Safety

⚠WARNING

HIGH VOLTAGE!

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

High Voltage

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

⚠WARNING

UNINTENDED START!

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

Unintended Start

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

⚠WARNING

DISCHARGE TIME!

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

⚠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	Power Size	Minimum Waiting Time [minutes]
200-240 V	0.75-3.7 kW 1-5 HP	4
	5.5-45 kW 7.5-60 HP	15
380-480 V	0.75-7.5 kW 1-10 HP	4
	11-90 kW 15-125 HP	15
	110-250 kW 150-350 HP	20
	315-1000 kW 450-1350 HP	40
525-600 V	0.75-7.5 kW 1-10 HP	4
	11-90 kW 15-125 HP	15
	110-315 kW 150-400 HP	20
	355-1000 kW 450-1350 HP	30
525-690 V	11-75 kW 15-125 HP	15
	110-400 kW 150-550 HP	20
	400-1400 kW 600-1900 HP	30

Table 1.1

Symbols

The following symbols are used in this manual.

⚠WARNING

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

⚠CAUTION

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

CAUTION

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

NOTE

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

Approvals

Table 1.2

Contents

1 Introduction

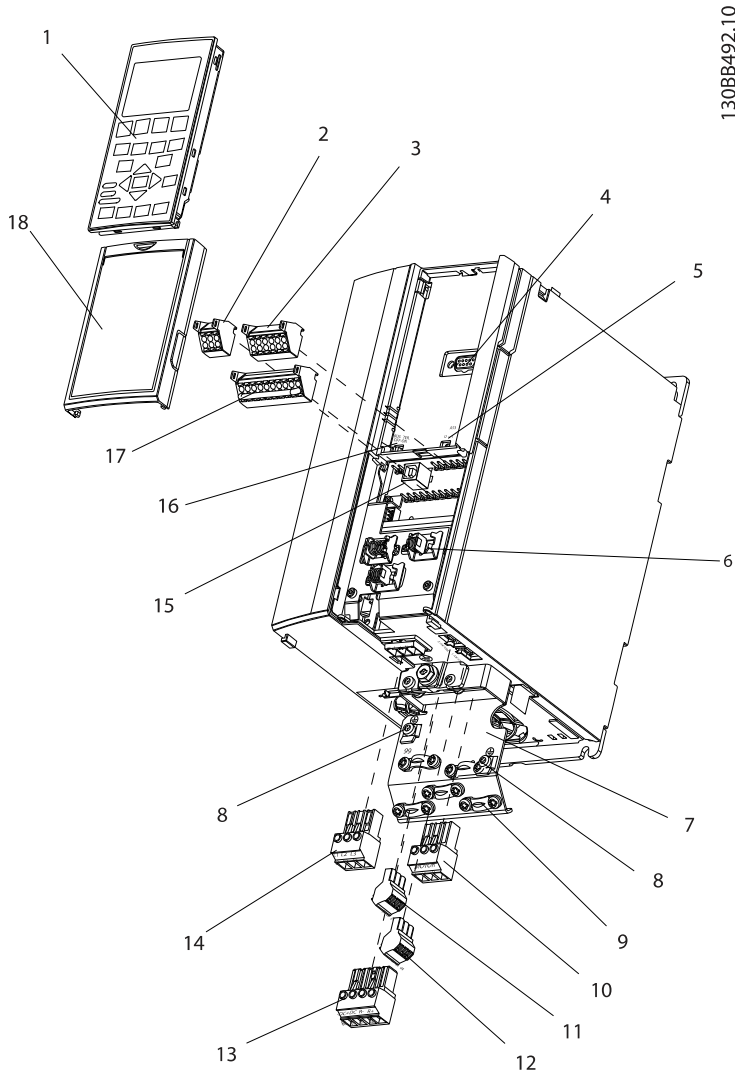


Illustration 1.1 Exploded View Unit Size 12 and 13

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

1

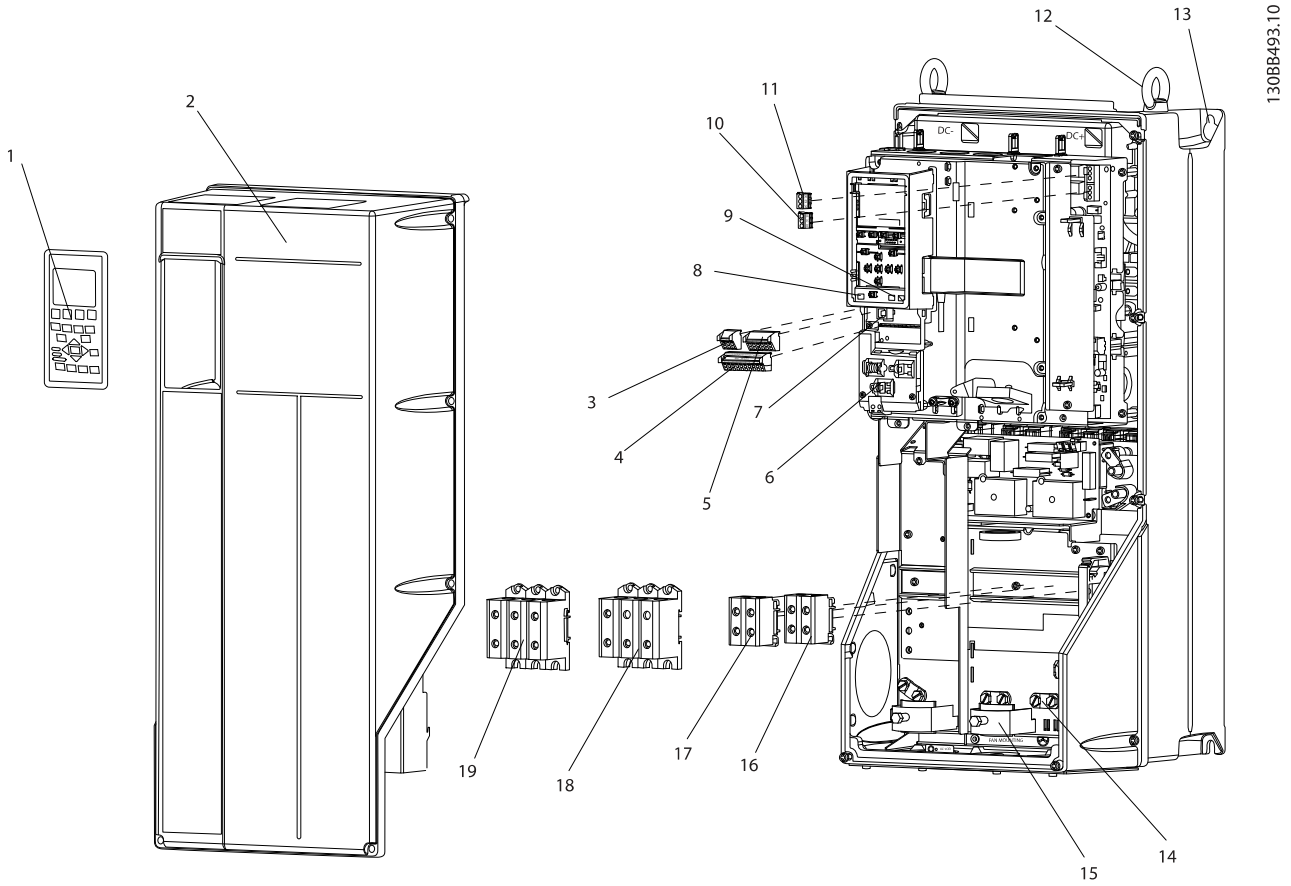


Illustration 1.2 Exploded View Unit Sizes 15, 21, 22, 31, and 32

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

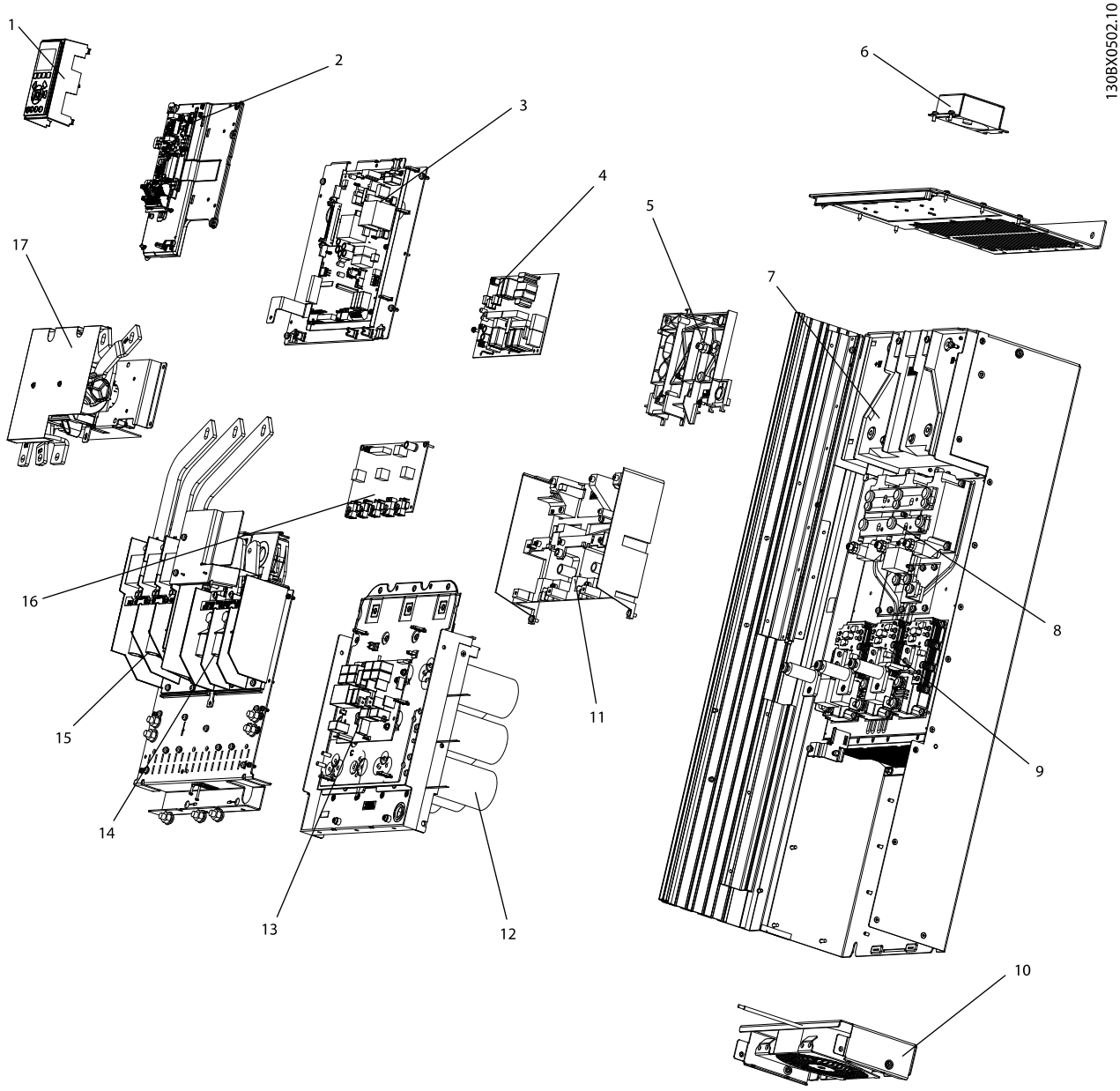


Illustration 1.3 Exploded View Unit Sizes 41h, 42h, 43h, 44h

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

1

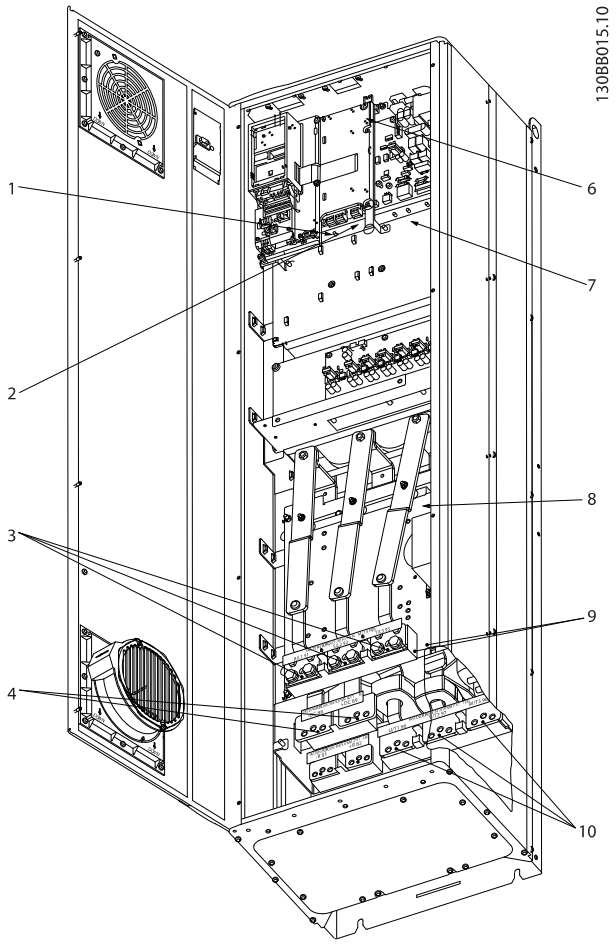


Illustration 1.4 Compact IP21 (NEMA 1) and IP54 (NEMA 12), Unit Sizes 41, 42, 43, 44, 51, 52

1)	AUX Relay		
	01 02 03		
	04 05 06		
2)	Temp Switch	6)	SMPS Fuse (see *12.3 Fuse Tables* 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 *12.3 Fuse Tables* 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

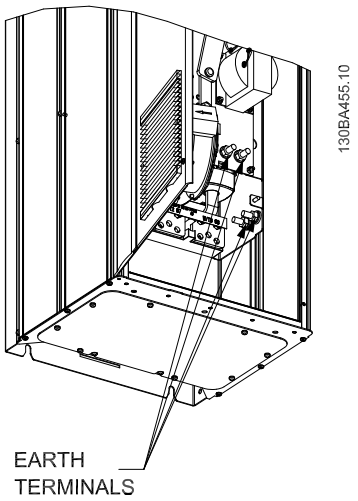


Illustration 1.5 Position of Earth Terminals IP21 (NEMA Type 1) and IP54 (NEMA Type 12)

