or separated shielded cables.	
Panel interior	• Make sure that the unit interior is free of dirt, metal chips, moisture, and corrosion.	
Switches	• Ensure that all switch and disconnect settings are in the proper position.	
Vibration	• Check that the unit is mounted solidly or that shock mounts are used, as necessary. • Check for any unusual amount of vibration the unit may be subjected to.	

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, start-up and maintenance should be performed by qualified personnel only. Failure to perform installation, start-up and maintenance by qualified personnel could result in death or serious injury.

⚠WARNING

UNINTENDED START!

When adjustable frequency drive is connected to AC line power, the motor may start at any time. The drive, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the 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 drive at this time. For units with a disconnect switch, turn to the ON position to apply power to the drive.

3.3 Basic Operational Programming

Adjustable frequency drives 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 start-up and checkout purposes. Application settings may vary. See *4 User Interface* for detailed instructions on entering data through the Keypad.

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

1. Press [Quick Menu] on the Keypad.
2. Use the navigation keys to scroll to Quick Start and press [OK].
3. Select language and press [OK]. Then enter the motor data in parameters P-02, P-03, P-06, P-07, F-04 and F-05. The information can be found on the motor nameplate.

   P-07 Motor Power [kW] or *P-02 Motor Power [HP]*

   F-05 Motor Rated Voltage

   F-04 Base Frequency

   P-03 Motor Current

   P-06 Base Speed
4. Enter *F-01 Frequency Setting 1* and press [OK].
5. Enter *F-02 Operation Method*. Local, Remote, or Linked to Hand/Auto. In local, the reference is entered on the keypad, and in remote, that reference is sourced depending on .
6. Enter the accel/decel time in *F-07 Accel Time 1* and *F-08 Decel Time 1*.
7. For *F-10 Electronic Overload* enter Elec OL Trip 1 for Class 20 overload protection. For further information, please see *2.4.1 Requirements*.
8. For *F-17 Motor Speed High Limit [RPM]* or *F-15 Motor Speed High Limit [Hz]*, enter the application requirements.
9. For *F-18 Motor Speed Low Limit [RPM]* or *F-16 Motor Speed Low Limit [Hz]*, enter the application requirements.
10. Set *H-08 Reverse Lock* to Clockwise, Counter-clockwise or Both directions.
11. In *P-04 Auto Tune*, select Reduced Auto Tune or Full Auto Tune and follow on-screen instructions. See *3.4 Auto Tune*

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

3

3.4 Auto Tune

Auto tune is a test procedure that measures the electrical characteristics of the motor to optimize compatibility between the drive and the motor.

- The 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 P-0#.
- 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 *Reduced Auto Tune*
- If an output filter is connected to the motor, select *Reduced Auto Tune*
- If warnings or alarms occur, see *8 Warnings and Alarms*
- Run this procedure on a cold motor for best results

3.5 Check Motor Rotation

Prior to running the adjustable frequency drive, check the motor rotation.

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

When *H-48 Clockwise Direction* is set to [0]* Normal (default clockwise):

4a. Verify that the motor turns clockwise.

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

When *H-48 Clockwise Direction* is set to [1] Inverse (counter-clockwise):

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

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

3.6 Local Control Test

⚠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.

NOTE!

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

1. Press [Hand].
2. Accelerate the 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 time in *F-07 Accel Time 1*
- Increase current limit in *F-43 Current Limit*
- Increase torque limit in *F-40 Torque Limiter (Driving)*

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 time in *F-08 Decel Time 1*
- Enable overvoltage control in *B-17 Over-voltage Control*

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

NOTE!

***3.1 Pre-start* through *3.6 Local Control Test* in this chapter conclude the procedures for applying power to the drive, basic programming, set-up, and functional testing.**

3.7 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].
2. Ensure that external control functions are properly wired to the 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*.

4 User Interface

4.1 Keypad

The Keypad is the combined display and keys on the front of the unit. The Keypad is the user interface to the adjustable frequency drive.

The Keypad 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

NOTE!

The display contrast can be adjusted by pressing [STATUS] and the up/down key.

4.1.1 Keypad Layout

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

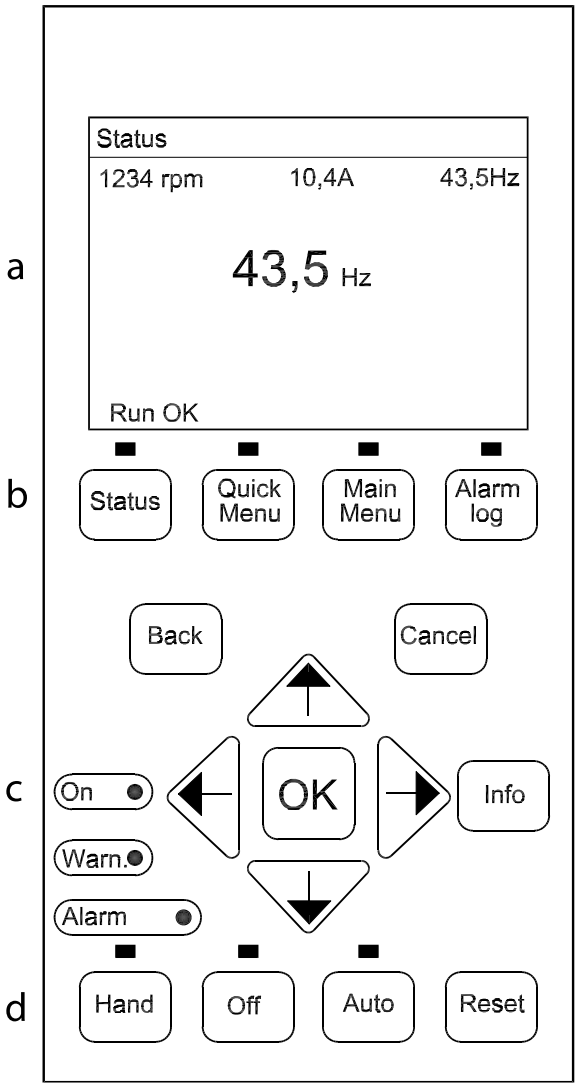


Figure 4.1 Keypad

a. Display area.

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

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

d. Operational mode keys and reset.

4.1.2 Setting Keypad 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 Keypad can be customized for user application.

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

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

Table 4.1

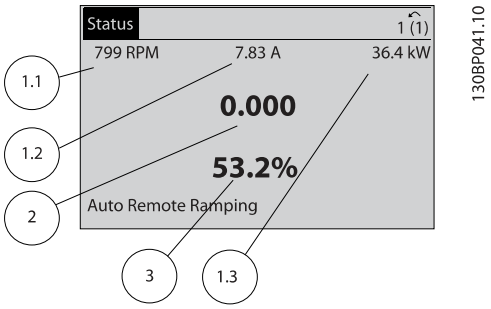


Figure 4.2

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 4.3

Key	Function
Status	Press to show operational information. • Press repeatedly to scroll through each status display. • Press and hold [Status] plus [▲] or [▼] to adjust the display brightness • The symbol in the upper right corner of the display shows the direction of motor rotation and which set-up is active. This is not programmable.
Quick Menu	Allows access to programming parameters for initial set-up instructions and many detailed application instructions. • Press to access *Quick Start* for sequenced instructions to program the basic frequency controller set up • Press to access *Trending* for realtime logging on the keypad display. • Press to access *Parameter Data Check* for changes in the parameter data set. • Follow the sequence of parameters as presented for the function set-up
Main Menu	Allows access to all programming parameters. • Press twice to access top level index. • Press once to return to the last location accessed. • Press and hold to enter a parameter number for direct access to that parameter.

Key	Function
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

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

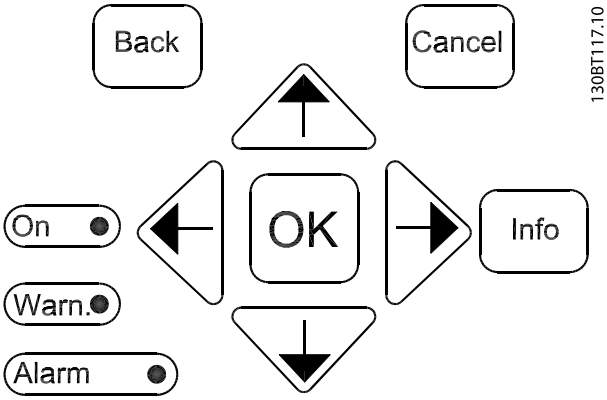


Figure 4.4

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 drive receives power from AC line voltage, a DC bus terminal, or an external 24V 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 Keypad.

Figure 4.5

Key	Function
Hand	Press to start the drive in local control. • Use the navigation keys to control drive speed • An external stop signal by control input or serial communication overrides the local hand
Off	Stops the motor but does not remove power to the drive.
Auto	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 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 drive.

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

⚠WARNING

UNINTENDED START!

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

4.2.1 Uploading Data to the Keypad

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

4.2.2 Downloading Data from the Keypad

1. Press [OFF] to stop the motor before uploading or downloading data.
2. Go to *K-50 Keypad Copy*.
3. Press [OK].
4. Select *All from* Keypad.
5. Press [OK]. A progress bar shows the downloading process.
6. Press [Hand] or [Auto] 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 Keypad provides a backup prior to initialization.

Restoring the drive parameter settings back to default values is done by initialization of the adjustable frequency drive. Initialization can be through *H-03 Restore Factory Settings* or manually.

- Initialization using *H-03 Restore Factory Settings* does not change drive data such as operating hours, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions
- Using *H-03 Restore Factory Settings* 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 *H-03 Restore Factory Settings*.
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 reset the following drive information

- *ID-00 Operating Hours*
- *ID-03 Power Up's*
- *ID-04 Over Temp's*
- *ID-05 Over Volt's*

5 About Frequency Converter Programming

5.1 Introduction

The adjustable frequency drive is programmed for its application functions using parameters. Parameters are accessed by pressing either [Quick Menu] or [Main Menu] on the Keypad. (See *4 User Interface* for details on using the Keypad function keys.) Parameters may also be accessed through a PC using the (see *5.7.1 Remote Programming with*).

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

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

5.2 Programming Example

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

- This procedure programs the drive to receive a 0–10V DC analog control signal on input terminal 53
- The drive will respond by providing 20–50Hz output to the motor proportional to the input signal (0–10V DC = 20–50Hz)

This is a common pump or fan application.

Press [Main Menu] twice and select the following parameters using the navigation keys to scroll to the titles and press [OK] after each action.

1. *Parameter Data Set*

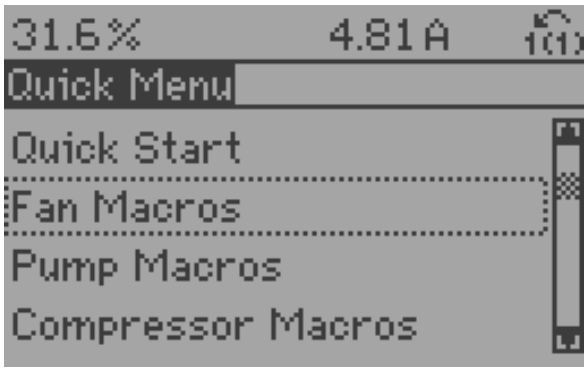


Figure 5.1

3. *Fundamental Parameters*

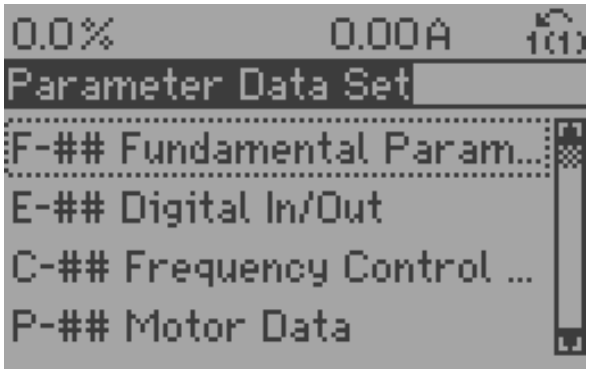


Figure 5.2

4. *Extended References*

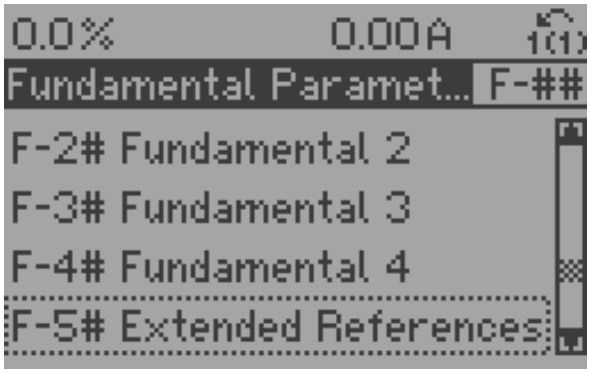


Figure 5.3

5. *F-52 Minimum Reference*. Set minimum internal drive reference to 0Hz. (This sets the minimum drive speed at 0Hz.)

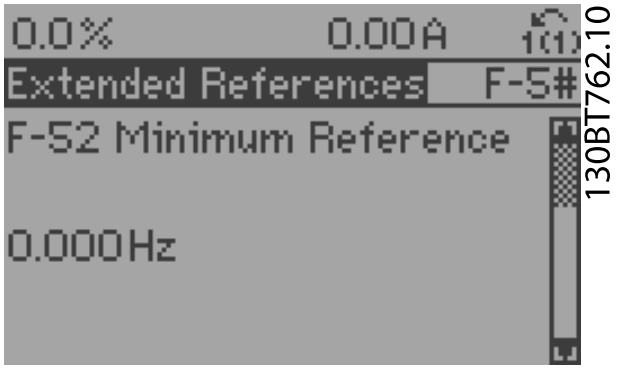


Figure 5.4

6. *F-53 Maximum Reference*. Set maximum internal drive reference to 60Hz. (This sets the maximum drive speed at 60Hz. Note that 50/60Hz is a regional variation.)

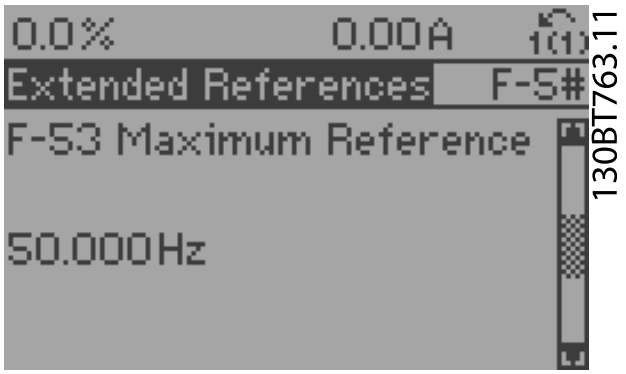


Figure 5.5

7. Press [Back] twice to return to Parameter Data Set and scroll to Analog In/Out

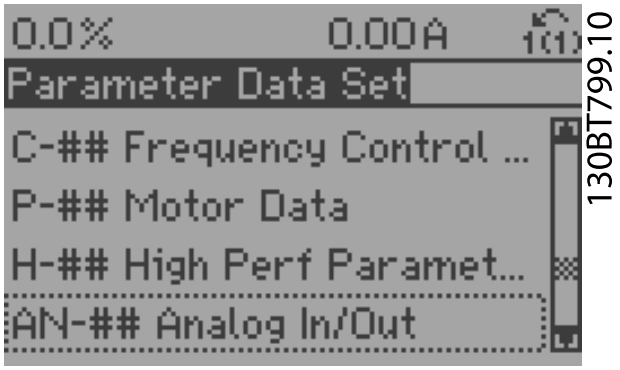


Figure 5.6

8. Analog Input 53

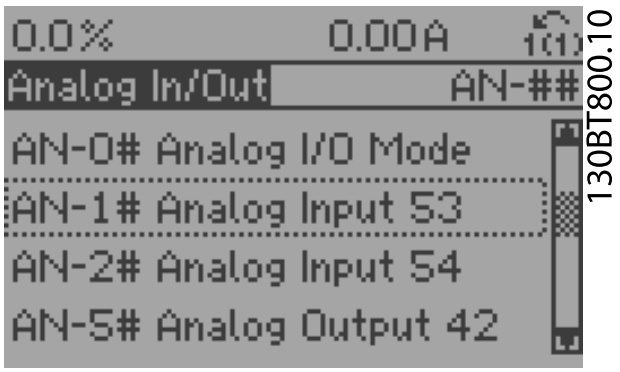


Figure 5.7

9. *AN-10 Terminal 53 Low Voltage*. Set minimum external voltage reference on Terminal 53 at 0V. (This sets the minimum input signal at 0V.)

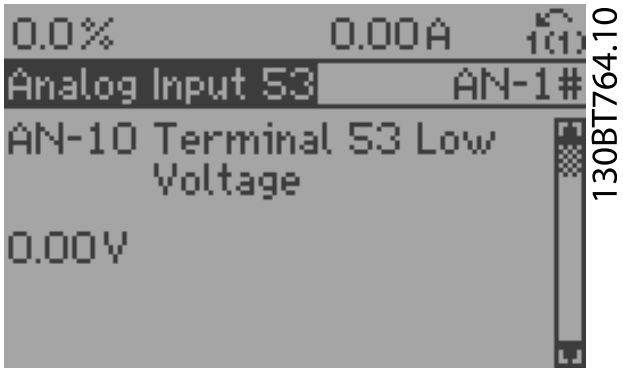


Figure 5.8

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

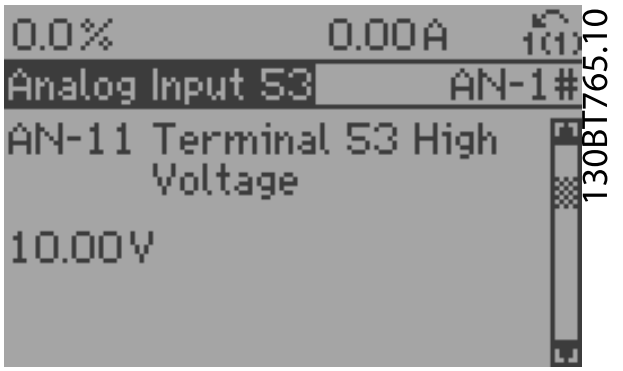


Figure 5.9

11. *AN-14 Terminal 53 Low Ref./Feedb. Value*. Set minimum speed reference on Terminal 53 at 20Hz. (This tells the drive that the minimum voltage received on Terminal 53 (0V) equals 20Hz output.)

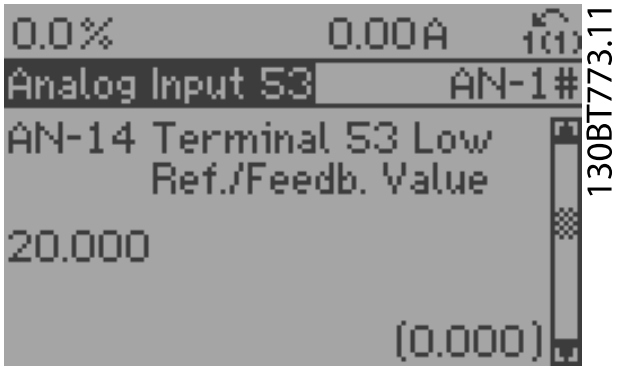


Figure 5.10

12. *AN-15 Terminal 53 High Ref./Feedb. Value*. Set maximum speed reference on Terminal 53 at 50Hz. (This tells the drive that the maximum voltage received on Terminal 53 (10V) equals 50Hz output.)

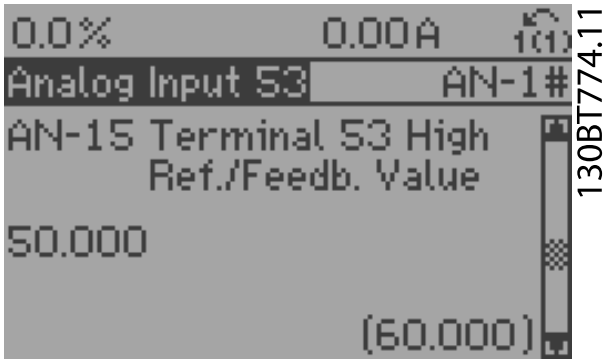


Figure 5.11

With an external device providing a 0–10V control signal connected to 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 5.12 shows the wiring connections used to enable this set-up.

