GE

AF-600 FP™
Fan & Pump Drive

Design and Installation Guide

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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.

⚠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.

⚠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.

⚠WARNING

DISCHARGE TIME!

Frequency converters contain DC link capacitors that can remain charged even when AC mains is disconnected. To avoid electrical hazards, remove AC mains from the frequency converter before doing any service or repair and wait the amount of time specified in *Table 1.1*. Failure to wait the specified time after power has been removed prior to doing service or repair on the unit could result in death or serious injury.

Voltage [V]	Power Size	Minimum Waiting Time [minutes]
200-240	0.75-3.7 kW 1-5 HP	4
	5.5-45 kW 7.5-60 HP	15
380-480	0.75-7.5 kW 1-10 HP	4
	11-90 kW 15-125 HP	15
	110-315 kW 150-450 HP	20
	355-1000 kW 500-1350 HP	40
525-600	0.75-7.5 kW 1-10 HP	4
	11-90 kW 15-125 HP	15
525-690	11-75 kW 15-125 HP	15
	110-400 kW 150-550 HP	20
	450-1400 kW 600-1900 HP	30

Table 1.1

Symbols

The following symbols are used in this manual.

⚠WARNING

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

⚠CAUTION

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

CAUTION

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

NOTE

Indicates highlighted information to regard with attention to avoid mistakes or operate equipment at less than optimal performance.

Approvals

Contents

1 Introduction

1.1 Exploded Views

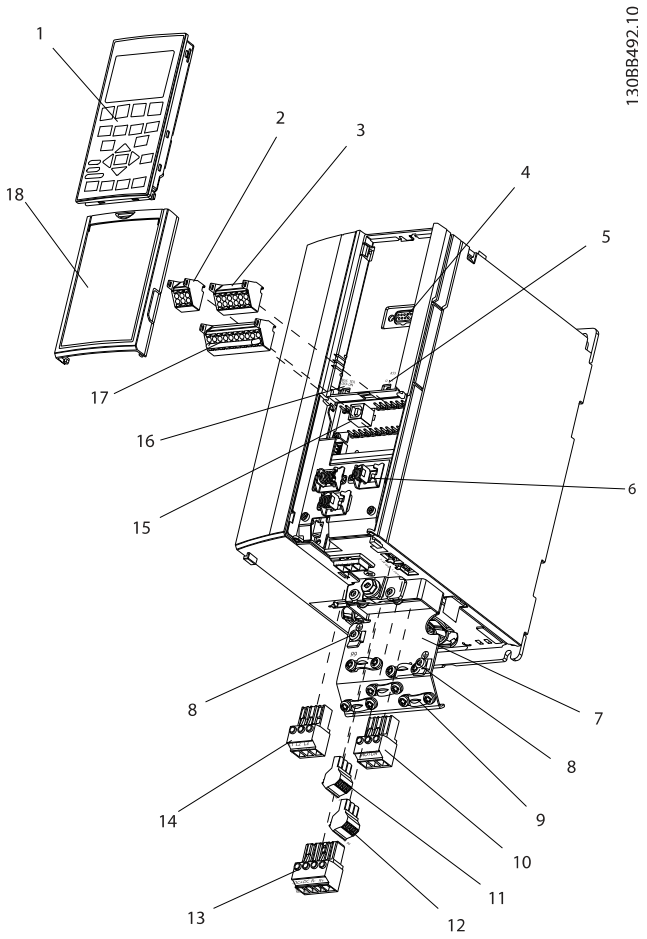


Illustration 1.1 Exploded View Unit Size 12 and 13

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 Legend to *Illustration 1.1*

1

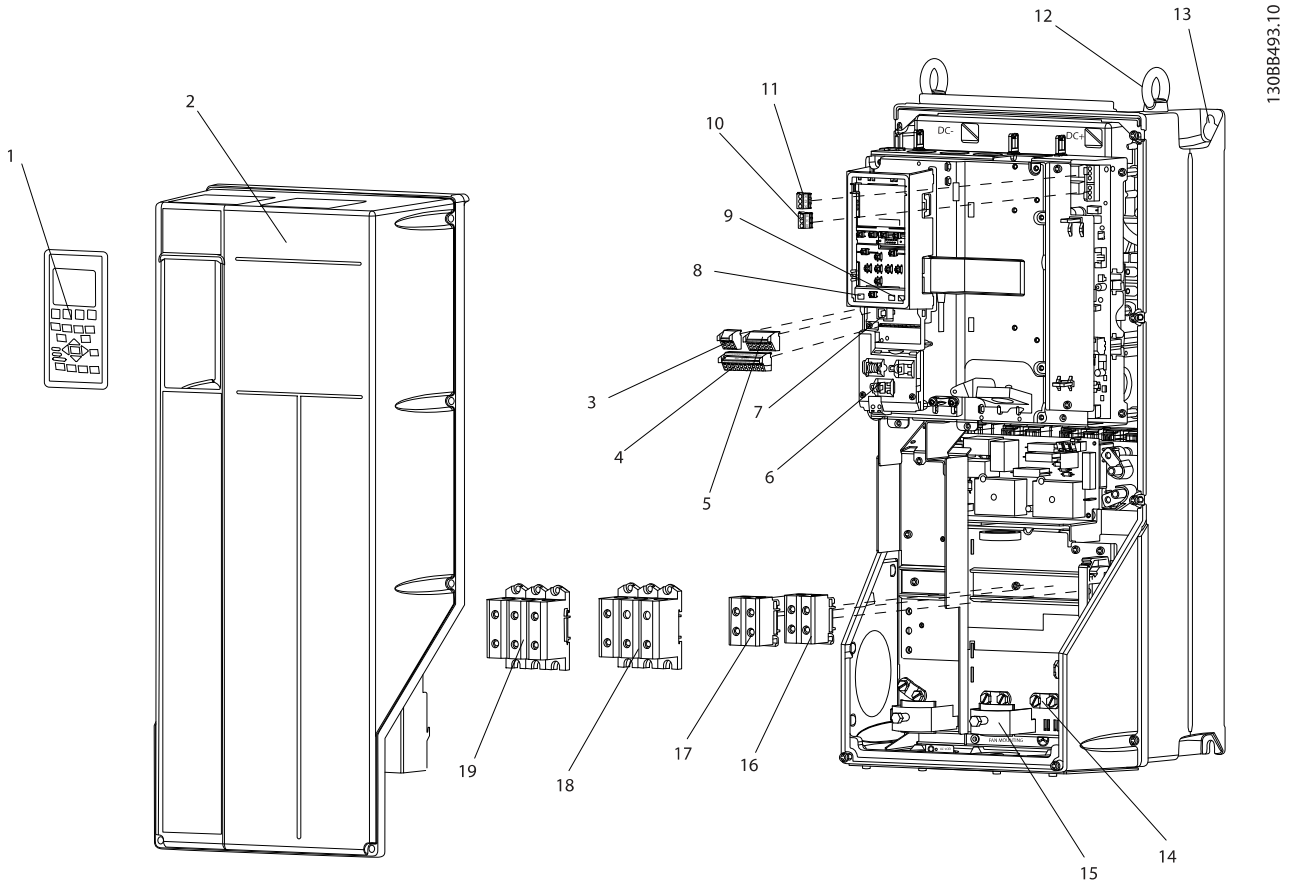


Illustration 1.2 Exploded View Unit Sizes 15, 21, 22, 31, and 32

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 Legend to *Illustration 1.2*

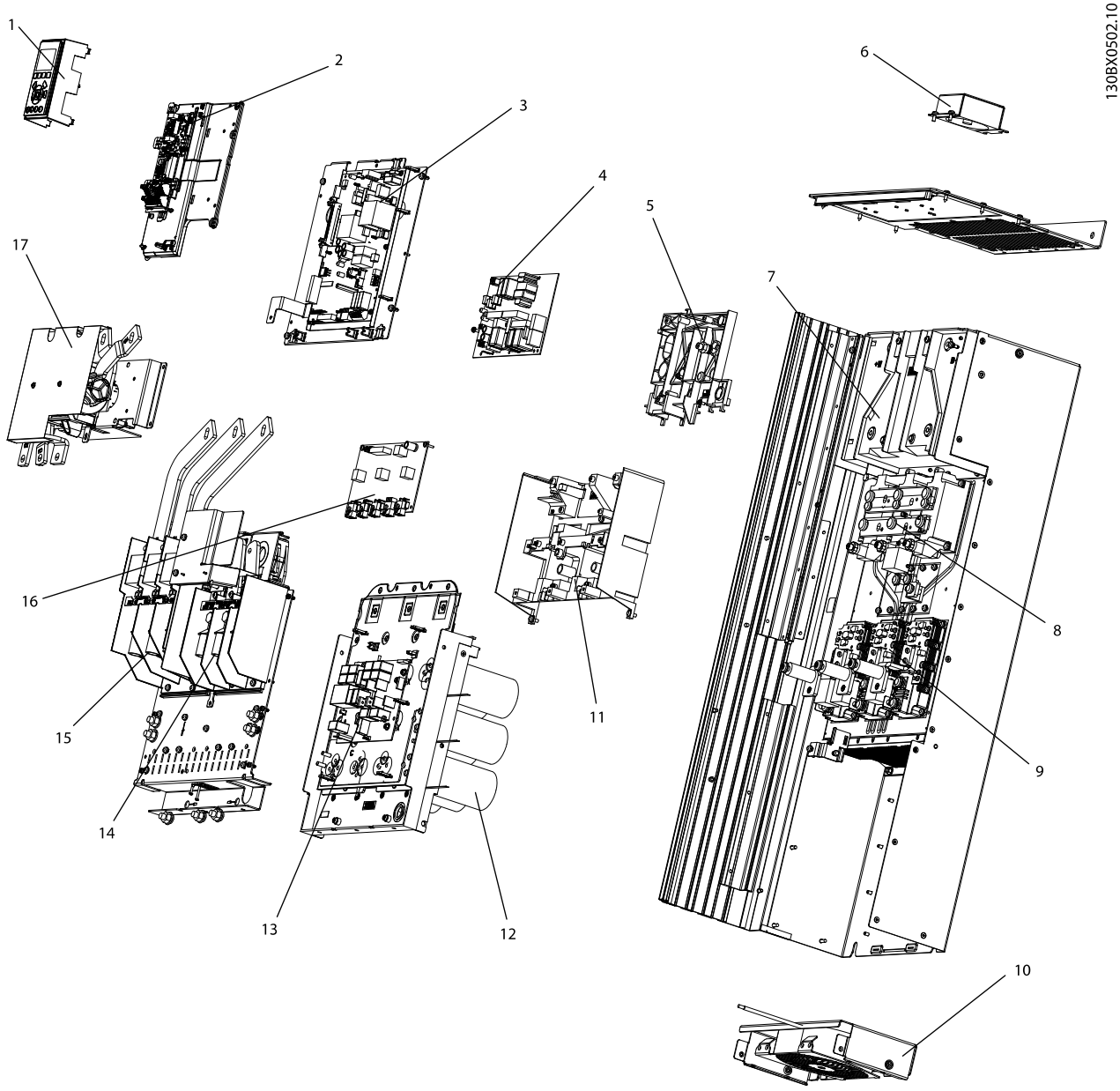


Illustration 1.3 Exploded View Unit Sizes 41h, 42h, 43h, 44h

1	Local control panel mounting bracket	10	Heatsink fan
2	Control card and mounting plate	11	Gate drive support bracket
3	Power card and mounting plate	12	Capacitor bank
4	Inrush card	13	Balance/High frequency card
5	Inrush card mounting bracket	14	Motor output terminals
6	Top fan (IP20 only)	15	Mains input terminals
7	DC inductor	16	Gate drive card
8	SCR/Diode modules	17	(optional) RFI filter
9	IGBT modules		

Table 1.3 Legend to *Illustration 1.3*

1

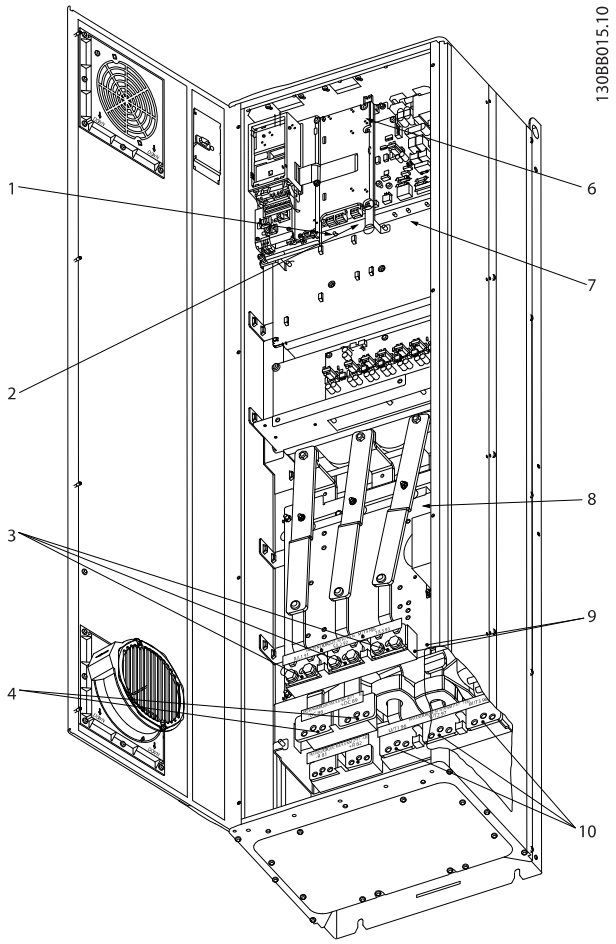


Illustration 1.4 Compact IP21 (NEMA 1) and IP54 (NEMA 12), Unit Sizes 41, 42, 43, 44, 51, 52

1)	AUX Relay		
	01 02 03		
	04 05 06		
2)	Temp Switch	6)	SMPS Fuse (see *13.3 Fuse Specifications* for part number)
	106 104 105	7)	AUX Fan
3)	Line		100 101 102 103
	R S T		L1 L2 L1 L2
	91 92 93	8)	Fan Fuse (see *13.3 Fuse Specifications* for part number)
	L1 L2 L3	9)	Mains ground
4)	Load sharing	10)	Motor
	-DC +DC		U V W
	88 89		96 97 98
			T1 T2 T3

Table 1.4 Legend to *Illustration 1.4*

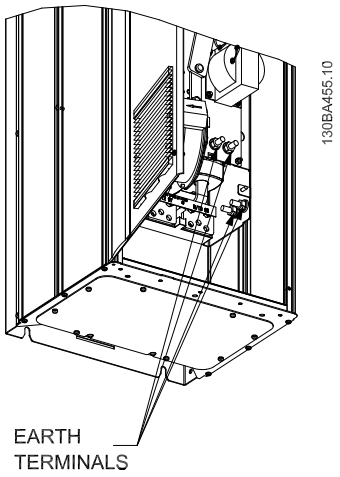


Illustration 1.5 Position of Earth Terminals IP21 (NEMA Type 1) and IP54 (NEMA Type 12)

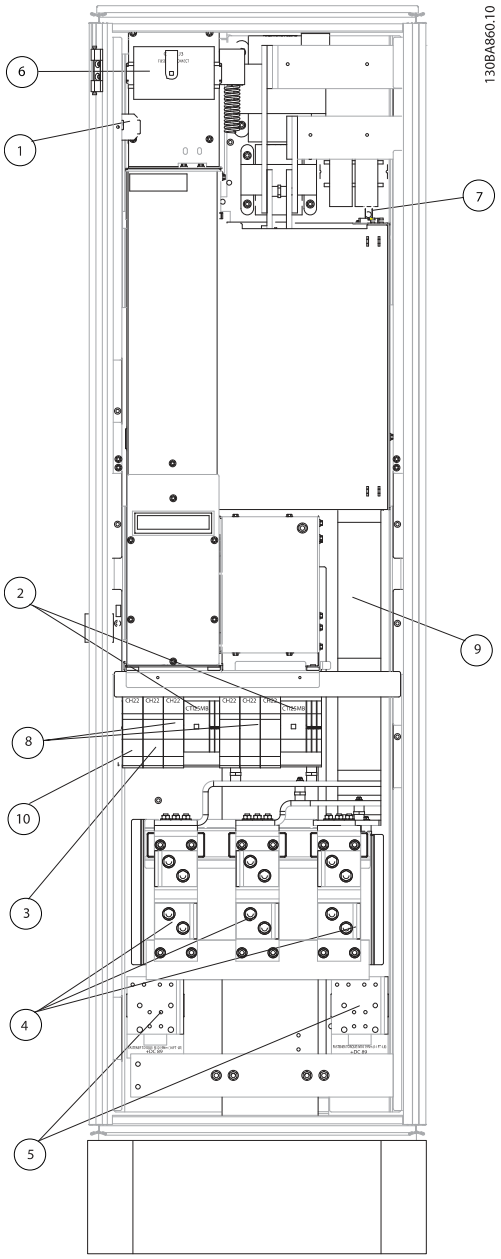


Illustration 1.6 Rectifier Cabinet, unit sizes 61, 62, 63 and 64

1)	24 V DC, 5 A	5)	Loadsharing
	T1 Output Taps		-DC +DC
	Temp Switch		88 89
	106 104 105	6)	Control Transformer Fuses (2 or 4 pieces). See *13.3 Fuse Specifications* for part numbers
2)	Manual Motor Starters	7)	SMPS Fuse. See *13.3 Fuse Specifications* for part numbers
3)	30 A Fuse Protected Power Terminals	8)	Manual Motor Controller fuses (3 or 6 pieces). See *13.3 Fuse Specifications* for part numbers
4)	Line	9)	Line Fuses, unit sizes 61 and 62 (3 pieces). See *13.3 Fuse Specifications* for part numbers
	R S T	10)	30 Amp Fuse Protected Power fuses
	L1 L2 L3		

Table 1.5 Legend to *Illustration 1.6*

1

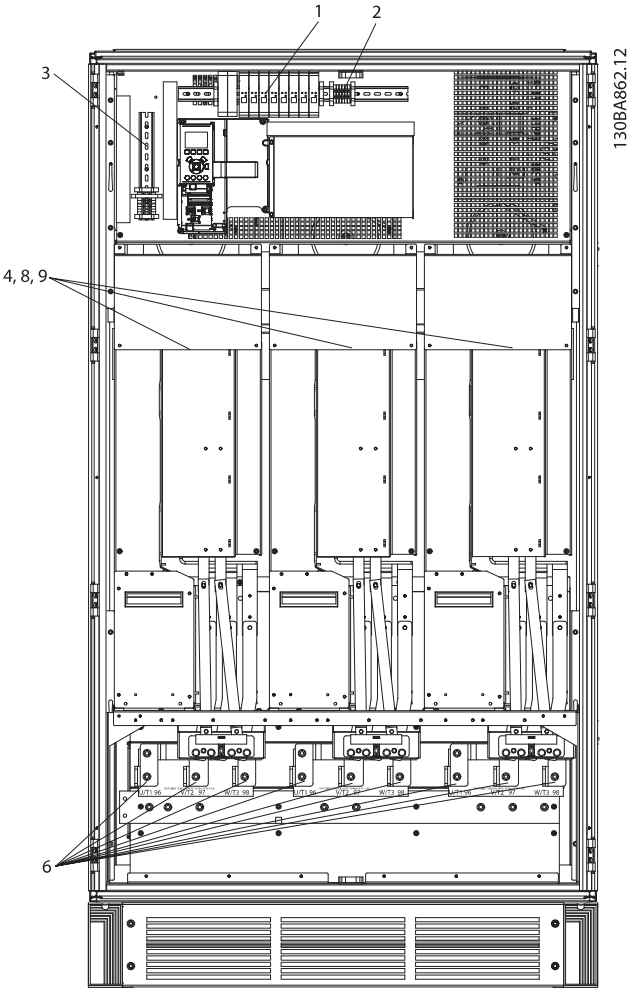


Illustration 1.7 Inverter Cabinet, Unit Sizes 62 and 64
(Unit Sizes 61 and 63 are similar with two inverter modules)

1)	External Temperature Monitoring	6)	Motor
2)	AUX Relay		U V W
	01 02 03		96 97 98
	04 05 06		T1 T2 T3
4)	AUX Fan	8)	Fan Fuses. See *13.3 Fuse Specifications* for part numbers
	100 101 102 103	9)	SMPS Fuses. See *13.3 Fuse Specifications* for part numbers
	L1 L2 L1 L2		

Table 1.6 Legend to *Illustration 1.6*

1.2 Purpose of the Manual

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

1.3 Additional Resources

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

- The *AF-600 FP Programming Guide, DET-620* provides greater detail on working with parameters and many application examples.
- Optional equipment is available that may change some of the procedures described. Reference the instructions supplied with those options for specific requirements. Contact the local GE supplier or visit the GE website for downloads or additional information.

1.4 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 changing temperature or pressure for controlling fan, compressor, or pump motors. 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.

1.5 Internal Frequency Converter Controller Functions

Illustration 1.8 is a block diagram of the frequency converter's internal components. See *Table 1.7* for their functions.

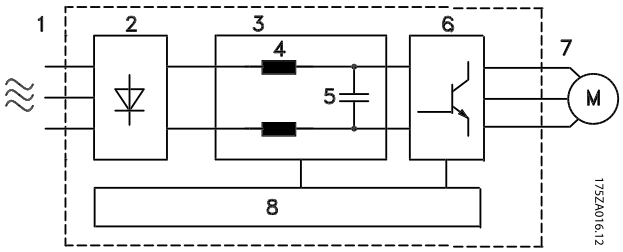


Illustration 1.8 Frequency Converter Block Diagram

Area	Title	Functions
1	Mains input	• Three-phase AC mains power supply to the frequency converter
2	Rectifier	• The rectifier bridge converts the AC input to DC current to supply inverter power
3	DC bus	• Intermediate DC-bus circuit handles the DC current
4	DC reactors	• Filter the intermediate DC circuit voltage • Prove line transient protection • Reduce RMS current • Raise the power factor reflected back to the line • Reduce harmonics on the AC input
5	Capacitor bank	• Stores the DC power • Provides ride-through protection for short power losses
6	Inverter	• Converts the DC into a controlled PWM AC waveform for a controlled variable output to the motor
7	Output to motor	• Regulated three-phase output power to the motor
8	Control circuitry	• Input power, internal processing, output, and motor current are monitored to provide efficient operation and control • User interface and external commands are monitored and performed • Status output and control can be provided

Table 1.7 Legend to *Illustration 1.8*

2 Installation

2.1 Installation Site Check List

- The frequency converter relies on the ambient air for cooling. Observe the limitations on ambient air temperature for optimal operation
- Ensure that the installation location has sufficient support strength to mount the frequency converter
- Keep the manual, drawings, and diagrams accessible for detailed installation and operation instructions. It is important that the manual is available for equipment operators.
- Locate equipment as near to the motor as possible. Keep motor cables as short as possible. Check the motor characteristics for actual tolerances. Do not exceed
    - 300 m (1000 ft) for unshielded motor leads
    - 150 m (500 ft) for shielded cable.
- Ensure that the ingress protection rating of the frequency converter is suitable for the installation environment. IP55 (NEMA 12) or IP66 (NEMA 4) enclosures may be necessary.

⚠CAUTION

Ingress protection

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

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

⚠CAUTION

Device damage through contamination

Do not leave the frequency converter uncovered.

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)

    Frequency converter

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

    Motor size and frequency converter power must match for proper overload protection

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

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 *2.3.4 Mounting*)
- Top and bottom clearance for air cooling must be provided. Generally, 100-225 mm (4-10 in) 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 1000 m (3300 ft) above sea level must be considered.

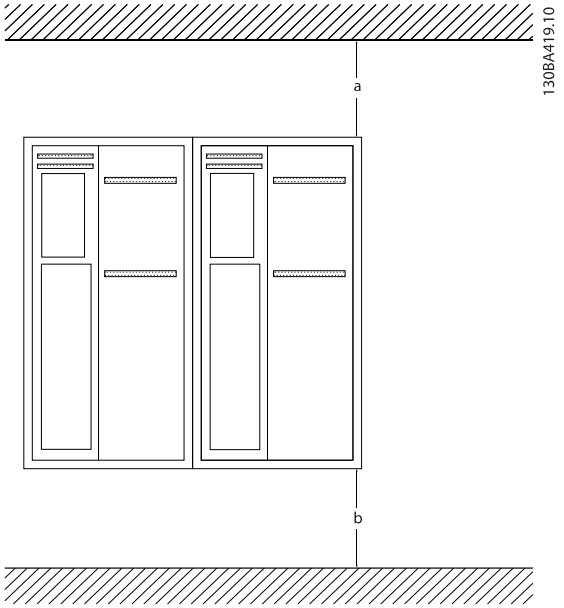


Illustration 2.1 Top and Bottom Cooling Clearance

Size	12-15	21-24	31, 33	32, 34, 41h, 42h, 43h, 44h, 51, and 52
a/b [mm]	100	200	200	225

Table 2.1 Minimum Airflow Clearance Requirements

2.3.2 Cooling and Airflow (125 HP and above)

Cooling

Cooling can be obtained in different ways, by using the cooling ducts in the bottom and the top of the unit, by taking air in and out the back of the unit or by combining the cooling possibilities.

2

Duct cooling

A back-channel cooling kit is available to direct the heatsink cooling air out of the panel when an IP20/chassis frequency converters is installed in a Rittal enclosure. Use of this kit reduces the heat in the panel and smaller door fans can be specified on the enclosure.

Back cooling

The back channel cooling air can be ventilated out of the room so that the heat from the back channel is not dissipated into the control room. A door fan(s) is required on the enclosure to remove the heat not contained in the backchannel of the frequency converters and any additional losses generated by other components inside the enclosure. The total required air flow must be calculated so that the appropriate fans can be selected.

Airflow

The necessary airflow over the heat sink must be secured. The flow rate is in *Table 2.2*.

Protection	Unit size	Door fan(s)/Top fan	Heatsink fan(s)
IP20/Chassis	43h	102 m^3/hr (60 CFM)	420 m^3/hr (250 CFM)
	44h	204 m^3/hr (120 CFM)	840 m^3/hr (500 CFM)
IP00/Chassis	51	340 m^3/h (200 cfm)	1445 m^3/h (850 cfm)
IP21/Nema 1	41h	102 m^3/hr (60 CFM)	420 m^3/hr (250 CFM)
	42h	204 m^3/hr (120 CFM)	840 m^3/hr (500 CFM)
	52	255 m^3/h (150 cfm)	1445 m^3/h (650 cfm)
	61, 62, 63, 64	700 m^3/h (412 cfm)*	985 m^3/h (580 cfm)*
IP54/Nema 12	41h	102 m^3/hr (60 CFM)	420 m^3/hr (250 CFM)
	42h	204 m^3/hr (120 CFM)	840 m^3/hr (500 CFM)
	52	255 m^33/h (150 cfm)	1445 m^3/h (650 cfm)
	61, 62, 63, 64	525 m^3/h (309 cfm)*	985 m^3/h (580 cfm)*

Table 2.2 Heatsink Airflow

** Airflow per fan. Unit Sizes 6X contain multiple fans.*

2.3.3 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

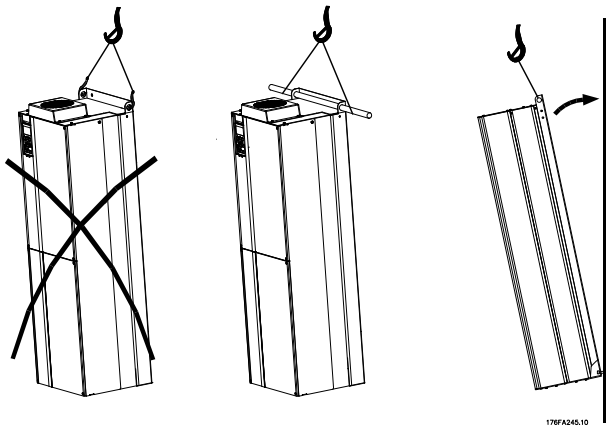


Illustration 2.2 Recommended Lifting Method, 4X and 5X Unit Sizes.

⚠WARNING

Maximum diameter for bar is 2.5 cm (1 inch). The angle from the top of the frequency converter to the lifting cable should be 60° or greater.

2.3.4 Mounting

- Mount the unit vertically
- The frequency converter 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 2.3* and *Illustration 2.4*)
- Improper mounting can result in over heating and reduced performance
- Use the slotted mounting holes on the unit for wall mounting, when provided
- For outdoor installations of Nema 4X / IP66 drives: The drive must be installed under a suitable cover to protect from direct exposure to sun, snow and ice.

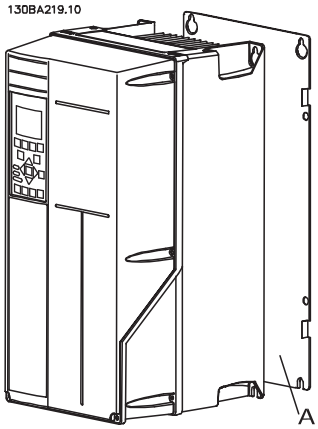


Illustration 2.3 Proper Mounting with Back Plate

Item A in *Illustration 2.3* and *Illustration 2.4* is a back plate properly installed for required airflow to cool the unit.

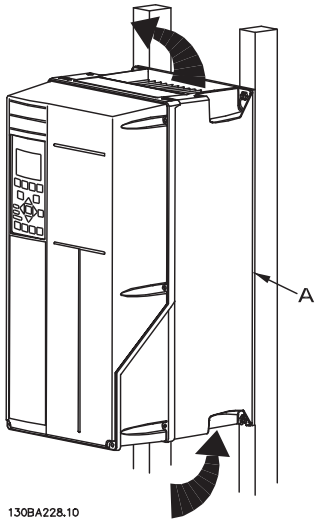


Illustration 2.4 Proper Mounting with Railings

NOTE

Back plate is needed when mounted on railings.

2.4 Acoustic Noise

The acoustic noise from the frequency converter originates from three sources:

1. DC intermediate circuit coils.
2. Integral fan.
3. RFI filter choke.

The typical values measured at a distance of 1 m from the unit:

Unit size	At reduced fan speed (50%) [dBA] *	Full fan speed [dBA]
12	51	60
13	51	60
14	50	55
15	54	63
21	61	67
22	58	70
23	59.4	70.5
24	53	62.8
31	52	62
32	55	65
33	56.4	67.3
34	-	-
41h/43h/45h	-	72
42h/44h/47h	-	75
61/62/63/64	78	80

Table 2.3 Measured Values

** For 4x, 5x and 6x sizes, reduced fan speed is at 87%, measured at 200 V.*

2.5 Electrical Installation

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

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

Illustration 2.5 shows a basic electrical connection.

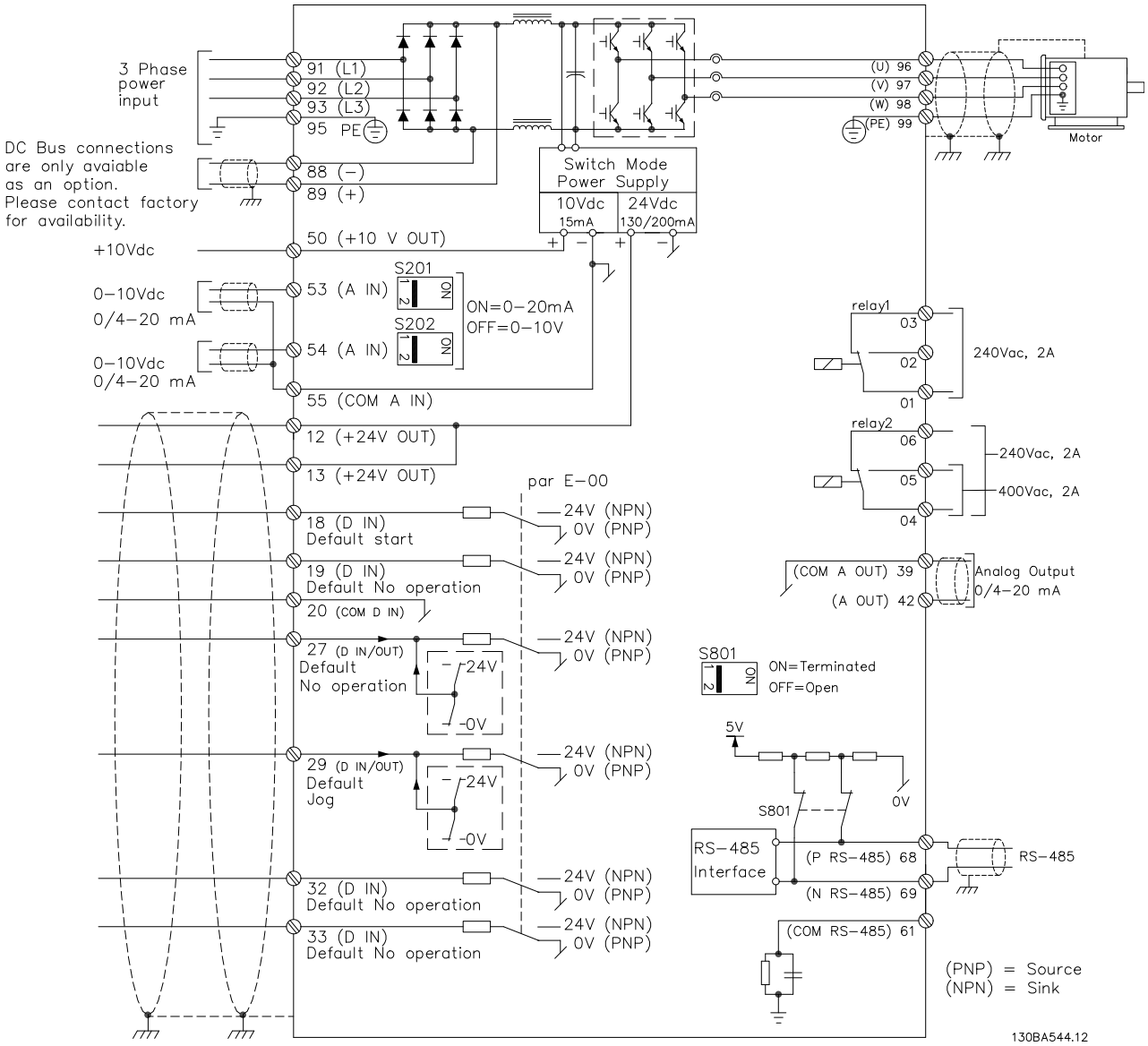


Illustration 2.5 Basic Wiring Schematic Drawing

2.5.1 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 *10 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 2.6*. See maximum fuse ratings in *13.3 Fuse Specifications*.

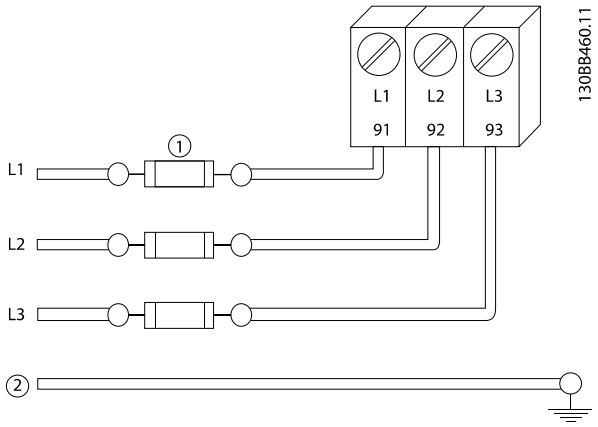


Illustration 2.6 Frequency Converter Fuses

Item #	Description
1	Fuses
2	Ground

Table 2.4 Legend to *Illustration 2.6*

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.

2.5.2 Earth (Grounding) Requirements

WARNING

GROUNDING HAZARD!

For operator safety, it is important to ground the frequency converter properly in accordance with national and local electrical codes as well as instructions contained within this document. Ground currents are higher than 3.5 mA. Failure to ground the frequency converter 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 3.5 mA must be established, see *2.5.2.1 Leakage Current (>3.5 mA)*
- A dedicated ground wire is required for input power, motor power and control wiring

- Do not ground one frequency converter to another in a “daisy chain” fashion
- Using high-strand wire to reduce electrical noise is recommended
- Follow motor manufacturer wiring requirements
- Use the clamps provided with on the equipment for proper ground connections to obtain a low HF impedance
- Keep the ground wire connections as short as possible to reduce the conductor impedance

2.5.2.1 Leakage Current (>3.5 mA)

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

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

- Earth ground wire of at least 10 mm^2
- 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

2.5.2.2 Grounding Using Shielded Cable

Earthing (grounding) clamps are provided for motor wiring (see *Illustration 2.7*).

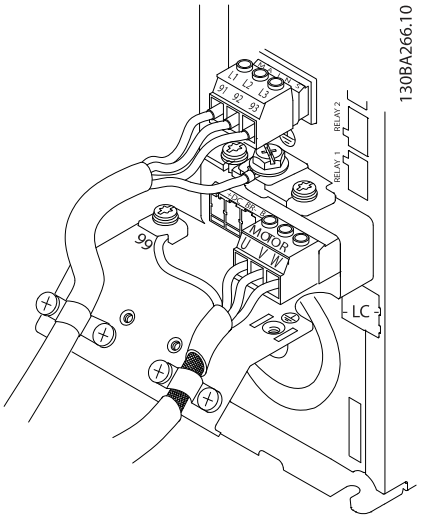


Illustration 2.7 Grounding with Shielded Cable

2.5.3 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.

- Comply with local and national electrical codes for cable sizes
- Do not install power factor correction capacitors between the frequency converter and the motor
- Do not wire a starting or pole-changing device between the frequency converter and the motor
- Connect the 3-phase motor wiring to terminals 96 (U), 97 (V), and 98 (W)
- Ground the cable in accordance with grounding instructions provided
- Follow motor manufacturer wiring requirements

NOTE

UNIT SIZE 6X REQUIREMENTS

An equal amount of wires to each inverter module is required. The cables must be of equal length within 10% between inverter and first common point in a phase (recommended at motor terminal)

2.5.4 AC Mains Connection

- Size wiring based upon the input current of the frequency converter.
- Comply with local and national electrical codes for cable sizes.
- Connect 3-phase AC input power wiring to terminals L1, L2, and L3.
- Connect 1-phase AC input power wiring to terminals L1 and L2. Only on single-phase rated drives.
- Input power will be connected to the mains input terminals.
- Ground the cable in accordance with grounding instructions provided in *2.5.2 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 filtercapacitors 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.

2.5.4.1 External Fan Supply (Unit Sizes 51 and 52)

In case the frequency converter is supplied by DC or if the fan must run independently of the power supply, an external power supply can be applied. The connection is made on the power card.

Terminal No.	Function
100, 101	Auxiliary supply S, T
102, 103	Internal supply S, T

Table 2.5

The connector located on the power card provides the connection of line voltage for the cooling fans. The fans are connected from factory to be supplied form a common AC line (jumpers between 100-102 and 101-103). If external supply is needed, the jumpers are removed and the supply is connected to terminals 100 and 101. A 5 Amp fuse should be used for protection. In UL applications this should be LittleFuse KLK-5 or equivalent.