1

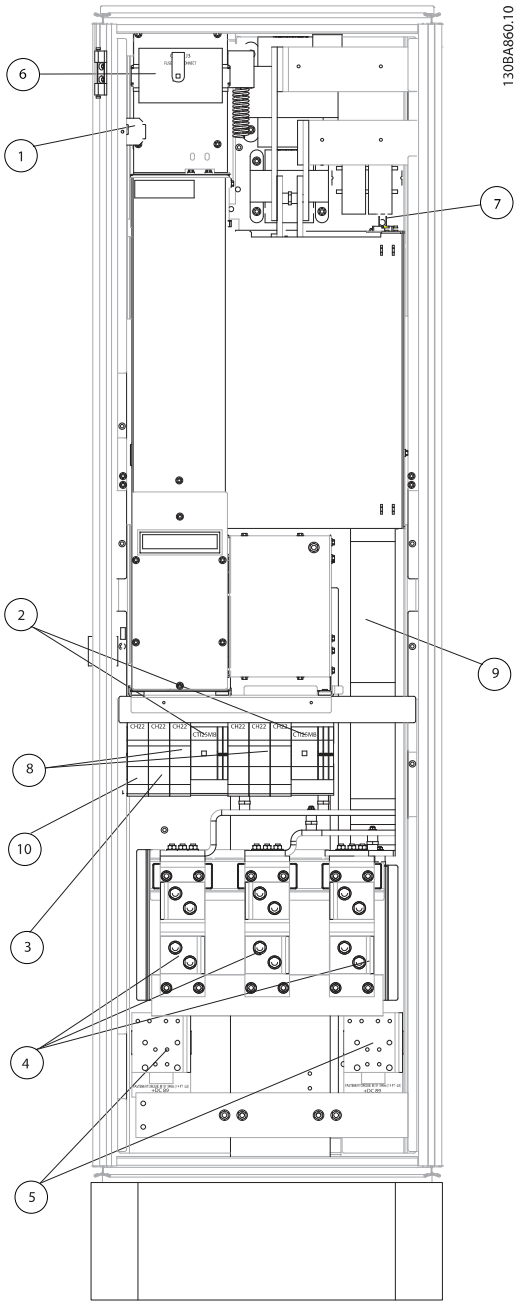


Illustration 1.6 Rectifier Cabinet, unit sizes 61, 62, 63 and 64

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 *12.3 Fuse Tables* for part numbers
2)	Manual Motor Starters	7)	SMPS Fuse. See *12.3 Fuse Tables* for part numbers
3)	30 A Fuse Protected Power Terminals	8)	Manual Motor Controller fuses (3 or 6 pieces). See *12.3 Fuse Tables* for part numbers
4)	Line	9)	Line Fuses, unit sizes 61 and 62 (3 pieces). See *12.3 Fuse Tables* for part numbers
	R S T	10)	30 Amp Fuse Protected Power fuses
	L1 L2 L3		

Table 1.5

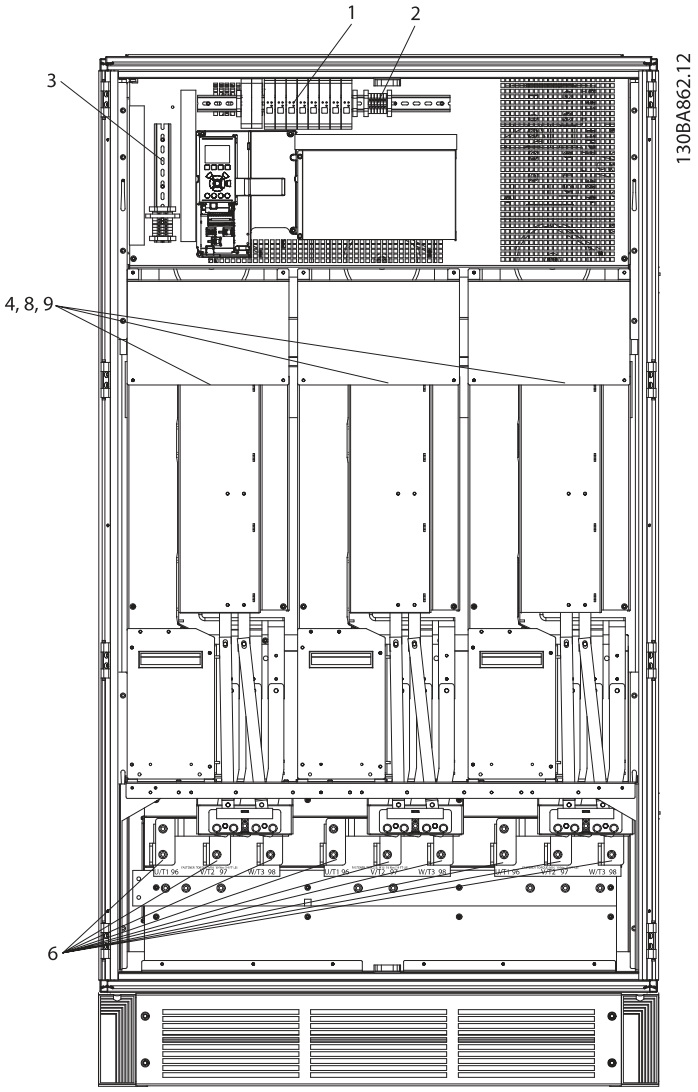


Illustration 1.7 Inverter Cabinet, Unit Sizes 62 and 64
(Unit Sizes 61 and 63 are similar with two inverter modules)

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 *12.3 Fuse Tables* for part numbers
	100 101 102 103	9)	SMPS Fuses. See *12.3 Fuse Tables* for part numbers
	L1 L2 L1 L2		

Table 1.6

1

1.1 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.

1.2 Additional Resources

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

- The *AF-600 FP Programming Guide, DET-618* 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.

1.3 Product Overview

A frequency converter is an electronic motor controller that converts AC mains input into a variable AC waveform output. The frequency and voltage of the output are regulated to control the motor speed or torque. The frequency converter can vary the speed of the motor in response to system feedback, such as 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.

1.4 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.

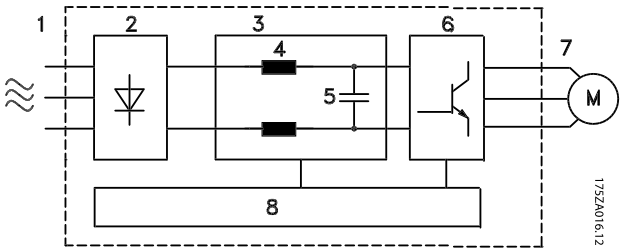


Illustration 1.8 Frequency Converter Block Diagram

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 Frequency Converter Internal Components

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 frequency converter interior free from dust and dirt. Ensure that the components stay as clean as possible. In construction areas, provide a protective covering. Optional IP54 (NEMA 12) enclosures may be necessary.
- Keep the manual, drawings, and diagrams accessible for detailed installation and operation instructions. It is important that the manual is available for equipment operators.
- Locate equipment as near to the motor as possible. Keep motor cables as short as possible. Check the motor characteristics for actual tolerances. Do not exceed
    - 300 m (1000 ft) for unshielded motor leads
    - 150 m (500 ft) for shielded cable.

2.2 Frequency Converter and Motor Pre-installation Check List

- Compare the model number of unit on the nameplate to what was ordered to verify the proper equipment
- Ensure each of the following are rated for same voltage:

  Mains (power)

  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. See the equipment Design Guide for detailed information.

