

GE

# AF-650 GP™

## General Purpose Drive

(230V to 50HP, 460/575V to 100HP)

### Operating Instructions



a product of  
**ecomagination**



# Safety

## Safety

### **⚠️ WARNING**

#### **HIGH VOLTAGE!**

Frequency converters contain high voltage when connected to AC mains input power. Installation, start up, and maintenance should be performed by qualified personnel only. Failure to perform installation, start up, and maintenance by qualified personnel could result in death or serious injury.

#### **High Voltage**

Frequency converters are connected to hazardous mains voltages. Extreme care should be taken to protect against shock. Only trained personnel familiar with electronic equipment should install, start, or maintain this equipment.

### **⚠️ WARNING**

#### **UNINTENDED START!**

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

#### **Unintended Start**

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

### **⚠️ WARNING**

#### **DISCHARGE TIME!**

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

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

High voltage may be present even when the warning LEDs are off!

#### **Discharge Time**

#### **Symbols**

The following symbols are used in this manual.

### **⚠️ WARNING**

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

### **⚠️ CAUTION**

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

## **CAUTION**

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

## **NOTE**

Indicates highlighted information that should be regarded with attention to avoid mistakes or operate equipment at less than optimal performance.

#### **Approvals**



Table 1.2





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# 1 Introduction

1

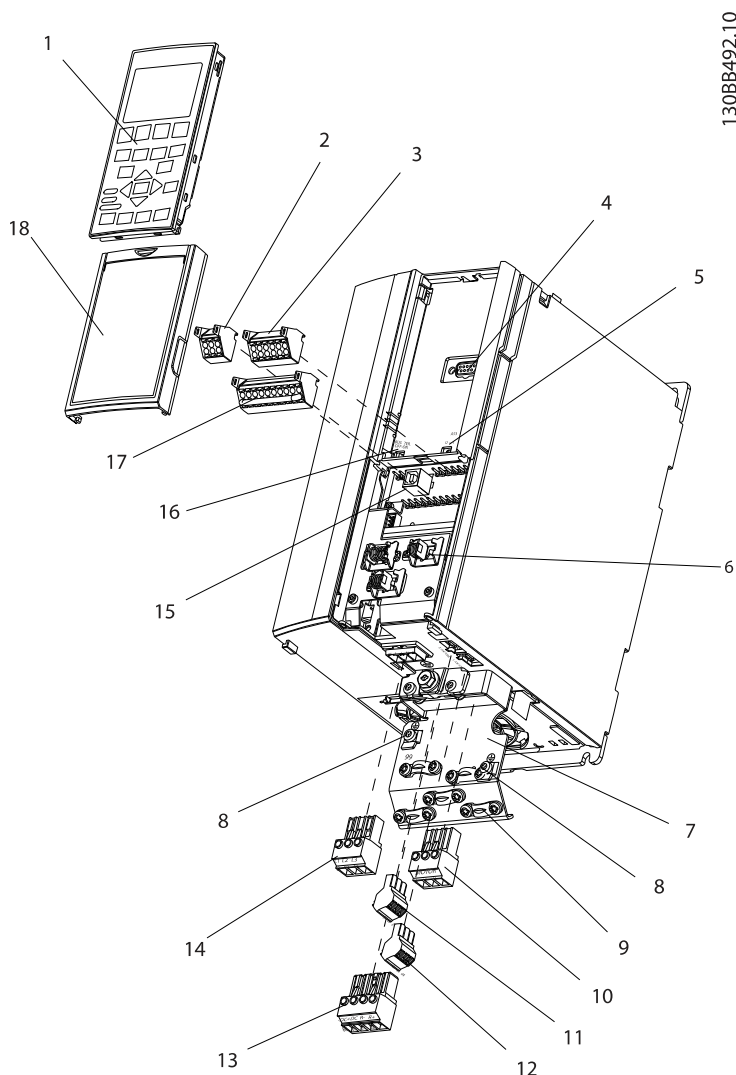
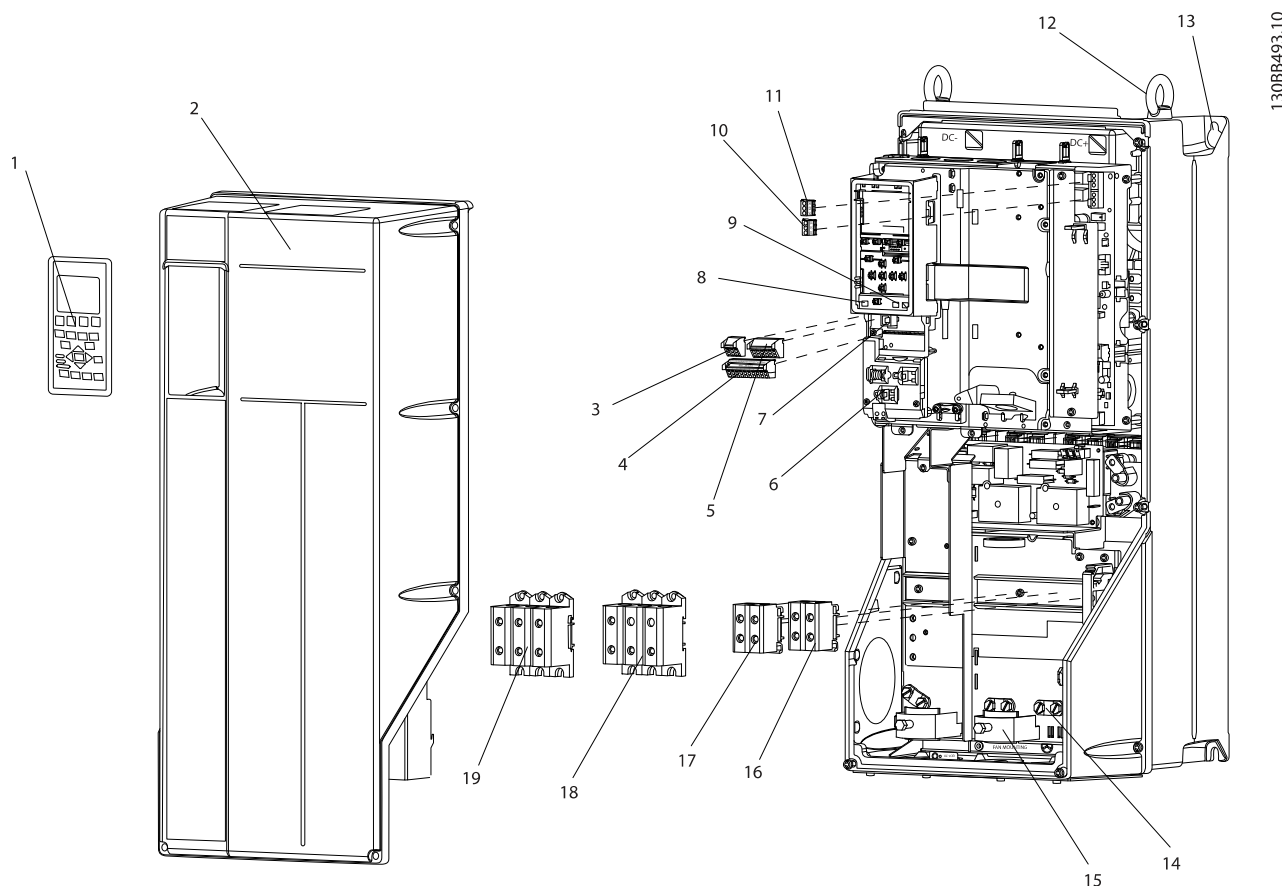


Illustration 1.1 Exploded View Unit Sizes 12-13, IP20

1	Keypad	10	Motor output terminals 96 (U), 97 (V), 98 (W)
2	RS-485 serial bus connector (+68, -69)	11	Relay 1 (01, 02, 03)
3	Analog I/O connector	12	Relay 2 (04, 05, 06)
4	Keypad input plug	13	Brake (-81, +82) and load sharing (-88, +89) terminals
5	Analog switches (A53), (A54)	14	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

Table 1.1



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

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

Table 1.2



## 1.1 Purpose of the Manual

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

## 1.2 Additional Resources

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

- The Programming Guide DET-618 provides greater detail on working with parameters and many application examples.
- The Design Guide DET-619 is intended to provide detailed capabilities and functionality to design motor control systems.
- Optional equipment is available that may change some of the procedures described. Be sure to see the instructions supplied with those options for specific requirements.

## 1.3 Product Overview

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

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

## 1.4 Internal Frequency Converter Controller Functions

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

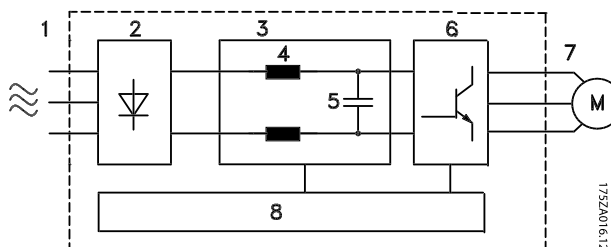


Illustration 1.3 Block Diagram



Area	Title	Functions
1	Mains input	<ul style="list-style-type: none"><li>• Three-phase AC mains power supply to the drive</li></ul>
2	Rectifier	<ul style="list-style-type: none"><li>• The rectifier bridge converts the AC input to DC current to supply inverter power</li></ul>
3	DC bus	<ul style="list-style-type: none"><li>• The frequency converter's intermediate DC-bus circuit handles the DC current</li></ul>
4	DC reactors	<ul style="list-style-type: none"><li>• Filter the intermediate DC circuit voltage</li><li>• Provide line transient protection</li><li>• Reduce RMS current</li><li>• Raise the power factor reflected back to the line</li><li>• Reduce harmonics on the AC input</li></ul>
5	Capacitor bank	<ul style="list-style-type: none"><li>• Stores the DC power</li><li>• Provides ride-through protection for short power losses</li></ul>
6	Inverter	<ul style="list-style-type: none"><li>• Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor</li></ul>
7	Output to motor	<ul style="list-style-type: none"><li>• Regulated three-phase output power to the motor</li></ul>
8	Control circuitry	<ul style="list-style-type: none"><li>• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control</li><li>• User interface and external commands are monitored and performed</li><li>• Status output and control can be provided</li></ul>

Table 1.3 Internal Components



1

### 1.5 Unit Sizes and Power Ratings

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

Table 1.4



## 2 Installation

### 2.1 Installation Site Check List

- The drive relies on the ambient air for cooling. Observe the limitations on ambient air temperature for optimal operation
- Ensure that the installation location has sufficient support strength to mount the drive
- Keep the drive interior free from dust and dirt. Ensure that the components stay as clean as possible. In construction areas, provide a protective covering. Optional IP55 (NEMA 12) enclosures may be necessary.
- Keep the manual, drawings, and diagrams accessible for detailed installation and operation instructions. It is important that the manual is available for equipment operators.
- Locate equipment as near to the motor as possible. Keep motor cables as short as possible. Check the motor characteristics for actual tolerances. Do not exceed
  - 300m (1000ft) for unshielded motor leads
  - 150m (500ft) for shielded cable.

### 2.2 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)
  - Drive
  - Motor
- Ensure that drive output current rating is equal to or greater than motor full load current for peak motor performance
  - Motor size and drive power must match for proper overload protection
  - If drive rating is less than motor, full motor output cannot be achieved

### 2.3 Mechanical Installation

#### 2.3.1 Cooling

- To provide cooling airflow, mount the unit to a solid flat surface or to the optional back plate (see 2.3.3 Mounting)
- Top and bottom clearance for air cooling must be provided. Generally, 100-225mm (4-10in) is required. See *Illustration 2.1* 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 1000m (3300ft) above sea level must be considered. See the equipment Design Guide for detailed information.

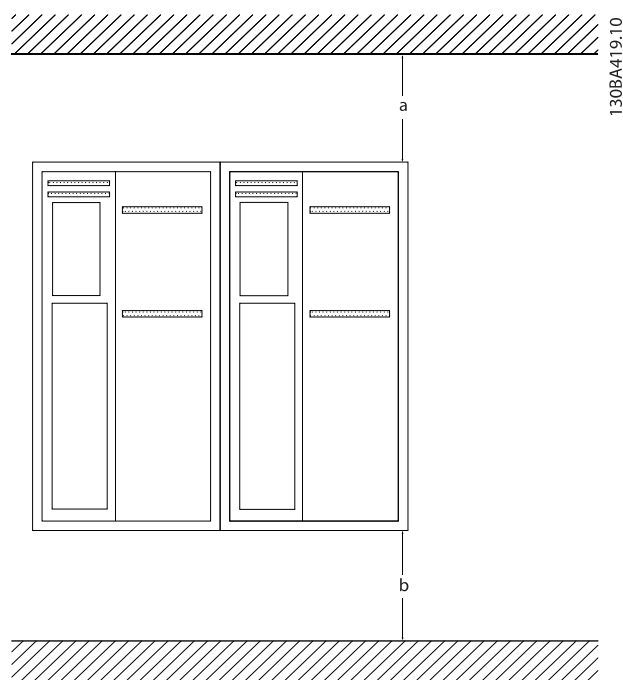


Illustration 2.1 Top and Bottom Cooling Clearance

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

Table 2.1 Minimum Airflow Clearance Requirements

### 2.3.2 Lifting

- Check the weight of the unit to determine a safe lifting method
- Ensure that the lifting device is suitable for the task
- If necessary, plan for a hoist, crane, or forklift with the appropriate rating to move the unit
- For lifting, use hoist rings on the unit, when provided

### 2.3.3 Mounting

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

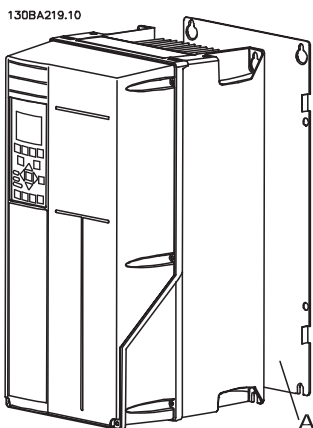


Illustration 2.2 Proper Mounting with Back Plate

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

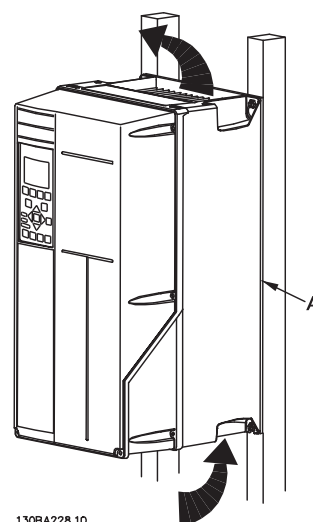


Illustration 2.3 Proper Mounting with Railings

### NOTE

Back plate is needed when mounted on railings.

### 2.3.4 Tightening Torques

See 10.4.1 Connection Tightening Torques for proper tightening specifications.



### 2.4 Electrical Installation

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

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

2

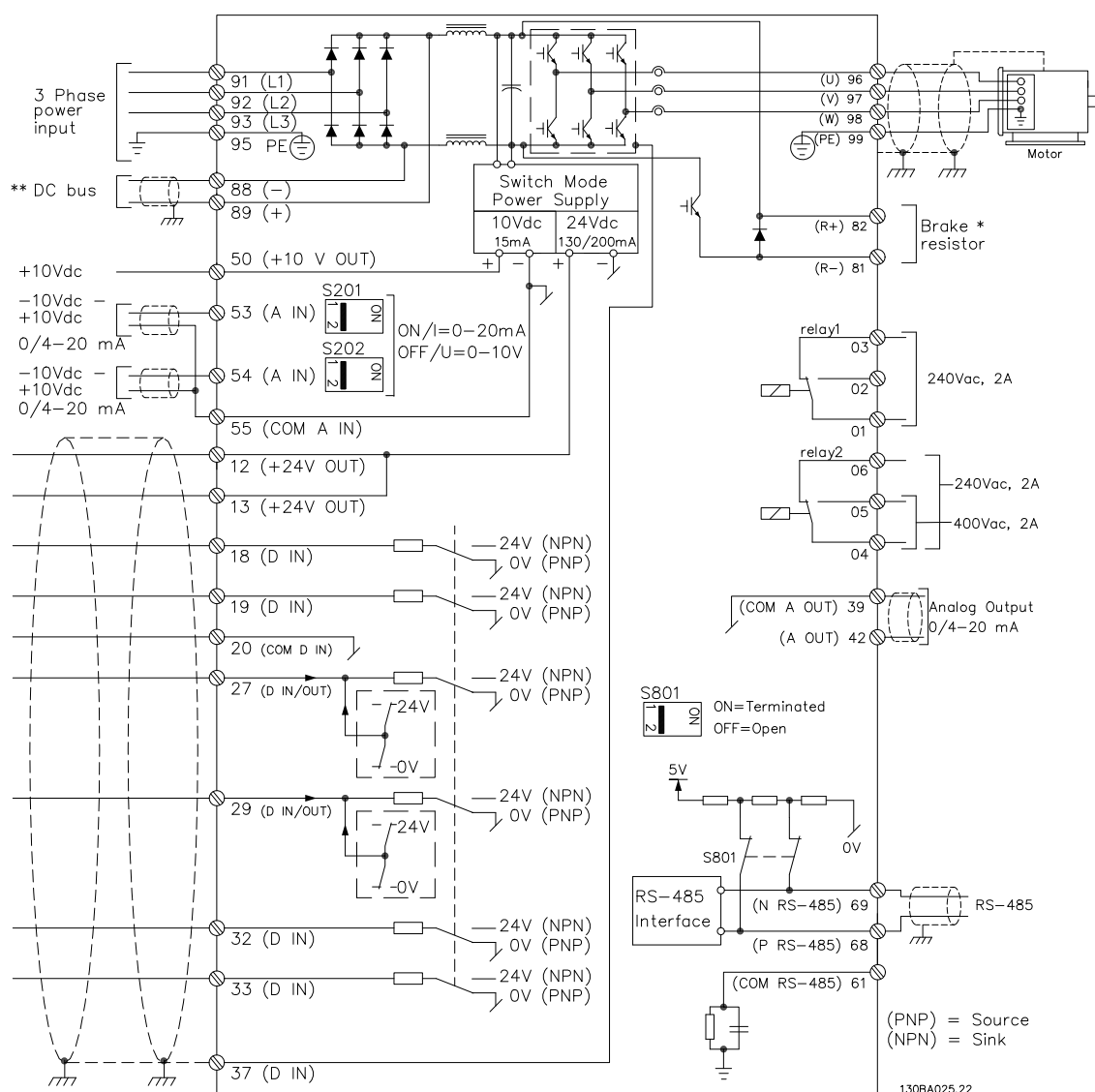


Illustration 2.4 Basic Wiring Schematic Drawing.

A=Analog, D=Digital

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

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

\*\*This is available when ordering the brake chopper option on unit size 23 and above drives.

### 2.4.1 Requirements

#### **⚠️ WARNING**

##### **EQUIPMENT HAZARD!**

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

#### **CAUTION**

##### **WIRING ISOLATION!**

Run input power, motor wiring and control wiring in three separate metallic conduits or use separated shielded cable for high frequency noise isolation. Failure to isolate power, motor and control wiring could result in less than optimum 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 *8 Warnings and Alarms* 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 over-current protection. Input fusing is required to provide this protection, see *Illustration 2.5*. Fuses must be provided by the

installer as part of installation. See maximum fuse ratings in *10.3 Fuse Tables*.

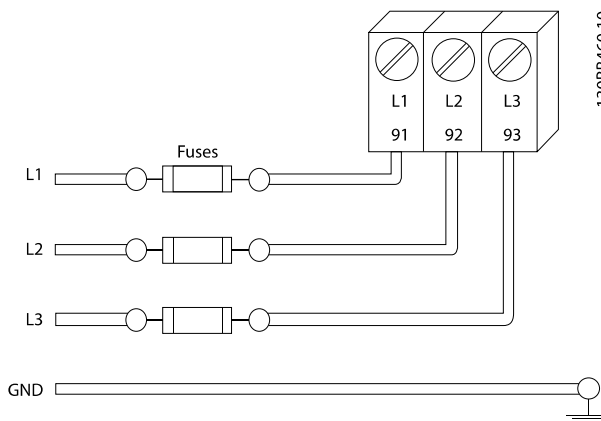


Illustration 2.5 Fuses

##### **Wire Type and Ratings**

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

### 2.4.2 Earth (Grounding) Requirements

#### **⚠️ WARNING**

##### **GROUNDING HAZARD!**

For operator safety, it is important to ground drive properly in accordance with national and local electrical codes as well as instructions contained within these instructions. Ground currents are higher than 3,5mA. Failure to ground drive properly could result in death or serious injury.

