GE
Industrial Solutions

AF-650 GP™ General Purpose Drive for Special Applications

Quick Guide

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Contents

1 Safety 4

1.1 Safety Symbols 4

1.2 Qualified Personnel 4

1.3 Safety Precautions 4

2 Introduction 6

3 Installation 7

3.1 Installation Site Check List 7

3.2 Frequency Converter and Motor Pre-installation Check List 7

3.3 Mechanical Installation 7

3.3.1 Cooling 7

3.3.2 Lifting 8

3.3.3 Mounting 8

3.4 Electrical Installation 9

3.4.1 Requirements 10

3.4.2 Grounding Requirements 10

3.4.2.1 Leakage Current (>3.5 mA) 11

3.4.2.2 Grounding Using Shielded Cable 11

3.4.3 Motor Connection 11

3.4.4 AC Mains Connection 12

3.4.5 Control Wiring 12

3.4.5.1 Access 12

3.4.5.2 Control Terminal Types 13

3.4.5.3 Wiring to Control Terminals 14

3.4.5.4 Using Shielded Control Cables 14

3.4.5.5 Control Terminal Functions 15

3.4.5.6 Terminal 53 and 54 Switches 15

3.4.5.7 Terminal 37 15

3.4.6 Serial Communication 16

4 Start-up and Functional Testing 17

4.1 Pre-start 17

4.1.1 Safety Inspection 17

4.2 Applying Power 19

4.3 Basic Operational Programming 19

4.4 Auto Tune 19

4.5 Check Motor Rotation 20

4.6 Local-control Test 20

4.7 System Start Up 21

4.8 Battery Back-up 21
4.8.1 Introduction 21
4.8.2 Operating Principle 21
4.8.3 Programming 22
4.8.3.1 Preparation 22
4.8.3.2 Basic Settings 22
4.8.4 Parameters for Battery Back-up Application 22
4.8.5 Updates to Existing Parameters 23
4.8.6 External Equipment and Component Sizing Considerations 23
4.8.6.1 DC Fuse and Isolation Diode Sizing 23
4.8.6.2 DC Inrush Considerations 24
4.8.7 Motor Operation with Reduced DC-link Voltage Considerations 25

5 User Interface 26
5.1 Keypad 26
5.1.1 Keypad Layout 26
5.1.2 Setting Keypad Display Values 27
5.1.3 Display Menu Keys 27
5.1.4 Navigation Keys 28
5.1.5 Operation Keys 28
5.2 Back-up and Copying Parameter Settings 28
5.2.1 Uploading data to the keypad 29
5.2.2 Downloading Data from the Keypad 29
5.3 Restoring Default Settings 29
5.3.1 Recommended Restoring 29
5.3.2 Manual Restoring 29

6 Parameter Menu Structure 30
6.1 Main Menu Structure 30
6.2 Remote Programming with DCT-10 35

7 Warnings and Alarm 36
7.1 System Monitoring 36
7.2 Warning and Alarm Types 36
7.3 Warning and Alarm Displays 36
7.4 Warning and Alarm Definitions 37

8 Specifications 40
8.1 General Technical Data 40
8.2 Fuses 44
8.2.1 CE Compliance 45
8.2.2 Fuse Specifications 45

8.2.3 NEC and UL Compliance 45

9 Terminal and Applicable Wire 47

9.1 Cables 47

Index 48

1 Safety

1.1 Safety Symbols

The following symbols are used in this guide:

⚠WARNING

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

⚠CAUTION

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

NOTICE

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

1.2 Qualified Personnel

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

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

1.3 Safety Precautions

⚠WARNING

HIGH VOLTAGE

Drives contain high voltage when connected to AC mains input or DC battery. Failure to perform installation, start-up, and maintenance by qualified personnel can result in death or serious injury.

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

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains or DC battery, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start via an external switch, a fieldbus command, an input reference signal from the keypad, or after a cleared fault condition.
To prevent unintended motor start:

- **Disconnect the frequency converter from the mains.**
- **Press [Off/Reset] on the keypad before programming parameters.**
- **Completely wire and assemble the frequency converter, motor, and any driven equipment before connecting the frequency converter to AC mains or DC battery.**

⚠WARNING

DISCHARGE TIME

The frequency converter contains DC-link capacitors, which can remain charged even when the frequency converter is not powered. High voltage can be present even when the warning indicator lights are off. Failure to wait the specified time after power has been removed before performing service or repair work, could result in death or serious injury.

1. **Stop the motor.**
2. **Disconnect AC mains, permanent magnet type motors, and remote DC-link supplies, including battery back-ups, UPS, and DC-link connections to other frequency converters.**
3. **Wait for the capacitors to discharge fully, before performing any service or repair work. The duration of waiting time is specified in *Table 1.1*.**

Voltage [V]	Power size [kW (hp)]	Minimum waiting time (minutes)
380–480	18 (25) 37 (50) 75 (100)	15
	132 (200) 250 (350)	20

Table 1.1 Discharge Time

⚠WARNING

LEAKAGE CURRENT HAZARD

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

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

⚠WARNING

EQUIPMENT HAZARD

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

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

⚠WARNING

UNINTENDED MOTOR ROTATION WINDMILLING

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

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

⚠CAUTION

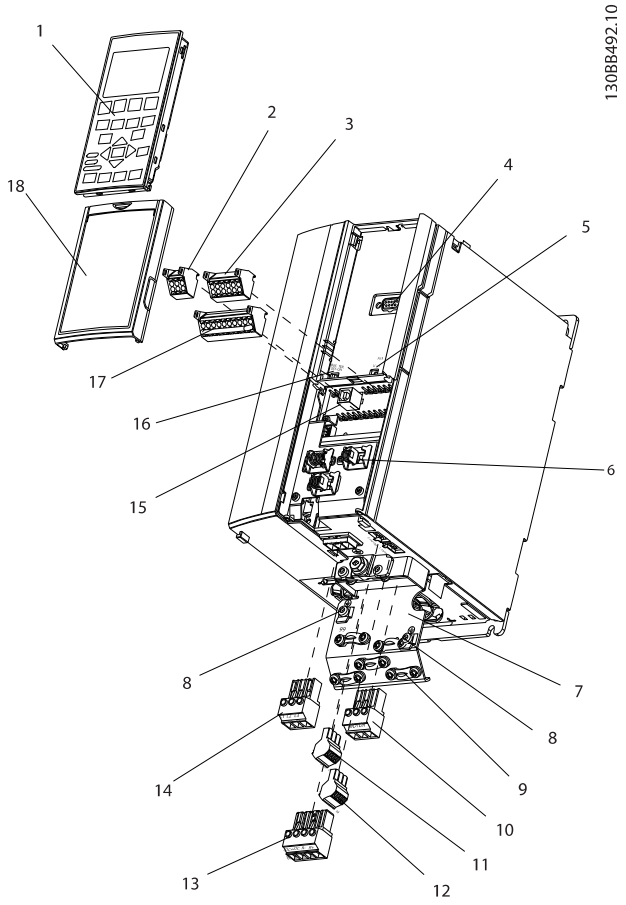
INTERNAL FAILURE HAZARD

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

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

2 Introduction

2



1	Keypad	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS485 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 DC battery input (-88, +89) terminals
5	Analog switches (A53), (A54)	14	Mains input terminals 91 (L1), 92 (L2), 93 (L3)
6	Cable strain relief/PE ground	15	USB connector
7	Decoupling plate	16	Serial bus terminal switch
8	Grounding clamp (PE)	17	Digital I/O and 24 V power supply
9	Shielded cable grounding clamp and strain relief	18	Control cable cover plate

Illustration 2.1 Exploded View Unit Sizes 12–13, IP20

NOTICE

Consult the AF-650 GP Design & Installation Guide for other unit sizes.

3 Installation

3.1 Installation Site Check List

- The frequency converter 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 frequency converter.
- 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:
  - 300 m (1000 ft) for unshielded motor cables.
  - 150 m (500 ft) for shielded cable.

⚠CAUTION

DEVICE DAMAGE THROUGH CONTAMINATION

Do not leave the frequency converter uncovered.

3.2 Frequency Converter and Motor Pre-installation Check List

- 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 same voltage:
  - Mains (power)
  - Frequency converter
  - Motor
- Ensure that the frequency converter output current rating is equal to or greater than motor full load current for peak motor performance:
  - Motor size and frequency converter power must match for proper overload protection.
  - If frequency converter rating is less than motor, full motor output cannot be achieved.

3.3 Mechanical Installation

3.3.1 Cooling

- To provide cooling airflow, mount the unit to a solid flat surface or to the optional backplate (see *chapter 3.3.3 Mounting*).
- Top and bottom clearance for air cooling must be provided. Generally, 100–225 mm (4–10 in) is required. See *Illustration 3.1* for clearance requirements.
- Improper mounting can result in over heating and reduced performance.
- Derating for temperatures starting between 40 °C (104 °F) and 50 °C (122 °F) and elevation 1000 m (3300 ft) above sea level must be considered. See the equipment Design Guide for detailed information.

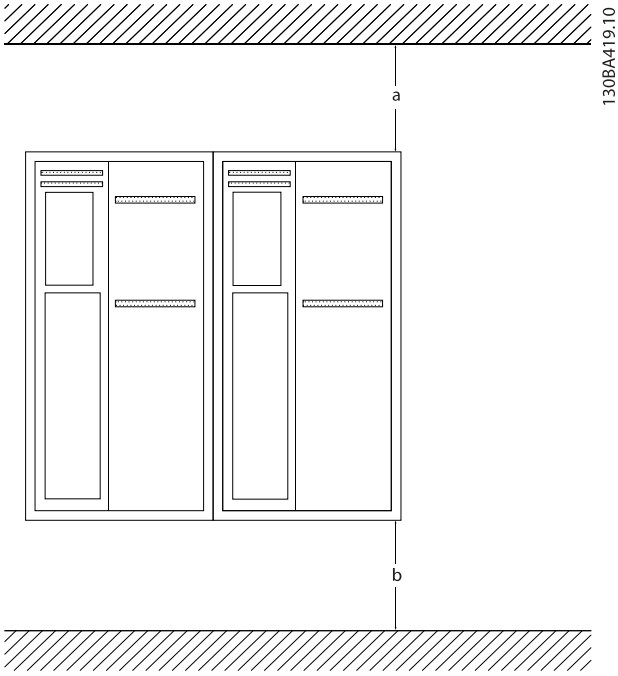


Illustration 3.1 Top and Bottom Cooling Clearance

Voltage [V]	Power size [kW (hp)]	Clearance a/b [mm (in)]
380–480	18, 37 (25, 50)	200 (8)
	75, 132, 250 (100, 200, 350)	225 (10)

Table 3.1 Minimum Airflow Clearance Requirements

3

3.3.2 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.

3.3.3 Mounting

- Mount the unit vertically.
- The frequency converter allows side-by-side installation.
- Ensure that the strength of the mounting location supports the unit weight.
- Mount the unit to a solid flat surface or to the optional backplate to provide cooling airflow (see *Illustration 3.2* and *Illustration 3.3*).
- Improper mounting can result in over heating and reduced performance.
- Use the slotted mounting holes on the unit for wall mount, when provided.

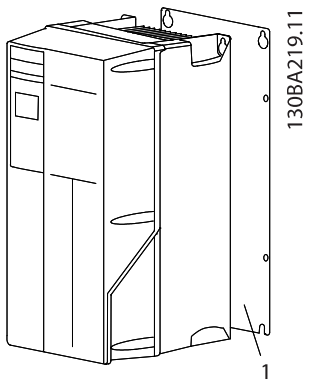


Illustration 3.2 Proper Mounting with Backplate

Item A in *Illustration 3.2* and *Illustration 3.3* is a backplate properly installed for required airflow to cool the unit.

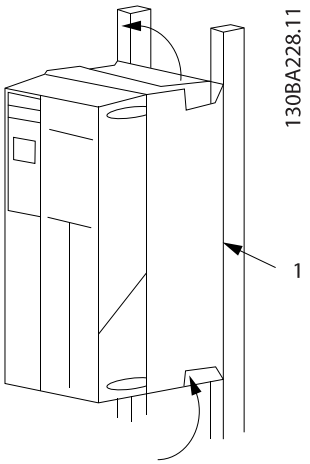


Illustration 3.3 Proper Mounting with Railings

NOTICE

Back plate is needed when mounted on railings.

3.4 Electrical Installation

This section contains detailed instructions for wiring the frequency converter.

The following tasks are described:

- Wiring the motor to the frequency converter output terminals.
- Wiring the AC mains to the frequency converter 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.

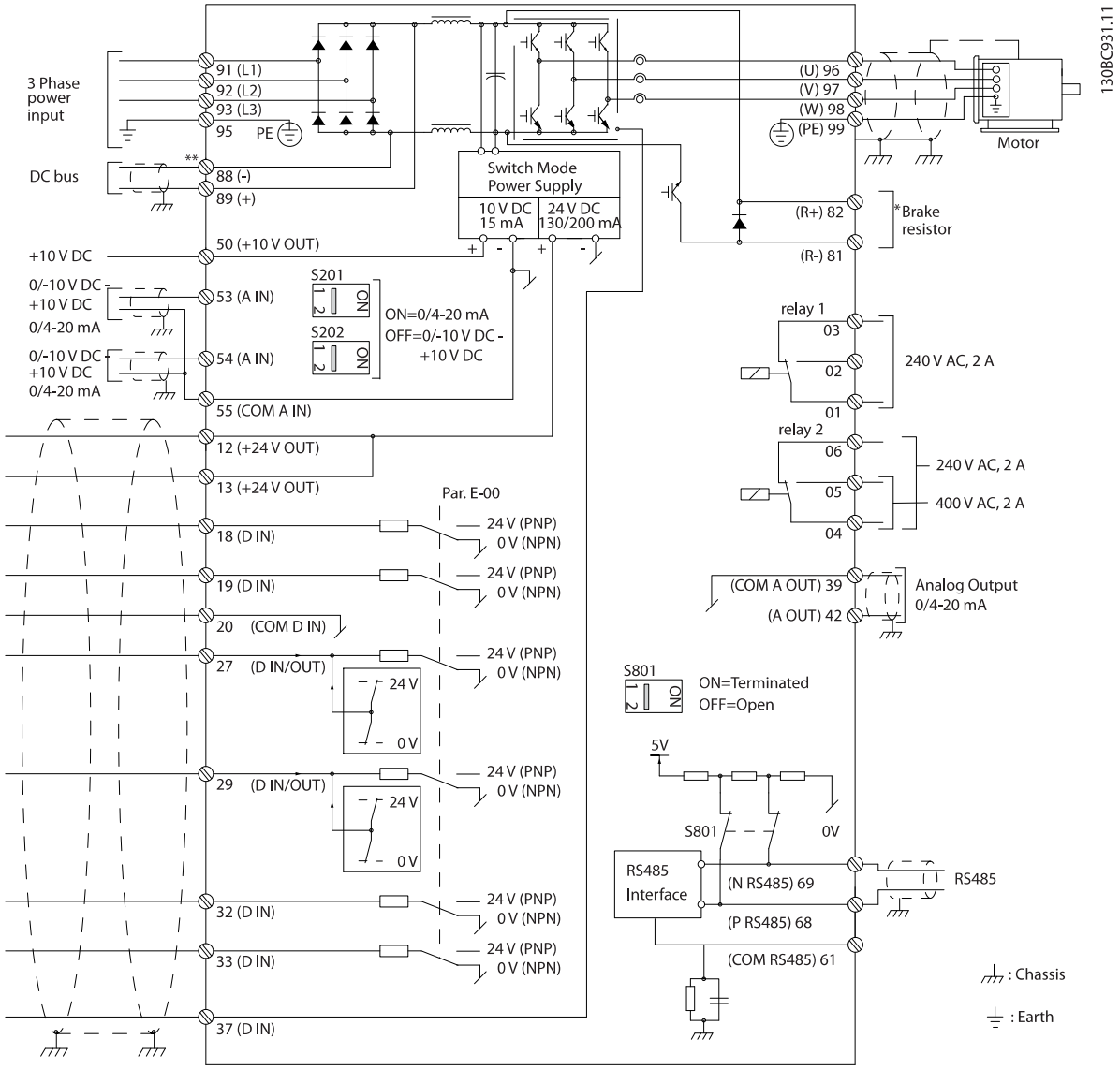


Illustration 3.4 Basic Wiring Schematic Drawing

A=Analog, D=Digital

Terminal 37 is used for Safe Torque Off. Refer to *Safe Torque Off Operating Instructions* for further information.