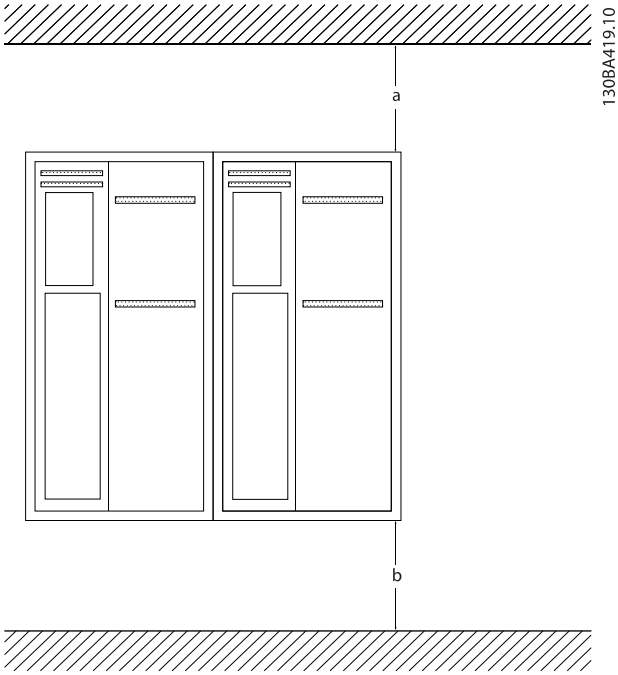


Illustration 2.1 Top and Bottom Cooling Clearance

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

Table 2.1 Minimum Airflow Clearance Requirements

2

2.3.2 Cooling and Airflow

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.

Duct cooling

A dedicated option has been developed to optimize installation of IP00/chassis drive types in Rittal TS8 Units utilizing the fan of the frequency converter for forced air cooling of the backchannel. Please consult GE for more details.

The air out of the top of the enclosure could but ducted outside a facility so the heat loses from the backchannel are not dissipated within the control room reducing air-conditioning requirements of the facility.

Please contact GE for more information.

Back cooling

The backchannel air can also be ventilated in and out the back of a Rittal TS8 Unit. This offers a solution where the backchannel could take air from outside the facility and return the heat loses outside the facility thus reducing air-conditioning requirements.

CAUTION

A door fan(s) is required on the enclosure to remove the heat losses not contained in the backchannel of the drive and any additional losses generated from other components installed inside the enclosure. The total required air flow must be calculated so that the appropriate fans can be selected. Some enclosure manufacturers offer software for performing the calculations (i.e. Rittal Therm software). If the drive is the only heat generating component in the enclosure, the minimum airflow required at an ambient temperature of 45°C for the 43 and 44 unit size drives is 391 m^3/h (230 cfm). The minimum airflow required at an ambient temperature of 45°C for the 52 drive is 782 m^3/h (460 cfm).

Airflow

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

Unit Size protection	Unit Size	Door fan(s) / Top fan airflow	Heatsink fan(s)
IP21 / NEMA 1 IP54 / NEMA 12	41 and 42	170 m^3/h (100 cfm)	765 m^3/h (450 cfm)
	51 350HP @ 460 V, 500 & 550 HP @ 690 V	340 m^3/h (200 cfm)	1105 m^3/h (650 cfm)
	51 450-550 HP @ 460V, 650-750 HP @ 690 V	340 m^3/h (200 cfm)	1445 m^3/h (850 cfm)
IP21 / NEMA 1	61, 62, 63 and 64	700 m^3/h (412 cfm)*	985 m^3/h (580 cfm)*
IP54 / NEMA 12	61, 62, 63 and 64	525 m^3/h (309 cfm)*	985 m^3/h (580 cfm)*
IP00 / Chassis	43 and 44	255 m^3/h (150 cfm)	765 m^3/h (450 cfm)
	52 350 HP @ 460V, 500 & 550 HP @ 690 V	255 m^3/h (150 cfm)	1105 m^3/h (650 cfm)
	52 450-550 HP @ 460V, 650-750 HP @ 690 V	255 m^3/h (150 cfm)	1445 m^3/h (850 cfm)
* Airflow per fan. Unit Sizes 6X contain multiple fans.			

Table 2.2 Heatsink Air Flow

External ducts

If additional duct work is added externally to the Rittal cabinet the pressure drop in the ducting must be calculated. Use the charts below to derate the frequency converter according to the pressure drop.

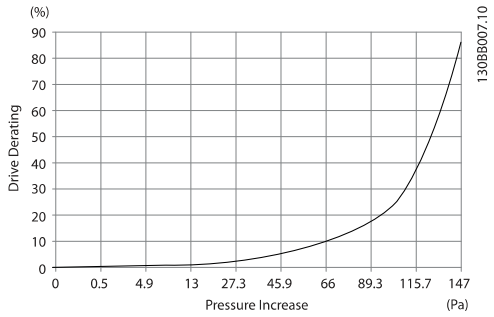


Illustration 2.2 Unit Size 4X Derating vs. Pressure Change
Drive air flow: 450 cfm (765 m³/h)

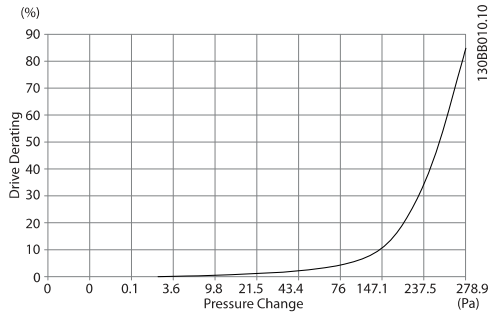


Illustration 2.3 Unit Size 5X Derating vs. Pressure Change (Small Fan), 350 HP @ 460V and 500-550 HP @ 690 V
Drive air flow: 650 cfm (1105 m³/h)

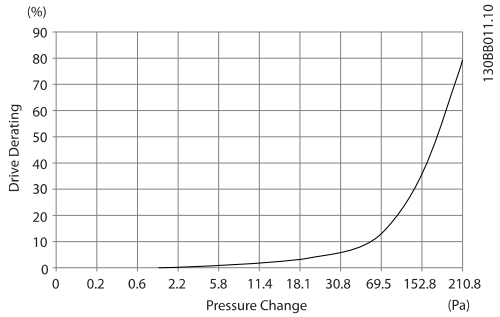


Illustration 2.4 Unit Size 5X Derating vs. Pressure Change (Large Fan)
Drive air flow: 850 cfm (1445 m³/h)

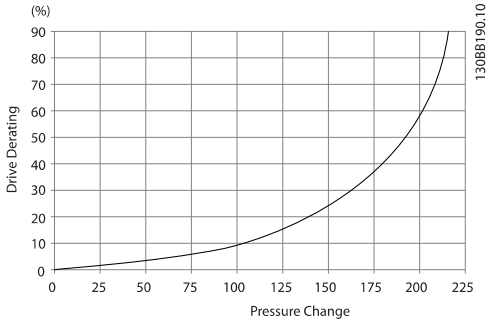


Illustration 2.5 Unit Size 61, 62, 63 and 64 Derating vs. Pressure Change
Drive air flow: 580 cfm (985 m³/h)

2

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

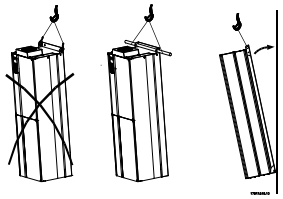


Illustration 2.6 Recommended Lifting Method, 4X and 5X Unit Sizes.