2.5.5 Knock-outs (Unit Sizes 15, 21, 22, 31, and 32)

The legend for the illustrations:

A: Line in

B: Load sharing

C: Motor out

D: Free space

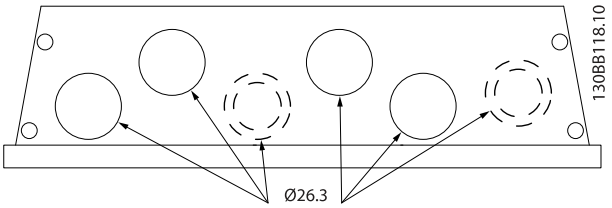


Illustration 2.8 Cable Entry Holes for Unit Size 15

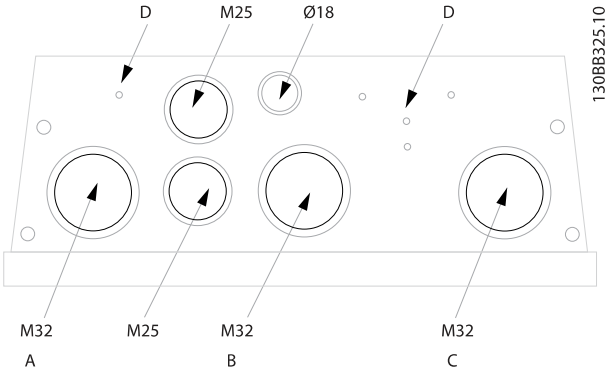


Illustration 2.9 Cable Entry Holes for Unit Size 21

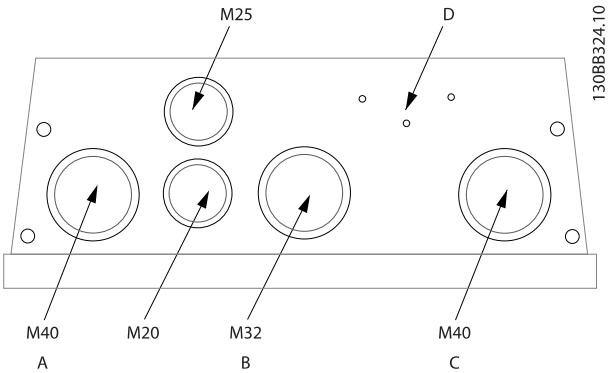


Illustration 2.10 Cable Entry Holes for Unit Size 22

2

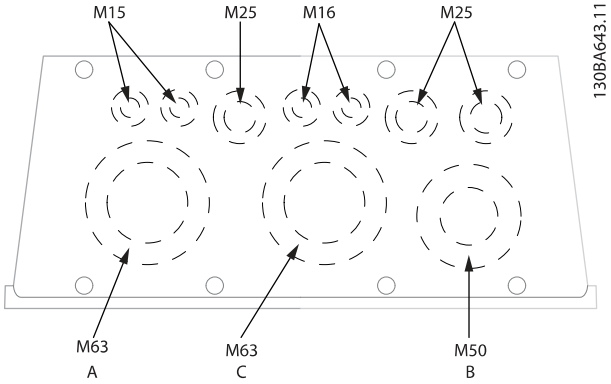


Illustration 2.11 Cable Entry Holes for Unit Size 31

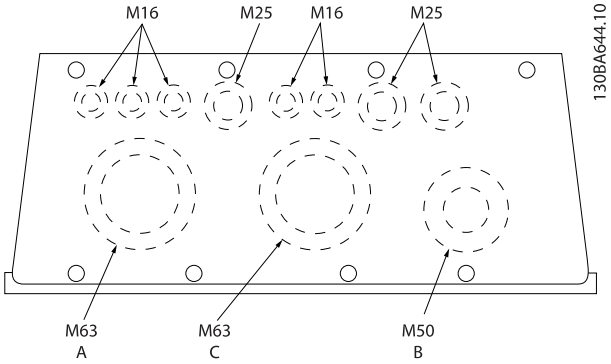


Illustration 2.12 Cable Entry Holes for Unit Size 32

2.5.6 Removal of Knockouts for Extra Cables

1. Remove cable entry from the frequency converter (Avoiding foreign parts falling into the frequency converter when removing knockouts)
2. Cable entry has to be supported around the knockout you intend to remove.
3. The knockout can now be removed with a strong mandrel and a hammer.
4. Remove burrs from the hole.
5. Mount Cable entry on frequency converter.

2.5.7 Gland/Conduit Entry (Unit Sizes 41h, 42h, and 51)

Cables are connected through the gland plate from the bottom. Remove the plate and plan where to place the entry for the glands or conduits. Prepare holes in the marked area on the drawing.

NOTE

The gland plate must be fitted to the frequency converter to ensure the specified protection degree, as well as ensuring proper cooling of the unit. If the gland plate is not mounted, the frequency converter may trip on Alarm 69, Pwr. Card Temp

2.5.8 Control Wiring

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

2.5.8.1 Access

- Remove access cover plate with a screw driver. See *Illustration 2.13*.
- Or remove front cover by loosening attaching screws. See *Illustration 2.14*.

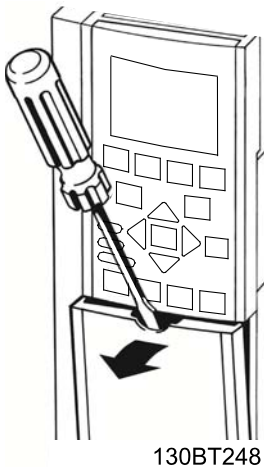


Illustration 2.13 Control Wiring Access for IP20/Open Chassis Enclosures

Illustration 2.14 Control Wiring Access for IP55/ Nema 12 and IP66/Nema 4X

2.5.8.2 Control Terminal Types

Illustration 2.15 shows the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 2.6*.

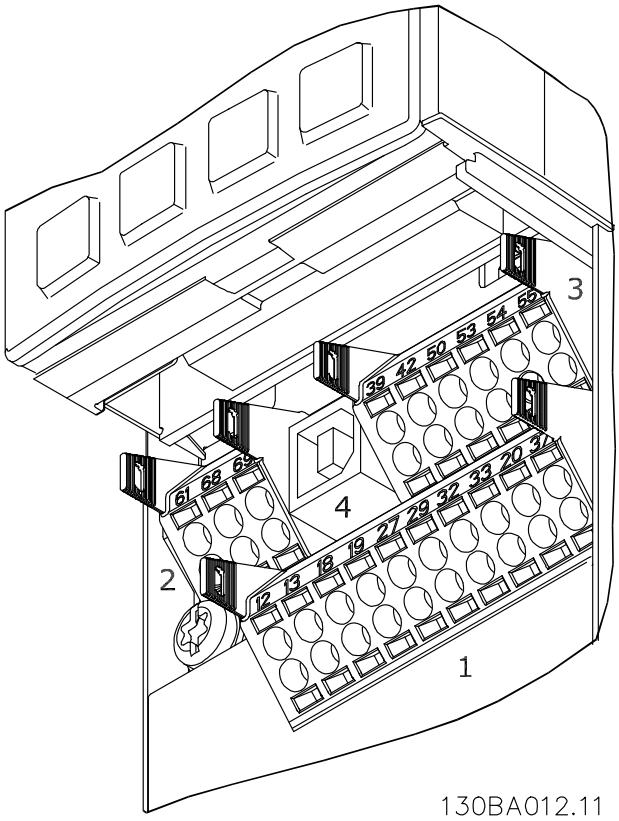


Illustration 2.15 Control Terminal Locations

- **Connector 1** provides four programmable digital inputs terminals, two additional digital terminals programmable as either input or output, a 24 V DC terminal supply voltage, and a common for optional customer supplied 24 V DC voltage
- **Connector 2** terminals (+)68 and (-)69 are for an RS-485 serial communications connection
- **Connector 3** provides two analog inputs, one analog output, 10 V DC supply voltage, and commons for the inputs and output
- **Connector 4** is a USB port available for use with the frequency converter
- 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 *13.2 General Technical Data* for terminal ratings details.

Terminal Description			
Digital Inputs/Outputs			
Terminal	**Parameter**	**Default Setting**	**Description**
12, 13	-	+24 V DC	24 V DC supply voltage. Maximum output current is 200 mA total for all 24 V loads. Useable for digital inputs and external transducers.
18	E-01	[8] Start	Digital inputs.
19	E-02	[0] No operation	
32	E-05	[0] No operation	
33	E-06	[0] No operation	
27	E-03	[0] No operation	Selectable for digital input and output. Default setting is input.
29	E-04	[14] JOG	
20	-		Common for digital inputs and 0 V potential for 24 V supply.
Analog Inputs/Outputs			
39	-		Common for analog output
42	AN-50	Speed 0 - High Limit	Programmable analog output. The analog signal is 0-20 mA or 4-20 mA at a maximum of 500 Ω

2

Terminal Description			
Digital Inputs/Outputs			
Terminal	Parameter	Default Setting	Description
50	-	+10 V DC	10 V DC analog supply voltage. 15 mA maximum commonly used for potentiometer or thermistor.
53	AN-1#	Reference	Analog input. Selectable for voltage or current. Switches A53 and A54 select mA or V.
54	AN-2#	Feedback	
55	-		Common for analog input
Serial Communication			
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#		
Relays			
01, 02, 03	E-24 [0]	[0] Alarm	Form C relay output. Usable for AC or DC voltage and resistive or inductive loads.
04, 05, 06	E-24 [1]	[0] Running	

Table 2.6 Terminal Description

2.5.8.3 Wiring to Control Terminals

Control terminal connectors can be unplugged from the frequency converter for ease of installation, as shown in *Illustration 2.16*.

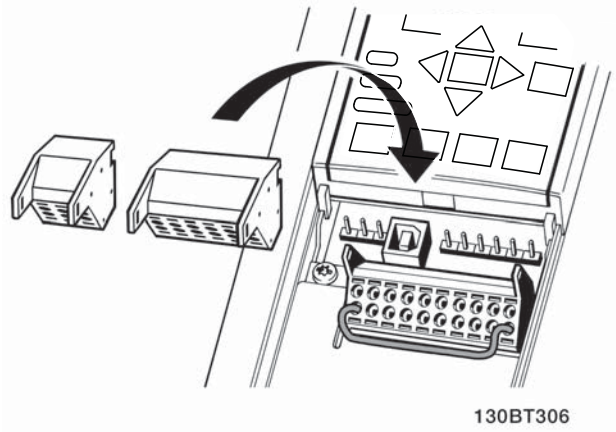


Illustration 2.16 Unplugging Control Terminals

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Illustration 2.17*.
2. Insert the bared control wire into the contact.
3. Remove the screwdriver to fasten the control wire into the contact.
4. Ensure the contact is firmly established and not loose. Loose control wiring can be the source of equipment faults or less than optimal operation.

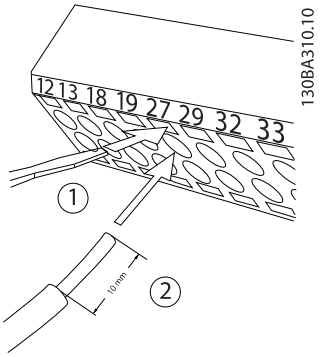


Illustration 2.17 Connecting Control Wiring

2.5.8.4 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^2.

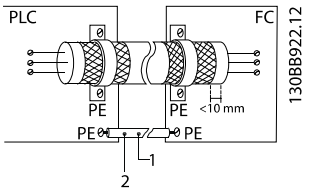


Illustration 2.18 Correct Screening

1	Min. 16 mm^2
2	Equalizing cable

Table 2.7 Legend to *Illustration 2.18*

50/60 Hz ground loops

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

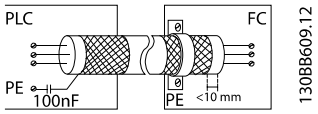


Illustration 2.19 50/60 Hz Ground Loops

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 in *Illustration 2.20*:

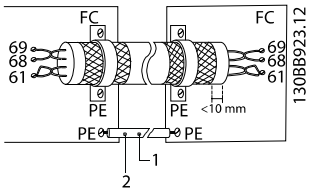


Illustration 2.20 Twisted-pair Cables

1	Min. 16 mm^2
2	Equalizing cable

Table 2.8 Legend to *Illustration 2.20*

Alternatively, the connection to terminal 61 can be omitted:

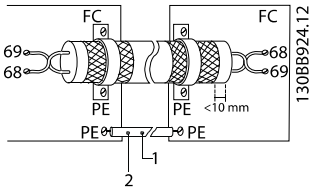


Illustration 2.21 Twisted-pair Cables without Terminal 61

1	Min. 16 mm^2
2	Equalizing cable

Table 2.9 Legend to *Illustration 2.21*

2.5.8.5 Control Terminal Functions

Frequency converter 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 2.6* for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See *4 User Interface* for details on accessing parameters and *5 About Programming* for details on programming.
- The default terminal programming is intended to initiate frequency converter functioning in a typical operational mode.

2.5.8.6 Terminal 53 and 54 Switches

- Analog input terminals 53 and 54 can select either voltage (0 to 10 V) or current (0/4-20 mA) input signals
- Remove power to the frequency converter before changing switch positions
- Set switches A53 and A54 to select the signal type. U selects voltage, I selects current.
- The switches are accessible when the keypad has been removed (see *Illustration 2.22*).

⚠WARNING

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*

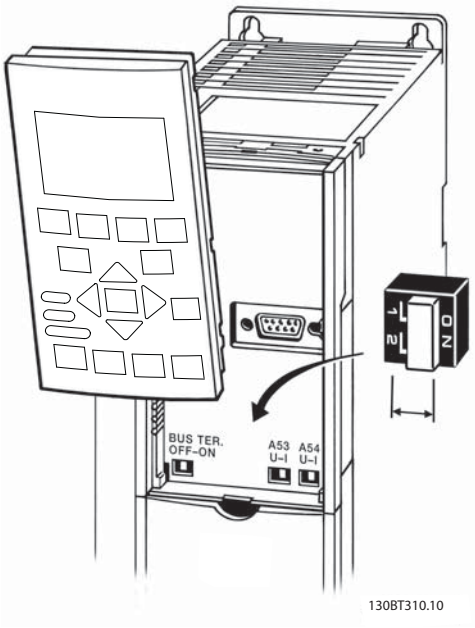


Illustration 2.22 Location of Terminals 53 and 54 Switches

Cable	Screened twisted pair (STP)
Impedance	120 Ω
Max. cable length [m]	1200 (including drop lines) 500 station-to-station

Table 2.10 Cable Information

2.5.9 Serial Communication

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

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 frequency converter, even when disconnected from mains input. For initial start up, make no assumptions about power components. Follow pre-start procedures. Failure to follow pre-start procedures could result in personal injury or damage to equipment.

1. Input power to the unit must be OFF and locked out. Do not rely on the frequency converter disconnect switches for input power isolation.
2. Verify that there is no voltage on input terminals L1 (91), L2 (92), and L3 (93), phase-to-phase and phase-to-ground,
3. Verify that there is no voltage on output terminals 96 (U), 97 (V), and 98 (W), phase-to-phase and phase-to-ground.
4. Confirm continuity of the motor by measuring ohm values on U-V (96-97), V-W (97-98), and W-U (98-96).
5. Check for proper grounding of the frequency converter as well as the motor.
6. Inspect the frequency converter 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 frequency converter and motor.

CAUTION

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

Inspect for	Description	☑
Auxiliary equipment	• Look for auxiliary equipment, switches, disconnects, or input fuses/circuit breakers that may reside on the input power side of the frequency converter or output side to the motor. Ensure that they are ready for full speed operation. • Check function and installation of any sensors used for feedback to the frequency converter • Remove power factor correction caps on motor(s), if present	
Cable routing	• Ensure that input power, motor wiring and control wiring are separated or in three separate metallic conduits for high frequency noise isolation	
Control wiring	• Check for broken or damaged wires and loose connections • Check that control wiring is isolated from power and motor wiring for noise immunity • Check the voltage source of the signals, if necessary • The use of shielded cable or twisted pair is recommended. Ensure that the shield is terminated correctly	
Cooling clearance	• Measure that top and bottom clearance is adequate to ensure proper air flow for cooling	
EMC considerations	• Check for proper installation regarding electromagnetic compatibility	

Inspect for	Description	☑
Environmental considerations	• See equipment label for the maximum ambient operating temperature limits • Humidity levels must be 5-95% non-condensing	
Fusing and circuit breakers	• Check for proper fusing or circuit breakers • Check that all fuses are inserted firmly and in operational condition and that all circuit breakers are in the open position	
Earthing (Grounding)	• The unit requires an earth wire (ground wire) from its chassis to the building earth (ground) • Check for good earth connections (ground connections) that are tight and free of oxidation • Earthing (grounding) to conduit or mounting the back panel to a metal surface is not a suitable earth (ground)	
Input and output power wiring	• Check for loose connections • Check that motor and mains are in separate conduit or separated screened cables	
Panel interior	• Inspect that the unit interior is free of dirt, metal chips, moisture, and corrosion	
Switches	• Ensure that all switch and disconnect settings are in the proper positions	
Vibration	• Check that the unit is mounted solidly or that shock mounts are used, as necessary • Check for an unusual amount of vibration	

Table 3.1 Start Up Check List

3.2 Applying Power

⚠WARNING

HIGH VOLTAGE!

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

⚠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 comply could result in death, serious injury, equipment, or property damage.

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

3.3 Basic Operational Programming

3.3.1 Required Initial Frequency Converter Programming

Frequency converters require basic operational programming before running for best performance. Basic operational programming requires entering motor-nameplate data for the motor being operated and the minimum and maximum motor speeds. 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 before 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 *F-01 Frequency Setting 1*.
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, see *2.5.1 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*

3.4 Auto Tune

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

- The frequency converter builds a mathematical model of the motor for regulating output motor current. The procedure also tests the input phase balance of electrical power. It compares the

motor characteristics with the data entered in P-02, P-03, P-06, P-07, F-04 and F-05.

- The motor shaft does not turn and no harm is done to the motor while running the Auto tune
- 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 *[2] Reduced Auto Tune*
- If warnings or alarms occur, see *10 Warnings and Alarms* for resetting the frequency converter after a trip.
- Run this procedure on a cold motor for best results

3.5 Check Motor Rotation

Before running the frequency converter, check the motor rotation. The motor will run briefly at 5 Hz or the minimum frequency set in *F-16 Motor Speed Low Limit [Hz]*.

1. Press [Main Menu] twice on the keypad.
2. Enter Parameter Data Set and scroll to *P-## Motor Data* and press [OK] to enter.
3. Scroll to *P-08 Motor Rotation Check*.
4. Press [OK].
5. Scroll to *[1] Enable*.

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

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

To change the direction of rotation, remove power to the frequency converter and wait for power to discharge. Reverse the connection of any two of the three motor cables on the motor or frequency converter side of the connection.

3.6 Local-control Test

⚠CAUTION

MOTOR START!

Ensure that the motor, system and any attached equipment are ready for start. It is the responsibility of the user to ensure safe operation under any 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 provides a local start command to the frequency converter. The [Off] key provides the stop function.

When operating in local mode, [▲] and [▼] increase and decrease the speed output of the frequency converter. [◄] and [►] move the display cursor in the numeric display.

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

If acceleration problems were encountered

- If warnings or alarms occur, see *10 Warnings and Alarms*
- Check that motor data is entered correctly
- Increase the accel 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 *10 Warnings and Alarms*.
- Check that motor data is entered correctly.
- Increase the decel time in *F-08 Decel Time 1*.

See *4.1.1 Keypad* for resetting the frequency converter after a trip.

NOTE

***3.1 Pre-start* to *3.6 Local-control Test* conclude the procedures for applying power to the frequency converter, 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. is intended to help with this task. Other aids to application set-up are listed in *1.3 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 condition. Failure to do so could result in personal injury or equipment damage.

1. Press [Auto].
2. Ensure that external control functions are properly wired to the frequency converter and all programming is 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 *10 Warnings and Alarms* for resetting the frequency converter after a trip..

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 [▲]/[▼] keys.

4.1.1 Keypad Layout

The keypad is divided into 4 functional groups (see *Illustration 4.1*).

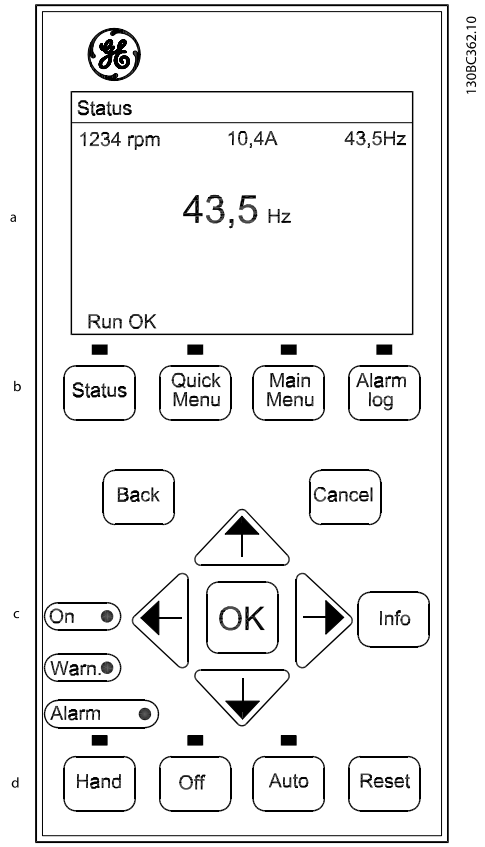


Illustration 4.1 Keypad

a	Display area.
b	Display menu keys for changing the display to show status options, programming, or error message history.
c	Navigation keys for programming functions, moving the display cursor, and speed control in local operation. The status indicator lights are also in this group.
d	Operational mode keys and reset.

Table 4.1 Legend to *Illustration 4.1*

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 24 V DC 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 the menu Keypad Set-up
- Display 2 has an alternate larger display option
- The frequency converter status at the bottom line of the display is generated automatically and is not selectable

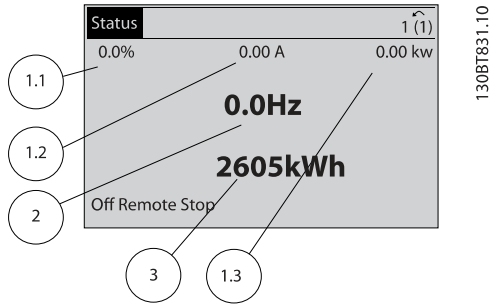


Illustration 4.2 Display Readouts

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

Table 4.2 Legend to *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 Menu Keys

Key	Function
Status	Shows operational information. • In Auto mode, press to toggle between status read-out displays • Press repeatedly to scroll through each status display • Press [Status] plus [▲] or [▼] to adjust the display brightness • The symbol in the upper right corner of the display shows the direction of motor rotation and which set-up is active. This is not programmable.
Quick Menu	Allows access to programming parameters for initial set up instructions and many detailed application instructions. • Press to access *Quick Start* for sequenced instructions to program the basic frequency controller set up • Follow the sequence of parameters as presented for the function set up
Main Menu	Allows access to all programming parameters. • Press twice to access top-level index • Press once to return to the last location accessed • Press to enter a parameter number for direct access to that parameter
Alarm Log	Displays a list of current warnings, the last 10 alarms, and the maintenance log. • For details about the frequency converter before it entered the alarm mode, select the alarm number using the navigation keys and press [OK].

Table 4.3 Function Description Menu Keys

4

4.1.4 Navigation Keys

Navigation keys are used for programming functions and moving the display cursor. The navigation keys also provide speed control in local (hand) operation. There are also 3 frequency converter status indicator lights in this area.

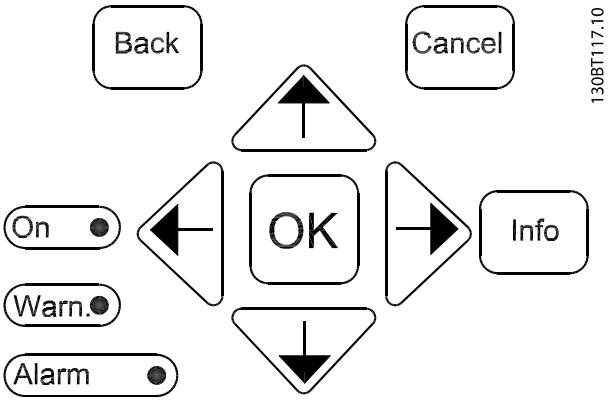


Illustration 4.4 Navigation Keys

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

Table 4.4 Navigation Keys Functions

Light	Indicator	Function
Green	ON	The ON light activates when the frequency converter receives power from mains voltage, a DC bus terminal, or 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 4.5 Indicator Lights Functions

4.1.5 Operation Keys

Operation keys are found at the bottom of the keypad.

Illustration 4.5 Operation Keys

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

Table 4.6 Operation Keys Functions

4.2 Back Up and Copying Parameter Settings

Programming data is stored internally in the frequency converter.

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

⚠WARNING

UNINTENDED START!

When the frequency converter is connected to AC mains, 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, or 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 before initialisation.

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

- Initialisation using *H-03 Restore Factory Settings* does not change frequency converter 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 frequency converter information

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

5 About Programming

5.1 Introduction

The frequency converter 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.

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

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

5.2 Programming Example

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

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

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

1. *F-01 Frequency Setting 1*

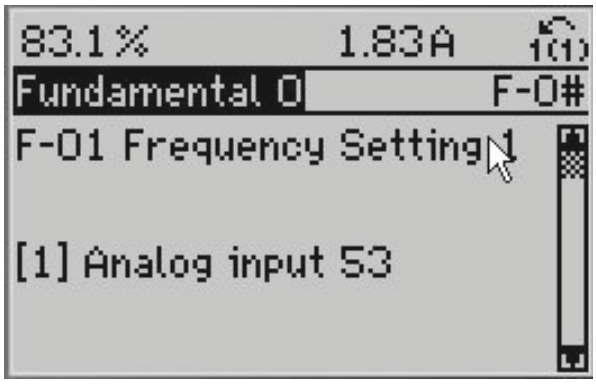


Illustration 5.1 References *F-01 Frequency Setting 1*

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

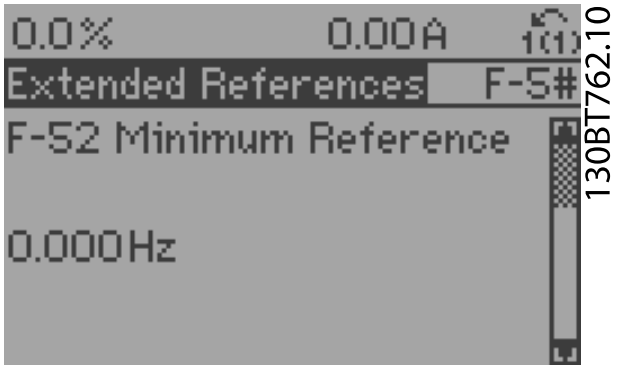


Illustration 5.2 Analog Reference *F-52 Minimum Reference*

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

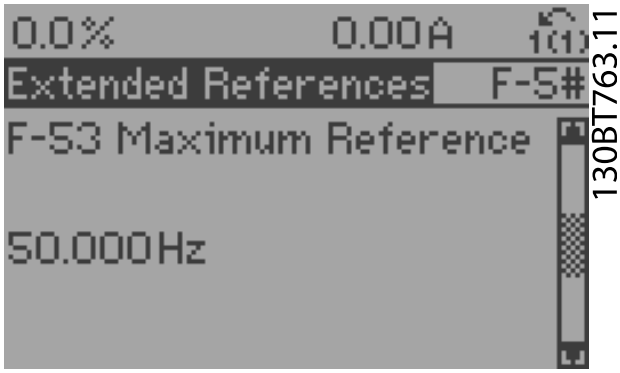


Illustration 5.3 Analog Reference *F-53 Maximum Reference*

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

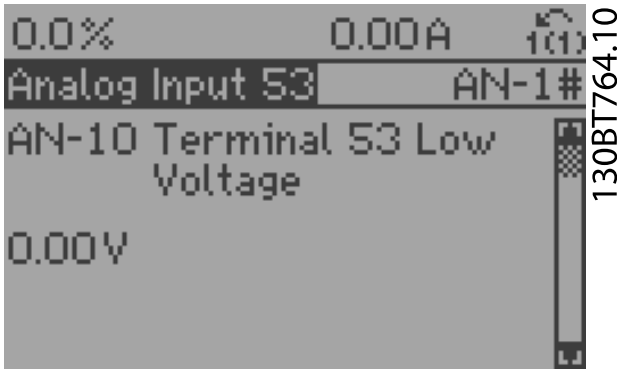


Illustration 5.4 Analog Reference *AN-10 Terminal 53 Low Voltage*

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

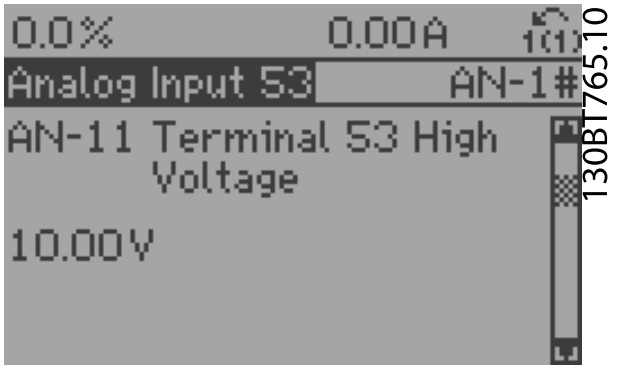


Illustration 5.5 Analog Reference *AN-11 Terminal 53 High Voltage*

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

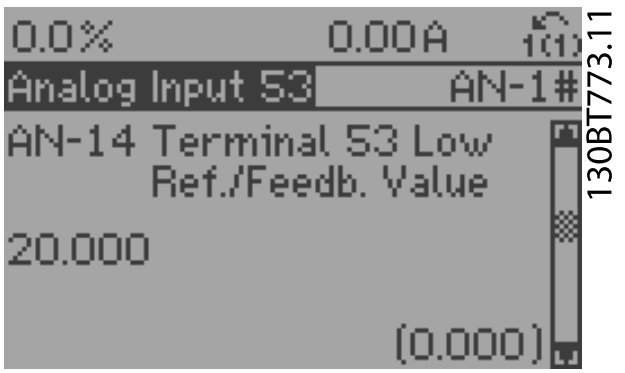


Illustration 5.6 Analog Reference *AN-14 Terminal 53 Low Ref./ Feedb. Value*

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

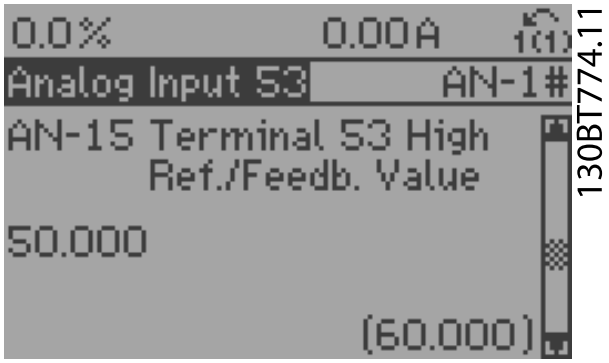


Illustration 5.7 Analog Reference *AN-15 Terminal 53 High Ref./ Feedb. Value*

With an external device providing a 0-10 V control signal connected to frequency converter 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 5.8 shows the wiring connections used to enable this set up.

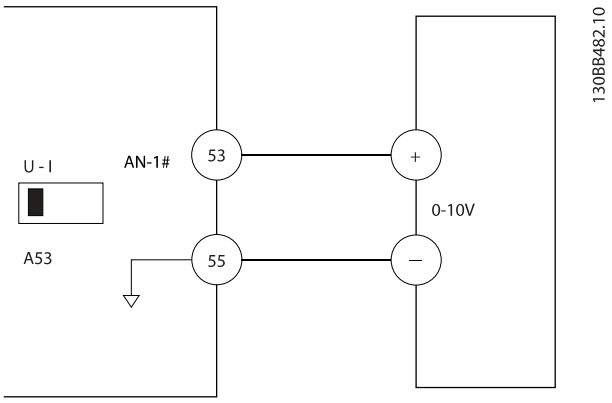


Illustration 5.8 Wiring Example for External Device Providing 0-10 V Control Signal (Frequency Converter Left, External Device Right)

5

5.3 Control Terminal Programming Examples

Control terminals can be programmed.

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

See *Table 2.6* for control terminal parameter number and default setting. (Default setting can change based on the selection in *K-03 Regional Settings*.)

5

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

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

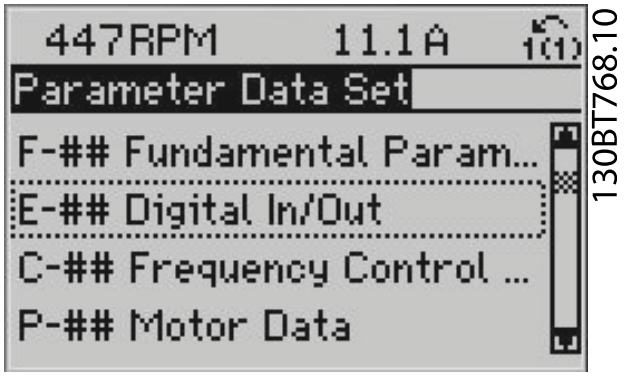


Illustration 5.9 *AN-15 Terminal 53 High Ref./Feedb. Value*

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

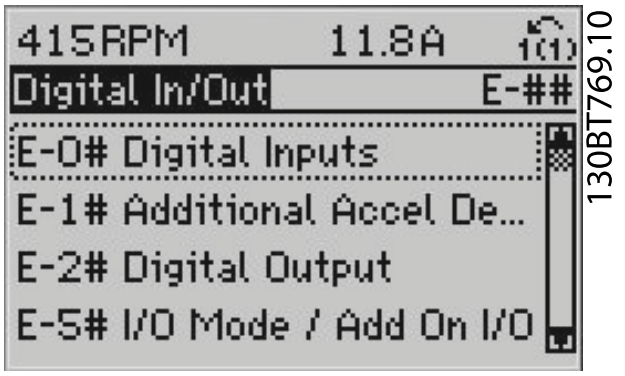


Illustration 5.10 Digital In/Out

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

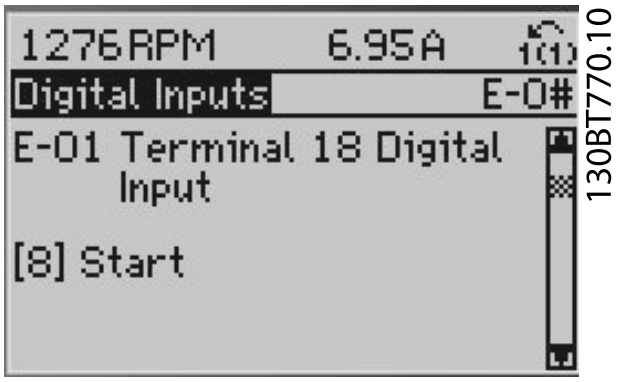


Illustration 5.11 Digital Inputs

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	230 V/400 V/575 V	208 V/460 V/575 V
F-04 Base Frequency	50 Hz	60 Hz
F-53 Maximum Reference	50 Hz	60 Hz
F-54 Reference Function	Sum	External/Preset
F-17 Motor Speed High Limit [RPM] See Note 3 and 5	1500 PM	1800 RPM
F-15 Motor Speed High Limit [Hz] See Note 4	50 Hz	60 Hz
F-03 Max Output Frequency 1	100 Hz	120 Hz
H-73 Warning Speed High	1500 RPM	1800 RPM
E-24 Function Relay	Alarm	No alarm
AN-15 Terminal 53 High Ref./Feedb. Value	50	60

Parameter	International default parameter value	North American default parameter value
AN-50 Terminal 42 Output	Speed 0-HighLim	Speed 4-20 mA
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 1500 RPM and for a 2 poled motor 3000 RPM. The corresponding values for North America is 1800 and 3600 RPM, respectively.

5.4.1 Parameter Data Check

1. Press [Quick Menu].
2. Scroll to *Parameter Data Check* and press [OK].

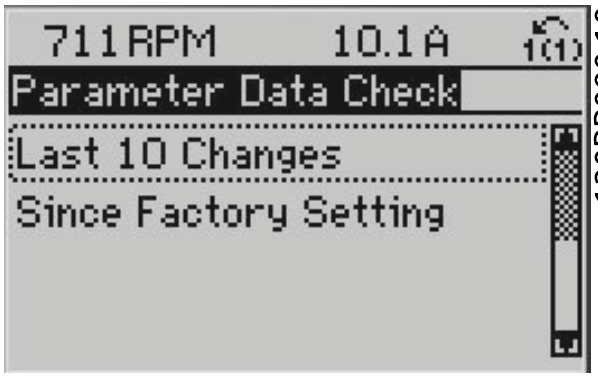


Illustration 5.12 Parameter Data Check

3. Select *Parameter Data Check* to view all programming changes or *Last 10 Changes* for the most recent.

5.5 Parameter Menu Structure

Establishing the correct programming for applications often requires setting functions in several related parameters. These parameter settings provide the frequency converter with system details it needs 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*.