*The brake chopper factory option must be ordered to use dynamic brake resistors.

3

3.4.1 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 recommended that installation, start up, and maintenance is performed only by trained and qualified personnel. Failure to follow these guidelines could result in death or serious injury.

⚠CAUTION

WIRING ISOLATION!

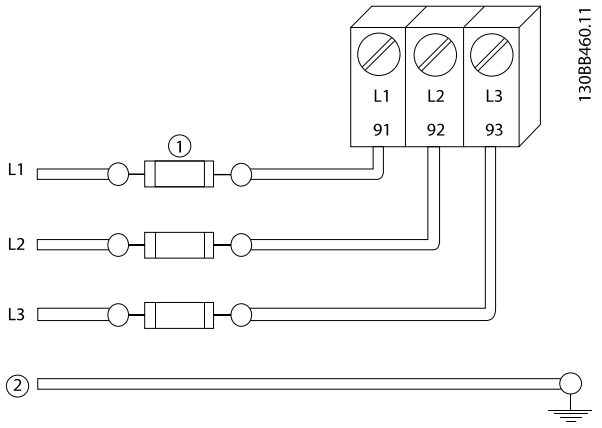
Run input power, motor wiring, and control wiring in three separate metallic conduits or use separated shielded cable for high frequency noise isolation. Failure to isolate power, motor, and control wiring could result in less than optimum frequency converter and associated equipment performance.

For your safety, comply with the following requirements:

- Electronic controls equipment is connected to hazardous mains voltage. Extreme care should be taken to protect against electrical hazards when applying power to the unit.
- Run motor cables from multiple frequency converters 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 frequency converter 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 *chapter 7 Warnings and Alarm* for details on the trip function.
- Because the motor wiring carries high frequency current, it is important that wiring for mains, motor power, and control are 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 frequency converters must be provided with short circuit and overcurrent protection. Input fusing is required to provide this protection, see *Illustration 3.5*. Fuses must be provided by the installer as part of installation. See maximum fuse ratings in *chapter 8.2 Fuses*.



1	Fuses
2	Ground

Illustration 3.5 Frequency Converter 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 75 ° C (167°F) rated copper wire.

3.4.2 Grounding Requirements

⚠WARNING

GROUNDING HAZARD!

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

NOTICE

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 *chapter 3.4.2.1 Leakage Current (>3.5 mA)*.

- A dedicated ground 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 frequency converter 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 motor manufacturer wiring requirements.

3.4.2.1 Leakage Current (>3.5 mA)

Follow national and local codes regarding protective earthing of equipment with a leakage current > 3.5 mA. Frequency converter technology implies high frequency switching at high power. This generates a leakage current in the ground connection. A fault current in the frequency converter 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 frequency converter power.

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

Grounding must be reinforced in one of the following ways:

- Ground wire of at least 10 mm^2 (8 AWG).
- 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 earth 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.

3.4.2.2 Grounding Using Shielded Cable

Grounding clamps are provided for motor wiring (see *Illustration 3.6*).

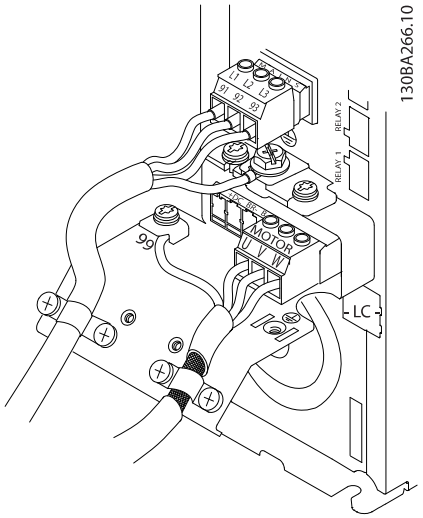


Illustration 3.6 Grounding with Shielded Cable

3.4.3 Motor Connection

⚠WARNING

INDUCED VOLTAGE!

Run output motor cables from multiple frequency converters 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 *Table 9.1*.
- Comply with local and national electrical codes for cable sizes.
- Do not install power factor correction capacitors between the frequency converter and the motor.
- Do not wire a starting or pole-changing device between the frequency converter and the motor.
- Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W).
- Ground the cable in accordance with grounding instructions provided.
- Torque terminals in accordance with the information provided in *chapter 9 Terminal and Applicable Wire*.
- Follow motor manufacturer wiring requirements.

Illustration 3.7 shows mains input, motor, and grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.

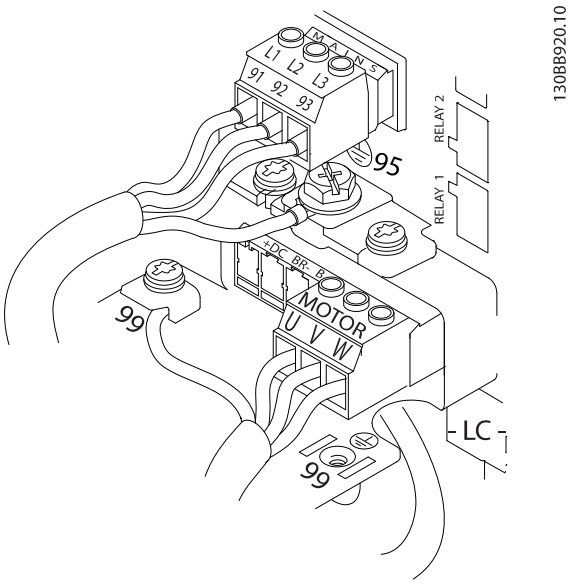


Illustration 3.7 Example of Motor, Mains, and Ground Wiring

3.4.4 AC Mains Connection

- Size wiring based on the input current of the frequency converter. For maximum wire sizes, see *Table 9.1*.
- Comply with local and national electrical codes for cable sizes.
- Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Illustration 3.7*).
- Depending on the configuration of the equipment, input power is connected to the mains input power or the input disconnect.
- Ground the cable in accordance with grounding instructions provided in *chapter 3.4.2 Grounding Requirements*.
- All frequency converters may be used with an isolated input source and with ground reference power lines. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), set *parameter SP-50 RFI Filter* to *[0] Off*. When off, the internal RFI filter capacitors between the chassis and the intermediate circuit are isolated to avoid damage to the DC link and to reduce ground capacity currents in accordance with IEC 61800-3.

3.4.5 Control Wiring

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

3.4.5.1 Access

- Remove access cover plate with a screwdriver. See *Illustration 3.8*.
- Or remove front cover by loosening attaching screws.
  Tightening torque for front cover is 2.0 Nm for unit size 15 Nm and 2.2 Nm for unit sizes 2X and 3X.

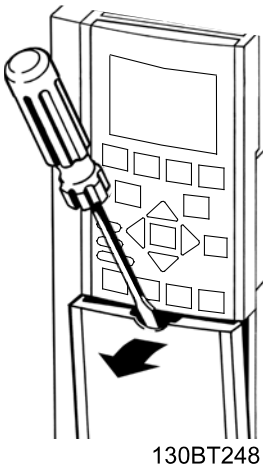


Illustration 3.8 Control Wiring Access for IP20/Open Chassis Enclosures

3.4.5.2 Control Terminal Types

Illustration 3.9 shows the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 3.3*.

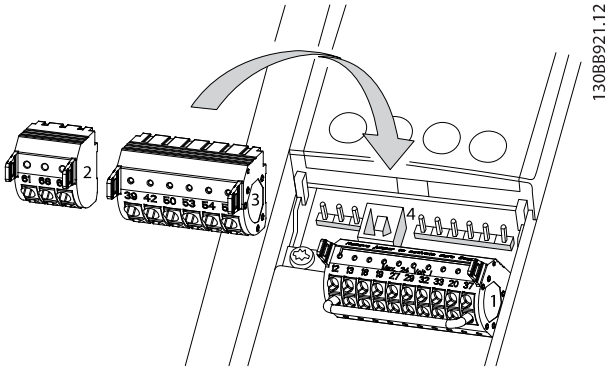


Illustration 3.9 Control Terminal Locations

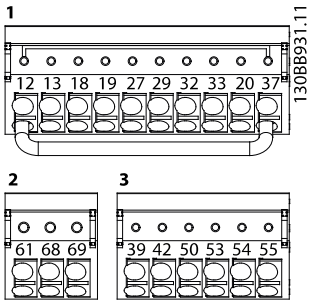


Illustration 3.10 Terminal Numbers

- **Connector 1** provides four programmable digital inputs terminals, two extra digital terminals programmable as either input or output, a 24 V DC terminal supply voltage, and a common for optional customer supplied 24 V DC voltage. A digital input for STO (Safe Torque Off) function.
- **Connector 2** terminals (+)68 and (-)69 are for an RS485 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 DCT-10.
- Also provided are two Form C relay outputs that are in various locations depending after the frequency converter configuration and size.
- Some options available for ordering with the unit may provide extra terminals. See the manual provided with the equipment option.

See *chapter 8.1 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.
42	AN-50	[0] No operation	Programmable analog output. The analog signal is 0–20 mA or 4–20 mA at a maximum of 500 Ω
50	–	+10 V DC	10 V DC analog supply voltage. 15 mA maximum commonly used for potentiometer 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 3.2 Terminal Description Digital Inputs/Outputs, Analog Inputs/Outputs

Terminal description			
Terminal	Parameter	Default setting	Description
Serial communication			
61	–	–	Integrated RC-Filter for cable screen. ONLY for connecting the shield when experiencing EMC problems.
68 (+)	O-3#	–	RS485 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 3.3 Terminal Description Serial Communication

3.4.5.3 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in *Illustration 3.9*.

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Illustration 3.11*.
2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure that the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

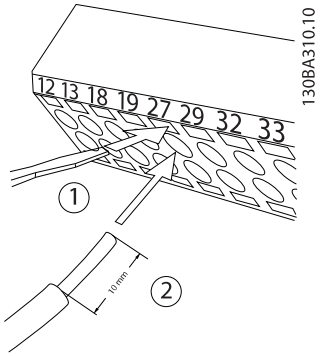


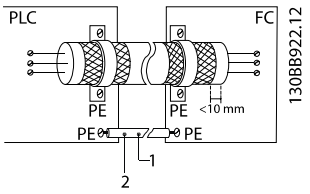
Illustration 3.11 Connecting Control Wiring

3.4.5.4 Using Shielded Control Cables

Correct screening

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

If the ground potential between the frequency converter and the PLC is different, electric noise may occur that disturbs the entire system. Solve this problem by fitting an equalizing cable next to the control cable. Minimum cable cross-section: 16 mm^2 (6 AWG).



1	Minimum 16 mm^2 (6 AWG)
2	Equalizing cable

Illustration 3.12 Correct Screening

50/60 Hz ground loops

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

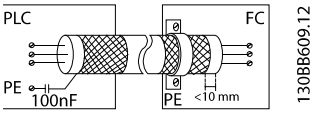
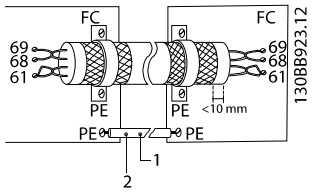


Illustration 3.13 50/60 Hz Ground Loops

Avoid EMC noise on serial communication

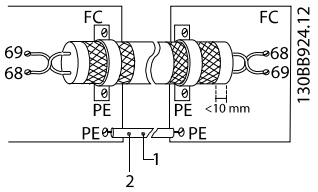
This terminal is connected to ground via an internal RC link. Use twisted-pair cables to reduce interference between conductors. The recommended method is in *Illustration 3.14*:



1	Minimum 16 mm^2 (6 AWG)
2	Equalizing cable

Illustration 3.14 Twisted-pair Cables

Alternatively, the connection to terminal 61 can be omitted:



1	Minimum 16 mm² (6 AWG)
2	Equalizing cable

Illustration 3.15 Twisted-pair Cables without Terminal 61

3.4.5.5 Control Terminal Functions

Frequency converter functions are commanded by receiving control input signals.

- Each terminal must be programmed for the function it is supporting in the parameters associated with that terminal. See *Table 3.3* for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See *chapter 5 User Interface* for details on accessing parameters and *chapter 6 Parameter Menu Structure* for details on programming.
- The default terminal programming is intended to initiate frequency converter functioning in a typical operational mode.

3.4.5.6 Terminal 53 and 54 Switches

- Analog input terminals 53 and 54 can select either voltage (-10 V to 10 V) or current (0/4–20 mA) input signals.
- Remove power to the frequency converter 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 *Illustration 3.16*).

NOTICE

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 *parameter DR-61 Terminal 53 Switch Setting*.
- Terminal 54 default is for a feedback signal in closed loop set in *parameter DR-63 Terminal 54 Switch Setting*.

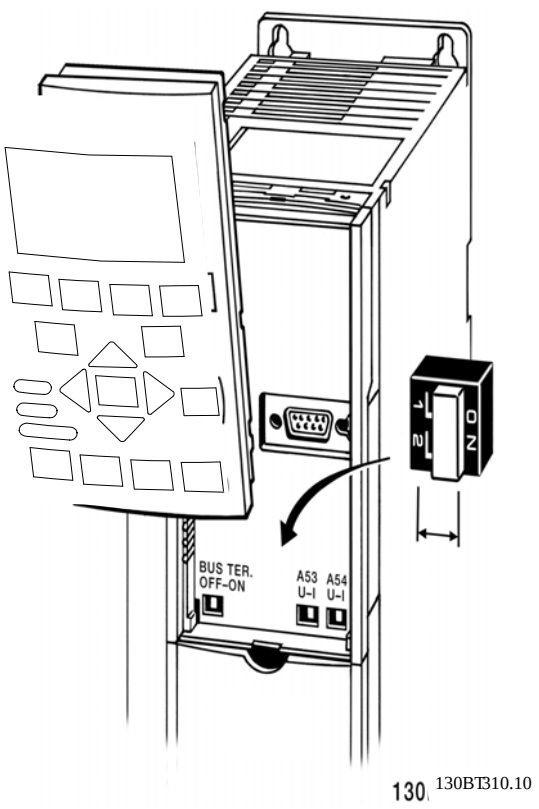


Illustration 3.16 Location of Terminals 53 and 54 Switches and Bus Termination Switch

3.4.5.7 Terminal 37

Terminal 37 Safe Torque Off function

The AF-650 GP is available with Safe Torque Off functionality via control terminal 37. Safe torque off (STO) disables the control voltage of the power semiconductors of the frequency converter output stage which in turn prevents generating the voltage required to rotate the motor. To run STO, additional wiring for the frequency converter is required. Refer to *Safe Torque Off Operating Instructions* for further information.