5

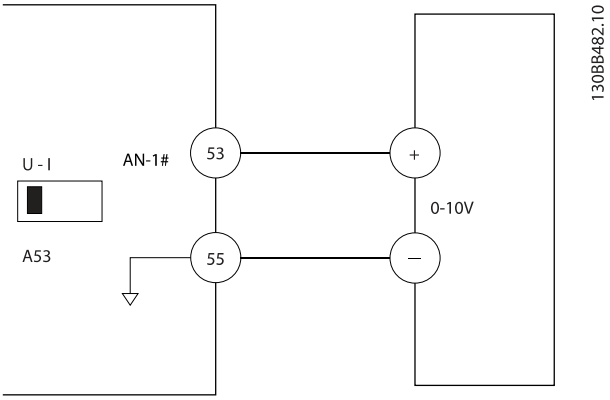


Figure 5.12 Wiring Example for External Device Providing 0–10V Control Signal

5

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 drive functioning, the control terminals must be

  Wired properly

  Programmed for the intended function

  Receiving a signal

See *Table 2.3* for control terminal parameter number and default setting. (Default setting can change based on the selection in *K-03 Regional Settings*.)

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

1. Press [Main Menu] twice, scroll to *Parameter Data Set* and press [OK].

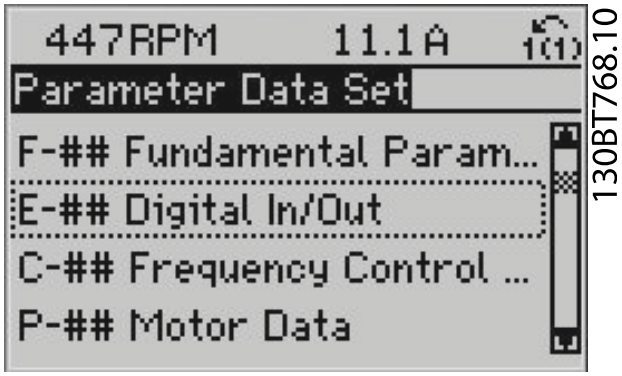


Figure 5.13

2. Scroll to parameter group E-## *Digital In/Out* and press [OK].

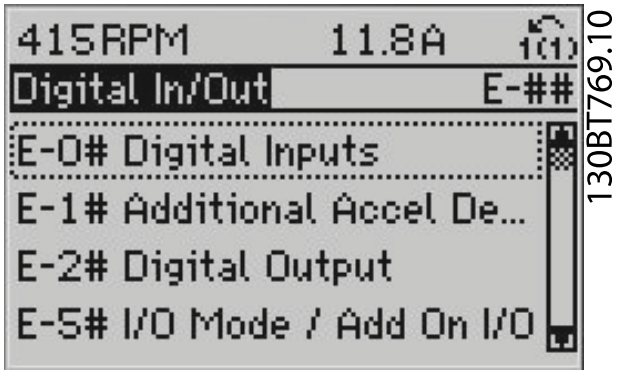


Figure 5.14

3. Scroll to parameter group E-0# *Digital Inputs* and press [OK]
4. Scroll to *E-01 Terminal 18 Digital Input*. Press [OK] to access function choices. The default setting *Start* is shown.

Figure 5.15

5.4 International/North American Default Parameter Settings

Setting *K-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
K-03 Regional Settings	International	North America
P-07 Motor Power [kW]	See Note 1	See Note 1
P-02 Motor Power [HP]	See Note 2	See Note 2
F-05 Motor Rated Voltage	230V/400V/575V	208V/460V/575V
F-04 Base Frequency	50Hz	60Hz
F-53 Maximum Reference	50Hz	60Hz
F-54 Reference Function	Sum	External/Preset
F-17 Motor Speed High Limit [RPM] See Note 3 and 5	1500RPM	1800RPM
F-15 Motor Speed High Limit [Hz] See Note 4	50Hz	60Hz
F-03 Max Output Frequency 1	132Hz	120Hz
H-73 Warning Speed High	1500RPM	1800RPM
E-03 Terminal 27 Digital Input	Coast inverse	External interlock
E-24 Function Relay	No operation	No alarm
AN-15 Terminal 53 High Ref./Feedb. Value	50	60
AN-50 Terminal 42 Output	No operation	Speed 4-20mA
H-04 Auto-Reset (Times)	Manual reset	Infinite auto reset

Table 5.1 International/North American Default Parameter Settings

Note 1: P-07 Motor Power [kW] is only visible when K-03 Regional Settings is set to [0] International.
Note 2: P-02 Motor Power [HP], is only visible when K-03 Regional Settings is set to [1] North America.
Note 3: This parameter is only visible when K-02 Motor Speed Unit is set to [0] RPM.
Note 4: This parameter is only visible when K-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 1500RPM and for a 2 poled motor 3000RPM. The corresponding values for North America is 1800 and 3600RPM, respectively.

5.5 Parameter Data Check

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 *Parameter Data Check* and press [OK].
3. Select *Since Factory Setting* to view all programming changes or *Last 10 Changes* for the most recent.

5.6 Parameter Menu Structure

Establishing the correct programming for applications often requires setting functions in several related parameters. These parameter settings provide the drive with system details for the 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 Keypad 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*.

- **0-** Operation/Display**
  - **0-0* Basic Settings**
    - 0-01 Language
    - 0-02 Motor Speed Unit
    - 0-03 Regional Settings
    - 0-04 Operating State at Power-up (Hand)
    - 0-09 Performance Monitor
  - **0-1* Set-up Operations**
    - 0-10 Active Set-up
    - 0-11 Edit Set-up
    - 0-12 This Set-up Linked to
    - 0-13 Readout: Linked Set-ups
    - 0-14 Readout: Edit Set-ups / Channel
    - 0-15 Readout: Actual set-up
  - **0-2* LCP Display**
    - 0-20 Display Line 1.1 Small
    - 0-21 Display Line 1.2 Small
    - 0-22 Display Line 1.3 Small
    - 0-23 Display Line 2 Large
    - 0-24 Display Line 3 Large
    - 0-25 My Personal Menu
  - **0-3* LCP Custom Readout**
    - 0-30 Unit for User-defined Readout
    - 0-31 Min Value of User-defined Readout
    - 0-32 Max Value of User-defined Readout
    - 0-37 Display Text 1
    - 0-38 Display Text 2
    - 0-39 Display Text 3
  - **0-4* LCP Keypad**
    - 0-40 [Hand on] Key on LCP
    - 0-41 [Off] Key on LCP
    - 0-42 [Auto on] Key on LCP
    - 0-43 [Reset] Key on LCP
    - 0-44 [Off/Reset] Key on LCP
    - 0-45 [Drive Bypass] Key on LCP
  - **0-5* Copy/Save**
    - 0-50 LCP Copy
    - 0-51 Set-up Copy
  - **0-6* Password**
    - 0-60 Main Menu Password
    - 0-61 Access to Main Menu w/o Password
    - 0-65 Quick Menu Password
    - 0-66 Access to Quick Menu w/o Password
    - 0-67 Bus Password Access
- **1-** Load and Motor**
  - **1-0* General Settings**
    - 1-00 Configuration Mode
    - 1-01 Motor Control Principle
    - 1-02 Flux Motor Feedback Source
    - 1-03 Torque Characteristics
    - 1-04 Overload Mode
    - 1-05 Local Mode Configuration
    - 1-06 Clockwise Direction
  - **1-1* Motor Selection**
    - 1-10 Motor Construction
  - **1-2* Motor Data**
    - 1-20 Motor Power [kW]
    - 1-21 Motor Power [HP]
    - 1-22 Motor Voltage
    - 1-23 Motor Frequency
    - 1-24 Motor Current
    - 1-25 Motor Nominal Speed
    - 1-26 Motor Cont. Rated Torque
    - 1-29 Automatic Motor Adaptation (AMA)
  - **1-3* Adv. Motor Data**
    - 1-30 Stator Resistance (Rs)
    - 1-31 Rotor Resistance (Rr)
    - 1-33 Stator Leakage Reactance (X1)
    - 1-34 Rotor Leakage Reactance (X2)
    - 1-35 Main Reactance (Xh)
    - 1-36 Iron Loss Resistance (Rfe)
    - 1-37 d-axis Inductance (Ld)
    - 1-39 Motor Poles
    - 1-40 Back EMF at 1000 RPM
    - 1-41 Motor Angle Offset
  - **1-5* Load Indep. Setting**
    - 1-50 Motor Magnetization at Zero Speed
    - 1-51 Min Speed Normal Magnetizing [RPM]
    - 1-52 Min Speed Normal Magnetizing [Hz]
    - 1-53 Model Shift Frequency
    - 1-54 Voltage reduction in fieldweakening
    - 1-55 U/f Characteristic - U
    - 1-56 U/f Characteristic - F
    - 1-58 Flystart Test Pulses Current
    - 1-59 Flystart Test Pulses Frequency
  - **1-6* Load Depen. Setting**
    - 1-60 Low Speed Load Compensation
    - 1-61 High Speed Load Compensation
    - 1-62 Slip Compensation
    - 1-63 Slip Compensation Time Constant
    - 1-64 Resonance Dampening
    - 1-65 Resonance Dampening Time Constant
    - 1-66 Min. Current at Low Speed
    - 1-67 Load Type
    - 1-68 Minimum Inertia
    - 1-69 Maximum Inertia
  - **1-7* Start Adjustments**
    - 1-71 Start Delay
    - 1-72 Start Function
    - 1-73 Flying Start
    - 1-74 Start Speed [RPM]
    - 1-75 Start Speed [Hz]
    - 1-76 Start Current
  - **1-8* Stop Adjustments**
    - 1-80 Function at Stop
    - 1-81 Min Speed for Function at Stop [RPM]
    - 1-82 Min Speed for Function at Stop [Hz]
    - 1-83 Precise Stop Function
    - 1-84 Precise Stop Counter Value
    - 1-85 Precise Stop Speed Compensation Delay
  - **1-9* Motor Temperature**
    - 1-90 Motor Thermal Protection
    - 1-91 Motor External Fan
    - 1-93 Thermistor Resource
    - 1-94 ATEX ETR cur.lim. speed reduction
    - 1-95 KTY Sensor Type
    - 1-96 KTY Thermistor Resource
    - 1-97 KTY Threshold level
    - 1-98 ATEX ETR interpol. points freq.
    - 1-99 ATEX ETR interpol points current
- **2-** Brakes**
  - **2-0* DC Brake**
    - 2-00 DC Hold Current
    - 2-01 DC Brake Current
    - 2-02 DC Braking Time
    - 2-03 DC Brake Cut-in Speed [RPM]
    - 2-04 DC Brake Cut-in Speed [Hz]
    - 2-05 Maximum Reference
  - **2-1* Brake Energy Funct.**
    - 2-10 Brake Function
    - 2-11 Brake Resistor (ohm)
    - 2-12 Brake Power Limit (kW)
    - 2-13 Brake Power Monitoring
    - 2-15 Brake Check
    - 2-16 AC brake Max. Current
    - 2-17 Over-voltage Control
    - 2-18 Brake Check Condition
    - 2-19 Over-voltage Gain
  - **2-2* Mechanical Brake**
    - 2-20 Release Brake Current
    - 2-21 Activate Brake Speed [RPM]
    - 2-22 Activate Brake Speed [Hz]
    - 2-23 Activate Brake Delay
    - 2-24 Stop Delay
    - 2-25 Brake Release Time
    - 2-26 Torque Ref
    - 2-27 Torque Ramp Time
    - 2-28 Gain Boost Factor
- **3-** Reference / Ramps**
  - **3-0* Reference Limits**
    - 3-00 Reference Range
    - 3-01 Reference/Feedback Unit
    - 3-02 Minimum Reference
    - 3-03 Maximum Reference
    - 3-04 Reference Function
  - **3-1* References**
    - 3-10 Preset Reference
    - 3-11 Jog Speed [Hz]
    - 3-12 Catch up/slow-down value
    - 3-13 Reference Site
    - 3-14 Preset Relative Reference
    - 3-15 Reference Resource 1
    - 3-16 Reference Resource 2
    - 3-17 Reference Resource 3
    - 3-18 Relative Scaling Reference Resource
    - 3-19 Jog Speed [RPM]
  - **3-4* Ramp 1**
    - 3-40 Ramp 1 Type
    - 3-41 Ramp 1 Ramp-up Time
    - 3-42 Ramp 1 Ramp-down Time
    - 3-45 Ramp 1 S-ramp Ratio at Accel. Start
    - 3-46 Ramp 1 S-ramp Ratio at Accel. End
    - 3-47 Ramp 1 S-ramp Ratio at Decel. Start
    - 3-48 Ramp 1 S-ramp Ratio at Decel. End
  - **3-5* Ramp 2**
    - 3-50 Ramp 2 Type
    - 3-51 Ramp 2 Ramp-up Time
    - 3-52 Ramp 2 Ramp-down Time
    - 3-55 Ramp 2 S-ramp Ratio at Accel. Start
    - 3-56 Ramp 2 S-ramp Ratio at Accel. End
    - 3-57 Ramp 2 S-ramp Ratio at Decel. Start
    - 3-58 Ramp 2 S-ramp Ratio at Decel. End
  - **3-6* Ramp 3**
    - 3-60 Ramp 3 Type
    - 3-61 Ramp 3 Ramp up Time
    - 3-62 Ramp 3 Ramp-down Time
    - 3-65 Ramp 3 S-ramp Ratio at Accel. Start
    - 3-66 Ramp 3 S-ramp Ratio at Accel. End
    - 3-67 Ramp 3 S-ramp Ratio at Decel. Start
    - 3-68 Ramp 3 S-ramp Ratio at Decel. End
  - **3-7* Ramp 4**
    - 3-70 Ramp 4 Type
    - 3-71 Ramp 4 Ramp-up Time
    - 3-72 Ramp 4 Ramp-down Time
    - 3-75 Ramp 4 S-ramp Ratio at Accel. Start
    - 3-76 Ramp 4 S-ramp Ratio at Accel. End
    - 3-77 Ramp 4 S-ramp Ratio at Decel. Start
    - 3-78 Ramp 4 S-ramp Ratio at Decel. End
  - **3-8* Other Ramps**
    - 3-80 Jog Ramp Time
    - 3-81 Quick Stop Ramp Time
    - 3-82 Quick Stop Ramp Type
    - 3-83 Quick Stop S-ramp Ratio at Decel. Start
    - 3-84 Quick Stop S-ramp Ratio at Decel. End
  - **3-9* Digital Pot. Meter**
    - 3-90 Step Size
    - 3-91 Ramp Time
    - 3-92 Power Restore
    - 3-93 Maximum Limit
    - 3-94 Minimum Limit
    - 3-95 Ramp Delay
- **4-** Limits / Warnings**
  - **4-1* Motor Limits**
    - 4-10 Motor Speed Direction
    - 4-11 Motor Speed Low Limit [RPM]
    - 4-12 Motor Speed Low Limit [Hz]
    - 4-13 Motor Speed High Limit [RPM]
    - 4-14 Motor Speed High Limit [Hz]
    - 4-16 Torque Limit Motor Mode
    - 4-17 Torque Limit Generator Mode
    - 4-18 Current Limit
    - 4-19 Max Output Frequency
  - **4-2* Limit Factors**
    - 4-20 Torque Limit Factor Source
    - 4-21 Speed Limit Factor Source
  - **4-3* Motor Speed Mon.**
    - 4-30 Motor Feedback Loss Function
    - 4-31 Motor Feedback Speed Error
    - 4-32 Motor Feedback Loss Timeout
    - 4-34 Tracking Error Function
    - 4-35 Tracking Error
    - 4-36 Tracking Error Timeout
    - 4-37 Tracking Error Ramping
    - 4-38 Tracking Error Ramping Timeout
    - 4-39 Tracking Error After Ramping Timeout
  - **4-5* Adj. Warnings**
    - 4-50 Warning Current Low
    - 4-51 Warning Current High
    - 4-52 Warning Speed Low
    - 4-53 Warning Speed High
    - 4-54 Warning Reference Low
    - 4-55 Warning Reference High
    - 4-56 Warning Feedback Low
    - 4-57 Warning Feedback High
    - 4-58 Missing Motor Phase Function
  - **4-6* Speed Bypass**
    - 4-60 Bypass Speed From [RPM]
    - 4-61 Bypass Speed From [Hz]
    - 4-62 Bypass Speed To [RPM]
    - 4-63 Bypass Speed To [Hz]
- **5-** Digital In/Out**
  - **5-0* Digital I/O mode**
    - 5-00 Digital I/O Mode
    - 5-01 Terminal 27 Mode
    - 5-02 Terminal 29 Mode
  - **5-1* Digital Inputs**
    - 5-10 Terminal 18 Digital Input
    - 5-11 Terminal 19 Digital Input
    - 5-12 Terminal 27 Digital Input
    - 5-13 Terminal 29 Digital Input
    - 5-14 Terminal 32 Digital Input
    - 5-15 Terminal 33 Digital Input
    - 5-16 Terminal X30/2 Digital Input
    - 5-17 Terminal X30/3 Digital Input
    - 5-18 Terminal X30/4 Digital Input
    - 5-19 Terminal 37 Safe Stop
    - 5-20 Terminal X46/1 Digital Input
    - 5-21 Terminal X46/3 Digital Input
    - 5-22 Terminal X46/5 Digital Input
    - 5-23 Terminal X46/7 Digital Input
    - 5-24 Terminal X46/9 Digital Input
    - 5-25 Terminal X46/11 Digital Input
    - 5-26 Terminal X46/13 Digital Input
  - **5-3* Digital Outputs**
    - 5-30 Terminal 27 Digital Output
    - 5-31 Terminal 29 Digital Output
    - 5-32 Term X30/6 Digi Out (MCB 101)
    - 5-33 Term X30/7 Digi Out (MCB 101)
  - **5-4* Relays**
    - 5-40 Function Relay
    - 5-41 On Delay, Relay
    - 5-42 Off Delay, Relay
  - **5-5* Pulse Input**
    - 5-50 Term. 29 Low Frequency
    - 5-51 Term. 29 High Frequency
    - 5-52 Term. 29 Low Ref./Feedb. Value
    - 5-53 Term. 29 High Ref./Feedb. Value
    - 5-54 Pulse Filter Time Constant #29