#### **NOTE**

It is the responsibility of the user or certified electrical installer to ensure correct grounding (earthing) 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 3,5mA must be established, see *Leakage Current (>3,5mA)*
- 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 drive to another in a “daisy chain” fashion
- Keep the ground wire connections as short as possible
- Use of high-strand wire to reduce electrical noise is recommended
- Follow motor manufacturer wiring requirements

### 2.4.2.1 Leakage Current (>3,5mA)

Follow national and local codes regarding protective earthing of equipment with a leakage current > 3,5mA. Drive technology implies high frequency switching at high power. This will generate a leakage current in the earth connection. A fault current in the drive at the output power terminals might contain a DC component which can charge the filter capacitors and cause a transient earth current. The earth leakage current depends on various system configurations including RFI filtering, screened motor cables, and drive power.

EN/IEC61800-5-1 (Power Drive System Product Standard) requires special care if the leakage current exceeds 3,5mA. Earth grounding must be reinforced in one of the following ways:

- Earth ground wire of at least 10mm<sup>2</sup>
- Two separate earth ground wires both complying with the dimensioning rules

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

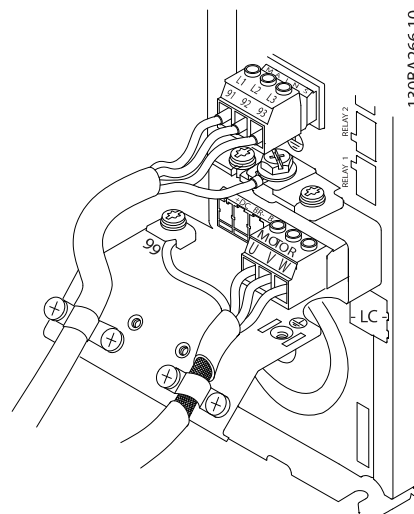
#### Using RCDs

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 earth currents
- Dimension RCDs according to the system configuration and environmental considerations

### 2.4.2.2 Grounding Using Shielded Cable

Earthing (grounding) clamps are provided for motor wiring (see *Illustration 2.6*).



**Illustration 2.6** Grounding with Shielded Cable

### 2.4.3 Motor Connection

#### **WARNING**

#### **INDUCED VOLTAGE!**

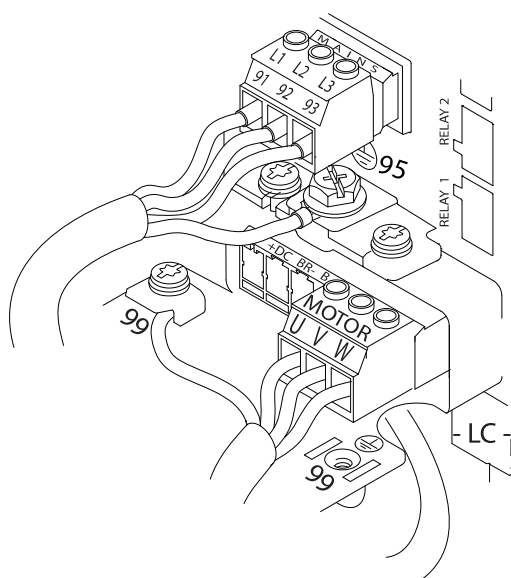
Run output motor cables from multiple frequency converters separately. Induced voltage from output motor cables run together can charge equipment capacitors even with the equipment turned off and locked out. Failure to run output motor cables separately could result in death or serious injury.

- For maximum wire sizes see *10.1 Power-dependent Specifications*
- Comply with local and national electrical codes for cable sizes
- Motor wiring knockouts or access panels are provided at the base of IP21 and higher (Nema 1, 12, and 4/4X Indoor) units
- Do not install power factor correction capacitors between the 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 *10.4.1 Connection Tightening Torques*



- Follow motor manufacturer wiring requirements

*Illustration 2.7* represents mains input, motor, and earth grounding for basic frequency converters. Actual configurations vary with unit types and optional equipment.



**Illustration 2.7** Example of Motor, Mains and Earth Wiring

### 2.4.4 AC Mains Connection

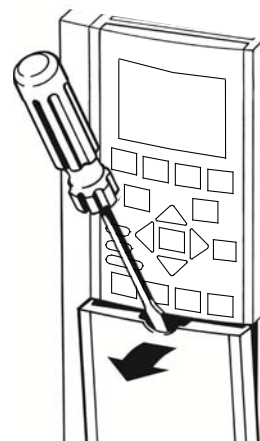
- Size wiring based upon the input current of the drive. For maximum wire sizes see *10.1 Power-dependent Specifications*.
- Comply with local and national electrical codes for cable sizes.
- Connect 3-phase AC input power wiring to terminals L1, L2, and L3 (see *Illustration 2.7*).
- Depending on the configuration of the equipment, input power will be connected to the mains input terminals or the input disconnect.
- Ground the cable in accordance with grounding instructions provided in *2.4.2 Earth (Grounding) Requirements*
- All frequency converters may be used with an isolated input source as well as 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 *SP-50 RFI Filter* to OFF. When off, the internal RFI filter capacitors between the chassis and the intermediate circuit are isolated to avoid damage to the intermediate circuit and to reduce earth capacity currents in accordance with IEC 61800-3.

### 2.4.5 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 VDC supply voltage is recommended.

#### 2.4.5.1 Access

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



**Illustration 2.8** Control Wiring Access for IP20 / Open chassis enclosures



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

### 2.4.5.2 Control Terminal Types

Illustration 2.10 and shows the removable frequency converter connectors. Terminal functions and default settings are summarized in Table 2.3.

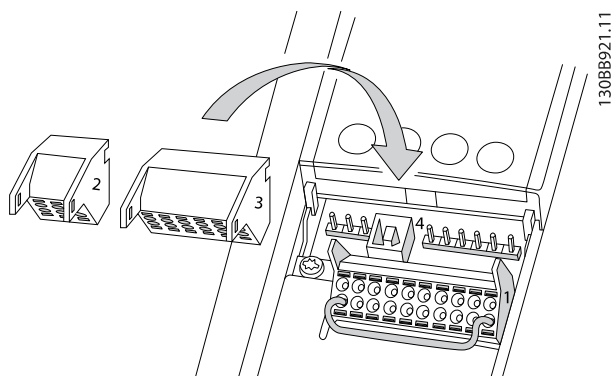


Illustration 2.10 Control Terminal Locations

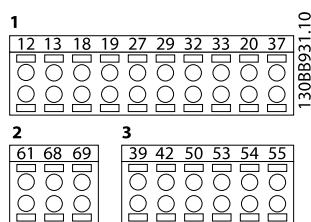


Illustration 2.11 Terminal Numbers

- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24V DC terminal supply voltage, and a common for optional customer supplied 24V DC voltage. A digital input for STO (Safe Torque Off) function.
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communications connection
- **Connector 3** provides two analog inputs, one analog output, 10V 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 upon the frequency converter configuration and size
- Some options available for ordering with the unit may provide additional terminals. See the manual provided with the equipment option.

See 10.2 General Technical Data for terminal ratings details.

Terminal description			
Terminal	Parameter	Default setting	Description
<b>Digital inputs/outputs</b>			
12, 13	-	+24V DC	24V DC supply voltage. Maximum output current is 200mA total for all 24V loads. Useable for digital inputs and external transducers.
18	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 0V potential for 24V supply.
37	-	Safe Torque Off (STO)	Safe input. Used for STO.
<b>Analog inputs/outputs</b>			
39	-		Common for analog output
42	AN-50	[0] No operation	Programmable analog output. The analog signal is 0-20mA or 4-20mA at a maximum of 500Ω
50	-	+10V DC	10V DC analog supply voltage. 15mA maximum commonly used for potentiometer or thermistor.
53	AN-1#	Reference	Analog input.
54	AN-2#	Feedback	Selectable for voltage or current. Switches A53 and A54 select mA or V.
55	-		Common for analog input

Table 2.2

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

Table 2.3 Terminal Description

### 2.4.5.3 Wiring to Control Terminals

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

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Illustration 2.12*.
2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

See 10.1 *Power-dependent Specifications* for control terminal wiring sizes.

See 6 *Application Set-Up Examples* for typical control wiring connections.

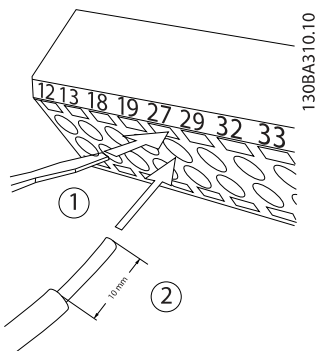


Illustration 2.12 Connecting Control Wiring

### 2.4.5.4 Using Screened Control Cables

#### Correct screening

The preferred method in most cases 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 earth potential between the frequency converter and the PLC is different, electric noise may occur that will disturb the entire system. Solve this problem by fitting an equalizing cable next to the control cable. Minimum cable cross section: 16 mm<sup>2</sup>.

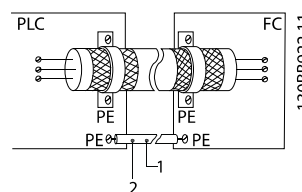


Illustration 2.13

#### 50/60Hz ground loops

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

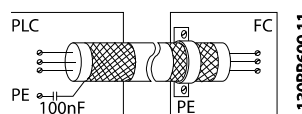


Illustration 2.14

#### Avoid EMC noise on serial communication

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

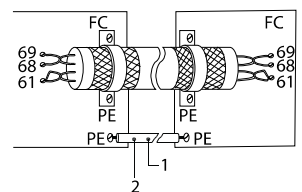


Illustration 2.15

Alternatively, the connection to terminal 61 can be omitted:

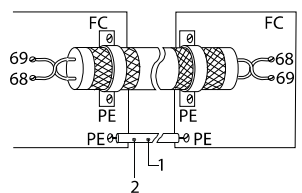


Illustration 2.16

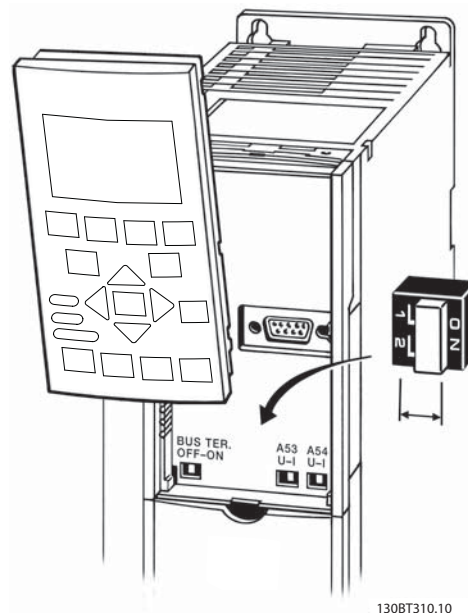
### 2.4.5.5 Control Terminal Functions

Drive functions are commanded by receiving control input signals.

- Each terminal must be programmed for the function it will be supporting in the parameters associated with that terminal. See *Table 2.3* for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See *4 User Interface* for details on accessing parameters and for details on programming.
- The default terminal programming is intended to initiate drive functioning in a typical operational mode.

### 2.4.5.6 Terminal 53 and 54 Switches

- Analog input terminals 53 and 54 can select either voltage (-10 to 10V) or current (0/4-20mA) input signals
- Remove power to the drive before changing switch positions
- Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.
- The switches are accessible when the Keypad has been removed (see *Illustration 2.17*). Note that some option cards available for the unit may cover these switches and must be removed to change switch settings. Always remove power to the unit before removing option cards.
- Terminal 53 default is for a speed reference signal in open loop set in *DR-61 Terminal 53 Switch Setting*
- Terminal 54 default is for a feedback signal in closed loop set in *DR-63 Terminal 54 Switch Setting*



**Illustration 2.17 Location of Terminals 53 and 54 Switches and Bus Termination Switch**

### 2.4.5.7 Terminal 37

#### Terminal 37 Safe Stop Function

The AF-650 GP is available with safe stop functionality via control terminal 37. Safe stop disables the control voltage of the power semiconductors of the drive output stage which in turn prevents generating the voltage required to rotate the motor. When the Safe Stop (T37) is activated, the drive issues an alarm, trips the unit, and coasts the motor to a stop. Manual restart is required. The safe stop function can be used for stopping the drive in emergency stop situations. In the normal operating mode when safe stop is not required, use the frequency converter's regular stop function instead. When automatic restart is used – the requirements according to ISO 12100-2 paragraph 5.3.2.5 must be fulfilled.

#### Liability Conditions

It is the responsibility of the user to ensure personnel installing and operating the Safe Stop function:

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

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

**Standards**

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

- EN 954-1: 1996 Category 3
- IEC 60204-1: 2005 category 0 – uncontrolled stop
- IEC 61508: 1998 SIL2
- IEC 61800-5-2: 2007 – safe torque off (STO) function
- IEC 62061: 2005 SIL CL2
- ISO 13849-1: 2006 Category 3 PL d
- ISO 14118: 2000 (EN 1037) – prevention of unexpected start up

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

**Protective Measures**

- Safety engineering systems may only be installed and commissioned by qualified and skilled personnel
- The unit must be installed in an IP54 cabinet or in an equivalent environment
- The cable between terminal 37 and the external safety device must be short circuit protected according to ISO 13849-2 table D.4
- If any external forces influence the motor axis (e.g. suspended loads), additional measures (e.g., a safety holding brake) are required in order to eliminate hazards

**Safe Stop Installation and Set-Up**
 **WARNING**
**SAFE STOP FUNCTION!**

The safe stop function does NOT isolate mains voltage to the drive or auxiliary circuits. Perform work on electrical parts of the drive or the motor only after isolating the mains voltage supply and waiting the length of time specified under Safety in this manual. Failure to isolate the mains voltage supply from the unit and waiting the time specified could result in death or serious injury.

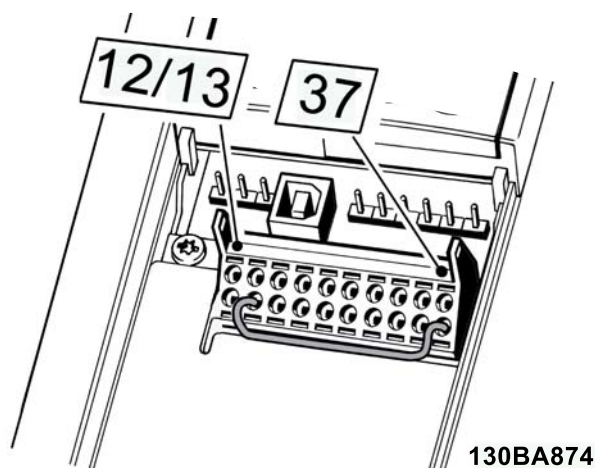
- It is not recommended to stop the drive by using the Safe Torque Off function. If a running drive is stopped by using the function, the unit will trip and stop by coasting. If this is not acceptable, e.g. causes danger, the drive and machinery must be stopped using the appropriate stopping mode

before using this function. Depending on the application a mechanical brake may be required.

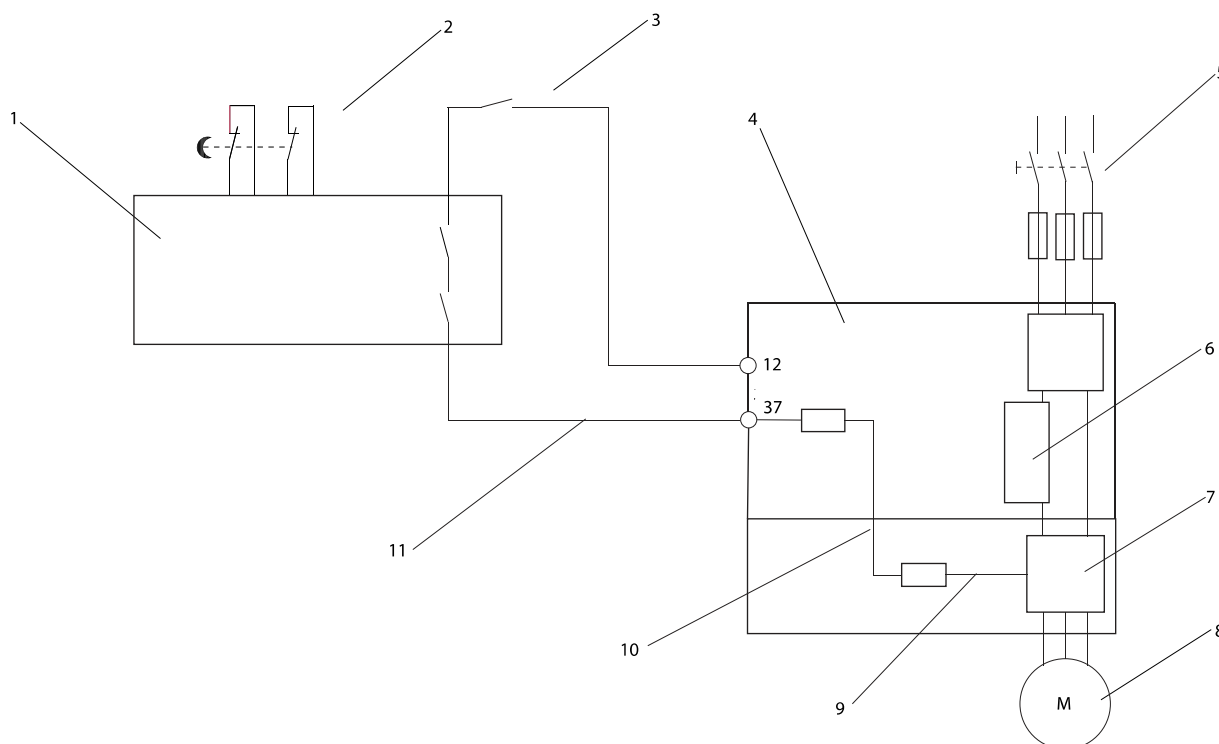
- Concerning synchronous and permanent magnet motor frequency converters in case of a multiple IGBT power semiconductor failure: In spite of the activation of the Safe torque off function, the drive system can produce an alignment torque which maximally rotates the motor shaft by  $180/p$  degrees.  $p$  denotes the pole pair number.
- This function is suitable for performing mechanical work on the drive system or affected area of a machine only. It does not provide electrical safety. This function should not be used as a control for starting and/or stopping the drive.

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

1. Remove the jumper wire between control terminals 37 and 12 or 13. Cutting or breaking the jumper is not sufficient to avoid short-circuiting. (See jumper on *Illustration 2.18*.)
2. Connect an external Safety monitoring relay via a NO safety function (the instruction for the safety device must be followed) to terminal 37 (safe stop) and either terminal 12 or 13 (24V DC). The Safety monitoring relay must comply with Category 3 (EN 954-1) / PL "d" (ISO 13849-1).



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



13088749.10

2

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

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

Table 2.4

**Safe Stop Commissioning Test**

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

## 2.4.6 Serial Communication

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

2

- Screened serial communication cable is recommended
- See 2.4.2 *Earth (Grounding) Requirements* for proper grounding

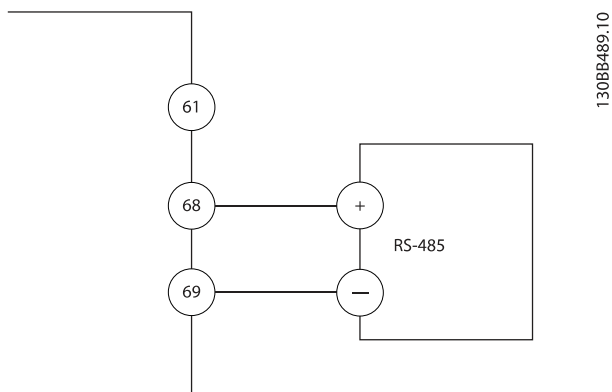


Illustration 2.20 Serial Communication Wiring Diagram

For basic serial communication set-up, select the following

1. Protocol type in *O-30 Protocol*.
  2. Frequency converter address in *O-31 Address*.
  3. Baud rate in *O-32 Drive Port Baud Rate*.
- Two communication protocols are internal to the drive.