5.5.1 Quick Menu Structure

K-01	Language
K-02	Motor Speed Unit
P-02	Motor Power [HP]
P-07	Motor Power [kW]
F-05	Motor Rated Voltage
P-03	Motor Current
F-04	Base Frequency
P-06	Base Speed
F-01	Frequency Setting 1
F-02	Operation Method
F-07	Accel Time 1
F-08	Decel Time 1
F-10	Electronic Overload
F-15	Motor Speed High Limit [Hz]
F-16	Motor Speed Low Limit [Hz]
H-08	Reverse Lock
P-04	Auto Tune

Table 5.2 Quick Start

5.5.2 Main Menu Structure

Keypad Set-Up
K-0# Keypad Basic Settings
K-01 Language
K-02 Motor Speed Unit
K-03 Regional Settings
K-04 Operating State at Power-up
K-05 Local Mode Unit
K-1# Keypad Set-Up Operations
K-10 Active Set-up
K-11 Edit Set-up
K-12 This Set-up Linked to
K-13 Readout: Linked Set-ups
K-14 Readout: Edit Set-ups / Channel
K-2# Keypad Display
K-20 Display Line 1.1 Small
K-21 Display Line 1.2 Small
K-22 Display Line 1.3 Small
K-23 Display Line 2 Large
K-24 Display Line 3 Large
K-25 Quick Start
K-3# Keypad Custom Readout
K-30 Unit for Custom Readout
K-31 Min Value of Custom Readout
K-32 Max Value of Custom Readout
K-37 Display Text 1
K-38 Display Text 2
K-39 Display Text 3
K-4# Keypad Buttons
K-40 [Hand] Button on Keypad
K-41 [Off] Button on Keypad
K-42 [Auto] Button on Keypad
K-43 [Reset] Button on Keypad
K-5# Copy/Save
K-50 Keypad Copy
K-51 Set-up Copy
K-6# Password Protection
K-60 Main Menu Password
K-61 Access to Main Menu w/o Password
K-65 Quick Menu Password
K-66 Access to Quick Menu w/o Password
K-67 Bus Password Access
K-7# Clock Settings
K-70 Date and Time
K-71 Date Format
K-72 Time Format
K-74 DST/Summertime
K-76 DST/Summertime Start
K-77 DST/Summertime End
K-79 Clock Fault
K-8# Days and Date/Time Readout
K-81 Working Days
K-82 Additional Working Days
K-83 Additional Non-Working Days
K-89 Date and Time Readout
Parameter Data Set
F-## Fundamental Parameters
F-0# Fundamental 0
F-01 Frequency Setting 1
F-02 Operation Method
F-03 Max Output Frequency 1
F-04 Base Frequency
F-05 Motor Rated Voltage
F-07 Accel Time 1
F-08 Decel Time 1
F-09 Torque Boost
F-1# Fundamental 1
F-10 Electronic Overload
F-11 Motor External Fan
F-12 Motor Thermistor Input
F-15 Motor Speed High Limit [Hz]
F-16 Motor Speed Low Limit [Hz]
F-17 Motor Speed High Limit [RPM]
F-18 Motor Speed Low Limit [RPM]
F-2# Fundamental 2
F-20 PM Start Mode
F-24 Holding Time
F-26 Motor Noise (Carrier Freq)
F-27 Motor Tone Random
F-3# Fundamental 3
F-37 Adv. Switching Pattern
F-38 Overmodulation
F-4# Fundamental 4
F-40 Torque Limiter (Driving)
F-41 Torque Limiter (Braking)
F-43 Current Limit
F-5# Extended References
F-52 Minimum Reference
F-53 Maximum Reference
F-54 Reference Function
F-6# References
F-64 Preset Relative Reference
F-9# Digital Pot.Meter
F-90 Step Size
F-91 Accel/Decel Time
F-92 Power Restore
F-93 Maximum Limit
F-94 Minimum Limit
F-95 Accel/Decel Ramp Delay
E-## Digital In/Out
E-0# Digital Inputs
E-00 Digital I/O Mode
E-01 Terminal 18 Digital Input
E-02 Terminal 19 Digital Input
E-03 Terminal 27 Digital Input
E-04 Terminal 29 Digital Input
E-05 Terminal 32 Digital Input
E-06 Terminal 33 Digital Input
E-1# Additional Accel Decel Ramps
E-10 Accel Time 2
E-11 Decel Time 2
E-2# Digital Outputs
E-20 Terminal 27 Digital Output
E-21 Terminal 29 Digital Output
E-24 Function Relay
E-26 On Delay, Relay
E-27 Off Delay, Relay
E-5# I/O Mode / Add On I/O
E-51 Terminal 27 Mode
E-52 Terminal 29 Mode
E-53 Terminal X30/2 Digital Input
E-54 Terminal X30/3 Digital Input
E-55 Terminal X30/4 Digital Input
E-56 Term X30/6 Digi Out (OPCGPIO)
E-57 Term X30/7 Digi Out (OPCGPIO)
E-6# Pulse Input
E-60 Term. 29 Low Frequency
E-61 Term. 29 High Frequency
E-62 Term. 29 Low Ref./Feedb. Value
E-63 Term. 29 High Ref./Feedb. Value
E-64 Pulse Filter Time Constant #29
E-65 Term. 33 Low Frequency
E-66 Term. 33 High Frequency
E-67 Term. 33 Low Ref./Feedb. Value
E-68 Term. 33 High Ref./Feedb. Value
E-69 Pulse Filter Time Constant #33
E-7# Pulse Output
E-70 Terminal 27 Pulse Output Variable
E-71 Pulse Output Max Freq #27
E-72 Terminal 29 Pulse Output Variable
E-74 Pulse Output Max Freq #29
E-75 Terminal X30/6 Pulse Output Variable
E-76 Pulse Output Max Freq #X30/6
E-9# Bus Controlled
E-90 Digital & Relay Bus Control
E-93 Pulse Out #27 Bus Control
E-94 Pulse Out #27 Timeout Preset
E-95 Pulse Out #29 Bus Control
E-96 Pulse Out #29 Timeout Preset
E-97 Pulse Out #X30/6 Bus Control
E-98 Pulse Out #X30/6 Timeout Preset
C-## Frequency Control Functions
C-0# Frequency Control Functions
C-01 Jump Frequency From [Hz]
C-02 Jump Speed From [RPM]
C-03 Jump Speed To [RPM]
C-04 Jump Frequency To [Hz]
C-05 Multi-step Frequency 1 - 8
C-2# Jog Setup
C-20 Jog Speed [Hz]
C-21 Jog Speed [RPM]
C-22 Jog Accel/Decel Time
C-23 Quick Stop Decel Time
C-3# Frequency Setting 2 and 3
C-30 Frequency Command 2
C-34 Frequency Command 3
C-4# Semi-Auto Jump Freq Set-up
C-40 Semi-Auto Jump Freq Set-up
P-## Motor Data
P-0# Motor Data
P-02 Motor Power [HP]
P-03 Motor Current
P-04 Auto Tune
P-06 Base Speed
P-07 Motor Power [kW]
P-08 Motor Rotation Check
P-09 Slip Compensation
P-10 Slip Compensation Time Constant
P-2# Motor Selection
P-20 Motor Construction
P-24 Damping Gain
P-25 Low Speed Filter Time Const.
P-26 High Speed Filter Time Const.
P-27 Voltage filter time const.
P-3# Adv. Motor Data
P-30 Stator Resistance (Rs)
P-31 Rotor Resistance (Rr)
P-35 Main Reactance (Xh)
P-36 Iron Loss Resistance (Rfe)
P-39 Motor Poles
P-46 Position Detection Gain
P-6# Locked Rotor
P-62 Locked Rotor Protection
P-63 Locked Rotor Detection Time [s]
H-## High Perf Parameters
H-0# High Perf Operations
H-03 Restore Factory Settings
H-04 Auto-Reset (Times)
H-05 Auto-Reset (Reset Interval)
H-06 Fan Operation
H-08 Reverse Lock
H-09 Start Mode
H-3# Stop Speed
H-36 Trip Speed Low [RPM]
H-37 Trip Speed Low [Hz]
H-4# Advanced Settings
H-40 Configuration Mode
H-43 Torque Characteristics
H-48 Clockwise Direction
H-5# Load Indep. Setting
H-50 Motor Magnetisation at Zero Speed
H-51 Min Speed Normal Magnetising [RPM]
H-52 Min Speed Normal Magnetising [Hz]
H-58 Flystart Test Pulses Current
H-59 Flystart Test Pulses Frequency
H-6# Load Depen. Setting
H-61 High Speed Load Compensation
H-64 Resonance Dampening
H-65 Resonance Dampening Time Constant
H-7# Adjustable Warnings
H-70 Warning Current Low
H-71 Warning Current High
H-72 Warning Speed Low
H-73 Warning Speed High
H-74 Warning Reference Low
H-75 Warning Reference High
H-76 Warning Feedback Low
H-77 Warning Feedback High
H-78 Missing Motor Phase Function
H-8# Stop Adjustments
H-80 Function at Stop
H-81 Min Speed for Function at Stop [RPM]
H-82 Min Speed for Function at Stop [Hz]
AN-## Analog In/Out
AN-0# Analog I/O Mode
AN-00 Live Zero Timeout Time
AN-01 Live Zero Timeout Function
AN-02 Fire Mode Live Zero Timeout Function
AN-1# Analog Input 53
AN-10 Terminal 53 Low Voltage
AN-11 Terminal 53 High Voltage
AN-12 Terminal 53 Low Current
AN-13 Terminal 53 High Current
AN-14 Terminal 53 Low Ref./Feedb. Value
AN-15 Terminal 53 High Ref./Feedb. Value
AN-16 Terminal 53 Filter Time Constant
AN-17 Terminal 53 Live Zero
AN-2# Analog Input 54
AN-20 Terminal 54 Low Voltage
AN-21 Terminal 54 High Voltage
AN-22 Terminal 54 Low Current
AN-23 Terminal 54 High Current
AN-24 Terminal 54 Low Ref./Feedb. Value
AN-25 Terminal 54 High Ref./Feedb. Value
AN-26 Terminal 54 Filter Time Constant
AN-27 Terminal 54 Live Zero
AN-3# Analog Input X30/11
AN-30 Terminal X30/11 Low Voltage
AN-31 Terminal X30/11 High Voltage
AN-34 Term. X30/11 Low Ref./Feedb. Value
AN-35 Term. X30/11 High Ref./Feedb. Value
AN-36 Term. X30/11 Filter Time Constant
AN-37 Term. X30/11 Live Zero
AN-4# Analog Input X30/12
AN-40 Terminal X30/12 Low Voltage
AN-41 Terminal X30/12 High Voltage
AN-44 Term. X30/12 Low Ref./Feedb. Value
AN-45 Term. X30/12 High Ref./Feedb. Value
AN-46 Term. X30/12 Filter Time Constant
AN-47 Term. X30/12 Live Zero
AN-5# Analog Output 42
AN-50 Terminal 42 Output
AN-51 Terminal 42 Output Min Scale
AN-52 Terminal 42 Output Max Scale
AN-53 Terminal 42 Output Bus Control
AN-54 Terminal 42 Output Timeout Preset
AN-55 Terminal 42 Output Filter
AN-6# Analog Output X30/8
AN-60 Terminal X30/8 Output
AN-61 Terminal X30/8 Min. Scale
AN-62 Terminal X30/8 Max. Scale
AN-63 Terminal X30/8 Output Bus Control
AN-64 Terminal X30/8 Output Timeout Preset
SP-## Special Functions
SP-0# Fault Settings
SP-00 Fault Level
SP-1# Line On/Off
SP-10 Line failure
SP-11 Line Voltage at Input Fault
SP-12 Function at Line Imbalance
SP-2# Reset Functions
SP-23 Typecode Setting

SP-25 Trip Delay at Torque Limit
SP-26 Trip Delay at Drive Fault
SP-28 Production Settings
SP-29 Service Code
SP-3# Current Limit Ctrl.
SP-30 Current Lim Ctrl, Proportional Gain
SP-31 Current Lim Ctrl, Integration Time
SP-32 Current Lim Ctrl, Filter Time
SP-4# Energy Savings
SP-40 VT Level
SP-41 Energy Savings Min. Magnetization
SP-42 Energy Savings Min. Frequency
SP-43 Motor Cosphi
SP-5# Environment
SP-50 RFI Filter
SP-51 DC Link Compensation
SP-53 Fan Monitor
SP-55 Output Filter
SP-59 Actual Number of Inverter Units
SP-6# Automatic Derate
SP-60 Function at Over Temperature
SP-61 Function at Drive Overload
SP-62 Drive Overload Derate Current
SP-7# Additional Accel/Decel Settings
O-## Options / Comms
O-0# General Settings
O-01 Control Site
O-02 Control Word Source
O-03 Control Word Timeout Time
O-04 Control Word Timeout Function
O-05 End-of-Timeout Function
O-06 Reset Control Word Timeout
O-07 Diagnosis Trigger
O-08 Readout Filtering
O-09 Communication Charset
O-1# Control Settings
O-10 Control Word Profile
O-13 Configurable Status Word STW
O-3# Drive Port Settings
O-30 Protocol
O-31 Address
O-32 Drive Port Baud Rate
O-33 Drive Port Parity
O-34 Estimated cycle time
O-35 Minimum Response Delay
O-36 Maximum Response Delay
O-37 Maximum Inter-Char Delay
O-4# Drive MC protocol set
O-40 Telegram Selection
O-42 PCD Write Configuration
O-43 PCD Read Configuration
O-5# Digital/Bus
O-50 Coasting Select
O-52 DC Brake Select
O-53 Start Select
O-54 Reversing Select
O-55 Set-up Select
O-56 Preset Reference Select
O-8# Drive Port Diagnostics
O-80 Bus Message Count
O-81 Bus Error Count
O-82 Slave Messages Rcvd
O-83 Slave Error Count
O-89 Diagnostics Count
O-9# Bus Jog / Feedback
O-90 Bus Jog 1 Speed
O-91 Bus Jog 2 Speed
O-94 Bus Feedback 1
O-95 Bus Feedback 2
O-96 Bus Feedback 3
AO-## Analog I/O Option
AO-0# Analog I/O Mode
AO-00 Terminal X42/1 Mode
AO-01 Terminal X42/3 Mode
AO-02 Terminal X42/5 Mode
AO-1# Analog Input X42/1
AO-10 Terminal X42/1 Low Voltage
AO-11 Terminal X42/1 High Voltage
AO-14 Term. X42/1 Low Ref./Feedb. Value
AO-15 Term. X42/1 High Ref./Feedb. Value
AO-16 Term. X42/1 Filter Time Constant
AO-17 Term. X42/1 Live Zero
AO-2# Analog Input X42/3
AO-20 Terminal X42/3 Low Voltage
AO-21 Terminal X42/3 High Voltage
AO-24 Term. X42/3 Low Ref./Feedb. Value
AO-25 Term. X42/3 High Ref./Feedb. Value
AO-26 Term. X42/3 Filter Time Constant
AO-27 Term. X42/3 Live Zero
AO-3# Analog Input X42/5
AO-30 Terminal X42/5 Low Voltage
AO-31 Terminal X42/5 High Voltage
AO-34 Term. X42/5 Low Ref./Feedb. Value
AO-35 Term. X42/5 High Ref./Feedb. Value
AO-36 Term. X42/5 Filter Time Constant
AO-37 Term. X42/5 Live Zero
AO-4# Analog Out X42/7
AO-40 Terminal X42/7 Output
AO-41 Terminal X42/7 Min. Scale
AO-42 Terminal X42/7 Max. Scale
AO-43 Terminal X42/7 Bus Control
AO-44 Terminal X42/7 Timeout Preset
AO-5# Analog Out X42/9
AO-50 Terminal X42/9 Output
AO-51 Terminal X42/9 Min. Scale
AO-52 Terminal X42/9 Max. Scale
AO-53 Terminal X42/9 Bus Control
AO-54 Terminal X42/9 Timeout Preset
AO-6# Analog Out X42/11
AO-60 Terminal X42/11 Output
AO-61 Terminal X42/11 Min. Scale
AO-62 Terminal X42/11 Max. Scale
AO-63 Terminal X42/11 Bus Control
AO-64 Terminal X42/11 Timeout Preset
PB-## PROFIdrive
PB-00 Setpoint
PB-07 Actual Value
PB-15 PCD Write Configuration
PB-16 PCD Read Configuration
PB-18 Node Address
PB-22 Telegram Selection
PB-23 Parameters for Signals
PB-27 Parameter Edit
PB-28 Process Control
PB-44 Fault Message Counter
PB-45 Fault Code
PB-47 Fault Number
PB-52 Fault Situation Counter
PB-53 Profibus Warning Word
PB-63 Actual Baud Rate
PB-64 Device Identification
PB-65 Profile Number
PB-67 Control Word 1
PB-68 Status Word 1
PB-70 Edit Set-up
PB-71 Profibus Save Data Values
PB-72 ProfibusDriveReset
PB-75 DO Identification
PB-80 Defined Parameters (1)
PB-81 Defined Parameters (2)
PB-82 Defined Parameters (3)
PB-83 Defined Parameters (4)
PB-84 Defined Parameters (5)
PB-90 Changed Parameters (1)
PB-91 Changed Parameters (2)
PB-92 Changed Parameters (3)
PB-93 Changed Parameters (4)
PB-94 Changed Parameters (5)
EN-## Ethernet
EN-0# IP Settings
EN-00 IP Address Assignment
EN-01 IP Address
EN-02 Subnet Mask
EN-03 Default Gateway
EN-04 DHCP Server
EN-05 Lease Expires
EN-06 Name Servers
EN-07 Domain Name
EN-08 Host Name
EN-09 Physical Address
EN-1# Ethernet Link Parameters
EN-10 Link Status
EN-11 Link Duration
EN-12 Auto Negotiation
EN-13 Link Speed
EN-14 Link Duplex
EN-2# Process Data
EN-20 Control Instance
EN-21 Process Data Config Write
EN-22 Process Data Config Read
EN-27 Primary Master
EN-28 Store Data Values
EN-29 Store Always
EN-30 Warning Parameter
EN-3# EtherNet/IP
EN-30 Warning Parameter
EN-31 Net Reference
EN-32 Net Control
EN-33 CIP Revision
EN-34 CIP Product Code
EN-35 EDS Parameter
EN-37 COS Inhibit Timer
EN-38 COS Filter
EN-4# Modbus TCP
EN-40 Status Parameter
EN-41 Slave Message Count
EN-42 Slave Exception Message Count
EN-8# Other Ethernet Services
EN-30 Warning Parameter
EN-80 FTP Server
EN-81 HTTP Server
EN-82 SMTP Service
EN-89 Transparent Socket Channel Port
EN-9# Advanced Ethernet Services
EN-90 Cable Diagnostic
EN-91 MDI-X
EN-92 IGMP Snooping
EN-93 Cable Error Length
EN-94 Broadcast Storm Protection
EN-95 Broadcast Storm Filter
EN-96 Port Mirroring
EN-98 Interface Counters
EN-99 Media Counters
LN-## LONWORKS
LN-0# LonWorks ID
LN-00 Neuron ID
LN-1# LON Functions
LN-10 Drive Profile
LN-15 LON Warning Word
LN-17 XIF Revision
LN-18 LonWorks Revision
LN-2# LON Param. Access
LN-21 Store Data Values
BN-## BACnet
BN-70 BACnet Device Instance
BN-72 MS/TP Max Masters
BN-73 MS/TP Max Info Frames
BN-74 "I-Am" Service
BN-75 Initialization Password
DN-## DeviceNet Fieldbus
DN-0# Common Settings
DN-00 DeviceNet Protocol
DN-01 Baud Rate Select
DN-02 MAC ID
DN-05 Readout Transmit Error Counter
DN-06 Readout Receive Error Counter
DN-07 Readout Bus Off Counter
DN-1# DeviceNet
DN-10 Process Data Type Selection
DN-11 Process Data Config Write
DN-12 Process Data Config Read
DN-13 Warning Parameter
DN-14 Net Reference
DN-15 Net Control
DN-18 internal_process_data_config_write
DN-19 internal_process_data_config_read
DN-2# COS Filters
DN-20 COS Filter 1
DN-21 COS Filter 2
DN-22 COS Filter 3
DN-23 COS Filter 4
DN-3# Parameter Access
DN-30 Array Index
DN-31 Store Data Values
DN-32 Devicenet Revision
DN-33 Store Always
DN-34 DeviceNet Product Code
DN-39 Devicenet F Parameters
Parameter Data Check
Last 10 Changes
Since Factory Setting
Input Assignments
Drive Information
ID-0# Operating Data
ID-00 Operating hours
ID-01 Running Hours
ID-02 kWh Counter
ID-03 Power Up's
ID-04 Over Temp's
ID-05 Over Volt's
ID-06 Reset kWh Counter
ID-07 Reset Running Hours Counter
ID-08 Number of Starts
ID-1# Data trending Settings
ID-10 Trending Source
ID-11 Trending Interval
ID-12 Trigger Event
ID-13 Trending Mode
ID-14 Samples Before Trigger
ID-2# Historic Log
ID-20 Historic Log: Event
ID-21 Historic Log: Value
ID-22 Historic Log: Time
ID-23 Historic log: Date and Time
ID-3# Alarm Log
ID-30 Alarm Log: Error Code
ID-31 Alarm Log: Value
ID-32 Alarm Log: Time
ID-33 Alarm Log: Date and Time
ID-4# Drive Identification
ID-40 Drive Type
ID-41 Power Section
ID-42 Voltage
ID-43 Software Version
ID-46 GE Product No.
ID-47 GE Power Card Model No
ID-48 Keypad ID Number
ID-49 SW ID Control Card
ID-50 SW ID Power Card
ID-51 Drive Serial Number
ID-53 Power Card Serial Number
ID-59 CSIV Filename
ID-6# Option Ident
ID-60 Option Mounted
ID-61 Option SW Version

ID-62 Option Ordering No
ID-63 Option Serial No
ID-70 Option in Slot A
ID-71 Slot A Option SW Version
ID-72 Option in Slot B
ID-73 Slot B Option SW Version
ID-74 Option in Slot C1
ID-75 Slot C0 Option SW Version
ID-76 Option in Slot C2
ID-77 Slot C1 Option SW Version
ID-8# Operating Data II
ID-80 Fan Running Hours
ID-81 Preset Fan Running Hours
ID-9# Parameter Info
ID-92 Defined Parameters
ID-93 Modified Parameters
ID-98 Drive Identification
ID-99 Parameter Metadata
Data Readouts
DR-0# General Status
DR-00 Control Word
DR-01 Reference [Unit]
DR-02 Reference [%]
DR-03 Status Word
DR-05 Main Actual Value [%]
DR-09 Custom Readout
DR-1# Motor Status
DR-10 Power [kW]
DR-11 Power [hp]
DR-12 Motor Voltage
DR-13 Frequency
DR-14 Motor current
DR-15 Frequency [%]
DR-16 Torque [Nm]
DR-17 Speed [RPM]
DR-18 Motor Thermal
DR-22 Torque [%]
DR-3# Drive Status
DR-30 DC Link Voltage
DR-32 Brake Energy /s
DR-33 Brake Energy /2 min
DR-34 Heatsink Temp.
DR-35 Drive Thermal
DR-36 Drive Nominal Current
DR-37 Drive Max. Current
DR-38 Logic Controller State
DR-39 Control Card Temp.
DR-40 Trending Buffer Full
DR-41 Keypad Bottom Statusline
DR-43 Timed Actions Status
DR-49 Current Fault Source
DR-5# Ref. & Feedb.
DR-50 External Reference
DR-52 Feedback[Unit]
DR-53 Digi Pot Reference
DR-54 Feedback 1 [Unit]
DR-55 Feedback 2 [Unit]
DR-56 Feedback 3 [Unit]
DR-58 PID Output [%]

DR-6# Inputs & Outputs
DR-60 Digital Input
DR-61 Terminal 53 Switch Setting
DR-62 Analog Input 53
DR-63 Terminal 54 Switch Setting
DR-64 Analog Input 54
DR-65 Analog Output 42 [mA]
DR-66 Digital Output [bin]
DR-67 Freq. Input #29 [Hz]
DR-68 Freq. Input #33 [Hz]
DR-69 Pulse Output #27 [Hz]
DR-70 Pulse Output #29 [Hz]
DR-71 Relay Output [bin]
DR-72 Counter A
DR-73 Counter B
DR-75 Analog In X30/11
DR-76 Analog In X30/12
DR-77 Analog Out X30/8 [mA]
DR-8# Fieldbus & Drive Port
DR-80 Fieldbus CTW 1
DR-82 Fieldbus REF 1
DR-84 Comm. Option STW
DR-85 Drive Port CTW 1
DR-86 Drive Port REF 1
DR-9# Diagnosis Readouts
DR-90 Alarm Word
DR-91 Alarm Word 2
DR-92 Warning Word
DR-93 Warning Word 2
DR-94 Ext. Status Word
DR-95 Ext. Status Word 2
DR-96 Maintenance Word
Logs & I/O Opt Status
LG-0# Maintenance Log
LG-00 Maintenance Log: Item
LG-01 Maintenance Log: Action
LG-02 Maintenance Log: Time
LG-03 Maintenance Log: Date and Time
LG-1# Fire Mode Log
LG-10 FireMode Log:Event
LG-11 Fire Mode Log: Time
LG-12 Fire Mode Log: Date and Time
LG-3# I/O Option Status
LG-30 Analog Input X42/1
LG-31 Analog Input X42/3
LG-32 Analog Input X42/5
LG-33 Analog Out X42/7 [V]
LG-34 Analog Out X42/9 [V]
LG-35 Analog Out X42/11 [V]
Adv Parameter Data Set
AP-## HVAC Appl. Param.
AP-0# Miscellaneous
AP-00 External Interlock Delay
AP-2# No-Flow Detection
AP-20 Low Power Auto Set-up
AP-21 Low Power Detection
AP-22 Low Speed Detection
AP-23 No-Flow Function
AP-24 No-Flow Delay
AP-26 Dry Pump Function
AP-27 Dry Pump Delay
AP-3# No-Flow Power Tuning
AP-30 No-Flow Power
AP-31 Power Correction Factor
AP-32 Low Speed [RPM]
AP-33 Low Speed [Hz]
AP-34 Low Speed Power [kW]
AP-35 Low Speed Power [HP]
AP-36 High Speed [RPM]
AP-37 High Speed [Hz]
AP-38 High Speed Power [kW]
AP-39 High Speed Power [HP]
AP-4# Sleep Mode
AP-40 Minimum Run Time
AP-41 Minimum Sleep Time
AP-42 Wake-up Speed [RPM]
AP-43 Wake-up Speed [Hz]
AP-44 Wake-up Ref./FB Difference
AP-45 Setpoint Boost
AP-46 Maximum Boost Time
AP-5# End of Curve
AP-50 End of Curve Function
AP-51 End of Curve Delay
AP-6# Broken Belt Detection
AP-60 Broken Belt Function
AP-61 Broken Belt Torque
AP-62 Broken Belt Delay
AP-7# Compressor
AP-70 Compressor Start Max Speed [RPM]
AP-71 Compressor Start Max Speed [Hz]
AP-72 Compressor Start Max Time to Trip
AP-73 Starting Acceleration Time
AP-75 Short Cycle Protection
AP-76 Interval between Starts
AP-77 Minimum Run Time
AP-8# Flow Compensation
AP-80 Flow Compensation
AP-81 Square-linear Curve Approximation
AP-82 Work Point Calculation
AP-83 Speed at No-Flow [RPM]
AP-84 Speed at No-Flow [Hz]
AP-85 Speed at Design Point [RPM]
AP-86 Speed at Design Point [Hz]
AP-87 Pressure at No-Flow Speed
AP-88 Pressure at Rated Speed
AP-89 Flow at Design Point
AP-90 Flow at Rated Speed
FB-## Fire/Bypass Operation
FB-0# Fire Mode
FB-00 Fire Mode Function
FB-01 Fire Mode Configuration
FB-02 Fire Mode Unit
FB-03 Fire Mode Min Reference
FB-04 Fire Mode Max Reference
FB-05 Fire Mode Preset Reference
FB-06 Fire Mode Reference Source
FB-07 Fire Mode Feedback Source
FB-09 Fire Mode Alarm Handling

FB-1# Drive Bypass
FB-10 Drive Bypass Function
FB-11 Drive Bypass Delay Time
T-## Timed Functions
T-0# Timed Actions
T-00 ON Time
T-01 ON Action
T-02 OFF Time
T-03 OFF Action
T-04 Occurrence
T-08 Timed Actions Mode
T-09 Timed Actions Reactivation
T-1# Maintenance
T-10 Maintenance Item
T-11 Maintenance Action
T-12 Maintenance Time Base
T-13 Maintenance Time Interval
T-14 Maintenance Date and Time
T-15 Reset Maintenance Word
T-16 Maintenance Text
T-5# Energy Log
T-50 Energy Log Resolution
T-51 Period Start
T-53 Energy Log
T-54 Reset Energy Log
T-6# Trending
T-60 Trend Variable
T-61 Continuous Bin Data
T-62 Timed Bin Data
T-63 Timed Period Start
T-64 Timed Period Stop
T-65 Minimum Bin Value
T-66 Reset Continuous Bin Data
T-67 Reset Timed Bin Data
T-8# Payback Counter
T-80 Power Reference Factor
T-81 Energy Cost
T-82 Investment
T-83 Energy Savings
T-84 Cost Savings
CL-## PID Closed Loop
CL-0# Feedback
CL-00 Feedback 1 Source
CL-01 Feedback 1 Conversion
CL-02 Feedback 1 Source Unit
CL-03 Feedback 2 Source
CL-04 Feedback 2 Conversion
CL-05 Feedback 2 Source Unit
CL-06 Feedback 3 Source
CL-07 Feedback 3 Conversion
CL-08 Feedback 3 Source Unit
CL-12 Reference/Feedback Unit
CL-13 Minimum Reference/Feedb.
CL-14 Maximum Reference/Feedb.
CL-2# Feedback/Setpoint
CL-20 Feedback Function
CL-21 Setpoint 1
CL-22 Setpoint 2
CL-23 Setpoint 3

CL-3# Feedback Adv. Conv
CL-30 Refrigerant
CL-31 User Defined Refrigerant A1
CL-32 User Defined Refrigerant A2
CL-33 User Defined Refrigerant A3
CL-34 Duct 1 Area [m2]
CL-35 Duct 1 Area [in2]
CL-36 Duct 2 Area [m2]
CL-37 Duct 2 Area [in2]
CL-38 Air Density Factor [%]
CL-7# PID Autotuning
CL-70 Closed Loop Type
CL-71 PID Performance
CL-72 PID Output Change
CL-73 Minimum Feedback Level
CL-74 Maximum Feedback Level
CL-79 PID Autotuning
CL-8# PID Basic Settings
CL-81 PID Normal/ Inverse Control
CL-82 PID Start Speed [RPM]
CL-83 PID Start Speed [Hz]
CL-84 On Reference Bandwidth
CL-9# PID Controller
CL-91 PID Anti Windup
CL-93 PID Proportional Gain
CL-94 PID Integral Time
CL-95 PID Differentiation Time
CL-96 PID Diff. Gain Limit
XC-## Ext. PID Closed Loop
XC-0# Ext. CL Autotuning
XC-00 Closed Loop Type
XC-01 PID Performance
XC-02 PID Output Change
XC-03 Minimum Feedback Level
XC-04 Maximum Feedback Level
XC-09 PID Autotuning
XC-1# Ext. CL 1 Ref./Fb.
XC-10 Ext. 1 Ref./Feedback Unit
XC-11 Ext. 1 Minimum Reference
XC-12 Ext. 1 Maximum Reference
XC-13 Ext. 1 Reference Source
XC-14 Ext. 1 Feedback Source
XC-15 Ext. 1 Setpoint
XC-17 Ext. 1 Reference [Unit]
XC-18 Ext. 1 Feedback [Unit]
XC-19 Ext. 1 Output [%]
XC-2# Ext. CL 1 PID
XC-20 Ext. 1 Normal/Inverse Control
XC-21 Ext. 1 Proportional Gain
XC-22 Ext. 1 Integral Time
XC-23 Ext. 1 Differentation Time
XC-24 Ext. 1 Dif. Gain Limit
XC-3# Ext. CL 2 Ref./Fb.
XC-30 Ext. 2 Ref./Feedback Unit
XC-31 Ext. 2 Minimum Reference
XC-32 Ext. 2 Maximum Reference
XC-33 Ext. 2 Reference Source
XC-34 Ext. 2 Feedback Source
XC-35 Ext. 2 Setpoint

XC-37 Ext. 2 Reference [Unit]
XC-38 Ext. 2 Feedback [Unit]
XC-39 Ext. 2 Output [%]
XC-4# Ext. CL 2 PID
XC-40 Ext. 2 Normal/Inverse Control
XC-41 Ext. 2 Proportional Gain
XC-42 Ext. 2 Integral Time
XC-43 Ext. 2 Differentation Time
XC-44 Ext. 2 Dif. Gain Limit
XC-5# Ext. CL 3 Ref./Fb.
XC-50 Ext. 3 Ref./Feedback Unit
XC-51 Ext. 3 Minimum Reference
XC-52 Ext. 3 Maximum Reference
XC-53 Ext. 3 Reference Source
XC-54 Ext. 3 Feedback Source
XC-55 Ext. 3 Setpoint
XC-57 Ext. 3 Reference [Unit]
XC-58 Ext. 3 Feedback [Unit]
XC-59 Ext. 3 Output [%]
XC-6# Ext. CL 3 PID
XC-60 Ext. 3 Normal/Inverse Control
XC-61 Ext. 3 Proportional Gain
XC-62 Ext. 3 Integral Time
XC-63 Ext. 3 Differentation Time
XC-64 Ext. 3 Dif. Gain Limit
PC-## Pump Controller
PC-0# System Settings
PC-00 Pump Controller
PC-02 Motor Start
PC-04 Pump Cycling
PC-05 Fixed Lead Pump
PC-06 Number of Pumps
PC-10 Minimum Run Time Override
PC-11 Minimum Run Time Override Value
PC-2# Bandwidth Settings
PC-20 Staging Bandwidth
PC-21 Override Bandwidth
PC-22 Fixed Speed Bandwidth
PC-23 SBW Staging Delay
PC-24 SBW Destaging Delay
PC-25 OBW Time
PC-26 Destage At No-Flow
PC-27 Stage Function
PC-28 Stage Function Time
PC-29 Destage Function
PC-30 Destage Function Time
PC-4# Staging Settings
PC-40 Decel Ramp Delay
PC-41 Accel Ramp Delay
PC-42 Staging Threshold
PC-43 Destaging Threshold
PC-44 Staging Speed [RPM]
PC-45 Staging Speed [Hz]
PC-46 Destaging Speed [RPM]
PC-47 Destaging Speed [Hz]
PC-5# Alternation Settings
PC-50 Lead Pump Alternation
PC-51 Alternation Event
PC-52 Alternation Time Interval
PC-53 Alternation Timer Value
PC-54 Alternation Predefined Time
PC-55 Alternate if Load < 50%
PC-56 Staging Mode at Alternation
PC-58 Run Next Pump Delay
PC-59 Run on Line Delay
PC-8# Status
PC-80 Pump Status
PC-81 Pump Status
PC-82 Lead Pump
PC-83 Relay Status
PC-84 Pump ON Time
PC-85 Relay ON Time
PC-86 Reset Relay Counters
PC-9# Service
PC-90 Pump Interlock
PC-91 Manual Alternation
LC-## Logic Controller
LC-0# LC Settings
LC-00 Logic Controller Mode
LC-01 Start Event
LC-02 Stop Event
LC-03 Reset Logic Controller
LC-1# Comparators
LC-10 Comparator Operand
LC-11 Comparator Operator
LC-12 Comparator Value
LC-2# Timers
LC-20 Logic Controller Timer
LC-4# Logic Rules
LC-40 Logic Rule Boolean 1
LC-41 Logic Rule Operator 1
LC-42 Logic Rule Boolean 2
LC-43 Logic Rule Operator 2
LC-44 Logic Rule Boolean 3
LC-5# States
LC-51 Logic Controller Event
LC-52 Logic Controller Action
B-## Braking Functions
B-0# DC-Brake
B-00 DC Hold Current
B-01 DC Brake Current
B-02 DC Braking Time
B-03 DC Brake Cut In Speed [RPM]
B-04 DC Brake Cut In Speed [Hz]
B-06 Parking Current
B-07 Parking Time
B-1# Brake Energy Funct.
B-10 Brake Function
B-11 Brake Resistor (ohm)
B-12 Brake Power Limit (kW)
B-13 Braking Thermal Overload
B-15 Brake Check
B-16 AC brake Max. Current
B-17 Over-voltage Control
Dynamic parameters

5.6 Remote Programming with DCT-10

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

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

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

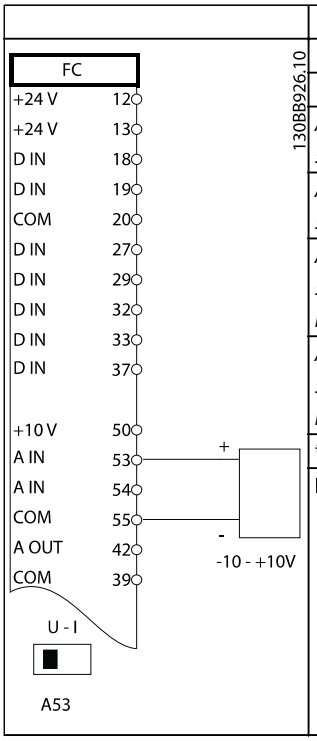
6 Application Set-Up Examples

6.1 Introduction

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

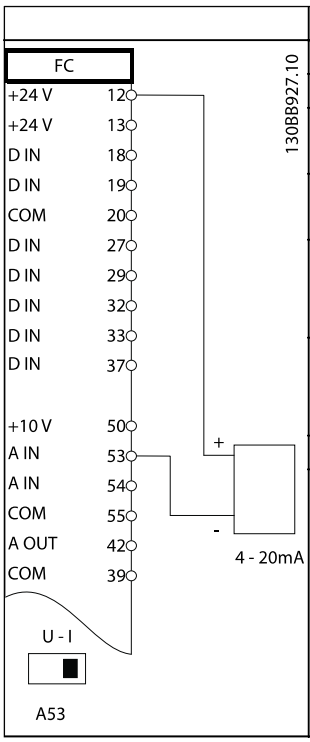
- Parameter settings are the regional default values unless otherwise indicated (selected in *K-03 Regional Settings*)
- Parameters associated with the terminals and their settings are shown next to the drawings
- Where switch settings for analog terminals A53 or A54 are required, these are also shown

6.2 Application Examples



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

Table 6.1 Analog Speed Reference (Voltage)



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

Table 6.2 Analog Speed Reference (Current)

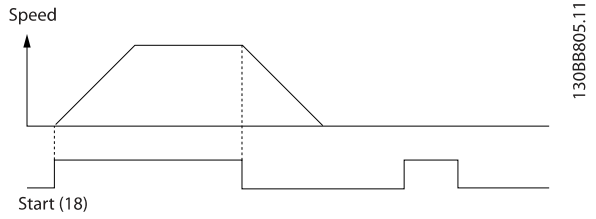


Illustration 6.1 Illustration for *Table 6.2*

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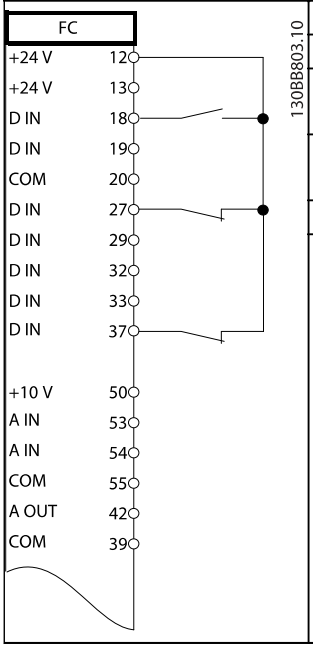


Parameters	
Function	**Setting**
E-01 Terminal 18 Digital Input	[9] Latched Start
E-03 Terminal 27 Digital Input	[6] Stop Inverse
* = Default Value	
Notes/comments:	

Table 6.3 Pulse Start/Stop

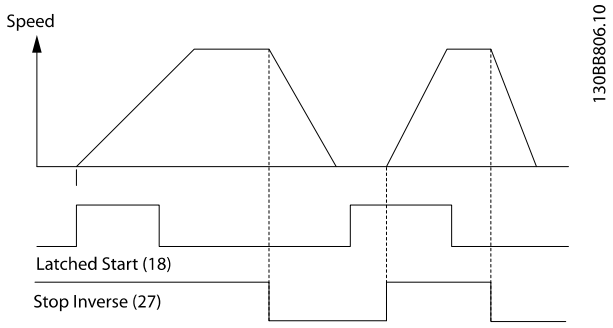
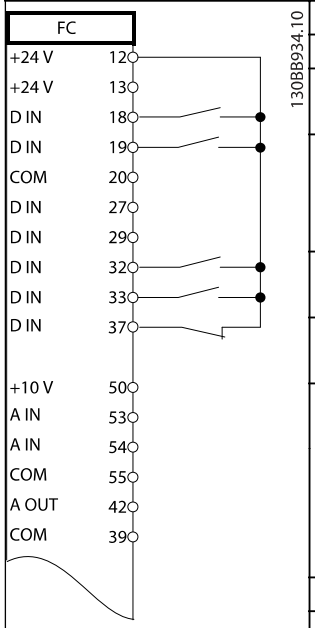
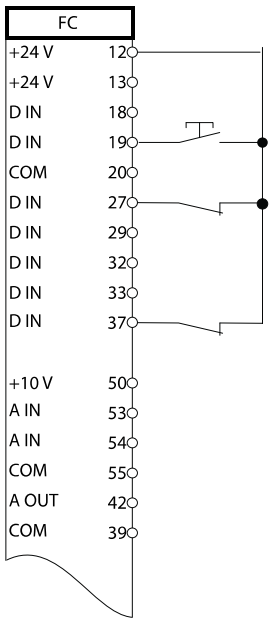


Illustration 6.2 Illustration for *Table 6.3*



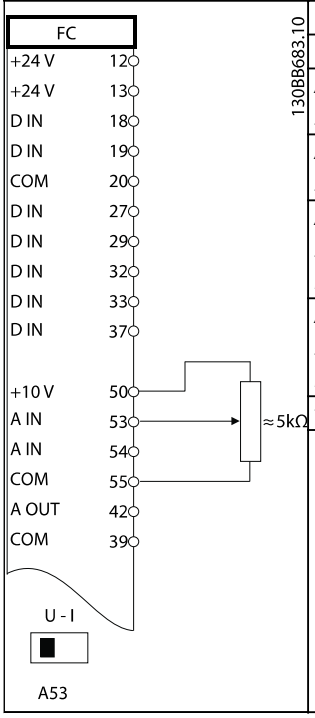
Parameters	
Function	**Setting**
E-01 Terminal 18 Digital Input	[8] Start
E-02 Terminal 19 Digital Input	[10] Reversing*
E-05 Terminal 32 Digital Input	[16] Preset ref bit 0
E-06 Terminal 33 Digital Input	[17] Preset ref bit 1
C-05 Multi-step Frequency 1 - 8	
Preset ref. 0	25%
Preset ref. 1	50%
Preset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

Table 6.4 Start/Stop with Reversing and 4 Preset Speeds



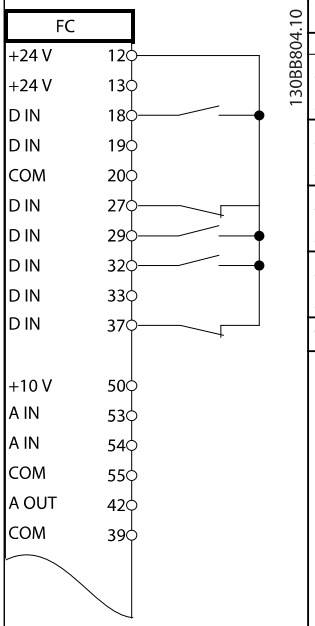
Parameters	
Function	**Setting**
E-02 Terminal 19 Digital Input	[1] Reset
* = Default Value	
Notes/comments:	

Table 6.5 External Alarm Reset



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

Table 6.6 Speed Reference (using a manual potentiometer)



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

Table 6.7 Speed Up/Down

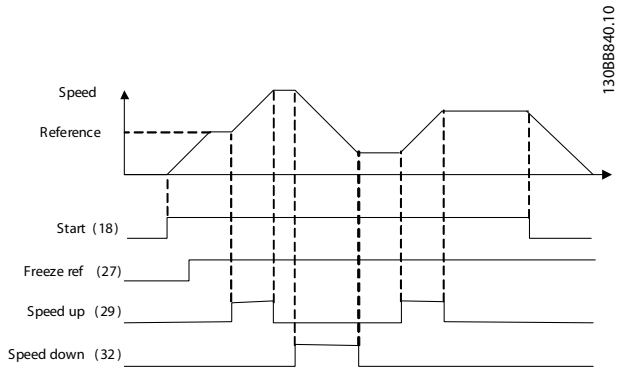
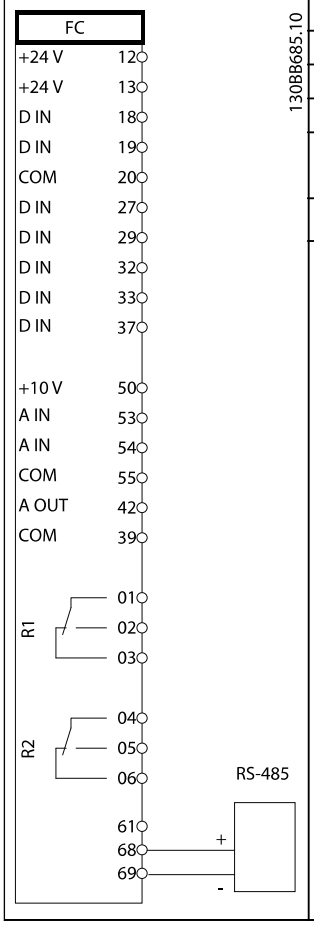


Illustration 6.3 Illustration for *Table 6.7*



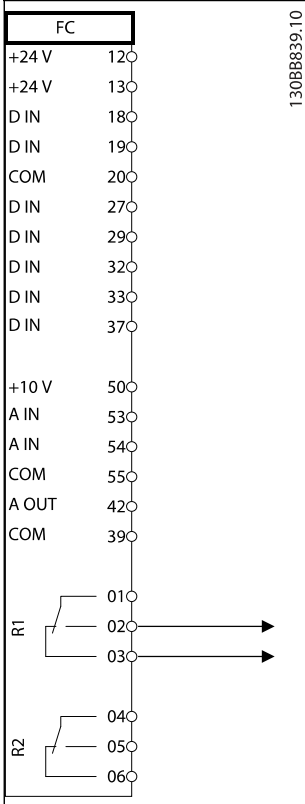
Parameters	
Function	**Setting**
O-30 Protocol	Modbus*
O-31 Address	1*
O-32 Drive Port Baud Rate	9600*
* = Default Value	
Notes/comments: Select protocol, address and baud rate in the above mentioned parameters.	