⚠WARNING

The lifting bar must be able to handle the weight of the frequency converter. See *Mechanical Dimensions* for the weight of the different unit sizes. 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 2.7* and *Illustration 2.8*)
- Improper mounting can result in over heating and reduced performance
- Use the slotted mounting holes on the unit for wall mounting, when provided

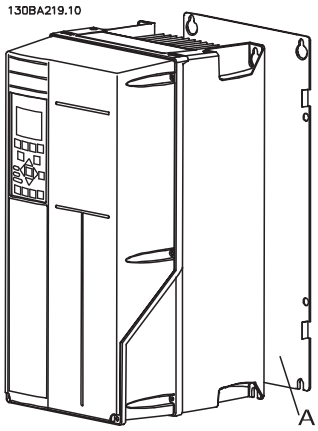


Illustration 2.7 Proper Mounting with Back Plate

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

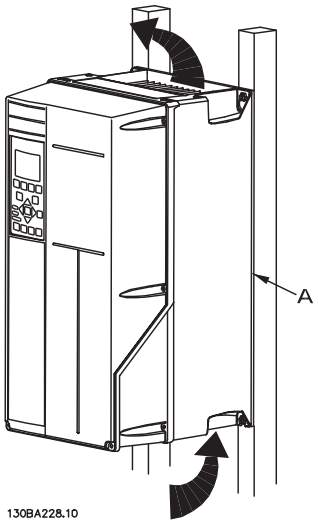


Illustration 2.8 Proper Mounting with Railings

NOTE

Back plate is needed when mounted on railings.

2.3.5 IP21 Drip Shield Installation (Unit Sizes 41 and 42)

To comply with the IP21 rating, a separate drip shield is to be installed as explained below:

- Remove the two front screws
- Insert the drip shield and replace screws
- Torque the screws to 5,6 Nm (50 in-lbs)

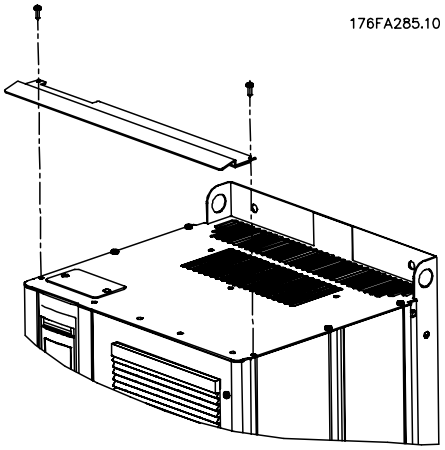


Illustration 2.9 Drip shield installation.

2.4 Field Installation of Options

2.4.1 Installation of Top-only Duct Cooling Kit

This description is for the installation of the top section only of the back-channel cooling kits available for unit sizes 43, 44 and 52. In addition to the enclosure a 200 mm vented pedestal is required.
The minimum enclosure depth is 500 mm (600 mm for unit size 52) and the minimum enclosure width is 600 mm (800 mm for unit size 52). The maximum depth and width are as required by the installation. When using multiple frequency converters in one enclosure mount each drive on its own back panel and support along the mid-section of the panel. The back-channel cooling kits are very similar in construction for all frames. The kits do not support "in frame" mounting of the frequency converters. The 52 kit is mounted "in frame" for additional support of the frequency converter.
Using these kits as described removes 85% of the losses via the back channel using the drive's main heat sink fan. The remaining 15% must be removed via the door of the enclosure.

Ordering information
Unit size 43 and 44: OPCDUCT4344T
Unit size 52: OPCDUCT52T

2.4.2 Installation of Top and Bottom Covers

Top and bottom covers can be installed on unit sizes 43, 44 and 52. These kits are designed to be used to direct the back-channel airflow in and out the back of the drive as opposed to in the bottom and out the top of the drive (when the drives are being mounted directly on a wall or inside a welded enclosure).

Notes:

1. If external duct work is added to the exhaust path of the drive, additional back pressure will be created that will reduce the cooling of the drive. The drive must be derated to accommodate the reduced cooling. First, the pressure drop must be calculated, then refer to the derating tables located earlier in this section.
2. A doorfan(s) is required on the enclosure to remove the heat losses not contained in the backchannel of the drive and any additional losses generated from other components installed inside the enclosure. The total required air flow must be calculated so that the appropriate fans can be selected. Some enclosure manufacturers offer software for performing the calculations (i.e. Rittal Therm software).
   If the drive is the only heat generating component in the enclosure, the minimum airflow required at an ambient temperature of 45°C for the unit sizes 43, 44 and 52 drives is 391 m^3/h (230 cfm). The minimum airflow required at an ambient temperature of 45°C for the 52 unit size drive is 782 m^3/h (460 cfm).

Ordering information
Unit size 43 and 44: OPCDUCT4344TB
Unit size 52: OPCDUCT52TB

2.4.3 Outside Installation /NEMA 3R Kit of Industrial Enclosures

The kits are available for the unit sizes 43, 44 and 52. These kits are designed and tested to be used with IP00/ Chassis drives in welded box construction enclosures with an environmental rating of NEMA-3R or NEMA-4. The NEMA-3R enclosure is a dust tight, rain tight, ice resistant, outdoor enclosure. The NEMA-4 enclosure is a dust tight and water tight enclosure.
This kit has been tested and complies with UL environmental rating Type-3R.

Note: The current rating of 43 and 44 unit size drives are de-rated by 3% when installed in a NEMA- 3R enclosure. 52 unit size drives require no de-rating when installed in a NEMA-3R enclosure.

2

Ordering information
Unit size 43: OPCDUCT433R
Unit size 44: OPCDUCT443R
Unit size 52: OPCDUCT523R

2.4.4 Installation of IP00 to IP20 Kits

The kits can be installed on unit sizes 43, 44, and 52 (IP00).

Ordering information
Unit size 43/44: Please consult GE
Unit size 52: Please consult GE

2.4.5 Installation of cable clamp bracket in open chassis drives.

The motor cable clamp brackets can be installed on open chassis drives in unit sizes 43, 44, and 52.

Ordering information
Unit size 43: Please consult GE
Unit size 44: Please consult GE
Unit size 52: Please consult GE

2.4.6 Installation on Pedestal

This section describes the installation of a pedestal unit available for the frequency converters Unit Sizes 41 and 42. This is a 200 mm high pedestal that allows these Units to be floor mounted. The front of the pedestal has openings for input air to the power components.

The frequency converter gland plate must be installed to provide adequate cooling air to the control components of the frequency converter via the door fan and to maintain the IP21/NEMA 1 or IP54/NEMA 12 degrees of Unit protections.


175ZT976.10

Illustration 2.10 Drive on pedestal

There is one pedestal that fits both Unit Sizes 41 and 42. The pedestal is standard for Unit Size 51.

Ordering information
Unit size 41/42: OPC4XPED

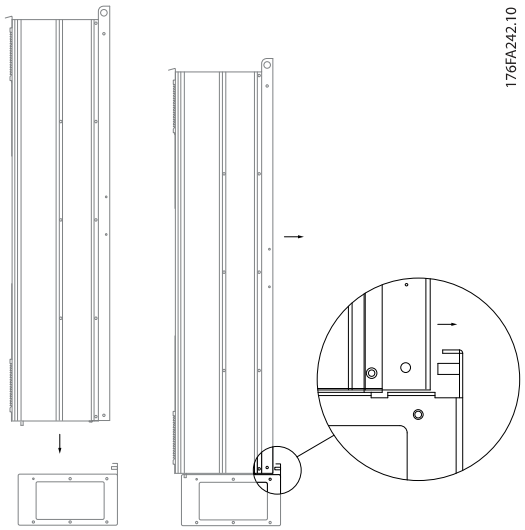

176FA242.10

Illustration 2.11 Mounting of drive to pedestal.

2.4.7 Installation of Mains Shield for Frequency Converters

This section is for the installation of a mains shield for the drive series with Unit Sizes 41, 42 and 51. It is not possible to install in the IP00/ Chassis drive types as these have included as standard a metal cover. These shields satisfy VBG-4 requirements.

NOTE

For further information, please consult GE.

2.4.8 USB Extension Kit

A USB extension cable can be installed into the door of unit size 6x frequency converters.