Drive profile

Modbus RTU

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





## 3 Start Up and Functional Testing

### 3.1 Pre-start

#### 3.1.1 Safety Inspection

#### **⚠ WARNING**

##### **HIGH VOLTAGE!**

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





## 3.1.2 Start Up Check List

**CAUTION**

Before applying power to the unit, inspect the entire installation as detailed in *Table 3.1*. Check mark those items when completed.

3

Inspect for	Description	<input checked="" type="checkbox"/>
Auxiliary equipment	<ul style="list-style-type: none"> <li>Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on input power side of drive or output side to motor. Examine their operational readiness and ensure that they are ready in all respects for operation at full speed.</li> <li>Check function and installation of any sensors used for feedback to drive</li> <li>Remove power factor correction caps on motor(s), if present</li> </ul>	
Cable routing	<ul style="list-style-type: none"> <li>Ensure that input power, motor wiring, and control wiring are separated or in three separate metallic conduits for high frequency noise isolation</li> </ul>	
Control wiring	<ul style="list-style-type: none"> <li>Check for broken or damaged wires and loose connections</li> <li>Check that control wiring is isolated from power and motor wiring for noise immunity</li> <li>Check the voltage source of the signals, if necessary</li> <li>The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly.</li> </ul>	
Cooling clearance	<ul style="list-style-type: none"> <li>Measure that top and bottom clearance is adequate to ensure proper air flow for cooling</li> </ul>	
EMC considerations	<ul style="list-style-type: none"> <li>Check for proper installation regarding electromagnetic compatibility</li> </ul>	
Environmental considerations	<ul style="list-style-type: none"> <li>See equipment label for the maximum ambient operating temperature limits</li> <li>Humidity levels must be 5-95% non-condensing</li> </ul>	
Fusing and circuit breakers	<ul style="list-style-type: none"> <li>Check for proper fusing or circuit breakers</li> <li>Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position</li> </ul>	
Grounding	<ul style="list-style-type: none"> <li>The unit requires a ground wire from its chassis to the building ground</li> <li>Check for good ground connections that are tight and free of oxidation</li> <li>Grounding to conduit or mounting the back panel to a metal surface is not a suitable ground</li> </ul>	
Input and output power wiring	<ul style="list-style-type: none"> <li>Check for loose connections</li> <li>Check that motor and mains are in separate conduit or separated screened cables</li> </ul>	
Panel interior	<ul style="list-style-type: none"> <li>Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion</li> </ul>	
Switches	<ul style="list-style-type: none"> <li>Ensure that all switch and disconnect settings are in the proper position</li> </ul>	
Vibration	<ul style="list-style-type: none"> <li>Check that the unit is mounted solidly or that shock mounts are used, as necessary</li> <li>Look for any unusual amount of vibration the unit may be subjected to</li> </ul>	

Table 3.1 Start Up Check List



### 3.2 Applying Power to the Frequency Converter

#### **⚠ WARNING**

##### **HIGH VOLTAGE!**

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

#### **⚠ WARNING**

##### **UNINTENDED START!**

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

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

### 3.3 Basic Operational Programming

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

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

1. Press [Quick Menu] on the Keypad.
2. Use the navigation keys to scroll to Quick Start and press [OK].

3. Select language and press [OK]. Then enter the motor data in parameters P-02, P-03, P-06, P-07, F-04 and F-05. The information can be found on the motor nameplate.

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

*F-05 Motor Rated Voltage*

*F-04 Base Frequency*

*P-03 Motor Current*

*P-06 Base Speed*

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

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



### 3.4 Auto Tune

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

- The drive builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the motor characteristics with the data entered in parameters P-0#.
- It does not cause the motor to run or harm to the motor
- Some motors may be unable to run the complete version of the test. In that case, select *Reduced Auto Tune*
- If an output filter is connected to the motor, select *Reduced Auto Tune*
- If warnings or alarms occur, see *8 Warnings and Alarms*
- Run this procedure on a cold motor for best results

### 3.5 Check Motor Rotation

Prior to running the frequency converter, check the motor rotation.

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

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

- 4a. Verify that the motor turns clockwise.
- 5a. Verify that the Keypad direction arrow is clockwise.

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

- 4b. Verify that the motor turns counter-clockwise.
- 5b. Verify that the Keypad direction arrow is counter-clockwise.

### 3.6 Local-control Test

#### **CAUTION**

#### **MOTOR START!**

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

#### **NOTE**

The Hand key on the Keypad provides a local start command to the drive. The OFF key provides the stop function.

When operating in local mode, the up and down arrows on the Keypad increase and decrease the speed output of the drive. The left and right arrow keys move the display cursor in the numeric display.

1. Press [Hand].
2. Accelerate the drive by pressing [▲] to full speed. Moving the cursor left of the decimal point provides quicker input changes.
3. Note any acceleration problems.
4. Press [OFF].
5. Note any deceleration problems.

If acceleration problems were encountered

- If warnings or alarms occur, see *8 Warnings and Alarms*
- Check that motor data is entered correctly
- Increase the ramp time in *F-07 Accel Time 1*
- Increase current limit in *F-43 Current Limit*
- Increase torque limit in *F-40 Torque Limiter (Driving)*

If deceleration problems were encountered

- If warnings or alarms occur, see *8 Warnings and Alarms*
- Check that motor data is entered correctly
- Increase the ramp time in *F-08 Decel Time 1*
- Enable overvoltage control in *B-17 Over-voltage Control*

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



## NOTE

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

### 3.7 System Start Up

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

#### CAUTION

##### MOTOR START!

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

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

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



## 4 User Interface

### 4.1 Keypad

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

The Keypad has several user functions.

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

#### NOTE

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

### 4.1.1 Keypad Layout

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

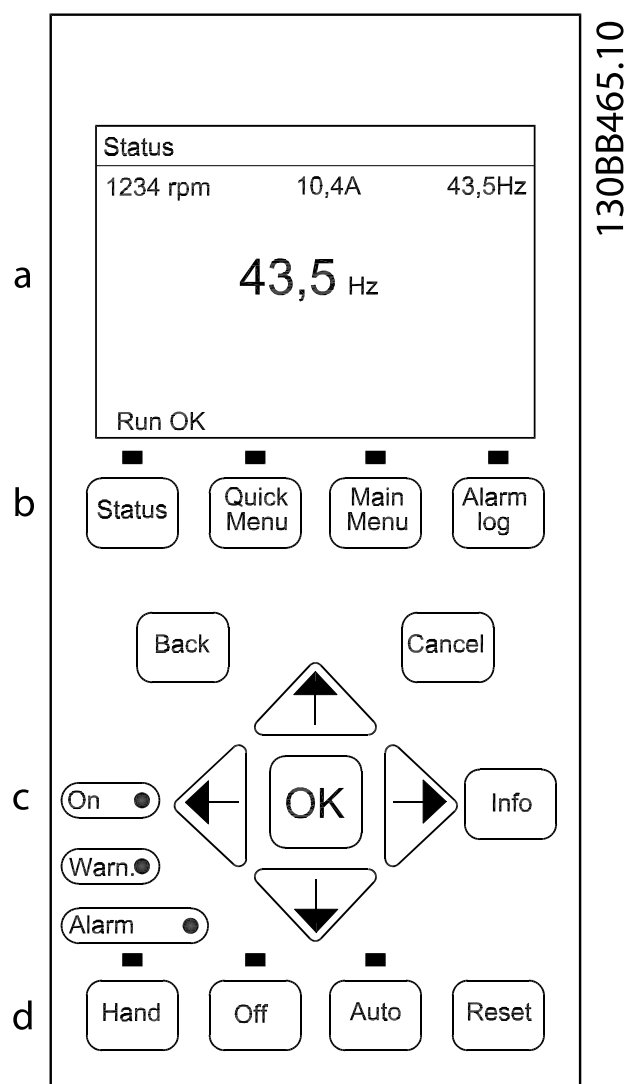


Illustration 4.1 Keypad

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

### 4.1.2 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 24V supply.

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

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

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

Table 4.1

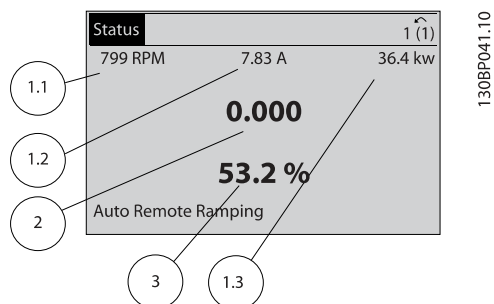


Illustration 4.2

### 4.1.3 Display Menu Keys

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



Illustration 4.3

Key	Function
<b>Status</b>	<p>Press to show operational information.</p> <ul style="list-style-type: none"> <li>• Press repeatedly to scroll through each status display</li> <li>• Press and hold [Status] plus [▲] or [▼] to adjust the display brightness</li> <li>• The symbol in the upper right corner of the display shows the direction of motor rotation and which set-up is active. This is not programmable.</li> </ul>
<b>Quick Menu</b>	<p>Allows access to programming parameters for initial set up instructions and many detailed application instructions.</p> <ul style="list-style-type: none"> <li>• Press to access <i>Quick Start</i> for sequenced instructions to program the basic frequency controller set up</li> <li>• Press to access <i>Trending</i> for realtime logging on keypad display.</li> <li>• Press to access <i>Parameter Data Check</i> for changes in parameter data set.</li> <li>• Follow the sequence of parameters as presented for the function set up</li> </ul>
<b>Main Menu</b>	<p>Allows access to all programming parameters.</p> <ul style="list-style-type: none"> <li>• Press twice to access top-level index</li> <li>• Press once to return to the last location accessed</li> <li>• Press and hold to enter a parameter number for direct access to that parameter</li> </ul>
<b>Alarm Log</b>	<p>Displays a list of current warnings, the last 10 alarms, and the maintenance log.</p> <ul style="list-style-type: none"> <li>• For details about the frequency converter before it entered the alarm mode, select the alarm number using the navigation keys and press [OK].</li> </ul>

Table 4.2

### 4.1.4 Navigation Keys

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

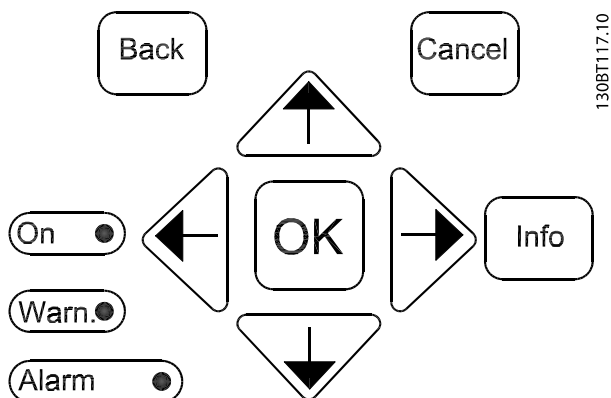


Illustration 4.4

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

Table 4.3

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

Table 4.4

### 4.1.5 Operation Keys

Operation keys are found at the bottom of the Keypad.

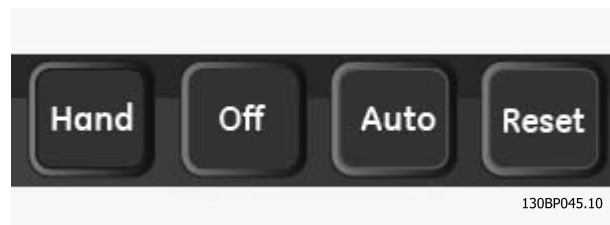


Illustration 4.5

Key	Function
<b>Hand</b>	Press to start the drive in local control. <ul style="list-style-type: none"> <li>Use the navigation keys to control drive speed</li> <li>An external stop signal by control input or serial communication overrides the local hand</li> </ul>
<b>Off</b>	Stops the motor but does not remove power to the drive.
<b>Auto</b>	Puts the system in remote operational mode. <ul style="list-style-type: none"> <li>Responds to an external start command by control terminals or serial communication</li> <li>Speed reference is from an external source</li> </ul>
<b>Reset</b>	Resets the drive manually after a fault has been cleared.

Table 4.5

## 4.2 Back Up and Copying Parameter Settings

Programming data is stored internally in the drive.

- The data can be up loaded into the Keypad memory as a storage back up
- Once stored in the Keypad, the data can be downloaded back into the drive
- Or 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.)
- Initialisation of the drive to restore factory default settings does not change data stored in the Keypad memory

**⚠ WARNING****UNINTENDED START!**

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

#### 4.2.1 Uploading Data to the Keypad

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

#### 4.2.2 Downloading Data from the Keypad

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

### 4.3 Restoring Default Settings

**CAUTION**

Initialisation restores the unit to factory default settings. Any programming, motor data, localization, and monitoring records will be lost. Uploading data to the Keypad provides a backup prior to initialisation.

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

- Initialisation using *H-03 Restore Factory Settings* does not change drive data such as operating hours, serial communication selections, personal

menu settings, fault log, alarm log, and other monitoring functions

- Using *H-03 Restore Factory Settings* is generally recommended
- Manual initialisation erases all motor, programming, localization, and monitoring data and restores factory default settings

#### 4.3.1 Recommended Initialisation

1. Press [Main Menu] twice to access parameters.
2. Scroll to *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 displayed.
9. Press [Reset] to return to operation mode.

#### 4.3.2 Manual Initialisation

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 initialisation does not reset the following drive information

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





# 5 About Frequency Converter Programming

## 5.1 Introduction

The drive is programmed for its application functions using parameters. Parameters are accessed by pressing either [Quick Menu] or [Main Menu] on the Keypad. (See 4 User Interface for details on using the Keypad function keys.) Parameters may also be accessed through a PC using the DCT-10.

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The quick menu is intended for initial start up. Data entered in a parameter can change the options available in the parameters following that entry.

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

## 5.2 Programming Example

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

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

This is a common pump or fan application.

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

1. *Parameter Data Set*
3. *Fundamental Parameters*

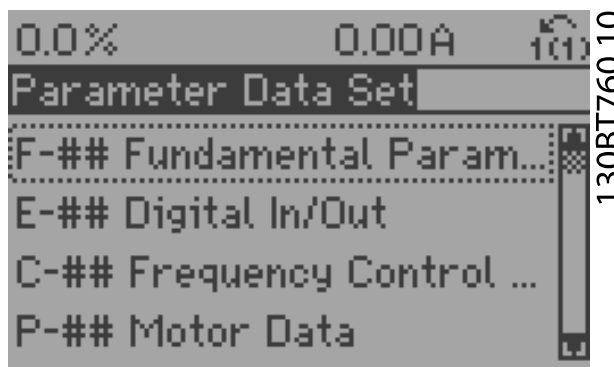


Illustration 5.1

4. *Extended References*

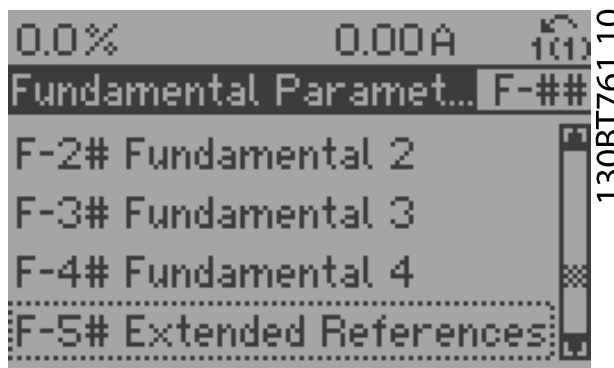


Illustration 5.2

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

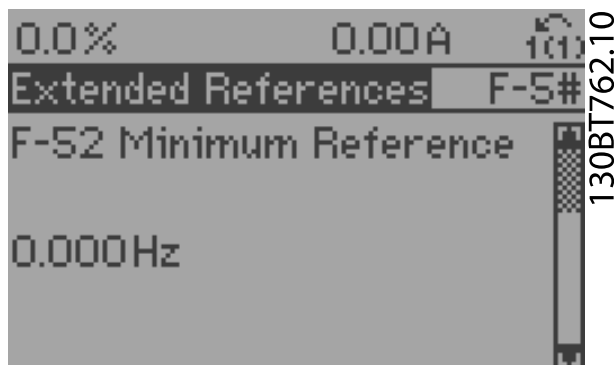


Illustration 5.3



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

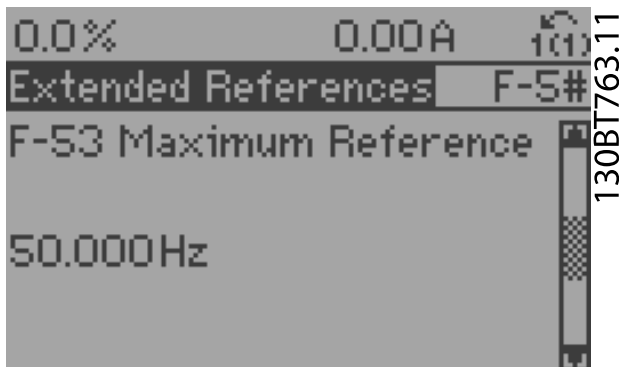


Illustration 5.4

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

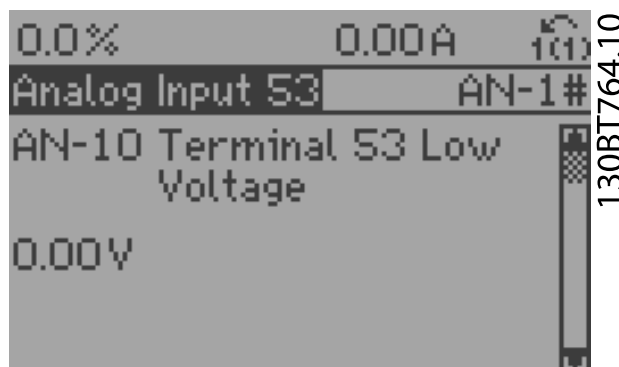


Illustration 5.7

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

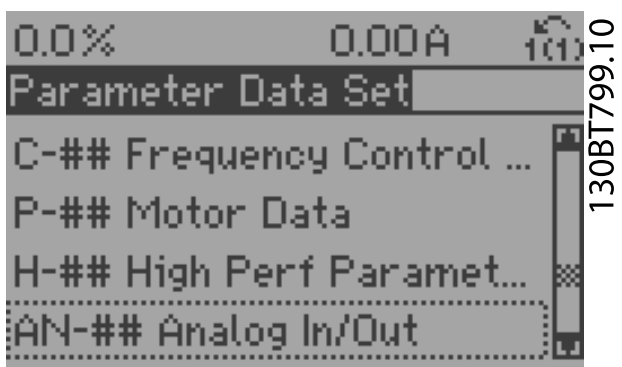


Illustration 5.5

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

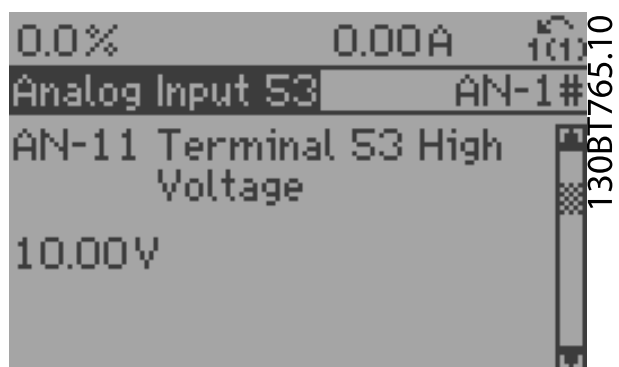


Illustration 5.8

- 8. Analog Input 53

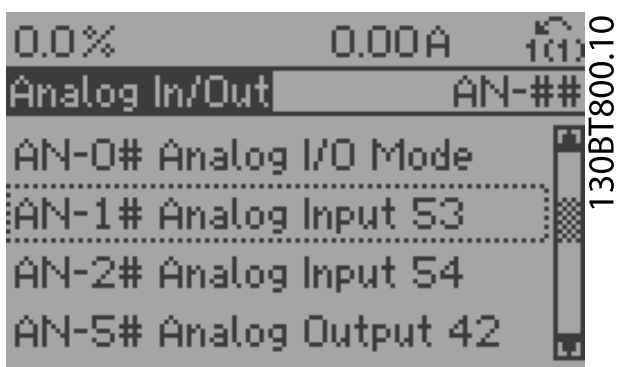


Illustration 5.6

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

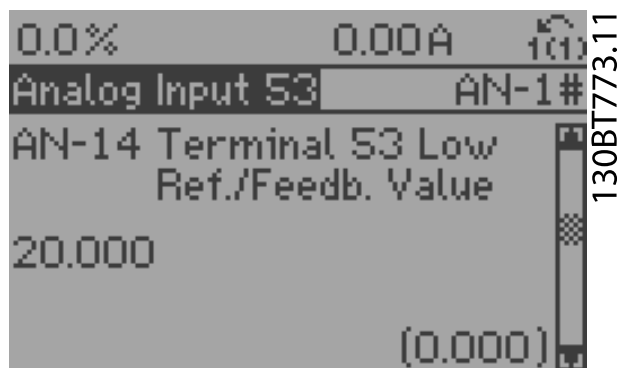


Illustration 5.9

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

- For proper drive functioning, the control terminals must be
  - Wired properly
  - Programmed for the intended function
  - Receiving a signal

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

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

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

5

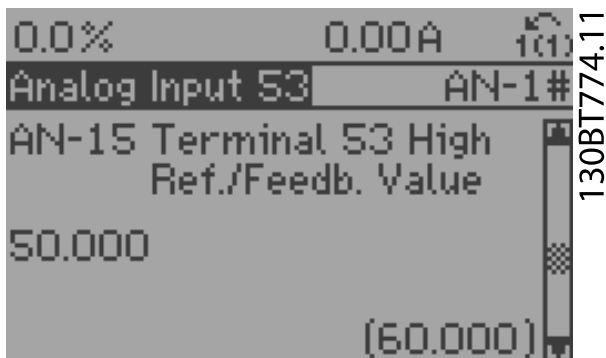


Illustration 5.10

With an external device providing a 0-10V control signal connected to drive terminal 53, the system is now ready for operation. Note that the scroll bar on the right in the last illustration of the display is at the bottom, indicating the procedure is complete.