5-55 Term. 33 Low Frequency
5-56 Term. 33 High Frequency
5-57 Term. 33 Low Ref./Feedb. Value
5-58 Term. 33 High Ref./Feedb. Value
5-59 Pulse Filter Time Constant #33
5-6* Pulse Output
5-60 Terminal 27 Pulse Output Variable
5-62 Pulse Output Max Freq #27
5-63 Terminal 29 Pulse Output Variable
5-65 Pulse Output Max Freq #29
5-66 Terminal X30/6 Pulse Output Variable
5-68 Pulse Output Max Freq #X30/6
5-7* 24V Encoder Input
5-70 Term 32/33 Pulses per Revolution
5-71 Term 32/33 Encoder Direction
5-9* Bus Controlled
5-90 Digital & Relay Bus Control
5-93 Pulse Out #27 Bus Control
5-94 Pulse Out #27 Timeout Preset
5-95 Pulse Out #29 Bus Control
5-96 Pulse Out #29 Timeout Preset
5-97 Pulse Out #X30/6 Bus Control
5-98 Pulse Out #X30/6 Timeout Preset
6- Analog In/Out**
6-0* Analog I/O Mode
6-00 Live Zero Timeout Time
6-01 Live Zero Timeout Function
6-1* Analog Input 1
6-10 Terminal 53 Low Voltage
6-11 Terminal 53 High Voltage
6-12 Terminal 53 Low Current
6-13 Terminal 53 High Current
6-14 Terminal 53 Low Ref./Feedb. Value
6-15 Terminal 53 High Ref./Feedb. Value
6-16 Terminal 53 Filter Time Constant
6-2* Analog Input 2
6-20 Terminal 54 Low Voltage
6-21 Terminal 54 High Voltage
6-22 Terminal 54 Low Current
6-23 Terminal 54 High Current
6-24 Terminal 54 Low Ref./Feedb. Value
6-25 Terminal 54 High Ref./Feedb. Value
6-26 Terminal 54 Filter Time Constant
6-3* Analog Input 53
6-30 Terminal X30/11 Low Voltage
6-31 Terminal X30/11 High Voltage
6-34 Term. X30/11 Low Ref./Feedb. Value
6-35 Term. X30/11 High Ref./Feedb. Value
6-36 Term. X30/11 Filter Time Constant
6-4* Analog Input 4
6-40 Terminal X30/12 Low Voltage
6-41 Terminal X30/12 High Voltage
6-44 Term. X30/12 Low Ref./Feedb. Value
6-45 Term. X30/12 High Ref./Feedb. Value
6-46 Term. X30/12 Filter Time Constant
6-5* Analog Output 1
6-50 Terminal 42 Output
6-51 Terminal 42 Output Min Scale
6-52 Terminal 42 Output Max Scale
6-53 Term 42 Output Bus Ctrl
6-54 Terminal 42 Output Timeout Preset
6-55 Analog Output Filter
6-6* Analog Output 2
6-60 Terminal X30/8 Output
6-61 Terminal X30/8 Min. Scale
6-62 Terminal X30/8 Max. Scale
6-63 Terminal X30/8 Bus Control
6-64 Terminal X30/8 Output Timeout Preset
6-7* Analog Output 3
6-70 Terminal X45/1 Output
6-71 Terminal X45/1 Min. Scale
6-72 Terminal X45/1 Max. Scale
6-73 Terminal X45/1 Bus Control
6-74 Terminal X45/1 Output Timeout Preset
6-8* Analog Output 4
6-80 Terminal X45/3 Output
6-81 Terminal X45/3 Min. Scale
6-82 Terminal X45/3 Max. Scale
6-83 Terminal X45/3 Bus Control
6-84 Terminal X45/3 Output Timeout Preset
7- Controllers**
7-0* Speed PID Ctrl.
7-00 Speed PID Feedback Source
7-02 Speed PID Proportional Gain
7-03 Speed PID Integral Time
7-04 Speed PID Differentiation Time
7-05 Speed PID Diff. Gain Limit
7-06 Speed PID Lowpass Filter Time
7-07 Speed PID Feedback Gear Ratio
7-08 Speed PID Feed Forward Factor
7-1* Torque PI Ctrl.
7-12 Torque PI Proportional Gain
7-13 Torque PI Integration Time
7-2* Process Ctrl. Feedb
7-20 Process CL Feedback 1 Resource
7-22 Process CL Feedback 2 Resource
7-3* Process PID Ctrl.
7-30 Process PID Normal/ Inverse Control
7-31 Process PID Anti Windup
7-32 Process PID Start Speed
7-33 Process PID Proportional Gain
7-34 Process PID Integral Time
7-35 Process PID Differentiation Time
7-36 Process PID Diff. Gain Limit
7-38 Process PID Feed Forward Factor
7-39 On Reference Bandwidth
7-4* Adv. Process PID I
7-40 Process PID I-part Reset
7-41 Process PID Output Neg. Clamp
7-42 Process PID Output Pos. Clamp
7-43 Process PID Gain Scale at Min. Ref.
7-44 Process PID Gain Scale at Max. Ref.
7-45 Process PID Feed Fwd Resource
7-46 Process PID Feed Fwd Normal/ Inv. Ctrl.
7-48 PCD Feed Forward
7-49 Process PID Output Normal/ Inv. Ctrl.
7-5* Adv. Process PID II
7-50 Process PID Extended PID
7-51 Process PID Feed Fwd Gain
7-52 Process PID Feed Fwd Ramp-up
7-53 Process PID Feed Fwd Ramp-down
7-56 Process PID Ref. Filter Time
7-57 Process PID Fb. Filter Time
8- Comm. and Options**
8-0* General Settings
8-01 Control Site
8-02 Control Word Source
8-03 Control Word Timeout Time
8-04 Control Word Timeout Function
8-05 End-of-Timeout Function
8-06 Reset Control Word Timeout
8-07 Diagnosis Trigger
8-08 Readout Filtering
8-1* Ctrl. Word Settings
8-10 Control Word Profile
8-13 Configurable Status Word STW
8-14 Configurable Control Word CTW
8-3* FC Port Settings
8-30 Protocol
8-31 Address
8-32 FC Port Baud Rate
8-33 Parity / Stop Bits
8-34 Estimated cycle time
8-35 Minimum Response Delay
8-36 Max Response Delay
8-37 Max Inter-Char Delay
8-4* FC MC protocol set
8-40 Telegram selection
8-41 Parameters for signals
8-42 PCD write configuration
8-43 PCD read configuration
8-5* Digital/Bus
8-50 Coasting Select
8-51 Quick Stop Select
8-52 DC Brake Select
8-53 Start Select
8-54 Reversing Select
8-55 Set-up Select
8-56 Preset Reference Select
8-57 Profidrive OFF2 Select
8-58 Profidrive OFF3 Select
8-8* FC Port Diagnostics
8-80 Bus Message Count
8-81 Bus Error Count
8-82 Slave Messages Rcvd
8-83 Slave Error Count
8-9* Bus Jog
8-90 Bus Jog 1 Speed
8-91 Bus Jog 2 Speed
9- PROFIdrive**
9-00 Setpoint
9-07 Actual Value
9-15 PCD Write Configuration
9-16 PCD Read Configuration
9-18 Node Address
9-22 Telegram Selection
9-23 Parameters for Signals
9-27 Parameter Edit
9-28 Process Control
9-44 Fault Message Counter
9-45 Fault Code
9-47 Fault Number
9-52 Fault Situation Counter
9-53 Profibus Warning Word
9-63 Actual Baud Rate
9-64 Device Identification
9-65 Profile Number
9-67 Control Word 1
9-68 Status Word 1
9-71 Profibus Save Data Values
9-72 ProfibusDriveReset
9-75 DO Identification
9-80 Defined Parameters (1)
9-81 Defined Parameters (2)
9-82 Defined Parameters (3)
9-83 Defined Parameters (4)
9-84 Defined Parameters (5)
9-90 Changed Parameters (1)
9-91 Changed Parameters (2)
9-92 Changed Parameters (3)
9-93 Changed parameters (4)
9-94 Changed parameters (5)
9-99 Profibus Revision Counter
10- CAN Fieldbus**
10-0* Common Settings
10-00 CAN Protocol
10-01 Baud Rate Select
10-02 MAC ID
10-05 Readout Transmit Error Counter
10-06 Readout Receive Error Counter
10-07 Readout Bus Off Counter
10-1* DeviceNet
10-10 Process Data Type Selection
10-11 Process Data Config Write
10-12 Process Data Config Read
10-13 Warning Parameter
10-14 Net Reference
10-15 Net Control
10-2* COS Filters
10-20 COS Filter 1
10-21 COS Filter 2
10-22 COS Filter 3
10-23 COS Filter 4
10-3* Parameter Access
10-30 Array Index
10-31 Store Data Values
10-32 DeviceNet Revision
10-33 Store Always
10-34 DeviceNet Product Code
10-39 DeviceNet F Parameters
10-5* CANopen
10-50 Process Data Config Write.
10-51 Process Data Config Read.
12- Ethernet**
12-0* IP Settings
12-00 IP Address Assignment
12-01 IP Address
12-02 Subnet Mask
12-03 Default Gateway
12-04 DHCP Server
12-05 Lease Expires
12-06 Name Servers
12-07 Domain Name
12-08 Host Name
12-09 Physical Address
12-1* Eth link par
12-10 Link Status
12-11 Link Duration
12-12 Auto Negotiation
12-13 Link Speed
12-14 Link Duplex
12-2* Process Data
12-20 Control Instance
12-21 Process Data Config Write
12-22 Process Data Config Read
12-23 Process Data Config Write Size
12-24 Process Data Config Read Size
12-27 Primary Master
12-28 Store Data Values
12-29 Store Always
12-3* EtherNet/IP
12-30 Warning Parameter
12-31 Net Reference
12-32 Net Control
12-33 CIP Revision
12-34 CIP Product Code
12-35 EDS Parameter
12-37 COS Inhibit Timer
12-38 COS Filter
12-4* Modbus TCP
12-40 Status Parameter
12-41 Slave Message Count
12-42 Slave Exception Message Count
12-5* EtherCAT
12-50 Configured Station Alias
12-51 Configured Station Address
12-59 EtherCAT Status
12-8* Other Ethernet Services
12-80 FTP Server
12-81 HTTP Server
12-82 SMTP Service
12-89 Transparent Socket Channel Port
12-9* Advanced Ethernet Services
12-90 Cable Diagnostic
12-91 Auto Cross Over
12-92 IGMP Snooping
12-93 Cable Error Length
12-94 Broadcast Storm Protection
12-95 Broadcast Storm Filter
12-96 Port Config
12-98 Interface Counters

12-99 Media Counters
13- Smart Logic**
13-0* SLC Settings
13-00 SL Controller Mode
13-01 Start Event
13-02 Stop Event
13-03 Reset SLC
13-1* Comparators
13-10 Comparator Operand
13-11 Comparator Operator
13-12 Comparator Value
13-1* RS Flip Flops
13-15 RS-FF Operand S
13-16 RS-FF Operand R
13-2* Timers
13-20 SL Controller Timer
13-4* Logic Rules
13-40 Logic Rule Boolean 1
13-41 Logic Rule Operator 1
13-42 Logic Rule Boolean 2
13-43 Logic Rule Operator 2
13-44 Logic Rule Boolean 3
13-5* States
13-51 SL Controller Event
13-52 SL Controller Action
14- Special Functions**
14-0* Inverter Switching
14-00 Switching Pattern
14-01 Switching Frequency
14-03 Overmodulation
14-04 PWM Random
14-06 Dead Time Compensation
14-1* Mains On/Off
14-10 Mains Failure
14-11 Mains Voltage at Mains Fault
14-12 Function at Mains Imbalance
14-13 Mains Failure Step Factor
14-14 Kin. Backup Timeout
14-2* Trip Reset
14-20 Reset Mode
14-21 Automatic Restart Time
14-22 Operation Mode
14-23 Typecode Setting
14-24 Trip Delay at Current Limit
14-25 Trip Delay at Torque Limit
14-26 Trip Delay at Inverter Fault
14-28 Production Settings
14-29 Service Code
14-3* Current Limit Ctrl.
14-30 Current Lim Ctrl, Proportional Gain
14-31 Current Lim Ctrl, Integration Time
14-32 Current Lim Ctrl, Filter Time
14-35 Stall Protection
14-4* Energy Optimizing
14-40 VT Level
14-41 AEO Minimum Magnetization
14-42 Minimum AEO Frequency
14-43 Motor Cos-Phi
14-5* Environment
14-50 RFI filter
14-51 DC Link Compensation
14-52 Fan Control
14-53 Fan Monitor
14-55 Output Filter
14-56 Capacitance Output Filter
14-57 Inductance Output Filter
14-59 Actual Number of Inverter Units
14-7* Compatibility
14-72 Legacy Alarm Word
14-73 Legacy Warning Word
14-74 Leg. Ext. Status Word
14-8* Options
14-80 Option Supplied by External 24VDC
14-89 Option Detection
14-9* Fault Settings
14-90 Fault Level
15- Drive Information**
15-0* Operating Data
15-00 Operating Hours
15-01 Running Hours
15-02 kWh Counter
15-03 Power-ups
15-04 Over Temps
15-05 Over Volts
15-06 Reset kWh Counter
15-07 Reset Running Hours Counter
15-1* Data Log Settings
15-10 Logging Source
15-11 Logging Interval
15-12 Trigger Event
15-13 Logging Mode
15-14 Samples Before Trigger
15-2* Historic Log
15-20 Historic Log: Event
15-21 Historic Log: Value
15-22 Historic Log: Time
15-3* Fault Log
15-30 Fault Log: Error Code
15-31 Fault Log: Value
15-32 Fault Log: Time
15-4* Drive Identification
15-40 FC Type
15-41 Power Section
15-42 Voltage
15-43 Software Version
15-44 Ordered Typecode String
15-45 Actual Typecode String
15-46 Frequency Converter Ordering No
15-47 Power Card Ordering No
15-48 LCP ID No
15-49 SW ID Control Card
15-50 SW ID Power Card
15-51 Frequency Converter Serial Number
15-53 Power Card Serial Number
15-59 CSIV Filename
15-6* Option Ident
15-60 Option Mounted
15-61 Option SW Version
15-62 Option Ordering No
15-63 Option Serial No
15-70 Option in Slot A
15-71 Slot A Option SW Version
15-72 Option in Slot B
15-73 Slot B Option SW Version
15-74 Option in Slot C0
15-75 Slot C0 Option SW Version
15-76 Option in Slot C1
15-77 Slot C1 Option SW Version
15-9* Parameter Info
15-92 Defined Parameters
15-93 Modified Parameters
15-98 Drive Identification
15-99 Parameter Metadata
16- Data Readouts**
16-0* General Status
16-00 Control Word
16-01 Reference [Unit]
16-02 Reference %
16-03 Status Word
16-05 Main Actual Value [%]
16-09 Custom Readout
16-1* Motor Status
16-10 Power [kW]
16-11 Power [hp]
16-12 Motor Voltage
16-13 Frequency
16-14 Motor Current
16-15 Frequency [%]
16-16 Torque [Nm]
16-17 Speed [RPM]
16-18 Motor Thermal
16-19 KTY sensor temperature
16-20 Motor Angle
16-21 Torque [%] High Res.
16-22 Torque [%]
16-25 Torque [Nm] High
16-3* Drive Status
16-30 DC Link Voltage
16-32 Brake Energy /s
16-33 Brake Energy /2 min
16-34 Heatsink Temp.
16-35 Inverter Thermal
16-36 Inv. Nom. Current
16-37 Inv. Max. Current
16-38 SL Controller State
16-39 Control Card Temp.
16-40 Logging Buffer Full
16-41 LCP Bottom Statusline
16-49 Current Fault Source
16-5* Ref. & Feedb.
16-50 External Reference
16-51 Pulse Reference
16-52 Feedback [Unit]
16-53 Digi Pot Reference
16-57 Feedback [RPM]
16-6* Inputs & Outputs
16-60 Digital Input
16-61 Terminal 53 Switch Setting
16-62 Analog Input 53
16-63 Terminal 54 Switch Setting
16-64 Analog Input 54
16-65 Analog Output 42 [mA]
16-66 Digital Output [bin]
16-67 Freq. Input #29 [Hz]
16-68 Freq. Input #33 [Hz]
16-69 Pulse Output #27 [Hz]
16-70 Pulse Output #29 [Hz]
16-71 Relay Output [bin]
16-72 Counter A
16-73 Counter B
16-74 Prec. Stop Counter
16-75 Analog In X30/11
16-76 Analog In X30/12
16-77 Analog Out X30/8 [mA]
16-78 Analog Out X45/1 [mA]
16-79 Analog Out X45/3 [mA]
16-8* Fieldbus & FC Port
16-80 Fieldbus CTW 1
16-82 Fieldbus REF 1
16-84 Comm. Option STW
16-85 FC Port CTW 1
16-86 FC Port REF 1
16-9* Diagnosis Readouts
16-90 Alarm Word
16-91 Alarm Word 2
16-92 Warning Word
16-93 Warning Word 2
16-94 Ext. Status Word
17- Feedback Option**
17-1* Inc. Enc. Interface
17-10 Signal Type
17-11 Resolution (PPR)
17-2* Abs. Enc. Interface
17-20 Protocol Selection
17-21 Resolution (Positions/Rev)
17-24 SSI Data Length
17-25 Clock Rate
17-26 SSI Data Format
17-34 HIPERFACE Baud rate
17-5* Resolver Interface
17-50 Poles
17-51 Input Voltage
17-52 Input Frequency
17-53 Transformation Ratio
17-56 Encoder Sim. Resolution
17-59 Resolver Interface
17-6* Monitoring and App.
17-60 Feedback Direction
17-61 Feedback Signal Monitoring
18- Data Readouts 2**
18-3* Analog Readouts
18-36 Analog Input X48/2 [mA]
18-37 Temp. Input X48/4
18-38 Temp. Input X48/7
18-39 Temp. Input X48/10
18-6* Inputs & Outputs 2
18-60 Digital Input 2
18-90 PID Readouts
18-90 Process PID Error
18-91 Process PID Output
18-92 Process PID Clamped Output
18-93 Process PID Gain Scaled Output
30- Special Features**
30-0* Wobbler
30-00 Wobble Mode
30-01 Wobble Delta Frequency [Hz]
30-02 Wobble Delta Frequency [%]
30-03 Wobble Delta Freq. Scaling Resource
30-04 Wobble Jump Frequency [Hz]
30-05 Wobble Jump Frequency [%]
30-06 Wobble Jump Time
30-07 Wobble Sequence Time
30-08 Wobble Up/Down Time
30-09 Wobble Random Function
30-10 Wobble Ratio
30-11 Wobble Random Ratio Max.
30-12 Wobble Random Ratio Min.
30-19 Wobble Delta Freq. Scaled
30-2* Adv. Start Adjust
30-20 High Starting Torque Time [s]
30-21 High Starting Torque Current [%]
30-22 Locked Rotor Protection
30-23 Locked Rotor Detection Time [s]
30-8* Compatibility (I)
30-80 d-axis Inductance (Ld)
30-81 Brake Resistor (ohm)
30-83 Speed PID Proportional Gain
30-84 Process PID Proportional Gain
31- Bypass Option**
31-00 Bypass Mode
31-01 Bypass Start Time Delay
31-02 Bypass Trip Time Delay
31-03 Test Mode Activation
31-10 Bypass Status Word
31-11 Bypass Running Hours
31-19 Remote Bypass Activation
32- MCO Basic Settings**
32-0* Encoder 2
32-00 Incremental Signal Type
32-01 Incremental Resolution
32-02 Absolute Protocol
32-03 Absolute Resolution
32-04 Absolute Encoder Baud Rate X55
32-05 Absolute Encoder Data Length
32-06 Absolute Encoder Clock Frequency
32-07 Absolute Encoder Clock Generation
32-08 Absolute Encoder Cable Length
32-09 Encoder Monitoring
32-10 Rotational Direction
32-11 User Unit Denominator
32-12 User Unit Numerator
32-13 Enc.2 Control
32-14 Enc.2 node ID
32-15 Enc.2 CAN guard