Ordering information
Unit size 1x through 5x: OPCUSB
Unit size 6x: OPCUSB6X

2.4.9 Installation of 4x or 5x Loadshare Option

The loadshare option can be installed on unit sizes 41, 42, 43, 44, 51 and 52.

Ordering information
Unit size 41/43: OPCLSK41
Unit size 42/44: OPCLSK42
Unit size 51/52: OPCLSK51 for 460 VAC
OPCLSK52 for 575 VAC

The drive can be purchased with the factory installed brake chopper which includes load share terminals as factory installed.

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 2.12 shows a basic electrical connection.

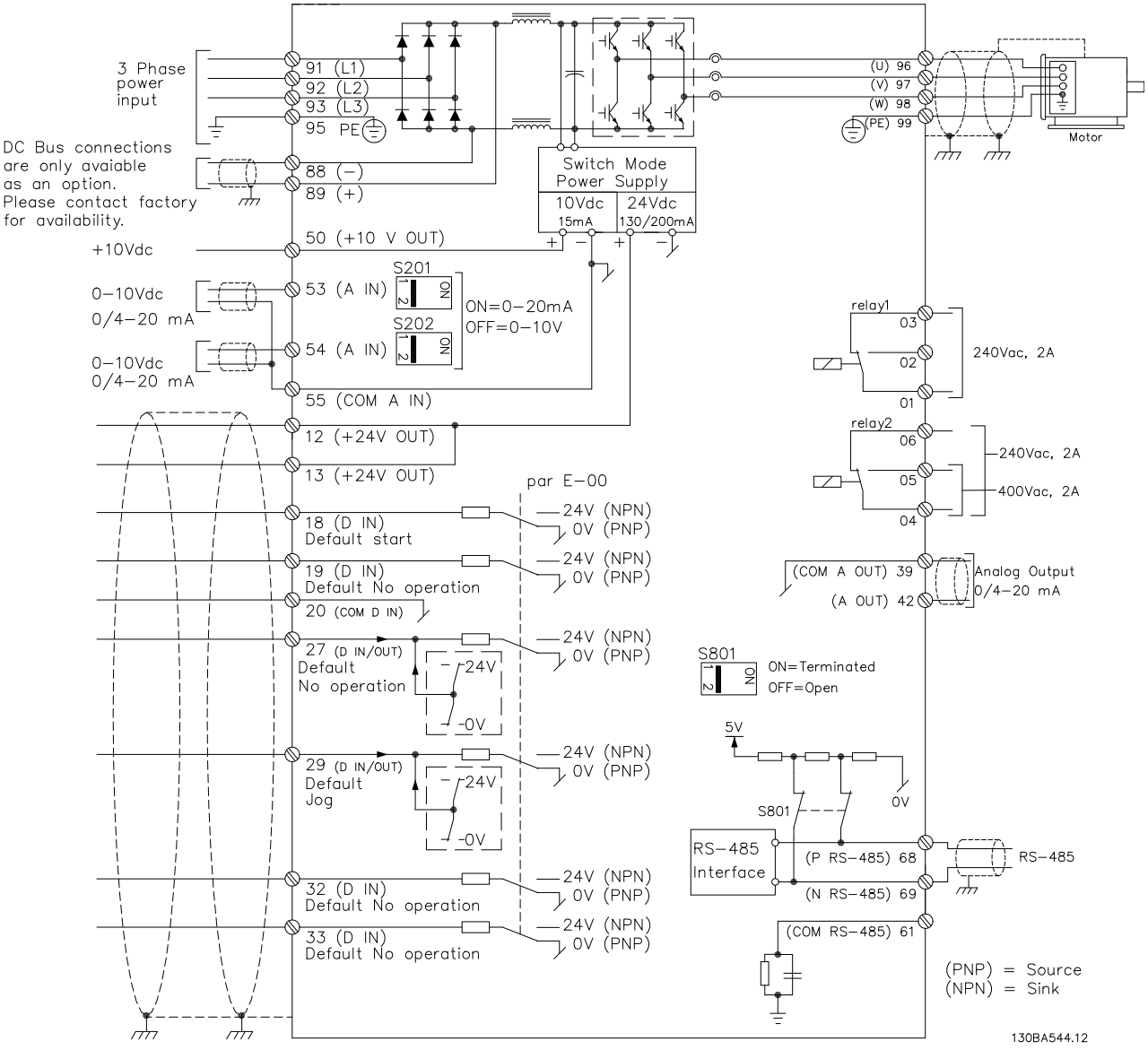


Illustration 2.12 Basic Wiring Schematic Drawing.

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 *9 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 2.13*. See maximum fuse ratings in *12.1 Power-dependent Specifications*.

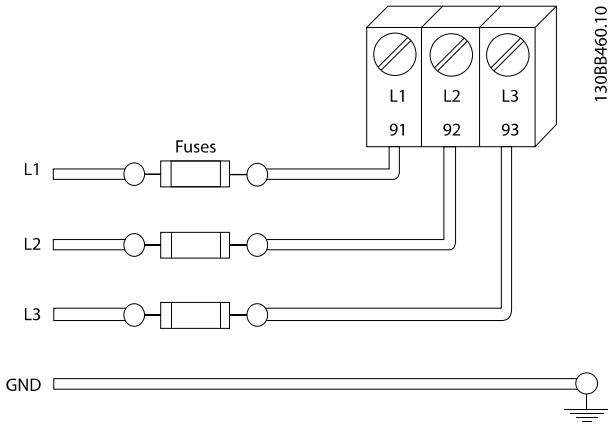


Illustration 2.13 Frequency Converter Fuses

Wire Type and Ratings

- All wiring must comply with local and national regulations regarding cross-section and ambient temperature requirements.
- GE recommends that all power connections be made with a minimum 75°C 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

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 2.14*).

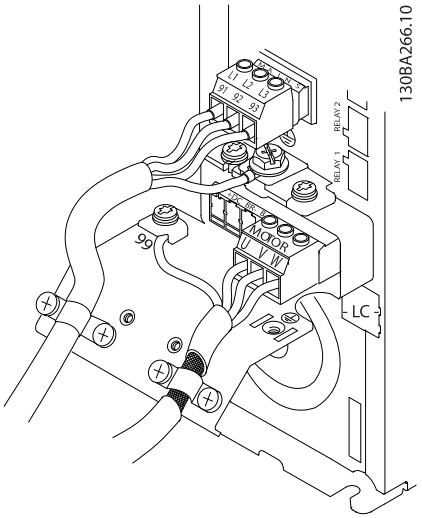


Illustration 2.14 Grounding with Shielded Cable

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.
- Input power will be connected to the mains input terminals.
- Ground the cable in accordance with grounding instructions provided in
- All frequency converters may be used with an isolated input source as well as with ground reference power lines. When supplied from an isolated mains source (IT mains or floating delta) or TT/TN-S mains with a grounded leg (grounded delta), set *SP-50 RFI Filter* to OFF. When off, the internal RFI filter capacitors between the chassis and the intermediate circuit are isolated to avoid damage to the intermediate circuit and to reduce earth capacity currents in accordance with IEC 61800-3.