Illustration 5.11 shows the wiring connections used to enable this set up.

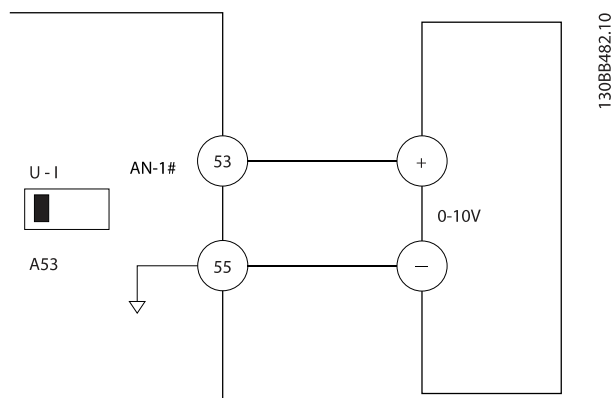


Illustration 5.11 Wiring Example for External Device Providing 0-10V Control Signal

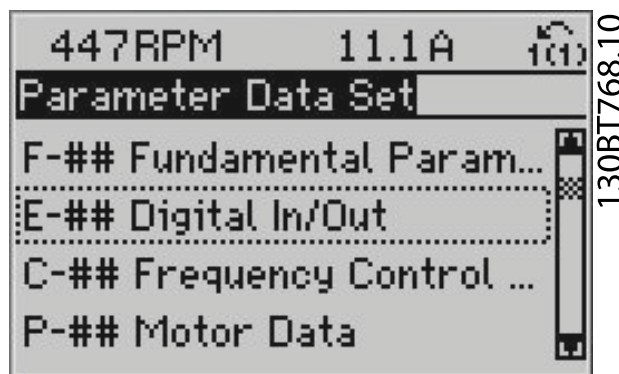


Illustration 5.12

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

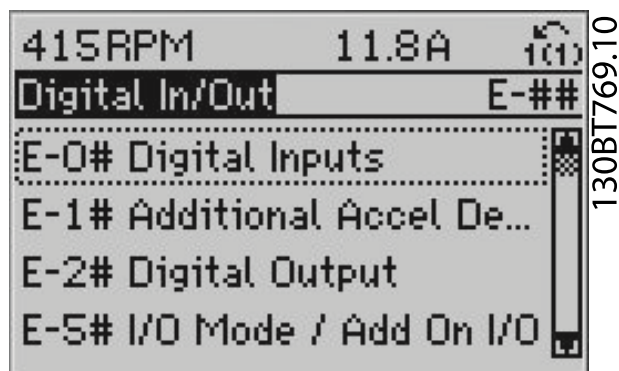


Illustration 5.13

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

### 5.3 Control Terminal Programming Examples

Control terminals can be programmed.

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

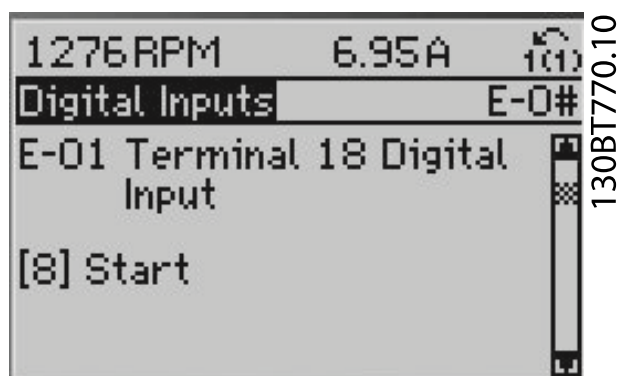


Illustration 5.14

### 5.4 International/North American Default Parameter Settings

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

Parameter	International default parameter value	North American default parameter value
K-03 Regional Settings	International	North America
P-07 Motor Power [kW]	See Note 1	See Note 1
P-02 Motor Power [HP]	See Note 2	See Note 2
F-05 Motor Rated Voltage	230V/400V/575V	208V/460V/575V
F-04 Base Frequency	50Hz	60Hz
F-53 Maximum Reference	50Hz	60Hz
F-54 Reference Function	Sum	External/Preset
F-17 Motor Speed High Limit [RPM] See Note 3 and 5	1500RPM	1800RPM
F-15 Motor Speed High Limit [Hz] See Note 4	50Hz	60Hz
F-03 Max Output Frequency 1	132Hz	120Hz
H-73 Warning Speed High	1500RPM	1800RPM
E-03 Terminal 27 Digital Input	Coast inverse	External interlock
E-24 Function Relay	No operation	No alarm

Parameter	International default parameter value	North American default parameter value
AN-15 Terminal 53 High Ref./Feedb. Value	50	60
AN-50 Terminal 42 Output	No operation	Speed 4-20mA
H-04 Auto-Reset (Times)	Manual reset	Infinite auto reset

Table 5.1 International/North American Default Parameter Settings

Note 1: P-07 Motor Power [kW] is only visible when K-03 Regional Settings is set to [0] International.

Note 2: P-02 Motor Power [HP], is only visible when K-03 Regional Settings is set to [1] North America.

Note 3: This parameter is only visible when K-02 Motor Speed Unit is set to [0] RPM.

Note 4: This parameter is only visible when K-02 Motor Speed Unit is set to [1] Hz.

Note 5: The default value depends on the number of motor poles. For a 4 poled motor the international default value is 1500RPM and for a 2 poled motor 3000RPM. The corresponding values for North America is 1800 and 3600RPM, respectively.

### 5.5 Parameter Data Check

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

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



## 5.6 Parameter Menu Structure

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

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







AN-31 Terminal X30/11 High Voltage	SP-43 Motor Cosphi	O-10 Control Word Profile	EN-20 Control Instance
AN-34 Term. X30/11 Low Ref./Feedb. Value	<b>SP-5# Environment</b>	O-13 Configurable Status Word STW	EN-21 Process Data Config Write
AN-35 Term. X30/11 High Ref./Feedb. Value	SP-50 RFI Filter	O-14 Configurable Control Word CTW	EN-22 Process Data Config Read
AN-36 Term. X30/11 Filter Time Constant	SP-51 DC Link Compensation	<b>O-3# Drive Port Settings</b>	EN-28 Store Data Values
<b>AN-4# Analog Input X30/12</b>	SP-52 Fan Operation	O-30 Protocol	EN-29 Store Data Values
AN-40 Terminal X30/12 Low Voltage	SP-53 Fan Monitor	O-31 Address	<b>EN-3# EtherNet/IP</b>
AN-41 Terminal X30/12 High Voltage	SP-55 Output Filter	O-32 Drive Port Baud Rate	EN-30 Warning Parameter K-11 Edit Set-up
AN-44 Term. X30/12 Low Ref./Feedb. Value	SP-56 Capacitance Output Filter	O-33 Drive port parity	EN-31 Net Reference
AN-45 Term. X30/12 High Ref./Feedb. Value	SP-57 Inductance Output Filter	O-34 Estimated cycle time	EN-32 Net Control
<b>AN-5# Analog Output X30/12</b>	SP-59 Actual Number of Inverter Units	O-35 Minimum Response Delay	EN-33 CIP Revision
AN-50 Terminal 42 Output	<b>SP-6# Automatic Derate</b>	O-36 Max Response Delay	EN-34 CIP Product Code
AN-51 Terminal 42 Output Min Scale	SP-63 Option Supplied by External 24VDC	O-37 Max Inter-Char Delay	EN-35 EDS Parameter
AN-52 Terminal 42 Output Max Scale	<b>SP-7# Additional ACC/DEC settings</b>	<b>O-4# Drive MC Port Settings</b>	EN-37 COS Inhibit Timer
AN-53 Terminal 42 Output Bus Control	SP-71 Accel Time 1 S-ramp Ratio at Accel.	O-40 Telegram Selection	<b>EN-4# Modbus TCP</b>
AN-54 Terminal 42 Output Timeout Preset	Start	O-41 Parameters for Signals	EN-40 Status Parameter
<b>AN-6# Analog Output X30/8</b>	SP-72 Accel Time 1 S-ramp Ratio at Decel.	O-42 PCD Write Configuration	EN-42 Slave Exception Message Count
AN-60 Terminal X30/8 Output	End	<b>O-5# Digital / Bus</b>	<b>EN-8# Other Ethernet Services</b>
AN-61 Terminal X30/8 Min. Scale	SP-74 Decel Time 1 S-ramp Ratio at Decel.	O-50 Coasting Select	EN-80 FTP Server
AN-62 Terminal X30/8 Max. Scale	End	O-51 Quick Stop Select	EN-81 HTTP Server
AN-63 Terminal X30/8 Bus Control	SP-76 Accel/Decel Time 2 Type	O-52 DC Brake Select	EN-82 SMTP Service
AN-64 Terminal X30/8 Output Timeout Preset	SP-79 Accel Time 2 S-ramp Ratio at Accel.	O-53 Start Select	EN-89 Transparent Socket Channel Port
<b>AN-7# Analog Output X45/1</b>	Start	O-54 Reversing Select	<b>EN-9# Advanced Ethernet Services</b>
AN-70 Terminal X45/1 Output	SP-80 Accel Time 2 S-ramp Ratio at Accel.	O-55 Set-up Select	EN-90 Cable Diagnostic
AN-71 Terminal X45/1 Min. Scale	End	O-56 Preset Reference Select	EN-91 MDI-X
AN-72 Terminal X45/1 Max. Scale	SP-81 Decel Time 2 S-ramp Ratio at Decel.	O-57 Profidrive OFF2 Select	EN-92 IGMP Snooping
AN-73 Terminal X45/1 Bus Control	Start	O-58 Profidrive OFF3 Select	EN-93 Cable Error Length
AN-74 Terminal X45/1 Output Timeout Preset	SP-82 Decel Time 2 S-ramp Ratio at Decel.	<b>O-8# Drive Port Diagnostics</b>	EN-94 Broadcast Storm Protection
<b>AN-8# Analog Output X45/3</b>	End	O-80 Bus Message Count	EN-95 Broadcast Storm Filter
AN-80 Terminal X45/3 Output	SP-84 Accel/Decel Ramp 3 Type	O-81 Bus Error Count	EN-96 Port Mirroring
AN-81 Terminal X45/3 Min. Scale	SP-87 Accel Time 3 S-ramp Ratio at Accel.	O-82 Slave Messages Rcvd	EN-99 Media Counters
AN-82 Terminal X45/3 Max. Scale	Start	O-83 Slave Error Count	<b>EC-1# Inc. Enc. Interface</b>
AN-83 Terminal X45/3 Bus Control	SP-88 Accel Time 3 S-ramp Ratio at Accel.	<b>O-9# Bus Jog / Feedback</b>	EC-10 Signal Type
AN-84 Terminal X45/3 Output Timeout Preset	End	O-90 Bus Jog 1 Speed	EC-11 Resolution (PPR)
<b>SP-# Special Functions</b>	SP-89 Decel Time 3 S-ramp Ratio at Decel.	End	<b>EC-2# Abs. Enc. Interface</b>
<b>SP-0# Fault Settings</b>	Start	<b>DN-# DeviceNet Fieldbus</b>	EC-20 Protocol Selection
SP-00 Fault Level	SP-90 Decel Time 3 S-ramp Ratio at Decel.	<b>DN-0# Common Settings</b>	EC-21 Resolution (Positions/Rev)
<b>SP-1# Line On/Off</b>	End	DN-00 DeviceNet Protocol	EC-24 SSI Data Length
SP-10 Line failure	SP-92 Accel/Decel Ramp 4 Type	DN-01 Baud Rate Select	EC-25 Clock Rate
SP-11 Line Voltage at Input Fault	SP-95 Accel Time 4 S-ramp Ratio at Accel.	DN-02 MAC ID	EC-26 SSI Data Format
SP-12 Function at Line Imbalance	Start	DN-05 MAC ID	EC-34 HIPERFACE Baudrate
<b>SP-2# Reset Functions</b>	SP-96 Accel Time 4 S-ramp Ratio at Accel.	DN-06 Readout Transmit Error Counter	<b>EC-6# Monitoring and App.</b>
SP-23 Typecode Setting	End	<b>DN-1# DeviceNet</b>	EC-60 Feedback Direction
SP-24 Trip Delay at Current Limit	SP-97 Decel Time 4 S-ramp Ratio at Decel.	DN-10 Process Data Type Selection	EC-61 Feedback Signal Monitoring
SP-25 Trip Delay at Torque Limit	Start	DN-11 Process Data Config Write	<b>RS-# Resolver Interface</b>
SP-26 Trip Delay at Drive Fault	End	DN-12 Process Data Config Read	RS-50 Poles
SP-28 Production Settings	<b>O-# Options / Comms</b>	DN-13 Warning Parameter	RS-51 Input Voltage
SP-29 Service Code	<b>O-0# General Settings</b>	DN-14 Net Reference	RS-52 Input Frequency
<b>SP-3# Current Limit Crf.</b>	O-01 Control Site	DN-15 Net Control	RS-53 Transformation Ratio
SP-30 Current Lim Contr, Proportional Gain	O-02 Control Word Source	DN-18 internal_process_data_config_write	RS-59 Resolver Interface
SP-31 Current Lim Contr, Integration Time	O-03 Control Word Timeout Time	DN-19 internal_process_data_config_read	<b>Parameter Data Check</b>
SP-32 Current Lim Ctr, Filter Time	O-04 Control Word Timeout Function	<b>DN-2# COS Filters</b>	Last 10 Changes
SP-35 Stall Protection	O-05 End-of-Timeout Function	DN-20 COS Filter 1	<b>Since Factory Setting</b>
<b>SP-4# Energy Savings</b>	O-06 Reset Control Word Timeout	DN-21 COS Filter 2	Drive Information
SP-40 VT Level	O-07 Diagnosis Trigger	DN-22 COS Filter 3	Operating Data
SP-41 Energy Savings Min. Magnetisation	O-08 Readout Filtering	DN-23 COS Filter 4	ID-0#
SP-42 Energy Savings Min. Frequency	<b>O-1# Control Settings</b>	<b>DN-3# Parameter Access</b>	ID-00
		DN-30 Array Index	Operating Hours



About Frequency Converter P...