- **32-3* Encoder 1**
- 32-30 Incremental Signal Type
- 32-31 Incremental Resolution
- 32-32 Absolute Protocol
- 32-33 Absolute Resolution
- 32-35 Absolute Encoder Data Length
- 32-36 Absolute Encoder Clock Frequency
- 32-37 Absolute Encoder Clock Generation
- 32-38 Absolute Encoder Cable Length
- 32-39 Encoder Monitoring
- 32-40 Encoder Termination
- 32-43 Enc.1 Control
- 32-44 Enc.1 node ID
- 32-45 Enc.1 CAN guard
- **32-5* Feedback Source**
- 32-50 Source Slave
- 32-51 MCO 302 Last Will
- 32-52 Source Master
- **32-6* PID Controller**
- 32-60 Proportional factor
- 32-61 Derivative factor
- 32-62 Integral factor
- 32-63 Limit Value for Integral Sum
- 32-64 PID Bandwidth
- 32-65 Velocity Feed-Forward
- 32-66 Acceleration Feed-Forward
- 32-67 Max. Tolerated Position Error
- 32-68 Reverse Behavior for Slave
- 32-69 Sampling Time for PID Control
- 32-70 Scan Time for Profile Generator
- 32-71 Size of the Control Window (Activation)
- 32-72 Size of the Control Window (Deactiv.)
- 32-73 Integral limit filter time
- 32-74 Position error filter time
- **32-8* Velocity & Accel.**
- 32-80 Maximum Velocity (Encoder)
- 32-81 Shortest Ramp
- 32-82 Ramp Type
- 32-83 Velocity Resolution
- 32-84 Default Velocity
- 32-85 Default Acceleration
- 32-86 Acc. up for limited jerk
- 32-87 Acc. down for limited jerk
- 32-88 Dec. up for limited jerk
- 32-89 Dec. down for limited jerk
- **32-9* Development**
- 32-90 Debug Source
- **33-** MCO Adv. Settings**
- **33-0* Home Motion**
- 33-00 Force HOME
- 33-01 Zero Point Offset from Home Pos.
- 33-02 Ramp for Home Motion
- 33-03 Velocity of Home Motion
- 33-04 Behavior during Home Motion
- **33-1* Synchronization**
- 33-10 Synchronization Factor Master
- 33-11 Synchronization Factor Slave
- 33-12 Position Offset for Synchronization
- 33-13 Accuracy Window for Position Sync.
- 33-14 Relative Slave Velocity Limit
- 33-15 Marker Number for Master
- 33-16 Marker Number for Slave
- 33-17 Master Marker Distance
- 33-18 Slave Marker Distance
- 33-19 Master Marker Type
- 33-20 Slave Marker Type
- 33-21 Master Marker Tolerance Window
- 33-22 Slave Marker Tolerance Window
- 33-23 Start Behavior for Marker Sync
- 33-24 Marker Number for Fault
- 33-25 Marker Number for Ready
- 33-26 Velocity Filter
- 33-27 Offset Filter Time
- 33-28 Marker Filter Configuration
- 33-29 Filter Time for Marker Filter
- 33-30 Maximum Marker Correction
- 33-31 Synchronization Type
- 33-32 Feed Forward Velocity Adaptation
- 33-33 Velocity Filter Window
- 33-34 Slave Marker filter time
- **33-4* Limit Handling**
- 33-40 Behavior at End Limit Switch
- 33-41 Negative Software End Limit
- 33-42 Positive Software End Limit
- 33-43 Negative Software End Limit Active
- 33-44 Positive Software End Limit Active
- 33-45 Time in Target Window
- 33-46 Target Window LimitValue
- 33-47 Size of Target Window
- **33-5* I/O Configuration**
- 33-50 Terminal X57/1 Digital Input
- 33-51 Terminal X57/2 Digital Input
- 33-52 Terminal X57/3 Digital Input
- 33-53 Terminal X57/4 Digital Input
- 33-54 Terminal X57/5 Digital Input
- 33-55 Terminal X57/6 Digital Input
- 33-56 Terminal X57/7 Digital Input
- 33-57 Terminal X57/8 Digital Input
- 33-58 Terminal X57/9 Digital Input
- 33-59 Terminal X57/10 Digital Input
- 33-60 Terminal X59/1 and X59/2 Mode
- 33-61 Terminal X59/1 Digital Input
- 33-62 Terminal X59/2 Digital Input
- 33-63 Terminal X59/1 Digital Output
- 33-64 Terminal X59/2 Digital Output
- 33-65 Terminal X59/3 Digital Output
- 33-66 Terminal X59/4 Digital Output
- 33-67 Terminal X59/5 Digital Output
- 33-68 Terminal X59/6 Digital Output
- 33-69 Terminal X59/7 Digital Output
- 33-70 Terminal X59/8 Digital Output
- **33-8* Global Parameters**
- 33-80 Activated Program Number
- 33-81 Power-up State
- 33-82 Drive Status Monitoring
- 33-83 Behavior after Error
- 33-84 Behavior afterEsc.
- 33-85 MCO Supplied by External 24VDC
- 33-86 Terminal at alarm
- 33-87 Terminal state at alarm
- 33-88 Status word at alarm
- **33-9* MCO Port Settings**
- 33-90 X62 MCO CAN node ID
- 33-91 X62 MCO CAN baud rate
- 33-94 X60 MCO RS485 serial termination
- 33-95 X60 MCO RS485 serial baud rate
- **34-** MCO Data Readouts**
- **34-0* PCD Write Par.**
- 34-01 PCD 1 Write to MCO
- 34-02 PCD 2 Write to MCO
- 34-03 PCD 3 Write to MCO
- 34-04 PCD 4 Write to MCO
- 34-05 PCD 5 Write to MCO
- 34-06 PCD 6 Write to MCO
- 34-07 PCD 7 Write to MCO
- 34-08 PCD 8 Write to MCO
- 34-09 PCD 9 Write to MCO
- 34-10 PCD 10 Write to MCO
- **34-2* PCD Read Par.**
- 34-21 PCD 1 Read from MCO
- 34-22 PCD 2 Read from MCO
- 34-23 PCD 3 Read from MCO
- 34-24 PCD 4 Read from MCO
- 34-25 PCD 5 Read from MCO
- 34-26 PCD 6 Read from MCO
- 34-27 PCD 7 Read from MCO
- 34-28 PCD 8 Read from MCO
- 34-29 PCD 9 Read from MCO
- 34-30 PCD 10 Read from MCO
- **34-4* Inputs & Outputs**
- 34-40 Digital Inputs
- 34-41 Digital Outputs
- **34-5* Process Data**
- 34-50 Actual Position
- 34-51 Commanded Position
- 34-52 Actual Master Position
- 34-53 Slave Index Position
- 34-54 Master Index Position
- 34-55 Curve Position
- 34-56 Track Error
- 34-57 Synchronizing Error
- 34-58 Actual Velocity
- 34-59 Actual Master Velocity
- 34-60 Synchronizing Status
- 34-61 Axis Status
- 34-62 Program Status
- 34-64 MCO 302 Status
- 34-65 MCO 302 Control
- **34-7* Diagnosis readouts**
- 34-70 MCO Alarm Word 1
- 34-71 MCO Alarm Word 2
- **35-** Sensor Input Option**
- **35-0* Temp. Input Mode**
- 35-00 Term. X48/4 Temp. Unit
- 35-01 Term. X48/4 Input Type
- 35-02 Term. X48/7 Temp. Unit
- 35-03 Term. X48/7 Input Type
- 35-04 Term. X48/10 Temp. Unit
- 35-05 Term. X48/10 Input Type
- 35-06 Temperature Sensor Alarm Function
- **35-1* Temp. Input X48/4**
- 35-14 Term. X48/4 Filter Time Constant
- 35-15 Term. X48/4 Temp. Monitor
- 35-16 Term. X48/4 Low Temp. Limit
- 35-17 Term. X48/4 High Temp. Limit
- **35-2* Temp. Input X48/7**
- 35-24 Term. X48/7 Filter Time Constant
- 35-25 Term. X48/7 Temp. Monitor
- 35-26 Term. X48/7 Low Temp. Limit
- 35-27 Term. X48/7 High Temp. Limit
- **35-3* Temp. Input X48/10**
- 35-34 Term. X48/10 Filter Time Constant
- 35-35 Term. X48/10 Temp. Monitor
- 35-36 Term. X48/10 Low Temp. Limit
- 35-37 Term. X48/10 High Temp. Limit
- **35-4* Analog Input X48/2**
- 35-42 Term. X48/2 Low Current
- 35-43 Term. X48/2 High Current
- 35-44 Term. X48/2 Low Ref./Feedb. Value
- 35-45 Term. X48/2 High Ref./Feedb. Value
- 35-46 Term. X48/2 Filter Time Constant

5.7 Remote Programming with

GE has a software program available for developing, storing, and transferring drive programming. The allows the user to connect a PC to the drive and perform live programming rather than using the Keypad. Also, all drive programming can be done off-line and simply downloaded into drive. Or the entire 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 drive.

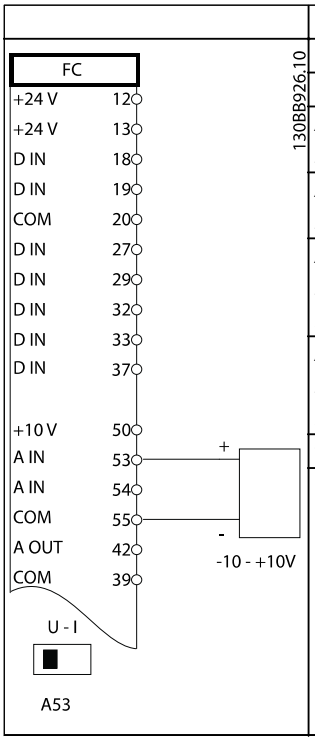
6 Application Set-Up Examples

6.1 Introduction

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

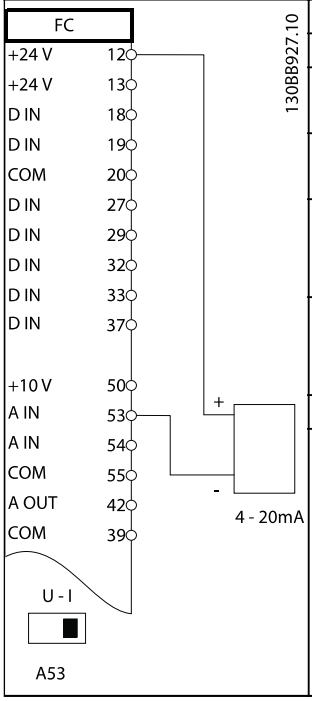
- Parameter settings are the regional default values unless otherwise indicated (selected in *K-03 Regional Settings*)
- Parameters associated with the terminals and their settings are shown next to the drawings.
- Where switch settings for analog terminals A53 or A54 are required, these are also shown.

6.2 Application Examples



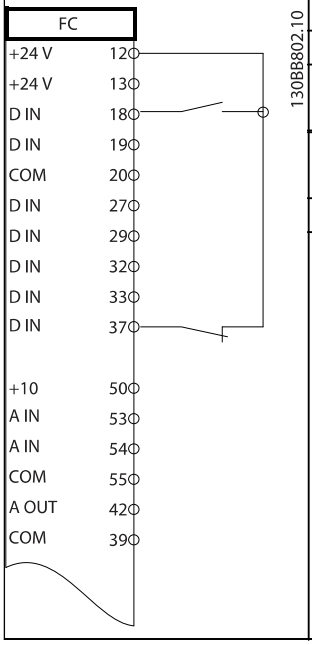
	Parameters	
	Function	**Setting**
	AN-10 Terminal 53 Low Voltage	0.07 V*
	AN-11 Terminal 53 High Voltage	10 V*
	AN-14 Terminal 53 Low Ref./ Feedb. Value	0 RPM
	AN-15 Terminal 53 High Ref./ Feedb. Value	1500RPM
	* = Default Value	
	Notes/comments:	

Table 6.1 Analog Speed Reference (Voltage)



	Parameters	
	Function	**Setting**
	AN-12 Terminal 53 Low Current	4 mA*
	AN-13 Terminal 53 High Current	20 mA*
	AN-14 Terminal 53 Low Ref./ Feedb. Value	0 RPM
	AN-15 Terminal 53 High Ref./ Feedb. Value	1500RPM
	* = Default Value	
	Notes/comments:	

Table 6.2 Analog Speed Reference (Current)



	Parameters	
	Function	**Setting**
	E-01 Terminal 18 Digital Input	[8] Start*
	E-07 Terminal 37 Safe Stop	[1] Safe Stop Alarm
	* = Default Value	
	Notes/comments:	

Table 6.3 Start/Stop Command with Safe Stop

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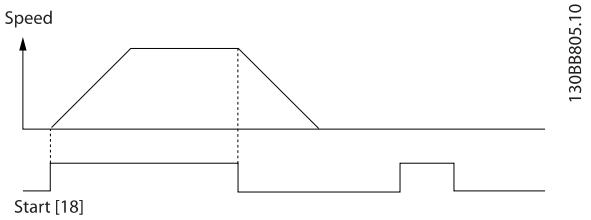
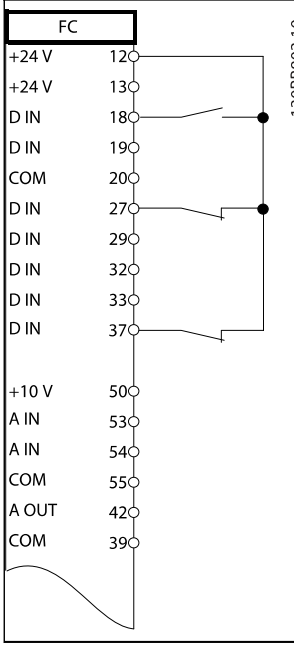


Figure 6.1



	Parameters	
	Function	**Setting**
	E-01 Terminal 18 Digital Input	[9] Latched Start
	E-03 Terminal 27 Digital Input	[6] Stop Inverse
* = Default Value		
Notes/comments:		

Table 6.4 Pulse Start/Stop

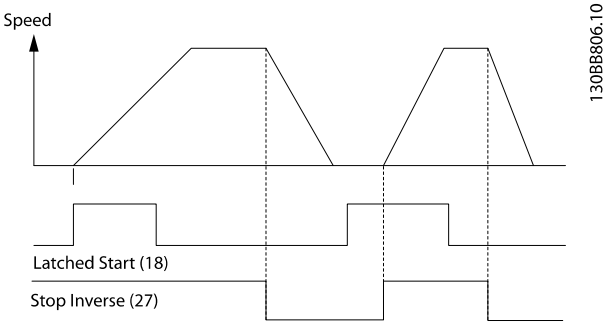
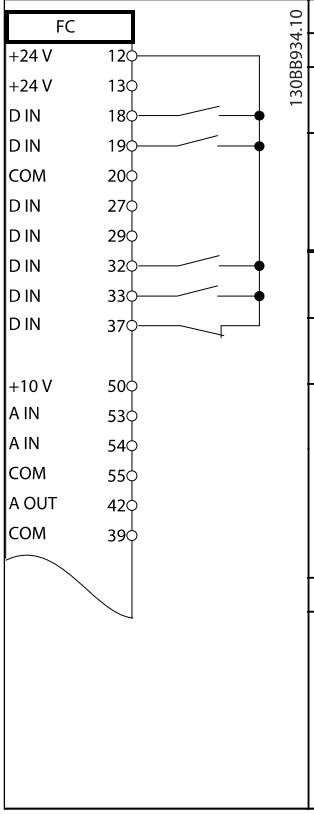
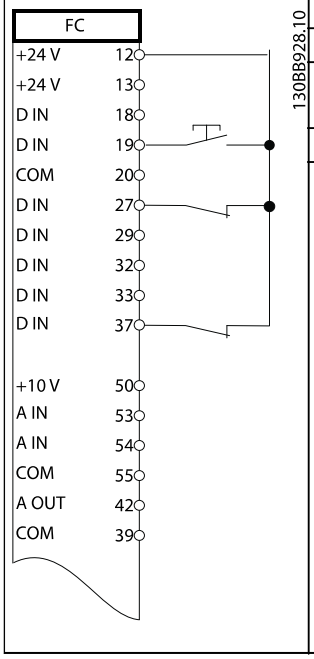


Figure 6.2



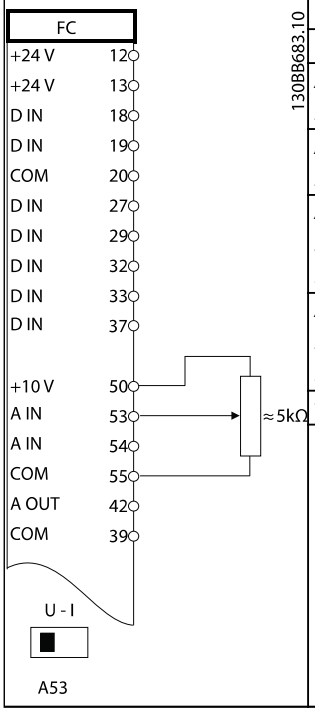
	Parameters	
	Function	**Setting**
	E-01 Terminal 18 Digital Input	[8] Start
	E-02 Terminal 19 Digital Input	[10] Reversing*
	E-05 Terminal 32 Digital Input	[16] Preset ref bit 0
	E-06 Terminal 33 Digital Input	[17] Preset ref bit 1
	C-05 Multi-step Frequency 1 - 8	
	Preset ref. 0	25%
	Preset ref. 1	50%
	Preset ref. 2	75%
	Preset ref. 3	100%
* = Default Value		
Notes/comments:		

Table 6.5 Start/Stop with Reversing and Four Preset Speeds



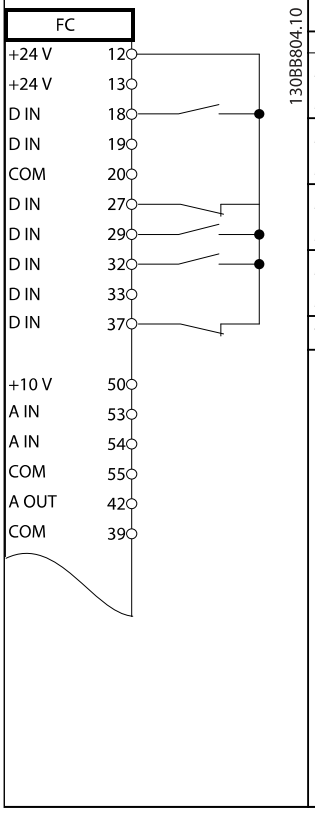
	Parameters	
	Function	**Setting**
	E-02 Terminal 19 Digital Input	[1] Reset
* = Default Value		
Notes/comments:		

Table 6.6 External Alarm Reset



Parameters	
Function	**Setting**
AN-10 Terminal 53 Low Voltage	0.07 V*
AN-11 Terminal 53 High Voltage	10 V*
AN-14 Terminal 53 Low Ref./ Feedb. Value	0 RPM
AN-15 Terminal 53 High Ref./ Feedb. Value	1500RPM
* = Default Value	
Notes/comments:	

Table 6.7 Speed Reference (using a manual potentiometer)



Parameters	
Function	**Setting**
E-01 Terminal 18 Digital Input	[8] Start*
E-03 Terminal 27 Digital Input	[19] Freeze Reference
E-04 Terminal 29 Digital Input	[21] Speed Up
E-05 Terminal 32 Digital Input	[22] Slow
* = Default Value	
Notes/comments:	

Table 6.8 Speed Up/Down

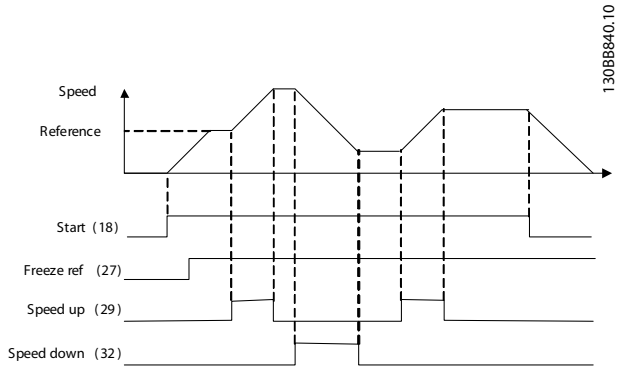
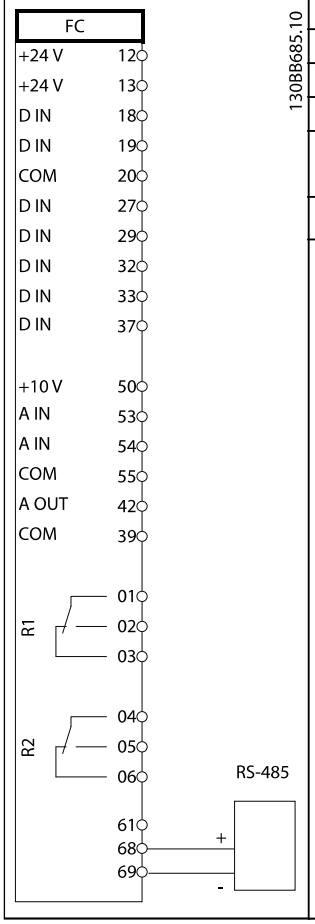


Figure 6.3

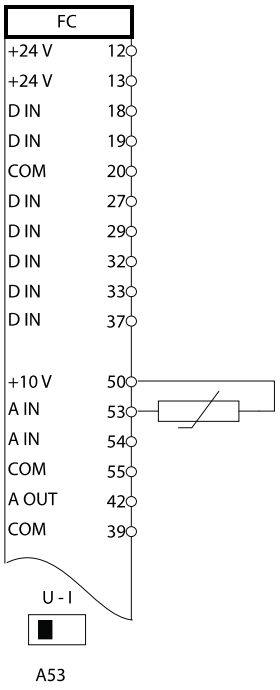


Parameters	
Function	**Setting**
O-30 Protocol	Modbus*
O-31 Address	1*
O-32 Drive Port Baud Rate	9600*
* = Default Value	
Notes/comments: Select protocol, address and baud rate in the above mentioned parameters.	

Table 6.9 RS-485 Network Connection

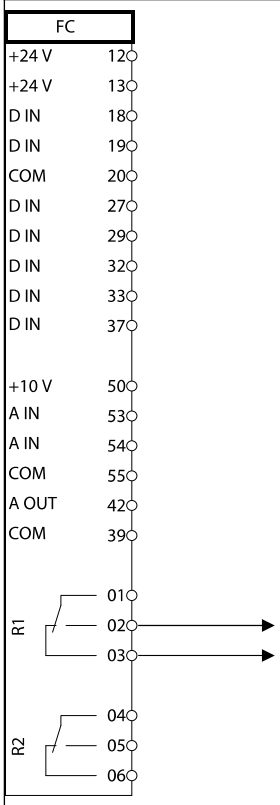
CAUTION

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



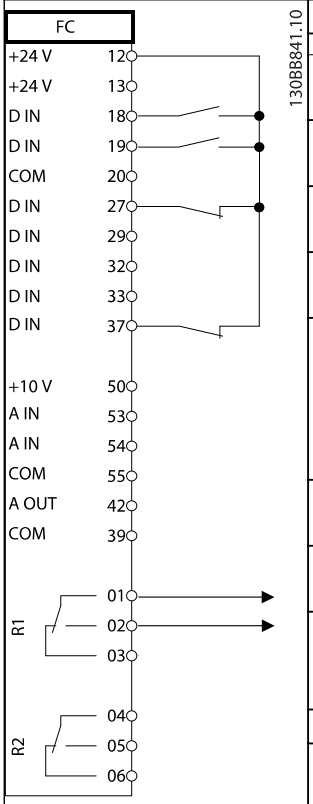
	Parameters	
	Function	**Setting**
	F-10 Electronic Overload	[2] Thermistor trip
	F-12 Motor Thermistor Input	[1] Analog input 53
	* = Default Value	
	Notes/comments: If only a warning is desired, *F-10 Electronic Overload* should be set to [1] *Thermistor warning*.	