2.5.4.1 External Fan Supply (Unit Sizes 41, 42, 43, 44, 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 2.3

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

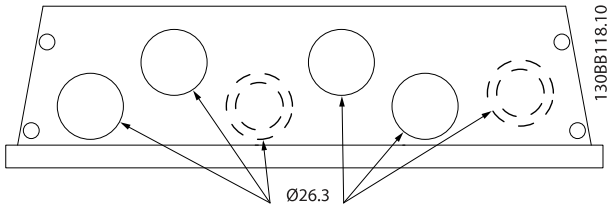


Illustration 2.15 Cable entry holes for unit size 15

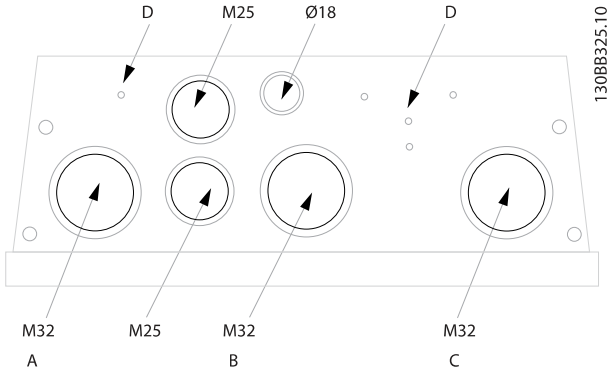


Illustration 2.16 Cable entry holes for unit size 21

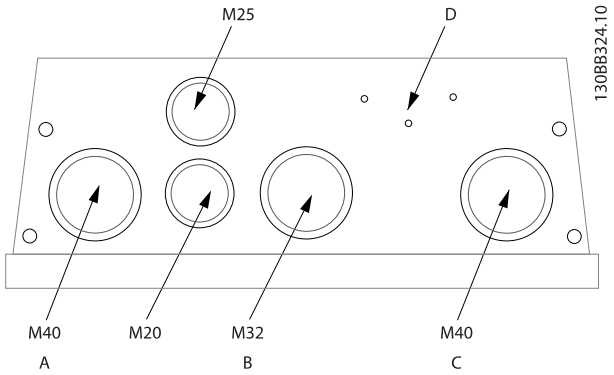


Illustration 2.17 Cable entry holes for unit size 22

2

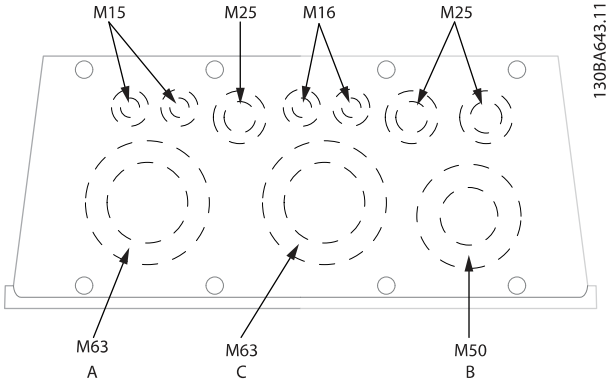


Illustration 2.18 Cable entry holes for unit size 31

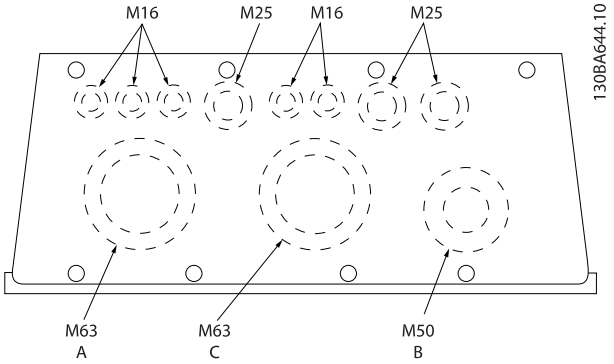


Illustration 2.19 Cable entry holes for unit size 32

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 41, 42, 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

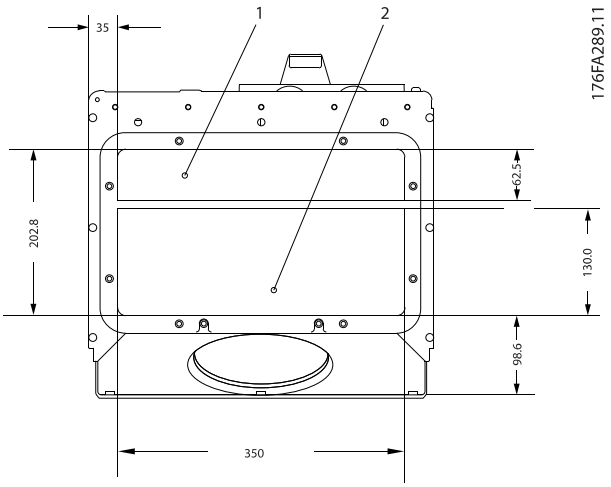


Illustration 2.20 Unit Sizes 41 + 42

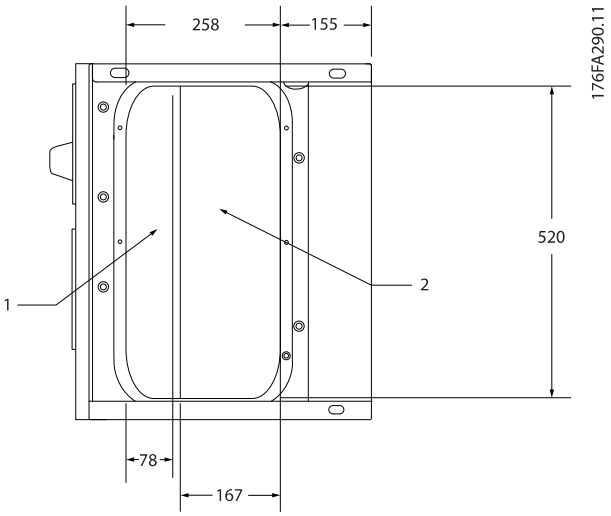


Illustration 2.21 Unit Size 51

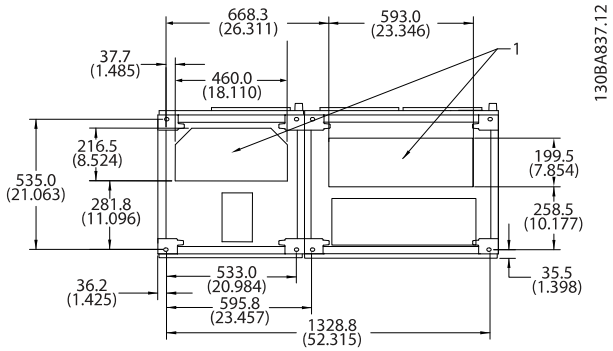


Illustration 2.22 Unit Size 61

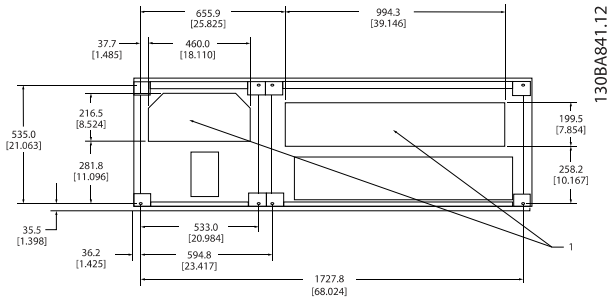


Illustration 2.23 Unit Size 62

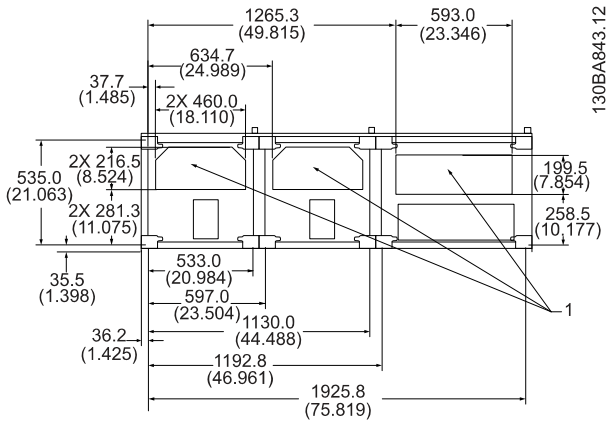


Illustration 2.24 Unit Size 63

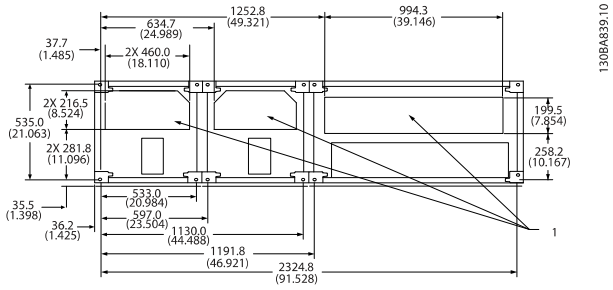


Illustration 2.25 Unit Size 64

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 2.26*.
- Or remove front cover by loosening attaching screws. See *Illustration 2.27*.