3.4.6 Serial Communication

Connect RS485 serial communication wiring to terminals (+)68 and (-)69.

3

- Shielded serial communication cable is recommended.
- See *chapter 3.4.2 Grounding Requirements* for proper grounding.

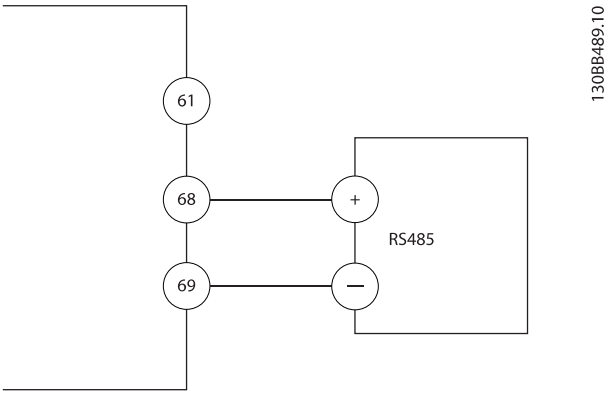


Illustration 3.17 Serial Communication Wiring Diagram

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

1. Protocol type in *parameter O-30 Protocol*.
2. Frequency converter address in *parameter O-31 Address*.
3. Baud rate in *parameter O-32 Drive Port Baud Rate*.

- Two communication protocols are internal to the frequency converter.
  - Drive profile
  - Modbus RTU
- Functions can be programmed remotely using the protocol software and RS485 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 extra protocol-specific parameters available.
- Option cards which install into the frequency converter are available to provide extra communication protocols. See the option-card documentation for installation and operation instructions.

4 Start-up and Functional Testing

4.1 Pre-start

4.1.1 Safety Inspection

⚠WARNING

HIGH VOLTAGE

If input and output connections have been connected improperly, there is potential for high voltage on these terminals. If power leads for multiple motors are improperly run in same conduit, there is potential for leakage current to charge capacitors within the frequency converter, even when disconnected from mains 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. Switch off the Input power to the unit and ensure that it is locked out. Do not rely on the frequency converter 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 frequency converter and the motor.
6. Inspect the frequency converter for loose connections on terminals.
7. Record the following motor nameplate data:
   - 7a Power
   - 7b Voltage
   - 7c Frequency
   - 7d Full load current
   - 7e Nominal speed.

   These values are needed to program the motor nameplate data later.
8. Confirm that the supply voltage matches the voltage of the frequency converter and the motor.

4.1.2 Pre-start

⚠CAUTION

Before applying power to the unit, inspect the entire installation as detailed in *Table 4.1*. Check mark those items when completed.

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers on the input power side of the frequency converter or output side to the motor. Ensure that they are ready for full speed operation. • Check function and installation of any sensors used for feedback to the frequency converter. • Remove power factor correction capacitors on motors, if present.	
Cable routing	• Use separate metallic conduits for each of the following: - Input power - Motor wiring - Control wiring	
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. • Use shielded or twisted-pair cable. Ensure that the shield is terminated correctly.	
Cooling clearance	• Measure that top and bottom clearance is adequate to ensure proper air flow 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 enclosure 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 sufficient.	
Input and output power wiring	• Check for loose connections. • Check that motor and mains are in separate conduit or separated shielded cables.	
Panel interior	• Inspect that the unit interior is free of debris and corrosion.	
Switches	• Ensure that all switch and disconnect settings are in the proper positions.	
Vibration	• Check that the unit is mounted solidly or that shock mounts are used as necessary. • Check for an unusual amount of vibration.	

Table 4.1 Start-up Checklist

4.2 Applying Power

⚠WARNING

HIGH VOLTAGE!

Frequency converters contain high voltage when connected to the energized DC bus. Only qualified personnel should install, start up, and maintain the frequency converters. Failure to let qualified personnel install, start up and maintain the frequency converters could result in death or serious injury.

⚠WARNING

UNINTENDED START!

When the frequency converter is connected to the energized DC bus, the motor may start at any time. The frequency converter, motor, and any driven equipment must be in operational readiness. Failure to be in operational readiness when the frequency converter is connected to the energized DC bus could result in death, serious injury, equipment, or property damage.

1. Confirm that 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 a cover-mounted.
4. Apply power to the unit. DO NOT start the frequency converter now. For units with a disconnect switch, turn to the ON position to apply power to the frequency converter.

4.3 Basic Operational Programming

Frequency converters require basic operational programming before running for best performance. Basic operational programming requires entering motor nameplate data for the motor being operated and the minimum and maximum motor speeds. Parameter settings recommended are intended for start-up and checkout purposes. Application settings may vary. See *chapter 5.1 Keypad* for detailed instructions on entering data through the keypad.

Enter data in accordance with the following procedure.

1. Press [Quick Menu] on the keypad.
2. Use the navigation keys to scroll to Quick Start.
3. Press [OK].
4. 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.

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

   Parameter F-05 Motor Rated Voltage

   Parameter F-04 Base Frequency

   Parameter P-03 Motor Current

   Parameter P-06 Base Speed
5. Enter *parameter F-01 Frequency Setting 1* and press [OK].
6. Enter *parameter F-02 Operation Method*. Local, Remote, or Linked to Hand/Auto. In local mode the reference is entered on the keypad, and in remote that reference is sourced depending on *parameter F-01 Frequency Setting 1*.
7. Enter the accel/decel time in *parameter F-07 Accel Time 1* and *parameter F-08 Decel Time 1*.
8. For *parameter F-10 Electronic Overload*, enter Elec OL Trip 1 for Class 20 overload protection. For further information, see *chapter 3.4.1 Requirements*.
9. For *parameter F-17 Motor Speed High Limit [RPM]* or *parameter F-15 Motor Speed High Limit [Hz]*, enter the application requirements.
10. For *parameter F-18 Motor Speed Low Limit [RPM]* or *parameter F-16 Motor Speed Low Limit [Hz]*, enter the application requirements.
11. Set *parameter H-08 Reverse Lock* to Clockwise, Counterclockwise or Both directions.
12. In *parameter P-04 Auto Tune*, select Reduced Auto Tune or Full Auto Tune and follow on-screen instructions.

4.4 Auto Tune

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

- The frequency converter 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 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 *[2] Reduced Auto Tune*.
- If an output filter is connected to the motor, select *[2] Reduced Auto Tune*.
- If warnings or alarms occur, see *chapter 7 Warnings and Alarm*
- Run this procedure on a cold motor for best results.

4

4.5 Check Motor Rotation

Before running the frequency converter, check the motor rotation.

1. Press [Hand].
2. Press [▲] for positive speed reference.
3. Check that the speed shown is positive.
4. Verify that the wiring between the frequency converter and the motor is correct.
5. Verify that the motor running direction matches the setting in *parameter H-48 Clockwise Direction*.
   - 5a When *parameter H-48 Clockwise Direction* is set to *[0] Normal* (default clockwise):
     a. Verify that the motor turns clockwise.
     b. Verify that the keypad direction arrow is clockwise.
   - 5b When *parameter H-48 Clockwise Direction* is set to *[1] Inverse* (counterclockwise):
     a. Verify that the motor turns counterclockwise.
     b. Verify that the keypad direction arrow is counter-clockwise.

4.6 Local-control Test

⚠CAUTION

MOTOR START!

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

NOTICE

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

1. Press [Hand].
2. Accelerate the frequency converter 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 *chapter 7 Warnings and Alarm*
- Check that motor data is entered correctly
- Increase the ramp time in *parameter F-07 Accel Time 1*
- Increase current limit in *parameter F-43 Current Limit*
- Increase torque limit in *parameter F-40 Torque Limiter (Driving)*

If deceleration problems were encountered:

- If warnings or alarms occur, see *chapter 7 Warnings and Alarm*.
- Check that motor data is entered correctly.
- Increase the ramp time in *parameter F-08 Decel Time 1*.
- Enable overvoltage control in *parameter B-17 Over-voltage Control*.

See *chapter 7.4 Warning and Alarm Definitions* for resetting the frequency converter after a trip.

NOTICE

***Chapter 4.1 Pre-start* through *chapter 4.6 Local-control Test* in this chapter conclude the procedures for applying power to the frequency converter, basic programming, set-up, and functional testing.**

4.7 System Start Up

The procedure in this section requires user-wiring and application programming to be completed. The following procedure (step 1–6) is recommended after application set-up by the user is completed.

⚠CAUTION

MOTOR START!

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

1. Press [Auto].
2. Ensure that external control functions are properly wired to the frequency converter 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 *chapter 7 Warnings and Alarm*.

4.8 Battery Back-up

4.8.1 Introduction

Use the battery back-up function for fault-tolerant applications where a load that has a variable torque characteristic over the whole speed range needs continuous operation when AC mains is lost and it is acceptable to operate at lower rate of output conditions.

Examples of fault-tolerant applications:

- Centrifugal pumps
- Fans

Examples of output conditions:

- Speed
- Flow
- Pressure
- Load
- Torque

If the AC mains source is lost, an interconnected DC battery source supplies power to the critical loads with no interruption.

The output current and power ratings for operation in battery back-up are summarized in *Table 4.2*:

Voltage [V]	Power size [kW (hp)]	235 V battery current limit [A_{rms}]	165 V battery current limit [A_{rms}]	235 V DC power limit[2)] [kW]	165 V DC power limit[2)] [kW]
380–480	18 (25)	40[1)]	40[1)]	8	6
	37 (50)	80[1)]	80[1)]	16	12
	75 (100)	120[1)]	120[1)]	25	17
	132 (200)	302[1)]	302[1)]	62	44
	250 (350)	535	535	110	77

Table 4.2 Power Ratings

1) Estimated based on preliminary testing

*2) Assumes 0.85 power factor, $V_{Line\text{-}to\text{-}Line}$ = 0.612 * V DC, efficiency = 97%*

4.8.2 Operating Principle

When supplied by AC mains, the frequency converter's DC link is nearly at a constant value approximately equal to the peak of the rectified line-to-line input voltage. The frequency converter's constant DC link can also be supplied by an external DC supply, in this case, a battery back-up supply. To provide an uninterrupted output, the battery back-up supply is connected to the frequency converter's DC link through a blocking diode. This connection provides a fixed minimum DC-link voltage to the source with the highest voltage providing power to the load, and no reverse power flows back to the battery back-up supply.

Operating modes

- Normal operation: AC source is present and the motor runs at variable speed controlled by its dedicated frequency converter. It can reach its nominal performances.
- Degraded operation: AC source is lost and the emergency DC source from batteries allows continuous running of the motor at part load without any interruption.
- Back to normal operation: AC source is restored and the motor resumes normal operation without any interruption.

4.8.3 Programming

4.8.3.1 Preparation

To configure frequency converter for battery back-up operation, complete the following tasks:

- Apply nominal 3-phase mains voltage to the frequency converter.
- Check the motor phase.
- In hand-on mode, set the frequency to a low positive value, for example +3 Hz.
- Make sure that the motor rotates in the positive direction. If it rotates in the negative direction, exchange the motor phases.
- Remove all signals to inputs.
- Press [Off] on the keypad.
- Restore the frequency converter in *parameter H-03 Restore Factory Settings*.
- Perform an auto tune.

4.8.3.2 Basic Settings

- Enable emergency power mode in *parameter SF-40 Emergency Power Mode*.
- Set the motor speed limit for high battery in *parameter SF-41 Speed Limit, High Battery [RPM]* or *parameter SF-42 Speed Limit, High Battery [Hz]*.
- Set the motor speed limit for low battery in *parameter SF-43 Speed Limit, Low Battery [RPM]* or *parameter SF-44 Speed Limit, Low Battery [Hz]*.
- Set the motor current limit for high battery in *parameter SF-45 Current Limit, High Battery*.
- Set the motor current limit for low battery in *parameter SF-46 Current Limit, Low Battery*.

The speed limits and current limits for high and low battery voltages are linear between the 2 setpoints. This allows the output to be automatically limited based on the measured battery voltage as it discharges over time.

In addition to the emergency mode specific parameters configured above, set the following parameters to ensure proper DC battery operation:

- To avoid output current oscillations at low voltage set *parameter F-38 Overmodulation* to *[0] Off*.
- To achieve the best output current regulation, set *parameter H-41 Motor Control Principle* to *[2] Flux Sensorless* or *[3] Flux w/ motor feedback*.
- To avoid nuisance current limit warnings at start-up, reduce *parameter H-66 Min. Current at Low Speed*.
- Set *parameter SP-10 Line failure* to *[0] No function*.

The frequency converter status can be monitored using the additional readout parameters of *parameter DR-42 Actual Current Limit [A]* and *parameter DR-43 Actual Speed Limit [RPM]* and *parameter DR-44 Actual Speed Limit*.

The emergency mode status can also be used to configure digital outputs, provide emergency mode indication in *parameter O-13 Configurable Status Word STW*, and can be used in the built-in logic controller in *parameter LC-10 Comparator Operand*.

4.8.4 Parameters for Battery Back-up Application

SF-40 Emergency Power Mode

Emergency power mode allows the frequency converter to run with reduced power capabilities from an emergency power supply.

Option:		Function:
[0] *	Disabled	
[1]	Enabled	

SF-41 Speed Limit, High Battery [RPM]

Range:		Function:
3600 RPM*	[0.0-par.F-17 RPM]	The speed limit that takes effect when the frequency converter is operating in emergency power supply mode and the battery voltage is at its highest value.

SF-42 Speed Limit, High Battery [Hz]

Range:		Function:
120.0 Hz*	[0.0-par.F-15 Hz]	The speed limit that takes effect when the frequency converter is operating in emergency power supply mode and the battery voltage is at its highest value.

SF-43 Speed Limit, Low Battery [RPM]

Range:		Function:
3600 RPM*	[0.0-par.SF-41 RPM]	The speed limit that takes effect when the frequency converter is operating in emergency power supply mode and the battery voltage is at its lowest value.

SF-44 Speed Limit, Low Battery [Hz]

Range:		Function:
120.0 Hz*	[0.0-par.SF-42 Hz]	The speed limit that takes effect when the frequency converter is operating in emergency power supply mode and the battery voltage is at its lowest value.

SF-45 Current Limit, High Battery [A]

Range:		Function:
Power Size Dependent A*	[0.0-Power Size Dependent A]	The output current limit that takes effect when the frequency converter is operating in emergency power supply mode and the battery voltage is at its highest value.

SF-46 Current Limit, Low Battery [A]

Range:		Function:
Power Size Dependent A*	[0.0-SF-45 A]	The current limit that takes effect when the frequency converter is operating in emergency power supply mode and the battery voltage is at its lowest value.

DR-42 Actual Current Limit [A]

Range:		Function:
0.0 A*	[0.0-10000.0 A]	The actual active motor current limit in Amps.

DR-43 Actual Speed Limit [RPM]

Range:		Function:
3600 RPM*	[0.0-10000.0 A]	The actual active motor speed limit in RPM.

DR-44 Actual Speed Limit [Hz]

Range:		Function:
120.0 Hz*	[0.0-10000.0 A]	The actual active motor speed limit in Hz.

4.8.5 Updates to Existing Parameters

The emergency mode state is added to the list of available items to assign to digital outputs, for example terminals 27 and 29, relay 1, relay 2 and so on.

Range:		Function:
200*	[Emergency Mode]	The value is high when the frequency converter is in the emergency power mode state.

The emergency mode state is also added to the list of available options for:

O-13 Configurable Status Word STW

Range:		Function:
93*	[Emergency Mode]	Allows bit 5 and bits 12–15 to be set as high when the frequency converter is in the emergency power mode state.