AF-650 GP Operating Instructions

ID-01	Running Hours	DR-86	Drive Port REF 1	PI-09	Wobble Random Function
ID-02	kWh Counter	DR-90	internal_ProfibusPCD_Config_Write	PI-10	Wobble Ratio
ID-03	Power Up's	DR-91	internal_ProfibusPCD_Config_Read	PI-11	Wobble Random Ratio Max.
ID-04	Over Temp's	DR-92	Diagnosis Readouts	PI-12	Wobble Random Ratio Min.
ID-05	Over Volt's	DR-93	Alarm Word	PI-13	Wobble Delta Freq. Scaled
ID-06	Reset kWh Counter	DR-94	Alarm Word 2	PI-14	Wobble Delta Freq. Scaled
ID-07	Reset Running Hours Counter	DR-95	Warning Word	PI-15	Wobble Delta Freq. Scaled
ID-08	Data Trending Settings	DR-96	Warning Word 2	PI-16	Wobble Delta Freq. Scaled
ID-09	Trending Source	DR-97	Torque [Nm]	PI-17	Wobble Delta Freq. Scaled
ID-10	Trending Interval	DR-98	Ext. Status Word	PI-18	Wobble Delta Freq. Scaled
ID-11	Trigger Event	DR-99	Ext. Status Word	PI-19	Wobble Delta Freq. Scaled
ID-12	Trigger Invert	DR-100	Adv Parameter Data Set	PI-20	Wobble Delta Freq. Scaled
ID-13	Trending Mode	DR-101	Logic Controller	PI-21	Wobble Delta Freq. Scaled
ID-14	Samples Before Trigger	DR-102	LC Settings	PI-22	Wobble Delta Freq. Scaled
ID-15	Historic Log: Event	DR-103	Logic Controller Mode	PI-23	Wobble Delta Freq. Scaled
ID-16	Historic Log: Value	DR-104	Start Event	PI-24	Wobble Delta Freq. Scaled
ID-17	Historic Log: Time	DR-105	Stop Event	PI-25	Wobble Delta Freq. Scaled
ID-18	Alarm Log	DR-106	Reset Logic Controller	PI-26	Wobble Delta Freq. Scaled
ID-19	Fault Log: Error Code	DR-107	Comparators	PI-27	Wobble Delta Freq. Scaled
ID-20	Fault Log: Value	DR-108	LC-1# Comparator Operand	PI-28	Wobble Delta Freq. Scaled
ID-21	Fault Log: Time	DR-109	LC-11 Comparator Operator	PI-29	Wobble Delta Freq. Scaled
ID-22	Historic Log: Error Code	DR-110	LC-12 Comparator Value	PI-30	Wobble Delta Freq. Scaled
ID-23	Historic Log: Value	DR-111	Timers	PI-31	Wobble Delta Freq. Scaled
ID-24	Historic Log: Time	DR-112	LC-2# Drive Nominal Current	PI-32	Wobble Delta Freq. Scaled
ID-25	Drive Identification	DR-113	LC-20 Logic Controller Timer	PI-33	Wobble Delta Freq. Scaled
ID-26	Drive Type	DR-114	LC-4# Logic Rules	PI-34	Wobble Delta Freq. Scaled
ID-27	Power Section	DR-115	LC-40 Logic Rule Boolean 1	PI-35	Wobble Delta Freq. Scaled
ID-28	Drive ID	DR-116	LC-41 Logic Rule Boolean 1	PI-36	Wobble Delta Freq. Scaled
ID-29	Software Version	DR-117	LC-42 Logic Rule Boolean 2	PI-37	Wobble Delta Freq. Scaled
ID-30	GE Product No.	DR-118	LC-43 Logic Rule Operator 1	PI-38	Wobble Delta Freq. Scaled
ID-31	Power Card Ordering No	DR-119	LC-44 Logic Rule Operator 2	PI-39	Wobble Delta Freq. Scaled
ID-32	Keypad ID Number	DR-120	LC-44 Logic Rule Boolean 3	PI-40	Wobble Delta Freq. Scaled
ID-33	SW ID Control Card	DR-121	States	PI-41	Wobble Delta Freq. Scaled
ID-34	SW ID Power Card	DR-122	LC-51 Logic Controller Event	PI-42	Wobble Delta Freq. Scaled
ID-35	Drive Serial Number	DR-123	LC-52 Logic Controller Action	PI-43	Wobble Delta Freq. Scaled
ID-36	Power Card Serial Number	DR-124	B-# Braking Functions	PI-44	Wobble Delta Freq. Scaled
ID-37	Option Ident	DR-125	B-0# DC-Brake	PI-45	Wobble Delta Freq. Scaled
ID-38	Option Mounted	DR-126	B-00 DC Hold Current	PI-46	Wobble Delta Freq. Scaled
ID-39	Option SW Version	DR-127	B-01 DC Brake Current	PI-47	Wobble Delta Freq. Scaled
ID-40	Option Ordering No	DR-128	B-02 DC Braking Time	PI-48	Wobble Delta Freq. Scaled
ID-41	Option Serial No	DR-129	B-03 DC Brake Cut In Speed [RPM]	PI-49	Wobble Delta Freq. Scaled
ID-42	Option in Slot A	DR-130	B-04 DC Brake Cut In Speed [Hz]	PI-50	Wobble Delta Freq. Scaled
ID-43	Option in Slot B	DR-131	B-05 Maximum Reference	PI-51	Wobble Delta Freq. Scaled
ID-44	Option SW Version	DR-132	B-1# Brake Energy Funct.	PI-52	Wobble Delta Freq. Scaled
ID-45	Option in Slot C	DR-133	B-10 Brake Function	PI-53	Wobble Delta Freq. Scaled
ID-46	Option SW Version	DR-134	B-12 Brake Power Limit (kW)	PI-54	Wobble Delta Freq. Scaled
ID-47	Option in Slot D	DR-135	B-13 Braking Thermal Overload	PI-55	Wobble Delta Freq. Scaled
ID-48	Option SW Version	DR-136	B-15 Brake Check	PI-56	Wobble Delta Freq. Scaled
ID-49	Option in Slot E	DR-137	B-16 AC brake Max. Current	PI-57	Wobble Delta Freq. Scaled
ID-50	Option SW Version	DR-138	B-17 Over-voltage Control	PI-58	Wobble Delta Freq. Scaled
ID-51	Option in Slot F	DR-139	B-18 Brake Check Condition	PI-59	Wobble Delta Freq. Scaled
ID-52	Option SW Version	DR-140	B-19 Over-voltage Gain	PI-60	Wobble Delta Freq. Scaled
ID-53	Option in Slot G	DR-141	B-2# Mechanical Brake	PI-61	Wobble Delta Freq. Scaled
ID-54	Option SW Version	DR-142	B-20 Release Brake Current	PI-62	Wobble Delta Freq. Scaled
ID-55	Option in Slot H	DR-143	B-21 Activate Brake Speed [RPM]	PI-63	Wobble Delta Freq. Scaled
ID-56	Option SW Version	DR-144	B-22 Activate Brake Speed [Hz]	PI-64	Wobble Delta Freq. Scaled
ID-57	Option in Slot I	DR-145	B-23 Activate Brake Delay	PI-65	Wobble Delta Freq. Scaled
ID-58	Option SW Version	DR-146	B-24 Stop Delay	PI-66	Wobble Delta Freq. Scaled
ID-59	Option in Slot J	DR-147	B-25 Brake Release Time	PI-67	Wobble Delta Freq. Scaled
ID-60	Option SW Version	DR-148	B-26 Torque Ref	PI-68	Wobble Delta Freq. Scaled
ID-61	Option in Slot K	DR-149	B-27 Torque Ramp Time	PI-69	Wobble Delta Freq. Scaled
ID-62	Option SW Version	DR-150	B-28 Gain Boost Factor	PI-70	Wobble Delta Freq. Scaled
ID-63	Option in Slot L	DR-151	DR-8# Fieldbus & Drive Port	PI-71	Wobble Delta Freq. Scaled
ID-64	Option SW Version	DR-152	DR-80 Fieldbus CTW 1	PI-72	Wobble Delta Freq. Scaled
ID-65	Option in Slot M	DR-153	DR-80 Fieldbus REF 1	PI-73	Wobble Delta Freq. Scaled
ID-66	Option SW Version	DR-154	DR-84 Comm. Option STW	PI-74	Wobble Delta Freq. Scaled
ID-67	Option in Slot N	DR-155	DR-85 Drive Port CTW 1	PI-75	Wobble Delta Freq. Scaled
ID-68	Option SW Version	DR-156	DR-85 Drive Port CTW 1	PI-76	Wobble Delta Freq. Scaled
ID-69	Option in Slot O	DR-157	DR-85 Drive Port CTW 1	PI-77	Wobble Delta Freq. Scaled
ID-70	Option SW Version	DR-158	DR-85 Drive Port CTW 1	PI-78	Wobble Delta Freq. Scaled
ID-71	Option in Slot P	DR-159	DR-85 Drive Port CTW 1	PI-79	Wobble Delta Freq. Scaled
ID-72	Option SW Version	DR-160	DR-85 Drive Port CTW 1	PI-80	Wobble Delta Freq. Scaled
ID-73	Option in Slot Q	DR-161	DR-85 Drive Port CTW 1	PI-81	Wobble Delta Freq. Scaled
ID-74	Option SW Version	DR-162	DR-85 Drive Port CTW 1	PI-82	Wobble Delta Freq. Scaled
ID-75	Option in Slot R	DR-163	DR-85 Drive Port CTW 1	PI-83	Wobble Delta Freq. Scaled
ID-76	Option SW Version	DR-164	DR-85 Drive Port CTW 1	PI-84	Wobble Delta Freq. Scaled
ID-77	Option in Slot S	DR-165	DR-85 Drive Port CTW 1	PI-85	Wobble Delta Freq. Scaled
ID-78	Option SW Version	DR-166	DR-85 Drive Port CTW 1	PI-86	Wobble Delta Freq. Scaled
ID-79	Option in Slot T	DR-167	DR-85 Drive Port CTW 1	PI-87	Wobble Delta Freq. Scaled
ID-80	Option SW Version	DR-168	DR-85 Drive Port CTW 1	PI-88	Wobble Delta Freq. Scaled
ID-81	Option in Slot U	DR-169	DR-85 Drive Port CTW 1	PI-89	Wobble Delta Freq. Scaled
ID-82	Option SW Version	DR-170	DR-85 Drive Port CTW 1	PI-90	Wobble Delta Freq. Scaled
ID-83	Option in Slot V	DR-171	DR-85 Drive Port CTW 1	PI-91	Wobble Delta Freq. Scaled
ID-84	Option SW Version	DR-172	DR-85 Drive Port CTW 1	PI-92	Wobble Delta Freq. Scaled
ID-85	Option in Slot W	DR-173	DR-85 Drive Port CTW 1	PI-93	Wobble Delta Freq. Scaled
ID-86	Option SW Version	DR-174	DR-85 Drive Port CTW 1	PI-94	Wobble Delta Freq. Scaled
ID-87	Option in Slot X	DR-175	DR-85 Drive Port CTW 1	PI-95	Wobble Delta Freq. Scaled
ID-88	Option SW Version	DR-176	DR-85 Drive Port CTW 1	PI-96	Wobble Delta Freq. Scaled
ID-89	Option in Slot Y	DR-177	DR-85 Drive Port CTW 1	PI-97	Wobble Delta Freq. Scaled
ID-90	Option SW Version	DR-178	DR-85 Drive Port CTW 1	PI-98	Wobble Delta Freq. Scaled
ID-91	Option in Slot Z	DR-179	DR-85 Drive Port CTW 1	PI-99	Wobble Delta Freq. Scaled
ID-92	Option SW Version	DR-180	DR-85 Drive Port CTW 1	PI-100	Wobble Delta Freq. Scaled
ID-93	Option in Slot AA	DR-181	DR-85 Drive Port CTW 1	PI-101	Wobble Delta Freq. Scaled
ID-94	Option SW Version	DR-182	DR-85 Drive Port CTW 1	PI-102	Wobble Delta Freq. Scaled
ID-95	Option in Slot AB	DR-183	DR-85 Drive Port CTW 1	PI-103	Wobble Delta Freq. Scaled
ID-96	Option SW Version	DR-184	DR-85 Drive Port CTW 1	PI-104	Wobble Delta Freq. Scaled
ID-97	Option in Slot AC	DR-185	DR-85 Drive Port CTW 1	PI-105	Wobble Delta Freq. Scaled
ID-98	Option SW Version	DR-186	DR-85 Drive Port CTW 1	PI-106	Wobble Delta Freq. Scaled
ID-99	Option in Slot AD	DR-187	DR-85 Drive Port CTW 1	PI-107	Wobble Delta Freq. Scaled
ID-100	Option SW Version	DR-188	DR-85 Drive Port CTW 1	PI-108	Wobble Delta Freq. Scaled





## 5.7 Remote Programming with DCT-10

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

The USB connector or RS-485 terminal are available for connecting to the drive.

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For more details please go to [www.geelectrical.com/drives](http://www.geelectrical.com/drives)



## 6 Application Set-Up Examples

### 6.1 Introduction

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

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

### 6.2 Application Examples

FC		Parameters	
		Function	Setting
+24 V	12		
+24 V	13		
D IN	18	AN-10 Terminal	
D IN	19	53 Low Voltage	0.07V*
COM	20	AN-11 Terminal	
D IN	27	53 High Voltage	10V*
D IN	29	AN-14 Terminal	
D IN	32	53 Low Ref./	
D IN	33	Feedb. Value	
D IN	37	AN-15 Terminal	
D IN	37	53 High Ref./	1500RPM
D IN	37	Feedb. Value	
* = Default Value		Notes/comments:	

Table 6.1 Analog Speed Reference (Voltage)

FC		Parameters	
		Function	Setting
+24 V	12		
+24 V	13		
D IN	18	AN-12 Terminal	
D IN	19	53 Low Current	4mA*
COM	20	AN-13 Terminal	
D IN	27	53 High Current	20mA*
D IN	29	AN-14 Terminal	
D IN	32	53 Low Ref./	
D IN	33	Feedb. Value	ORPM
D IN	37	AN-15 Terminal	
D IN	37	53 High Ref./	1500RPM
D IN	37	Feedb. Value	
* = Default Value		Notes/comments:	

Table 6.2 Analog Speed Reference (Current)

FC		Parameters	
		Function	Setting
+24 V	12		
+24 V	13		
D IN	18	E-01 Terminal 18	[8] Start*
D IN	19	Digital Input	
COM	20	E-07 Terminal 37	
D IN	27	Safe Stop	[1] Safe Stop
D IN	29	Safe Stop	Alarm
* = Default Value		Notes/comments:	

Table 6.3 Start/Stop Command with Safe Stop

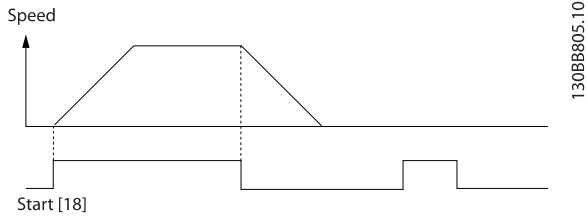


Illustration 6.1

		Parameters	
FC		Function	Setting
+24 V	12		
+24 V	13		
D IN	18	E-01 Terminal 18 Digital Input	[9] Latched Start
D IN	19	E-03 Terminal 27 Digital Input	[6] Stop Inverse
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	37		
* = Default Value			
Notes/comments:			
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

Table 6.4 Pulse Start/Stop

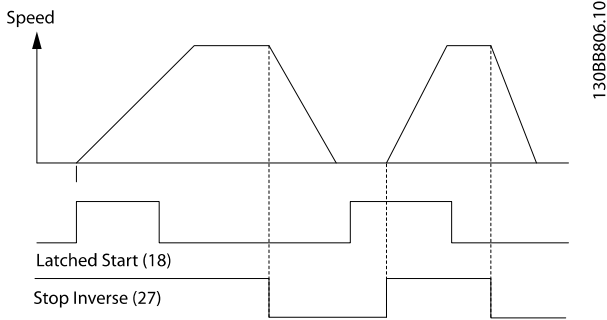


Illustration 6.2

		Parameters	
FC		Function	Setting
+24 V	12		
+24 V	13		
D IN	18	E-01 Terminal 18 Digital Input	[8] Start
D IN	19	E-02 Terminal 19 Digital Input	[10] Reversing*
COM	20		
D IN	27		
D IN	29		
D IN	32	E-05 Terminal 32 Digital Input	[16] Preset ref bit 0
D IN	33	E-06 Terminal 33 Digital Input	[17] Preset ref bit 1
D IN	37		
+10 V	50		
A IN	53	C-05 Multi-step Frequency 1 - 8	
A IN	54	Preset ref. 0	25%
COM	55	Preset ref. 1	50%
A OUT	42	Preset ref. 2	75%
COM	39	Preset ref. 3	100%
* = Default Value			
Notes/comments:			

Table 6.5 Start/Stop with Reversing and 4 Preset Speeds

		Parameters	
FC		Function	Setting
+24 V	12		
+24 V	13		
D IN	18		
D IN	19	E-02 Terminal 19 Digital Input	[1] Reset
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	37		
* = Default Value			
Notes/comments:			
+10 V	50		
A IN	53		
A IN	54		
COM	55		
A OUT	42		
COM	39		

Table 6.6 External Alarm Reset



Application Set-Up Examples

AF-650 GP Operating Instructions

FC		Parameters		
		Function	Setting	
+24 V	12	130BB683.10	AN-10 Terminal 53 Low Voltage	0.07V*
+24 V	13		AN-11 Terminal 53 High Voltage	10V*
D IN	18		AN-14 Terminal 53 Low Ref./ Feedb. Value	ORPM
D IN	19		AN-15 Terminal 53 High Ref./ Feedb. Value	1500RPM
COM	20		* = Default Value	
D IN	27		Notes/comments:	
D IN	29			
D IN	32			
D IN	33			
D IN	37			
D IN	37			
+10 V	50	Notes/comments:		
A IN	53			
A IN	54			
COM	55			
A OUT	42			
COM	39			

Table 6.7 Speed Reference (using a manual potentiometer)

FC		Parameters		
		Function	Setting	
+24 V	12	130BB804.10	E-01 Terminal 18 Digital Input	[8] Start*
+24 V	13		E-03 Terminal 27 Digital Input	[19] Freeze Reference
D IN	18		E-04 Terminal 29 Digital Input	[21] Speed Up
D IN	19		E-05 Terminal 32 Digital Input	[22] Speed Down
COM	20		* = Default Value	
D IN	27	Notes/comments:		
D IN	29			
D IN	32			
D IN	33			
D IN	37			
D IN	37			
+10 V	50	Notes/comments:		
A IN	53			
A IN	54			
COM	55			
A OUT	42			
COM	39			

Table 6.8 Speed Up/Down

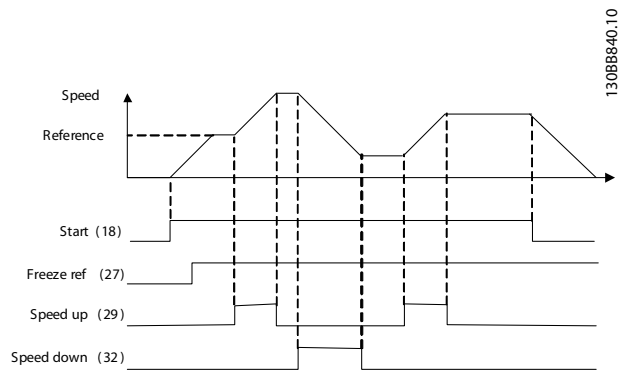


Illustration 6.3

FC		Parameters		
		Function	Setting	
+24 V	12	130BB685.10	O-30 Protocol	Modbus*
+24 V	13		O-31 Address	1*
D IN	18		O-32 Drive Port Baud Rate	9600*
D IN	19		* = Default Value	
COM	20		Notes/comments:	
D IN	27			
D IN	29			
D IN	32			
D IN	33			
D IN	37			
+10 V	50	Notes/comments:		
A IN	53			
A IN	54			
COM	55			
A OUT	42			
COM	39			

Table 6.9 RS-485 Network Connection



# CAUTION

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

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		Parameters	
FC		Function	Setting
+24 V	12	130B8686.11	F-10 Electronic Overload
+24 V	13		
D IN	18		
D IN	19		
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	37		
+10 V	50	F-12 Motor Thermistor Input	[1] Analog input 53
A IN	53	* = Default Value	
A IN	54	<b>Notes/comments:</b> If only a warning is desired, F-10 Electronic Overload should be set to [1] Thermistor warning.	
COM	55		
A OUT	42		
COM	39		

Table 6.10 Motor Thermistor

		Parameters	
FC		Function	Setting
+24 V	12	130B8686.11	H-20 Motor Feedback Loss Function
+24 V	13		
D IN	18		
D IN	19		
COM	20		
D IN	27		
D IN	29		
D IN	32		
D IN	33		
D IN	37		
+10 V	50	LC-00 Logic Controller Mode	[1] On
A IN	53	LC-01 Start Event	[19] Warning
A IN	54	LC-02 Stop Event	[44] Reset key
COM	55	LC-10 Comparator Operand	[21] Warning no.
A OUT	42	LC-11 Comparator Operator	[1] ≈*
COM	39	LC-12 Comparator Value	90
		LC-51 Logic Controller Event	[22] Comparator 0
		LC-52 Logic Controller Action	[32] Set digital out A low
		E-24 Function Relay	[80] Logic Controller digital output A
* = Default Value			
<b>Notes/comments:</b> If the limit in the feedback monitor is exceeded, Warning 90 will be issued. The monitors Warning 90 and in the case that Warning 90 becomes TRUE then Relay 1 is triggered. External equipment may then indicate that service may be required. If the feedback error goes below the limit again within 5 sec. then the drive continues and the warning disappears. But Relay 1 will still be triggered until [Reset] on the Keypad.			

Table 6.11 Using Logic Controller to Set a Relay



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

Table 6.12 Mechanical Brake Control

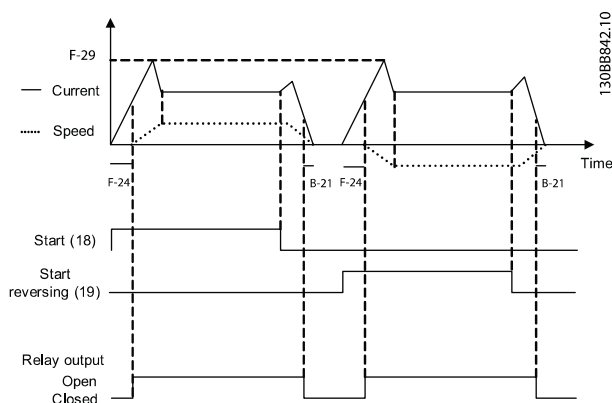


Illustration 6.4

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

To have a HOA system with an external 0-10V potentiometer for the hand reference and a 4-20mA signal for the auto reference, 2 set-ups should be used. In this example set-up 1 is used for the hand mode and set-up 2 for the auto mode. Analog input 53 is used for the hand reference (0-10V potentiometer) and analog input 54 for the auto reference (4-20mA) and digital input 27 for the set-up

selector. Please ensure that the analog inputs have the correct dip settings (A-53 [U] and A-54 [I]).

In the upper right corner of the keypad 2 numbers are shown – like 1(1). The number outside the parenthesis is the active set-up and the number inside the parenthesis is the set-up which will be edited. Default will always be 1(1). Make sure you edit set-up 1.