Table 6.10 Motor Thermistor



	Parameters	
	Function	**Setting**
	H-20 Motor Feedback Loss Function	[1] Warning
	H-21 Motor Feedback Speed Error	100 RPM
	H-22 Motor Feedback Loss Timeout	5 sec
	LC-00 Logic Controller Mode	[1] On
	LC-01 Start Event	[19] Warning
	LC-02 Stop Event	[44] Reset key
	LC-10 Comparator Operand	[21] Warning number
	LC-11 Comparator Operator	[1] ≈*
	LC-12 Comparator Value	90
	LC-51 Logic Controller Event	[22] Comparator 0
	LC-52 Logic Controller Action	[32] Set digital out A low
	E-24 Function Relay	[80] Logic Controller digital output A
	* = Default Value	
	Notes/comments: If the limit in the feedback monitor is exceeded, Warning 90 will be issued. The monitors Warning 90 and in the case that 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 Keypad.	

Table 6.11 Using Logic Controller to Set a Relay



Parameters	
Function	**Setting**
E-24 Function Relay	[32] Mech. brake ctrl.
E-01 Terminal 18 Digital Input	[8] Start*
E-02 Terminal 19 Digital Input	[11] Start reversing
F-24 Holding Time	0.2
F-25 Start Function	[5] Advanced Vector Control/ FLUX Clockwise
F-29 Start Current	Im,n
B-20 Release Brake Current	Application dependent
B-21 Activate Brake Speed [RPM]	Half of nominal slip of the motor
* = Default Value	
Notes/comments:	

Table 6.12 Mechanical Brake Control

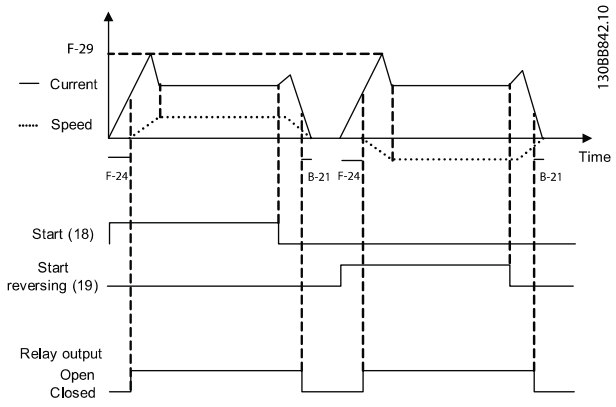


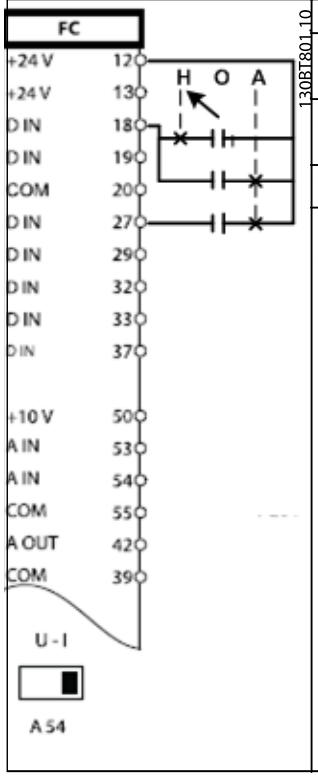
Figure 6.4

Hand Off Auto (HOA), without the use of the drive keypad

To have a HOA system with an external 0–10 V potentiometer for the hand reference and a 4–20 mA signal for the auto reference, 2 set-ups should be used. In this example, set-up 1 is used for the hand mode and set-up 2 for the auto mode. Analog input 53 is used for the hand reference (0–10 V potentiometer) and analog input 54 for the auto reference (4–20 mA) and digital input 27 for the set-up selector. Please ensure that the analog inputs have the correct dip settings (A-53 [U] and A-54 [I]).

In the upper right corner of the keypad, two numbers are shown, e.g., 1(1). The number outside the parenthesis is the active set-up and the number inside the parenthesis is the set-up which will be edited. Default will always be 1(1). Make sure you edit set-up 1.

1. Make all the parameter changes you need, that will be common for auto and hand mode, like motor parameters, etc.
2. Set par. K-10 Active set-up to [9] Multi Set-up. This parameter change is needed to be able to change set-up from an external source, like a digital input.
3. Set par. K-11 Edit Set-up to [9] Active Set-up. This is recommended because then the active set-up will always be the set-up that is edited. If you prefer, you can also ignore this and manually control what set-up you want to edit through par. K-11.
4. Set par. E-03 Terminal 27 Digital Input to [23] Set-up select bit 0. When terminal 27 is OFF, set-up 1 (hand) is active, when it is ON, set-up 2 (auto) is active.
5. Set par. F-01 Frequency Setting 1 to Analog input 53 (hand mode).
6. Copy set-up 1 to set-up 2. Set par. K-51 Set-up Copy to [2] Copy to set-up 2. Now set-up 1 and 2 are identical.
7. If you need to be able to change between hand and auto mode while the motor is running, you will have to link the 2 set-ups together. Set par. K-12 This Set-up Linked to [2] set-up 2.
8. Change to set-up 2 by setting input 27 ON (if par. K-11 is [9]) or by setting par. K-11 Edit Set-up to set-up 2.
9. Set par. F-01 Frequency Setting 1 to Analog input 54 (auto mode). If you want different settings in hand and auto mode, such as different accel/ decel ramps, speed limits, etc., you can now program them. You just have to make sure you edit the correct set-up. Set-up 1 is hand mode, and set-up 2 is auto mode.



	Parameters	
	Function	**Setting**
	E-01 Terminal 18 Digital Input	[8] Start*
	E-03 Terminal 27 Digital Input	[23[Set-up select bit 0
	* = Default Value	
	Notes/comments: GE 30mm HOA Cat# (1) 104PSG34B & (3) CR104PXC1	

Table 6.13 HOA

7 Status Messages

7.1 Status Display

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

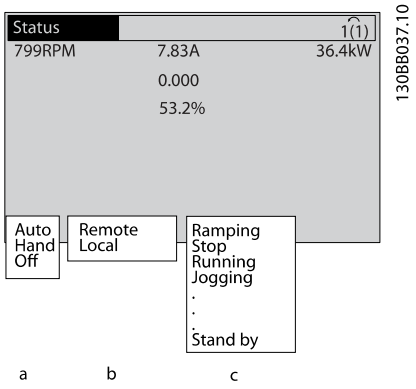


Figure 7.1 Status Display

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 drive status. These show the operational mode the drive is in.

NOTE!

In auto/remote mode, the 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] or [Hand] is pressed.
Auto	The adjustable frequency drive is controlled from the control terminals and/or the serial communication.
Hand	The adjustable frequency drive can be controlled by the navigation keys on the Keypad. 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] control or reference values from the Keypad.

Table 7.2

	Operation status
AC Brake	AC Brake was selected in *B-10 Brake Function*. The AC brake over-magnetizes the motor to achieve a controlled slow down.
Auto Tune finish OK	Auto Tune was carried out successfully.
Auto Tune ready	Auto Tune is ready to start. Press [Hand] to start.
Auto Tune running	Auto Tune 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 *B-12 Brake Power Limit (kW)* is reached.

	Operation status
Coast	• Coast inverse was selected as a function for a digital input (parameter group E-0#). The corresponding terminal is not connected. • Coast activated by serial communication
Ctrl. Ramp	Control Ramp was selected in *SP-10 Line failure*. • The AC line voltage is below the value set in *SP-11 Line Voltage at Input Fault* at line power fault • The adjustable frequency drive ramps down the motor using a controlled ramp-
Current High	The adjustable frequency drive output current is above the limit set in *H-71 Warning Current High*.
Current Low	The adjustable frequency drive output current is below the limit set in *H-70 Warning Current Low*
DC Hold	DC hold is selected in *H-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *B-00 DC Hold Current*.
DC Stop	The motor is held with a DC current (*B-01 DC Brake Current*) for a specified time (*B-02 DC Braking Time*). • DC Brake is activated in *B-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 E-0#). 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 *H-77 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *H-76 Warning Feedback Low*.
Freeze output	The remote reference is active which holds the present speed. • Freeze output was selected as a function for a digital input (parameter group E-0#). The corresponding terminal is active. Speed control is only possible via the terminal functions speed up and slow. • Hold ramp is activated via serial communi-cation.

	Operation status
Freeze output request	A freeze output command has been given, but the motor will remain stopped until a run permissive signal is received.
Freeze ref.	*Freeze Reference* was chosen as a function for a digital input (parameter group E-0#). 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 *C-21 Jog Speed [RPM]*. • *Jog* was selected as function for a digital input (parameter group E-0#). 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 *H-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.
OVC control	*Overvoltage* control was activated in *B-17 Over-voltage 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 24 V power supply installed only.) Line power supply to the adjustable frequency drive is removed, but the control card is supplied by the external 24 V.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10sec. • Protection mode can be restricted in *SP-26 Trip Delay at Drive Fault*

	Operation status
QStop	The motor is decelerating using *C-23 Quick Stop Decel Time*. • *Quick stop inverse* was chosen as a function for a digital input (parameter group E-0#). 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-. 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 *H-75 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *H-74 Warning Reference Low*.
Run on ref.	The adjustable frequency drive is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command has been given, but the motor is stopped until a run permissive signal is received via digital input.
Running	The motor is driven by the adjustable frequency drive.
Speed high	Motor speed is above the value set in *H-73 Warning Speed High*.
Speed low	Motor speed is below the value set in *H-72 Warning Speed Low*.
Standby	In Auto mode, the adjustable frequency drive will start the motor with a start signal from a digital input or serial communication.
Start delay	In *F-24 Holding Time*, 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 E-0#). 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 Keypad, 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

8 Warnings and Alarms

8.1 System Monitoring

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

Alarms
Trip
An alarm is issued when the drive is tripped, that is, the drive suspends operation to prevent drive or system damage. The motor will coast to a stop. The drive logic will continue to operate and monitor the drive status. After the fault condition is remedied, the 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 Keypad
- Digital reset input command
- Serial communication reset input command
- Auto reset

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

8.3 Warning and Alarm Displays

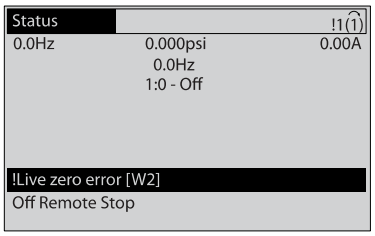


Figure 8.1

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

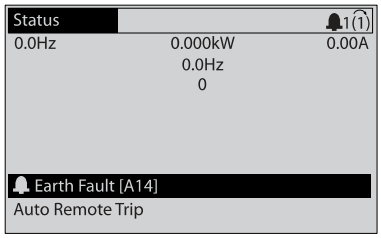


Figure 8.2

In addition to the text and alarm code on the drive display, the status indicator lights operate.

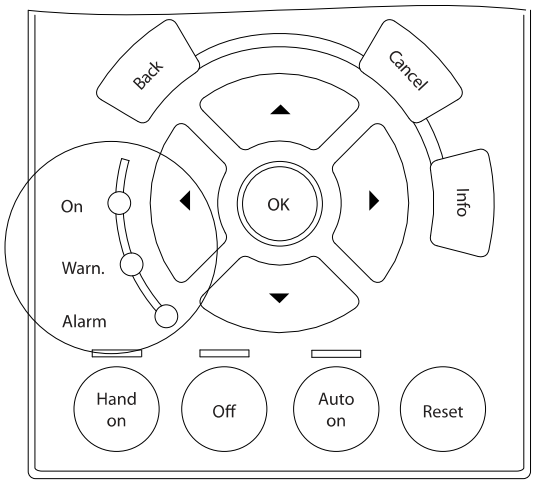


Figure 8.3

	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 prior to an alarm, and whether the alarm trips the unit or trip locks the unit.

#	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		AN-01 Live Zero Timeout Function
3	No motor	(X)			H-80 Function at Stop
4	Line phase loss	(X)	(X)	(X)	SP-12 Function at Line Imbalance
5	DC link voltage high	X			
6	DC link voltage low	X			
7	DC over-voltage	X	X		
8	DC undervoltage	X	X		
9	Inverter overloaded	X	X		
10	Motor Electronic OL overtemperature	(X)	(X)		F-10 Electronic Overload
11	Motor thermistor over temperature	(X)	(X)		F-10 Electronic Overload
12	Torque limit	X	X		*F-40 Torque Limiter (Driving)* *F-41 Torque Limiter (Braking)*
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)		O-04 Control Word Timeout Function
20	Temp. Input Error				
21	Param Error				
22	Hoist Mech. Brake	(X)	(X)		Parameter group B-2#
23	Internal Fans	X			
24	External Fans	X			
25	Brake resistor short-circuited	X			
26	Brake resistor power limit	(X)	(X)		B-13 Braking Thermal Overload
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		B-15 Brake Check
29	Heatsink temp	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	H-78 Missing Motor Phase Function

#	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
31	Motor phase V missing	(X)	(X)	(X)	H-78 Missing Motor Phase Function
32	Motor phase W missing	(X)	(X)	(X)	H-78 Missing Motor Phase Function
33	Soft-charge fault		X	X	
34	Network communication fault	X	X		
35	Option Fault				
36	Line failure	X	X		
37	Phase imbalance		X		
38	Internal Fault		X	X	
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			E-00 Digital I/O Mode, E-51 Terminal 27 Mode
41	Overload of Digital Output Terminal 29	(X)			E-00 Digital I/O Mode, E-52 Terminal 29 Mode
42	Ovrld X30/6-7	(X)			
43	Ext. Supply (option)				
45	Ground Fault 2	X	X	X	
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			
50	Auto Tune calibration failed		X		
51	Auto Tune check U_{nom} and I_{nom}		X		
52	Auto Tune low I_{nom}		X		
53	Auto Tune motor too big		X		
54	Auto Tune motor too small		X		
55	Auto Tune parameter out of range		X		
56	Auto Tune interrupted by user		X		
57	Auto Tune timeout		X		
58	Auto Tune internal fault	X	X		
59	Current limit	X			*F-43 Current Limit*
61	Feedback Error	(X)	(X)		H-20 Motor Feedback Loss Function
62	Output Frequency at Maximum Limit	X			
63	Mechanical Brake Low		(X)		B-20 Release Brake Current
64	Voltage Limit	X			
65	Control Board Over-temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Module Configuration has Changed		X		
68	Safe Stop	(X)	(X)[1)]		E-07 Terminal 37 Safe Stop
69	Pwr. Card Temp		X	X	
70	Illegal Drive configuration			X	
76	Power Unit Set-up	X			
77	Reduced power mode	X			SP-59 Actual Number of Inverter Units
78	Tracking Error	(X)	(X)		H-24 Tracking Error Function

#	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
79	Illegal PS config		X	X	
80	Drive Restored to Factory Settings		X		
83	Illegal Option Combination			X	
90	Feedback Monitor	(X)	(X)		EC-61 Feedback Signal Monitoring
91	Analog input 54 wrong settings			X	S202
243	Brake IGBT	X	X	X	
244	Heatsink temp	X	X	X	
245	Heatsink sensor		X	X	
246	Pwr.card supply			X	
247	Pwr.card temp		X	X	
248	Illegal PS config			X	
249	Rect. low temp.	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 H-04 Auto-Reset (Times)

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8.4.1 Fault Messages

The warning/alarm information below defines the 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 *AN-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. OPCGPIO terminals 11 and 12 for signals, terminal 10 common. OPCAIO terminals 1, 3, 5 for signals, terminals 2, 4, 6 common).

Check that the drive programming and switch settings match the analog signal type.

Perform Input Terminal Signal Test.

WARNING/ALARM 3, No motor

No motor has been connected to the output of the drive.

WARNING/ALARM 4, Mains phase loss

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

Troubleshooting: Check the supply voltage and supply currents to the 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 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 drive voltage rating. The unit is still active.

WARNING/ALARM 7, DC overvoltage

If the intermediate circuit voltage exceeds the limit, the drive trips after a time.

Troubleshooting

Connect a brake resistor

Extend the ramp time

Change the ramp type

Activate the functions in *B-10 Brake Function*

Increase *SP-26 Trip Delay at Drive Fault*

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

Troubleshooting:

Check that the supply voltage matches the drive voltage.

Perform input voltage test

Perform soft charge circuit test

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

Troubleshooting

Compare the output current shown on the Keypad with the drive rated current.

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

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

See the derating section in the *Design Guide* for more details if a high switching frequency is required.

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection, the motor is too hot. Select whether the drive gives a warning or an alarm when the counter reaches 100% in *F-10 Electronic Overload* . 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 *P-03 Motor Current* is correct.

Ensure that Motor data in parameters P-02, P-03, P-06, P-07, F-04 and F-05 are set correctly.

If an external fan is in use, check in *F-11 Motor External Fan* that it is selected.

Running Auto tune in *P-04 Auto Tune* may tune the drive to the motor more accurately and reduce thermal loading.

WARNING/ALARM 11, Motor thermistor over temp
The thermistor might be disconnected. Select whether the drive gives a warning or an alarm in *F-10 Electronic Overload* .

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 *F-12 Motor Thermistor Input* 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 *F-12 Motor Thermistor Input* selects terminal 18 or 19.

WARNING/ALARM 12, Torque limit
The torque has exceeded the value in *F-40 Torque Limiter (Driving)* or the value in *F-41 Torque Limiter (Braking)*. *SP-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, extend the ramp time.

If the generator torque limit is exceeded during ramp, extend the ramp- 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 secs., then the drive trips and issues an alarm. This fault may be caused by shock loading or fast acceleration with high inertia loads. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting:

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

Check that the motor size matches the drive.

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Check parameters P-02, P-03, P-06, P-07, F-04 and F-05 for correct motor data.

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

Troubleshooting:

Remove power to the drive and repair the ground fault.

Check for ground faults in the motor by measuring the resistance to ground of the motor 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 GE supplier:

ID-40 Drive Type

ID-41 Power Section

ID-42 Voltage

ID-43 Software Version

ID-45 Actual Typecode String

ID-49 SW ID Control Card

ID-50 SW ID Power Card

ID-60 Option Mounted

ID-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 drive and repair the short circuit.

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

Troubleshooting:

Check connections on the serial communication cable.

Increase *O-03 Control Word Timeout Time*

Check the operation of the communication equipment.

Verify a proper installation based on EMC requirements.

WARNING/ALARM 20, Temp. input error
The temperature sensor is not connected.

WARNING/ALARM 21, Parameter error
The parameter is out of range. The parameter number is reported in the Keypad. The affected parameter must be set to a valid value.

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

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

Troubleshooting:

Check for proper fan operation.

Cycle power to the 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 *SP-53 Fan Monitor* ([0] Disabled).

Troubleshooting:

Check for proper fan operation.

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

Check the sensors on the heatsink and control card.

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 drive power size.

Troubleshooting:
Check for the following conditions.

Ambient temperature too high.

Motor cable too long.

Incorrect airflow clearance above and below the drive

Blocked airflow around the drive.

Damaged heatsink fan.

Dirty heatsink.

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

Remove power from the drive and check motor phase U.

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

Remove power from the drive and check motor phase V.

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

Remove power from the 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 network on the communication option card is not working.

WARNING/ALARM 35, Option fault
An option alarm is received. The alarm is option specific. The most likely cause is a power-up or a communication fault.

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

ALARM 37, Imb of sup volt
There is a current imbalance between the power units

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 GE supplier or service department. Note the code number for further trouble-shooting directions.

No.	Text
0	Serial port cannot be initialized. Contact yourGE supplier or GEService Department.
256-258	Power EEPROM data is defect or too old
512-519	Internal fault. Contact yourGE supplier or GE Service Department.
783	Parameter value outside of min/max limits
1024-1284	Internal fault. Contact your GE supplier or the GE 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 yourGE supplier or GEService Department.
2820	Keypad 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 yourGE supplier or GEService 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 *E-00 Digital I/O Mode* and *E-51 Terminal 27 Mode*.