LC-10 Comparator Operand

Range:		Function:
213*	[Emergency Mode]	The value is high when the frequency converter is in the emergency power mode state.

4.8.6 External Equipment and Component Sizing Considerations

4.8.6.1 DC Fuse and Isolation Diode Sizing

To protect the DC bus against short circuits and the frequency converters from overload, install fuses in series with the load sharing terminals of all connected units.

NOTICE

Respect the following guidelines when dimensioning the DC bus fuses.

- The voltage class of the fuse must be able to handle the maximum DC bus voltage (1.35 x U_{LL})
- The fuse must be a fast semiconductor type, for example aR or gR.
- The maximum fuse current rating must not exceed the mains fuse current rating for the individual frequency converter ($I_{\text{fuse, DC – link, max}} \leq I_{\text{fuse, mains}}$)

The recommended DC bus fuses are based on equation 1 and the fuse is selected up 1 size after rounding up to the next available fuse size. The nominal voltage, U_{LL}, is reduced by 10% as a worst case scenario in the calculation to allow for tolerances.

Equation 1: Calculation of DC bus fuse - AC mains

$$I_{\text{DC}} = \frac{P_{\text{in}}}{U_{\text{DC}}} = \frac{P_{\text{in}}}{1.35 \; x \; U_{\text{LL},n} \; x \; 0.9}$$

Equation 2: Calculation of DC bus fuse - battery

If the maximum power supplied when running on the DC battery is less than calculated power at full mains voltage, the DC fuses may be decreased. Using a calculated frequency converter output power and an assumed frequency converter efficiency of 97%:

$$I_{\text{DC}} = \frac{P_{\text{out}}}{U_{\text{DC}} \; x \; \eta} = \frac{P_{\text{out}}}{U_{\text{Battery}} \; x \; 0.97}$$

Remember to round up 1 size after rounding up to the next available fuse size and to calculate over the entire DC battery operating range.

Example: For equation 1 - U_{LL}=400 V and P_{in}=90 kW gives I_{DC}=185.2 A.
Equation 2 for $U_{Battery}$=235 V and P_{out}=39.6 kW gives I_{DC}=173.7 A.

For both cases, the next available fuse size is aR-200, hence aR-250 is selected.

NOTICE

The recommendations are for ambient temperatures of around 20 °C (68 °F). At 40 °C (104 °F) gR/aR fuses are rounded 1 size further up, that is, rounded up to the nearest fuse size and 2 further sizes up. For high ambient temperatures, contact the fuse supplier.

The isolation diode voltage and current considerations are calculated similar to the DC fuse. The diode should be sized for the maximum DC-link voltage and the maximum DC current.

4

4.8.6.2 DC Inrush Considerations

Take care when connecting the DC battery to the frequency converter to avoid potential inrush currents which may damage the frequency converter, the isolation diode, or clear the fuses. One possible strategy is shown in *Illustration 4.1*.

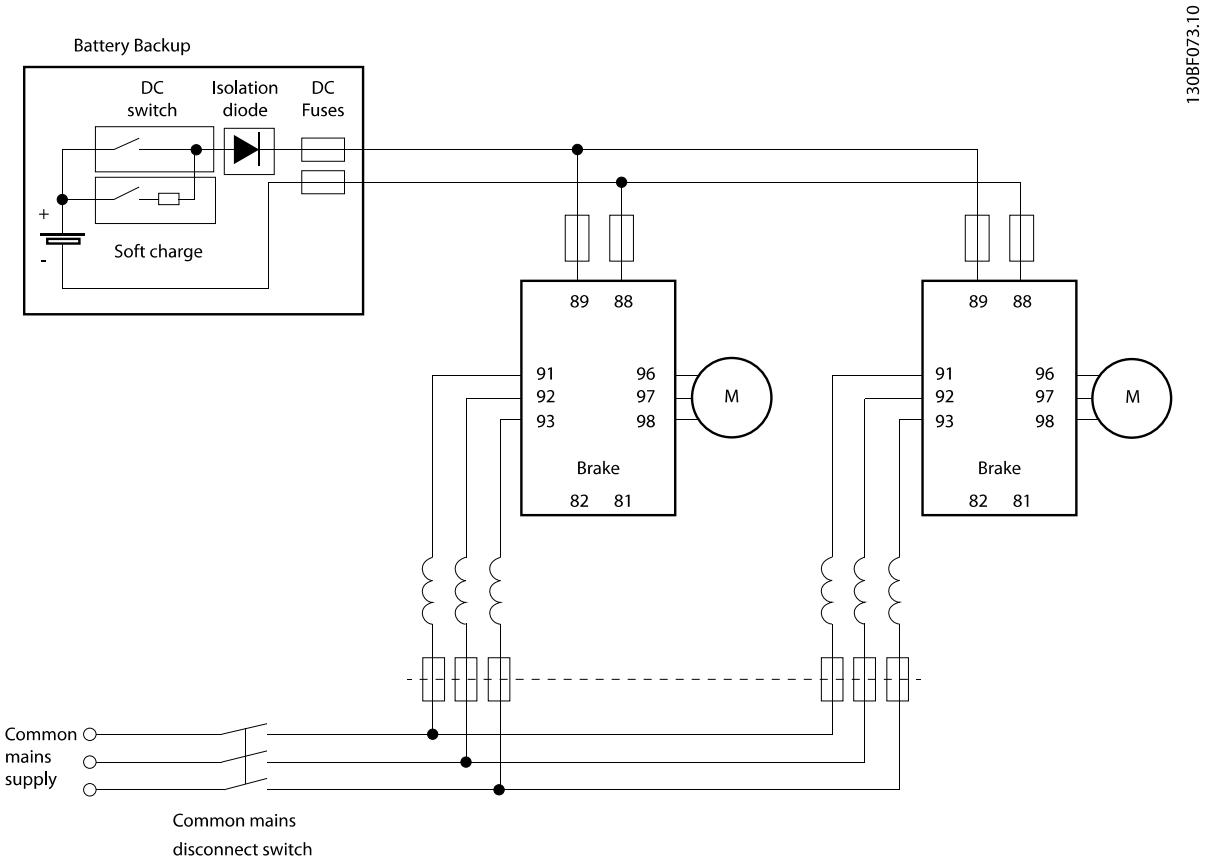


Illustration 4.1 Example DC Battery Connection

The frequency converter has a large DC-link capacitance that must be charged. The charge current for a successful charge-up is a decreasing exponential waveform.

The soft charge resistance should be selected to provide an appropriate charge-up time of approximately 5 times the RxC time constant of the circuit.

To calculate the effective RMS charge current that the soft charge resistor sees, use the following equations:

Equation 3: Calculation of soft charge resistor current

$$I_{\mathrm{RMS}} = \sqrt{\frac{1}{T}\left(\frac{V_{\mathrm{DC}}}{R_{\mathrm{charge}}}\right)^2 x \left(1 - e^{2t/\tau au}\right)}$$

Example: RMS current for 2 s of charging with a 235 V DC link, 90 Ω soft charge resistor, 4.05 mF capacitor bank: tau = R x C = 0.3645 s.

Equation 4: Example soft charge resistor current

$$I_{\mathrm{RMS}} = \sqrt{\frac{1}{2}\left(\frac{235}{90}\right)^2 x \frac{0.3645}{2} x \left(1 - e^{4/0.3645}\right)} = 0.79\ A$$

Resistor power required: $P_R=I^2$ x R=56 W

4.8.7 Motor Operation with Reduced DC-link Voltage Considerations

Notes

- A frequency converter is able to output a maximum 3-phase, line-to-line voltage which is approximately equal to 70% of its DC-link voltage. For example, a 570 V DC link can output a 400 V AC line-to-line voltage.
- An induction machine's torque capability is proportional to the square of its input voltage.
- If the ratio of frequency converter output voltage to frequency is kept constant (constant flux operation), the motor torque is proportional to phase current.
- If a speed is required which exceeds the constant flux capability of the frequency converter (see bullet 1 and bullet 3), the motor is now operated in the field weakening range.
- In the field weakening range, the slip for a given load may be larger than the slip for that same operating point in the constant flux range.
- An asynchronous motor's rotor losses are equal to the equal to the motor's slip multiplied with the air gap power. In the field weakening range, this may be much larger than the rated rotor losses.
- Do not exceed the motor's operating limits, especially if motor cooling is a function of its operating speed.

5 User Interface

5.1 Keypad

The keypad is the combined display and keys on the front of the unit. The keypad is the user interface to the frequency converter.

The keypad has several user functions:

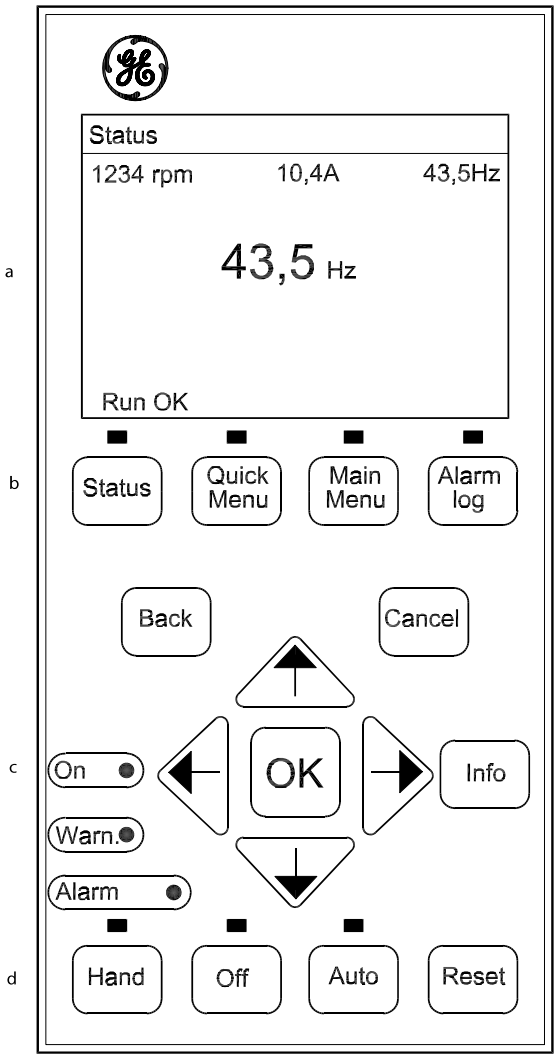
- Start, stop, and control speed when in local control
- Show operational data, status, warnings, and cautions
- Programming frequency converter functions
- Manually reset the frequency converter after a fault when auto reset is inactive

NOTICE

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

5.1.1 Keypad Layout

The keypad is divided into 4 functional groups (see *Illustration 5.1*).



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. The status indicator lights are also in this group.
d	Operational mode keys and reset.

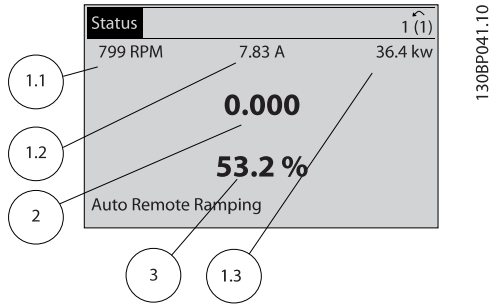
Illustration 5.1 Keypad

5.1.2 Setting Keypad Display Values

The display area is activated when the frequency converter receives power from mains voltage, a DC bus terminal, or an external 24 V supply.

The information shown 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 frequency converter status at the bottom line of the display is generated automatically and is not selectable.



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 5.1

Illustration 5.2 Keypad Display Values

5.1.3 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.

Illustration 5.3 Menu Keys

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 motor rotation direction 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 keypad display. • Press to access *Parameter Data Check* for changes in 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
Alarm Log	Shows a list of current warnings, the last 5 alarms, and the maintenance log. • For details about the frequency converter before it entered the alarm mode, select the alarm number using the navigation keys and press [OK].

Table 5.2 Legend to *Illustration 5.3*

5

5

5.1.4 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. There are also 3 frequency converter status indicator lights in this area.

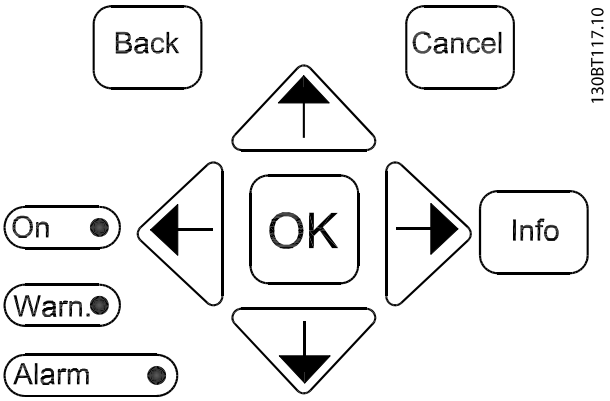


Illustration 5.4 Navigation Keys

Key	Function
Back	Reverts to the previous step or list in the menu structure.
Cancel	Cancels the last change or command as long as the display mode has not changed.
Info	Press for a definition of the function being shown.
Navigation Keys	Press the 4 navigation keys to move between items in the menu.
OK	Press to access parameter groups or to enable a choice.

Table 5.3 Navigation Keys Functions

Light	Indicator	Function
Green	ON	The ON light activates when the frequency converter receives power from mains voltage, a DC bus terminal, or a 24 V external 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 shown.

Table 5.4 Indicator Lights Functions

5.1.5 Operation Keys

Operation keys are located at the bottom of the keypad.

Illustration 5.5 Operation Keys

Key	Function
Hand	Starts the frequency converter in local control. • Use the navigation keys to control frequency converter 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 frequency converter.
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 frequency converter manually after a fault has been cleared.

Table 5.5 Operation Keys Functions

5.2 Back-up and Copying Parameter Settings

Programming data is stored internally in the frequency converter.

- The data can be uploaded into the keypad memory as storage back-up.
- Once stored in the keypad, the data can be downloaded back into the frequency converter.
- Data can also be downloaded into other frequency converters 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).
- Restoring of the frequency converter to restore factory default settings does not change data stored in the keypad memory.

⚠WARNING

UNINTENDED START

When the frequency converter is connected to AC mains, or DC power supply, the motor may start at any time. Unintended start during programming, service, or repair work can result in death, serious injury, or property damage. The motor can start with an external switch, a serial bus command, an input reference signal from the keypad, or after a cleared fault condition.

To prevent unintended motor start:

- **Disconnect the frequency converter from mains.**
- **Press [Off/Reset] on the keypad, before programming parameters.**
- **The frequency converter, motor, and any driven equipment must be fully wired and assembled when the frequency converter is connected to AC mains, or DC power supply.**

5.2.1 Uploading data to the keypad

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

5.2.2 Downloading Data from the Keypad

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

5.3 Restoring Default Settings

NOTICE

Restore sets the unit to factory default settings. Any programming, motor data, localization, and monitoring records are lost. Uploading data to the keypad provides a back-up before restoring.

Restoring the frequency converter parameter settings back to default values is done by restoring of the frequency converter. Restoring can be carried out via *parameter H-03 Restore Factory Settings* or manually.

- Restoring using *parameter H-03 Restore Factory Settings* does not change frequency converter data such as hours run, serial communication selections, personal menu settings, fault log, alarm log, and other monitoring functions.
- Using *parameter H-03 Restore Factory Settings* is recommended.
- Manual restore erases all motor, programming, localization, and monitoring data and restores factory default settings.