Table 6.8 RS-485 Network Connection

6

CAUTION

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



	Parameters	
	Function	Setting
	H-20 Motor Feedback Loss Function	[1] Warning
	H-21 Motor Feedback Speed Error	100RPM
	H-22 Motor Feedback Loss Timeout	5 sec
	LC-00 Logic Controller Mode	[1] On
	LC-01 Start Event	[19] Warning
	LC-02 Stop Event	[44] Reset key
	LC-10 Comparator Operand	[21] Warning no.
	LC-11 Comparator Operator	[1] ≈*
	LC-12 Comparator Value	90
	LC-51 Logic Controller Event	[22] Comparator 0
	LC-52 Logic Controller Action	[32] Set digital out A low
	E-24 Function Relay	[80] Logic Controller digital output A
* = Default Value		
Notes/comments: If the limit in the feedback monitor is exceeded, Warning 90 will be issued. The monitors Warning 90 and in the case that Warning 90 becomes TRUE then Relay 1 is triggered. External equipment may then indicate that service may be required. If the feedback error goes below the limit again within 5 sec. then the drive continues and the warning disappears. But Relay 1 will still be triggered until [Reset] on the keypad.		

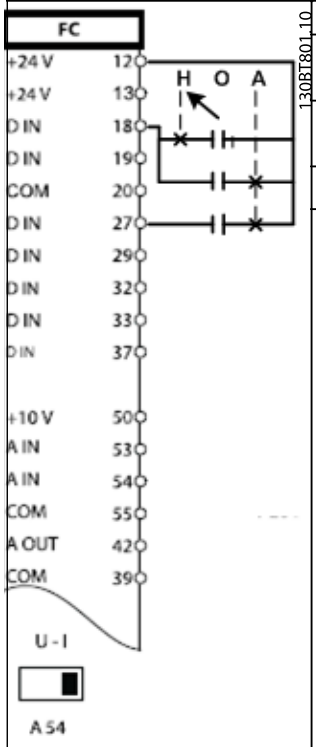
Table 6.9 Using Logic Controller to Set a Relay

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

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

In the upper right corner of the keypad 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 *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 *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 parameter K-11.
4. Set *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 *F-01 Frequency Setting 1* to *Analog input 53 (hand mode)*.
6. Copy set-up 1 to set-up 2. Set *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 *K-12 This Set-up Linked to* to *[2] set-up 2*.
8. Change to set-up 2 by setting input 27 ON (if parameter K-11 is [9]) or by setting *K-11 Edit Set-up* to *set-up 2*.
9. Set *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 program them. You just have to make sure you edit the correct set-up. Set-up 1 is Hand mode and set-up 2 is Auto mode.



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

Table 6.10 HOA

6.3 Advantages

6.3.1 Why use a Frequency Converter for Controlling Fans and Pumps?

A frequency converter takes advantage of the fact that centrifugal fans and pumps follow the laws of proportionality for such fans and pumps. For further information see the text and figure *The Laws of Proportionality*.

6.3.2 The Clear Advantage - Energy Savings

The very clear advantage of using a frequency converter for controlling the speed of fans or pumps lies in the electricity savings.
When comparing with alternative control systems and technologies, a frequency converter is the optimum energy control system for controlling fan and pump systems.

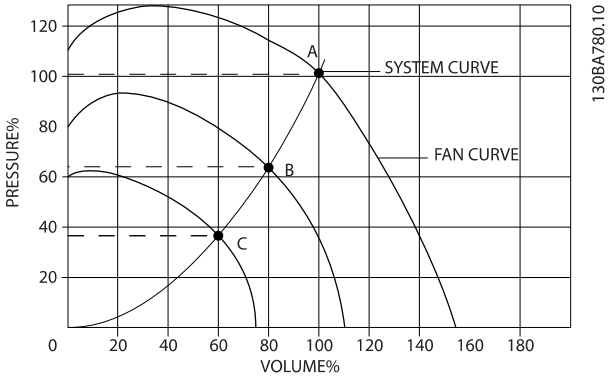


Illustration 6.4 The Graph is showing Fan Curves (A, B and C) for Reduced Fan Volumes

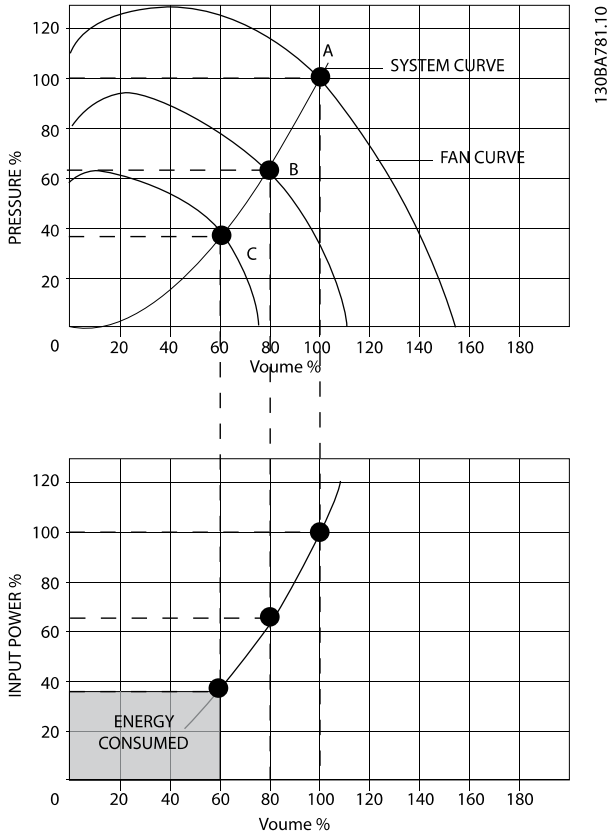


Illustration 6.5 When using a Frequency Converter to reduce Fan Capacity to 60% - more than 50% Energy Savings may be Obtained in Typical Applications

6

6.3.3 Example of Energy Savings

As can be seen from the figure (*Illustration 6.6*), the flow is controlled by changing the RPM. By reducing the speed only 20% from the rated speed, the flow is also reduced by 20%. This is because the flow is directly proportional to the RPM. The consumption of electricity, however, is reduced by 50%.
If the system in question only needs to be able to supply a flow that corresponds to 100% a few days in a year, while the average is below 80% of the rated flow for the remainder of the year, the amount of energy saved is even more than 50%.

Illustration 6.6 describes the dependency of flow, pressure and power consumption on RPM.

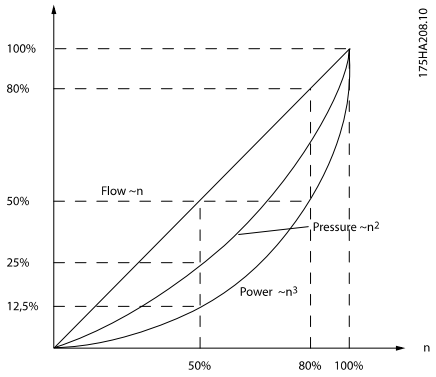


Illustration 6.6 The Laws of Proportionality

$$Flow : \frac{Q_1}{Q_2} = \frac{n_1}{n_2}$$

$$Pressure : \frac{H_1}{H_2} = \left(\frac{n_1}{n_2}\right)^2$$

$$Power : \frac{P_1}{P_2} = \left(\frac{n_1}{n_2}\right)^3$$

Q = Flow

Q_1 = Rated flow

Q_2 = Reduced flow

H = Pressure

H_1 = Rated pressure

H_2 = Reduced pressure

P = Power

P_1 = Rated power

P_2 = Reduced power

n = Speed regulation

n_1 = Rated speed

n_2 = Reduced speed

6.3.4 Better Control

If a frequency converter is used for controlling the flow or pressure of a system, improved control is obtained.
A frequency converter can vary the speed of the fan or pump, thereby obtaining variable control of flow and pressure.
Furthermore, a frequency converter can quickly adapt the speed of the fan or pump to new flow or pressure conditions in the system.
Simple control of process (Flow, Level or Pressure) utilizing the built in PID control.

6.3.5 Cos φ Compensation

Generally speaking, the AF-600 FP has a cos φ of 1 and provides power factor correction for the cos φ of the motor, which means that there is no need to make allowance for the cos φ of the motor when sizing the power factor correction unit.

6.3.6 Using a Frequency Converter Saves Money

The example on the following page shows that a lot of equipment is not required when a frequency converter is used. It is possible to calculate the cost of installing the two different systems. In the example on the following page, the two systems can be established at roughly the same price.

6.3.7 Without a Frequency Converter

Illustration 6.7 shows a fan system made in the traditional way.

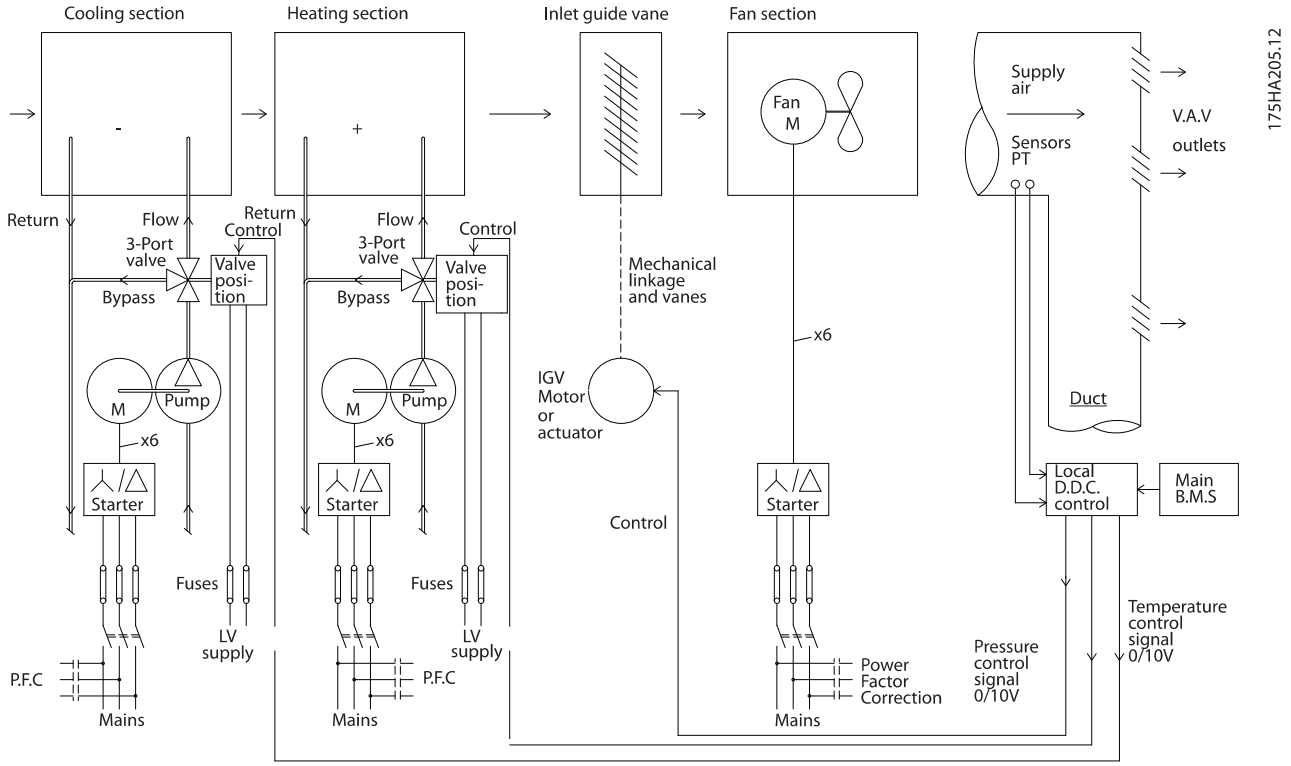


Illustration 6.7 Traditional Fan System

D.D.C.=Direct Digital Control

V.A.V.=Variable Air Volume

Sensor P=Pressure

E.M.S.=Energy Management system

Sensor T=Temperature

6.3.8 With a Frequency Converter

Illustration 6.8 shows a fan system controlled by frequency converters

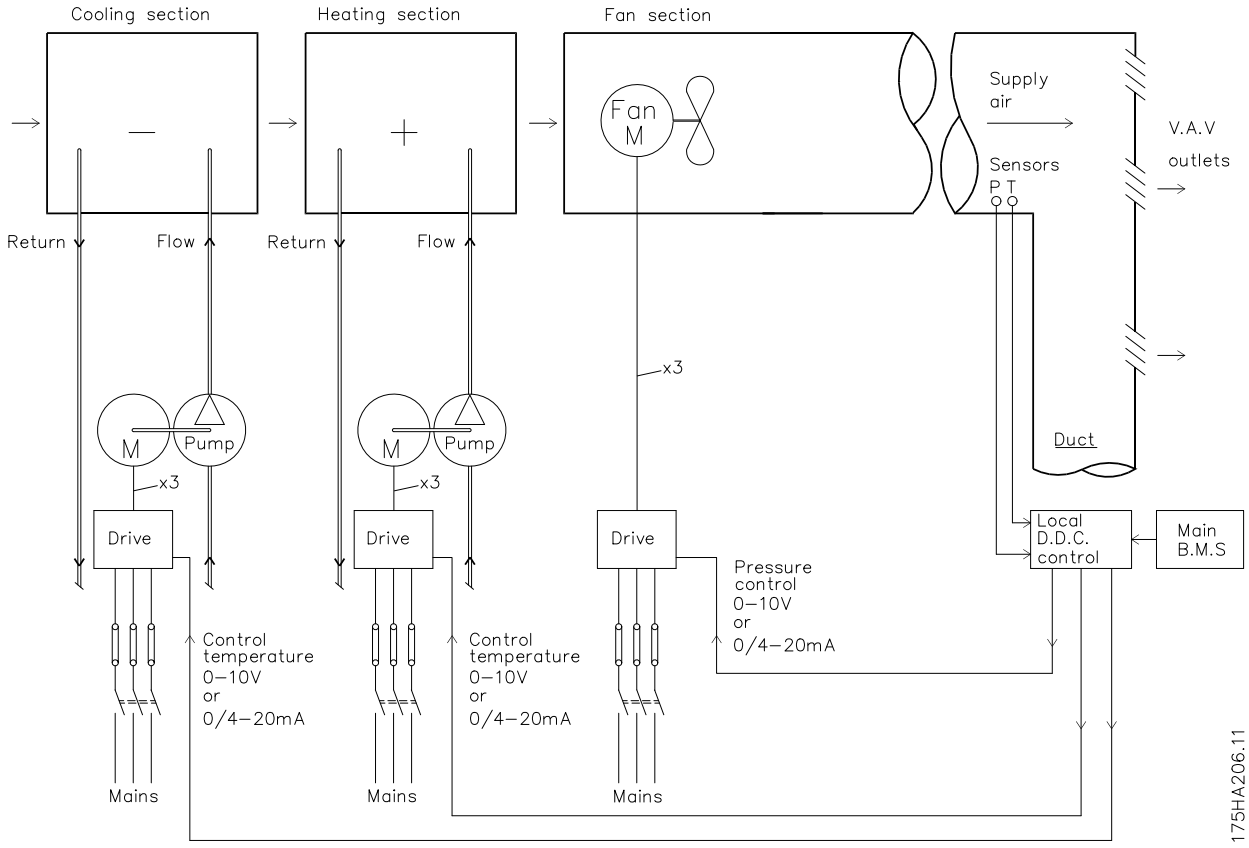


Illustration 6.8 Frequency Converter Controlled Fan System

6.3.9 Application Examples

The next few pages give typical examples of applications within HVAC.

6.3.10 Variable Air Volume

VAV or Variable Air Volume systems, are used to control both the ventilation and temperature to satisfy the requirements of a building. Central VAV systems are considered to be the most energy efficient method to air condition buildings. By designing central systems instead of distributed systems, a greater efficiency can be obtained.
The efficiency comes from utilizing larger fans and larger chillers which have much higher efficiencies than small motors and distributed air-cooled chillers. Savings are also seen from the decreased maintenance requirements.

6.3.11 The AF-600 FP Solution

While dampers and IGVs work to maintain a constant pressure in the ductwork, a frequency converter solution saves much more energy and reduces the complexity of the installation. Instead of creating an artificial pressure drop or causing a decrease in fan efficiency, the frequency converter decreases the speed of the fan to provide the flow and pressure required by the system.
Centrifugal devices such as fans behave according to the centrifugal laws. This means the fans decrease the pressure and flow they produce as their speed is reduced. Their power consumption is thereby significantly reduced.
The return fan is frequently controlled to maintain a fixed difference in airflow between the supply and return. The advanced PID controller of the HVAC frequency converter can be used to eliminate the need for additional controllers.

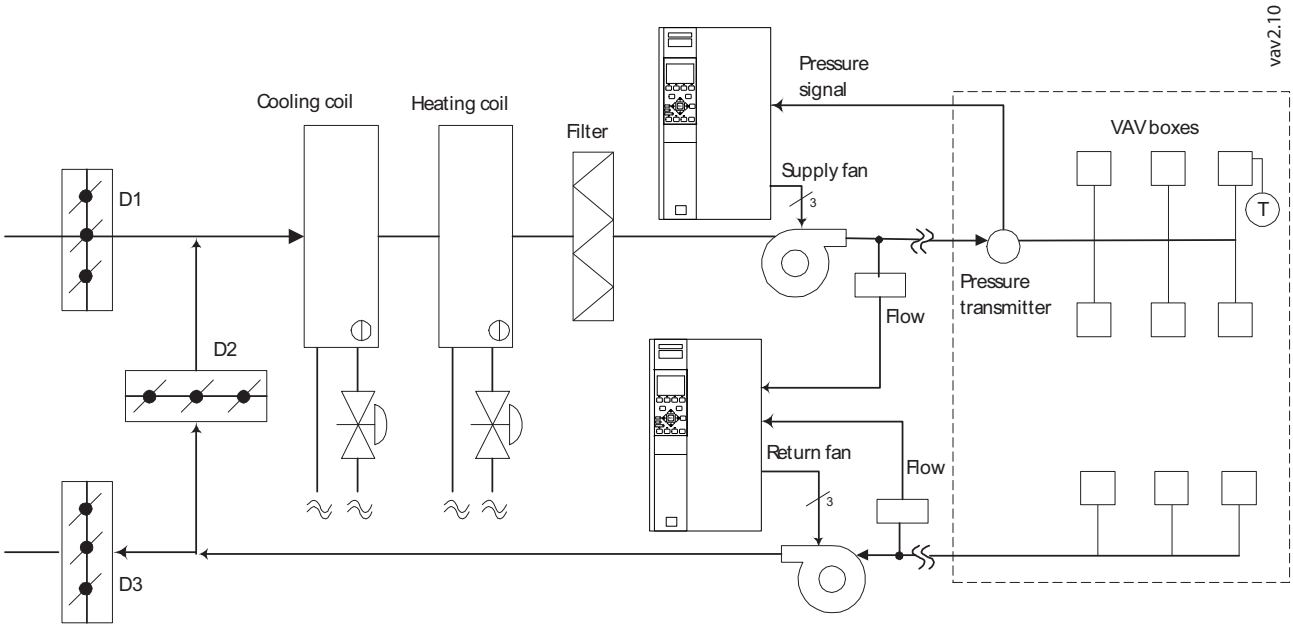


Illustration 6.9 Variable Air Volume System

6.3.12 Constant Air Volume

CAV, or Constant Air Volume systems are central ventilation systems usually used to supply large common zones with the minimum amounts of fresh tempered air. They preceded VAV systems and therefore are found in older multi-zoned commercial buildings as well. These systems preheat amounts of fresh air utilizing Air Handling Units (AHUs) with a heating coil, and many are also used to air condition buildings and have a cooling coil. Fan coil units are frequently used to assist in the heating and cooling requirements in the individual zones.

6.3.13 The AF-600 FP Solution

With a frequency converter, significant energy savings can be obtained while maintaining decent control of the building. Temperature sensors or CO_2 sensors can be used as feedback signals to frequency converters. Whether controlling temperature, air quality, or both, a CAV system can be controlled to operate based on actual building conditions. As the number of people in the controlled area decreases, the need for fresh air decreases. The CO_2 sensor detects lower levels and decreases the supply fans speed. The return fan modulates to maintain a static pressure setpoint or fixed difference between the supply and return air flows.

6

With temperature control, especially used in air conditioning systems, as the outside temperature varies as well as the number of people in the controlled zone changes, different cooling requirements exist. As the temperature decreases below the set-point, the supply fan can decrease its speed. The return fan modulates to maintain a static pressure set-point. By decreasing the air flow, energy used to heat or cool the fresh air is also reduced, adding further savings.
Several features of the GE dedicated frequency converter can be utilized to improve the performance of your CAV system. One concern of controlling a ventilation system is poor air quality. The programmable minimum frequency can be set to maintain a minimum amount of supply air regardless of the feedback or reference signal. The frequency converter also includes a 3-zone, 3 setpoint PID controller which allows monitoring both temperature and air quality. Even if the temperature requirement is satisfied, the frequency converter will maintain enough supply air to satisfy the air quality sensor. The controller is capable of monitoring and comparing two feedback signals to control the return fan by maintaining a fixed differential air flow between the supply and return ducts as well.

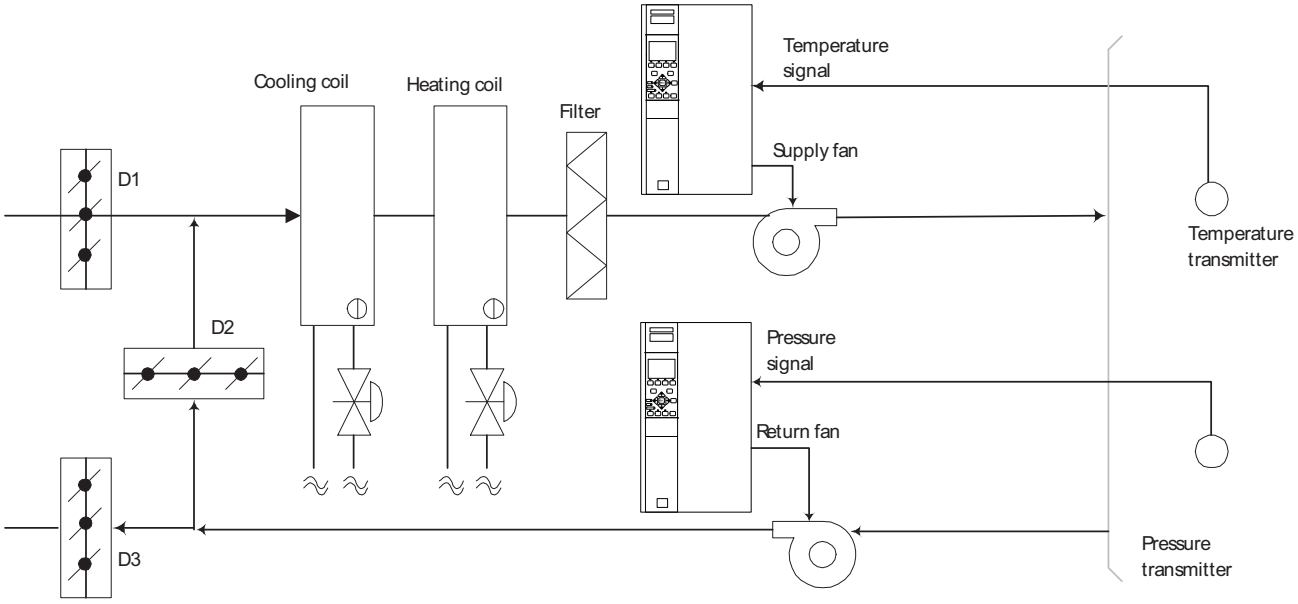


Illustration 6.10 Constant Air Volume System

6.3.14 Cooling Tower Fan

Cooling Tower Fans are used to cool condenser water in water cooled chiller systems. Water cooled chillers provide the most efficient means of creating chilled water. They are as much as 20% more efficient than air cooled chillers. Depending on climate, cooling towers are often the most energy efficient method of cooling the condenser water from chillers.
They cool the condenser water by evaporation.
The condenser water is sprayed into the cooling tower onto the cooling towers "fill" to increase its surface area. The tower fan blows air through the fill and sprayed water to aid in the evaporation. Evaporation removes energy from the water dropping its temperature. The cooled water collects in the cooling towers basin where it is pumped back into the chillers condenser and the cycle is repeated.

6.3.15 The AF-600 FP Solution

With a frequency converter, the cooling towers fans can be controlled to the required speed to maintain the condenser water temperature. The frequency converters can also be used to turn the fan on and off as needed.

Several features of the GE dedicated frequency converter, the HVAC frequency converter can be utilized to improve the performance of your cooling tower fans application. As the cooling tower fans drop below a certain speed, the effect the fan has on cooling the water becomes small. Also, when utilizing a gear-box to frequency control the tower fan, a minimum speed of 40-50% may be required.
The customer programmable minimum frequency setting is available to maintain this minimum frequency even as the feedback or speed reference calls for lower speeds.

Also as a standard feature, you can program the frequency converter to enter a "sleep" mode and stop the fan until a higher speed is required. Additionally, some cooling tower fans have undesireable frequencies that may cause vibrations. These frequencies can easily be avoided by programming the bypass frequency ranges in the frequency converter.

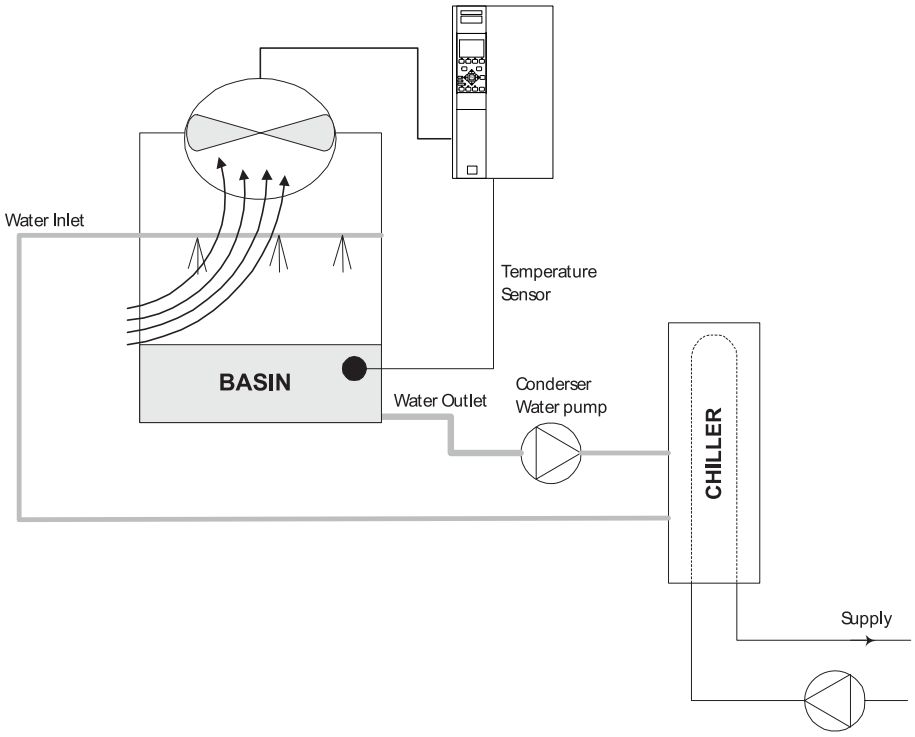


Illustration 6.11 Cooling Tower Fan

6.3.16 Condenser Pumps

Condenser Water pumps are primarily used to circulate water through the condenser section of water cooled chillers and their associated cooling tower. The condenser water absorbs the heat from the chiller's condenser section and releases it into the atmosphere in the cooling tower. These systems are used to provide the most efficient means of creating chilled water, they are as much as 20% more efficient than air cooled chillers.

6.3.17 The AF-600 FP Solution

Frequency converters can be added to condenser water pumps instead of balancing the pumps with a throttling valve or trimming the pump impeller.

Using a frequency converter instead of a throttling valve simply saves the energy that would have been absorbed by the valve. This can amount to savings of 15-20% or more. Trimming the pump impeller is irreversible, thus if the conditions change and higher flow is required the impeller must be replaced.

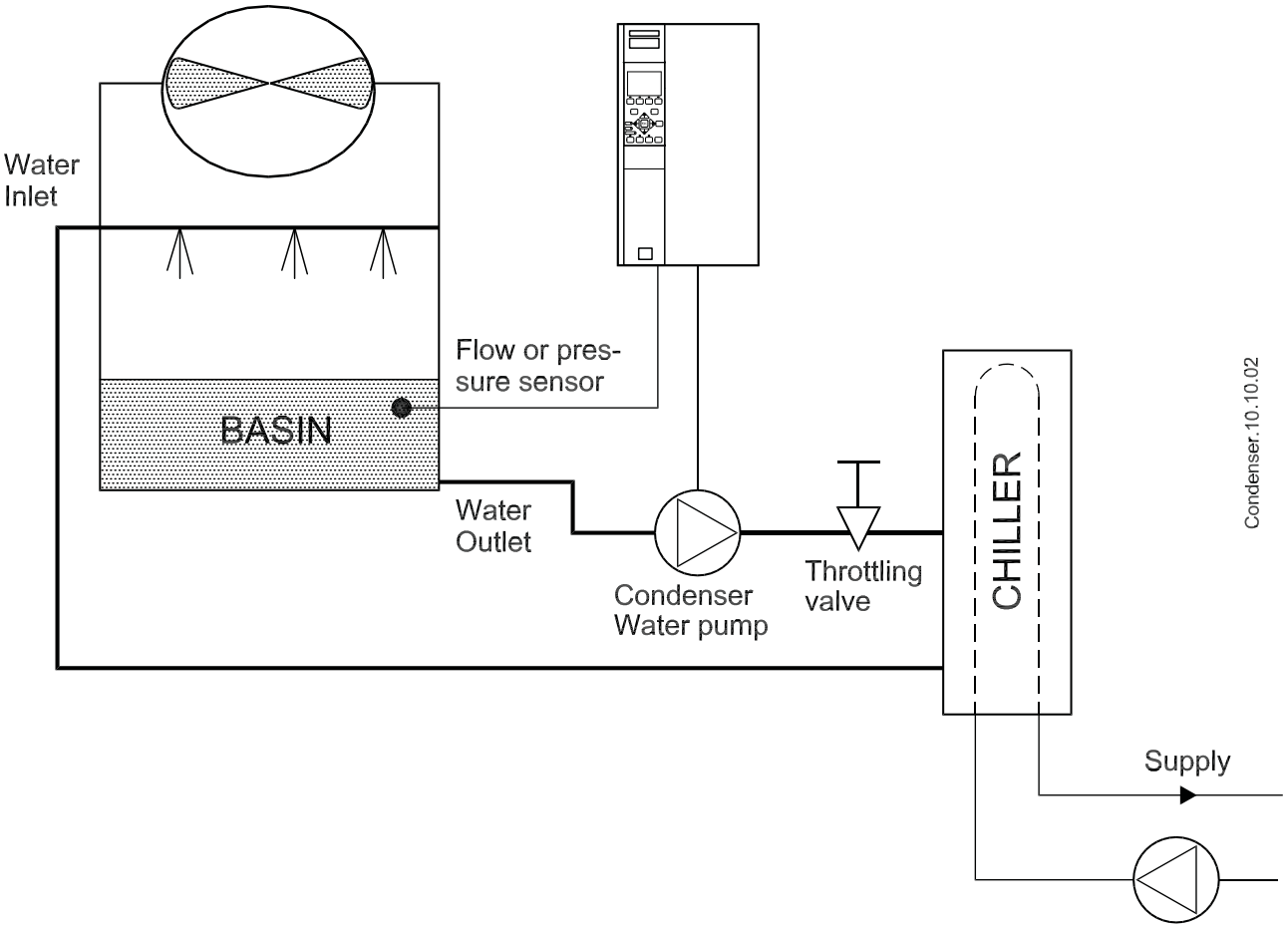


Illustration 6.12 Condenser Water Pump

6.3.18 Primary Pumps

Primary pumps in a primary/secondary pumping system can be used to maintain a constant flow through devices that encounter operation or control difficulties when exposed to variable flow. The primary/ secondary pumping technique decouples the “primary” production loop from the “secondary” distribution loop. This allows devices such as chillers to obtain constant design flow and operate properly while allowing the rest of the system to vary in flow.

As the evaporator flow rate decreases in a chiller, the chilled water begins to become over-chilled. As this happens, the chiller attempts to decrease its cooling capacity. If the flow rate drops far enough, or too quickly, the chiller cannot shed its load sufficiently and the chiller’s low evaporator temperature safety trips the chiller requiring a manual reset. This situation is common in large installations especially when two or more chillers in parallel are installed if primary/ secondary pumping is not utilized.

6.3.19 The AF-600 FP Solution

Depending on the size of the system and the size of the primary loop, the energy consumption of the primary loop can become substantial.
A frequency converter can be added to the primary system, to replace the throttling valve and/or trimming of the impellers, leading to reduced operating expenses. Two control methods are common:

The first method uses a flow meter. Because the desired flow rate is known and is constant, a flow meter installed at the discharge of each chiller, can be used to control the pump directly. Using the built-in PID controller, the frequency converter will always maintain the appropriate flow rate, even compensating for the changing resistance in the primary piping loop as chillers and their pumps are staged on and off.

The other method is local speed determination. The operator simply decreases the output frequency until the design flow rate is achieved.
Using a frequency converter to decrease the pump speed is very similar to trimming the pump impeller, except it doesn’t require any labor and the pump efficiency remains higher. The balancing contractor simply decreases the speed of the pump until the proper flow rate is achieved and leaves the speed fixed. The pump will operate at this speed any time the chiller is staged on. Because the primary loop doesn’t have control valves or other devices that can cause the system curve to change and the variance due to staging pumps and chillers on and off is usually small, this fixed speed will remain appropriate. In the event the flow rate needs to be increased later in the systems life, the frequency converter can simply increase the pump speed instead of requiring a new pump impeller.

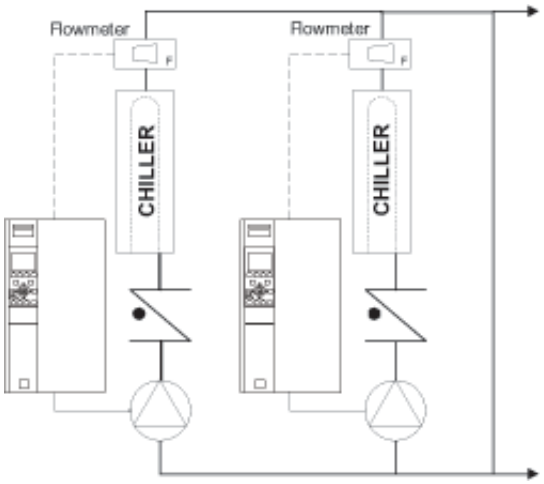


Illustration 6.13 Primary Pump

6.3.20 Secondary Pumps

Secondary pumps in a primary/secondary chilled water pumping system are used to distribute the chilled water to the loads from the primary production loop. The primary/secondary pumping system is used to hydronically de-couple one piping loop from another. In this case. The primary pump is used to maintain a constant flow through the chillers while allowing the secondary pumps to vary in flow, increase control and save energy.
If the primary/secondary design concept is not used and a variable volume system is designed, when the flow rate drops far enough or too quickly, the chiller cannot shed its load properly. The chiller's low evaporator temperature safety then trips the chiller requiring a manual reset. This situation is common in large installations especially when two or more chillers in parallel are installed.

6.3.21 The AF-600 FP Solution

While the primary-secondary system with two-way valves improves energy savings and eases system control problems, the true energy savings and control potential is realized by adding frequency converters.
With the proper sensor location, the addition of frequency converters allows the pumps to vary their speed to follow the system curve instead of the pump curve.
This results in the elimination of wasted energy and eliminates most of the over-pressurization, two-way valves can be subjected too.
As the monitored loads are reached, the two-way valves close down. This increases the differential pressure measured across the load and two-way valve. As this differential pressure starts to rise, the pump is slowed to maintain the control head also called setpoint value. This set-point value is calculated by summing the pressure drop of the load and two way valve together under design conditions.

6

NOTE

When running multiple pumps in parallel, they must run at the same speed to maximize energy savings, either with individual dedicated drives or one frequency converter running multiple pumps in parallel.