WARNING 41, Overload of digital output terminal 29
Check the load connected to terminal 29 or remove short-circuit connection. Check *E-00 Digital I/O Mode* and *E-52 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 short-circuit connection. Check *E-56 Term X30/6 Digi Out (OPCGPIO)*.

For X30/7, check the load connected to X30/7 or remove short-circuit connection. Check *E-57 Term X30/7 Digi Out (OPCGPIO)*.

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

Troubleshooting

Check for proper grounding and loose connections.

Check for proper wire size.

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Check motor cables for short-circuits or leakage currents.

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 three-phase AC line voltage, all three supplied 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, 24V supply low
The 24 V DC is measured on the control card. The external 24V DC backup power supply may be overloaded; otherwise, contact your GE supplier.

WARNING 48, 1.8V supply low
The 1.8V 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 F-18 and F-17, the drive will show a warning. When the speed is below the specified limit in *H-36 Trip Speed Low [RPM]* (except when starting or stopping) the drive will trip.

ALARM 50, Auto Tune calibration failed
Contact your GE supplier or GE Service Department.

ALARM 51, Auto tune check U_{nom} and I_{nom}
The settings for motor voltage, motor current, and motor power are wrong. Check the settings in parameters P-02, P-03, P-06, P-07, F-04 and F-05.

ALARM 52, Auto tune low I_{nom}
The motor current is too low. Check the setting in *F-43 Current Limit*.

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

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

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

ALARM 56, Auto Tune interrupted by user
The Auto Tune has been interrupted by the user.

ALARM 57, Auto tune timeout
Try to restart Auto tune again. Repeated restarts may overheat the motor.

ALARM 58, Auto Tune internal fault
Contact your GE supplier.

WARNING 59, Current limit
The current is higher than the value in *F-43 Current Limit*. Ensure that Motor data in parameters P-02, P-03, P-06, P-07, F-04 and F-05 are set correctly. Possibly increase the current limit. Be sure 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 drive. An external interlock has commanded the drive to trip. Clear the external fault condition. To resume normal operation, apply 24V DC to the terminal programmed for external interlock. Reset the drive.

WARNING/ALARM 61, Tracking error
An error has been detected between calculated speed and speed measurement from feedback device. The function Warning/Alarm/Disabling setting is in *H-20 Motor Feedback Loss Function*. Accepted error setting in *H-21 Motor Feedback Speed Error* and the allowed time the error occur setting in *H-22 Motor Feedback Loss Timeout*. During a commissioning procedure the function may be effective.

WARNING 62, Output frequency at maximum limit
The output frequency has reached the value set in *F-03 Max Output Frequency 1*. 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.

ALARM 63, Mechanical brake low
The actual motor current has not exceeded the “release brake” current within the “Start delay” time window.

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 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 drive whenever the motor is stopped by setting *B-00 DC Hold Current* at 5% and *H-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 69, Power card temperaturePower 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 drive configuration
The control card and power card are incompatible. Contact your supplier with the model number of the unit from the nameplate and the part numbers of the cards to check compatibility.

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

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

ALARM 78, Tracking error
The difference between setpoint value and actual value has exceeded the value in *H-25 Tracking Error*. Disable the function by *H-24 Tracking Error Function* or select an alarm/ warning also in *H-24 Tracking Error Function*. Investigate the mechanics around the load and motor. Check feedback connections from motor – encoder – to drive. Select motor feedback function in *H-20 Motor Feedback Loss Function*. Adjust tracking error band in *H-25 Tracking Error* and *H-27 Tracking Error Ramping*.

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

ALARM 80, Unit Restored to Factory Settings
Parameter settings are restored to factory settings after a manual reset. Reset the unit to clear the alarm.

ALARM 83, Illegal option combination
The mounted options are not supported to work together.

WARNING 89, Mechanical brake sliding
The hoist brake monitor has detected a motor speed > 10rpm.

ALARM 90, Feedback mon.
Check the connection to encoder/ resolver option and eventually replace the OPCENC or OPCRES.

ALARM 91, Analogue input 54 wrong settings
Switch S202 has to be set in position OFF (voltage input) when a KTY sensor is connected to analog input terminal 54.

ALARM 243, Brake IGBT
This alarm is only for 6x unit size drives. It is equivalent to Alarm 27. The report value in the alarm log indicates which power module generated the alarm:

ALARM 244, Heatsink temperature
This alarm is only for 6x unit size adjustable frequency drives. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm:

ALARM 245, Heatsink sensor
This alarm is only for 6x unit size adjustable frequency drives. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in 62 or 64 drive.

2 = right inverter module in 61 or 63 drivee.

3 = right inverter module in 62 or 64 drive.

5 = rectifier module.

ALARM 246, Power card supply
This alarm is only for 6x unit size drive. It is equivalent to Alarm 46. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in 62 or 64 drive.

2 = right inverter module in 61 or 63 drive.

3 = right inverter module in 62 or 64 drive.

5 = rectifier module.

ALARM 69, Power card temperaturePower card temperature
This alarm is only for 6x unit size drive. It is equivalent to Alarm 69. The report value in the alarm log indicates which power module generated the alarm.

1 = left most inverter module.

2 = middle inverter module in 62 or 64 drive.

2 = right inverter module in 61 or 63 drive.

3 = right inverter module in 62 or 64 drive.

5 = rectifier module.

ALARM 248, Illegal power section configuration
This alarm is only for 6x unit size adjustable frequency drives. It is equivalent to Alarm 79. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in 62 or 64 drive.

2 = right inverter module in 61 or 63 drive.

3 = right inverter module in 62 or 64 drive.

5 = rectifier module.

WARNING 249, Rect. low temperature
IGBT sensor fault (highpower units only).

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

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

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9 Basic Troubleshooting

9.1 Start Up and Operation

See *Alarm Log* in *Table 4.2*.

Symptom	Possible Cause	Test	Solution
Display dark / No function	Missing input power	See *Table 3.1*.	Check the input power source.
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this table for possible causes.	Follow the recommendations provided.
	No power to the Keypad	Check the Keypad cable for proper connection or damage.	Replace the faulty Keypad 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 contrast setting		Press [Status] + Up/Down arrows to adjust the contrast.
	Display (Keypad) is defective	Test using a different Keypad.	Replace the faulty Keypad 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 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 drive.	Apply line power to run the unit.
	Keypad Stop	Check if [Off] has been pressed.	Press [Auto] or [Hand] (depending on your operation mode) to run the motor.
	Missing start signal (Standby)	Check *E-01 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 *E-03 Terminal 27 Digital Input* all digital inputs in parameter group E-0# for Coast inv. setting.	Deactivate Coast Inv signal
	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 *F-02 Operation Method* Set preset reference active in parameter *C-05 Multi-step Frequency 1 - 8*. Check for correct wiring. Check scaling of terminals. Check reference signal.
Motor running in wrong direction	Motor rotation limit	Check that *H-08 Reverse Lock* is programmed correctly.	Program correct settings.
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group *E-0#*	Deactivate reversing signal.
	Wrong motor phase connection		See *3.5 Check Motor Rotation* in this manual.
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in*F-17 Motor Speed High Limit [RPM]*, *F-15 Motor Speed High Limit [Hz]*, and *F-03 Max Output Frequency 1*	Program correct limits.
	Reference input signal not scaled correctly	Check reference input signal scaling in parameter group *AN-## Analog In/Out* and parameter group *F-01 Frequency Setting 1*	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.	Program correct settings.
Motor runs rough	Possible over-magnetization	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups *P-0#, Motor data, P-3# Adv motor data*, and *H-5# Load indep. setting.*
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short rampvæt times.	Check brake parameters. Check ramp time settings.	Check parameter group *B-0# DC brake* and *F-5# Extended References*.

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 to for shorts.	Eliminate any shorts detected.
	Motor overload	Motor is overloaded for the application.	Perform start-up test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application.
	Loose connections	Perform pre-startup check for loose connections.	Tighten loose connections.
Line power current imbalance greater than 3%	Problem with line power (See *Alarm 4 Line phase loss* description)	Rotate input power leads into the drive one position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check line power supply.
	Problem with the drive unit	Rotate input power leads into the drive one position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with drive unit	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact supplier.

Table 9.1

10 Specifications

10.1 Power-dependent Specifications

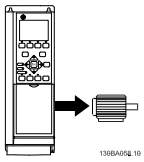
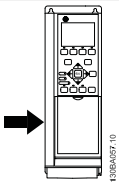
Line Power Supply 3 x 200–240 V AC							
AF-650 GP							
	Typical Shaft Output [hp/kW]	0.25	0.37	0.75	1.5	2.2	3.7
	Typical Shaft Output [HP] at 208 V	0.3	0.5	1.0	2.0	3.0	5.0
	Unit Size IP20	12	12	12	12	12	13
	Unit Size IP55, 66	15	15	15	15	15	15
Output current							
	Continuous (3 x 200–240 V) [A]	1.8	2.4	4.6	7.5	10.6	16.7
	Intermittent (3 x 200–240 V) [A]	2.9	3.8	7.4	12.0	17.0	26.7
	Continuous kVA (208 V AC) [kVA]	0.65	0.86	1.66	2.70	3.82	6.00
	Max. cable size (mains, motor, brake) [AWG (mm^2)][2)]	24–10 (0.2–4)					
Max. input current							
	Continuous (3 x 200–240 V) [A]	1.6	2.2	4.1	6.8	9.5	15.0
	Intermittent (3 x 200–240 V) [A]	2.6	3.5	6.6	10.9	15.2	24.0
	Max. electrical fuses[1)] [A]	10	10	10	20	20	32
	Environment						
	Estimated power loss at rated max. load [hp, W] [4)]	0.03 hp, 21 W	0.04 hp, 29 W	0.07 hp, 54 W	0.11 hp , 82 W	0.16 hp / 116 W	0.25 hp, 185 W
	Weight, Unit size 12/13 (lbs [kg])	10.36 [4.7]	10.36 [4.7]	10.58 [4.8]	10.8 [4.9]	10.8 [4.9]	14.55 [6.6]
	Weight, Unit size 15 (lbs [kg])	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]
	Efficiency [4)]	0.94	0.94	0.95	0.96	0.96	0.96
0.33 – 5 hp only available as 160% heavy duty (HD).							

Table 10.1

Line Power Supply 3 x 200–240 V AC								
AF-650 GP		7.5HP		10HP		15HP		
High/ Normal Load[1]		HD	LD	HD	LD	HD	LD	
	Typical Shaft Output [kW]	5.5	7.5	7.5	11	11	15	
	Typical Shaft Output [HP] at 208 V	7.5	10	10	15	15	20	
	Unit Size IP20	23		23		24		
	Unit Size IP55, 66	21		21		22		
Output current								
	Continuous (3 x 200–240 V) [A]	24.2	30.8	30.8	46.2	46.2	59.4	
	Intermittent (60 sec overload) (3 x 200–240 V) [A]	38.7	33.9	49.3	50.8	73.9	65.3	
	Continuous kVA (208 V AC) [kVA]	8.7	11.1	11.1	16.6	16.6	21.4	
Max. input current								
	Continuous (3 x 200–240 V) [A]	22	28	28	42	42	54	
	Intermittent (60 sec overload) (3 x 200–240 V) [A]	35.2	30.8	44.8	46.2	67.2	59.4	
Additional specifications								
	IP55/66 max. cable cross-section[5] (line power, brake, load sharing) [AWG (mm^2)] [2]	6,8,6 (16,10,16)		6,8,6 (16,10, 16)		2,-,- (35,-,-)		
	IP55/66 max. cable cross-section[5] (motor) [AWG (mm^2)] [2]	8,8,- (10,10,-)		8,8,- (10,10,-)		2,4,4 (35,25,25)		
	IP20 max. cable cross-section[5] (line power, brake, motor and load sharing)	8,8,- (10,10,-)		8,8,- (10,10,-)		2,-,- (35,-,-)		
	Estimated power loss at rated max. load [hp, W] [4]	0.32 hp, 239 W	0.42 hp, 310 W	0.50 hp, 371 W	0.69 hp, 514 W	0.62, 463 W	0.81 hp, 602 W	
	Weight, Unit Size IP55, 66 (lbs [kg])	50.71 [23]		50.71 [23]		59.52 [27]		
	Efficiency[4]	0.964		0.959		0.964		

Table 10.2

Line Power Supply 3 x 200–240 V AC											
AF-650 GP		20 hp		25 hp		30 hp		40 hp		50 hp	
High/ Normal Load[1]		HD	LD	HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft Output [kW]	15	18.5	18.5	22	22	30	30	37	37	45
	Typical Shaft Output [HP] at 208 V	20	25	25	30	30	40	40	50	50	60
	Unit Size IP20	24		33		33		34		34	
	Unit Size IP55, IP66	31		31		31		32		32	
Output current											
	Continuous (3 x 200–240 V) [A]	59.4	74.8	74.8	88	88	115	115	143	143	170
	Intermittent (60 sec overload) (3 x 200–240 V) [A]	89.1	82.3	112	96.8	132	127	173	157	215	187
	Continuous kVA (208 V AC) [kVA]	21.4	26.9	26.9	31.7	31.7	41.4	41.4	51.5	51.5	61.2
Max. input current											
	Continuous (3 x 200–240 V) [A]	54	68	68	80	80	104	104	130	130	154
	Intermittent (60 sec overload) (3 x 200–240 V) [A]	81	74.8	102	88	120	114	156	143	195	169
Additional specifications											
	IP20 max. cable cross-section[5] (line power, brake, motor and load sharing)	35 (2)		50 (1)		50 (1)		300MCM (150)		300MCM (150)	
	IP55, IP66 max. cable cross-section[5] (line power, motor) [AWG (mm^2)] [2]	1 (50)		1 (50)		1 (50)		300MCM (150)		300MCM (150)	
	IP55, IP66 max. cable cross-section[5] (brake, load sharing) [AWG (mm^2)] [2]	1 (50)		1 (50)		1 (50)		3/0 (95)		3/0 (95)	
	Estimated power loss at rated max. load [hp, W] [4]	0.84 hp, 624 W	0.99 hp, 737 W	0.99 hp, 740 W	1.13 hp, 845 W	1.17 hp, 874 W	1.53 hp, 1,140 W	1.53 hp, 1,143 W	1.81 hp, 1,353 W	1.88 hp, 1,400 W	2.19 hp, 1,636 W
	Weight, Unit Size 55/66 (lbs [kg])	99.2 [45]		99.2 [45]		99.2 [45]		143.3 [65]		143.3 [65]	
	Efficiency[4]	0.96		0.97		0.97		0.97		0.97	

Table 10.3

For fuse ratings, see 10.3.1 Fuses

1) Heavy duty (HD) = 160% torque during 60 sec., Light duty (LD) = 110% torque during 60 sec.

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 nominal load conditions and expected to be within +/-15% (tolerance relates to variety in voltage and cable conditions).

Values are based on a typical motor efficiency (eff2/eff3 border line) value. Motors with lower efficiency will also add to the power loss in the drive and opposite.

If the switching frequency is increased compared to the default setting, the power losses may rise significantly.

Keypad and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typical, only 4 W extra for a fully loaded control card, or options for slot A or slot B, each.)

Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/-5%).

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

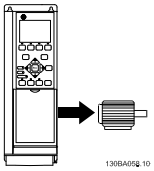
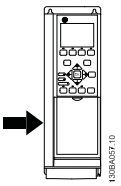
Line Power Supply 3 x 380–480 V AC								
AF-650 GP Typical Shaft Output [kW]		0.37	0.75	1.5	2.2	4	5.5	7.5
Typical Shaft Output [HP] at 460 V		0.5	1.0	2.0	3.0	5.0	7.5	10
Unit Size IP20		12	12	12	12	12	13	13
Unit Size IP55, IP66		15	15	15	15	15	15	15
Output current **Heavy duty (HD) 160% for 1 minute**								
	Shaft output [hp, kW]	0.5 hp / 0.37 kW	1 hp / 0.75 kW	2 hp / 1.5 kW	3 hp / 2.2 kW	5.4 hp / 4 kW	7.38 hp / 5.5 kW	10 hp / 7.5 kW
	Continuous (3 x 380–440 V) [A]	1.3	2.4	4.1	5.6	10	13	16
	Intermittent (3 x 380–440 V) [A]	2.1	3.8	6.6	9.0	16	20.8	25.6
	Continuous (3 x 441–480 V) [A]	1.2	2.1	3.4	4.8	8.2	11	14.5
	Intermittent (3 x 441–480 V) [A]	1.9	3.4	5.4	7.7	13.1	17.6	23.2
	Continuous kVA (400 V AC) [kVA]	0.9	1.7	2.8	3.9	6.9	9.0	11.0
	Continuous kVA (460 V AC) [kVA]	0.9	1.7	2.7	3.8	6.5	8.8	11.6
	Max. cable size (line power, motor, brake) [AWG] [mm^2] [2)]	24 - 10 AWG 0.2 - 4 mm^2				24 - 10 AWG 0.2 - 4 mm2		
Max. input current								
	Continuous (3 x 380–440 V) [A]	1.2	2.2	3.7	5.0	9.0	11.7	14.4
	Intermittent (3 x 380–440 V) [A]	1.9	3.5	5.9	8.0	14.4	18.7	23.0
	Continuous (3 x 441–480 V) [A]	1.0	1.9	3.1	4.3	7.4	9.9	13.0
	Intermittent (3 x 441–480 V) [A]	1.6	3.0	5.0	6.9	11.8	15.8	20.8
	Max. electrical fuses[1)][A]	10	10	10	20	20	32	32
	Environment							
	Estimated power loss at rated max. load [hp / W] [4)]	0.05 hp / 35 W	0.06 hp / 46 W	0.08 hp / 62 W	0.12 hp / 88 W	0.17 hp / 124 W	0.25 hp / 187 W	0.34 hp / 255 W
	Weight (lbs [kg]), Unit Size IP20	10.36 [4.7]	10.58 [4.8]	10.8 [4.9]	10.8 [4.9]	10.8 [4.9]	14.55 [6.6]	14.55 [6.6]
	Unit Size IP55, 66	13.5	13.5	13.5	13.5	13.5	14.2	14.2
	Efficiency [4)]	0.93	0.96	0.97	0.97	0.97	0.97	0.97
0.5–10hp only available as 160% heavy duty (HD).								