5.3.1 Recommended Restoring

1. Press [Main Menu] twice to access parameters.
2. Scroll to *parameter H-03 Restore Factory Settings*.
3. Press [OK].
4. Scroll to *[2] Restore Factory Settings*.
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 shown.
9. Press [Reset] to return to operation mode.

5.3.2 Manual Restoring

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 start-up. This may take slightly longer than normal.

Manual restoring does not reset the following frequency converter information:

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

6 Parameter Menu Structure

6.1 Main Menu Structure

6.1.1 Main Menu Structure

Keypad Setup

K-0# Keypad Basic Settings
K-01 Language
K-02 Motor Speed Unit
K-03 Regional Settings
K-04 Operating State at Power-up

K-1# Keypad Set-up Operations
K-10 Active Set-up
K-11 Edit Set-up
K-12 This Set-up Linked to
K-13 Readout: Linked Set-ups
K-14 Readout: Edit Set-ups / Channel
K-15 Readout: Actual Set-up

K-2# Keypad Display
K-20 Display Line 1.1 Small
K-21 Display Line 1.2 Small
K-22 Display Line 1.3 Small
K-23 Display Line 2 Large
K-24 Display Line 3 Large
K-25 Quick Start

K-3# Keypad Custom Readout
K-30 Unit for Custom Readout
K-31 Min Value of Custom Readout
K-32 Max Value of Custom Readout
K-37 Display Text 1
K-38 Display Text 2
K-39 Display Text 3

K-4# Keypad Buttons
K-40 [Hand] Button on Keypad
K-41 [Off] Button on Keypad
K-42 [Auto] Button on Keypad
K-43 [Reset] Button on Keypad

K-5# Copy/Save
K-50 Keypad Copy
K-51 Set-up Copy

K-6# Password Protection
K-60 Main Menu Password
K-61 Access to Main Menu w/o Password
K-65 Quick Menu Password
K-66 Access to Quick Menu w/o Password
K-67 Bus Password Access

Parameter Data Set

F-## Fundamental Parameters
F-0# Fundamental 0
F-01 Frequency Setting 1
F-02 Operation Method
F-03 Max Output Frequency 1
F-04 Base Frequency
F-05 Motor Rated Voltage
F-07 Accel Time 1
F-08 Decel Time 1
F-09 Torque Boost
F-1# Fundamental 1
F-10 Electronic Overload
F-11 Motor External Fan
F-12 Motor Thermistor Input
F-15 Motor Speed High Limit [Hz]
F-16 Motor Speed Low Limit [Hz]
F-17 Motor Speed High Limit [RPM]
F-18 Motor Speed Low Limit [RPM]
F-2# Fundamental 2
F-20 PM Start Mode
F-22 Start Speed [RPM]
F-23 Start Speed [Hz]
F-24 Holding Time
F-25 Start Function
F-26 Motor Noise (Carrier Freq)
F-27 Motor Tone Random
F-28 Dead Time Compensation
F-29 Start Current
F-3# Fundamental 3
F-33 Source for User-defined Readout
F-37 Adv. Switching Pattern
F-38 Overmodulation
F-4# Fundamental 4
F-40 Torque Limiter (Driving)
F-41 Torque Limiter (Braking)
F-43 Current Limit
F-5# Extended References
F-50 Reference Range
F-51 Reference/Feedback Unit
F-52 Minimum Reference
F-53 Maximum Reference
F-54 Reference Function
F-6# References
F-62 Catch up/slow Down Value
F-64 Preset Relative Reference
F-68 Relative Scaling Reference Resource
F-9# Digital Potentiometer
F-90 Step Size
F-91 Accel/Decel Time
F-92 Power Restore
F-93 Maximum Limit
F-94 Minimum Limit
F-95 Accel/Decel Ramp Delay

E-## Digital In/Out
E-0# Digital Inputs
E-00 Digital I/O Mode
E-01 Terminal 18 Digital Input
E-02 Terminal 19 Digital Input
E-03 Terminal 27 Digital Input
E-04 Terminal 29 Digital Input
E-05 Terminal 32 Digital Input
E-06 Terminal 33 Digital Input
E-07 Terminal 37 Safe Stop
E-1# Additional Accel Decel Ramps
E-10 Accel Time 2
E-11 Decel Time 2
E-12 Accel Time 3
E-13 Decel Time 3
E-14 Accel Time 4
E-15 Decel Time 4
E-2# Digital Output
E-20 Terminal 27 Digital Output
E-21 Terminal 29 Digital Output
E-24 Function Relay
E-26 On Delay, Relay
E-27 Off Delay, Relay
E-5# I/O Mode / Add On I/O
E-51 Terminal 27 Mode
E-52 Terminal 29 Mode
E-53 Terminal X30/2 Digital Input
E-54 Terminal X30/3 Digital Input
E-55 Terminal X30/4 Digital Input
E-56 Term X30/6 Digi Out (OPCGPIO)
E-57 Term X30/7 Digi Out (OPCGPIO)
E-6# Pulse Input
E-60 Term. 29 Low Frequency
E-61 Term. 29 High Frequency
E-62 Term. 29 Low Ref./Feedb. Value
E-63 Term. 29 High Ref./Feedb. Value
E-64 Pulse Filter Time Constant #29
E-65 Term. 33 Low Frequency
E-66 Term. 33 High Frequency
E-67 Term. 33 Low Ref./Feedb. Value
E-68 Term. 33 High Ref./Feedb. Value
E-69 Pulse Filter Time Constant #33
E-7# Pulse Output
E-70 Terminal 27 Pulse Output Variable
E-72 Pulse Output Max Freq #27
E-73 Terminal 29 Pulse Output Variable
E-75 Pulse Output Max Freq #29
E-76 Terminal X30/6 Pulse Output Variable
E-78 Pulse Output Max Freq #X30/6
E-8# 24V Encoder Input
E-80 Term 32/33 Pulses Per Revolution
E-81 Term 32/33 Encoder Direction
E-9# Bus Controlled
E-90 Digital & Relay Bus Control
E-93 Pulse Out #27 Bus Control
E-94 Pulse Out #27 Timeout Preset
E-95 Pulse Out #29 Bus Control
E-96 Pulse Out #29 Timeout Preset
E-97 Pulse Out #X30/6 Bus Control
E-98 Pulse Out #X30/6 Timeout Preset

C-## Frequency Control Functions
C-0# Frequency Control Functions
C-01 Jump Frequency From [Hz]
C-02 Jump Speed From [RPM]
C-03 Jump Speed To [RPM]
C-04 Jump Frequency To [Hz]
C-05 Multi-step Frequency 1 - 8
C-2# Jog Setup
C-20 Jog Speed [Hz]
C-21 Jog Speed [RPM]
C-22 Jog Accel/Decel Time
C-23 Quick Stop Decel Time
C-24 Quick Stop Ramp Type
C-25 Quick Stop S-ramp Ratio at Decel. Start
C-26 Quick Stop S-ramp Ratio at Decel. End
C-29 Ramp Lowpass Filter Time
C-3# Frequency Setting 2 and 3
C-30 Frequency Command 2
C-34 Frequency Command 3

P-## Motor Data
P-0# Motor Data
P-01 Motor Poles
P-02 Motor Power [HP]
P-03 Motor Current
P-04 Auto Tune
P-05 Motor Cont. Rated Torque
P-06 Base Speed
P-07 Motor Power [kW]
P-09 Slip Compensation
P-10 Slip Compensation Time Constant
P-2# Motor Selection
P-20 Motor Construction
P-24 Damping Gain
P-25 Low Speed Filter Time Const.
P-26 High Speed Filter Time Const.
P-27 Voltage filter time const.
P-28 Min. Current at No Load
P-3# Adv. Motor Data
P-30 Stator Resistance (Rs)
P-31 Rotor Resistance (Rr)
P-33 Stator Leakage Reactance (X1)
P-34 Rotor Leakage Reactance (X2)
P-35 Main Reactance (Xh)
P-36 Iron Loss Resistance (Rfe)
P-37 d-axis Inductance (Ld)
P-38 q-axis Inductance (Lq)
P-44 d-axis Inductance Sat. (LdSat)
P-45 q-axis Inductance Sat. (LqSat)
P-46 Position Detection Gain
P-47 Torque Calibration
P-48 Inductance Sat. Point

H-## High Perf Parameters
H-0# High Perf Operations
H-01 Option Detection
H-02 Option Data Storage
H-03 Restore Factory Settings
H-04 Auto-Reset (Times)
H-05 Auto-Reset (Reset Interval)
H-07 Accel/Decel Time 1 Type
H-08 Reverse Lock
H-09 Start Mode
H-2# Motor Feedback Monitoring
H-20 Motor Feedback Loss Function
H-21 Motor Feedback Speed Error
H-22 Motor Feedback Loss Timeout
H-23 Motor Check At Start
H-24 Tracking Error Function
H-25 Tracking Error
H-26 Tracking Error Timeout
H-27 Tracking Error Ramping
H-28 Tracking Error Ramping Timeout
H-29 Tracking Error After Ramping Timeout
H-3# Speed Monitor
H-30 Motor Speed Monitor Function
H-31 Motor Speed Monitor Max
H-32 Motor Speed Monitor Timeout
H-4# Advanced Settings
H-40 Configuration Mode
H-41 Motor Control Principle
H-42 Flux Motor Feedback Source
H-43 Torque Characteristics
H-44 Constant or Variable Torque OL
H-45 Local Mode Configuration
H-46 Back EMF at 1000 RPM
H-47 Motor Angle Offset
H-48 Clockwise Direction
H-49 Motor Angle Offset Adjust
H-5# Load Indep. Settings
H-50 Motor Magnetisation at Zero Speed
H-51 Min Speed Normal Magnetising [RPM]
H-52 Min Speed Normal Magnetising [Hz]
H-53 Model Shift Frequency
H-54 Voltage reduction in fieldweakening
H-55 U/f Characteristic - U
H-56 U/f Characteristic - F
H-58 Flying Start Test Pulses Current
H-59 Flying Start Test Pulses Frequency
H-6# Load Depen. Settings
H-61 High Speed Load Compensation
H-62 Brake Check Limit Factor Source
H-63 Brake Check Limit Factor
H-64 Resonance Dampening
H-65 Resonance Dampening Time Constant
H-66 Min. Current at Low Speed
H-67 Torque Limit Factor Source
H-68 Speed Limit Factor Source
H-7# Adjustable Warnings
H-70 Warning Current Low
H-71 Warning Current High
H-72 Warning Speed Low
H-73 Warning Speed High
H-74 Warning Reference Low
H-75 Warning Reference High
H-76 Warning Feedback Low
H-77 Warning Feedback High
H-78 Missing Motor Phase Function
H-8# Stop Adjustments
H-80 Function at Stop
H-81 Min Speed for Function at Stop [RPM]
H-82 Min Speed for Function at Stop [Hz]
H-83 Precise Stop Function
H-84 Precise Stop Counter Value
H-85 Precise Stop Speed Compensation Delay
H-87 Load Type
H-88 Motor Inertia
H-89 System Inertia
H-9# Motor Temperature
H-94 ATEX overload cur.lim. speed reduction
H-95 KTY Sensor Type
H-96 KTY Thermistor Input
H-97 KTY Threshold level
H-98 ATEX overload interpol. points freq.
H-99 ATEX overload interpol points current