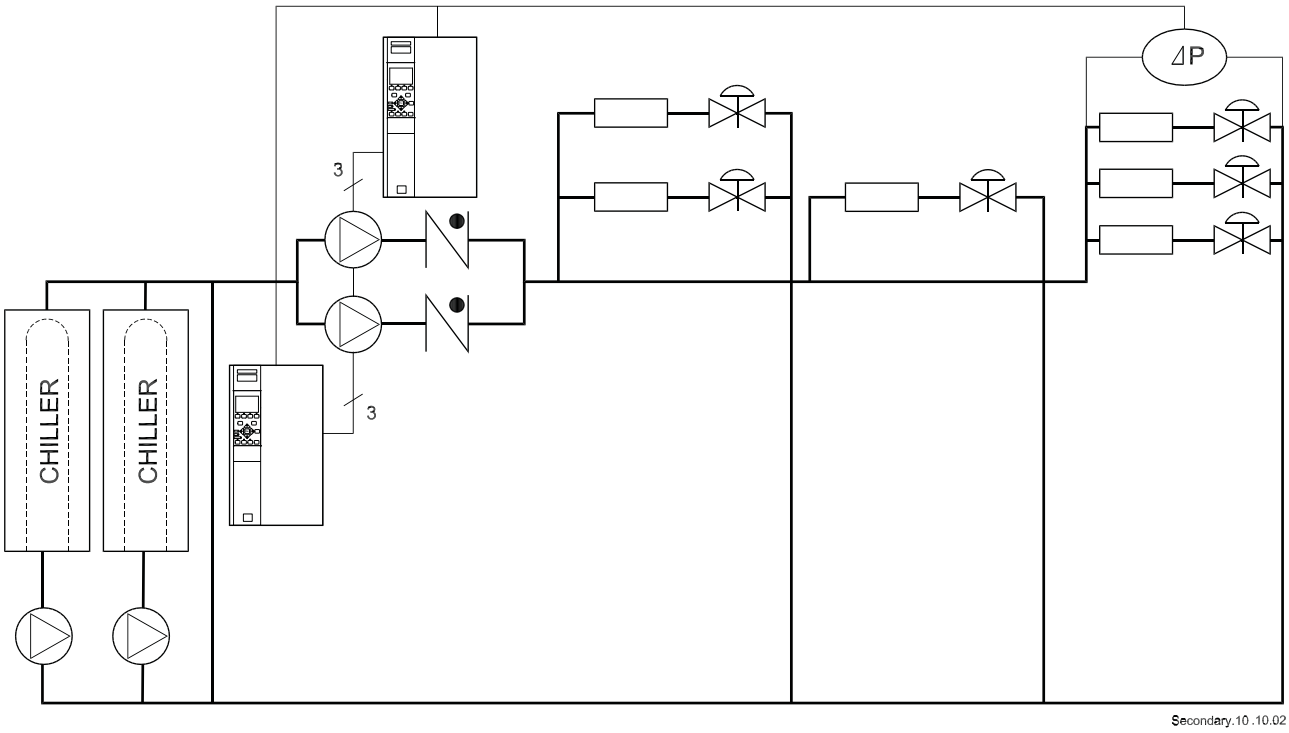


Illustration 6.14 Secondary Pump

7 Installation Consideration

7.1 General Aspects of EMC

7.1.1 General Aspects of EMC Emissions

Electrical interference is usually conducted at frequences in the range 150 kHz to 30 MHz. Airborne interference from the drive system in the range 30 MHz to 1 GHz is generated from the inverter, motor cable, and the motor.
Capacitive currents in the motor cable coupled with a high dV/dt from the motor voltage generate leakage currents.
The use of a screened motor cable increases the leakage current (see illustration below) because screened cables have higher capacitance to earth than unscreened cables. If the leakage current is not filtered, it will cause greater interference on the mains in the radio frequency range below approximately 5 MHz. Since the leakage current (I_1) is carried back to the unit through the screen (I_3), there will only be a small electro-magnetic field (I_4) from the screened motor cable.

The screen reduces the radiated interference but increases the low-frequency interference on the mains. The motor cable screen must be connected to the frequency converter enclosure as well as to the motor enclosure. This is best done by using integrated screen clamps so as to avoid twisted screen ends (pigtails). These increase the screen impedance at higher frequencies, which reduces the screen effect and increases the leakage current (I_4).
If a screened cable is used for networknetwork, relay, control cable, signal interface and brake, the screen must be mounted on the enclosure at both ends. In some situations, however, it will be necessary to break the screen to avoid current loops.

7

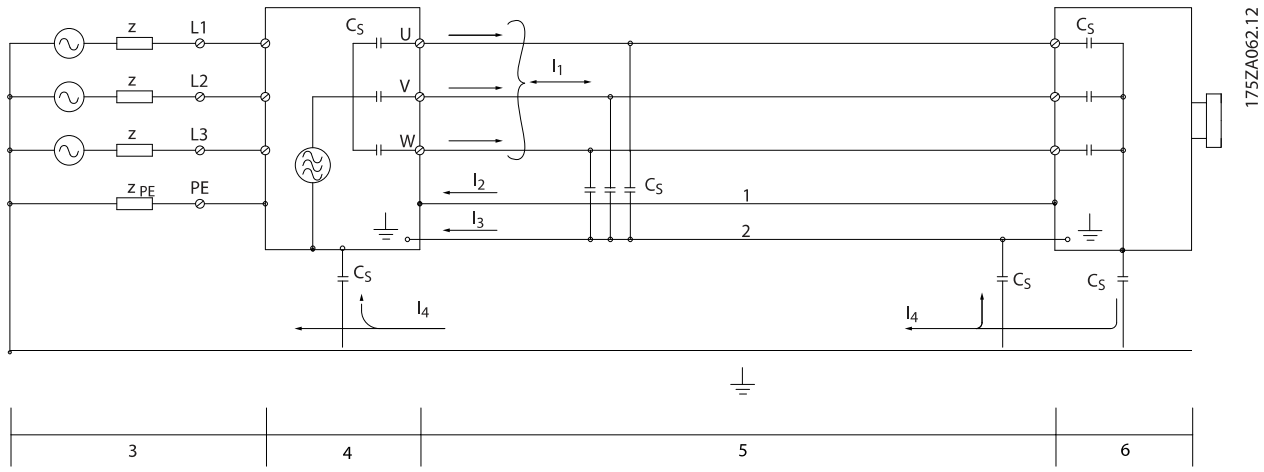


Illustration 7.1 EMC Emission

1	Earth wire
2	Screen
3	AC mains supply
4	Frequency converter
5	Screened motor cable
6	Motor

Table 7.1 Legend to *Illustration 7.1*

If the screen is to be placed on a mounting plate for the frequency converter, the mounting plate must be made of metal, because the screen currents have to be conveyed back to the unit. Moreover, ensure good electrical contact from the mounting plate through the mounting screws to the frequency converter chassis.

When unscreened cables are used, some emission requirements are not complied with, although the immunity requirements are observed.

In order to reduce the interference level from the entire system (unit + installation), make motor and brake cables as short as possible. Avoid placing cables with a sensitive signal level alongside motor and brake cables. Radio interference higher than 50 MHz (airborne) is especially generated by the control electronics.

7.1.2 Emission Requirements

According to the EMC product standard for adjustable speed frequency converters EN/IEC61800-3:2004 the EMC requirements depend on the intended use of the frequency converter. Four categories are defined in the EMC product standard. The definitions of the four categories together with the requirements for mains supply voltage conducted emissions are given in *Table 7.2*:

Category	Definition	Conducted emission requirement according to the limits given in EN55011
C1	Frequency converters installed in the first environment (home and office) with a supply voltage less than 1000 V.	Class B
C2	Frequency converters installed in the first environment (home and office) with a supply voltage less than 1000 V, which are neither plug-in nor movable and are intended to be installed and commissioned by a professional.	Class A Group 1
C3	Frequency converters installed in the second environment (industrial) with a supply voltage lower than 1000 V.	Class A Group 2
C4	Frequency converters installed in the second environment with a supply voltage equal to or above 1000 V or rated current equal to or above 400 A or intended for use in complex systems.	No limit line. An EMC plan should be made.

Table 7.2 Categories

When the generic emission standards are used the frequency converters are required to comply with the limits in *Table 7.3*:

Environment	Generic standard	Conducted emission requirement according to the limits given in EN55011
First environment (home and office)	EN/IEC61000-6-3 Emission standard for residential, commercial and light industrial environments.	Class B
Second environment (industrial environment)	EN/IEC61000-6-4 Emission standard for industrial environments.	Class A Group 1

Table 7.3 Limits

7.1.3 EMC Test Results (Emission)

The following test results have been obtained using a system with a frequency converter (with options if relevant), a screened control cable, a control box with potentiometer, as well as a motor and motor screened cable.

RFI filter type	Conducted emission Maximum shielded cable length			Radiated emission	
	Industrial environment		Housing, trades and light industries	Industrial environment	Housing, trades and light industries
Standard	EN 55011 Class A2	EN 55011 Class A1	EN 55011 Class B	EN 55011 Class A1	EN 55011 Class B
Class A1/B RFI Filter installed					
0.75-45 kW 200-240 V	150 m	150 m	50 m	Yes	No
0.75-90 kW 380-480 V	150 m	150 m	50 m	Yes	No
Class A2 RFI Filter installed					
0.75-3.7 kW 200-240 V	5 m	No	No	No	No
5.5-37 kW 200-240 V	25 m	No	No	No	No
0.75-7.5 kW 380-480 V	5 m	No	No	No	No
11-75 kW 380-480 V	25 m	No	No	No	No
90-800 kW 380-480 V	150 m	No	No	No	No
90-1200 kW 525-690 V	150 m	No	No	No	No
No RFI Filter installed					
0.75-75 kW 525-600 V	-	-	-	-	-

Table 7.4 EMC Test Results (Emission)

7.2 Immunity Requirements

The immunity requirements for frequency converters depend on the environment where they are installed. The requirements for the industrial environment are higher than the requirements for the home and office environment. All GE frequency converters comply with the requirements for the industrial environment and consequently comply also with the lower requirements for home and office environment with a large safety margin.

In order to document immunity against electrical interference from electrical phenomena, the following immunity tests have been made on a system consisting of a frequency converter (with options if relevant), a screened control cable and a control box with potentiometer, motor cable and motor.
The tests were performed in accordance with the following basic standards:

- **EN 61000-4-2 (IEC 61000-4-2):** Electrostatic discharges (ESD): Simulation of electrostatic discharges from human beings.
- **EN 61000-4-3 (IEC 61000-4-3):** Incoming electromagnetic field radiation, amplitude modulated simulation of the effects of radar and radio communication equipment as well as mobile communications equipment.
- **EN 61000-4-4 (IEC 61000-4-4):** Burst transients: Simulation of interference brought about by switching a contactor, relay or similar devices.
- **EN 61000-4-5 (IEC 61000-4-5):** Surge transients: Simulation of transients brought about e.g. by lightning that strikes near installations.
- **EN 61000-4-6 (IEC 61000-4-6):** RF Common mode: Simulation of the effect from radio-transmission equipment joined by connection cables.

See *Table 7.5*.

Voltage range: 200-240 V, 380-480 V					
Basic standard	**Burst IEC 61000-4-4**	**Surge IEC 61000-4-5**	**ESD IEC 61000-4-2**	**Radiated electromagnetic field IEC 61000-4-3**	**RF common mode voltage IEC 61000-4-6**
Acceptance criterion	**B**	**B**	**B**	**A**	**A**
Line	4 kV CM	2 kV/2 Ω DM 4 kV/12 Ω CM	—	—	10 V_{RMS}
Motor	4 kV CM	4 kV/2 Ω[1)]	—	—	10 V_{RMS}
Brake	4 kV CM	4 kV/2 Ω[1)]	—	—	10 V_{RMS}
Load sharing	4 kV CM	4 kV/2 Ω[1)]	—	—	10 V_{RMS}
Control wires	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
Standard bus	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
Relay wires	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
Application and network options	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
Keypad cable	2 kV CM	2 kV/2 Ω[1)]	—	—	10 V_{RMS}
External 24 V DC	2 kV CM	0.5 kV/2 Ω DM 1 kV/12 Ω CM	—	—	10 V_{RMS}
Enclosure	—	—	8 kV AD 6 kV CD	10 V/m	—

AD: Air Discharge
CD: Contact Discharge
CM: Common mode
DM: Differential mode
1. Injection on cable shield.

Table 7.5 EMC Immunity Form

7.3 General Aspects of Harmonics Emission

A frequency converter takes up a non-sinusoidal current from mains, which increases the input current I_{RMS}. A non-sinusoidal current is transformed by means of a Fourier analysis and split up into sine-wave currents with different frequencies, i.e. different harmonic currents I_N with 50 Hz as the basic frequency:

Harmonic currents	I_1	I_5	I_7
Hz	50 Hz	250 Hz	350 Hz

Table 7.6 Harmonics Emission

The harmonics do not affect the power consumption directly but increase the heat losses in the installation (transformer, cables). Consequently, in plants with a high percentage of rectifier load, maintain harmonic currents at a low level to avoid overload of the transformer and high temperature in the cables.

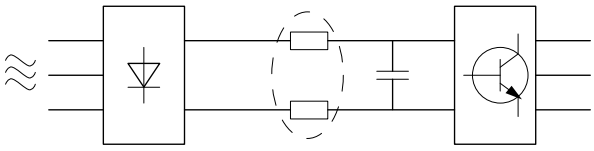


Illustration 7.2 Harmonics

NOTE

Some of the harmonic currents might disturb communication equipment connected to the same transformer or cause resonance in connection with power-factor correction batteries.

To ensure low harmonic currents, the frequency converter is equipped with intermediate circuit coils as standard. This normally reduces the input current I_{RMS} by 40%.

The voltage distortion on the mains supply voltage depends on the size of the harmonic currents multiplied by the mains impedance for the frequency in question. The total voltage distortion THD is calculated on the basis of the individual voltage harmonics using this formula:

$$THD\ \% = \sqrt{U\frac{2}{5} + U\frac{2}{7} + \ldots + U\frac{2}{N}}$$

(U_N% of U)

7.3.1 Harmonics Emission Requirements

Equipment connected to the public supply network:

Options	Definition
1	IEC/EN 61000-3-2 Class A for 3-phase balanced equipment (for professional equipment only up to 1 kW total power).
2	IEC/EN 61000-3-12 Equipment 16A-75A and professional equipment as from 1 kW up to 16A phase current.

Table 7.7 Connected Equipment

7.3.2 Harmonics Test Results (Emission)

Power sizes from 0.75 kW and up to 18.5 kW in 200 V and up to 90 kW in 460 V complies with IEC/EN 61000-3-12, Table 4. Power sizes 110 - 450 kW in 460 V also complies with IEC/EN 61000-3-12 even though not required because currents are above 75 A.

Provided that the short-circuit power of the supply S_{sc} is greater than or equal to:

$$S_{SC} = \sqrt{3} \times R_{SCE} \times U_{mains} \times I_{equ} =$$

$$\sqrt{3} \times 120 \times 400 \times I_{equ}$$

at the interface point between the user's supply and the public system (R_{sce}).

It is the responsibility of the installer or user of the equipment to ensure, by consultation with the distribution network operator if necessary, that the equipment is connected only to a supply with a short-circuit power S_{sc} greater than or equal to specified above.
Other power sizes can be connected to the public supply network by consultation with the distribution network operator.

Compliance with various system level guidelines:
The harmonic current data in the table are given in accordance with IEC/EN61000-3-12 with reference to the Power Drive Systems product standard. They may be used as the basis for calculation of the harmonic currents' influence on the power supply system and for the documentation of compliance with relevant regional guidelines: IEEE 519 -1992; G5/4.

7.4 Galvanic Isolation (PELV)

7.4.1 PELV - Protective Extra Low Voltage

PELV offers protection by way of extra low voltage. Protection against electric shock is ensured when the electrical supply is of the PELV type and the installation is made as described in local/national regulations on PELV supplies.

All control terminals and relay terminals 01-03/04-06 comply with PELV (Protective Extra Low Voltage) (Does not apply to grounded Delta leg above 400 V).

Galvanic (ensured) isolation is obtained by fulfilling requirements for higher isolation and by providing the relevant creapage/clearance distances. These requirements are described in the EN 61800-5-1 standard.

The components that make up the electrical isolation, as described below, also comply with the requirements for higher isolation and the relevant test as described in EN 61800-5-1.
The PELV galvanic isolation can be shown in six locations (see *Illustration 7.3*):

In order to maintain PELV all connections made to the control terminals must be PELV, e.g. thermistor must be reinforced/double insulated.

1. Power supply (SMPS) incl. signal isolation of U_{DC}, indicating the intermediate current voltage.
2. Gate drive that runs the IGBTs (trigger transformers/opto-couplers).
3. Current transducers.
4. Opto-coupler, brake module.
5. Internal inrush, RFI, and temperature measurement circuits.
6. Custom relays.

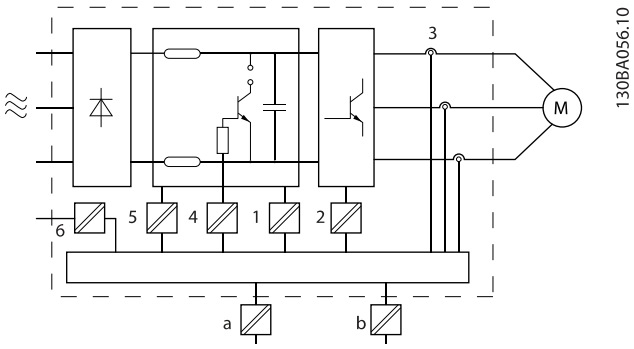


Illustration 7.3 Galvanic Isolation

The functional galvanic isolation (a and b on drawing) is for the 24 V back-up option and for the RS 485 standard bus interface.

⚠WARNING

Installation at high altitude:
380 - 480 V, unit size 1x, 2x and 3x: At altitudes above 2 km, please contact GE regarding PELV.
380 - 480V, unit size 4x, 5x and 6x: At altitudes above 3 km, please contact GE regarding PELV.
525 - 690 V: At altitudes above 2 km, please contact GE regarding PELV.

7.5 Derating

7.5.1 Purpose of Derating

Derating must be taken into account when using the frequency converter at low air pressure (heights), at low speeds, with long motor cables, cables with a large cross section or at high ambient temperature. The required action is described in this section.

7.5.2 Derating for Ambient Temperature

90% frequency converter output current can be maintained up to max. 50 °C ambient temperature.

With a typical full load current of EFF 2 motors, full output shaft power can be maintained up to 50 °C.
For more specific data and/or derating information for other motors or conditions, please contact GE.

7.5.3 Automatic Adaptations to Ensure Performance

The frequency converter 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 frequency converter can adjust the switching frequency and / or change the switching pattern in order to ensure the performance of the frequency converter. The capability to automatically reduce the output current extends the acceptable operating conditions even further.

7.5.4 Derating for Low Air Pressure

The cooling capability of air is decreased at lower air pressure.

Below 1000 m altitude no derating is necessary but above 1000 m the ambient temperature (T_{AMB}) or max. output current (I_{out}) should be derated in accordance with the shown diagram.

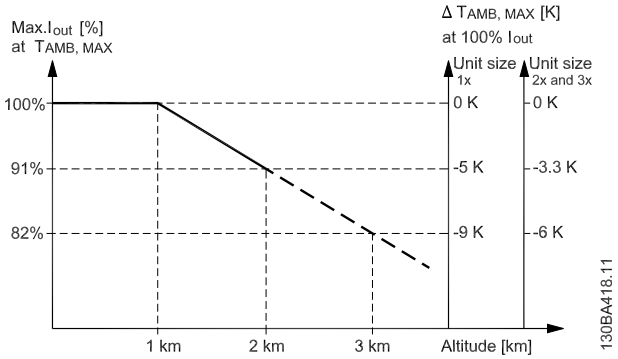


Illustration 7.4 Derating of output current versus altitude at $T_{AMB, MAX}$ for unit sizes 1x, 2x and 3x. At altitudes above 2 km, please contact GE regarding PELV.

An alternative is to lower the ambient temperature at high altitudes and thereby ensure 100% output current at high altitudes. As an example of how to read the graph, the situation at 2 km is elaborated. At a temperature of 45° C ($T_{AMB, MAX}$ - 3.3 K), 91% of the rated output current is available. At a temperature of 41.7° C, 100% of the rated output current is available.

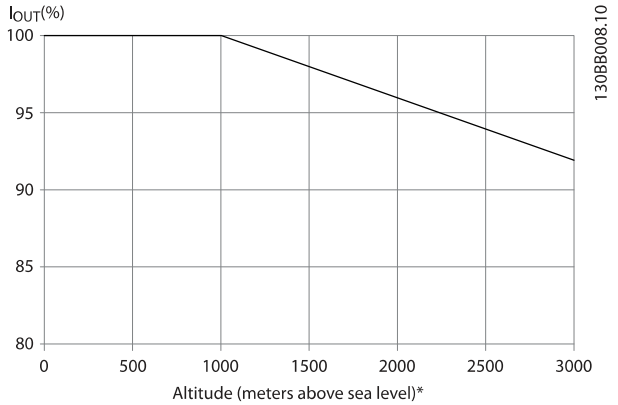


Illustration 7.5 Derating of Output Current versus Altitude at $T_{AMB, MAX}$ for Unit Sizes 4x, 5x and 6x

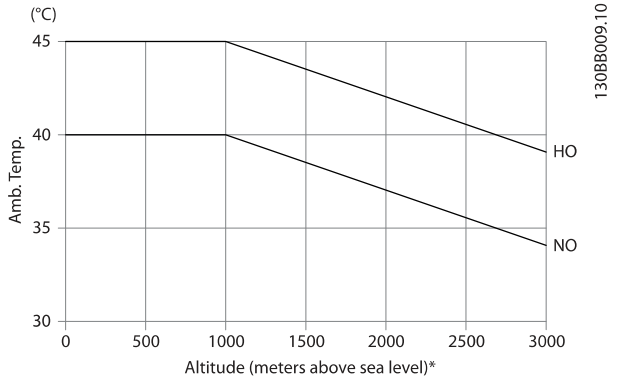


Illustration 7.6 Derating of Output Current versus Altitude at $T_{AMB, MAX}$ for Unit Sizes 4x, 5x and 6x

7.5.5 Derating for Running at Low Speed

When a motor is connected to a frequency converter, it is necessary to check that the cooling of the motor is adequate.
The level of heating depends on the load on the motor, as well as the operating speed and time.

Constant torque applications (CT mode)
Variable (Quadratic) torque applications (VT)
In VT applications such as centrifugal pumps and fans, where the torque is proportional to the square of the speed and the power is proportional to the cube of the speed, there is no need for additional cooling or de-rating of the motor.

In the graphs shown below, the typical VT curve is below the maximum torque with de-rating and maximum torque with forced cooling at all speeds.

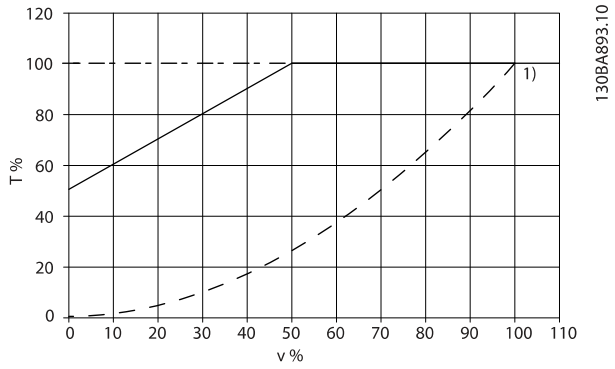


Illustration 7.7 Maximum load for a standard motor at 40 °C driven by an AF-600 FP drive

– – – –	Typical torque at VT load
–•–•–•–	Max torque with forced cooling
———	Max torque

Table 7.8 Legend to *Illustration 7.7*

Note 1) Over-syncronous speed operation will result in the available motor torque decreasing inversely proportional with the increase in speed. This must be considered during the design phase to avoid over-loading of the motor.

7.6 Motor Insulation

For motor cable lengths ≤ the maximum cable length listed in the General Specifications tables the following motor insulation ratings are recommended because the peak voltage can be up to twice the DC link voltage, 2.8 times the mains voltage, due to transmission line effects in the motor cable. If a motor has lower insulation rating it is recommended to use a du/dt or sine wave filter.

Nominal Mains Voltage	Motor Insulation
$U_N \leq 420$ V	Standard U_{LL} = 1300 V
420 V < $U_N \leq$ 500 V	Reinforced U_{LL} = 1600 V
500 V < $U_N \leq$ 600 V	Reinforced U_{LL} = 1800 V
600 V < $U_N \leq$ 690 V	Reinforced U_{LL} = 2000 V

Table 7.9 Motor Insulation

7.7 Motor Bearing Currents

All motors installed with 150 HP or higher power drives should have NDE (Non-Drive End) insulated bearings installed to eliminate circulating bearing currents. To minimize DE (Drive End) bearing and shaft currents proper grounding of the drive, motor, driven machine, and motor to the driven machine is required.

Standard Mitigation Strategies:

1. Use an insulated bearing
2. Apply rigorous installation procedures
   - Ensure the motor and load motor are aligned
   - Strictly follow the EMC Installation guideline
   - Reinforce the PE so the high frequency impedance is lower in the PE than the input power leads
   - Provide a good high frequency connection between the motor and the frequency converter for instance by screened cable which has a 360° connection in the motor and the frequency converter
   - Make sure that the impedance from frequency converter to building ground is lower that the grounding impedance of the machine. This can be difficult for pumps
   - Make a direct earth connection between the motor and load motor
3. Lower the IGBT switching frequency
4. Modify the inverter waveform, 60° AVM vs. SFAVM
5. Install a shaft grounding system or use an isolating coupling
6. Apply conductive lubrication
7. Use minimum speed settings if possible
8. Try to ensure the line voltage is balanced to ground. This can be difficult for IT, TT, TN-CS or Grounded leg systems
9. Use a dU/dt or sinus filter

7

8 Status Messages

8.1 Status Display

When the frequency converter is in status mode, status messages are generated automatically and appear in the bottom line of the display (see *Illustration 8.1*.)

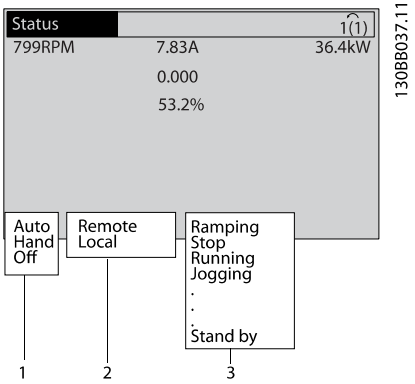


Illustration 8.1 Status Display

1	Operation Mode (see *Table 8.2*)
2	Reference Site (see *Table 8.3*)
3	Operation Status (see *Table 8.4*)

Table 8.1 Legend to *Illustration 8.1*

8.2 Status Message Definitions

Table 8.2 to *Table 8.4* described the displayed status messages.

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 8.2 Operation Mode

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 8.3 Reference Site

AC Brake	AC Brake was selected in *B-10 Brake Function*. The AC brake over-magnetizes the motor to achieve a controlled slow down.
Auto Tune finish OK	Auto Tune was carried out successfully.
Auto Tune ready	Auto Tune is ready to start. Press [Hand] to start.
Auto Tune running	Auto Tune process is in progress.
Coast	• Coast inverse was selected as a function for a digital input. The corresponding terminal is not connected. • Coast activated by serial communication
Ctrl. Ramp-down	Control Ramp-down was selected in *SP-10 Line failure*. • The mains voltage is below the value set in *SP-11 Line Voltage at Input Fault* at mains fault • The frequency converter ramps down the motor using a controlled ramp down
Current High	The frequency converter output current is above the limit set in *H-71 Warning Current High*.
Current Low	The frequency converter output current is below the limit set in *H-70 Warning Current Low*
DC Hold	DC hold is selected in *H-80 Function at Stop* and a stop command is active. The motor is held by a DC current set in *B-00 DC Hold Current*.
DC Stop	The motor is held with a DC current (*B-01 DC Brake Current*) for a specified time (*B-02 DC Braking Time*). • DC Brake is activated in *B-03 DC Brake Cut In Speed [RPM]* and a Stop command is active. • DC Brake (inverse) is selected as a function for a digital input. The corresponding terminal is not active. • The DC Brake is activated via serial communication.

Feedback high	The sum of all active feedbacks is above the feedback limit set in *H-77 Warning Feedback High*.
Feedback low	The sum of all active feedbacks is below the feedback limit set in *H-76 Warning Feedback Low*.
Freeze output	The remote reference is active, which holds the present speed. • Freeze output was selected as a function for a digital input. The corresponding terminal is active. Speed control is only possible via the terminal functions Speed Up and Speed Down. • Hold ramp is activated via serial communication.
Freeze output request	A freeze output command has been given, but the motor will remain stopped until a run permissive signal is received.
Freeze ref.	*Freeze Reference* was chosen as a function for a digital input. 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 remains stopped until a run permissive signal is received via a digital input.
Jogging	The motor is running as programmed in *C-21 Jog Speed [RPM]*. • *Jog* was selected as function for a digital input. The corresponding terminal (e.g. Terminal 29) is active. • The Jog function is activated via the serial communication. • The Jog function was selected as a reaction for a monitoring function (e.g. No signal). The monitoring function is active.
OVC control	*Overvoltage* control was activated in *B-17 Over-voltage Control*, *[2] Enabled*. 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	(Only frequency converters with an external 24 V power supply installed). Mains supply to the frequency converter is removed, but the control card is supplied by the external 24 V.
Protection md	Protection mode is active. The unit has detected a critical status (an overcurrent or overvoltage). • To avoid tripping, switching frequency is reduced to 4 kHz. • If possible, protection mode ends after approximately 10 s • Protection mode can be restricted in *SP-26 Trip Delay at Drive Fault*
QStop	The motor is decelerating using *C-23 Quick Stop Decel Time*. • *Quick stop inverse* was chosen as a function for a digital input. The corresponding terminal is not active. • The quick stop function was activated via serial communication.
Ramping	The motor is accelerating/decelerating using the active Ramp Up/Down. The reference, a limit value or a standstill is not yet reached.
Ref. high	The sum of all active references is above the reference limit set in *H-75 Warning Reference High*.
Ref. low	The sum of all active references is below the reference limit set in *H-74 Warning Reference Low*.
Run on ref.	The 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.
Sleep Mode	The energy saving function is enabled. This means that at present the motor has stopped, but that it will restart automatically when required.
Speed high	Motor speed is above the value set in *H-73 Warning Speed High*.
Speed low	Motor speed is below the value set in *H-72 Warning Speed Low*.
Standby	In Auto mode, the frequency converter will start the motor with a start signal from a digital input or serial communication.
Start delay	In *F-24 Holding Time*, a delay starting time was set. A start command is activated and the motor will start after the start delay time expires.

Start fwd/rev	Start forward and start reverse were selected as functions for two different digital inputs. 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 8.4 Operation Status

NOTE

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

8

9 RS-485 Installation and Set-up

9.1 Installation and Set-up

9.1 Network Configuration

9.1.1 Frequency Converter with Modbus RTU

To enable Modbus RTU on the frequency converter, set the following parameters

Parameter	Setting
O-30 Protocol	Modbus RTU
O-31 Address	1-247
O-32 Drive Port Baud Rate	2400-115200
O-33 Drive Port Parity	Even parity, 1 stop bit (default)

Table 9.1

9.1.2 How to Access Parameters

9.1.2.1 Parameter Handling

The PNU (Parameter Number) is translated from the register address contained in the Modbus read or write message. The parameter number is translated to Modbus as (10 x parameter number) DECIMAL.

All parameters are named with one or two letters, a "-" and a number for example, F-07. To access parameters, use *Table 9.2* because letters cannot be addressed.
Example: F-07=7, E-01=101, DR-53=1253.

Letter	Number
F	0
E	1
C	2
P	3
H	4
K	5
AN	6
B	7
O	8
PB	9
SP	10
XC	11
DR	12
LG	13
CL	14
ID	15
AP	16
T	17
FB	18
PC	19
AO	20
BP	21
DN	22
PI	23
LC	24
EC	25
RS	26
BN	27
LN	28
EN	29
CB	30
CA	31
CD	32

Table 9.2

9.1.2.2 Storage of Data

The Coil 65 decimal determines whether data written to the frequency converter are stored in EEPROM and RAM (coil 65=1) or only in RAM (coil 65=0).

9.1.2.3 IND

The array index is set in Holding Register 9 and used when accessing array parameters.

9.1.2.4 Text Blocks

Parameters stored as text strings are accessed in the same way as the other parameters. The maximum text block size is 20 characters. If a read request for a parameter is for more characters than the parameter stores, the response is truncated. If the read request for a parameter is for fewer characters than the parameter stores, the response is space filled.

9.1.2.5 Conversion Factor

The different attributes for each parameter can be seen in the section on factory settings. Since a parameter value can only be transferred as a whole number, a conversion factor must be used to transfer decimals.

Conversion index	Conversion factor
67	1/60 (time)
6	1000000
5	100000
4	10000
3	1000
2	100
1	10
0	1
-1	0.1
-2	0.01
-3	0.001
-4	0.0001
-5	0.00001
-6	0.000001
-7	0.0000001

Table 9.3 Conversion Table

9.1.2.6 Parameter Values

Standard data types

Standard data types are int16, int32, uint8, uint16 and uint32. They are stored as 4x registers (40001–4FFFF). The parameters are read using function 03HEX "Read Holding Registers." Parameters are written using the function 6HEX "Preset Single Register" for 1 register (16 bits), and the function 10 HEX "Preset Multiple Registers" for 2 registers (32 bits). Readable sizes range from 1 register (16 bits) up to 10 registers (20 characters).

Non standard data types

Non standard data types are text strings and are stored as 4x registers (40001–4FFFF). The parameters are read using function 03HEX "Read Holding Registers" and written using function 10HEX "Preset Multiple Registers." Readable sizes range from 1 register (2 characters) up to 10 registers (20 characters).

9.2 Drive Control Profile

9.2.1 Control Word According to Drive Profile (*O-10 Control Word Profile* = Drive profile)

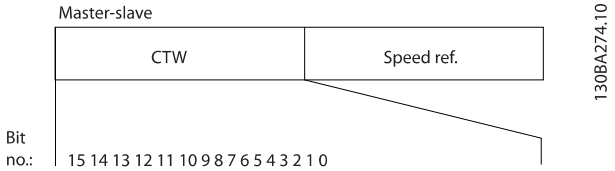


Illustration 9.1 Control Word

Bit	Bit value = 0	Bit value = 1
00	Reference value	external selection lsb
01	Reference value	external selection msb
02	DC brake	Ramp
03	Coasting	No coasting
04	Quick stop	Ramp
05	Hold output frequency	use ramp
06	Ramp stop	Start
07	No function	Reset
08	No function	Jog
09	Ramp 1	Ramp 2
10	Data invalid	Data valid
11	No function	Relay 01 active
12	No function	Relay 02 active
13	Parameter set-up	selection lsb
14	Parameter set-up	selection msb
15	No function	Reverse

Table 9.4 Control Word Bits

Explanation of the Control Bits

Bits 00/01

Bits 00 and 01 are used to choose between the four reference values, which are pre-programmed in *C-05 Multi-step Frequency 1 - 8* according to *Table 9.5*.

Programmed ref. value	Parameter	Bit 01	Bit 00
1	*C-05 Multi-step Frequency 1 - 8* [0]	0	0
2	*C-05 Multi-step Frequency 1 - 8* [1]	0	1
3	*C-05 Multi-step Frequency 1 - 8* [2]	1	0
4	*C-05 Multi-step Frequency 1 - 8* [3]	1	1

Table 9.5 Reference Values

Bit 02, DC brake

Bit 02 = '0' leads to DC braking and stop. Set braking current and duration in *B-01 DC Brake Current* and *B-02 DC Braking Time*. Bit 02 = '1' leads to ramping.

Bit 03, Coasting

Bit 03 = '0': The frequency converter immediately "lets go" of the motor, (the output transistors are "shut off") and it coasts to a standstill. Bit 03 = '1': The frequency converter starts the motor if the other starting conditions are met.

Bit 04, Quick stop
Bit 04 = '0': Makes the motor speed decel to stop (set in *C-23 Quick Stop Decel Time*).
Bit 04 = '1' leads to ramping.

Bit 05, Hold output frequency
Bit 05 = '0': The present output frequency (in Hz) freezes. Change the frozen output frequency only by means of the digital inputs (*E-01 Terminal 18 Digital Input* to *E-06 Terminal 33 Digital Input*) programmed to *Speed up* and *Slow down*.

NOTE

If Freeze output is active, the frequency converter can only be stopped by the following:

- **Bit 03 Coasting stop**
- **Bit 02 DC braking**
- **Digital input (*E-01 Terminal 18 Digital Input* to *E-06 Terminal 33 Digital Input*) programmed to *DC braking*, *Coasting stop*, or *Reset* and *coasting stop*.**

Bit 06, Ramp stop/start
Bit 06 = '0': Causes a stop and makes the motor speed decel to stop via the selected decel parameter. Bit 06 = '1': Permits the frequency converter to start the motor, if the other starting conditions are met.

Bit 07, Reset Bit 07 = '0': No reset. Bit 07 = '1': Resets a trip. Reset is activated on the signal's leading edge, i.e. when changing from logic '0' to logic '1'.

Bit 08, Jog
Bit 08 = '1': The output frequency is determined by *C-21 Jog Speed [RPM]*.

Bit 09, Selection of ramp 1/2
Bit 09 = "0": Ramp 1 is active (*F-07 Accel Time 1* to *F-08 Decel Time 1*). Bit 09 = "1": Ramp 2 (*E-10 Accel Time 2* to *E-11 Decel Time 2*) is active.

Bit 10, Data not valid/Data valid
Tell the frequency converter whether to use or ignore the control word. Bit 10 = '0': The control word is ignored. Bit 10 = '1': The control word is used. This function is relevant because the telegram always contains the control word, regardless of the telegram type. Thus, you can turn off the control word if you do not want to use it when updating or reading parameters.

Bit 11, Relay 01
Bit 11 = "0": Relay not activated. Bit 11 = "1": Relay 01 activated provided that *Control word bit 11* is chosen in *E-24 Function Relay*.

Bit 12, Relay 04
Bit 12 = "0": Relay 04 is not activated. Bit 12 = "1": Relay 04 is activated provided that *Control word bit 12* is chosen in *E-24 Function Relay*.

Bit 13/14, Selection of set-up
Use bits 13 and 14 to choose from the four menu set-ups according to *Table 9.6*.

Set-up	Bit 14	Bit 13
1	0	0
2	0	1
3	1	0
4	1	1

Table 9.6 Four Menu Set-ups

The function is only possible when *Multi Set-Ups* is selected in *K-10 Active Set-up*.

Bit 15 Reverse
Bit 15 = '0': No reversing. Bit 15 = '1': Reversing. In the default setting, reversing is set to digital in *O-54 Reversing Select*. Bit 15 causes reversing only when Ser. communication, Logic or or Logic and is selected.

9.2.2 Status Word According to Drive Profile (STW) (*O-10 Control Word Profile* = Drive profile)

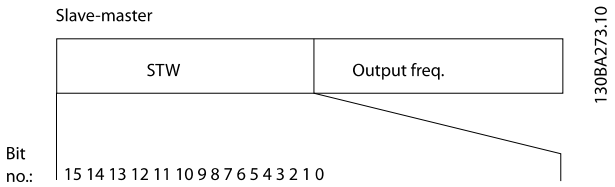


Illustration 9.2 Status Word

Bit	Bit = 0	Bit = 1
00	Control not ready	Control ready
01	Drive not ready	Drive ready
02	Coasting	Enable
03	No error	Trip
04	No error	Error (no trip)
05	Reserved	-
06	No error	Triplock
07	No warning	Warning
08	Speed ≠ reference	Speed = reference
09	Local operation	Bus control
10	Out of frequency limit	Frequency limit OK
11	No operation	In operation
12	Drive OK	Stopped, auto start
13	Voltage OK	Voltage exceeded
14	Torque OK	Torque exceeded
15	Timer OK	Timer exceeded

Table 9.7 Status Word Bits

Explanation of the Status Bits

Bit 00, Control not ready/ready
Bit 00 = '0': The frequency converter trips. Bit 00 = '1': The frequency converter controls are ready but the power component does not necessarily receive any power supply (in case of external 24V supply to controls).

Bit 01, Drive ready
Bit 01 = '1': The frequency converter is ready for operation but the coasting command is active via the digital inputs or via serial communication.

Bit 02, Coasting stop
Bit 02 = '0': The frequency converter releases the motor. Bit 02 = '1': The frequency converter starts the motor with a start command.

Bit 03, No error/trip
Bit 03 = '0' : The frequency converter is not in fault mode. Bit 03 = '1': The frequency converter trips. To re-establish operation, enter [Reset].

Bit 04, No error/error (no trip)
Bit 04 = '0': The frequency converter is not in fault mode. Bit 04 = "1": The frequency converter shows an error but does not trip.

Bit 05, Not used
Bit 05 is not used in the status word.

Bit 06, No error/triplock
Bit 06 = '0': The frequency converter is not in fault mode. Bit 06 = "1": The frequency converter is tripped and locked.

Bit 07, No warning/warning
Bit 07 = '0': There are no warnings. Bit 07 = '1': A warning has occurred.

Bit 08, Speed≠ reference/speed = reference
Bit 08 = '0': The motor is running but the present speed is different from the preset speed reference. It might e.g. be the case when the speed accels/decels during start/stop. Bit 08 = '1': The motor speed matches the preset speed reference.

Bit 09, Local operation/bus control
Bit 09 = '0': [STOP/RESET] is activate on the control unit or *Local control* in *F-02 Operation Method* is selected. You cannot control the frequency converter via serial communication. Bit 09 = '1' It is possible to control the frequency converter via the network / serial communication.

Bit 10, Out of frequency limit
Bit 10 = '0': The output frequency has reached the value in *F-18 Motor Speed Low Limit [RPM]* or *F-17 Motor Speed High Limit [RPM]*. Bit 10 = "1": The output frequency is within the defined limits.