Table 10.4

Line Power Supply 3 x 380–480 V AC									
AF-650 GP		15 hp		20 hp		25 hp		30 hp	
High/ Normal Load[1]		HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft output [kW]	11	15	15	18.5	18.5	22.0	22.0	30.0
	Typical Shaft Output [HP] at 460 V	15	20	20	25	25	30	30	40
	Unit Size IP20	23		23		24		24	
	Unit Size IP55, IP66	21		21		22		22	
Output current									
	Continuous (3 x 380–440 V) [A]	24	32	32	37.5	37.5	44	44	61
	Intermittent (60 sec overload) (3 x 380–440 V) [A]	38.4	35.2	51.2	41.3	60	48.4	70.4	67.1
	Continuous (3 x 441–480 V) [A]	21	27	27	34	34	40	40	52
	Intermittent (60 sec overload) (3 x 441–480 V) [A]	33.6	29.7	43.2	37.4	54.4	44	64	57.2
	Continuous kVA (400 V AC) [kVA]	16.6	22.2	22.2	26	26	30.5	30.5	42.3
	Continuous kVA (460 V AC) [kVA]		21.5		27.1		31.9		41.4
Max. input current									
	Continuous (3 x 380–440 V) [A]	22	29	29	34	34	40	40	55
	Intermittent (60 sec overload) (3 x 380–440 V) [A]	35.2	31.9	46.4	37.4	54.4	44	64	60.5
	Continuous (3 x 441–480 V) [A]	19	25	25	31	31	36	36	47
	Intermittent (60 sec overload) (3 x 441–480 V) [A]	30.4	27.5	40	34.1	49.6	39.6	57.6	51.7
Additional specifications									
	IP55, IP66 max. cable cross-section[5] (line power, brake, load sharing) [AWG (mm^2)] 2)	6, 8, 6 (16, 10, 16)		6, 8, 6 (16, 10, 16)		2,-,- (35,-,-)		2,-,- (35,-,-)	
	IP55, IP66 max. cable cross-section[5] (motor) [AWG (mm^2)] [2]	8, 8,- (10, 10,-)		8, 8,- (10, 10,-)		2, 4, 4 (35, 25, 25)		2, 4, 4 (35, 25, 25)	
	IP20 max. cable cross-section[5] (line power, brake, motor and load sharing)	8, 8,- (10, 10,-)		8, 8,- (10, 10,-)		2,-,- (35,-,-)		2,-,- (35,-,-)	
	Estimated power loss at rated max. load [hp, W] [4]	0.4 hp / 291 W	0.53 hp / 392 W	0.51 hp / 379 W	0.62 hp /465 W	0.6 hp / 444 W	0.70 hp / 525 W	0.73 hp / 547 W	1 hp / 739 W
	Weight, Unit Size IP20 (lbs [kg])	26.46 [12]		26.46 [12]		51.8 [23.5]		51.8 [23.5]	
	Weight, Unit Size IP55, 66 (lbs [kg])	50.71 [23]		50.71 [23]		59.52 [27]		59.52 [27]	
	Efficiency[4]	0.98		0.98		0.98		0.98	

Table 10.5

Line Power Supply 3 x 380–480 V AC											
AF-650 GP		40 hp		50 hp		60 hp		75 hp		100 hp	
High/ Normal Load[1]		HD	LD	HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft output [kW]	30	37	37	45	45	55	55	75	75	90
	Typical Shaft Output [HP] at 460 V	40	50	50	60	60	75	75	100	100	120
	Unit Size IP20	24		33		33		34		34	
	Unit Size IP55, IP66	31		31		31		32		32	
Output current											
	Continuous (3 x 380–440 V) [A]	61	73	73	90	90	106	106	147	147	177
	Intermittent (60 sec. overload) (3 x 380–440 V) [A]	91.5	80.3	110	99	135	117	159	162	221	195
	Continuous (3 x 441–480 V) [A]	52	65	65	80	80	105	105	130	130	160
	Intermittent (60 sec overload) (3 x 441–480 V) [A]	78	71.5	97.5	88	120	116	158	143	195	176
	Continuous kVA (400 V AC) [kVA]	42.3	50.6	50.6	62.4	62.4	73.4	73.4	102	102	123
	Continuous kVA (460 V AC) [kVA]		51.8		63.7		83.7		104		128
Max. input current											
	Continuous (3 x 380–440 V) [A]	55	66	66	82	82	96	96	133	133	161
	Intermittent (60 sec. overload) (3 x 380–440 V) [A]	82.5	72.6	99	90.2	123	106	144	146	200	177
	Continuous (3 x 441–480 V) [A]	47	59	59	73	73	95	95	118	118	145
	Intermittent (60 sec. overload) (3 x 441–480 V) [A]	70.5	64.9	88.5	80.3	110	105	143	130	177	160
Additional specifications											
	IP20 max. cable cross-section[5] (line power and motor)	2 (35)		1 (50)		1 (50)		150 (300 mcm)		150 (300 mcm)	
	IP20 max. cable cross-section[5] (brake and load sharing)	2 (35)		1 (50)		1 (50)		4/0 (95)		4/0 (95)	
	IP55, IP66 max. cable cross-section[5] (line power, motor) [AWG (mm^2)] [2]	1 (50)		1 (50)		1 (50)		300MCM (150)		300MCM (150)	
	IP55, IP66 max. cable cross-section[5] (brake, load sharing) [AWG (mm^2)] [2]	1 (50)		1 (50)		1 (50)		3/0 (95)		3/0 (95)	
	Estimated power loss at rated max. load [hp, W] [4]	0.76 hp / 570 W	0.94 hp / 698 W	0.94 hp / 697 W	1.13 hp / 843 W	1.19 hp / 891 W	1.45 hp / 1083 W	1.37 hp / 1022 W	1.86 hp, 1384 W	1.65 hp, 1232 W	1.98 hp, 1474 W
	Weight, Unit SizeIP55, IP66 (lbs [kg])	99.2 [45]		99.2 [45]		99.2 [45]		143.3 [65]		143.3 [65]	
	Efficiency[4]	0.98		0.98		0.98		0.98		0.99	

Table 10.6

For fuse ratings, see 10.3.1 Fuses

1) Heavy duty (HD) = 160% torque during 60 sec., Light duty (LD) = 110% torque during 60 sec.

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 nominal load conditions and expected to be within +/-15% (tolerance relates to variety in voltage and cable conditions).
Values are based on a typical motor efficiency (eff2/eff3 border line) value. Motors with lower efficiency will also add to the power loss in the drive and opposite.
If the switching frequency is increased compared to the default setting, the power losses may rise significantly.

Keypad and typical control card power consumptions are included. Further options and customer load may add up to 30 W to the losses. (Though typical, only 4 W extra for a fully loaded control card, or options for slot A or slot B, each.)
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/-5%).

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

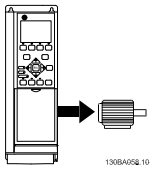
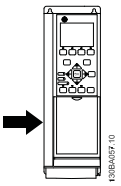
Line Power Supply 3 x 525–600 V AC							
AF-650 GP							
	Typical Shaft Output [hp/kW]	0.75	1.5	2.2	4	5.5	7.5
	Typical Shaft Output [HP] at 575 V	1.0	2.0	3.0	5.0	7.5	10
	Unit Size IP20	13	13	13	13	13	13
	Unit Size IP55	15	15	15	15	15	15
Output current							
	Continuous (3 x 525–550 V) [A]	1.8	2.9	4.1	6.4	9.5	11.5
	Intermittent (3 x 525–550 V) [A]	2.9	4.6	6.6	10.2	15.2	18.4
	Continuous (3 x 551–600 V) [A]	1.7	2.7	3.9	6.1	9.0	11.0
	Intermittent (3 x 551–600 V) [A]	2.7	4.3	6.2	9.8	14.4	17.6
	Continuous kVA (525 V AC) [kVA]	1.7	2.8	3.9	6.1	9.0	11.0
	Continuous kVA (575 V AC) [kVA]	1.7	2.7	3.9	6.1	9.0	11.0
	Max. cable size (mains, motor, brake) [AWG (mm^2)][2)]	24–10 AWG 0.2–4 mm2			24–10 AWG 0.2–4 mm2		
Max. input current							
	Continuous (3 x 525–600 V) [A]	1.7	2.7	4.1	5.8	8.6	10.4
	Intermittent (3 x 525–600 V) [A]	2.7	4.3	6.6	9.3	13.8	16.6
	Max. electrical fuses[1)] [A]	10	10	20	20	32	32
	Environment						
	Estimated power loss at rated max. load [hp, W] [4)]	0.05 hp / 35 W	0.09 hp, 65 W	0.12 hp, 92 W	0.19 hp, 145 W	0.26 hp, 195 W	0.35 hp, 261 W
	Weight, Unit Size IP20 (lbs [kg])	14.33 [6.5]	14.33 [6.5]	14.33 [6.5]	14.33 [6.5]	14.55 [6.6]	14.55 [6.6]
	Weight, Unit Size IP55, IP66 (lbs [kg])	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	29.76 [13.5]	31.3 [14.2]	31.3 [14.2]
	Efficiency [4)]	0.97	0.97	0.97	0.97	0.97	0.97

Table 10.7

Line Power Supply 3 x 525–600 V AC											
AF-650 GP		15 hp		20 hp		25 hp		30 hp		40 hp	
High/ Normal Load[1]		HD	LD	HD	LD	HD	LD	HD	LD	HD	LD
Typical Shaft Output [kW]		11	15	15	18.5	18.5	22	22	30	30	37
	Typical Shaft Output [HP] at 575 V	15	20	20	25	25	30	30	40	40	50
	Unit Size IP IP55, IP66	21		21		22		22		31	
	Unit Size IP20	23		23		24		24		24	
Output current											
	Continuous (3 x 525–550 V) [A]	19	23	23	28	28	36	36	43	43	54
	Intermittent (3 x 525–550 V) [A]	30	25	37	31	45	40	58	47	65	59
	Continuous (3 x 525–600 V) [A]	18	22	22	27	27	34	34	41	41	52
	Intermittent (3 x 525–600 V) [A]	29	24	35	30	43	37	54	45	62	57
	Continuous kVA (550 V AC) [kVA]	18.1	21.9	21.9	26.7	26.7	34.3	34.3	41.0	41.0	51.4
	Continuous kVA (575 V AC) [kVA]	17.9	21.9	21.9	26.9	26.9	33.9	33.9	40.8	40.8	51.8
Max. input current											
	Continuous at 550 V [A]	17.2	20.9	20.9	25.4	25.4	32.7	32.7	39	39	49
	Intermittent at 550 V [A]	28	23	33	28	41	36	52	43	59	54
	Continuous at 575 V [A]	16	20	20	24	24	31	31	37	37	47
	Intermittent at 575 V [A]	26	22	32	27	39	34	50	41	56	52
Additional specifications											
	IP55, IP66 max. cable cross-section[5] (line power, brake, load sharing) [AWG (mm^2)] 2)	6, 8, 8 (16, 10, 10)		6, 8, 8 (16, 10, 10)		2,-,- (35,-,-)		2,-,- (35,-,-)		1,-,- (50,-,-)	
	IP55, IP66 max. cable cross-section[5] (motor) [AWG (mm^2)] [2]	8, 8,- (10, 10,-)		8, 8,- (10, 10,-)		2, 4, 4 (35, 25, 25)		2, 4, 4 (35, 25, 25)		1,-,- (50,-,-)	
	IP20 max. cable cross-section[5] (line power, brake, motor and load sharing)	8, 8,- (10, 10,-)		8, 8,- (10, 10,-)		2,-,- (35,-,-)		2,-,- (35,-,-)		2,-,- (35,-,-)	
	Estimated power loss at rated max. load [hp, W] [4]		0.30 hp, 225 W		0.38 hp, 285 W		0.44 hp, 329 W		0.94 hp, 700 W		0.94 hp, 700 W
	Weight, Unit Size , IP55, IP66 (lbs [kg])	50.71 [23]		50.71 [23]		59.52 [27]		59.52 [27]		59.52 [27]	
	Weight, Unit Size IP20 (lbs [kg])	26.46 [12]		26.46 [12]		51.8 [23.5]		51.8 [23.5]		51.8 [23.5]	
	Efficiency [4]	0.98		0.98		0.98		0.98		0.98	

Table 10.8

Line Power Supply 3 x 525–600 V AC									
AF-650 GP		50 hp		60 hp		75 hp		100 hp	
High/ Normal Load*		HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft Output [kW]	37	45	45	55	55	75	75	90
	Typical Shaft Output [HP] at 575 V	50	60	60	74	75	100	100	120
	Unit Size IP IP55, IP66	31	31	31		32		32	
	Unit Size IP20	33	33	33		34		34	
Output current									
	Continuous (3 x 525–550 V) [A]	54	65	65	87	87	105	105	137
	Intermittent (3 x 525–550 V) [A]	81	72	98	96	131	116	158	151
	Continuous (3 x 525–600 V) [A]	52	62	62	83	83	100	100	131
	Intermittent (3 x 525–600 V) [A]	78	68	93	91	125	110	150	144
	Continuous kVA (550 V AC) [kVA]	51.4	61.9	61.9	82.9	82.9	100.0	100.0	130.5
	Continuous kVA (575 V AC) [kVA]	51.8	61.7	61.7	82.7	82.7	99.6	99.6	130.5
Max. input current									
	Continuous at 550 V [A]	49	59	59	78.9	78.9	95.3	95.3	124.3
	Intermittent at 550 V [A]	74	65	89	87	118	105	143	137
	Continuous at 575 V [A]	47	56	56	75	75	91	91	119
	Intermittent at 575 V [A]	70	62	85	83	113	100	137	131
Additional specifications									
	IP20 max. cable cross-section[5] (line power and motor)	50 (1)				300MCM (150)			
	IP20 max. cable cross-section[5] (brake and load sharing)	50 (1)				95 (4/0)			
	IP55, IP66 max. cable cross-section[5] (line power, motor) [AWG (mm²)] [2]	1 (50)				300MCM (150)			
	IP55, IP66 max. cable cross-section[5] (brake, load sharing) [AWG (mm²)] [2]	1 (50)				4/0 (95)			
	Estimated power loss at rated max. load [hp, W] [4]		1.14 hp, 850 W		1.48 hp, 1,100 W		1.88 hp, 1,400 W		2.01 hp, 1,500 W
	Weight, Unit Size IP20 (lbs [kg])	77.2 [35]		77.2 [35]		110.2 [50]		110.2 [50]	
	Weight, Unit Size IP IP55 IP66 (lbs [kg])	99.2 [45]		99.2 [45]		143.3 [65]		143.3 [65]	
	Efficiency [4]	0.98		0.98		0.98		0.98	

Table 10.9

Line Power Supply 3 x 525–690 V AC									
AF-650 GP		15 hp		20 hp		25 hp		30 hp	
Heavy Duty/Light Duty[1]		HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft output at 550 V [kW]	7.5	11	11	15	15	18.5	18.5	22
	Typical Shaft output at 575 V [HP]	11	15	15	20	20	25	25	30
	Typical Shaft output at 690 V [kW]	11	15	15	18.5	18.5	22	22	30
	Enclosure IP21, 55	22		22		22		22	
Output current									
	Continuous (3 x 525–550 V) [A]	14	19	19	23	23	28	28	36
	Intermittent (60 sec overload) (3 x 525–550 V) [A]	22.4	20.9	30.4	25.3	36.8	30.8	44.8	39.6
	Continuous (3 x 551–690 V) [A]	13	18	18	22	22	27	27	34
	Intermittent (60 sec overload) (3 x 551–690 V) [A]	20.8	19.8	28.8	24.2	35.2	29.7	43.2	37.4
	Continuous KVA (at 550 V) [KVA]	13.3	18.1	18.1	21.9	21.9	26.7	26.7	34.3
	Continuous KVA (at 575 V) [KVA]	12.9	17.9	17.9	21.9	21.9	26.9	26.9	33.9
	Continuous KVA (at 690 V) [KVA]	15.5	21.5	21.5	26.3	26.3	32.3	32.3	40.6
Max. input current									
	Continuous (3 x 525–690 V) [A]	15	19.5	19.5	24	24	29	29	36
	Intermittent (60 sec overload) (3 x 525–690 V) [A]	23.2	21.5	31.2	26.4	38.4	31.9	46.4	39.6
Additional specifications									
	Max. cable cross-section (line power, load share and brake) [AWG (mm^2)]	2,-,- (35,-,-)							
	Max. cable cross-section (motor) [AWG (mm^2)]	2, 4, 4 (35, 25, 25)							
	Estimated power loss at rated max. load [hp, W] [4]	1.65 hp, 228 W		0.38 hp, 285 W		0.45 hp, 335 W		0.51 hp, 375 W	
	Weight, Unit Size IP21, IP55 (lbs [kg])	59.52 [27]							
	Efficiency[4]	0.98		0.98		0.98		0.98	

Table 10.10

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Line Power Supply 3 x 525–690 V AC											
AF-650 GP		40 hp		50 hp		60 hp		75 hp		100 hp	
Heavy Duty/Light Duty*		HD	LD	HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft output at 550 V [kW]	22	30	30	37	37	45	45	55	55	75
	Typical Shaft output at 575 V [HP]	30	40	40	50	50	60	60	75	75	100
	Typical Shaft output at 690 V [kW]	30	37	37	45	45	55	55	75	75	90
	Enclosure IP21, 55	32		32		32		32		32	
Output current											
	Continuous (3 x 525–550 V) [A]	36	43	43	54	54	65	65	87	87	105
	Intermittent (60 sec overload) (3 x 525–550 V) [A]	54	47.3	64.5	59.4	81	71.5	97.5	95.7	130.5	115.5
	Continuous (3 x 551–690 V) [A]	34	41	41	52	52	62	62	83	83	100
	Intermittent (60 sec overload) (3 x 551–690 V) [A]	51	45.1	61.5	57.2	78	68.2	93	91.3	124.5	110
	Continuous KVA (at 550 V) [KVA]	34.3	41.0	41.0	51.4	51.4	61.9	61.9	82.9	82.9	100.0
	Continuous KVA (at 575 V) [KVA]	33.9	40.8	40.8	51.8	51.8	61.7	61.7	82.7	82.7	99.6
	Continuous KVA (at 690 V) [KVA]	40.6	49.0	49.0	62.1	62.1	74.1	74.1	99.2	99.2	119.5
Max. input current											
	Continuous (at 550 V) [A]	36	49	49	59	59	71	71	87	87	99
	Continuous (at 575 V) [A]	54	53.9	72	64.9	87	78.1	105	95.7	129	108.9
Additional specifications											
	Max. cable cross-section (line power and motor) [AWG (mm^2)]	300MCM (150)									
	Max. cable cross section (load share and brake) [mm^2 (AWG)]	3/0 (95)									
										-	
	Estimated power loss at rated max. load [hp, W] [4]	0.64 hp, 480 W		0.79 hp, 592 W		0.97 hp, 720 W		1.18 hp, 880 W		1.61 hp, 1,200 W	
	Weight, Unit Size IP21, IP55 (lbs [kg])	143.3 [65]									
	Efficiency[4]	0.98		0.98		0.98		0.98		0.98	

Table 10.11

For fuse ratings, see 10.3.1 Fuses

1) Heavy duty (HD) = 160% torque during 60 sec., Light duty (LD) = 110% torque during 60 sec.

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

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

10.2 General Technical Data

Line power supply:	
Supply Terminals (6-pulse)	L1, L2, L3
Supply Terminals (12-pulse)	L1-1, L2-1, L3-1, L1-2, L2-2, L3-2
Supply voltage	200–240V ±10%
Supply voltage	380–480V ±10%
Supply voltage	525–600V ±10%
Supply voltage	525–690V ±10%

AC line voltage low / line drop-out:
During low AC line voltage or a line drop-out, the AF-650 GPdrive continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the adjustable frequency drive's lowest rated supply voltage. Power-up and full torque cannot be expected at AC line voltage lower than 10% below the adjustable frequency drive's lowest rated supply voltage.

Supply frequency	50/60Hz ±5%
Max. imbalance temporary between line phases	3.0% of rated supply voltage
True Power Factor (λ)	≥ 0.9 nominal at rated load
Displacement Power Factor (cos ϕ)	near unity (> 0.98)
Switching on input supply L1, L2, L3 (power-ups) ≤ 10 hp [7.5kW]	maximum 2 times/min.
Switching on input supply L1, L2, L3 (power-ups) 15–100 hp [11–75 kW]	maximum 1 time/min.
Switching on input supply L1, L2, L3 (power-ups) ≥ 125 hp [90kW]	maximum 1 time/2 min.
Environment according to EN60664-1	overvoltage category III/pollution degree 2

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

Motor output (U, V, W):	
Output voltage	0–100% of supply voltage
Output frequency (0.33–10 hp [0.25–75 kW])	0 - 1000Hz
Output frequency (125–1350 hp [90–1000 kW])	0–800[1)]Hz
Output frequency in flux mode	0–300Hz
Switching on output	Unlimited
Ramp times	0.01–3600 sec.

[1) Voltage and power dependent

Torque characteristics:	
Starting torque (Constant torque)	maximum 160% for 60 sec.[1)]
Starting torque	maximum 180% up to 0.5 sec.[1)]
Overload torque (Constant torque)	maximum 160% for 60 sec.[1)]
Starting torque (Variable torque)	maximum 110% for 60 sec.[1)]
Overload torque (Variable torque)	maximum 110% for 60 sec.
Torque rise time in (independent of fsw)	10 ms
Torque rise time in FLUX (for 5 kHz fsw)	1 ms

[1) Percentage relates to the nominal torque.

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

Digital inputs:	
Programmable digital inputs	4 (6)[1)]
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[2)]	> 19V DC

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

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

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

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

2) See for further information about terminal 37 and Safe Stop.

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

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

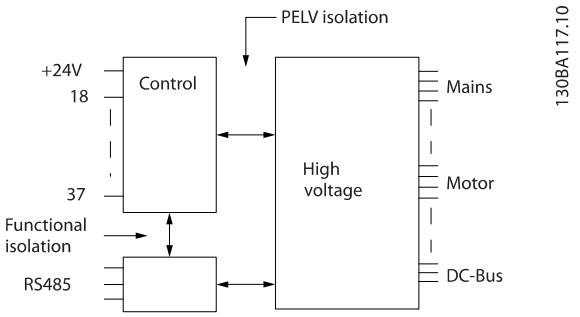

Figure 10.1

Pulse/encoder inputs:	
Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29, 33[1)] / 32[2)], 33[2)]
Max. frequency at terminal 29, 32, 33	110 kHz (push-pull driven)
Max. frequency at terminal 29, 32, 33	5 kHz (open collector)

Min. frequency at terminal 29, 32, 33	4 Hz
Voltage level	see section on Digital input
Maximum voltage on input	28V DC
Input resistance, R_i	approx. 4kΩ
Pulse input accuracy (0.1–1 kHz)	Max. error: 0.1% of full scale
Encoder input accuracy (1–11 kHz)	Max. error: 0.05% of full scale

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

Digital output:

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

[1)] Terminal 27 and 29 can also be programmed as input.