AN-## Analog In / Out
AN-0# Analog I/O Mode
AN-00 Live Zero Timeout Time
AN-01 Live Zero Timeout Function
AN-1# Analog Input 53
AN-10 Terminal 53 Low Voltage
AN-11 Terminal 53 High Voltage
AN-12 Terminal 53 Low Current
AN-13 Terminal 53 High Current
AN-14 Terminal 53 Low Ref./Feedb. Value
AN-15 Terminal 53 High Ref./Feedb. Value
AN-16 Terminal 53 Filter Time Constant
AN-17 Terminal 53 Live Zero
AN-2# Analog Input 54
AN-20 Terminal 54 Low Voltage
AN-21 Terminal 54 High Voltage
AN-22 Terminal 54 Low Current
AN-23 Terminal 54 High Current
AN-24 Terminal 54 Low Ref./Feedb. Value
AN-25 Terminal 54 High Ref./Feedb. Value
AN-26 Terminal 54 Filter Time Constant
AN-27 Terminal 54 Live Zero
AN-3# Analog Input X30/11
AN-30 Terminal X30/11 Low Voltage
AN-31 Terminal X30/11 High Voltage
AN-34 Term. X30/11 Low Ref./Feedb. Value
AN-35 Term. X30/11 High Ref./Feedb. Value
AN-36 Term. X30/11 Filter Time Constant
AN-37 Term. X30/11 Live Zero
AN-4# Analog Input X30/12
AN-40 Terminal X30/12 Low Voltage
AN-41 Terminal X30/12 High Voltage
AN-44 Term. X30/12 Low Ref./Feedb. Value
AN-45 Term. X30/12 High Ref./Feedb. Value
AN-46 Term. X30/12 Filter Time Constant
AN-47 Term. X30/12 Live Zero
AN-5# Analog Output 42
AN-50 Terminal 42 Output
AN-51 Terminal 42 Output Min Scale
AN-52 Terminal 42 Output Max Scale
AN-53 Terminal 42 Output Bus Control
AN-54 Terminal 42 Output Timeout Preset
AN-55 Terminal 42 Output Filter
AN-6# Analog Output X30/8
AN-60 Terminal X30/8 Output
AN-61 Terminal X30/8 Min. Scale
AN-62 Terminal X30/8 Max. Scale
AN-63 Terminal X30/8 Bus Control
AN-64 Terminal X30/8 Output Timeout Preset
SF-## Battery Back-up Application
SF-40 Emergency Power Mode
SF-41 Speed Limit, High Battery [RPM]
SF-42 Speed Limit, High Battery [Hz]
SF-43 Speed Limit, Low Battery [RPM]
SF-44 Speed Limit, Low Battery [Hz]
SF-45 Current Limit, High Battery [A]
SF-46 Current Limit, Low Battery [A]
SP-## Special Functions
SP-0# Fault Settings
SP-00 Fault Level
SP-1# Line On/Off
SP-10 Line failure
SP-11 Line Voltage at Input Fault
SP-12 Function at Line Imbalance
SP-14 Kin. Backup Time Out
SP-15 Kin. Backup Trip Recovery Level
SP-16 Kin. Backup Gain
SP-2# Reset Functions
SP-23 Typecode Setting
SP-24 Trip Delay at Current Limit
SP-25 Trip Delay at Torque Limit
SP-26 Trip Delay at Drive Fault
SP-29 Service Code
SP-3# Current Limit Ctrl.
SP-30 Current Lim Cont, Proportional Gain
SP-31 Current Lim Contr, Integration Time
SP-32 Current Lim Ctrl, Filter Time
SP-35 Stall Protection
SP-36 Fieldweakening Function
SP-37 Fieldweakening Speed
SP-4# Energy Savings
SP-40 VT Level
SP-41 Energy Savings Min. Magnetisation
SP-42 Energy Savings Min. Frequency
SP-43 Motor Cosphi
SP-5# Environment
SP-50 RFI Filter
SP-51 DC Link Compensation
SP-52 Fan Operation
SP-53 Fan Monitor
SP-54 AHF Cap Reconnect Delay
SP-55 Output Filter
SP-56 Capacitance Output Filter
SP-57 Inductance Output Filter
SP-59 Actual Number of Inverter Units
SP-6# Automatic Derate
SP-7# Additional ACC/DEC settings
SP-71 Accel Time 1 S-ramp Ratio at Accel. Start
SP-72 Accel Time 1 S-ramp Ratio at Accel. End
SP-73 Decel Time 1 S-ramp Ratio at Decel. Start
SP-74 Decel Time 1 S-ramp Ratio at Decel. End
SP-76 Accel/Decel Time 2 Type
SP-79 Accel Time 2 S-ramp Ratio at Accel. Start
SP-80 Accel Time 2 S-ramp Ratio at Accel. End
SP-81 Decel Time 2 S-ramp Ratio at Decel. Start
SP-82 Decel Time 2 S-ramp Ratio at Decel. End
SP-84 Accel/Decel Ramp 3 Type
SP-87 Accel Time 3 S-ramp Ratio at Accel. Start
SP-88 Accel Time 3 S-ramp Ratio at Accel. End
SP-89 Decel Time 3 S-ramp Ratio at Decel. Start
SP-90 Decel Time 3 S-ramp Ratio at Decel. End
SP-92 Accel/Decel Ramp 4 Type
SP-95 Accel Time 4 S-ramp Ratio at Accel. Start
SP-96 Accel Time 4 S-ramp Ratio at Accel. End
SP-97 Decel Time 4 S-ramp Ratio at Decel. Start
SP-98 Decel Time 4 S-ramp Ratio at Decel. End
O-## Options / Comms
O-0# General Settings
O-01 Control Site
O-02 Control Word Source
O-03 Control Word Timeout Time
O-04 Control Word Timeout Function
O-05 End-of-Timeout Function
O-06 Reset Control Word Timeout
O-07 Diagnosis Trigger
O-08 Readout Filtering
O-1# Control Settings
O-10 Control Word Profile
O-13 Configurable Status Word STW
O-14 Configurable Control Word CTW
O-16 Store Data Values
O-17 Configurable Alarm and Warningword
O-19 Product Code
O-3# Drive Port Settings
O-30 Protocol
O-31 Address
O-32 Drive Port Baud Rate
O-33 Drive Port Parity
O-34 Estimated cycle time
O-35 Minimum Response Delay
O-36 Max Response Delay
O-37 Max Inter-Char Delay
O-4# Drive MC Port Settings
O-40 Telegram Selection
O-41 Parameters for Signals
O-42 PCD Write Configuration
O-43 PCD Read Configuration
O-5# Digital / Bus
O-50 Coasting Select
O-51 Quick Stop Select
O-52 DC Brake Select
O-53 Start Select
O-54 Reversing Select
O-55 Set-up Select
O-56 Preset Reference Select
O-57 Profidrive OFF2 Select
O-58 Profidrive OFF3 Select
O-8# Drive Port Diagnostics
O-80 Bus Message Count
O-81 Bus Error Count
O-82 Slave Messages Rcvd
O-83 Slave Error Count
O-9# Bus Jog / Feedback
O-90 Bus Jog 1 Speed
O-91 Bus Jog 2 Speed
DN-## Devicenet Fieldbus
DN-0# Common Settings
DN-00 DeviceNet Protocol
DN-01 Baud Rate Select
DN-02 MAC ID
DN-05 Readout Transmit Error Counter
DN-06 Readout Receive Error Counter
DN-07 Readout Bus Off Counter
DN-1# DeviceNet
DN-10 Process Data Type Selection
DN-11 Process Data Config Write
DN-12 Process Data Config Read
DN-13 Warning Parameter
DN-14 Net Reference
DN-15 Net Control
DN-18 internal_process_data_config_write
DN-19 internal_process_data_config_read
DN-2# COS Filters
DN-20 COS Filter 1
DN-21 COS Filter 2
DN-22 COS Filter 3
DN-23 COS Filter 4
DN-3# Parameter Access
DN-30 Array Index
DN-31 Store Data Values
DN-32 Devicenet Revision
DN-33 Store Always
DN-34 DeviceNet Product Code
DN-39 Devicenet F Parameters
DN-5# DeviceNet Process Data
PB-## PROFIdrive
PB-00 Setpoint
PB-07 Actual Value
PB-15 PCD Write Configuration
PB-16 PCD Read Configuration
PB-18 Node Address
PB-22 Telegram Selection
PB-23 Parameters for Signals
PB-27 Parameter Edit
PB-28 Process Control
PB-44 Fault Message Counter
PB-45 Fault Code
PB-47 Fault Number
PB-52 Fault Situation Counter
PB-53 Profibus Warning Word
PB-63 Actual Baud Rate
PB-64 Device Identification
PB-65 Profile Number
PB-67 Control Word 1
PB-68 Status Word 1
PB-70 Edit Set-up
PB-71 Profibus Save Data Values
PB-72 ProfibusDriveReset
PB-75 DO Identification
PB-80 Defined Parameters (1)
PB-81 Defined Parameters (2)
PB-82 Defined Parameters (3)
PB-83 Defined Parameters (4)
PB-84 Defined Parameters (5)
PB-85 Defined Parameters (6)
PB-90 Changed Parameters (1)
PB-91 Changed Parameters (2)
PB-92 Changed Parameters (3)
PB-93 Changed Parameters (4)
PB-94 Changed Parameters (5)
PB-99 Profibus Revision Counter
EN-## Ethernet
EN-0# IP Settings
EN-00 IP Address Assignment
EN-01 IP Address
EN-02 Subnet Mask
EN-03 Default Gateway
EN-04 DHCP Server
EN-05 Lease Expires
EN-06 Name Servers
EN-07 Domain Name
EN-08 Host Name
EN-09 Physical Address
EN-1# Ethernet Link Parameters
EN-10 Link Status
EN-11 Link Duration
EN-12 Auto Negotiation
EN-13 Link Speed
EN-14 Link Duplex
EN-2# Process Data
EN-20 Control Instance
EN-21 Process Data Config Write
EN-22 Process Data Config Read
EN-23 Process Data Config Write Size
EN-24 Process Data Config Read Size
EN-27 Primary Master
EN-28 Store Data Values
EN-29 Store Always
EN-3# EtherNet/IP
EN-30 Warning Parameter
EN-31 Net Reference
EN-32 Net Control
EN-33 CIP Revision
EN-34 CIP Product Code
EN-35 EDS Parameter
EN-37 COS Inhibit Timer
EN-38 COS Filter
EN-4# Modbus TCP
EN-40 Status Parameter
EN-41 Slave Message Count
EN-42 Slave Exception Message Count
EN-8# Other Ethernet Services
EN-80 FTP Server
EN-81 HTTP Server
EN-82 SMTP Service
EN-89 Transparent Socket Channel Port
EN-9# Advanced Ethernet Services
EN-90 Cable Diagnostic

EN-91 MDI-X
EN-92 IGMP Snooping
EN-93 Cable Error Length
EN-94 Broadcast Storm Protection
EN-95 Broadcast Storm Filter
EN-96 Port Mirroring
EN-98 Interface Counters
EN-99 Media Counters
EC-## Feedback Option
EC-1# Inc. Enc. Interface
EC-10 Signal Type
EC-11 Resolution (PPR)
EC-2# Abs. Enc. Interface
EC-20 Protocol Selection
EC-21 Resolution (Positions/Rev)
EC-24 SSI Data Length
EC-25 Clock Rate
EC-26 SSI Data Format
EC-34 HIPERFACE Baudrate
RS-56 Encoder Sim. Resolution
EC-6# Monitoring and App.
EC-60 Feedback Direction
EC-61 Feedback Signal Monitoring
RS-## Resolver Interface
RS-50 Poles
RS-51 Input Voltage
RS-52 Input Frequency
RS-53 Transformation Ratio
RS-56 Encoder Sim. Resolution
RS-59 Resolver Interface
IO-## Programmable I/O Option
IO-0# I/O Mode
IO-00 Terminal X49/1 Mode
IO-01 Terminal X49/3 Mode
IO-02 Terminal X49/5 Mode
IO-03 Terminal X49/7 Mode
IO-04 Terminal X49/9 Mode
IO-05 Terminal X49/11 Mode
IO-1# Analog Input X49/1
IO-10 Terminal X49/1 Low Voltage
IO-11 Terminal X49/1 Low Current
IO-12 Terminal X49/1 High Voltage
IO-13 Terminal X49/1 High Current
IO-14 Term. X49/1 Low Ref./Feedb. Value
IO-15 Term. X49/1 High Ref./Feedb. Value
IO-16 Term. X49/1 Filter Time Constant
IO-17 Term. X49/1 Live Zero
IO-2# Analog Input X49/3
IO-20 Terminal X49/3 Low Voltage
IO-21 Terminal X49/3 Low Current
IO-22 Terminal X49/3 High Voltage
IO-23 Terminal X49/3 High Current
IO-24 Term. X49/3 Low Ref./Feedb. Value
IO-25 Term. X49/3 High Ref./Feedb. Value
IO-26 Term. X49/3 Filter Time Constant
IO-27 Term. X49/3 Live Zero
IO-3# Analog Input X49/5
IO-30 Terminal X49/5 Low Voltage
IO-31 Terminal X49/5 Low Current
IO-32 Terminal X49/5 High Voltage
IO-33 Terminal X49/5 High Current
IO-34 Term. X49/5 Low Ref./Feedb. Value
IO-35 Term. X49/5 High Ref./Feedb. Value
IO-36 Term. X49/5 Filter Time Constant
IO-37 Term. X49/5 Live Zero
IO-4# Output X49/7
IO-40 Terminal X49/7 Analogue Output
IO-41 Terminal X49/7 Digital Output
IO-42 Terminal X49/7 Min. Scale
IO-43 Terminal X49/7 Max. Scale
IO-44 Terminal X49/7 Bus Control
IO-45 Terminal X49/7 Timeout Preset
IO-5# Output X49/9
IO-50 Terminal X49/9 Analogue Output
IO-51 Terminal X49/9 Digital Output
IO-52 Terminal X49/9 Min. Scale
IO-53 Terminal X49/9 Max. Scale
IO-54 Terminal X49/9 Bus Control
IO-55 Terminal X49/9 Timeout Preset
IO-6# Output X49/11
IO-60 Terminal X49/11 Analogue Output
IO-61 Terminal X49/11 Digital Output
IO-62 Terminal X49/11 Min. Scale
IO-63 Terminal X49/11 Max. Scale
IO-64 Terminal X49/11 Bus Control
IO-65 Terminal X49/11 Timeout Preset
Parameter Data Check
Last 10 Changes
Since Factory Setting
Drive Information
ID-0# Operating Data
ID-00 Operating hours
ID-01 Running Hours
ID-02 kWh Counter
ID-03 Power Up's
ID-04 Over Temp's
ID-05 Over Volt's
ID-06 Reset kWh Counter
ID-07 Reset Running Hours Counter
ID-1# Data Trending Settings
ID-10 Trending Source
ID-11 Trending Interval
ID-12 Trigger Event
ID-13 Trending Mode
ID-14 Samples Before Trigger
ID-2# Historic Log
ID-20 Historic Log: Event
ID-21 Historic Log: Value
ID-22 Historic Log: Time
ID-3# Alarm Log
ID-30 Fault Log: Error Code
ID-31 Fault Log: Value
ID-32 Fault Log: Time
ID-4# Drive Identification
ID-40 Drive Type
ID-41 Power Section
ID-42 Voltage
ID-43 Software Version
ID-44 Ordered Typecode String
ID-45 Actual Typecode String
ID-46 GE Product No.
ID-47 Power Card Ordering No
ID-48 Keypad ID Number
ID-49 SW ID Control Card
ID-50 SW ID Power Card
ID-51 Drive Serial Number
ID-53 Power Card Serial Number
ID-59 Filename
ID-6# Option Ident
ID-60 Option Mounted
ID-61 Option SW Version
ID-62 Option Ordering No
ID-63 Option Serial No
ID-70 Option in Slot A
ID-71 Slot A Option SW Version
ID-72 Option in Slot B
ID-73 Slot B Option SW Version
ID-74 Option in Slot C1
ID-75 Slot C0 Option SW Version
ID-76 Option in Slot C2
ID-77 Slot C1 Option SW Version
ID-8# Operating Data II
ID-80 Fan Running Hours
ID-81 Preset Fan Running Hours
ID-9# Parameter Info
ID-92 Defined Parameters
ID-93 Modified Parameters
ID-98 Drive Identification
ID-99 Parameter Metadata
Data Readouts
DR-0# General Status
DR-00 Control Word
DR-01 Reference [Unit]
DR-02 Reference %
DR-03 Status Word
DR-05 Main Actual Value [%]
DR-09 Custom Readout
DR-1# Motor Status
DR-10 Power [kW]
DR-11 Power [hp]
DR-12 Motor Voltage
DR-13 Frequency
DR-14 Motor current
DR-15 Frequency [%]
DR-16 Torque [Nm]
DR-17 Speed [RPM]
DR-18 Motor Thermal
DR-19 KTY sensor temperature
DR-20 Motor Angle
DR-21 Torque [%] High Res.
DR-22 Torque [%]
DR-23 Motor Shaft Power [kW]
DR-24 Calibrated Stator Resistance
DR-25 Torque [Nm] High
DR-3# Drive Status
DR-30 DC Link Voltage
DR-32 Brake Energy /s
DR-33 Brake Energy Average
DR-34 Heatsink Temp.
DR-35 Drive Thermal
DR-36 Drive Nominal Current
DR-37 Drive Max. Current
DR-38 Logic Controller State
DR-39 Control Card Temp.
DR-40 Trending Buffer Full
DR-42 Actual Current Limit [A]
DR-43 Actual Speed Limit [RPM]
DR-44 Actual Speed Limit [Hz]
DR-45 Motor Phase U Current
DR-46 Motor Phase V Current
DR-47 Motor Phase W Current
DR-48 Speed Ref. After Ramp [RPM]
DR-49 Current Fault Source
DR-5# Ref. & Feedb.
DR-50 External Reference
DR-51 Pulse Reference
DR-52 Feedback[Unit]
DR-53 Digi Pot Reference
DR-57 Feedback [RPM]
DR-6# Inputs & Outputs
DR-60 Digital Input
DR-61 Terminal 53 Switch Setting
DR-62 Analog Input 53
DR-63 Terminal 54 Switch Setting
DR-64 Analog Input 54
DR-65 Analog Output 42 [mA]
DR-66 Digital Output [bin]
DR-67 Freq. Input #29 [Hz]
DR-68 Freq. Input #33 [Hz]
DR-69 Pulse Output #27 [Hz]
DR-70 Pulse Output #29 [Hz]
DR-71 Relay Output [bin]
DR-72 Counter A
DR-73 Counter B
DR-74 Prec. Stop Counter
DR-75 Analog In X30/11
DR-76 Analog In X30/12
DR-77 Analog Out X30/8 [mA]
DR-8# Fieldbus & Drive Port
DR-80 Fieldbus CTW 1
DR-82 Fieldbus REF 1
DR-84 Comm. Option STW
DR-85 Drive Port CTW 1
DR-86 Drive Port REF 1
DR-87 Bus Readout Alarm/Warning
DR-89 Configurable Alarm/Warning Word
99-30 internal_ProfibusPCD_Config_Write
99-31 internal_ProfibusPCD_Config_Read
DR-9# Diagnosis Readouts
DR-90 Alarm Word
DR-91 Alarm Word 2
DR-92 Warning Word
DR-93 Warning Word 2
DR-94 Ext. Status Word
DR-95 Ext. Status Word 2
Logs & I/O Opt Status
LG-4# OPCPRGIO Data Readouts
LG-40 Analog Input X49/1
LG-41 Analog Input X49/3
LG-42 Analog Input X49/5
LG-43 Analog Out X49/7
LG-44 Analog Out X49/9
LG-45 Analog Out X49/11
LG-46 X49 Digital Output [bin]
LG-5# Active Alarms/Warnings
LG-55 Active Alarm Numbers
LG-56 Active Warning Numbers
Adv Parameter Data Set
LC-## Logic Controller
LC-0# LC Settings
LC-00 Logic Controller Mode
LC-01 Start Event
LC-02 Stop Event
LC-03 Reset Logic Controller
LC-1# Comparators
LC-10 Comparator Operand
LC-11 Comparator Operator
LC-12 Comparator Value
LC-1# RS Flip Flops
LC-15 RS-FF Operand S
LC-16 RS-FF Operand R
LC-2# Timers
LC-20 Logic Controller Timer
LC-4# Logic Rules
LC-40 Logic Rule Boolean 1
LC-41 Logic Rule Operator 1
LC-42 Logic Rule Boolean 2
LC-43 Logic Rule Operator 2
LC-44 Logic Rule Boolean 3
LC-5# States
LC-51 Logic Controller Event
LC-52 Logic Controller Action
B-## Braking Functions
B-0# DC-Brake
B-00 DC Hold Current
B-01 DC Brake Current
B-02 DC Braking Time
B-03 DC Brake Cut In Speed [RPM]
B-04 DC Brake Cut In Speed [Hz]
B-05 Maximum Reference
B-06 Parking Current
B-07 Parking Time
B-1# Brake Energy Funct.
B-10 Brake Function
B-11 Brake Resistor (ohm)
B-12 Brake Power Limit (kW)
B-13 Braking Thermal Overload
B-15 Brake Check
B-16 AC brake Max. Current
B-17 Over-voltage Control
B-18 Brake Check Condition
B-19 Over-voltage Gain
B-2# Mechanical Brake
B-20 Release Brake Current
B-21 Activate Brake Speed [RPM]