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





## 7 Status Messages

### 7.1 Status Display

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

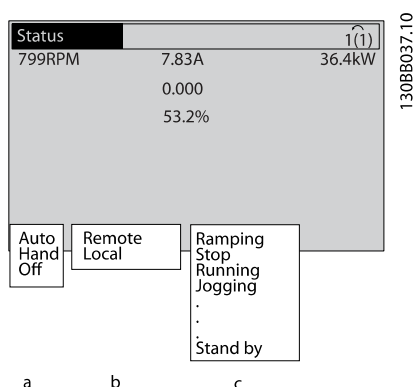


Illustration 7.1 Status Display

- The first word on the status line indicates where the stop/start command originates.
- The second word on the status line indicates where the speed control originates.
- The last part of the status line gives the present drive status. These show the operational mode the drive is in.

#### NOTE

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

### 7.2 Status Message Definitions Table

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

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

Table 7.1

	Reference site
Remote	The speed reference is given from external signals, serial communication, or internal preset references.
Local	The frequency converter uses [Hand] control or reference values from the Keypad.

Table 7.2

	Operation status
AC Brake	AC Brake was selected in <i>B-10 Brake Function</i> . The AC brake over-magnetizes the motor to achieve a controlled slow down.
Auto Tune finish OK	Auto Tune was carried out successfully.
Auto Tune ready	Auto Tune is ready to start. Press [Hand] to start.
Auto Tune running	Auto Tune process is in progress.
Braking	The brake chopper is in operation. Generative energy is absorbed by the brake resistor.
Braking max.	The brake chopper is in operation. The power limit for the brake resistor defined in <i>B-12 Brake Power Limit (kW)</i> is reached.
Coast	<ul style="list-style-type: none"> <li>Coast inverse was selected as a function for a digital input (parameter group E-0#). The corresponding terminal is not connected.</li> <li>Coast activated by serial communication</li> </ul>





Status Messages

AF-650 GP Operating Instructions

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	Operation status
Ctrl. Ramp	Control Ramp was selected in <i>SP-10 Line failure</i> . <ul style="list-style-type: none"> <li>The mains voltage is below the value set in <i>SP-11 Line Voltage at Input Fault</i> at mains fault</li> <li>The frequency converter ramps down the motor using a controlled ramp</li> </ul>
Current High	The frequency converter output current is above the limit set in <i>H-71 Warning Current High</i> .
Current Low	The frequency converter output current is below the limit set in <i>H-70 Warning Current Low</i>
DC Hold	DC hold is selected in <i>H-80 Function at Stop</i> and a stop command is active. The motor is held by a DC current set in <i>B-00 DC Hold Current</i> .
DC Stop	The motor is held with a DC current ( <i>B-01 DC Brake Current</i> ) for a specified time ( <i>B-02 DC Braking Time</i> ). <ul style="list-style-type: none"> <li>DC Brake is activated in <i>B-03 DC Brake Cut In Speed [RPM]</i> and a Stop command is active.</li> <li>DC Brake (inverse) is selected as a function for a digital input (parameter group E-0#). The corresponding terminal is not active.</li> <li>The DC Brake is activated via serial communication.</li> </ul>
Feedback high	The sum of all active feedbacks is above the feedback limit set in <i>H-77 Warning Feedback High</i> .
Feedback low	The sum of all active feedbacks is below the feedback limit set in <i>H-76 Warning Feedback Low</i> .
Freeze output	The remote reference is active which holds the present speed. <ul style="list-style-type: none"> <li>Freeze output was selected as a function for a digital input (parameter group E-0#). The corresponding terminal is active. Speed control is only possible via the terminal functions speed up and speed down.</li> <li>Hold ramp is activated via serial communication.</li> </ul>
Freeze output request	A freeze output command has been given, but the motor will remain stopped until a run permissive signal is received.

	Operation status
Freeze ref.	<i>Freeze Reference</i> was chosen as a function for a digital input (parameter group E-0#). The corresponding terminal is active. The frequency converter saves the actual reference. Changing the reference is now only possible via terminal functions speed up and speed down.
Jog request	A jog command has been given, but the motor will be stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in <i>C-21 Jog Speed [RPM]</i> . <ul style="list-style-type: none"> <li><i>Jog</i> was selected as function for a digital input (parameter group E-0#). The corresponding terminal (e.g. Terminal 29) is active.</li> <li>The Jog function is activated via the serial communication.</li> <li>The Jog function was selected as a reaction for a monitoring function (e.g. No signal). The monitoring function is active.</li> </ul>
Motor check	In <i>H-80 Function at Stop, Motor Check</i> was selected. A stop command is active. To ensure that a motor is connected to the frequency converter, a permanent test current is applied to the motor.
OVC control	<i>Overvoltage control</i> was activated in <i>B-17 Overvoltage Control</i> . The connected motor is supplying the frequency converter with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.
PowerUnit Off	(For frequency converters with an external 24V power supply installed only.) Mains supply to the frequency converter is removed, but the control card is supplied by the external 24V.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). <ul style="list-style-type: none"> <li>To avoid tripping, switching frequency is reduced to 4kHz.</li> <li>If possible, protection mode ends after approximately 10sec.</li> <li>Protection mode can be restricted in <i>SP-26 Trip Delay at Drive Fault</i></li> </ul>
QStop	The motor is decelerating using <i>C-23 Quick Stop Decel Time</i> . <ul style="list-style-type: none"> <li><i>Quick stop inverse</i> was chosen as a function for a digital input (parameter group E-0#). The corresponding terminal is not active.</li> <li>The quick stop function was activated via serial communication.</li> </ul>



	Operation status
Ramping	The motor is accelerating/decelerating using the active Ramp. The reference, a limit value or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in <i>H-75 Warning Reference High</i> .
Ref. low	The sum of all active references is below the reference limit set in <i>H-74 Warning Reference Low</i> .
Run on ref.	The frequency converter is running in the reference range. The feedback value matches the setpoint value.
Run request	A start command has been given, but the motor is stopped until a run permissive signal is received via digital input.
Running	The motor is driven by the frequency converter.
Speed high	Motor speed is above the value set in <i>H-73 Warning Speed High</i> .
Speed low	Motor speed is below the value set in <i>H-72 Warning Speed Low</i> .
Standby	In Auto mode, the frequency converter will start the motor with a start signal from a digital input or serial communication.
Start delay	In <i>F-24 Holding Time</i> , a delay starting time was set. A start command is activated and the motor will start after the start delay time expires.
Start fwd/rev	Start forward and start reverse were selected as functions for two different digital inputs (parameter group E-0#). The motor will start in forward or reverse depending on which corresponding terminal is activated.
Stop	The frequency converter has received a stop command from the Keypad, digital input or serial communication.
Trip	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, the frequency converter can be reset manually by pressing [Reset] or remotely by control terminals or serial communication.
Trip lock	An alarm occurred and the motor is stopped. Once the cause of the alarm is cleared, power must be cycled to the frequency converter. The frequency converter can then be reset manually by pressing [Reset] or remotely by control terminals or serial communication.

Table 7.3

## 8 Warnings and Alarms

### 8.1 System Monitoring

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

### 8.2 Warning and Alarm Types

#### Warnings

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

#### Alarms

##### Trip

An alarm is issued when the drive is tripped, that is, the drive suspends operation to prevent drive or system damage. The motor will coast to a stop. The drive logic will continue to operate and monitor the drive status. After the fault condition is remedied, the drive can be reset. It will then be ready to start operation again.

A trip can be reset in any of 4 ways:

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

##### Trip-lock

An alarm that causes the drive to trip-lock requires that input power be cycled. The motor will coast to a stop. The drive logic will continue to operate and monitor the drive status. Remove input power to the drive and correct the cause of the fault, then restore power. This action puts the drive into a trip condition as described above and may be reset in any of those 4 ways.

### 8.3 Warning and Alarm Displays

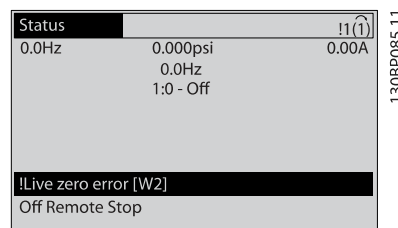


Illustration 8.1

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

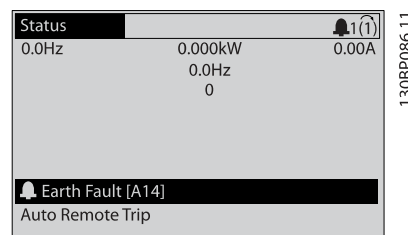


Illustration 8.2

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

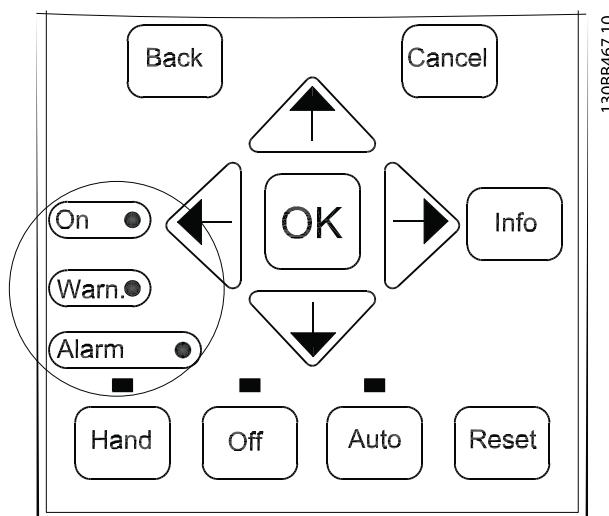


Illustration 8.3



**Warnings and Alarms** **AF-650 GP Operating Instructions**

	<b>Warn. LED</b>	<b>Alarm LED</b>
Warning	ON	OFF
Alarm	OFF	ON (Flashing)
Trip-Lock	ON	ON (Flashing)

**Table 8.1**

### 8.4 Warning and Alarm Definitions

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

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


**Warnings and Alarms**
**AF-650 GP Operating Instructions**

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
35	Option Fault				
36	Mains failure	X	X		
37	Phase imbalance		X		
38	Internal Fault		X	X	
39	Heatsink sensor		X	X	
40	Overload of Digital Output Terminal 27	(X)			E-00 Digital I/O Mode, E-51 Terminal 27 Mode
41	Overload of Digital Output Terminal 29	(X)			E-00 Digital I/O Mode, E-52 Terminal 29 Mode
42	Ovrlld 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			<i>F-43 Current Limit</i>
61	Feedback Error	(X)	(X)		H-20 Motor Feedback Loss Function
62	Output Frequency at Maximum Limit	X			
63	Mechanical Brake Low		(X)		B-20 Release Brake Current
64	Voltage Limit	X			
65	Control Board Over-temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Module Configuration has Changed		X		
68	Safe Stop	(X)	(X) <sup>1)</sup>		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			SP-59 Actual Number of Inverter Units
78	Tracking Error	(X)	(X)		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)		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	



No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
245	Heatsink sensor		X	X	
246	Pwr.card supply			X	
247	Pwr.card temp		X	X	
248	Illegal PS config			X	
249	Rect. low temp.	X			
250	New spare parts			X	
251	New Type Code		X	X	

**Table 8.2 Alarm/Warning Code List**

(X) Dependent on parameter

1) Can not be Auto reset via H-04 Auto-Reset (Times)

### 8.4.1 Fault Messages

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

**WARNING 1, 10 Volts low**

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

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

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

**WARNING/ALARM 2, Live zero error**

This warning or alarm will only appear if programmed by the user in *AN-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. This condition can be caused by broken wiring or faulty device sending the signal.

**Troubleshooting**

Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. OPCGPIO terminals 11 and 12 for signals, terminal 10 common. OPCAIO terminals 1, 3, 5 for signals, terminals 2, 4, 6 common).

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

Perform Input Terminal Signal Test.

**WARNING/ALARM 3, No motor**

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

**WARNING/ALARM 4, Mains phase loss**

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

**Troubleshooting:** Check the supply voltage and supply currents to the drive.

**WARNING 5, DC link voltage high**

The intermediate circuit voltage (DC) is higher than the high voltage warning limit. The limit is dependent on the drive voltage rating. The unit is still active.

**WARNING 6, DC link voltage low**

The intermediate circuit voltage (DC) is lower than the low voltage warning limit. The limit is dependent on the drive voltage rating. The unit is still active.

**WARNING/ALARM 7, DC overvoltage**

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

**Troubleshooting**

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

**WARNING/ALARM 8, DC under voltage**

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

**Troubleshooting:**

Check that the supply voltage matches the drive voltage.

Perform input voltage test

Perform soft charge circuit test

**WARNING/ALARM 9, Inverter overload**

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

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

**Troubleshooting**

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

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

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

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

**WARNING/ALARM 10, Motor overload temperature**

According to the electronic thermal protection, the motor is too hot. Select whether the drive gives a warning or an alarm when the counter reaches 100% in *F-10 Electronic Overload*. The fault occurs when the motor is overloaded by more than 100% for too long.

**Troubleshooting**

Check for motor overheating.

Check if the motor is mechanically overloaded

Check that the motor current set in *P-03 Motor Current* is correct.

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

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

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

**WARNING/ALARM 11, Motor thermistor over temp**

The thermistor might be disconnected. Select whether the drive gives a warning or an alarm in *F-10 Electronic Overload*.

**Troubleshooting**

Check for motor overheating.

Check if the motor is mechanically overloaded.

When using terminal 53 or 54, check that the thermistor is connected correctly between either terminal 53 or 54 (analog voltage input) and terminal 50 (+10V supply) and that the terminal switch for 53 or 54 is set for voltage. Check *F-12 Motor Thermistor Input* selects terminal 53 or 54.

When using digital inputs 18 or 19, check that the thermistor is connected correctly between either terminal 18 or 19 (digital input PNP only) and terminal 50. Check *F-12 Motor Thermistor Input* selects terminal 18 or 19.

**WARNING/ALARM 12, Torque limit**

The torque has exceeded the value in *F-40 Torque Limiter (Driving)* or the value in *F-41 Torque Limiter (Braking)*. *SP-25 Trip Delay at Torque Limit* can change this from a warning only condition to a warning followed by an alarm.

**Troubleshooting**

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

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

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

Check the application for excessive current draw on the motor.

**WARNING/ALARM 13, Over current**

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

**Troubleshooting:**

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

Check that the motor size matches the drive.

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

**ALARM 14, Earth (ground) fault**

There is current from the output phases to earth, either in the cable between the drive and the motor or in the motor itself.



**Troubleshooting:**

Remove power to the drive and repair the earth fault.

Check for earth faults in the motor by measuring the resistance to ground of the motor leads and the motor with a megohmmeter.

**ALARM 15, Hardware mismatch**

A fitted option is not operational with the present control board hardware or software.

Record the value of the following parameters and contact your GE supplier:

*ID-40 Drive Type*

*ID-41 Power Section*

*ID-42 Voltage*

*ID-43 Software Version*

*ID-45 Actual Typecode String*

*ID-49 SW ID Control Card*

*ID-50 SW ID Power Card*

*ID-60 Option Mounted*

*ID-61 Option SW Version (for each option slot)*

**ALARM 16, Short circuit**

There is short-circuiting in the motor or motor wiring.

Remove power to the drive and repair the short circuit.

**WARNING/ALARM 17, Control word timeout**

There is no communication to the drive.

The warning will only be active when *O-04 Control Word Timeout Function* is NOT set to OFF.

If *O-04 Control Word Timeout Function* is set to *Stop* and *Trip*, a warning appears and the drive ramps down until it stops then displays an alarm.

**Troubleshooting:**

Check connections on the serial communication cable.

Increase *O-03 Control Word Timeout Time*

Check the operation of the communication equipment.

Verify a proper installation based on EMC requirements.

**WARNING/ALARM 20, Temp. input error**

The temperature sensor is not connected.

**WARNING/ALARM 21, Parameter error**

The parameter is out of range. The parameter number is reported in the Keypad. The affected parameter must be set to a valid value.

**WARNING/ALARM 22, Hoist mechanical brake**

Report value will show what kind it is. 0 = The torque ref. was not reached before timeout. 1 = There was no brake feedback before timeout.

**WARNING 23, Internal fan fault**

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

**Troubleshooting:**

Check for proper fan operation.

Cycle power to the drive and check that the fan operates briefly at start up.

Check the sensors on the heatsink and control card.

**WARNING 24, External fan fault**

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

**Troubleshooting:**

Check for proper fan operation.

Cycle power to the drive and check that the fan operates briefly at start up.

Check the sensors on the heatsink and control card.

**ALARM 29, Heatsink temp**

The maximum temperature of the heatsink has been exceeded. The temperature fault will not reset until the temperature falls below a defined heatsink temperature. The trip and reset points are different based on the drive power size.

**Troubleshooting:**

Check for the following conditions.

Ambient temperature too high.

Motor cable too long.

Incorrect airflow clearance above and below the drive

Blocked airflow around the drive.

Damaged heatsink fan.

Dirty heatsink.

**ALARM 30, Motor phase U missing**

Motor phase U between the drive and the motor is missing.

Remove power from the drive and check motor phase U.

**ALARM 31, Motor phase V missing**

Motor phase V between the drive and the motor is missing.

Remove power from the drive and check motor phase V.

**ALARM 32, Motor phase W missing**

Motor phase W between the drive and the motor is missing.

Remove power from the drive and check motor phase W.

**ALARM 33, Inrush fault**

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





**WARNING/ALARM 34, communication fault**

The network on the communication option card is not working.

**WARNING/ALARM 35, Option fault**

An option alarm is received. The alarm is option specific. The most likely cause is a power-up or a communication fault.

**WARNING/ALARM 36, Mains failure**

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

**ALARM 37, Phase imbalance**

There is a current imbalance between the power units

**ALARM 38, Internal fault**

When an internal fault occurs, a code number defined in the table below is displayed.

**Troubleshooting**

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

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

No.	Text
5126	Option in slot C1: Hardware incompatible with control board hardware
5376-6231	Internal fault. Contact yourGE supplier or GEService Department.

Table 8.3

**ALARM 39, Heatsink sensor**

No feedback from the heatsink temperature sensor.

The signal from the IGBT thermal sensor is not available on the power card. The problem could be on the power card, on the gate drive card, or the ribbon cable between the power card and gate drive card.

**WARNING 40, Overload of digital output terminal 27**

Check the load connected to terminal 27 or remove short-circuit connection. Check *E-00 Digital I/O Mode* and *E-51 Terminal 27 Mode*.

**WARNING 41, Overload of digital output terminal 29**

Check the load connected to terminal 29 or remove short-circuit connection. Check *E-00 Digital I/O Mode* and *E-52 Terminal 29 Mode*.

**WARNING 42, Overload of digital output on X30/6 or overload of digital output on X30/7**

For X30/6, check the load connected to X30/6 or remove short-circuit connection. Check *E-56 Term X30/6 Digi Out (OPCGPIO)*.

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

**ALARM 45, Earth fault 2**

Earth (ground) fault on start up.

**Troubleshooting**

- Check for proper earthing (grounding) and loose connections.
- Check for proper wire size.
- Check motor cables for short-circuits or leakage currents.

**ALARM 46, Power card supply**

The supply on the power card is out of range.

There are three power supplies generated by the switch mode power supply (SMPS) on the power card: 24V, 5V, +/- 18V. When powered with three phase mains voltage, all three supplied are monitored.

**Troubleshooting**

- Check for a defective power card.
- Check for a defective control card.
- Check for a defective option card.
- If a 24V DC power supply is used, verify proper supply power.

No.	Text
0	Serial port cannot be initialised. Contact yourGE supplier or GEService Department.
256-258	Power EEPROM data is defect or too old
512-519	Internal fault. Contact yourGE supplier or GE Service Department.
783	Parameter value outside of min/max limits
1024-1284	Internal fault. Contact your GE supplier or the GE Service Department.
1299	Option SW in slot A is too old
1300	Option SW in slot B is too old
1302	Option SW in slot C1 is too old
1315	Option SW in slot A is not supported (not allowed)
1316	Option SW in slot B is not supported (not allowed)
1318	Option SW in slot C1 is not supported (not allowed)
1379-2819	Internal fault. Contact yourGE supplier or GEService Department.
2820	Keypad stack overflow
2821	Serial port overflow
2822	USB port overflow
3072-5122	Parameter value is outside its limits
5123	Option in slot A: Hardware incompatible with control board hardware
5124	Option in slot B: Hardware incompatible with control board hardware
5125	Option in slot C0: Hardware incompatible with control board hardware

**WARNING 47, 24V supply low**

The 24 V DC is measured on the control card. The external 24V DC backup power supply may be overloaded, otherwise contact your GE supplier.