Bit 11, No operation/in operation
Bit 11 = '0': The motor is not running. Bit 11 = '1': The frequency converter has a start signal or the output frequency is greater than 0 Hz.

Bit 12, Drive OK/stopped, autostart
Bit 12 = '0': There is no temporary over temperature on the inverter. Bit 12 = '1': The inverter stops because of over temperature but the unit does not trip and will resume operation once the over temperature stops.

Bit 13, Voltage OK/limit exceeded
Bit 13 = '0': There are no voltage warnings. Bit 13 = '1': The DC voltage in the frequency converter's intermediate circuit is too low or too high.

Bit 14, Torque OK/limit exceeded
Bit 14 = '0': The motor current is lower than the torque limit selected in *F-43 Current Limit*. Bit 14 = '1': The torque limit in *F-43 Current Limit* is exceeded.

Bit 15, Timer OK/limit exceeded
Bit 15 = '0': The timers for motor thermal protection and thermal protection are not exceeded 100%. Bit 15 = '1': One of the timers exceeds 100%.

All bits in the STW are set to '0' if the connection between the Interbus option and the frequency converter is lost, or an internal communication problem has occurred.

9.2.3 Bus Speed Reference Value

Speed reference value is transmitted to the frequency converter in a relative value in %. The value is transmitted in the form of a 16-bit word; in integers (0-32767) the value 16384 (4000 Hex) corresponds to 100%. Negative figures are formatted by means of 2's complement. The Actual Output frequency (MAV) is scaled in the same way as the bus reference.

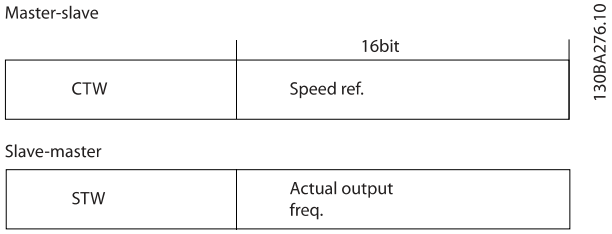


Illustration 9.3 Actual Output Frequency (MAV)

The reference and MAV are scaled as follows:

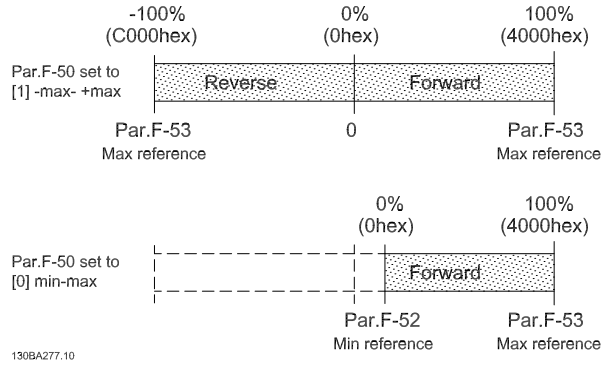


Illustration 9.4 Reference and MAV

10 Warnings and Alarms

10.1 System Monitoring

The frequency converter 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 frequency converter 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 frequency converter as indicated in the alarm or warning.

10.2 Warning and Alarm Types

Warnings

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

Alarms

Trip

An alarm is issued when the frequency converter is tripped, that is, the frequency converter suspends operation to prevent frequency converter or system damage. The motor will coast to a stop. The frequency converter logic will continue to operate and monitor the frequency converter status. After the fault condition is remedied, the frequency converter 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

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

10.3 Warning and Alarm Displays

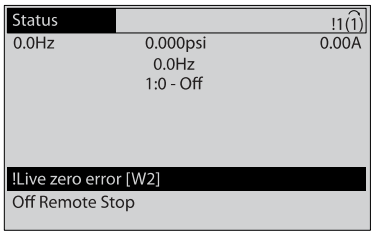


Illustration 10.1 Warning Display

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

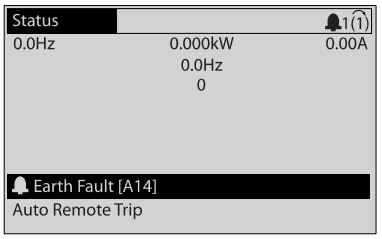


Illustration 10.2 Alarm Display

In addition to the text and alarm code on the frequency converter keypad, there are three status indicator lights.

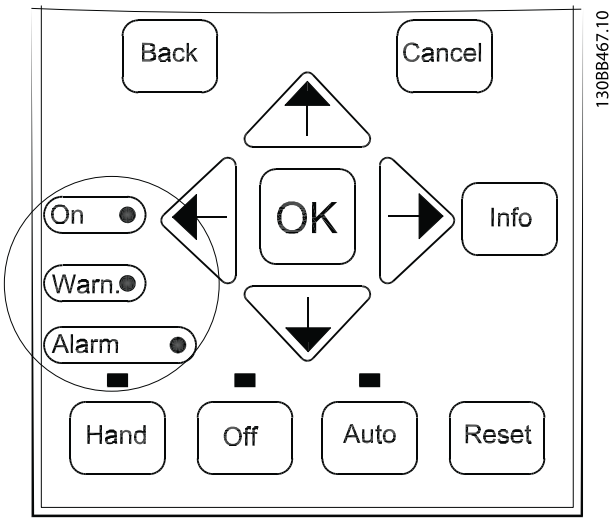


Illustration 10.3 Status Indicator Lights

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

Table 10.1 Status Indicator Lights Explanations

10.3.1 Warnings/Alarm Messages

A warning or an alarm is signalled by the relevant LED on the front of the frequency converter and indicated by a code on the display.

A warning remains active until its cause is no longer present. Under certain circumstances, operation of the motor may still be continued. Warning messages may be critical, but are not necessarily so.

In the event of an alarm, the frequency converter trips. Reset the alarm to resume operation once the cause has been rectified.

Three ways to reset:

- Press [Reset].
- Via a digital input with the "Reset" function.
- Via serial communication/optional network.

NOTE

After a manual reset pressing [Reset], press [Auto] to restart the motor.

If an alarm cannot be reset, the reason may be that its cause has not been rectified, or the alarm is trip-locked (see also *Table 10.2*).

Alarms that are trip-locked offer additional protection, meaning that the mains supply must be switched off before the alarm can be reset. After being switched back on, the frequency converter is no longer blocked and can be reset as described above once the cause has been rectified.

Alarms that are not trip-locked can also be reset using the automatic reset function in *H-04 Auto-Reset (Times)* (Warning: automatic wake-up is possible!)

If a warning or alarm is marked against a code in *Table 10.2*, this means that either a warning occurs before an alarm, or else that it is possible to specify whether a warning or an alarm should be displayed for a given fault.

This is possible, for instance, in *F-10 Electronic Overload*. After an alarm or trip, the motor carries on coasting, and the alarm and warning flash. Once the problem has been rectified, only the alarm continues flashing until the frequency converter is reset.

NOTE

No missing motor phase detection (numbers 30-32) and no stall detection is active when *P-20 Motor Construction* is set to *[1] PM non salient SPM*.

10

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		
13	Over Current	X	X	X	
14	Earth Fault	X	X		
15	Hardware mismatch		X	X	
16	Short Circuit		X	X	

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
17	Control word time-out	(X)	(X)		O-04 Control Word Timeout Function
20	Temp. Input Error				
21	Param Error				
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		
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	Ovrld X30/6-7	(X)			
43	Ext. Supply (option)				
45	Earth Fault 2	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		H-36 Trip Speed Low [RPM]
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			
61	Feedback Error	(X)	(X)		H-20 Motor Feedback Loss Function
62	Output Frequency at Maximum Limit	X			
64	Voltage Limit	X			
65	Control Board Over-temperature	X	X	X	

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
66	Heat sink Temperature Low	X			
67	Option Module Configuration has Changed		X		
69	Pwr. Card Temp		X	X	
70	Illegal Drive configuration			X	
75	Illegal Profile Sel.		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		
81	CSIV corrupt		X		
82	CSIV parameter error		X		
83	Illegal Option Combination			X	
88	Option Detection			X	
91	Analog input 54 wrong settings			X	S202
246	Pwr.card supply				
250	New spare parts			X	
251	New Type Code		X	X	

Table 10.2 Alarm/Warning Code List

(X) Dependent on parameter

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

A trip is the action following an alarm. The trip coasts the motor and is reset by pressing [Reset] or by a digital input (parameter group E-1# [1]). The origin event that caused an alarm cannot damage the frequency converter or cause dangerous conditions. A trip lock is an action when an alarm occurs, which could damage the frequency converter or connected parts. A trip lock situation can only be reset by a power cycling.

Warning	yellow
Alarm	flashing red
Trip locked	yellow and red

Table 10.3 LED Indication

10

Bit	Hex	Dec	Alarm Word	Alarm Word 2	Warning Word	Warning Word 2	Extended Status Word
Alarm Word Extended Status Word							
0	00000001	1	Brake Check (A28)	ServiceTrip, Read/Write	Brake Check (W28)	reserved	Ramping
1	00000002	2	Pwr. Card Temp (A69)	ServiceTrip, (reserved)	Pwr. Card Temp (W69)	reserved	Auto Tune Running
2	00000004	4	Earth Fault (A14)	ServiceTrip, Typecode/ Sparepart	Earth Fault (W14)	reserved	Start CW/CCW
3	00000008	8	Ctrl.Card Temp (A65)	ServiceTrip, (reserved)	Ctrl.Card Temp (W65)	reserved	Slow Down
4	00000010	16	Ctrl. Word TO (A17)	ServiceTrip, (reserved)	Ctrl. Word TO (W17)		Catch Up
5	00000020	32	Over Current (A13)	reserved	Over Current (W13)	reserved	Feedback High
6	00000040	64	Torque Limit (A12)	reserved	Torque Limit (W12)	reserved	Feedback Low
7	00000080	128	Motor Th Over (A11)	reserved	Motor Th Over (W11)	reserved	Output Current High

Bit	Hex	Dec	Alarm Word	Alarm Word 2	Warning Word	Warning Word 2	Extended Status Word
8	00000100	256	Motor Electronic OL Over (A10)	reserved	Motor Electronic OL Over (W10)	reserved	Output Current Low
9	00000200	512	Drive Overld. (A9)	reserved	Drive Overld (W9)	reserved	Output Freq High
10	00000400	1024	DC under Volt (A8)	reserved	DC under Volt (W8)		Output Freq Low
11	00000800	2048	DC over Volt (A7)	reserved	DC over Volt (W7)		Brake Check OK
12	00001000	4096	Short Circuit (A16)	reserved	DC Voltage Low (W6)	reserved	Braking Max
13	00002000	8192	Inrush Fault (A33)	reserved	DC Voltage High (W5)		Braking
14	00004000	16384	Mains ph. Loss (A4)	reserved	Mains ph. Loss (W4)		Out of Speed Range
15	00008000	32768	Auto Tune Not OK	reserved	No Motor (W3)		OVC Active
16	00010000	65536	Live Zero Error (A2)	reserved	Live Zero Error (W2)		AC Brake
17	00020000	131072	Internal Fault (A38)	KTY error	10V Low (W1)	KTY Warn	Password Timelock
18	00040000	262144	Brake Overload (A26)	Fans error	Brake Overload (W26)	Fans Warn	Password Protection
19	00080000	524288	U phase Loss (A30)	reserved	Brake Resistor (W25)	reserved	
20	00100000	1048576	V phase Loss (A31)	reserved	Brake IGBT (W27)	reserved	
21	00200000	2097152	W phase Loss (A32)	reserved	Speed Limit (W49)	reserved	
22	00400000	4194304	Network Fault (A34)	reserved	Network Fault (W34)	reserved	Unused
23	00800000	8388608	24 V Supply Low (A47)	reserved	24V Supply Low (W47)	reserved	Unused
24	01000000	16777216	Mains Failure (A36)	reserved	Mains Failure (W36)	reserved	Unused
25	02000000	33554432	1.8V Supply Low (A48)	reserved	Current Limit (W59)	reserved	Unused
26	04000000	67108864	Brake Resistor (A25)	reserved	Low Temp (W66)	reserved	Unused
27	08000000	134217728	Brake IGBT (A27)	reserved	Voltage Limit (W64)	reserved	Unused
28	10000000	268435456	Option Change (A67)	reserved	Encoder loss (W90)	reserved	Unused
29	20000000	536870912	Drive Restored to factory settings(A80)	Feedback Fault (A61, A90)	Feedback Fault (W61, W90)		Unused
30	40000000	1073741824	Safe Stop (A68)	Safe Stop (A71)	Safe Stop (W68)	Safe Stop (W71)	Unused
31	80000000	2147483648	Mech. brake low (A63)	Dangerous Failure (A72)	Extended Status Word		Unused

Table 10.4 Description of Alarm Word, Warning Word and Extended Status Word

The alarm words, warning words and extended status words can be read out via serial bus or optional network for diagnostics. See also *DR-94 Ext. Status Word*.

10.4 Warning and Alarm Definitions

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

WARNING 1, 10 Volts low
The control card voltage is below 10 V from terminal 50. Remove some of the load from terminal 50, as the 10 V supply is overloaded. Max. 15 mA or minimum 590 Ω.

A short circuit in a connected potentiometer or improper wiring of the potentiometer can cause this condition.

Troubleshooting

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

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed 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. Broken wiring or faulty device sending the signal can cause this condition.

Troubleshooting

Check connections on all the analog input terminals. Control card terminals 53 and 54 for signals, terminal 55 common. 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 frequency converter programming and switch settings match the analog signal type.

Perform Input Terminal Signal Test.

WARNING/ALARM 4, Mains phase loss
A phase is missing on the supply side, or the mains voltage imbalance is too high. This message also appears for a fault in the input rectifier on the frequency converter. Options are programmed at *SP-12 Function at Line Imbalance*.

Troubleshooting

Check the supply voltage and supply currents to the frequency converter.

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 frequency converter 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 frequency converter voltage rating. The unit is still active.

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

Troubleshooting

Extend the ramp time

Change the ramp type

Activate the functions in *B-10 Brake Function*

Increase *SP-26 Trip Delay at Drive Fault*

If the alarm/warning occurs during a power sag, use kinetic back-up (*SP-10 Line failure*)

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

Troubleshooting

Check that the supply voltage matches the frequency converter voltage.

Perform input voltage test.

Perform soft charge circuit test.

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

Troubleshooting

Compare the output current shown on the keypad with the frequency converter 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 frequency converter continuous current rating, the counter increases. When running below the frequency converter continuous current rating, the counter decreases.

WARNING/ALARM 10, Motor overload temperature
According to the electronic thermal protection, the motor is too hot. Select whether the frequency converter issues a warning or an alarm when the counter reaches 100% in *F-10 Electronic Overload*. The fault occurs when the motor runs with more than 100% overload for too long.

Troubleshooting

Check for motor overheating.

Check if the motor is mechanically overloaded

Check that the motor current set in *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* tunes the frequency converter to the motor more accurately and reduces thermal loading.

WARNING/ALARM 11, Motor thermistor over temp
Check whether the thermistor is disconnected. Select whether the frequency converter issues 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 (+10 V supply). Also check 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 warning 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. Make sure that the system can operate safely at a higher torque.

Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Over current
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the frequency converter trips and issues an alarm. Shock loading or quick acceleration with high inertia loads can cause this fault . It can also appear after kinetic back-up, if the acceleration during ramp up is quick. If extended mechanical brake control is selected, trip can be reset externally.

Troubleshooting

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

Check that the motor size matches the frequency converter.

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 frequency converter and the motor or in the motor itself.

Troubleshooting

Remove power to the frequency converter 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 frequency converter and repair the short circuit.

WARNING/ALARM 17, Control word timeout
There is no communication to the frequency converter. The warning is only active when *O-04 Control Word Timeout Function* is NOT set to *[0] Off*.
If *O-04 Control Word Timeout Function* is set to *[5] Stop and Trip*, a warning appears and the frequency converter 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.

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

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

Troubleshooting

Check for proper fan operation.

Cycle power to the frequency converter 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 frequency converter and check that the fan operates briefly at start-up.

Check the sensors on the heatsink and control card.

WARNING 25, Brake resistor short circuit
The brake resistor is monitored during operation. If a short circuit occurs, the brake function is disabled and the warning appears. The frequency converter is still operational but without the brake function. Remove power to the frequency converter and replace the brake resistor (see *B-15 Brake Check*).

WARNING/ALARM 26, Brake resistor power limit
The power transmitted to the brake resistor is calculated as a mean value over the last 120 seconds of run time. The calculation is based on the intermediate circuit voltage and the brake resistance value set in *B-16 AC brake Max.* *Current*. The warning is active when the dissipated braking is higher than 90% of the brake resistance power. If *[2] Trip* is selected in *B-13 Braking Thermal Overload*, the frequency converter trips when the dissipated braking power reaches 100%.

WARNING/ALARM 27, Brake chopper fault
The brake transistor is monitored during operation and if a short circuit occurs, the brake function is disabled and a warning is issued. The frequency converter is still operational but, since the brake transistor has short-circuited, substantial power is transmitted to the brake resistor, even if it is inactive.
Remove power to the frequency converter and remove the brake resistor.

High power drives: This alarm/warning could also occurs should the brake resistor overheat. Terminals 104 to 106 of FK102 are available as brake resistor temperature switch on the power card of high power drives. Unless used as an input, a jumper must be placed between terminals 104 and 106 of FK102.

WARNING/ALARM 28, Brake check failed
The brake resistor is not connected or not working. Check *B-15 Brake Check*.

ALARM 29, Heatsink temp
The maximum temperature of the heatsink has been exceeded. The temperature fault will not reset until the temperature falls below a defined heatsink temperature. The trip and reset points are different based on the frequency converter power size.

Troubleshooting
Check for the following conditions.

Ambient temperature too high.

Motor cable too long.

Incorrect airflow clearance above and below the frequency converter.

Blocked airflow around the frequency converter.

Damaged heatsink fan.

Dirty heatsink.

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

Remove power from the frequency converter and check motor phase U.

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

Remove power from the frequency converter and check motor phase V.

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

Remove power from the frequency converter and check motor phase W.

ALARM 33, Inrush fault
Too many power-ups have occurred within a short time period. Let the unit cool to operating temperature.

WARNING/ALARM 34, Fieldbus communication fault
The network on the communication option card is not working.

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

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in *Table 10.5* is displayed.

Troubleshooting

Cycle power

Check that the option is properly installed

Check for loose or missing wiring

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

No.	Text
0	Serial port cannot be restore. Contact your GE supplier or GE Service Department.
256-258	Power EEPROM data is defective or too old. Replace power card.
512-519	Internal fault. Contact your GE 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
1315	Option SW in slot A is not supported (not allowed)
1316	Option SW in slot B is not supported (not allowed)
1379-2819	Internal fault. Contact your GE supplier or GE Service Department.
2561	Replace control card
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
5376-6231	Internal fault. Contact your GE supplier or GE Service Department.

Table 10.5 Internal Fault Codes

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 the short-circuit connection. Check *E-56 Term X30/6 Digi Out (OPCGPIO)*.

For X30/7, check the load connected to X30/7 or remove the 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: 24 V, 5 V, ±18 V. When powered with three phase mains voltage, all three supplies are monitored.

Troubleshooting

Check for a defective power card.

Check for a defective control card.

Check for a defective option card.

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

WARNING 47, 24 V supply low
The 24 V DC is measured on the control card. The external 24 V DC back-up power supply may be overloaded, otherwise contact the GE supplier.

WARNING 48, 1.8 V supply low
The 1.8 V DC supply used on the control card is outside of allowable limits. The power supply is measured on the control card. Check for a defective control card. If an option card is present, check for an overvoltage condition.

WARNING 49, Speed limit
When the speed is not within the specified range in F-18 and F-17, the frequency converter shows a warning. When the speed is below the specified limit in *H-36 Trip Speed Low [RPM]* (except when starting or stopping), the frequency converter trips.

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 settings.

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 cannot run.

ALARM 56, Auto tune interrupted by user
The user has interrupted the Auto tune.

ALARM 57, Auto tune internal fault
Try to restart Auto tune again. Repeated restarts can over heat the motor.

ALARM 58, 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 that the system can operate safely at a higher limit.

WARNING 60, External interlock
A digital input signal is indicating a fault condition external to the frequency converter. An external interlock has commanded the frequency converter to trip. Clear the external fault condition. To resume normal operation, apply 24 V DC to the terminal programmed for external interlock. Reset the frequency converter.

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.

WARNING/ALARM 65, Control card over temperature
The cut-out 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 frequency converter 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 frequency converter 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 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. To check compatibility, contact your supplier with the model number of the unit from the nameplate and the part numbers of the cards.

ALARM 80, Drive initialised to default value
Parameter settings are restored to factory settings after a manual reset. To clear the alarm, reset the unit.

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

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

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

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

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

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

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

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

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

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

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

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

WARNING 250, New spare part
A component in the frequency converter has been replaced. Reset the frequency converter 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.

11 Basic Troubleshooting

11.1 Start Up and Operation

Symptom	Possible cause	Test	Solution
Display dark/No function	Missing input power	See *Table 3.1*	Check the input power source
	Missing or open fuses or circuit breaker tripped	See open fuses and tripped circuit breaker in this table for possible causes	Follow the recommendations provided
	No power to the keypad	Check the keypad cable for proper connection or damage	Replace the faulty keypad or connection cable
	Shortcut on control voltage (terminal 12 or 50) or at control terminals	Check the 24 V control voltage supply for terminals 12/13 to 20-39 or 10 V supply for terminals 50 to 55	Wire the terminals properly
	Wrong contrast setting		Press [Status] + [▲]/[▼] 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 frequency converter	To rule out a problem in the control wiring, disconnect all control wiring by removing the terminal blocks.	If the display stays lit, then the problem is in the control wiring. Check the wiring for shorts or incorrect connections. If the display continues to cut out, follow the procedure for display dark.
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 24 V DC option card	If the display is functioning but no output, check that mains power is applied to the frequency converter.	Apply mains power to run the unit
	keypad Stop	Check if [Off] has been pressed	Press [Auto] or [Hand] (depending on operation mode) to run the motor
	Missing start signal (Standby)	Check *E-01 Terminal 18 Digital Input* for correct setting for terminal 18 (use default setting)	Apply a valid start signal to start the motor
	Motor coast signal active (Coasting)	Check if a coast inv command is programmed for the terminal in parameter group E-0# Digital Inputs.	Apply 24 V on terminal or program this terminal to *No operation*
	Wrong reference signal source	Check reference signal: Local, remote or bus reference? Preset reference active? Terminal connection correct? Scaling of terminals correct? Reference signal available?	Program correct settings. Check *F-02 Operation Method*. Set preset reference active in parameter *C-05 Multi-step Frequency 1 - 8*. Check for correct wiring. Check scaling of terminals. Check reference signal.

Symptom	Possible cause	Test	Solution
Motor running in wrong direction	Motor rotation limit	Check that *H-08 Reverse Lock* is programmed correctly.	Program correct settings
	Active reversing signal	Check if a reversing command is programmed for the terminal in parameter group *E-0# Digital inputs.*.	Deactivate reversing signal
	Wrong motor phase connection		
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in *F-17 Motor Speed High Limit [RPM]*, *F-15 Motor Speed High Limit [Hz]* and *F-03 Max Output Frequency 1*.	Program correct limits
	Reference input signal not scaled correctly	Check reference input signal scaling in AN-## Reference limits in parameter group F-5#.	Program correct settings
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed loop operation, check PID settings.	Check settings in parameter group AN-##. For closed loop operation, check settings in parameter group CL-0#.
Motor runs rough	Possible over-magnetization	Check for incorrect motor settings in all motor parameters	Check motor settings in parameter groups P-0# *Motor Data*, P-3# *Adv Motor Data*, and H-5# *Load Indep. Setting*.
Motor will not brake	Possible incorrect settings in the brake parameters. Possible too short ramp down times	Check brake parameters. Check ramp time settings	Check parameter group *B-0# DC Brake* and *F-5# Extended Reference*.
Open power fuses or circuit breaker trip	Phase to phase short	Motor or panel has a short phase to phase. Check motor and panel phase for shorts	Eliminate any shorts detected
	Motor overload	Motor is overloaded for the application	Perform 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 *Alarm 4 Mains phase loss* description)	Rotate input power leads into the frequency converter 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 frequency converter	Rotate input power leads into the frequency converter one position: A to B, B to C, C to A.	If imbalance leg stays on same input terminal, it is a problem with the unit. Contact the supplier.
Motor current imbalance greater than 3%	Problem with motor or motor wiring	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalanced leg follows the wire, the problem is in the motor or motor wiring. Check motor and motor wiring.
	Problem with the frequency converters	Rotate output motor leads one position: U to V, V to W, W to U.	If imbalance leg stays on same output terminal, it is a problem with the unit. Contact the supplier.

Symptom	Possible cause	Test	Solution
Acoustic noise or vibration (e.g. a fan blade is making noise or vibrations at certain frequencies)	Resonances, e.g. in the motor/fan system	Bypass critical frequencies by using parameters in parameter group C-0#	Check if noise and/or vibration have been reduced to an acceptable limit
		Turn off over-modulation in *F-38 Overmodulation*	
		Change switching pattern and frequency in parameter group F-3#	
		Increase Resonance Dampening in *H-64 Resonance Dampening*	

Table 11.1 Troubleshooting

Power [kW/HP]				Enclosure	Mains		Motor		Load share		Brake		Earth*
200-240V	380-480V	525-600V	525-690V		Tightening torque [Nm/in-lbs]	Wire size [mm² (AWG)]	Tightening torque [Nm/in-lbs]	Wire size [mm² (AWG)]	Tightening torque [Nm/in-lbs]	Wire size [mm² (AWG)]	Tightening torque [Nm/in-lbs]	Wire size [mm² (AWG)]	Tightening torque [Nm/in-lbs]
0.75-2.2kW 1-3HP	0.75-3.7kW 1-5HP			IP20	1.8 / 16	4 (10)	1.8 / 16	4 (10)	1.8 / 16	4 (10)	1.8 / 16	4 (10)	3 / 27
3.7kW 5HP	5.5-7.5kW 7.5-10HP	0.75-7.5kW 1-10HP		IP20									
0.75-3.7kW 1-5HP	0.75-7.5kW 1-10HP	0.75-7.5kW 1-10HP		IP55 or IP66									
5.5-11kW 7.5-15HP	11-18.5kW 15-25HP	11-18.5kW 15-25HP		IP20		16 (6)		16 (6)		16 (6)		16 (6)	
5.5-11kW 7.5-15HP	11-18.5kW 15-25HP	11-18.5kW 15-25HP		IP55 or IP66					1.5 / 14		1.5 / 14		
15-18.5kW 20-25HP	22-37kW 30-50HP	22-37kW 30-50HP		IP20	4.5 / 40	35 (2)	4.5 / 40	35 (2)	4.5 / 40	35 (2)	4.5 / 40	35 (2)	
15kW 20HP	22-30kW 30-40HP	22-30kW 30-40HP	11-30kW 15-40HP	IP55 or IP66					3.7 / 33		3.7 / 33		
22-30kW 30-40HP	45-55kW 60-75HP	45-55kW 60-75HP		IP20	10 / 89	50 (1)	10 / 89	50 (1)	10 / 89	50 (1)	10 / 89	50 (1)	
18.5-30kW 25-40HP	37-55kW 50-75HP	37-55kW 50-75HP		IP55 or IP66		90 (3/0)		90 (3/0)		90 (3/0)		90 (3/0)	
37-45kW 50-60HP	75-90kW 100-125HP	75-90kW 100-125HP		IP20	14 / 124	150 (300mcm)	14 / 124	150 (300mcm)	14 / 124	95 (4/0)	14 / 124	95 (4/0)	
37-45kW 50-60HP	75-90kW 100-125HP	75-90kW 100-125HP	37-90kW 50-125HP	IP55 or IP66		120 (4/0)		120 (4/0)		120 (4/0)		120 (4/0)	
	110-160kW 150-250HP		110-160kW 150-250HP	all	19 / 168	2x95 (2x3/0)	19 / 168	2x95 (2x3/0)	19 / 168	2x95 (2x3/0)	8.5 / 75	2x95 (2x3/0)	8.5 / 75
	200-315kW 300-450HP		200-400kW 300-550HP	all		2x185 (2x350mcm)		2x185 (2x350mcm)		2x185 (2x350mcm)		2x185 (2x350mcm)	19 / 168
	355-450kW 500-600HP		450-630kW 600-900HP	all		4x240 (4x500mcm)		4x240 (4x500mcm)	19 / 168	4x240 (4x500mcm)			
	500-710kW 650-1000HP		710-900kW 1000-1250HP	all		8x240 (8x500mcm)		8x150 (8x300mcm)		4x120 (4x250mcm)		4x185 (4x350mcm)	
	800-1000kW 1200-1350HP		1000-1400kW 1350-1900HP	all				12x150 (12x300mcm)				6x185 (6x350mcm)	
* Maximum cable size according to national code													

Table 12.1 Cables

13 Specifications

13.1 Power-dependent Specifications

13.1.1 Power, Currents and Enclosures

200-240 V							
HP	kW	A	Input	Efficiency	IP20/Chassis	IP55/Type 12	IP66/Type 4X
1	0.75	4.6	5.9	0.96	Unit size 12	Unit size 15	Unit size 15
2	1.5	7.5	6.8	0.96			
3	2.2	10.6	9.5	0.96			
5	3.7	16.7	15	0.96			
7.5	5.5	24.2	22	0.96			
10	7.5	30.8	28	0.96	Unit size 23	Unit size 21	Unit size 21
15	11	46.2	42	0.96			
20	15	59.4	54	0.96	Unit size 24	Unit size 22	Unit size 22
25	18	74.8	68	0.96		Unit size 31	Unit size 31
30	22	88	80	0.96	Unit size 33		
40	30	115	104	0.96			
50	37	143	130	0.96	Unit size 34	Unit size 32	Unit size 32
60	45	170	154	0.96			

Table 13.1 200-240 V

		380-480 V								
HP	kW	A		Input	Efficiency	IP00/ Chassis	IP20/Chassis	IP21/Type 1	IP54/IP55/Type 12	IP66/Type 4X
		≤ 440 V	>440 V							
1	0.75	2.4	2.12.7	2.7	0.96		Unit size 12		Unit size 15	Unit size 15
2	1.5	4.1	3.4	3.7	0.97					
3	2.2	5.6	4.8	5	0.97					
5	4.0	10	8.2	9	0.97		Unit size 12		Unit size 15	Unit size 15
7.5	5.5	13	11	11.7	0.97		Unit size 13			
10	7.5	16	14.5	14.4	0.97					
15	11	24	21	22	0.98		Unit size 23		Unit size 21	Unit size 21
20	15	32	27	29	0.98					
25	18	37.5	34	34	0.98					
30	22	44	40	40	0.98		Unit size 24		Unit size 22	Unit size 22
40	30	61	52	55	0.98					
50	37	73	65	66	0.98				Unit size 31	Unit size 31
60	45	90	80	82	0.98		Unit size 33			
75	55	106	105	96	0.98					
100	75	147	130	133	0.98		Unit size 34		Unit size 32	Unit size 32
125	90	177	160	161	0.98					
150	110	212	190	204	0.98		Unit size 43h	Unit size 41h	Unit size 41h	
200	132	260	240	251	0.98					
250	160	315	302	304	0.98		Unit size 43h	Unit size 41h	Unit size 41h	
300	200	395	361	381	0.98		Unit size 44h	Unit size 42h	Unit size 42h	
350	250	480	443	463	0.98					

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		380-480 V								
HP	kW	A		Input	Efficiency	IP00/ Chassis	IP20/Chassis	IP21/Type 1	IP54/IP55/Type 12	IP66/Type 4X
		≤ 440 V	>440 V							
450	315	588	535	588	0.98	Unit size 52		Unit size 42h	Unit size 42h	
500	355	658	590	647	0.98			Unit size 51	Unit size 51	
550	400	745	678	733	0.98					
600	450	800	730	787	0.98					
650	500	880	780	857	0.98			Unit size 61/63	Unit size 61/63	
750	560	990	890	964	0.98					
900	630	1120	1050	1090	0.98					
1000	710	1260	1160	1227	0.98					
1200	800	1460	1380	1422	0.98			Unit size 62/64	Unit size 62/64	
1350	1000	1720	1530	1675	0.98					

Table 13.2 380-480 V

525-600 V								
HP	kW	A		Input	Efficiency	IP20/Chassis	IP55/Type 12	IP66/Type 12
		≤ 550 V	>550 V					
1	0.75	1.8	1.7	2.4	0.97	Unit size 13	Unit size 15	Unit size 15
2	1.5	2.9	2.7	2.7	0.97			
3	2.2	4.1	3.9	3.9	0.97			
5	4.0	6.4	6.1	6.1	0.97			
7.5	5.5	9.5	9	9	0.97			
10	7.5	11.5	11	11	0.97			
15	11	19	18	18	0.98	Unit size 23	Unit size 21	Unit size 21
20	15	23	22	22	0.98			
25	18	28	27	27	0.98			
30	22	36	34	34	0.98	Unit size 24	Unit size 22	Unit size 22
40	30	43	41	41	0.98			
50	37	54	52	52	0.98			
60	45	65	62	62	0.98	Unit size 33	Unit size 31	Unit size 31
75	55	87	83	83	0.98			
100	75	105	100	100	0.98	Unit size 34	Unit size 32	Unit size 32
125	90	137	131	131	0.98			

Table 13.3 525-600 V

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525-690 V									
HP	kW	A		Input	Efficiency	IP00/Chassis	IP20/Chassis	IP21/Type 1	IP54/IP55/Type 12
		≤ 550 V	>690 V						
15	11	14	13	15	0.98			Unit size 22	Unit size 22
20	15	19	18	19.5	0.98				
25	18	23	22	24	0.98				
30	22	28	27	29	0.98				
40	30	32	34	36	0.98				
50	37	43	41	49	0.98			Unit size 32	Unit size 32
60	45	564	52	59	0.98				
75	55	65	62	71	0.98				
100	75	87	83	87	0.98				
125	90	105	100	99	0.98				
150	110	137	131	128	0.98		Unit size 43h	Unit size 41h	Unit size 41h
200	132	162	155	155	0.98				
250	160	201	192	197	0.98				

525-690 V									
HP	kW	A		Input	Efficiency	IP00/Chassis	IP20/Chassis	IP21/Type 1	IP54/IP55/Type 12
		≤ 550 V	>690 V						
300	200	253	242	240	0.98		Unit size 44h	Unit size 42h	Unit size 42h
350	250	303	290	296	0.98				
450	315	360	344	352	0.98				
550	400	418	400	400	0.98				
600	450	470	450	434	0.98	Unit size 52		Unit size 51	Unit size 51
650	500	523	500	482	0.98				
750	560	596	570	549	0.98				
900	630	630	630	607	0.98				
1000	710	763	730	730	0.98			Unit size 61/63	Unit size 61/63
1150	800	889	850	850	0.98				
1250	900	988	945	945	0.98				
1350	1000	1108	1060	1060	0.98			Unit size 62/64	Unit size 62/64
1600	1200	1317	1260	1260	0.98				
1900	1400	1479	1415	1415	0.98				