B-22 Activate Brake Speed [Hz]
B-23 Activate Brake Delay
B-24 Stop Delay
B-25 Brake Release Time
B-26 Torque Ref
B-27 Torque Ramp Time
B-28 Gain Boost Factor
PI-## PID Controls
PI-0# Speed PID Control
PI-00 Speed PID Feedback Source
PI-01 Speed PID Droop
PI-02 Speed PID Proportional Gain
PI-03 Speed PID Integral Time
PI-04 Speed PID Differentiation Time
PI-05 Speed PID Diff. Gain Limit
PI-06 Speed PID Lowpass Filter Time
PI-07 Speed PID Feedback Gear Ratio
PI-08 Speed PID Feed Forward Factor
PI-09 Speed PID Error Correction w/ Ramp
PI-1# Torque PI Ctrl.
PI-10 Torque PI Feedback Source
PI-12 Torque PI Proportional Gain
PI-13 Torque PI Integration Time
PI-16 Torque PI Lowpass Filter Time
PI-18 Torque PI Feed Forward Factor
PI-19 Current Controller Rise Time
PI-2# Process PID Feedback
PI-20 Process CL Feedback 1 Resource
PI-22 Process CL Feedback 2 Resource
PI-3# Process PID Control
PI-30 Process PID Normal/ Inverse Control
PI-31 Process PID Anti Windup
PI-32 Process PID Start Speed
PI-33 Process PID Proportional Gain
PI-34 Process PID Integral Time
PI-35 Process PID Differentiation Time
PI-36 Process PID Diff. Gain Limit
PI-38 Process PID Feed Forward Factor
PI-39 On Reference Bandwidth
PI-4# Adv. Process PID I
PI-40 Process PID I-part Reset
PI-41 Process PID Output Neg. Clamp
PI-42 Process PID Output Pos. Clamp
PI-43 Process PID Gain Scale at Min. Ref.
PI-44 Process PID Gain Scale at Max. Ref.
PI-45 Process PID Feed Fwd Resource
PI-46 Process PID Feed Fwd Normal/ Inv. Ctrl.
PI-48 PCD Feed Forward
PI-49 Process PID Output Normal/ Inv. Ctrl.
PI-5# Adv. Process PID II
PI-50 Process PID Extended PID
PI-51 Process PID Feed Fwd Gain
PI-52 Process PID Feed Fwd Ramp up
PI-53 Process PID Feed Fwd Ramp down
PI-56 Process PID Ref. Filter Time
PI-57 Process PID Fb. Filter Time
PI-6# PID Readouts
PI-60 Process PID Error
PI-61 Process PID Output
PI-62 Process PID Clamped Output
PI-63 Process PID Gain Scaled Output
SF-## Special Features
SF-0# Wobbler
SF-00 Wobble Mode
SF-01 Wobble Delta Frequency [Hz]
SF-02 Wobble Delta Frequency [%]
SF-03 Wobble Delta Freq. Scaling Resource
SF-04 Wobble Jump Frequency [Hz]
SF-05 Wobble Jump Frequency [%]
SF-06 Wobble Jump Time
SF-07 Wobble Sequence Time
SF-08 Wobble Up/ Down Time
SF-09 Wobble Random Function
SF-10 Wobble Ratio
SF-11 Wobble Random Ratio Max.
SF-12 Wobble Random Ratio Min.
SF-19 Wobble Delta Freq. Scaled
SF-2# Adv. Start Adjust
SF-20 High Starting Torque Time [s]
SF-21 High Starting Torque Current [%]
SF-22 Locked Rotor Protection
SF-23 Locked Rotor Detection Time [s]
SF-24 Locked Rotor Detection Speed Error [%]
SF-25 Light Load Delay [s]
SF-26 Light Load Current [%]
SF-27 Light Load Speed [%]
SF-3# Miscellaneous
SF-30 External Interlock Delay
SF-84 Process PID Proportional Gain

6.2 Remote Programming with DCT-10

GE has a software program available for developing, storing, and transferring frequency converter programming. The DCT-10 allows the user to connect a PC to the frequency converter and perform live programming rather than using the keypad. Also, all frequency converter programming can be done off-line and downloaded to the frequency converter. Or the entire frequency converter profile can be loaded onto the PC for back-up storage or analysis.

The USB connector or RS485 terminal is available for connecting to the frequency converter.

For more details, go to *www.geelectrical.com/drives*

7 Warnings and Alarm

7.1 System Monitoring

The frequency converter monitors the condition of its input power, output, and motor factors, and other system performance indicators. A warning or alarm does not necessarily indicate a problem internally in the frequency converter.

Often, it indicates failure conditions from:

- Input voltage.
- Motor load.
- Motor temperature.
- External signals.
- Other areas monitored by internal logic.

Investigate as indicated in the alarm or warning.

7.2 Warning and Alarm Types

Warnings
A warning is issued when an alarm condition is impending or when an abnormal operating condition is present and may result in the frequency converter issuing an alarm. A warning clears by itself when the abnormal condition is removed.

Alarms
Trip
An alarm is issued when the frequency converter is tripped, that is, the frequency converter suspends operation to prevent frequency converter or system damage. The motor will coast to a stop. The frequency converter logic continues to operate and monitor the frequency converter status. After the fault condition is remedied, the frequency converter can be reset. It is then 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 frequency converter to trip lock requires that input power is cycled. The motor will coast to a stop. The frequency converter logic continues to operate and monitor the frequency converter status. Remove input power to the frequency converter and correct the cause of the fault, then restore power. This action puts the frequency converter into a trip condition as described above and may be reset in any of those 4 ways.

7.3 Warning and Alarm Displays

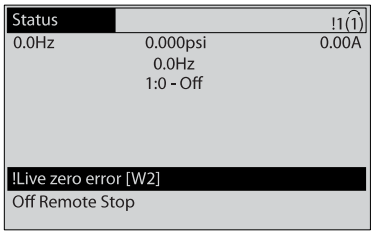


Illustration 7.1 Warning Display

An alarm or trip lock alarm flashes in the display along with the alarm number.

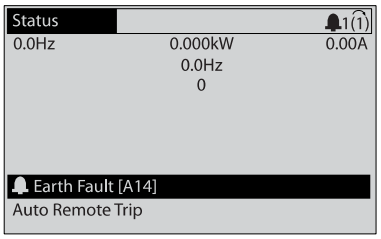


Illustration 7.2 Alarm Display

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

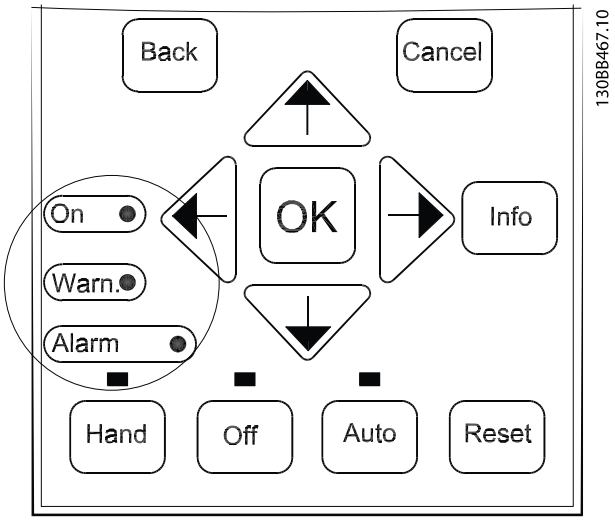


Illustration 7.3 Status Indicator Lights

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

Table 7.1 Status Indicator Lights Explanations

7.4 Warning and Alarm Definitions

Table 7.2 defines whether a warning is issued before an alarm, and whether the alarm trips the unit or trip locks the unit.

No.	Description	Warning	Alarm/Trip	Alarm/Trip lock	Parameter reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		*Parameter AN-01 Live Zero Timeout Function*
3	No motor	(X)			*Parameter H-80 Function at Stop*
4	Mains phase loss	(X)	(X)	(X)	*Parameter 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 under voltage	X	X		
9	Inverter overloaded	X	X		
10	Motor Electronic OL over temperature	(X)	(X)		*Parameter F-10 Electronic Overload*
11	Motor thermistor over temperature	(X)	(X)		*Parameter F-10 Electronic Overload*
12	Torque limit	X	X		*Parameter F-40 Torque Limiter (Driving)* *Parameter F-41 Torque Limiter (Braking)*
13	Over Current	X	X	X	
14	Earth Fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short Circuit		X	X	
17	Control word time-out	(X)	(X)		*Parameter 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)		*Parameter B-13 Braking Thermal Overload*
27	Brake chopper short-circuited	X	X		
28	Brake check	(X)	(X)		*Parameter B-15 Brake Check*
29	Heatsink temp	X	X	X	
30	Motor phase U missing	(X)	(X)	(X)	*Parameter H-78 Missing Motor Phase Function*
31	Motor phase V missing	(X)	(X)	(X)	*Parameter H-78 Missing Motor Phase Function*
32	Motor phase W missing	(X)	(X)	(X)	*Parameter H-78 Missing Motor Phase Function*
33	Inrush Fault		X	X	
34	Network communication fault	X	X		
35	Option Fault				
36	Mains failure	X	X		

7

No.	Description	Warning	Alarm/Trip	Alarm/Trip lock	Parameter reference
37	Phase imbalance		X		
38	Internal Fault		X	X	
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			*Parameter E-00 Digital I/O Mode, parameter E-51 Terminal 27 Mode*
41	Overload of Digital Output Terminal 29	(X)			*Parameter E-00 Digital I/O Mode, parameter E-52 Terminal 29 Mode*
42	Ovrld X30/6-7	(X)			
43	Ext. Supply (option)				
45	Earth 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 time-out		X		
58	Auto Tune internal fault	X	X		
59	Current limit	X			*Parameter F-43 Current Limit*
61	Feedback Error	(X)	(X)		*Parameter H-20 Motor Feedback Loss Function*
62	Output Frequency at Maximum Limit	X			
63	Mechanical Brake Low		(X)		*Parameter 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)]		*Parameter E-07 Terminal 37 Safe Stop*
69	Pwr. Card Temp		X	X	
70	Illegal Drive configuration			X	
76	Power Unit Setup	X			
77	Reduced power mode	X			*Parameter SP-59 Actual Number of Inverter Units*
78	Tracking Error	(X)	(X)		*Parameter H-24 Tracking Error Function*
79	Illegal PS config		X	X	
80	Drive Restored to Factory Settings		X		
83	Illegal Option Combination			X	
90	Feedback Monitor	(X)	(X)		*Parameter 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			

No.	Description	Warning	Alarm/Trip	Alarm/Trip lock	Parameter reference
250	New spare parts			X	
251	New Type Code		X	X	

Table 7.2 Alarm/Warning Code List

(X) Dependent on parameter

1) Cannot be auto reset via parameter H-04 Auto-Reset (Times)

8 Specifications

8.1 General Technical Data

Mains supply	
Supply terminals (6-pulse)	L1, L2, L3
Supply voltage	380–480 V ±10%

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

Supply frequency	50/60 Hz ±5%
Maximum imbalance temporary between mains 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) 18.5–75 kW (25–100 hp)	maximum 1 time/minute
Switching on input supply L1, L2, L3 (power-ups) ≥ 132 kW (200 hp)	maximum 1 time/2 minute
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 100kAIC RMS symmetrical Amperes, 240/500/600/690 V maximum.

Motor output (U, V, W)	
Output voltage	0–100% of supply voltage
Output frequency	0–590 Hz
Output frequency in Flux Mode	0–300 Hz
Switching on output	Unlimited
Ramp times	0.01–3600 s

1) Voltage and power dependent

Torque characteristics	
Starting torque (constant torque)	Maximum 150% for 60 s[1)] once in 10 minutes
Starting/overload torque (variable torque)	Maximum 110% for 60 s[1)] once in 10 minutes
Torque rise time in Flux Vector Vector Control (for 5 kHz fsw)	1 ms
Torque rise time in Advanced Vector Control (independent of fsw)	10 ms

1) Percentage relates to the nominal torque.
2) The torque response time depends on application and load but as a 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	0–24 V DC
Voltage level, logic 0 PNP	<5 V DC
Voltage level, logic 1 PNP	>10 V DC
Voltage level, logic 0 NPN[2)]	>19 V DC
Voltage level, logic 1 NPN[2)]	<14 V DC
Maximum voltage on input	28 V DC
Pulse frequency range	0–110 kHz
(Duty cycle) minimum pulse width	4.5 ms
Input resistance, R_i	approximately 4 kΩ

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

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

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

2) See chapter 3.4.5.7 Terminal 37 for further information about terminal 37 and STO.

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

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

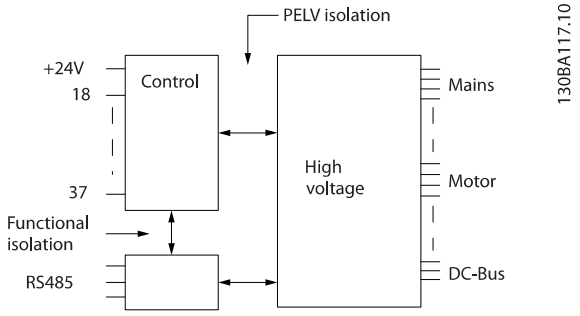


Illustration 8.1 PELV Isolation

Pulse/encoder inputs	
Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29, 33[1]/32[2], 33[2]
Maximum frequency at terminal 29, 32, 33	110 kHz (Push-pull driven)
Maximum frequency at terminal 29, 32, 33	5 kHz (Open collector)
Minimum frequency at terminal 29, 32, 33	4 Hz
Voltage level	See section *E-0# Digital Inputs* in the *programming guide*.
Maximum voltage on input	28 V DC
Input resistance, R_i	Approximately 4 kΩ
Pulse input accuracy (0.1–1 kHz)	Maximum error: 0.1% of full scale
Encoder input accuracy (1–11 kHz)	Maximum error: 0.05% of full scale

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, 33=B.