**WARNING 48, 1.8V supply low**

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

**WARNING 49, Speed limit**

When the speed is not within the specified range in F-18 and F-17, the drive will show a warning. When the speed is below the specified limit in *H-36 Trip Speed Low [RPM]* (except when starting or stopping) the drive will trip.

**ALARM 50, Auto tune calibration failed**

Contact your GE supplier or GE Service Department.

**ALARM 51, Auto tune check  $U_{nom}$  and  $I_{nom}$** 

The settings for motor voltage, motor current, and motor power are wrong. Check the settings in parameters P-02, P-03, P-06, P-07, F-04 and F-05.

**ALARM 52, Auto tune low  $I_{nom}$** 

The motor current is too low. Check the setting in *F-43 Current Limit*.

**ALARM 53, Auto tune motor too big**

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

**ALARM 54, Auto tune motor too small**

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

**ALARM 55, Auto tune Parameter out of range**

The parameter values of the motor are outside of the acceptable range. Auto tune will not run.

**ALARM 56, Auto tune interrupted by user**

The Auto tune has been interrupted by the user.

**ALARM 57, Auto tune timeout**

Try to restart Auto tune again. Repeated restarts may over heat the motor.

**ALARM 58, Auto tune internal fault**

Contact your GE supplier.

**WARNING 59, Current limit**

The current is higher than the value in *F-43 Current Limit*. Ensure that Motor data in parameters P-02, P-03, P-06, P-07, F-04 and F-05 are set correctly. Possibly increase the current limit. Be sure the system can operate safely at a higher limit.

**WARNING 60, External interlock**

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

**WARNING/ALARM 61, Feedback error**

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

**WARNING 62, Output frequency at maximum limit**

The output frequency has reached the value set in *F-03 Max Output Frequency 1*. Check the application to determine the cause. Possibly increase the output frequency limit. Be sure the system can operate safely at a higher output frequency. The warning will clear when the output drops below the maximum limit.

**ALARM 63, Mechanical brake low**

The actual motor current has not exceeded the "release brake" current within the "Start delay" time window.

**WARNING/ALARM 65, Control card over temperature**

The cutout temperature of the control card is 80° C.

**Troubleshooting**

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

**WARNING 66, Heatsink temperature low**

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

**ALARM 67, Option module configuration has changed**

One or more options have either been added or removed since the last power-down. Check that the configuration change is intentional and reset the unit.

**ALARM 69, Power card temperaturePower card temperature**

The temperature sensor on the power card is either too hot or too cold.

**Troubleshooting**

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

**ALARM 70, Illegal drive configuration**

The control card and power card are incompatible. Contact your supplier with the model number of the unit from the nameplate and the part numbers of the cards to check compatibility.

**WARNING 76, Power unit setup**

The required number of power units does not match the detected number of active power units.

**77 WARNING, Reduced power mode**

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

**ALARM 78, Tracking error**

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

**ALARM 79, Illegal power section configuration**

The scaling card is the incorrect part number or not installed. Also MK102 connector on the power card could not be installed.

**ALARM 80, Unit Restored to Factory Settings**

Parameter settings are restored to factory settings after a manual reset. Reset the unit to clear the alarm.

**ALARM 83, Illegal option combination**

The mounted options are not supported to work together.

**WARNING 89, Mechanical brake sliding**

The hoist brake monitor has detected a motor speed > 10rpm.

**ALARM 90, Feedback monitor**

Check the connection to encoder/ resolver option and eventually replace the OPCENC or OPCRES.

**ALARM 91, Analogue input 54 wrong settings**

Switch S202 has to be set in position OFF (voltage input) when a KTY sensor is connected to analogue input terminal 54.

**ALARM 243, Brake IGBT**

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

**ALARM 244, Heatsink temperature**

This alarm is only for 6x unit size frequency converters. It is equivalent to Alarm 29. The report value in the alarm log indicates which power module generated the alarm:

**ALARM 245, Heatsink sensor**

This alarm is only for 6x unit size frequency converters. It is equivalent to Alarm 39. The report value in the alarm log indicates which power module generated the alarm

1 = left most inverter module.

2 = middle inverter module in 62 or 64 drive.

2 = right inverter module in 61 or 63 drivee.

3 = right inverter module in 62 or 64 drive.

5 = rectifier module.

**ALARM 246, Power card supply**

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

1 = left most inverter module.

2 = middle inverter module in 62 or 64 drive.

2 = right inverter module in 61 or 63 drive.

3 = right inverter module in 62 or 64 drive.

5 = rectifier module.

**ALARM 69, Power card temperaturePower card temperature**

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

1 = left most inverter module.

2 = middle inverter module in 62 or 64 drive.

2 = right inverter module in 61 or 63 drive.

3 = right inverter module in 62 or 64 drive.

5 = rectifier module.

**ALARM 248, Illegal power section configuration**

This alarm is only for 6x unit size frequency converters. It is equivalent to Alarm 79. The report value in the alarm log indicates which power module generated the alarm:

1 = left most inverter module.

2 = middle inverter module in 62 or 64 drive.

2 = right inverter module in 61 or 63 drive.

3 = right inverter module in 62 or 64 drive.

5 = rectifier module.

**WARNING 249, Rect. low temperature**

IGBT sensor fault (highpower units only).

**WARNING 250, New spare part**

A component in the drive has been replaced. Reset the drive for normal operation.

**WARNING 251, New typecode**

The power card or other components have been replaced and the typecode changed. Reset to remove the warning and resume normal operation.



## 9 Basic Troubleshooting

### 9.1 Start Up and Operation

See *Alarm Log* in *Table 4.2*.

Symptom	Possible Cause	Test	Solution
Display dark / No function	Missing input power	See <i>Table 3.1</i> .	Check the input power source.
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this table for possible causes.	Follow the recommendations provided
	No power to the Keypad	Check the Keypad cable for proper connection or damage.	Replace the faulty Keypad or connection cable.
	Shortcut on control voltage (terminal 12 or 50) or at control terminals	Check the 24V control voltage supply for terminal 12/13 to 20-39 or 10V supply for terminal 50 to 55.	Wire the terminals properly.
	Wrong contrast setting		Press [Status] + Up/Down arrows to adjust the contrast.
	Display (Keypad) is defective	Test using a different Keypad.	Replace the faulty Keypad or connection cable.
	Internal voltage supply fault or SMPS is defective		Contact supplier.
	Intermittent display	Overloaded power supply (SMPS) due to improper control wiring or a fault within the drive	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.
Motor not running	Service switch open or missing motor connection	Check if the motor is connected and the connection is not interrupted (by a service switch or other device).	Connect the motor and check the service switch.
	No mains power with 24V DC option card	If the display is functioning but no output, check that mains power is applied to the drive.	Apply mains power to run the unit.
	Keypad Stop	Check if [Off] has been pressed.	Press [Auto] or [Hand] (depending on your operation mode) to run the motor.
	Missing start signal (Standby)	Check <i>E-01 Terminal 18 Digital Input</i> for correct setting for terminal 18 (use default setting).	Apply a valid start signal to start the motor.
	Motor coast signal active (Coasting)	Check <i>E-03 Terminal 27 Digital Input</i> all digital inputs in parameter group E-0# for Coast inv. setting.	Deactivate Coast Inv signal
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings Check <i>F-02 Operation Method</i> Set preset reference active in parameter <i>C-05 Multi-step Frequency 1 - 8</i> . Check for correct wiring. Check scaling of terminals. Check reference signal.



Basic Troubleshooting

AF-650 GP Operating Instructions

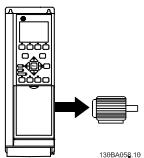
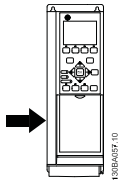
Symptom	Possible Cause	Test	Solution
Motor running in wrong direction	Motor rotation limit	Check that <i>H-08 Reverse Lock</i> is programmed correctly.	Program correct settings.
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group <i>E-0#</i>	Deactivate reversing signal.
	Wrong motor phase connection		See 3.5 <i>Check Motor Rotation</i> in this manual.
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in <i>F-17 Motor Speed High Limit [RPM]</i> , <i>F-15 Motor Speed High Limit [Hz]</i> , and <i>F-03 Max Output Frequency 1</i>	Program correct limits.
	Reference input signal not scaled correctly	Check reference input signal scaling in parameter group <i>AN-## Analog In/Out</i> and parameter group <i>F-01 Frequency Setting 1</i>	Program correct settings.
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed loop operation, check PID settings.	Program correct settings.
Motor runs rough	Possible over-magnetization	Check for incorrect motor settings in all motor parameters.	Check motor settings in parameter groups <i>P-0# Motor data</i> , <i>P-3# Adv motor data</i> , and <i>H-5# Load indep. setting</i> .
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short rampvæt times.	Check brake parameters. Check ramp time settings.	Check parameter group <i>B-0# DC brake</i> and <i>F-5# Extended References</i> .
Open power fuses or circuit breaker trip	Phase to phase short	Motor or panel has a short phase to phase. Check motor and panel phase to for shorts.	Eliminate any shorts detected.
	Motor overload	Motor is overloaded for the application.	Perform startup test and verify motor current is within specifications. If motor current is exceeding nameplate full load current, motor may run only with reduced load. Review the specifications for the application.
	Loose connections	Perform pre-startup check for loose connections.	Tighten loose connections.
Mains current imbalance greater than 3%	Problem with mains power (See <i>Alarm 4 Mains phase loss</i> description)	Rotate input power leads into the drive one position: A to B, B to C, C to A.	If imbalanced leg follows the wire, it is a power problem. Check mains power supply.
	Problem with the drive unit	Rotate input power leads into the drive one position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with drive unit	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact supplier.

Table 9.1



# 10 Specifications

## 10.1 Power-dependent Specifications

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

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Table 10.1



Specifications

AF-650 GP Operating Instructions

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

Table 10.2





**Specifications**

**AF-650 GP Operating Instructions**

<b>Mains Supply 3 x 200 - 240V AC</b>											
AF-650 GP		20 HP		25 HP		30 HP		40 HP		50 HP	
High/ Normal Load <sup>1)</sup>		HD	LD	HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft Output [kW]	15	18.5	18.5	22	22	30	30	37	37	45
	Typical Shaft Output [HP] at 208V	20	25	25	30	30	40	40	50	50	60
	Unit Size IP20	24		33		33		34		34	
	Unit Size IP55, IP66	31		31		31		32		32	
<b>Output current</b>											
	Continuous (3 x 200-240V) [A]	59.4	74.8	74.8	88	88	115	115	143	143	170
	Intermittent (60 sec overload) (3 x 200-240V) [A]	89.1	82.3	112	96.8	132	127	173	157	215	187
	Continuous kVA (208V AC) [kVA]	21.4	26.9	26.9	31.7	31.7	41.4	41.4	51.5	51.5	61.2
<b>Max. input current</b>											
	Continuous (3 x 200-240V) [A]	54	68	68	80	80	104	104	130	130	154
	Intermittent (60 sec overload) (3 x 200-240V) [A]	81	74.8	102	88	120	114	156	143	195	169
<b>Additional specifications</b>											
	IP20 max. cable cross-section <sup>5)</sup> (mains, brake, motor and load sharing)	35 (2)		50 (1)		50 (1)		150 (300MCM)		150 (300MCM)	
	IP55, IP66 max. cable cross-section <sup>5)</sup> (mains, motor) [mm <sup>2</sup> (AWG)] <sup>2)</sup>	50 (1)		50 (1)		50 (1)		150 (300MCM)		150 (300MCM)	
	IP55, IP66 max. cable cross-section <sup>5)</sup> (brake, load sharing) [mm <sup>2</sup> (AWG)] <sup>2)</sup>	50 (1)		50 (1)		50 (1)		95 (3/0)		95 (3/0)	
	Estimated power loss at rated max. load [W] <sup>4)</sup>	624	737	740	845	874	1140	1143	1353	1400	1636
	Weight, Unit Size 55/66 [kg]	45		45		45		65		65	
	Efficiency <sup>4)</sup>	0.96		0.97		0.97		0.97		0.97	

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**Table 10.3**

For fuse ratings, see 10.3.1 Fuses

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

2) American Wire Gauge.

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

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

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

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

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

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

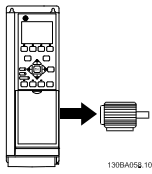
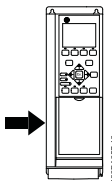




**Specifications**

**AF-650 GP Operating Instructions**

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

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

1/2 - 10HP only available as 160% heavy duty (HD).

**Table 10.4**

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Specifications

AF-650 GP Operating Instructions

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

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Table 10.5



**Specifications**

**AF-650 GP Operating Instructions**

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

**Table 10.6**

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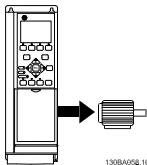
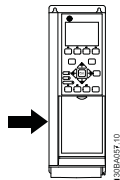


**Specifications**

**AF-650 GP Operating Instructions**

For fuse ratings, see 10.3.1 Fuses

- 1) Heavy duty (HD) = 160% torque during 60 sec., Light duty (LD) = 110% torque during 60 sec.
- 2) American Wire Gauge.
- 3) Measured using 5 m screened motor cables at rated load and rated frequency.
- 4) The typical power loss is at nominal load conditions and expected to be within +/-15% (tolerance relates to variety in voltage and cable conditions).  
Values are based on a typical motor efficiency (eff2/eff3 border line). Motors with lower efficiency will also add to the power loss in the drive and opposite.  
If the switching frequency is increased compared to the default setting, the power losses may rise significantly.  
Keypad and typical control card power consumptions are included. Further options and customer load may add up to 30W to the losses. (Though typical only 4W extra for a fully loaded control card, or options for slot A or slot B, each).  
Although measurements are made with state of the art equipment, some measurement inaccuracy must be allowed for (+/-5%).
- 5) The three values for the max. cable cross section are for single core, flexible wire and flexible wire with sleeve, respectively.

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

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Table 10.7



Specifications

AF-650 GP Operating Instructions

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

Table 10.8



**Specifications**

**AF-650 GP Operating Instructions**

<b>Mains Supply 3 x 525 - 600V AC</b>									
AF-650 GP		50 HP		60 HP		75 HP		100 HP	
High/ Normal Load*		HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft Output [kW]	37	45	45	55	55	75	75	90
	Typical Shaft Output [HP] at 575V	50	60	60	74	75	100	100	120
	Unit Size IP 55, IP66	31	31	31		32		32	
	Unit Size IP20	33	33	33		34		34	
<b>Output current</b>									
	Continuous (3 x 525-550V) [A]	54	65	65	87	87	105	105	137
	Intermittent (3 x 525-550V) [A]	81	72	98	96	131	116	158	151
	Continuous (3 x 525-600V) [A]	52	62	62	83	83	100	100	131
	Intermittent (3 x 525-600V) [A]	78	68	93	91	125	110	150	144
	Continuous kVA (550V AC) [kVA]	51.4	61.9	61.9	82.9	82.9	100.0	100.0	130.5
	Continuous kVA (575V AC) [kVA]	51.8	61.7	61.7	82.7	82.7	99.6	99.6	130.5
<b>Max. input current</b>									
	Continuous at 550V [A]	49	59	59	78.9	78.9	95.3	95.3	124.3
	Intermittent at 550V [A]	74	65	89	87	118	105	143	137
	Continuous at 575V [A]	47	56	56	75	75	91	91	119
	Intermittent at 575V [A]	70	62	85	83	113	100	137	131
<b>Additional specifications</b>									
	IP20 max. cable cross-section <sup>5)</sup> (mains and motor)	50 (1)				150 (300MCM)			
	IP20 max. cable cross-section <sup>5)</sup> (brake and load sharing)	50 (1)				95 (4/0)			
	IP55, IP66 max. cable cross-section <sup>5)</sup> (mains, motor) [mm <sup>2</sup> (AWG)] <sup>2)</sup>	50 (1)				150 (300MCM)			
	IP55, IP66 max. cable cross-section <sup>5)</sup> (brake, load sharing) [mm <sup>2</sup> (AWG)] <sup>2)</sup>	50 (1)				95 (4/0)			
	Estimated power loss at rated max. load [W] <sup>4)</sup>		850		1100		1400		1500
	Weight, Unit Size IP20 [kg]	35		35		50		50	
	Weight, Unit Size IP 55 IP66 [kg]	45		45		65		65	
	Efficiency <sup>4)</sup>	0.98		0.98		0.98		0.98	

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**Table 10.9**



**Specifications**

**AF-650 GP Operating Instructions**

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

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**Table 10.10**



**Specifications**

**AF-650 GP Operating Instructions**

<b>Mains Supply 3 x 525 - 690V AC</b>											
AF-650 GP		40 HP		50 HP		60 HP		75 HP		100 HP	
Heavy Duty/Light Duty*		HD	LD	HD	LD	HD	LD	HD	LD	HD	LD
	Typical Shaft output at 550V [kW]	22	30	30	37	37	45	45	55	55	75
	Typical Shaft output at 575V [HP]	30	40	40	50	50	60	60	75	75	100
	Typical Shaft output at 690V [kW]	30	37	37	45	45	55	55	75	75	90
	Enclosure IP21, 55	32		32		32		32		32	
<b>Output current</b>											
	Continuous (3 x 525-550V) [A]	36	43	43	54	54	65	65	87	87	105
	Intermittent (60 sec overload) (3 x 525-550V) [A]	54	47.3	64.5	59.4	81	71.5	97.5	95.7	130.5	115.5
	Continuous (3 x 551-690V) [A]	34	41	41	52	52	62	62	83	83	100
	Intermittent (60 sec overload) (3 x 551-690V) [A]	51	45.1	61.5	57.2	78	68.2	93	91.3	124.5	110
	Continuous KVA (at 550V) [KVA]	34.3	41.0	41.0	51.4	51.4	61.9	61.9	82.9	82.9	100.0
	Continuous KVA (at 575V) [KVA]	33.9	40.8	40.8	51.8	51.8	61.7	61.7	82.7	82.7	99.6
	Continuous KVA (at 690V) [KVA]	40.6	49.0	49.0	62.1	62.1	74.1	74.1	99.2	99.2	119.5
<b>Max. input current</b>											
	Continuous (at 550V) [A]	36	49	49	59	59	71	71	87	87	99
	Continuous (at 575V) [A]	54	53.9	72	64.9	87	78.1	105	95.7	129	108.9
<b>Additional specifications</b>											
	Max. cable cross section (mains and motor) [mm <sup>2</sup> (AWG)]	150 (300MCM)									
	Max. cable cross section (load share and brake) [mm <sup>2</sup> (AWG)]	95 (3/0)									
		-									
	Estimated power loss at rated max. load [W] <sup>4)</sup>	480		592		720		880		1200	
	Weight, Unit Size IP21, IP55 [kg]	65									
Efficiency <sup>4)</sup>	0.98		0.98		0.98		0.98		0.98		

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**Table 10.11**

For fuse ratings, see 10.3.1 Fuses

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

2) American Wire Gauge.

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

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

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

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

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

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

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





## 10.2 General Technical Data

## Mains supply:

Supply Terminals (6-Pulse)	L1, L2, L3
Supply Terminals (12-Pulse)	L1-1, L2-1, L3-1, L1-2, L2-2, L3-2
Supply voltage	200-240V $\pm 10\%$
Supply voltage	380-480V $\pm 10\%$
Supply voltage	525-600V $\pm 10\%$
Supply voltage	525-690V $\pm 10\%$

*Mains voltage low / mains drop-out:*

*During low mains voltage or a mains drop-out, the AF-650 GPdrive continues until the intermediate circuit voltage drops below the minimum stop level, which corresponds typically to 15% below the 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	50/60Hz $\pm 5\%$
Max. imbalance temporary between mains phases	3.0 % of rated supply voltage
True Power Factor ( $\lambda$ )	$\geq 0.9$ nominal at rated load
Displacement Power Factor ( $\cos \phi$ )	near unity ( $> 0.98$ )
Switching on input supply L1, L2, L3 (power-ups) $\leq 7.5$ kW	maximum 2 times/min.
Switching on input supply L1, L2, L3 (power-ups) 11-75 kW	maximum 1 time/min.
Switching on input supply L1, L2, L3 (power-ups) $\geq 90$ kW	maximum 1 time/2 min.
Environment according to EN60664-1	overvoltage category III/pollution degree 2

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

## Motor output (U, V, W):

Output voltage	0 - 100% of supply voltage
Output frequency (0.25-75kW)	0 - 1000Hz
Output frequency (90-1000kW)	0 - 800 <sup>1)</sup> Hz
Output frequency in Flux Mode	0 - 300Hz
Switching on output	Unlimited
Ramp times	0.01 - 3600sec.