Table 13.4 525-690 V

13.1.2 Dimensions, Unit Size 1x

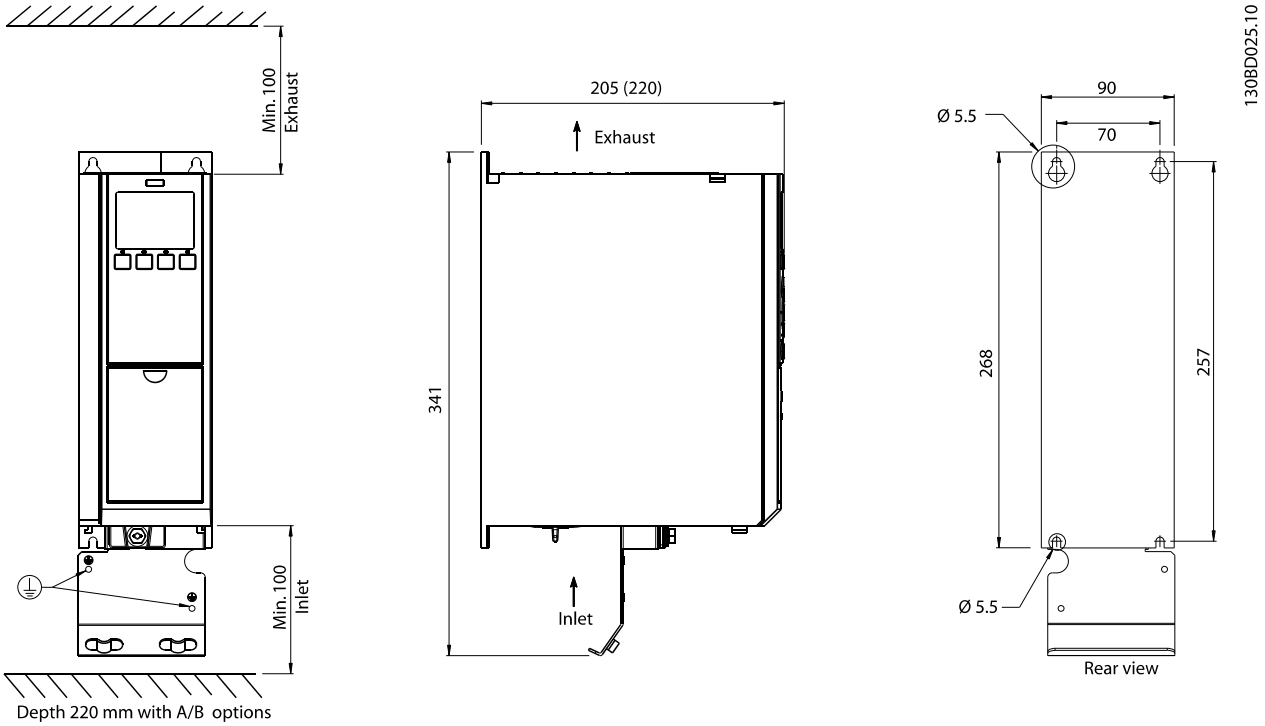

Illustration 13.1 Unit Size 12

13

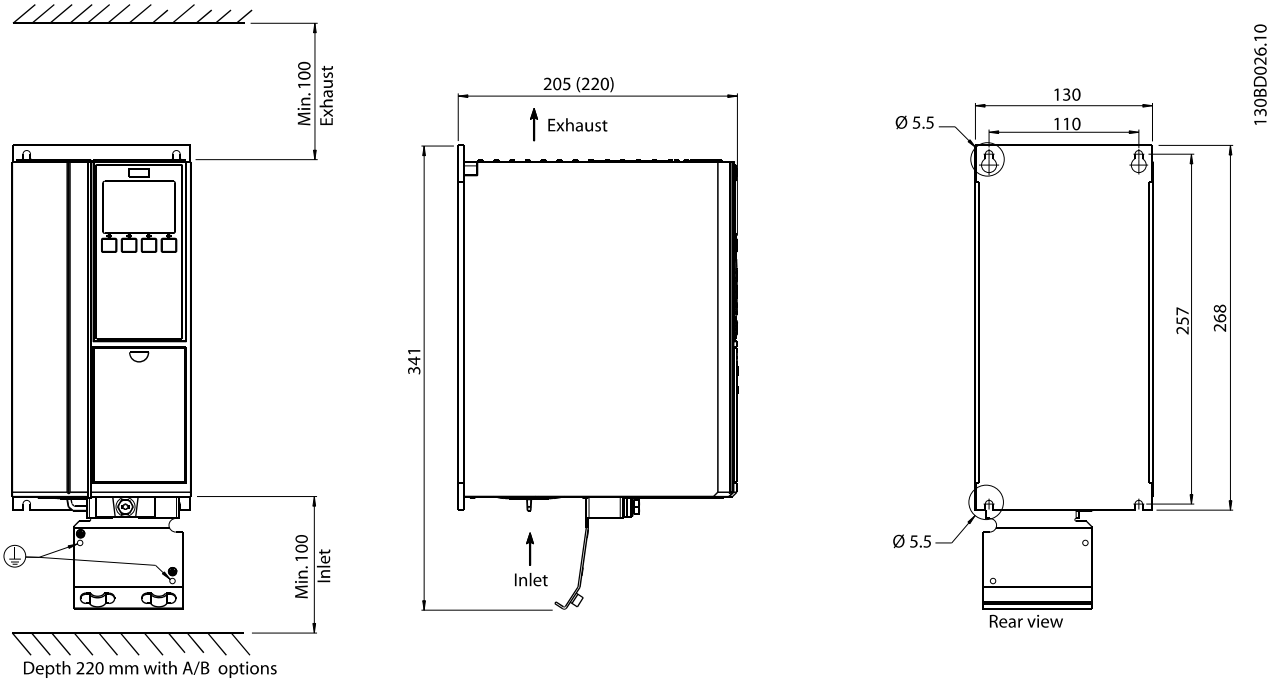

Illustration 13.2 Unit Size 13

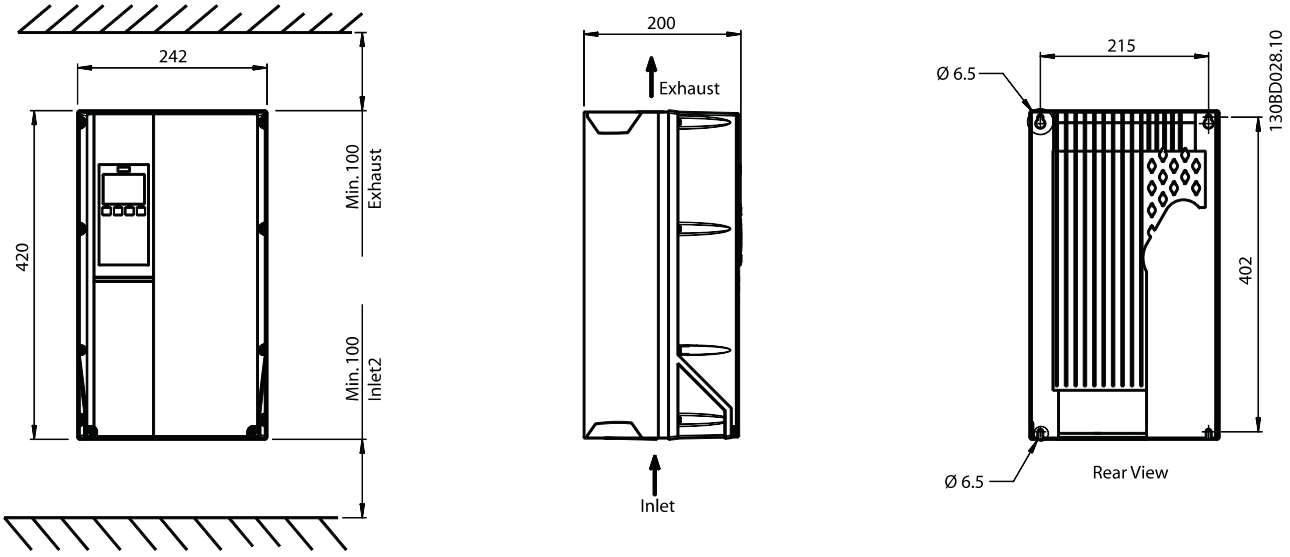

Illustration 13.3 Unit Size 15

13

13.1.3 Dimensions, Unit Size 2x

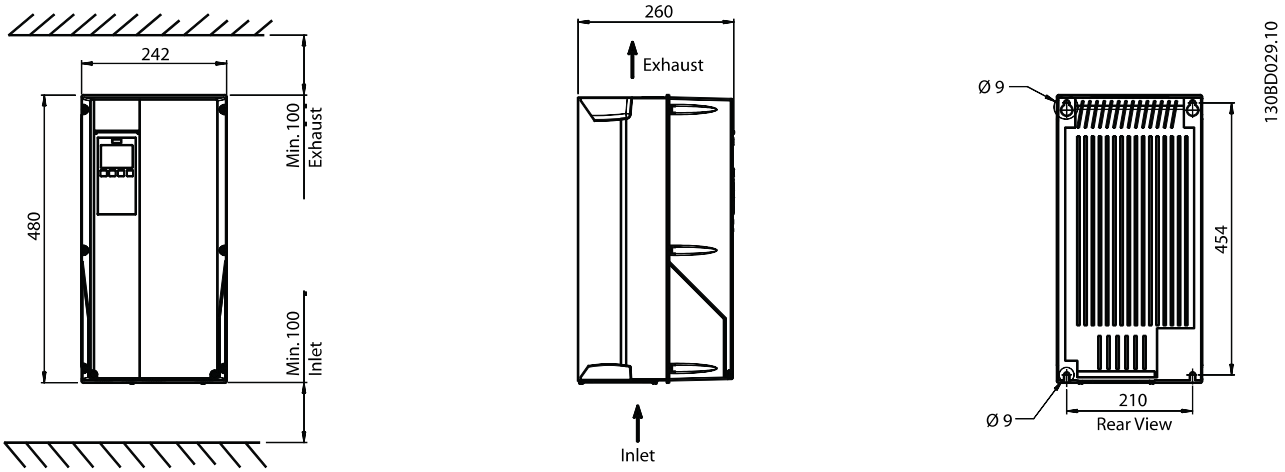

Illustration 13.4 Unit Size 21

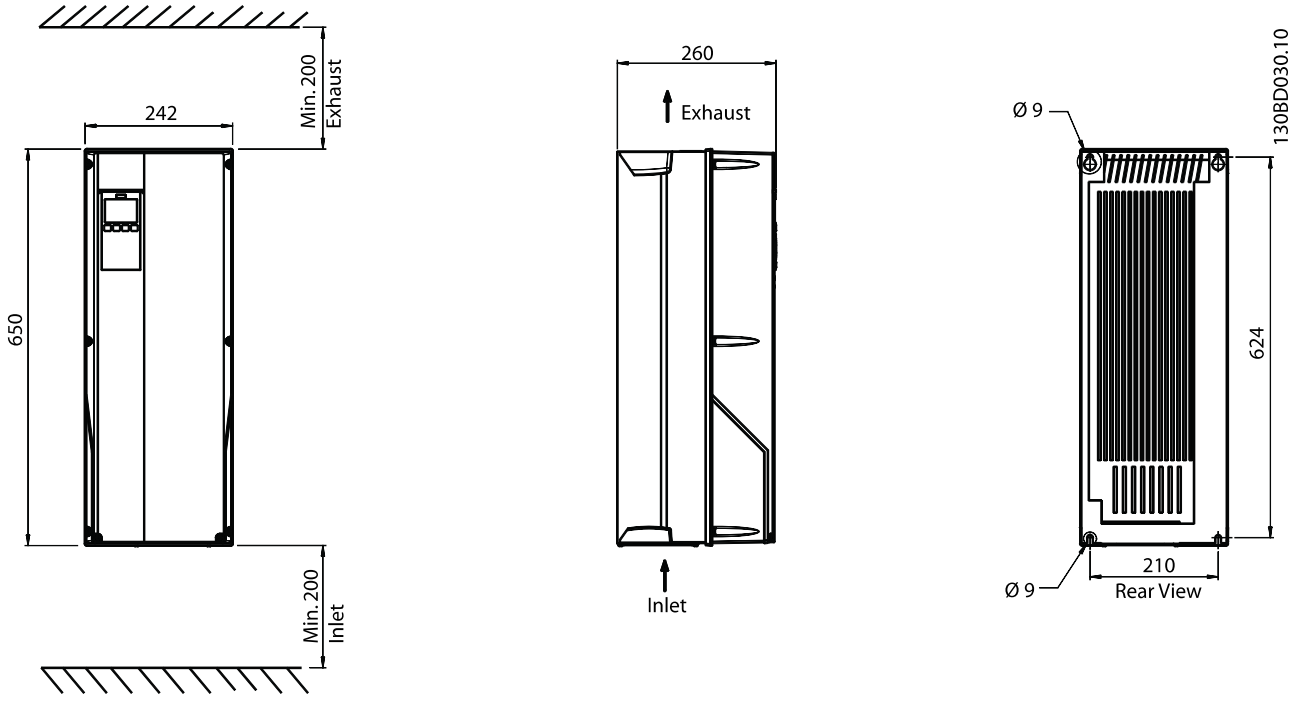

Illustration 13.5 Unit Size 22

13

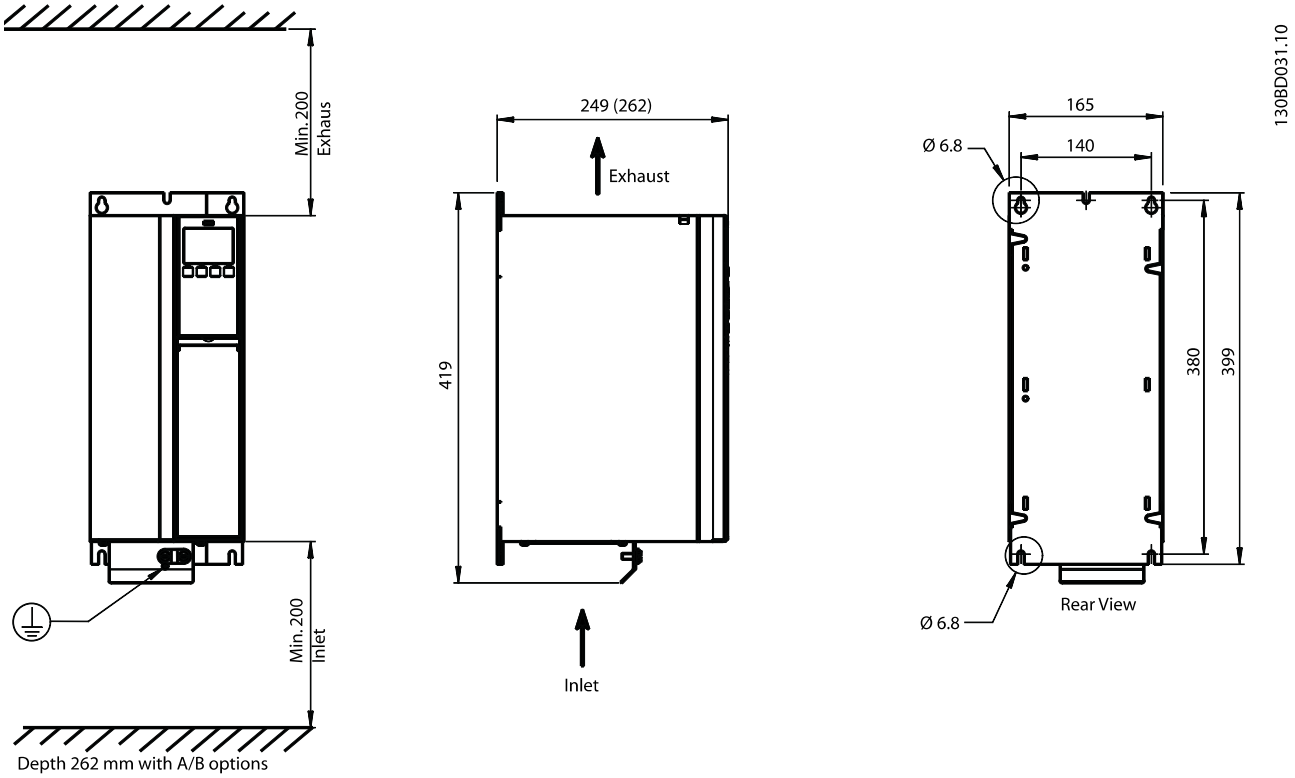

Illustration 13.6 Unit Size 23

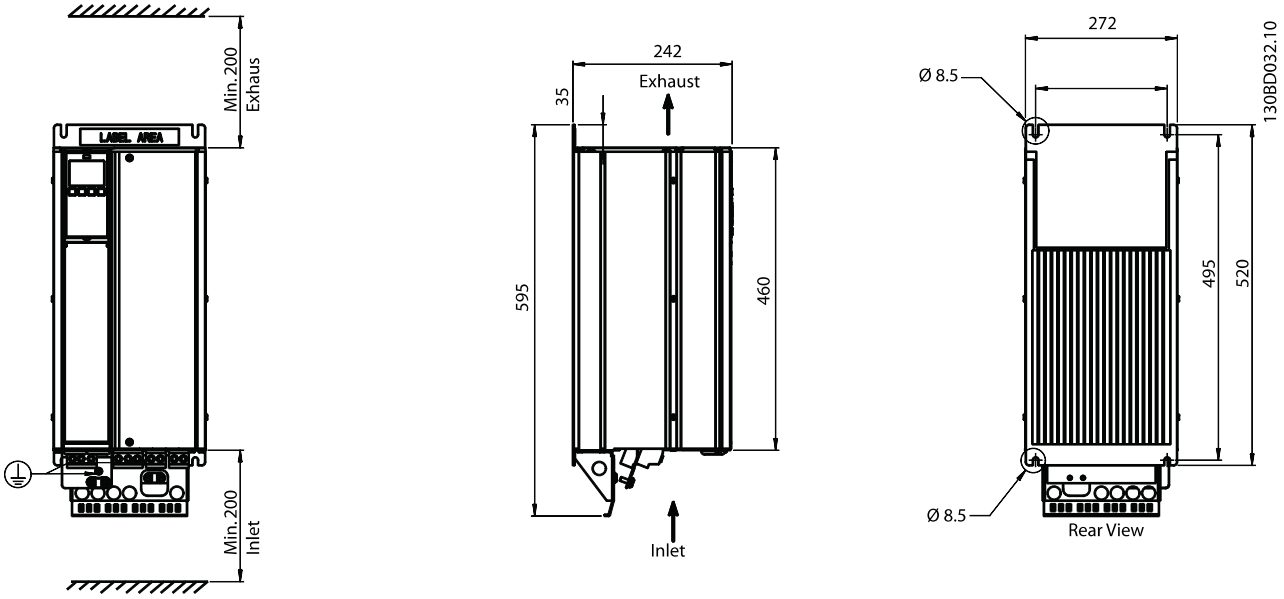

Illustration 13.7 Unit Size 24

13

13.1.4 Dimensions, Unit Size 3x

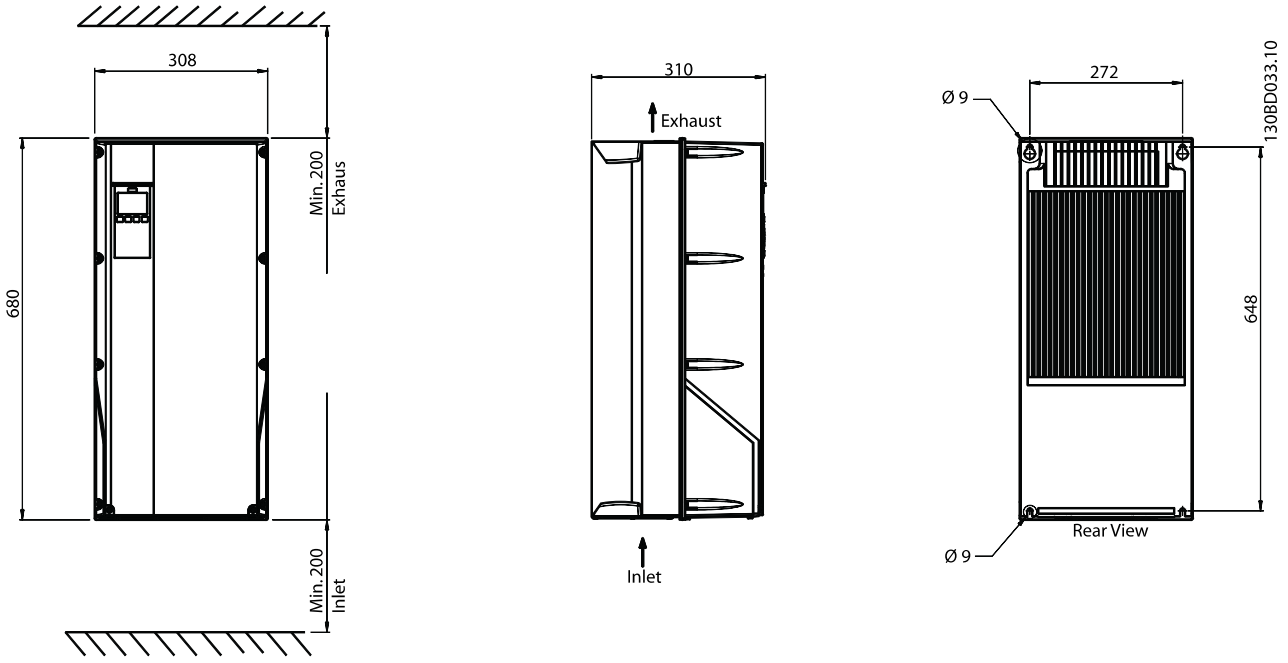

Illustration 13.8 Unit Size 31

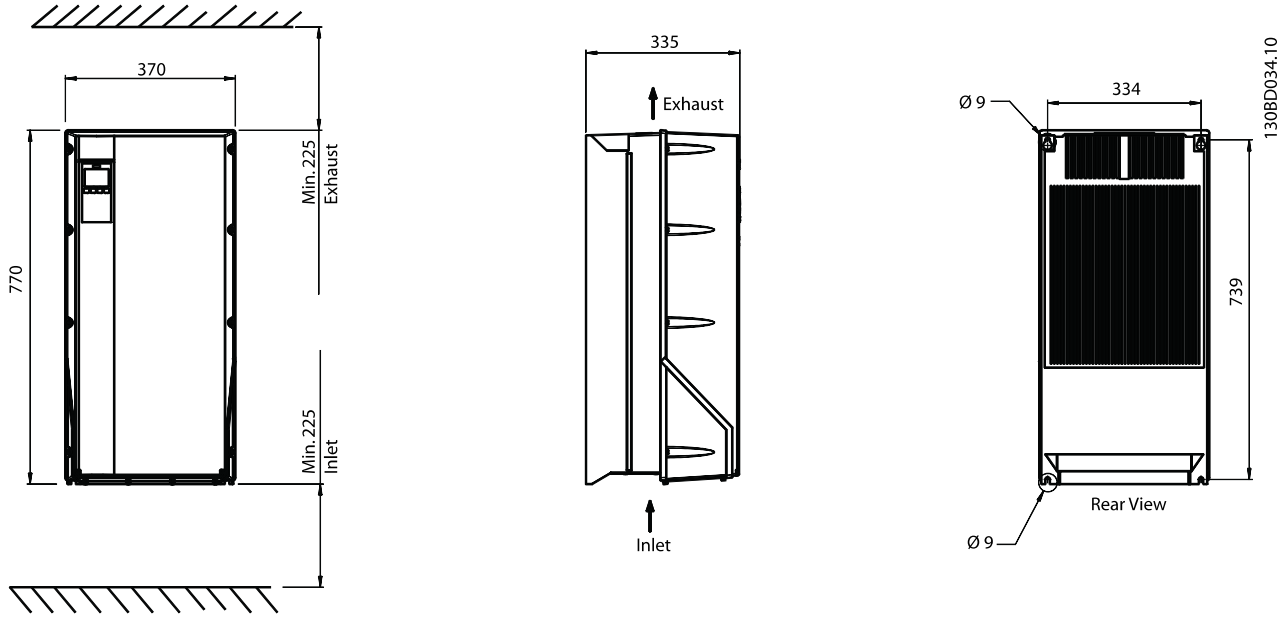

Illustration 13.9 Unit Size 32

13

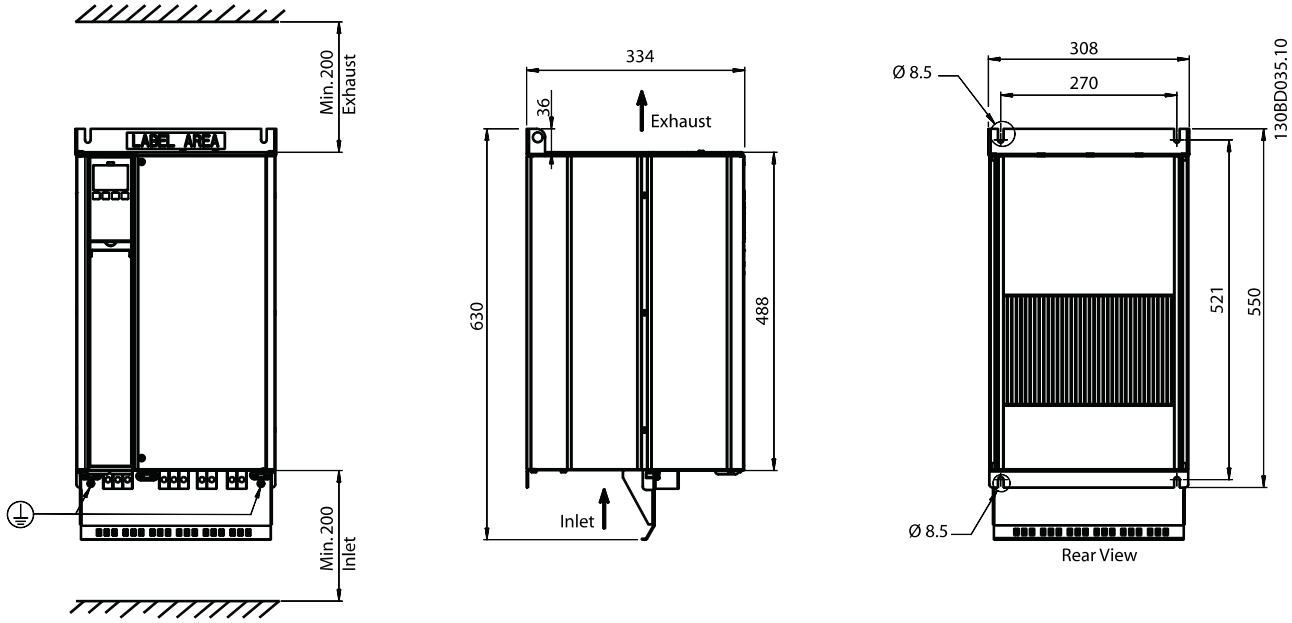

Illustration 13.10 Unit Size 33

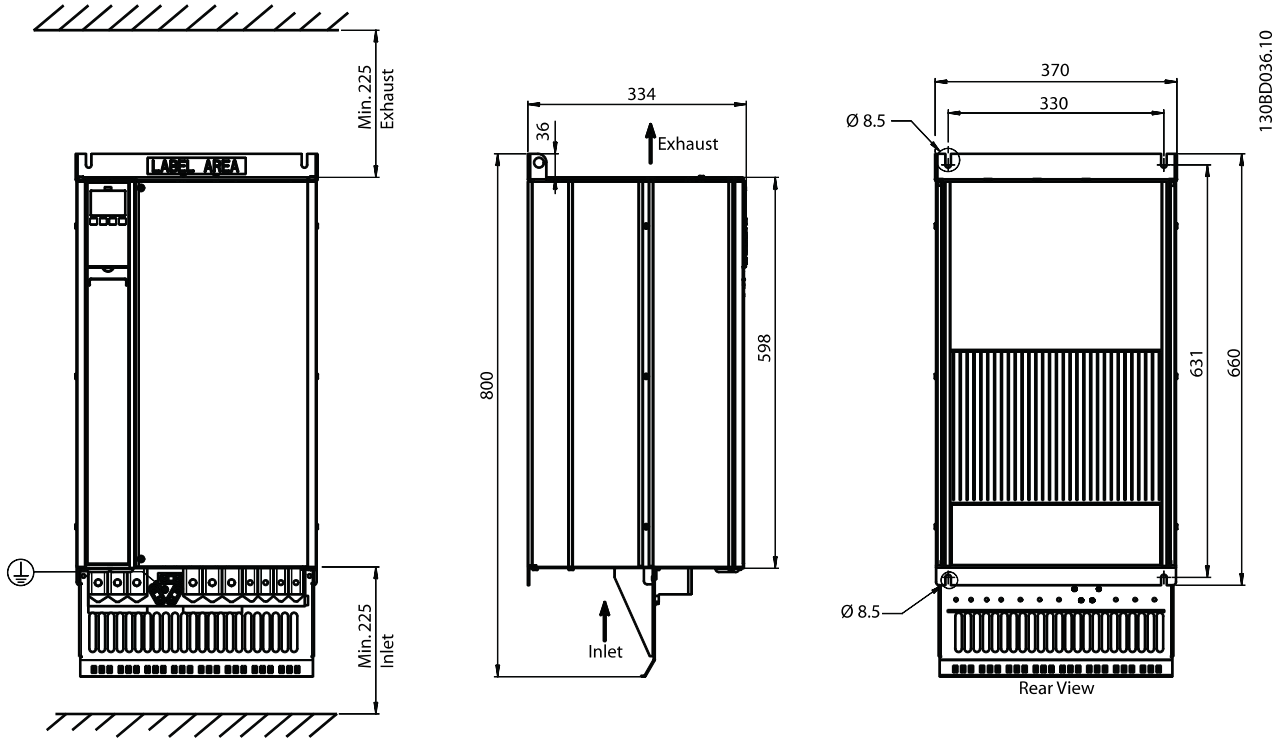

Illustration 13.11 Unit Size 34

13

13.1.5 Dimensions, Unit Size 4xh

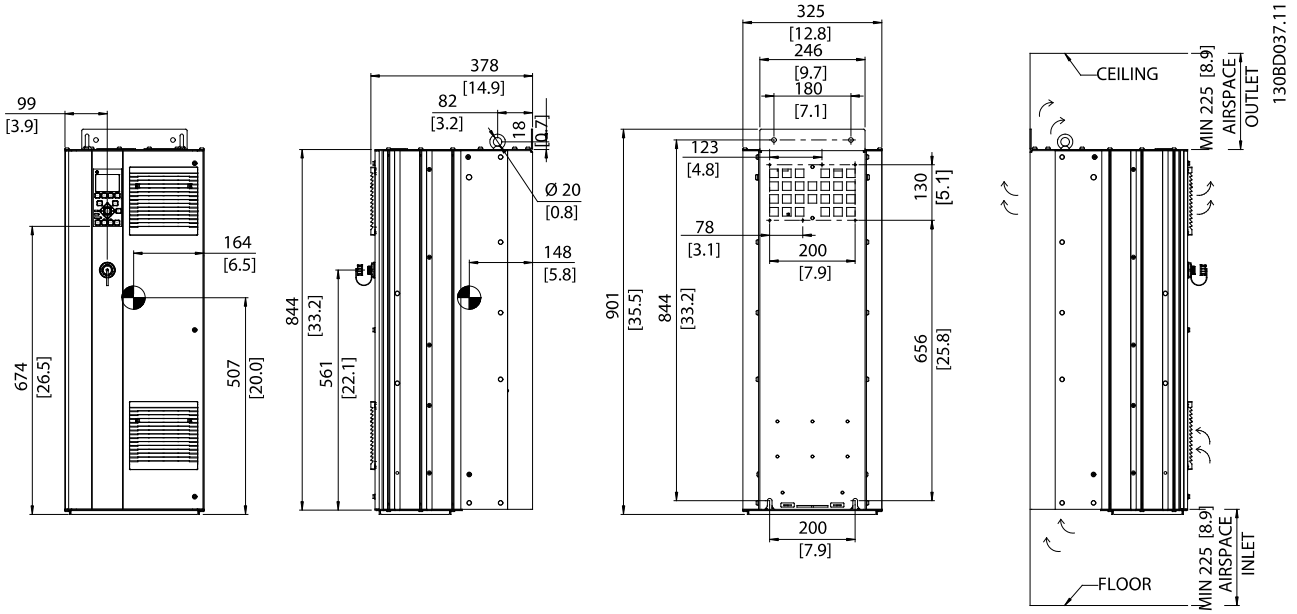

Illustration 13.12 Unit Size 41h

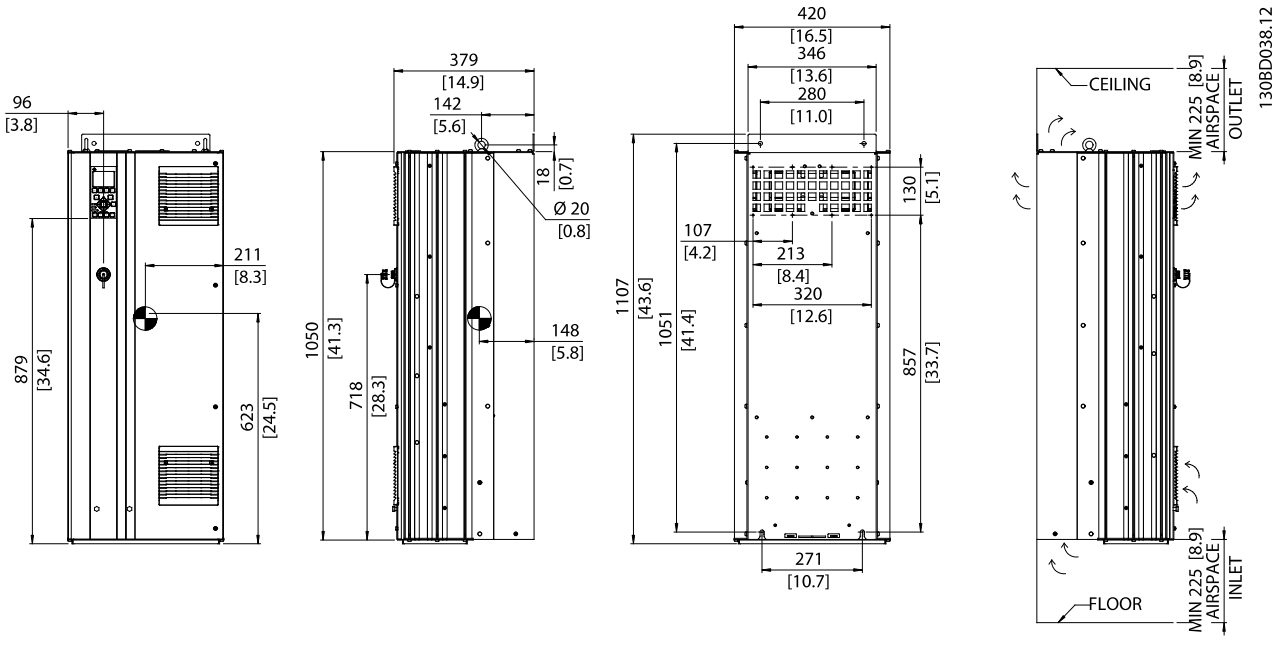

Illustration 13.13 Unit Size 42h

13

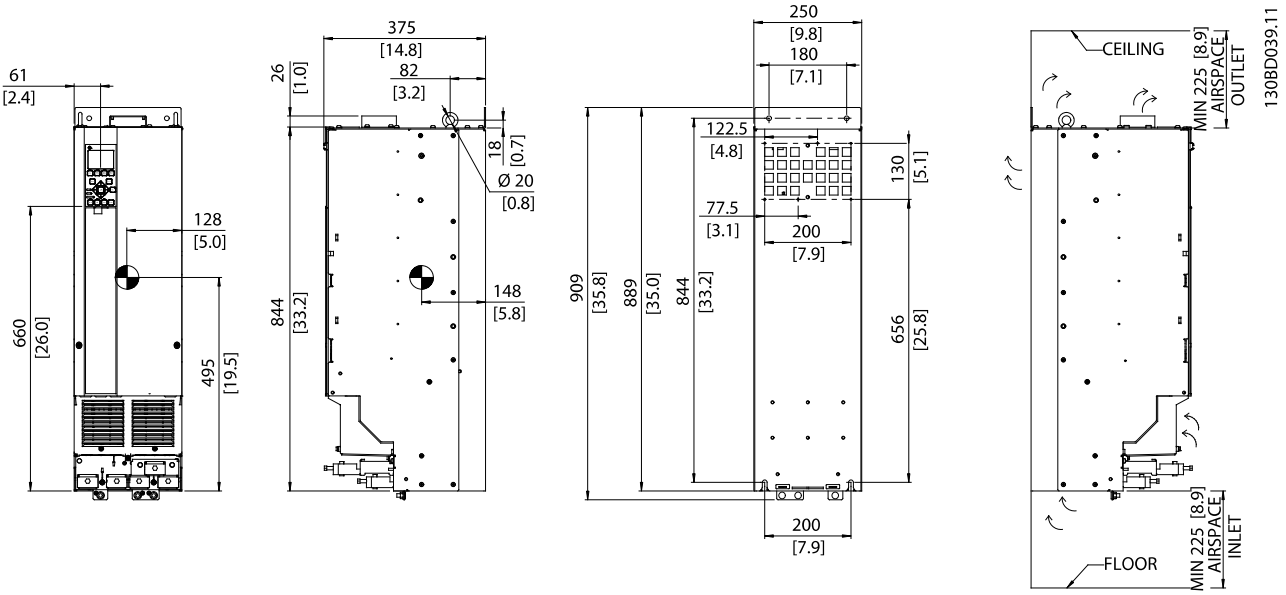

Illustration 13.14 Unit Size 43h

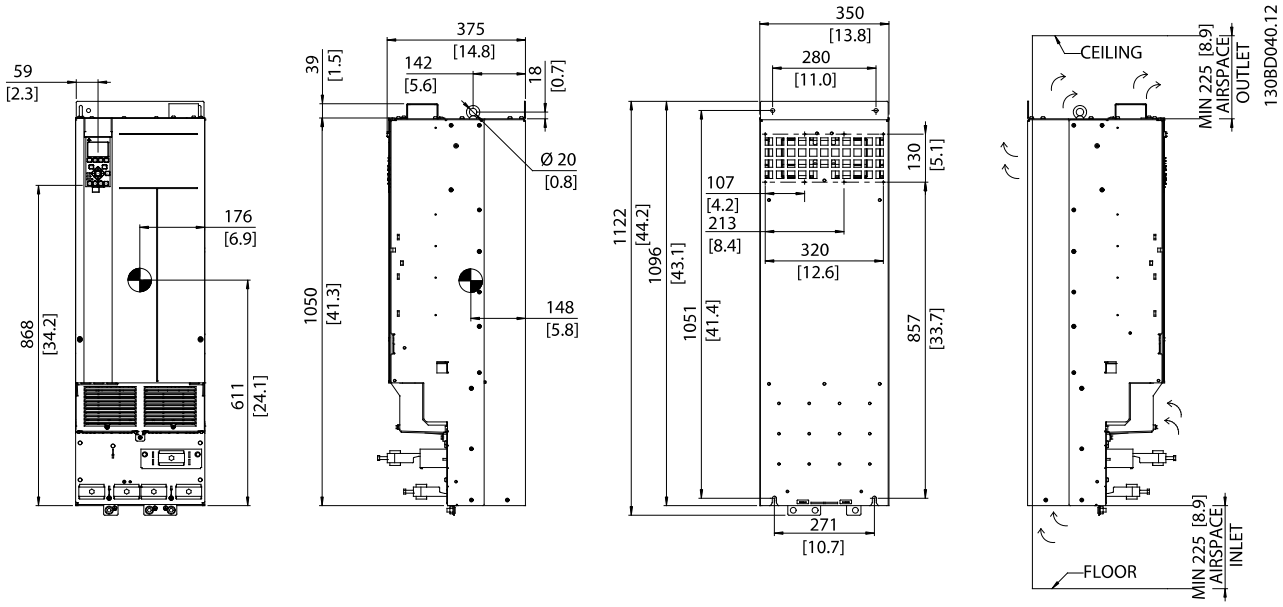

Illustration 13.15 Unit Size 44h

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13.1.6 Dimensions, Unit Size 5x

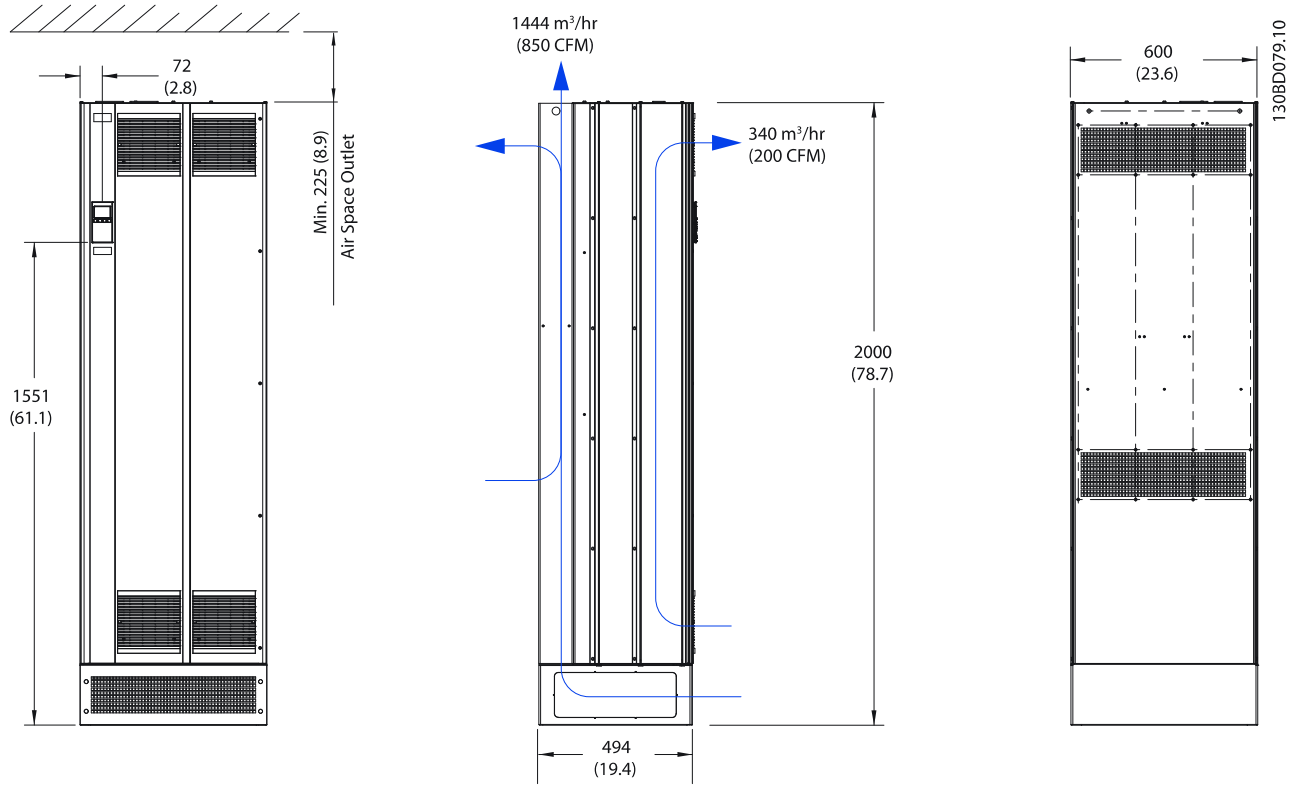

Illustration 13.16 Unit Size 51 (Floor Mount)

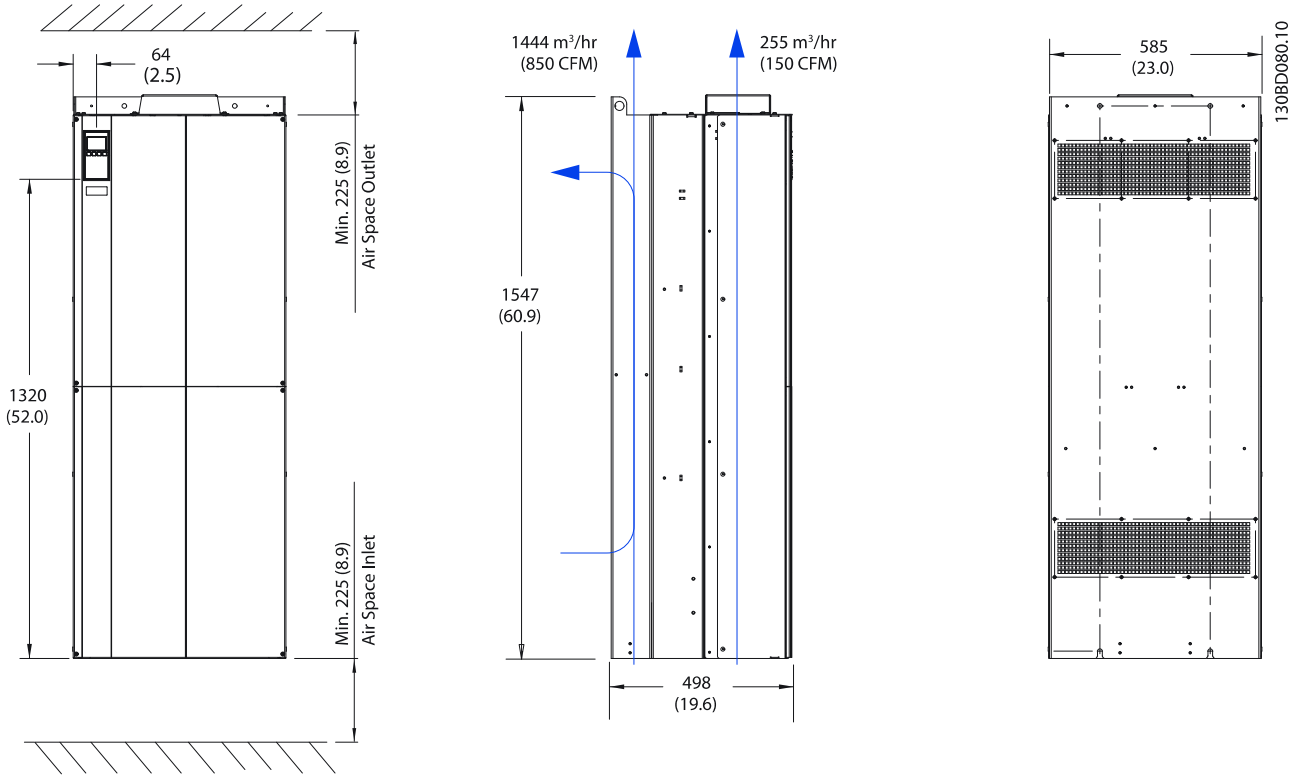

Illustration 13.17 Unit Size 52 (Cabinet Mount)