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

Analog output:

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

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

Control card, 24V DC output:

Terminal number	12, 13
Output voltage	24V +1, -3 V
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.

Control card, 10V DC output:

Terminal number	50
Output voltage	10.5V ±0.5V
Max. load	15mA

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

Control card, RS-485 serial communication:

Terminal number	68 (P,TX+, RX+), 69 (N,TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

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

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

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

Relay outputs:	
Programmable relay outputs	2 Form C
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)	24 V 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] Overvoltage cat. II	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)	24 V 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)	24 V DC, 0.1A
Min. terminal load on 1-3 (NC), 1-2 (NO), 4-6 (NC), 4-5 (NO)	24V DC 10mA, 24V AC 20mA
Environment according to EN 60664-1	overvoltage category III/pollution degree 2

[1] IEC 60947 part 4 and 5
The relay contacts are galvanically isolated from the rest of the circuit by reinforced isolation (PELV).
[2] Overvoltage Category II
[3] UL applications 300V AC2A

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Cable lengths and cross-sections for control cables[1]:	
Max. motor cable length, shielded	492 ft [150 m]
Max. motor cable length, non-shielded	984 ft [300 m]
Maximum cross section to control terminals, flexible/rigid wire without cable end sleeves	1.5mm²/16 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves	1mm²/18 AWG
Maximum cross-section to control terminals, flexible wire with cable end sleeves with collar	0.5mm²/20 AWG
Minimum cross-section to control terminals	0.25mm²/ 24AWG

[1]For power cables, see electrical data tables.

Control card performance:	
Scan interval	AF-650 GP: 1 ms
Control characteristics:	
Resolution of output frequency at 0–1000Hz	± 0.003Hz
Repeat accuracy of *Precise start/stop* (terminals 18, 19)	≤± 0.1ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2ms
Speed control range (open-loop)	1:100 of synchronous speed
Speed control range (closed-loop)	1:1000 of synchronous speed
Speed accuracy (open-loop)	30–4000 rpm: error ±8rpm
Speed accuracy (closed-loop), depending on resolution of feedback device	0–6000 rpm: error ±0.15 rpm
Torque control accuracy (speed feedback)	max error±5% of rated torque

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

Environment:	
Enclosure	IP20 Open Chassis, Nema 1 with field-installed kit, Nema 12, and Nema 4
Vibration test	1.0g
Max. relative humidity	5%–93% (IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class Kd
Ambient temperature	Max. 122°F [50°C]

1) Only for ≤ 3.7 kW / 5 hp(200–240 V), ≤ 7.5 kW / 10hp (400–480V)

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

3) Derating for high ambient temperature, see special conditions in the Design Guide

Minimum ambient temperature during full-scale operation	32°F [0°C]
Minimum ambient temperature at reduced performance	14°F [-10°C]
Temperature during storage/transport	-13°- +149°/158°F [-25°- +65°/70°C]
Maximum altitude above sea level without derating	3,300 ft [1000 m]

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

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

See section on special conditions in the AF-650 GP Design Guide. Please see www.geelectrical.com/drives for more information.

Protection and Features:

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the drive trips if the temperature reaches a predefined level. An overload temperature cannot be reset until the temperature of the heatsink is below the values stated in the tables on the following pages (guideline - these temperatures may vary for different power sizes, unit sizes, enclosure ratings, etc.).
- The drive is protected against short-circuits on motor terminals U, V, W.
- If a line phase is missing, the drive trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the drive trips if the intermediate circuit voltage is too low or too high.
- The drive constantly checks for critical levels of internal temperature, load current, high voltage on the intermediate circuit and low motor speeds. As a response to a critical level, the drive can adjust the switching frequency and/ or change the switching pattern in order to ensure the performance of the drive.

10.3 Fuse Tables

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

NOTE!

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

WARNING

Personnel and property must be protected against the consequence of internal component break-down in the drive.

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

NOTE!

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

Short-circuit protection:
GE recommends using the fuses/circuit breakers mentioned below to protect service personnel and property in case of component break-down in the drive.

Overcurrent protection:
The drive provides overload protection to limit threats to human life, property damage and to avoid fire hazard due to overheating of the cables in the installation. The drive is equipped with an internal overcurrent protection (*F-43 Current Limit*) that can be used for upstream overload protection (UL applications excluded). Moreover, fuses or circuit breakers can be used to provide the overcurrent protection in the installation. Overcurrent protection must always be carried out according to national regulations.

10.3.1 Recommendations

WARNING

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

The following tables list the recommended rated current. Recommended fuses are of the type gG for small to medium power sizes. For larger powers, aR fuses are recommended. Circuit breakers must be used provided they meet the national/international regulations and they limit the energy into the drive to an equal or lower level than the compliant circuit breakers.

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

10.3.2 CE Compliance

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

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

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker
[kW] / [HP]			
0.25 / 0.33	gG-16	gG-25	PKZM0-25
0.37 / 0.5			
0.75 / 1			
1.5 / 2			
2.2 / 3			
3.7 / 5	gG-20	gG-32	
5.5 / 7.5	gG-50	gG-63	PKZM4-50
7.5 / 10	gG-80	gG-125	NZMB1-A100
11 / 15			
15 / 20			
18.5 / 25	gG-125	gG-150	NZMB2-A200
22 / 30	aR-160	aR-160	
30 / 40	aR-200	aR-200	NZMB2-A250
37 / 50	aR-250	aR-250	

Table 10.12 200–240V. IP20 / Open Chassis

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker
[kW] / [HP]			
0.25 / 0.33	gG-20	gG-32	PKZM0-25
0.37 / 0.5			
0.75 / 1			
1.5 / 2			
2.2 / 3			
3.7 / 5			
5.5 / 7.5	gG-63	gG-80	PKZM4-63
7.5 / 10			
11 / 15	gG-80	gG-100	NZMB1-A100
15 / 20	gG-125	gG-160	NZMB2-A200
18.5 / 25			
22 / 30	aR-160	aR-160	
30 / 40	aR-200	aR-200	NZMB2-A250
37 / 50	aR-250	aR-250	

Table 10.13 200–240V. IP55 / Nema 12 and IP66 / Nema 4

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker
[kW] / [HP]			
0.37 / 0.5	gG-16	gG-25	PKZM0-25
0.75 / 1			
1.5 / 2			
2.2 / 3			
3.7 / 5			
5.5 / 7.5	gG-20	gG-32	
7.5 / 10			
11 / 15	gG-50	gG-63	PKZM4-50
15 / 20			
18.5 / 25	gG-80	gG-125	NZMB1-A100
22 / 30			
30 / 40			
37 / 50	gG-125	gG-150	NZMB2-A200
45 / 60	aR-160	aR-160	
55 / 75	aR-250	aR-250	NZMB2-A250
75 / 100			
90 / 125	gG-300	gG-300	-
110 / 150	gG-350	gG-350	
132 / 200	gG-400	gG-400	
160 / 250	gG-500	gG-500	
200 / 300	gG-630	gG-630	
250 / 350	aR-700	aR-700	
315 / 450	aR-900	aR-900	
355 / 500			
400 / 550			
450 / 600	aR-1600	aR-1600	
500 / 650			
560 / 750	aR-2000	aR-2000	
630 / 900			
710 / 1000	aR-2500	aR-2500	
800 / 1200			

Table 10.14 380–480V. IP20 / Open Chassis

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker
[kW] / [HP]			
0.37 / 0.5	gG-20	gG-32	PKZM0-25
0.75 / 1			
1.5 / 2			
2.2 / 3			
3.7 / 5			
5.5 / 7.5			
7.5 / 10			
11 / 15	gG-50	gG-80	PKZM4-63
15 / 20			
18.5 / 25	gG-80	gG-100	NZMB1-A100
22 / 30			
30 / 40	gG-125	gG-160	NZMB2-A200
37 / 50			
45 / 60			
55 / 75	aR-250	aR-250	NZMB2-A250
75 / 100			
90 / 125	gG-300	gG-300	-
110 / 150	gG-350	gG-350	
132 / 200	gG-400	gG-400	
160 / 250	gG-500	gG-500	
200 / 300	gG-630	gG-630	
250 / 350	aR-700	aR-700	
315 / 450	aR-900	aR-900	
355 / 500			
400 / 550			
450 / 600	aR-1600	aR-1600	
500 / 650			
560 / 750	aR-2000	aR-2000	
630 / 900			
710 / 1000	aR-2500	aR-2500	
800 / 1200			

Table 10.15 380–480V. IP55 / Nema 12 and IP66 / Nema 4

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker
[kW] / [HP]			
0.75 / 1	gG-10	gG-25	PKZM0-25
1.5 / 2			
2.2 / 3			
3.7 / 5			
5.5 / 7.5	gG-16	gG-32	
7.5 / 10			
11 / 15	gG-35	gG-63	PKZM4-50
15 / 20			
18.5 / 25	gG-63	gG-125	NZMB1-A100
22 / 30			
30 / 40			
37 / 50	gG-100	gG-150	NZMB2-A200
45 / 60			
55 / 75	aR-250	aR-250	NZMB2-A250
75 / 100			

Table 10.16 525–600V. IP20 / Open Chassis

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker
[kW] / [HP]			
0.75 / 1	gG-16	gG-32	PKZM0-25
1.5 / 2			
2.2 / 3			
3.7 / 5			
5.5 / 7.5			
7.5 / 10			
11 / 15	gG-35	gG-80	PKZM4-63
15 / 20			
18.5 / 25	gG-50	gG-100	NZMB1-A100
22 / 30			
30 / 40	gG-125	gG-160	NZMB2-A200
37 / 50			
45 / 60			
55 / 75	aR-250	aR-250	NZMB2-A250
75 / 100			

Table 10.17 525–600V. IP55 / Nema 12 and IP66 / Nema 4

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker
[kW] / [HP]			
11 / 15	gG-25	gG-63	-
15 / 20	gG-32		
18.5 / 25			
22 / 30	gG-40		
30 / 40	gG-63	gG-80	
37 / 50		gG-100	
45 / 60	gG-80	gG-125	
55 / 75	gG-100	gG-160	
75 / 100	gG-125		
90 / 125	aR-250	aR-250	
110 / 150	aR-315	aR-315	
132 / 200	aR-350	aR-350	
160 / 250			
200 / 300	aR-400	aR-400	
250 / 350	aR-500	aR-500	
315 / 400	aR-550	aR-550	
355 / 500	aR-700	aR-700	
400 / 550			
500 / 650	aR-900	aR-900	
560 / 750			
630 / 900	aR-1600	aR-1600	
710 / 1000			
800 / 1150			
900 / 1250			
1000 / 1350	aR-2000	aR-2000	

Table 10.18 525–690V. IP21 / Nema 1 and IP55 / Nema 12 and IP66 / Nema 4

10.3.3 NEC and UL Compliance

Fuses or circuit breakers are mandatory to comply with NEC 2009. We recommend using a selection of the following.

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

	Recommended max. fuse					
AF-650 GP Power	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**
[kW] / [HP]	Type RK1 [1)]	Type J	Type T	Type CC	Type CC	Type CC
0.25–0.37 / 0.33–0.5	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
0.75 / 1	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
1.5 / 2	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
2.2 / 3	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
3.7 / 5	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
5.5 / 7.5	KTN-R-50	KS-50	JJN-50	-	-	-
7.5 / 10	KTN-R-60	JKS-60	JJN-60	-	-	-
11 / 15	KTN-R-80	JKS-80	JJN-80	-	-	-
15–18.5 / 20–25	KTN-R-125	JKS-125	JJN-125	-	-	-
22 / 30	KTN-R-150	JKS-150	JJN-150	-	-	-
30 / 40	KTN-R-200	JKS-200	JJN-200	-	-	-
37 / 50	KTN-R-250	JKS-250	JJN-250	-	-	-

Table 10.19 200–240V

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	Recommended max. fuse			
AF-650 GP Power	**SIBA**	**Littel fuse**	**Ferraz-Shawmut**	**Ferraz-Shawmut**
[kW] / [HP]	Type RK1	Type RK1	Type CC	Type RK1[3)]
0.25-0.37 / 0.33-0.5	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R
0.75 / 1	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R
1.5 / 2	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R
2.2 / 3	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R
3.7 / 5	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R
5.5 / 7.5	5014006-050	KLN-R-50	-	A2K-50-R
7.5 / 10	5014006-063	KLN-R-60	-	A2K-60-R
11 / 15	5014006-080	KLN-R-80	-	A2K-80-R
15-18.5 / 20-25	2028220-125	KLN-R-125	-	A2K-125-R
22 / 30	2028220-150	KLN-R-150	-	A2K-150-R
30 / 40	2028220-200	KLN-R-200	-	A2K-200-R
37 / 50	2028220-250	KLN-R-250	-	A2K-250-R

Table 10.20 200–240V

	Recommended max. fuse			
AF-650 GP	Bussmann	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW] / [HP]	Type JFHR2[2)]	JFHR2	JFHR2[4)]	J
0.25-0.37 / 0.33-0.5	FWX-5	-	-	HSJ-6
0.75 / 1	FWX-10	-	-	HSJ-10
1.5 / 2	FWX-15	-	-	HSJ-15
2.2 / 3	FWX-20	-	-	HSJ-20
3.7 / 5	FWX-30	-	-	HSJ-30
5.5 / 7.5	FWX-50	-	-	HSJ-50
7.5 / 10	FWX-60	-	-	HSJ-60
11 / 15	FWX-80	-	-	HSJ-80
15-18.5 / 20-25	FWX-125	-	-	HSJ-125
22 / 30	FWX-150	L25S-150	A25X-150	HSJ-150
30 / 40	FWX-200	L25S-200	A25X-200	HSJ-200
37 / 50	FWX-250	L25S-250	A25X-250	HSJ-250

Table 10.21 200-240 V

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

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

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

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

	Recommended max. fuse					
AF-650 GP	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[kW] / [HP]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
0.37-0.75 / 0.5-1	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
1.5-2.2 / 2-3	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3.7 / 5	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5 / 7.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5 / 10	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11 / 15	KTS-R-40	JKS-40	JJS-40	-	-	-
15 / 20	KTS-R-50	JKS-50	JJS-50	-	-	-
18.5 / 25	KTS-R-60	JKS-60	JJS-60	-	-	-
22 / 30	KTS-R-80	JKS-80	JJS-80	-	-	-
30 / 40	KTS-R-100	JKS-100	JJS-100	-	-	-
37 / 50	KTS-R-125	JKS-125	JJS-125	-	-	-
45 / 60	KTS-R-150	JKS-150	JJS-150	-	-	-
55 / 75	KTS-R-200	JKS-200	JJS-200	-	-	-
75 / 100	KTS-R-250	JKS-250	JJS-250	-	-	-

Table 10.22 380–480V

	Recommended max. fuse			
AF-650 GP	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW] / [HP]	Type RK1	Type RK1	Type CC	Type RK1
0.37-0.75 / 0.5-1	5017906-006	KLS-R-6	ATM-R-6	A6K-6-R
1.5-2.2 / 2-3	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R
3.7 / 5	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R
5.5 / 7.5	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R
7.5 / 10	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R
11 / 15	5014006-040	KLS-R-40	-	A6K-40-R
15 / 20	5014006-050	KLS-R-50	-	A6K-50-R
18.5 / 25	5014006-063	KLS-R-60	-	A6K-60-R
22 / 30	2028220-100	KLS-R-80	-	A6K-80-R
30 / 40	2028220-125	KLS-R-100	-	A6K-100-R
37 / 50	2028220-125	KLS-R-125	-	A6K-125-R
45 / 60	2028220-160	KLS-R-150	-	A6K-150-R
55 / 75	2028220-200	KLS-R-200	-	A6K-200-R
75 / 100	2028220-250	KLS-R-250	-	A6K-250-R

Table 10.23 380–480V

	Recommended max. fuse			
AF-650 GP	Bussmann	Ferraz-Shawmut	Ferraz-Shawmut	Littel fuse
[kW] / [HP]	JFHR2	J	JFHR2[1)]	JFHR2
0.37-0.75 / 0.5-1	FWH-6	HSJ-6	-	-
1.5-2.2 / 2-3	FWH-10	HSJ-10	-	-
3.7 / 5	FWH-20	HSJ-20	-	-
5.5 / 7.5	FWH-25	HSJ-25	-	-
7.5 / 10	FWH-30	HSJ-30	-	-
11 / 15	FWH-40	HSJ-40	-	-
15 / 20	FWH-50	HSJ-50	-	-
18.5 / 25	FWH-60	HSJ-60	-	-
22 / 30	FWH-80	HSJ-80	-	-
30 / 40	FWH-100	HSJ-100	-	-
37 / 50	FWH-125	HSJ-125	-	-
45 / 60	FWH-150	HSJ-150	-	-
55 / 75	FWH-200	HSJ-200	A50-P-225	L50-S-225
75 / 100	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 10.24 380–480V

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

	Recommended max. fuse					
AF-650 GP	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[kW] / [HP]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
0.75 / 1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5-2.2 / 2-3	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3.7 / 5	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5 / 7.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5 / 10	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11 / 15	KTS-R-35	JKS-35	JJS-35	-	-	-
15 / 20	KTS-R-45	JKS-45	JJS-45	-	-	-
18.5 / 25	KTS-R-50	JKS-50	JJS-50	-	-	-
22 / 30	KTS-R-60	JKS-60	JJS-60	-	-	-
30 / 40	KTS-R-80	JKS-80	JJS-80	-	-	-
37 / 50	KTS-R-100	JKS-100	JJS-100	-	-	-
45 / 60	KTS-R-125	JKS-125	JJS-125	-	-	-
55 / 75	KTS-R-150	JKS-150	JJS-150	-	-	-
75 / 100	KTS-R-175	JKS-175	JJS-175	-	-	-

Table 10.25 525–600V

	Recommended max. fuse			
AF-650 GP	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW] / [HP]	Type RK1	Type RK1	Type RK1	J
0.75 / 1	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5-2.2 / 2-3	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3.7 / 5	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5 / 7.5	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5 / 10	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11 / 15	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
15 / 20	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
18.5 / 25	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
22 / 30	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
30 / 40	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
37 / 50	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
45 / 60	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
55 / 75	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
75 / 100	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 10.26 525–600V

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

	Recommended max. fuse							
AF-650 GP [kW] / [HP]	Max. prefuse	Bussmann E52273 RK1/JDDZ	Bussmann E4273 J/JDDZ	Bussmann E4273 T/JDDZ	SIBA E180276 RK1/JDDZ	LittelFuse E81895 RK1/JDDZ	Ferraz-Shawmut E163267/E2137 RK1/JDDZ	Ferraz-Shawmut E2137 J/HSJ
11 / 15	30 A	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
15-18.5 / 20-25	45 A	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
22 / 30	60 A	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
30 / 40	80 A	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
37 / 50	90 A	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
45 / 60	100 A	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
55 / 75	125 A	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
75 / 100	150 A	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150
* UL compliance only 525–600 V								

Table 10.27 525–690V*, 100 HP and below, Unit Sizes 2x and 3x

10.4 Connection Tightening Torques

	Power (HP [kW])			Torque (Nm)						
Unit	200–240 V	380–480/500 V	525–600 V	525–690 V	Line power	Motor	DC connection	Brake	Ground	Relay
12		0.37–4.0			1.8	1.8	1.8	1.8	3	0.6
13	3.0–3.7	5.5–7.5	5.5–7.5		1.8	1.8	1.8	1.8	3	0.6
15		0.37–7.5	0.75–7.5		1.8	1.8	1.8	1.8	3	0.6
21	5.5–7.5	11–15	11–15		1.8	1.8	1.5	1.5	3	0.6
22	11	18 22	18 22	11 22	4.5 4.5	4.5 4.5	3.7 3.7	3.7 3.7	3 3	0.6 0.6
23	5.5–7.5	11–15			1.8	1.8	1.8	1.8	3	0.6
24	11–15	18–30			4.5	4.5	4.5	4.5	3	0.6
31	15–22	30–45	30–45		10	10	10	10	3	0.6
32	30–37	55–75	55–75	30–75	14/24[1)]	14/24[1)]	14	14	3	0.6
33	18–22	37–45	37–45		10	10	10	10	3	0.6
34	30–37	55–75	55–75		14/24 [1)]	14/24 [1)]	14	14	3	0.6

Table 10.28 Tightening of Terminals

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

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The instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the GE company.

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