<sup>1)</sup> Voltage and power dependent

## Torque characteristics:

Starting torque (Constant torque)	maximum 160% for 60 sec. <sup>1)</sup>
Starting torque	maximum 180% up to 0.5 sec. <sup>1)</sup>
Overload torque (Constant torque)	maximum 160% for 60 sec. <sup>1)</sup>
Starting torque (Variable torque)	maximum 110% for 60 sec. <sup>1)</sup>
Overload torque (Variable torque)	maximum 110% for 60 sec.

Torque rise time in (independent of fsw)	10ms
Torque rise time in FLUX (for 5kHz fsw)	1ms

<sup>1)</sup> Percentage relates to the nominal torque.

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

**Specifications****AF-650 GP Operating Instructions****Digital inputs:**

Programmable digital inputs	4 (6) <sup>1)</sup>
Terminal number	18, 19, 27 <sup>1)</sup> , 29 <sup>1)</sup> , 32, 33,
Logic	PNP or NPN
Voltage level	0 - 24V DC
Voltage level, logic '0' PNP	< 5V DC
Voltage level, logic '1' PNP	> 10V DC
Voltage level, logic '0' NPN <sup>2)</sup>	> 19V DC
Voltage level, logic '1' NPN <sup>2)</sup>	< 14V DC
Maximum voltage on input	28V DC
Pulse frequency range	0 - 110kHz
(Duty cycle) Min. pulse width	4.5ms
Input resistance, R <sub>i</sub>	approx. 4 kΩ

**Safe stop Terminal 37<sup>2)</sup> (Terminal 37 is fixed PNP logic):**

Voltage level	0 - 24V DC
Voltage level, logic '0' PNP	< 4V DC
Voltage level, logic '1' PNP	> 20V DC
Maximum voltage on input	28V DC
Typical input current at 24V	50mA rms
Typical input current at 20V	60mA rms
Input capacitance	400nF

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

<sup>1)</sup> Terminals 27 and 29 can also be programmed as output.

<sup>2)</sup> See 2.4.5.7 Terminal 37 for further information about terminal 37 and Safe Stop.

**Analog inputs:**

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

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

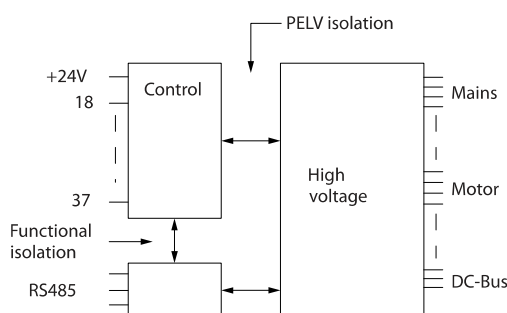


Illustration 10.1

Pulse/encoder inputs:

Programmable pulse/encoder inputs	2/1
Terminal number pulse/encoder	29, 33 <sup>1)</sup> / 32 <sup>2)</sup> , 33 <sup>2)</sup>
Max. frequency at terminal 29, 32, 33	110kHz (Push-pull driven)
Max. frequency at terminal 29, 32, 33	5kHz (open collector)
Min. frequency at terminal 29, 32, 33	4Hz
Voltage level	see section on Digital input
Maximum voltage on input	28V DC
Input resistance, R <sub>i</sub>	approx. 4kΩ
Pulse input accuracy (0.1 - 1kHz)	Max. error: 0.1% of full scale
Encoder input accuracy (1 - 11 kHz)	Max. error: 0.05 % of full scale

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

- 1) Pulse inputs are 29 and 33
- 2) Encoder inputs: 32 = A, and 33 = B

Digital output:

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

<sup>1)</sup> Terminal 27 and 29 can also be programmed as input.

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

Analog output:

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

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



**Specifications** **AF-650 GP Operating Instructions**

Control card, 24V DC output:

Terminal number	12, 13
Output voltage	24V +1, -3 V
Max. load	200mA

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

Control card, 10V DC output:

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

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

Control card, RS-485 serial communication:

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

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

Control card, USB serial communication:

USB standard	1.1 (Full speed)
USB plug	USB type B "device" plug

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

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

The USB ground connection is not galvanically isolated from protection earth. Use only an isolated laptop as PC connection to the USB connector on the drive.

Relay outputs:

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

<sup>1)</sup> IEC 60947 part 4 and 5

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

<sup>2)</sup> Overvoltage Category II

<sup>3)</sup> UL applications 300V AC2A

**Specifications****AF-650 GP Operating Instructions****Cable lengths and cross sections for control cables<sup>1)</sup>:**

Max. motor cable length, screened	150m
Max. motor cable length, unscreened	300m
Maximum cross section to control terminals, flexible/ rigid wire without cable end sleeves	1.5mm <sup>2</sup> /16 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves	1mm <sup>2</sup> /18 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves with collar	0.5mm <sup>2</sup> /20 AWG
Minimum cross section to control terminals	0.25mm <sup>2</sup> / 24AWG

<sup>1)</sup>For power cables, see electrical data tables.

**Control card performance:**

Scan interval	AF-650 GP: 1 ms
---------------	-----------------

**Control characteristics:**

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

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

**Environment:**

Enclosure	IP20 Open Chassis, Nema 1 with field installed kit, Nema 12, and Nema 4
Vibration test	1.0g
Max. relative humidity	5% - 93%(IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H <sub>2</sub> S test	class Kd
Ambient temperature	Max. 50°C

<sup>1)</sup> Only for ≤ 3.7kW/5HP(200 - 240V), ≤ 7.5kW/10HP (400 - 480V)

<sup>2)</sup> As enclosure kit for ≤ 3.7kW/5HP (200 - 240V), ≤ 7.5kW/10HP (400 - 480V)

<sup>3)</sup> Derating for high ambient temperature, see special conditions in the Design Guide

Minimum ambient temperature during full-scale operation	0°C
Minimum ambient temperature at reduced performance	- 10°C
Temperature during storage/transport	-25 - +65/70°C
Maximum altitude above sea level without derating	1000m

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

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

*See section on special conditions in the AF-650 GP Design Guide. Please see [www.geelectrical.com/drives](http://www.geelectrical.com/drives) for more information.*

**Protection and Features:**

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



## 10.3 Fuse Tables

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

### NOTE

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

### **⚠ WARNING**

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

#### Branch Circuit Protection

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

### NOTE

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

#### Short-circuit protection:

GE recommends using the fuses/Circuit Breakers mentioned below to protect service personnel and property in case of component break-down in the drive.

#### Over current protection:

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

## 10.3.1 Recommendations

### **⚠ WARNING**

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

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

If fuses/Circuit Breakers according to recommendations are chosen, possible damages on the drive will mainly be limited to damages inside the unit.



### 10.3.2 CE Compliance

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

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

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker	Max trip level
[HP]				[A]
<b>IP20 / Open Chassis</b>				
1/3	gG-16	gG-25	PKZM0-25	25
1/2				
1				
2				
3				
5	gG-20	gG-32	PKZM4-50	50
7,5	gG-50	gG-63		
10	gG-80	gG-125	NZMB1-A100	100
15				
20				
25	gG-125	gG-150	NZMB2-A200	150
30	aR-160	aR-160		
40	aR-200	aR-200	NZMB2-A250	250
50	aR-250	aR-250		

Table 10.12 200-240V. IP20 / Open Chassis

AF-650 GP 3-phase	Recommended fuse size	Recommended max fuse	Recommended circuit breaker	Max trip level
[HP]				[A]
<b>IP55 / Nema 12 and IP66 / Nema 4</b>				
1/3	gG-20	gG-32	PKZM0-25	25
1/2				
1				
2				
3				
5	gG-63	gG-80	PKZM4-63	63
7,5				
10	gG-80	gG-100	NZMB1-A100	100
15				
20				
25	gG-125	gG-160	NZMB2-A200	160
30	aR-160	aR-160		
40	aR-200	aR-200	NZMB2-A250	250
50	aR-250	aR-250		

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





Specifications

AF-650 GP Operating Instructions

AF-650 GP 3-phase [HP]	Recommended fuse size	Recommended max fuse	Recommended circuit breaker	Max trip level [A]
<b>IP20 / Open Chassis</b>				
1/2	gG-16	gG-25	PKZM0-25	25
1				
2				
3				
5				
7,5	gG-20	gG-32	PKZM4-50	50
10				
15	gG-50	gG-63	PKZM4-50	50
20				
25				
30	gG-80	gG-125	NZMB1-A100	100
40				
50	gG-125	gG-150	NZMB2-A200	150
60	aR-160	aR-160		
75	aR-250	aR-250	NZMB2-A250	250
100				
125	gG-300	gG-300	-	-
150	gG-350	gG-350		
200	gG-400	gG-400		
250	gG-500	gG-500		
300	gG-630	gG-630		
350	aR-700	aR-700		
450	aR-900	aR-900		
500				
550				
600	aR-1600	aR-1600		
650				
750	aR-2000	aR-2000		
900				
1000	aR-2500	aR-2500		
1200				

Table 10.14 380-480V. IP20 / Open Chassis

10



Specifications

AF-650 GP Operating Instructions

AF-650 GP 3-phase [HP]	Recommended fuse size	Recommended max fuse	Recommended circuit breaker	Max trip level [A]
<b>IP55 / Nema 12 and IP66 / Nema 4</b>				
1/2	gG-20	gG-32	PKZM0-25	25
1				
2				
3				
5				
7,5				
10	gG-50	gG-80	PKZM4-63	63
15				
20				
25	gG-80	gG-100	NZMB1-A100	100
30				
40	gG-125	gG-160	NZMB2-A200	160
50				
60				
75	aR-250	aR-250	NZMB2-A250	250
100				
125	-	-	-	-
150				
200				
250				
300				
350				
450				
500				
550				
600				
650	aR-1600	aR-1600		
750				
900				
1000	aR-2000	aR-2000		
1200				
	aR-2500	aR-2500		

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



**Specifications AF-650 GP Operating Instructions**

AF-650 GP 3-phase [HP]	Recommended fuse size	Recommended max fuse	Recommended circuit breaker	Max trip level [A]
<b>IP20 / Open Chassis</b>				
1	gG-10	gG-25	PKZM0-25	25
2				
3				
5				
7,5	gG-16	gG-32	PKZM4-50	50
10				
15	gG-35	gG-63	PKZM4-50	50
20				
25	gG-63	gG-125	NZMB1-A100	100
30				
40				
50	gG-100	gG-150	NZMB2-A200	150
60				
75	aR-250	aR-250	NZMB2-A250	250
100				

**Table 10.16 525-600V. IP20 / Open Chassis**

AF-650 GP 3-phase [HP]	Recommended fuse size	Recommended max fuse	Recommended circuit breaker	Max trip level [A]
<b>IP55 / Nema 12 and IP66 / Nema 4</b>				
1	gG-16	gG-32	PKZM0-25	25
2				
3				
5				
7,5				
10	gG-35	gG-80	PKZM4-63	63
15				
20				
25	gG-50	gG-100	NZMB1-A100	100
30				
40	gG-125	gG-160	NZMB2-A200	160
50				
60				
75	aR-250	aR-250	NZMB2-A250	250
100				

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

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Specifications

AF-650 GP Operating Instructions

AF-650 GP 3-phase [HP]	Recommended fuse size	Recommended max fuse	Recommended circuit breaker	Max trip level [A]
<b>IP21 / Nema 1 and IP55 / Nema 12 and IP66 / Nema 4</b>				
15	gG-25	gG-63		
20	gG-32			
25				
30	gG-40			
40	gG-63	gG-80		
50		gG-100		
60	gG-80	gG-125		
75	gG-100	gG-160		
100	gG-125			
125	aR-250	aR-250		
150	aR-315	aR-315		
200	aR-350	aR-350		
250				
300	aR-400	aR-400		
350	aR-500	aR-500		
400	aR-550	aR-550		
500	aR-700	aR-700		
550				
650	aR-900	aR-900		
750				
900	aR-1600	aR-1600		
1000				
1150				
1250				
1350	aR-2000	aR-2000		

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

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10.3.3 NEC and UL Compliance

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

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

AF-650 GP Power	Recommended max. fuse					
	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
HP	Type RK1 <sup>1)</sup>	Type J	Type T	Type CC	Type CC	Type CC
0.33-0.5	KTN-R-05	JKS-05	JJN-05	FNQ-R-5	KTK-R-5	LP-CC-5
1	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
2	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
3	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
5	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
7.5	KTN-R-50	KS-50	JJN-50	-	-	-
10	KTN-R-60	JKS-60	JJN-60	-	-	-
15	KTN-R-80	JKS-80	JJN-80	-	-	-
20-25	KTN-R-125	JKS-125	JJN-125	-	-	-
30	KTN-R-150	JKS-150	JJN-150	-	-	-
40	KTN-R-200	JKS-200	JJN-200	-	-	-
50	KTN-R-250	JKS-250	JJN-250	-	-	-

Table 10.19 200-240V, Unit Sizes 1X, 2X and 3X



Specifications

AF-650 GP Operating Instructions

AF-650 GP Power	Recommended max. fuse			
	SIBA	Littell fuse	Ferraz-Shawmut	Ferraz-Shawmut
HP	Type RK1	Type RK1	Type CC	Type RK1 <sup>3)</sup>
0.33-0.5	5017906-005	KLN-R-05	ATM-R-05	A2K-05-R
1	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R
2	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R
3	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R
5	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R
7.5	5014006-050	KLN-R-50	-	A2K-50-R
10	5014006-063	KLN-R-60	-	A2K-60-R
15	5014006-080	KLN-R-80	-	A2K-80-R
20-25	2028220-125	KLN-R-125	-	A2K-125-R
30	2028220-150	KLN-R-150	-	A2K-150-R
40	2028220-200	KLN-R-200	-	A2K-200-R
50	2028220-250	KLN-R-250	-	A2K-250-R

Table 10.20 200-240V, Unit Sizes 1X, 2X and 3X



Specifications

AF-650 GP Operating Instructions

AF-650 GP	Recommended max. fuse			
	Bussmann	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
HP	Type JFHR2 <sup>2)</sup>	JFHR2	JFHR2 <sup>4)</sup>	J
0.33-0.5	FWX-5	-	-	HSJ-6
1	FWX-10	-	-	HSJ-10
2	FWX-15	-	-	HSJ-15
3	FWX-20	-	-	HSJ-20
5	FWX-30	-	-	HSJ-30
7.5	FWX-50	-	-	HSJ-50
10	FWX-60	-	-	HSJ-60
15	FWX-80	-	-	HSJ-80
20-25	FWX-125	-	-	HSJ-125
30	FWX-150	L25S-150	A25X-150	HSJ-150
40	FWX-200	L25S-200	A25X-200	HSJ-200
50	FWX-250	L25S-250	A25X-250	HSJ-250

Table 10.21 200-240V, Unit Sizes 1X, 2X and 3X

- 1) KTS-fuses from Bussmann may substitute KTN for 240V frequency converters.
- 2) FWH-fuses from Bussmann may substitute FWX for 240V frequency converters.
- 3) A6KR fuses from FERRAZ SHAWMUT may substitute A2KR for 240V frequency converters.
- 4) A50X fuses from FERRAZ SHAWMUT may substitute A25X for 240V frequency converters.

AF-650 GP	Recommended max. fuse					
	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[HP]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
0.5-1	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
2-3	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
5	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
7.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
10	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
15	KTS-R-40	JKS-40	JJS-40	-	-	-
20	KTS-R-50	JKS-50	JJS-50	-	-	-
25	KTS-R-60	JKS-60	JJS-60	-	-	-
30	KTS-R-80	JKS-80	JJS-80	-	-	-
40	KTS-R-100	JKS-100	JJS-100	-	-	-
50	KTS-R-125	JKS-125	JJS-125	-	-	-
60	KTS-R-150	JKS-150	JJS-150	-	-	-
75	KTS-R-200	JKS-200	JJS-200	-	-	-
100	KTS-R-250	JKS-250	JJS-250	-	-	-

Table 10.22 380-480V, Unit Sizes 1x, 2x and 3x



Specifications

AF-650 GP Operating Instructions

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

Table 10.23 380-480V, Unit Sizes 1x, 2x, and 3x

AF-650 GP	Recommended max. fuse			
	Bussmann	Ferraz-Shawmut	Ferraz-Shawmut	Littel fuse
[HP]	JFHR2	J	JFHR2 <sup>1)</sup>	JFHR2
0.5-1	FWH-6	HSJ-6	-	-
2-3	FWH-10	HSJ-10	-	-
5	FWH-20	HSJ-20	-	-
7.5	FWH-25	HSJ-25	-	-
10	FWH-30	HSJ-30	-	-
15	FWH-40	HSJ-40	-	-
20	FWH-50	HSJ-50	-	-
25	FWH-60	HSJ-60	-	-
30	FWH-80	HSJ-80	-	-
40	FWH-100	HSJ-100	-	-
50	FWH-125	HSJ-125	-	-
60	FWH-150	HSJ-150	-	-
75	FWH-200	HSJ-200	A50-P-225	L50-S-225
100	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 10.24 380-480V, Unit Sizes 1x, 2x, and 3x

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



Specifications

AF-650 GP Operating Instructions

AF-650 GP	Recommended max. fuse					
	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[HP]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
2-3	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
5	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
7.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
10	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
15	KTS-R-35	JKS-35	JJS-35	-	-	-
20	KTS-R-45	JKS-45	JJS-45	-	-	-
25	KTS-R-50	JKS-50	JJS-50	-	-	-
30	KTS-R-60	JKS-60	JJS-60	-	-	-
40	KTS-R-80	JKS-80	JJS-80	-	-	-
50	KTS-R-100	JKS-100	JJS-100	-	-	-
60	KTS-R-125	JKS-125	JJS-125	-	-	-
75	KTS-R-150	JKS-150	JJS-150	-	-	-
100	KTS-R-175	JKS-175	JJS-175	-	-	-

Table 10.25 525-600V, Unit Sizes 1x, 2x and 3x

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

Table 10.26 525-600V, Unit Sizes 1x, 2x, and 3x

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





Specifications

AF-650 GP Operating Instructions

AF-650 GP HP	Max. prefuse	Recommended max. fuse						
		Bussmann E52273 RK1/JDDZ	Bussmann E4273 J/JDDZ	Bussmann E4273 T/JDDZ	SIBA E180276 RK1/JDDZ	LittelFuse E81895 RK1/JDDZ	Ferraz-Shawmut E163267/E2137 RK1/JDDZ	Ferraz-Shawmut E2137 J/HSJ
15	30 A	KTS-R-30	JKS-30	JKJS-30	5017906-030	KLS-R-030	A6K-30-R	HST-30
20-25	45 A	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45-R	HST-45
30	60 A	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60-R	HST-60
40	80 A	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80-R	HST-80
50	90 A	KTS-R-90	JKS-90	JJS-90	5014006-100	KLS-R-090	A6K-90-R	HST-90
60	100 A	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100-R	HST-100
75	125 A	KTS-R-125	JKS-125	JJS-125	2028220-125	KLS-150	A6K-125-R	HST-125
100	150 A	KTS-R-150	JKS-150	JJS-150	2028220-150	KLS-175	A6K-150-R	HST-150

\* UL compliance only 525-600V

Table 10.27 525-690V\*, Unit Sizes 2x and 3x

10.4 Connection Tightening Torques

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

Table 10.28 Tightening of Terminals

<sup>1)</sup> For different cable dimensions x/y, where  $x \leq 95\text{mm}^2$  and  $y \geq 95\text{mm}^2$ .



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

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