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

1) Terminal 27 and 29 can also be programmed as input.
The digital output is galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.

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

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

Control card, 24 V DC output	
Terminal number	12, 13
Output voltage	24 V +1, -3 V
Maximum load	200 mA

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

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

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

Control card, RS485 serial communication	
Terminal number	68 (P, TX+, RX+), 69 (N, TX-, RX-)
Terminal number 61	Common for terminals 68 and 69

The RS485 serial communication circuit is 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 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 protective earth. Use only an isolated laptop as PC connection to the USB connector on the frequency converter.

Relay outputs	
Programmable relay outputs	2 Form C
Relay 01 terminal number	1–3 (break), 1–2 (make)
Maximum terminal load (AC-1)[1)] on 1–3 (NC), 1–2 (NO) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 1–2 (NO), 1–3 (NC) (resistive load)	60 V DC, 1 A
Maximum terminal load (DC-13)[1)] (inductive load)	24 V DC, 0.1 A
Relay 02 terminal number	4–6 (break), 4–5 (make)

Maximum terminal load (AC-1)[1)] on 4–5 (NO) (resistive load)[2)3)] overvoltage cat. II	400 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 4–5 (NO) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 4–5 (NO) (resistive load)	80 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 4–5 (NO) (inductive load)	24 V DC, 0.1 A
Maximum terminal load (AC-1)[1)] on 4–6 (NC) (resistive load)	240 V AC, 2 A
Maximum terminal load (AC-15)[1)] on 4–6 (NC) (inductive load @ cosφ 0.4)	240 V AC, 0.2 A
Maximum terminal load (DC-1)[1)] on 4–6 (NC) (resistive load)	50 V DC, 2 A
Maximum terminal load (DC-13)[1)] on 4–6 (NC) (inductive load)	24 V DC, 0.1 A
Minimum terminal load on 1–3 (NC), 1–2 (NO), 4–6 (NC), 4–5 (NO)	24 V DC 10 mA, 24 V AC 20 mA
Environment according to EN 60664-1	Overvoltage category III/pollution degree 2

1) IEC 60947 part 4 and 5

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

2) Overvoltage Category II.

3) UL applications 300 V AC2A.

Cable lengths and cross-sections for control cables

Maximum motor cable length, shielded	150 m
Maximum motor cable length, unscreened	300 m
Maximum cross-section to control terminals, flexible/rigid wire without cable end sleeves	2.5 mm^2/14 AWG
Maximum cross-section to control terminals, with ferrules without plastic sleeves	2.5 mm^2/14 AWG
Maximum cross-section to control terminals, with ferrules with plastic sleeves	1 mm^2/18 AWG
Minimum cross-section to control terminals	0.25 mm^2/24 AWG

Control card performance

Scan interval	1 ms

Control characteristics

Resolution of output frequency at 0–590 Hz	±0.003 Hz
Repeat accuracy of precise start/stop (terminals 18, 19)	≤±0.1 ms
System response time (terminals 18, 19, 27, 29, 32, 33)	≤2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed control range (closed loop)	1:1000 of synchronous speed
Speed accuracy (open loop)	30–4000 RPM: error ±8 RPM
Speed accuracy (closed loop), depending on resolution of feedback device	0–6000 RPM: error ±0.15 RPM
Torque control accuracy (speed feedback)	Maximum error ±5% of rated torque

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

Environment

Vibration test	1.0 g
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. 50 °C (122 °F)

1) Only for ≤3.7 kW (5 hp)(200–240 V), ≤ 7.5 kW (10 hp) (400–500 V)

2) As enclosure kit for ≤ 3.7 kW (5 hp) (200–240 V), ≤ 7.5 kW (10 hp) (400–500 V)

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

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

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 & Installation Guide.

8

Protection and Features

- Electronic motor thermal protection against overload.
- If the temperature reaches 95 °C ± 5 °C, temperature monitoring of the heat sink ensures that the frequency converter trips. An overload temperature cannot be reset until the temperature of the heat sink is below 70 °C ± 5 °C (Guideline - these temperatures may vary for different power sizes, enclosures etc.). The frequency converter has an auto derating function to avoid it's heatsink reaching 95 °C.
- The frequency converter is protected against short circuits on motor terminals U, V, W.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- If the DC-link voltage is too low or too high, monitoring of the DC-link voltage ensures that the frequency converter trips.
- The frequency converter constantly checks for critical levels of internal temperature, load current, high voltage on the DC link, and low motor speeds. As a response to a critical level, the frequency converter can adjust the switching frequency and/or change the switching pattern to ensure the performance of the frequency converter.

8.2 Fuses

It is recommended to use fuses and/or circuit breakers on the supply side as protection if there is component break-down inside the frequency converter (first fault).

8

NOTICE

Using fuses and/or circuit breakers on the supply side is mandatory to ensure compliance with IEC 60364 for CE or NEC 2009 for UL.

⚠WARNING

Protect personnel and property against the consequence of component break-down internally in the frequency converter.

Branch circuit protection
To protect the installation against electrical and fire hazard, all branch circuits in an installation, switch gear, machines, and so on, must be protected against short circuit and overcurrent according to national/international regulations.

NOTICE

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 if there is component break-down in the frequency converter.

Overcurrent protection
The frequency converter 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 frequency converter is equipped with an internal overcurrent protection (*parameter 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.

⚠WARNING

If there is malfunction, not following the recommendation may result in personnel risk and damage to the frequency converter 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 frequency converter to an equal or lower level than the compliant circuit breakers.
If fuses/circuit breakers according to recommendations are selected, possible damages on the frequency converter will mainly be limited to damages inside the unit.

8.2.1 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 100000 Arms (symmetrical), 240 V, 500 V, 600 V, or 690 V depending on the frequency converter voltage rating. With the proper fusing, the frequency converter short circuit current rating (SCCR) is 100000 Arms.

AF-650 GP 3-phase [hp]	Recommended fuse size	Recommended maximum fuse	Recommended circuit breaker	Maximum trip level [A]
IP20/Open Chassis				
25	gG-80	gG-125	NZMB1-A100	100
40				
50	gG-125	gG-150	NZMB2-A200	150
100	aR-250	aR-250	NZMB2-A250	250
200	gG-400	gG-400	–	–
350	aR-700	aR-700		

Table 8.1 380–480 V, Unit Sizes 3X, 4hX

8.2.2 Fuse Specifications

AF-650 GP 3-phase [kW (hp)]	Recommended fuse size	Recommended maximum fuse
18.5 (25)	gG-80	gG-125
37 (50)	gG-125	gG-150
75 (100)	aR-250	aR-250
132 (200)	aR-400	aR-400
250 (350)	aR-700	aR-700

Table 8.2 380–500 V, IP20/Open Chassis

8.2.3 NEC and UL Compliance

	Recommended maximum fuse					
AF-650 GP	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**	**Bussmann**
[kW (hp)]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
18.5 (25)	KTS-R-60	JKS-60	JJS-60	–	–	–
37 (50)	KTS-R-125	JKS-125	JJS-125	–	–	–
75 (100)	KTS-R-250	JKS-250	JJS-250	–	–	–

Table 8.3 380–500 V

	Recommended maximum fuse			
AF-650 GP	**SIBA**	**Littelfuse**	**Ferraz-Shawmut**	**Ferraz-Shawmut**
[kW (hp)]	Type RK1	Type RK1	Type CC	Type RK1
18.5 (25)	5014006-063	KLS-R-60	–	A6K-60-R
37 (50)	2028220-125	KLS-R-125	–	A6K-125-R
75 (100)	2028220-250	KLS-R-250	–	A6K-250-R

Table 8.4 380–500 V

	Recommended maximum fuse			
AF-650 GP	**Bussmann**	**Ferraz Shawmut**	**Ferraz Shawmut**	**Littelfuse**
[kW (hp)]	JFHR2	J	JFHR2[1)]	JFHR2
18.5 (25)	FWH-60	HSJ-60	–	–
37 (50)	FWH-125	HSJ-125	–	–
75 (100)	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 8.5 380–500 V

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

Recommended maximum fuse					
AF-650 GP	**Bussmann PN**	**Alternate Bussmann PN**	**Siba PN**	**Littelfuse PN**	**Ferraz Shawmut PN**
[kW (hp)]	**Type JFHR2**	**Type T/JDDZ**	**Type JFHR2**	**Type JFHR2**	
132 (200)	170M2621	JJS-400	20 610 31.400	L50-S-400	6.9URD31D08A0400
250 (350)	170M4017	–	20 610 31.800	–	6.9URD31D08A0700

Table 8.6 380–500 V, above 125 hp

8

9 Terminal and Applicable Wire

9.1 Cables

Power [kW (hp)]	Enclosure	Mains		Motor		DC battery		Brake		Ground*
380–500 V [kW (hp)]		Tightening torque [Nm (in-lbs)]	Wire size [mm^2 (AWG)]	Tightening torque [Nm (in-lbs)]	Wire size [mm^2 (AWG)]	Tightening torque [Nm (in-lbs)]	Wire size [mm^2 (AWG)]	Tightening torque [Nm (in-lbs)]	Wire size [mm^2 (AWG)]	Tightening torque [Nm (in-lbs)]
18.5 (25)	IP20	4.5 (40)	35 (2)	4.5 (40)	35 (2)	4.5 (40)	35 (2)	4.5 (40)	35 (2)	3 (27)
37 (50)	IP20	10 (89)	50 (1)	10 (89)	50 (1)	10 (89)	50 (1)	10 (89)	50 (1)	
75 (100)	IP20	14 (124)	150 (300)	14 (124)	150 (300)	14 (124)	95 (4/0)	14 (124)	95 (4/0)	
132 (200)	IP20	19 (168)	2x95 (2x3/0)	19 (168)	2x95 (2x3/0)	19 (75)	2x95 (2x3/0)	8.5 (75)	2x95 (2x3/0)	8.5 (7.5)
250 (350)	IP20		2x185 (2x350)		2x185 (2x350)		2x185 (2x350)		2x185 (2x350)	19 (168)

* Maximum cable size according to national code

Table 9.1 Cables

Index

A

AC input ... 12
AC mains ... 9, 12
Alarm Log ... 27
Alarm/warning types ... 36
Alarms ... 36
Analog inputs ... 13
Analog output ... 13, 42
Auto ... 28
Auto tune ... 19
Auto-reset ... 26

B

Back plate ... 8
Basic operational programming ... 19
Branch circuit protection ... 44

C

Cable
  Screened cable ... 18
Cable lengths, cross sections ... 43
Circuit breaker ... 18
Circuit breakers ... 44
Clearance requirements ... 7
Closed loop ... 15
Conduit ... 10, 18
Control
  characteristics ... 43
  wiring ... 18
Control cables ... 14
Control card
  Control card ... 42, 43
  RS485 ... 42
  Serial communication ... 42
  USB serial communication ... 42
Control terminal ... 28
Control terminals ... 9, 14, 19
Control wire ... 14
Control wiring ... 10, 11, 14
Cooling ... 7
Cooling clearance ... 18
Current limit ... 20
Current rating ... 7

D

DC battery ... 4
DCT-10 ... 13, 35
Derating ... 7
Digital inputs ... 13
Digital output ... 42
Discharge time ... 4
Disconnect switch ... 17, 19
Downloading data from the keypad ... 29
Drive profile ... 16

E

Electrical noise ... 11
EMC ... 18

F

Fault log ... 27
Feedback ... 15, 18
Floating delta ... 12
Full load current ... 7, 17
Functional testing ... 20
Fuse ... 18
Fuses ... 44
Fusing ... 10, 18

G

Ground connection ... 18
Ground connections ... 11
Ground loops ... 14
Ground wire ... 11, 18
Grounded delta ... 12
Grounding ... 10, 11, 12, 17, 18
Grounding, using shielded cable ... 11

H

Hand ... 20, 28
High voltage ... 4

I

IEC 61800-3 ... 12
Induced voltage ... 10
Input
  Analog input ... 41
  Digital input ... 40
  power ... 18
Input current ... 12
Input disconnect ... 12
Input power ... 10, 11, 12, 17, 36
Input signals ... 15

Input terminal ... 17
Input terminals ... 9, 15
Input voltage ... 19
Installation ... 7, 8, 10, 14, 16, 18, 19
Isolated mains ... 12

L

Leakage current ... 5, 10, 17
Lifting ... 8
Local control ... 26, 28
Local mode ... 20
Local operation ... 26
Local start ... 20
Local-control test ... 20

M

Main menu ... 27
Main Menu ... 27
Mains ... 10
Mains voltage ... 27, 28
Menu key ... 26
Menu keys ... 27
Menu structure ... 28
Modbus RTU ... 16
Motor
  protection ... 44
  wiring ... 18
  Rotation ... 20
  Unintended motor rotation ... 5
Motor cables ... 7, 10, 11
Motor current ... 19
Motor Current ... 27
Motor data ... 19, 20
Motor output ... 40
Motor power ... 9, 10, 11
Motor protection ... 10
Motor rotation ... 27
Motor speeds ... 19
Motor wiring ... 10, 11
Mounting ... 8, 18
Multiple frequency converters ... 10, 11
Multiple motors ... 17

N

Navigation key ... 26, 28
Navigation keys ... 19
Noise isolation ... 10, 18

O

Open loop ... 15
Operation key ... 28
Operational programming, basic ... 19
Optional equipment ... 11, 19
Output performance (U, V, W) ... 40
Output terminal ... 17
Output terminals ... 9
Overload protection ... 7, 10
Overvoltage ... 20

P

Parameter setting ... 28
PELV ... 12
Performance ... 43
Power
  Input power ... 18, 36
  Input voltage ... 36
  factor ... 18
  Power, input ... 36
Power connections ... 10
Power factor ... 11
Pre-start ... 17
Programming ... 19, 20, 26, 27, 28, 35
Pulse/encoder input ... 41

Q

Qualified personnel ... 4
Quick Menu ... 27
Quick set-up ... 19

R

Ramp time ... 20
RCD ... 11
Reference ... 27
Relay output ... 42
Relay outputs ... 13
Remote programming ... 35
Remote Programming ... 35
Reset ... 26, 28, 29, 36
Restore ... 29
Restoring ... 29
Restoring default setting ... 29
Restoring Default Settings ... 29
RFI filter ... 12
Run command ... 21

S

Safety..... 5
Safety inspection..... 17
Screened control cables..... 14
Serial communication..... 9, 13, 14, 16, 28, 36
Serial communication
Serial communication..... 42
Set-up..... 21, 27
Shielded cable..... 7, 10
Shielded cable, grounding..... 11
Shielded wire..... 10
Smart Application Set-up (SAS)..... 19
Specifications..... 16
Speed reference..... 15, 21
Start-up..... 29
Supply voltage..... 12, 13, 17
Surroundings..... 43
System monitoring..... 36
System Start Up..... 21

T

Temperature limit..... 18
Terminal 53..... 15
Terminal 54..... 15
Terminal programming..... 15
Thermistor..... 12
Thermistor control wiring..... 12
Torque
characteristics..... 40
Torque limit..... 20
Trip..... 36
Trip function..... 10
Trip lock..... 36

U

Unintended start..... 4, 29
Uploading data to the keypad..... 29

V

Voltage
Voltage, input..... 36
Voltage level..... 40

W

Warning and alarm displays..... 36
Warning and alarm types..... 36
Warning/alarm types..... 36
Windmilling..... 5
Wire sizes..... 11

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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