13

13.1.7 Dimensions, Unit Size 6x

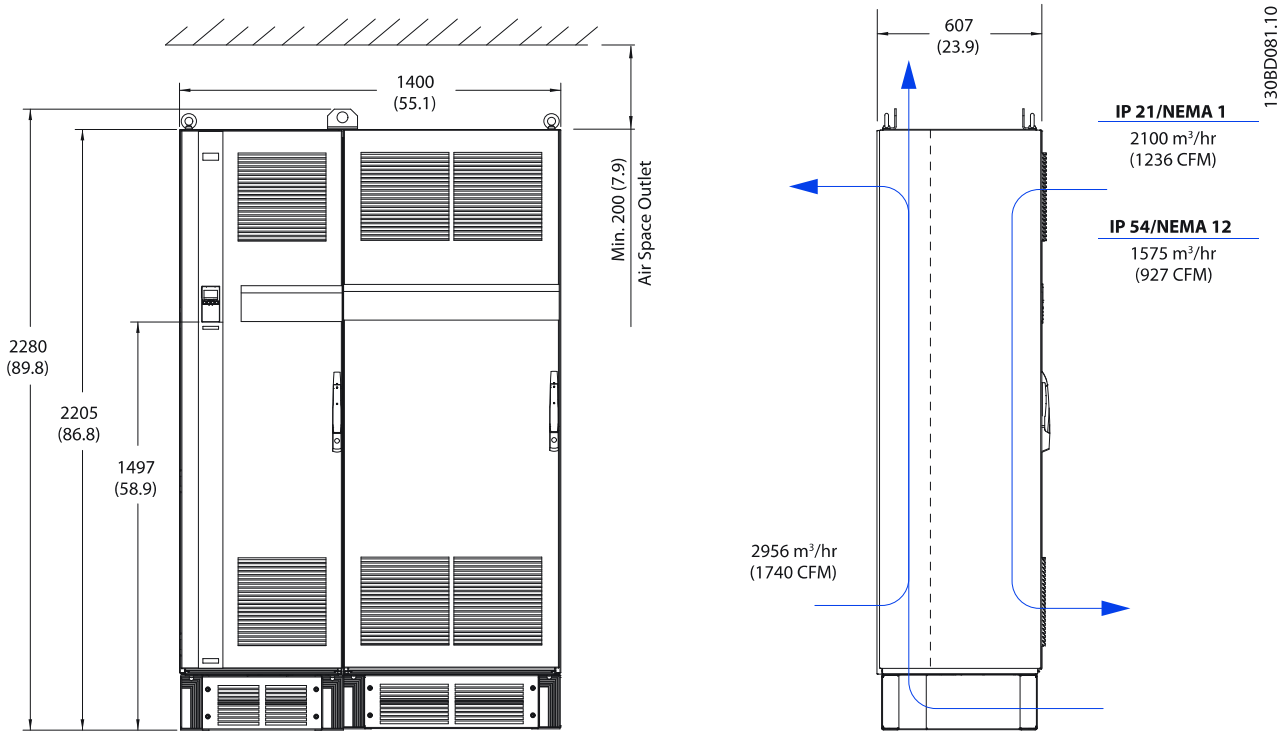

Illustration 13.18 Unit Size 61 (Floor Mount)

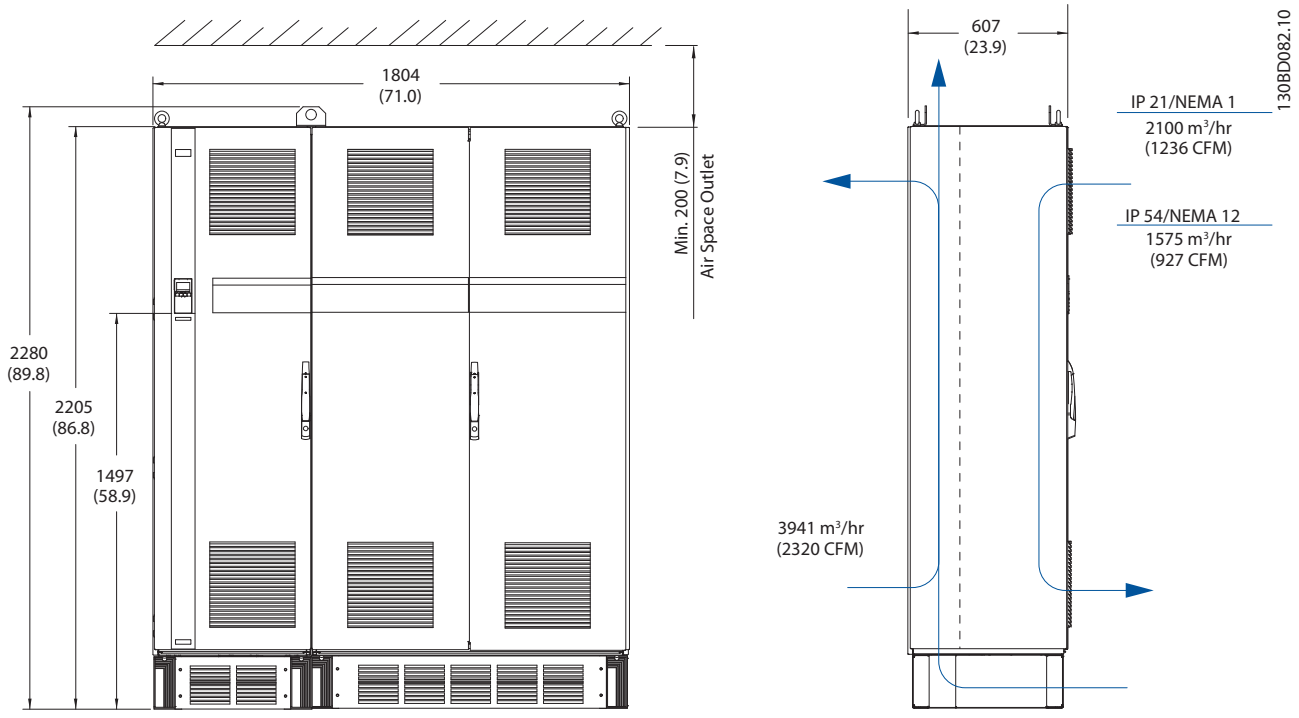

Illustration 13.19 Unit Size 62 (Floor Mount)

13

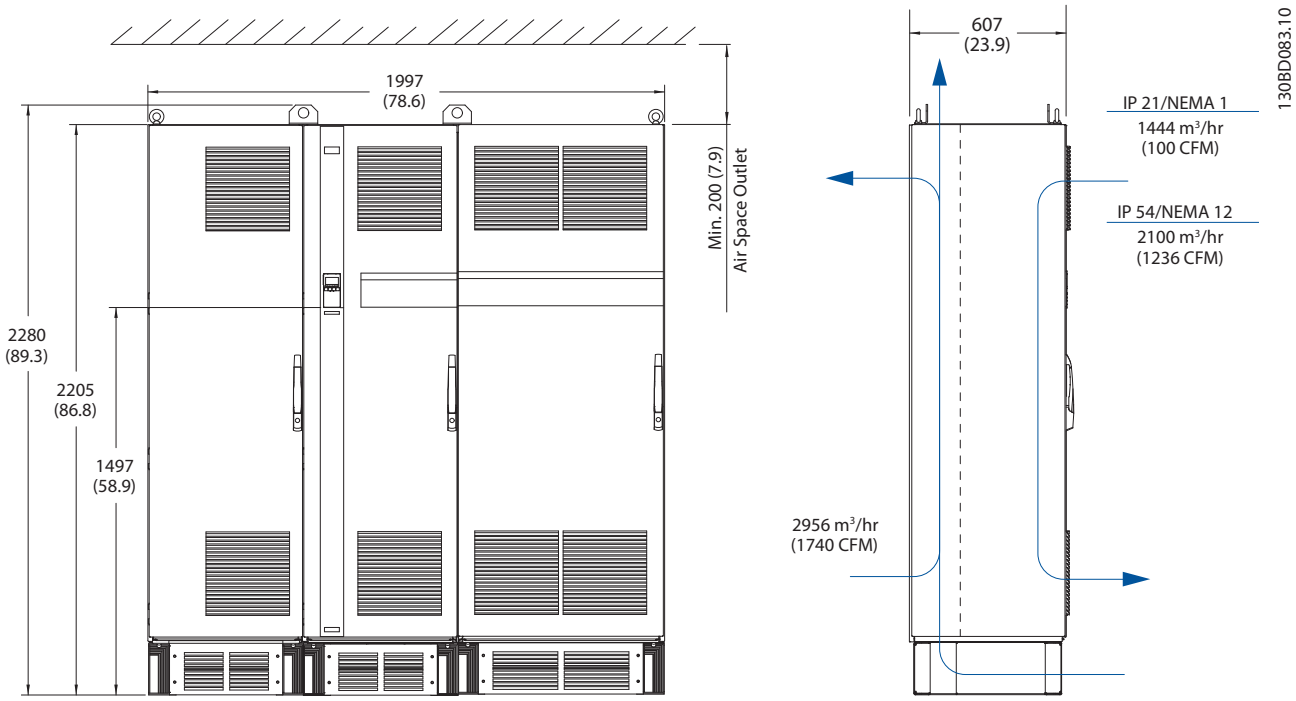

Illustration 13.20 Unit Size 63 (Floor Mount)

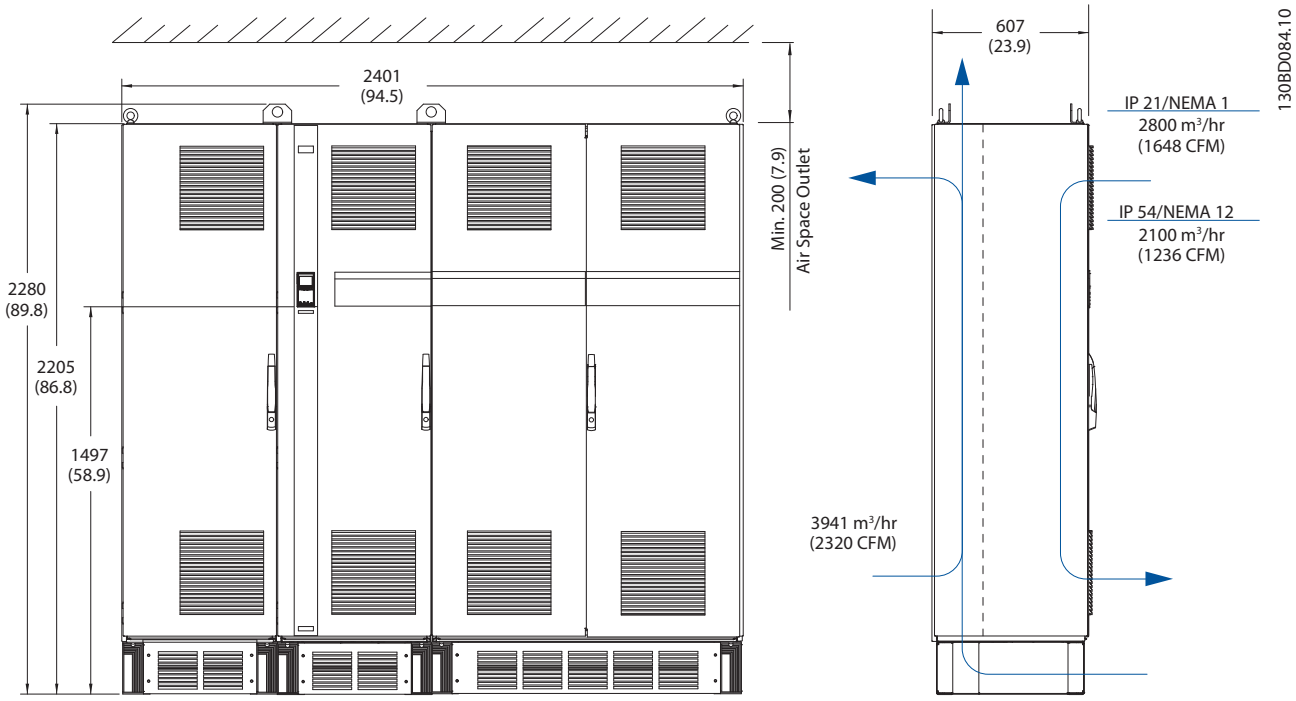

Illustration 13.21 Unit Size 64 (Floor Mount)

13

13.2 General Technical Data

Mains supply (L1, L2, L3)	
Supply voltage	380-480 V ±10%
Supply voltage	525-600 V ±10%

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

Supply frequency	50/60 Hz ±5%
Max. imbalance temporary between mains phases	3.0 % of rated supply voltage
True Power Factor (λ)	≥ 0.9 nominal at rated load
Displacement Power Factor (cosφ) near unity	(> 0.98)
Switching on input supply L1, L2, L3 (power-ups)	maximum once/2 min.
Environment according to EN60664-1	overvoltage category III/pollution degree 2

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

Motor output (U, V, W)	
Output voltage	0-100% of supply voltage
Output frequency	0-590 Hz
Switching on output	Unlimited
Accel/Decel Times	1-3600 s

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

**Percentage relates to AF-600 FP Drive's nominal torque.*

Cable lengths and cross sections for control cables	
Max. motor cable length, screened	150 m
Max. motor cable length, unscreened	300 m
Maximum cross section to control terminals, flexible/ rigid wire without cable end sleeves	1.5mm²/16 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves	1mm²/18 AWG
Maximum cross section to control terminals, flexible wire with cable end sleeves with collar	0.5mm²/20 AWG
Minimum cross section to control terminals	0.25mm²/ 24AWG
Digital inputs	
Programmable digital inputs	4 (6)
Terminal number	18, 19, 27 [1)], 29, 32, 33,
Logic	PNP or NPN
Voltage level	0-24 V DC
Voltage level, logic'0' PNP	<5 V DC
Voltage level, logic'1' PNP	>10 V DC
Voltage level, logic '0' NPN	>19 V DC
Voltage level, logic '1' NPN	<14 V DC
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ

All digital inputs are galvanically isolated from the supply voltage (PELV) and other high-voltage terminals.
1) Terminals 27 and 29 can also be programmed as output.

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

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

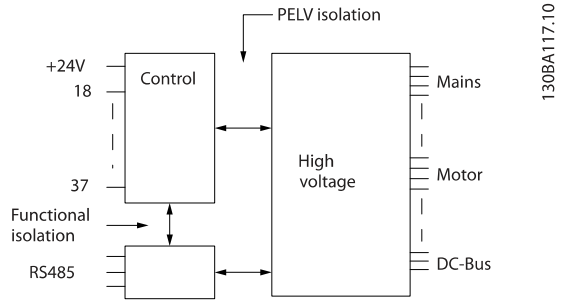

Illustration 13.22 PELV Isolation of Analog Inputs

Pulse inputs	
Programmable pulse inputs	2
Terminal number pulse	29, 33
Max. frequency at terminal, 29, 33	110 kHz (Push-pull driven)
Max. frequency at terminal, 29, 33	5 kHz (open collector)
Min. frequency at terminal 29, 33	4 Hz
Voltage level	see *13.2.1*
Maximum voltage on input	28 V DC
Input resistance, R_i	approx. 4 kΩ
Pulse input accuracy (0.1-1 kHz)	Max. error: 0.1% of full scale
Analog output	
Number of programmable analog outputs	1
Terminal number	42
Current range at analog output	0/4-20 mA
Max. resistor load to common at analog output	500 Ω
Accuracy on analog output	Max. error: 0.8% of full scale
Resolution on analog output	8 bit

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

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

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

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

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

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

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

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

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

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

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

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

Control characteristics	
Resolution of output frequency at 0 - 590 Hz	±0.003 Hz
System response time (terminals 18, 19, 27, 29, 32, 33)	≤ 2 ms
Speed control range (open loop)	1:100 of synchronous speed
Speed accuracy (open loop)	30-4000 rpm: Maximum error of ±8 rpm

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

Surroundings	
Enclosure, frame size 4X and 5X	IP00, IP21, IP54
Enclosure, frame size 6X	IP21, IP54
Vibration test	0.7 g
Relative humidity	5% - 95%(IEC 721-3-3; Class 3K3 (non-condensing) during operation
Aggressive environment (IEC 60068-2-43) H_2S test	class kD
Test method according to IEC 60068-2-43 H_2S (10 days)	
- with derating	max. 55 °C[1)]
- with full output power, typical EFF2 motors	max. 50 °C[1)]
- at full continuous drive output current	max. 45 °C[1)]

1) For more information on derating see the AF-600 FP, section on Special Conditions.

Minimum ambient temperature during full-scale operation	0 °C
Minimum ambient temperature at reduced performance	-10 °C
Temperature during storage/transport	-25 to +65/70 °C
Maximum altitude above sea level without derating	1000 m
Maximum altitude above sea level with derating	3000 m

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

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

See section on special conditions in the Design Guide!

Control card performance	
Scan interval	5 ms

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

CAUTION

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

Protection and Features

- Electronic thermal motor protection against overload.
- Temperature monitoring of the heatsink ensures that the frequency converter 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 frequency converter is protected against short-circuits on motor terminals U, V, W.
- If a mains phase is missing, the frequency converter trips or issues a warning (depending on the load).
- Monitoring of the intermediate circuit voltage ensures that the frequency converter trips if the intermediate circuit voltage is too low or too high.
- The frequency converter is protected against earth faults on motor terminals U, V, W.

13.3 Fuse Specifications

13.3.1 Fuses

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

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 frequency converter.

Over current protection:
The frequency converter provides overload protection to limit threats to human life, property damage and to avoid fire hazard due to overheating of the cables in the installation. The frequency converter is equipped with an internal 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.

⚠WARNING

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

The following tables list the recommended rated current. Recommended fuses are of the type gG for small to medium power sizes. For larger powers, aR fuses are recommended. Circuit breakers must be used provided they meet the national/international regulations and they limit the energy into the frequency converter to an equal or lower level than the compliant circuit breakers.
If fuses/Circuit Breakers according to recommendations are chosen, possible damages on the frequency converter will mainly be limited to damages inside the unit.

13.3.2 Recommendations

⚠WARNING

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

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

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

13.3.3 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), 240 V, 480 V, 500 V, 600 V, or 690 V depending on the frequency converter voltage rating. With the proper fusing the frequency converter short circuit current rating (SCCR) is 100,000 Arms.

13.3.4 Fuse Specifications

AF-600 3-phase	Recommended fuse size	Recommended max fuse
[kW]/[HP]		
0.75/1	gG-16	gG-25
1.5/2		
2.2/3		
3.7/5	gG-20	gG-32
5.5/7.5	gG-50	gG-63
7.5/10		
11/15		
15/20	gG-80	gG-125
18.5/25		
22/30	gG-125	gG-150
30/40	aR-160	aR-160
37/50	aR-200	aR-200
45/60	aR-250	aR-250

Table 13.5 200-240 V, IP20/Open Chassis

AF-600 3-phase	Recommended fuse size	Recommended max fuse
[kW]/[HP]		
0.75/1	gG-20	gG-32
1.5/2		
2.2/3		
3.7/5		
5.5/7.5	gG-63	gG-80
7.5/10		
11/15		
15/20	gG-80	gG-100
18.5/25	gG-125	gG-160
22/30		
30/40	aR-160	aR-160
37/50	aR-200	aR-200
45/60	aR-250	aR-250

Table 13.6 200-240 V, IP55/Nema 12 and IP66/Nema 4X

AF-600 3-phase	Recommended fuse size	Recommended max fuse
[kW]/[HP]		
0.75/1	gG-16	gG-25
1.5/2		
2.2/3		
3.7/5		
5.5/7.5	gG-20	gG-32
7.5/10		
11/15	gG-50	gG-63
15/20		
18.5/25		
22/30	gG-80	gG-125
30/40		
37/50		
45/60	gG-125	gG-150
55/75	aR-160	aR-160
75/100	aR-250	aR-250
90/125		
110/150	aR-300	aR-300
132/200	aR-350	aR-350
160/250	aR-400	aR-400
200/300	aR-500	aR-500
250/350	aR-630	aR-630
315/450	aR-700	aR-700
355/500	aR-900	aR-900
400/550		
450/600		
500/650	aR-1600	aR-1600
560/750		
630/900	aR-2000	aR-2000
710/1000		
800/1200	aR-2500	aR-2500
1000/1350		

Table 13.7 380-480 V, IP20/Open Chassis

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AF-600 3-phase	Recommended fuse size	Recommended max fuse
[kW]/[HP]		
0.75/1	gG-20	gG-32
1.5/2		
2.2/3		
3.7/5		
5.5/7.5		
7.5/10		
11/15	gG-50	gG-80
15/20		
18.5/25		
22/30	gG-80	gG-100
30/40		
37/50	gG-125	gG-160
45/60		
55/75		
75/100	aR-250	aR-250
90/125		
110/150	aR-300	aR-300
132/200	aR-350	aR-350
160/250	aR-400	aR-400
200/300	aR-500	aR-500
250/350	aR-630	aR-630
315/450	aR-700	aR-700
355/500	aR-900	aR-900
400/550		
450/600		
500/650	aR-1600	aR-1600
560/750		
630/900	aR-2000	aR-2000
710/1000		
800/1200	aR-2500	aR-2500
1000/1350		

Table 13.8 380-480 V, IP55/Nema 12 and IP66/Nema 4X

AF-600 3-phase	Recommended fuse size	Recommended max fuse
[kW]/[HP]		
0.75/1	gG-10	gG-25
1.5/2		
2.2/3		
3.7/5		
5.5/7.5	gG-16	gG-32
7.5/10		
11/15	gG-35	gG-63
15/20		
18.5/25		
22/30	gG-63	gG-125
30/40		
37/50		
45/60	gG-100	gG-150
55/75		
75/100	aR-250	aR-250
90/125		

Table 13.9 525-600 V, IP20/Open Chassis

AF-600 3-phase	Recommended fuse size	Recommended max fuse
[kW]/[HP]		
0.75/1	gG-16	gG-32
1.5/2		
2.2/3		
3.7/5		
5.5/7.5		
7.5/10		
11/15	gG-35	gG-80
15/20		
18.5/25		
22/30	gG-50	gG-100
30/40		
37/50	gG-125	gG-160
45/60		
55/75	aR-250	aR-250
75/100		
90/125		

Table 13.10 525-600 V, IP55/Nema 12

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AF-600 3-phase	Recommended fuse size	Recommended max fuse
[kW]/[HP]		
11/15	gG-25	gG-63
15/20	gG-32	
18.5/25		
22/30	gG-40	
30/40	gG-63	gG-80
37/50		gG-100
45/60	gG-80	gG-125
55/75	gG-100	gG-160
75/100	gG-125	
90/125		
110/150	aR-250	aR-250
132/200	aR-315	aR-315
160/250	aR-350	aR-350
200/300		
250/350	aR-400	aR-400
315/450	aR-500	aR-500
400/550	aR-550	aR-550
450/600	aR-700	aR-700
500/650		
560/750	aR-900	aR-900
630/900		
710/1000	aR-1600	aR-1600
800/1150		
900/1250		
1000/1350		
1200/1600	aR-2000	aR-2000
1400/1900	aR-2500	aR-2500

Table 13.11 525-690 V, IP21/Nema 1 and IP55/Nema 12

13.3.5 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), 240 V, or 480 V, or 600 V depending on the drive voltage rating. With the proper fusing the drive Short Circuit Current Rating (SCCR) is 100,000 Arms.

Recommended max. fuse							
AF-600 1-phase Power	AF-600 3-phase Power	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[kW]/[HP]	[kW]/[HP]	Type RK1 [1)]	Type J	Type T	Type CC	Type CC	Type CC
	0.75/1	KTN-R-10	JKS-10	JJN-10	FNQ-R-10	KTK-R-10	LP-CC-10
	1.5/2	KTN-R-15	JKS-15	JJN-15	FNQ-R-15	KTK-R-15	LP-CC-15
1.5/2	2.2/3	KTN-R-20	JKS-20	JJN-20	FNQ-R-20	KTK-R-20	LP-CC-20
2.2/3	3.7/5	KTN-R-30	JKS-30	JJN-30	FNQ-R-30	KTK-R-30	LP-CC-30
3.7/5	5.5-7.5/7.5-10	KTN-R-50	KS-50	JJN-50	-	-	-
5.5/7.5	11/15	KTN-R-60	JKS-60	JJN-60	-	-	-
7.5/10	15/20	KTN-R-80	JKS-80	JJN-80	-	-	-
	18.5-22/25-30	KTN-R-125	JKS-125	JJN-125	-	-	-
15/20	30/40	KTN-R-150	JKS-150	JJN-150	-	-	-
23/30	37/50	KTN-R-200	JKS-200	JJN-200	-	-	-
	45/60	KTN-R-250	JKS-250	JJN-250	-	-	-

Table 13.12 200-240 V

Recommended max. fuse					
AF-600 1-phase Power	AF-600 3-phase Power	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]/[HP]	[kW]/[HP]	Type RK1	Type RK1	Type CC	Type RK1[3)]
	0.75/1	5017906-010	KLN-R-10	ATM-R-10	A2K-10-R
	1.5/2	5017906-016	KLN-R-15	ATM-R-15	A2K-15-R
1.5/2	2.2/3	5017906-020	KLN-R-20	ATM-R-20	A2K-20-R
2.2/3	3.7/5	5012406-032	KLN-R-30	ATM-R-30	A2K-30-R
3.7/5	5.5-7.5/7.5-10	5014006-050	KLN-R-50	-	A2K-50-R
5.5/7.5	11/15	5014006-063	KLN-R-60	-	A2K-60-R
7.5/10	15/20	5014006-080	KLN-R-80	-	A2K-80-R
	18.5-22/25-30	2028220-125	KLN-R-125	-	A2K-125-R
15/20	30/40	2028220-150	KLN-R-150	-	A2K-150-R
23/30	37/50	2028220-200	KLN-R-200	-	A2K-200-R
	45/60	2028220-250	KLN-R-250	-	A2K-250-R

Table 13.13 200-240 V

Recommended max. fuse					
AF-600 1-phase	AF-600 3-phase	Bussmann	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]/[HP]	[kW]/[HP]	Type JFHR2[2)]	Type JFHR2	Type JFHR2[4)]	Type J
	0.75/1	FWX-10	-	-	HSJ-10
	1.5/2	FWX-15	-	-	HSJ-15
1.5/2	2.2/3	FWX-20	-	-	HSJ-20
2.2/3	3.7/5	FWX-30	-	-	HSJ-30
3.7/5	5.5-7.5/7.5-10	FWX-50	-	-	HSJ-50
5.5/7.5	11/15	FWX-60	-	-	HSJ-60
7.5/10	15/20	FWX-80	-	-	HSJ-80
	18.5-22/25-30	FWX-125	-	-	HSJ-125
15/20	30/40	FWX-150	L25S-150	A25X-150	HSJ-150
23/30	37/50	FWX-200	L25S-200	A25X-200	HSJ-200
	45/60	FWX-250	L25S-250	A25X-250	HSJ-250

Table 13.14 200-240 V

1) KTS-fuses from Bussmann may substitute KTN for 240 V frequency converters.

2) FWH-fuses from Bussmann may substitute FWX for 240 V frequency converters.

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

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

Recommended max. fuse							
AF-600 1-phase	AF-600 3-phase	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[kW]/[HP]	[kW]/[HP]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
	0.75/1	KTS-R-6	JKS-6	JJS-6	FNQ-R-6	KTK-R-6	LP-CC-6
	1.5-2.2/2-3	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
	3.7/5	KTS-R-20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
	5.5/7.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
	7.5/10	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
	11-15/15-20	KTS-R-40	JKS-40	JJS-40	-	-	-
	18.5/25	KTS-R-50	JKS-50	JJS-50	-	-	-
7.5/10	22/30	KTS-R-60	JKS-60	JJS-60	-	-	-
11/15	30/40	KTS-R-80	JKS-80	JJS-80	-	-	-
	37/50	KTS-R-100	JKS-100	JJS-100	-	-	-
	45/60	KTS-R-125	JKS-125	JJS-125	-	-	-
18.5/25	55/75	KTS-R-150	JKS-150	JJS-150	-	-	-
37/50	75/100	KTS-R-200	JKS-200	JJS-200	-	-	-
	90/125	KTS-R-250	JKS-250	JJS-250	-	-	-

Table 13.15 380-480 V, 125 HP and below

Recommended max. fuse					
AF-600 1-phase	AF-600 3-phase	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]/[HP]	[kW]/[HP]	Type RK1	Type RK1	Type CC	Type RK1
	0.75/1	5017906-006	KLS-R-6	ATM-R-6	A6K-10-6
	1.5-2.2/2-3	5017906-010	KLS-R-10	ATM-R-10	A6K-10-R
	3.7/5	5017906-020	KLS-R-20	ATM-R-20	A6K-20-R
	5.5/7.5	5017906-025	KLS-R-25	ATM-R-25	A6K-25-R
	7.5/10	5012406-032	KLS-R-30	ATM-R-30	A6K-30-R
	11-15/15-20	5014006-040	KLS-R-40	-	A6K-40-R
	18.5/25	5014006-050	KLS-R-50	-	A6K-50-R
7.5/10	22/30	5014006-063	KLS-R-60	-	A6K-60-R
11/15	30/40	2028220-100	KLS-R-80	-	A6K-80-R
	37/50	2028220-125	KLS-R-100	-	A6K-100-R
	45/60	2028220-125	KLS-R-125	-	A6K-125-R
18.5/25	55/75	2028220-160	KLS-R-150	-	A6K-150-R
37/50	75/100	2028220-200	KLS-R-200	-	A6K-200-R
	90/125	2028220-250	KLS-R-250	-	A6K-250-R

Table 13.16 380-480 V, 125 HP and below

Recommended max. fuse					
AF-600 1-phase	AF-600 3-phase	Bussmann	Ferraz- Shawmut	Ferraz- Shawmut	Littel fuse
[kW]/[HP]	[kW]/[HP]	Type JFHR2	Type J	Type JFHR2[1)]	Type JFHR2
	0.75/1	FWH-6	HSJ-6	-	-
	1.5-2.2/2-3	FWH-10	HSJ-10	-	-
	3.7/5	FWH-20	HSJ-20	-	-
	5.5/7.5	FWH-25	HSJ-25	-	-
	7.5/10	FWH-30	HSJ-30	-	-
	11-15/15-20	FWH-40	HSJ-40	-	-
	18.5/25	FWH-50	HSJ-50	-	-
7.5/10	22/30	FWH-60	HSJ-60	-	-
11/15	30/40	FWH-80	HSJ-80	-	-
	37/50	FWH-100	HSJ-100	-	-
	45/60	FWH-125	HSJ-125	-	-
18.5/25	55/75	FWH-150	HSJ-150	-	-
37/50	75/100	FWH-200	HSJ-200	A50-P-225	L50-S-225
	90/125	FWH-250	HSJ-250	A50-P-250	L50-S-250

Table 13.17 380-480 V, 125 HP and below

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

	Recommended max. fuse					
AF-600	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann	Bussmann
[kW]/[HP]	Type RK1	Type J	Type T	Type CC	Type CC	Type CC
0.75/1	KTS-R-5	JKS-5	JJS-6	FNQ-R-5	KTK-R-5	LP-CC-5
1.5-2.2/2-3	KTS-R-10	JKS-10	JJS-10	FNQ-R-10	KTK-R-10	LP-CC-10
3.7/5	KTS-R20	JKS-20	JJS-20	FNQ-R-20	KTK-R-20	LP-CC-20
5.5/7.5	KTS-R-25	JKS-25	JJS-25	FNQ-R-25	KTK-R-25	LP-CC-25
7.5/10	KTS-R-30	JKS-30	JJS-30	FNQ-R-30	KTK-R-30	LP-CC-30
11-15/15-20	KTS-R-35	JKS-35	JJS-35	-	-	-
18.5/25	KTS-R-45	JKS-45	JJS-45	-	-	-
22/30	KTS-R-50	JKS-50	JJS-50	-	-	-
30/40	KTS-R-60	JKS-60	JJS-60	-	-	-
37/50	KTS-R-80	JKS-80	JJS-80	-	-	-
45/60	KTS-R-100	JKS-100	JJS-100	-	-	-
55/75	KTS-R-125	JKS-125	JJS-125	-	-	-
75/100	KTS-R-150	JKS-150	JJS-150	-	-	-
90/125	KTS-R-175	JKS-175	JJS-175	-	-	-

Table 13.18 525-600 V, 125 HP and below

	Recommended max. fuse			
AF-600	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]/[HP]	Type RK1	Type RK1	Type RK1	Type J
0.75/1	5017906-005	KLS-R-005	A6K-5-R	HSJ-6
1.5-2.2/2-3	5017906-010	KLS-R-010	A6K-10-R	HSJ-10
3.7/5	5017906-020	KLS-R-020	A6K-20-R	HSJ-20
5.5/7.5	5017906-025	KLS-R-025	A6K-25-R	HSJ-25
7.5/10	5017906-030	KLS-R-030	A6K-30-R	HSJ-30
11-15/15-20	5014006-040	KLS-R-035	A6K-35-R	HSJ-35
18.5/25	5014006-050	KLS-R-045	A6K-45-R	HSJ-45
22/30	5014006-050	KLS-R-050	A6K-50-R	HSJ-50
30/40	5014006-063	KLS-R-060	A6K-60-R	HSJ-60
37/50	5014006-080	KLS-R-075	A6K-80-R	HSJ-80
45/60	5014006-100	KLS-R-100	A6K-100-R	HSJ-100
55/75	2028220-125	KLS-R-125	A6K-125-R	HSJ-125
75/100	2028220-150	KLS-R-150	A6K-150-R	HSJ-150
90/125	2028220-200	KLS-R-175	A6K-175-R	HSJ-175

Table 13.19 525-600 V, 125 HP and below

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

AF-600 3-phase	Bussmann	Bussmann	Bussmann	SIBA	Littel fuse	Ferraz-Shawmut	Ferraz-Shawmut
[kW]/[HP]	Type RK1	Type J	Type T	Type RK1	Type RK1	Type RK1	Type J
11/15	KTS-R-30	JKS-30	JJS-30	5017906-030	KLS-R-030	A6K-30R	HST-30
15/20	KTS-R-35	JKS-35	JJS-35	5014006-040	KLS-R-035	A6K-35R	HST-35
18.5/25	KTS-R-45	JKS-45	JJS-45	5014006-050	KLS-R-045	A6K-45R	HST-45
22/30	KTS-R50	JKS-50	JJS-50	5014006-050	KLS-R-50	A6K-50R	HST-50
30/40	KTS-R-60	JKS-60	JJS-60	5014006-063	KLS-R-060	A6K-60R	HST-60
37/50	KTS-R-80	JKS-80	JJS-80	5014006-080	KLS-R-075	A6K-80R	HST-80
45/60	KTS-R-100	JKS-100	JJS-100	5014006-100	KLS-R-100	A6K-100R	HST-100
55/75	KTS-R125	JKS-125	JJS-125	2028220-125	KLS-125	A6K-125R	HST-125
75/100	KTS-R150	JKS-150	JJS-150	2028220-150	KLS-150	A6K-150R	HST-150
90/125	KTS-R175	JKS-175	JJS-175	2028220-200	KLS-175	A6K-175R	HST-175

Table 13.20 525-690 V, IP21/Nema 1 and IP55/Nema 12

Recommended max. fuse						
AF-600	Bussmann PN	Bussmann PN	Siba PN	Littlefuse PN	Ferraz-Shawmut PN	Ferraz-Shawmut PN
[kW]/ [HP]		Type JFHR2	Type JFHR2	Type JFHR2	Type JFHR2	
110/ 150	170M2919	FWH-300	20 610 31.315	L50-S-300	A50QS300-4	A070URD31KI0315
132/ 200	170M2620	FWH-350	20 610 31.350	L50-S-350	A50QS350-4	A070URD31KI0350
160/ 250	170M2621	FWH-400	20 610 31.400	L50-S-400	A50QS400-4	A070URD31KI0400
200/ 300	170M4015	FWH-500	20 610 31.550	L50-S-500	A50QS500-4	A070URD31KI0550
250/ 350	170M4016	FWH-600	20 610 31.630	L50-S-600	A50QS600-4	A070URD31KI0630
315/ 450	170M4017	FWH-800	20 610 32.700	L50-S-800	A50QS800-4	A070URD31KI0800
355/ 500	170M6013		22 610 32.900			
400/ 550	170M6013		22 610 32.900			
450/ 600	170M6013		22 610 32.900			
500/ 650	170M7081					
560/ 750	170M7081					
630/ 900	170M7082					
710/ 1000	170M7082					
800/ 1200	170M7083					
1000/ 1350	170M7083					

Table 13.21 380-480 V, above 125 HP

AF-600	Bussmann PN	Rating	Alternate Siba PN
[kW]/[HP]			
500/650	170M8611	1100A, 1000V	20 781 32.1000
560/750	170M8611	1100A, 1000V	20 781 32.1000
630/900	170M6467	1400A, 700V	20 681 32.1400
710/1000	170M6467	1400A, 700V	20 681 32.1400
800/1200	170M8611	1100A, 1000V	20 781 32.1000
1000/1350	170M6467	1400A, 700V	20 681 32.1400

Table 13.22 380-480 V, Frame Size 6, Inverter Module DC Link Fuses

AF-600	Bussmann PN	Siba PN	Ferraz-Shawmut PN
[kW]/[HP]		Type JFHR2	Type JFHR2
132/200	170M2619	20 610 31.315	A070URD31KI0315
160/250	170M2619	20 610 31.315	A070URD31KI0315
200/300	170M4015	20 620 31.550	A070URD32KI0550
250/350	170M4015	20 620 31.550	A070URD32KI0550
315/450	170M4015	20 620 31.550	A070URD32KI0550
400/550	170M4015	20 620 31.550	A070URD32KI0550
450/600	170M4017		
500/650	170M4017	20 610 32.700	6.9URD31D08A0700
560/750	170M6013	20 610 32.700	6.9URD31D08A0700
630/900	170M6013	22 610 32.900	6.9URD33D08A0900
710/1000	170M7081	22 610 32.900	6.9URD33D08A0900
800/1150	170M7081		
900/1250	170M7081		
1000/1350	170M7081		
1200/1600	170M7082		
1400/1900	170M7083		

Table 13.23 525-690 V, above 125 HP

AF-600	Bussmann PN	Rating	Alternate Siba PN
[kW]/[HP]			
710/1000	170M8611	1100A, 1000V	20 781 32.1000
800/1150	170M8611	1100A, 1000V	20 781 32.1000
900/1250	170M8611	1100A, 1000V	20 781 32.1000
1000/1350	170M8611	1100A, 1000V	20 781 32.1000
1200/1600	170M8611	1100A, 1000V	20 781 32.1000
1400/1900	170M8611	1100A, 1000V	20 781 32.1000

Table 13.24 525-690 V, Frame Size 6, Inverter Module DC Link Fuses

**170M fuses from Bussmann shown 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 for external use*

***Any minimum 500 V UL listed fuse with associated current rating may be used to meet UL requirements.*

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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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