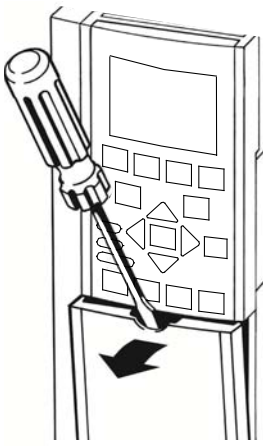


Illustration 2.26 Control Wiring Access for IP20/Open chassis enclosures

Illustration 2.27 Control Wiring Access for IP55/ Nema 12 and IP66/Nema 4X

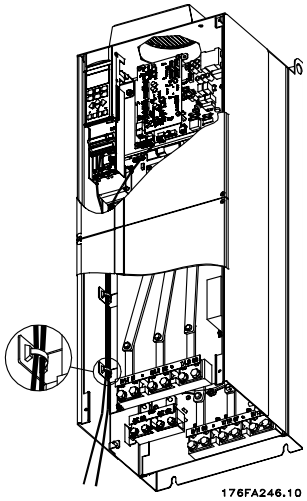


Illustration 2.28 Control Card Wiring Path for Unit Size 43. Control Card Wiring for Unit Sizes 41, 42, 44, 51 and 52 Use the Same Path.

2.5.8.2 Control Terminal Types

Illustration 2.29 shows the removable frequency converter connectors. Terminal functions and default settings are summarized in *Table 2.4*.

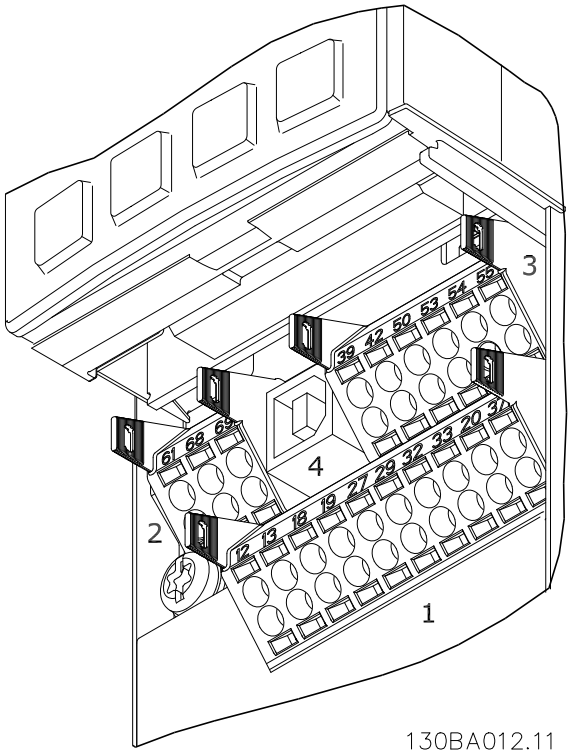


Illustration 2.29 Control Terminal Locations

- **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 *12.2 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 either digital input or output. Default setting is input.
29	E-04	[14] JOG	
20	-		Common for digital inputs and 0 V potential for 24 V supply.
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

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 potenti-ometer or thermistor.
53	AN-1#	Reference	Analog input. Selectable for voltage or current. Switches A53 and A54 select mA or V.
54	AN-2#	Feedback	
55	-		Common for analog input
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 2.4 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 2.30*.

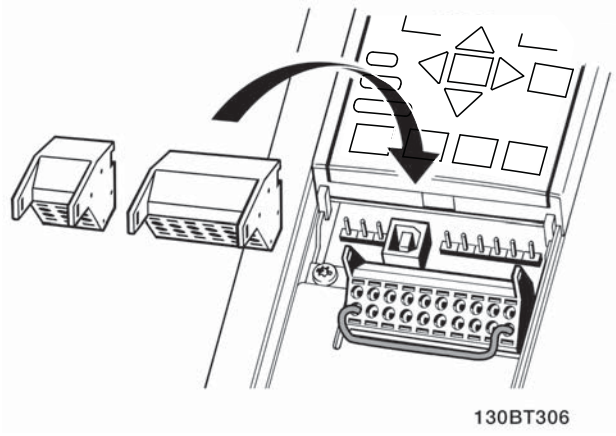


Illustration 2.30 Unplugging Control Terminals

1. Open the contact by inserting a small screwdriver into the slot above or below the contact, as shown in *Illustration 2.31*.
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.

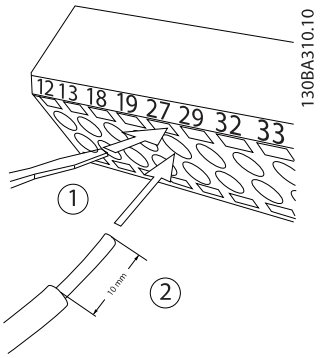


Illustration 2.31 Connecting Control Wiring

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.

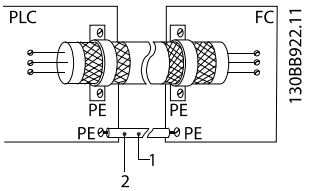


Illustration 2.32

1	Min. 16 mm^2
2	Equalizing cable

Table 2.5

2

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).

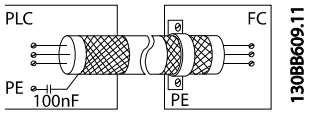


Illustration 2.33

Avoid EMC noise on serial communication

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

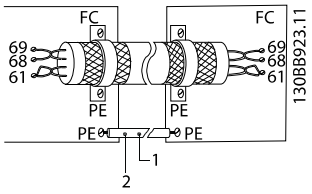


Illustration 2.34

1	Min. 16 mm^2
2	Equalizing cable

Table 2.6

Alternatively, the connection to terminal 61 can be omitted:

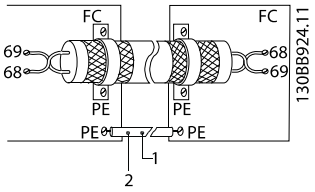


Illustration 2.35

1	Min. 16 mm^2
2	Equalizing cable

Table 2.7

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 2.4* for terminals and associated parameters.
- It is important to confirm that the control terminal is programmed for the correct function. See *4 User Interface* for details on accessing parameters and *5 About 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 2.36*). Note that some option cards available for the unit may cover these switches and must be removed to change switch settings. Always remove power to the unit before removing option cards.
- Terminal 53 default is for a speed reference signal in open loop set in *DR-61 Terminal 53 Switch Setting*
- Terminal 54 default is for a feedback signal in closed loop set in *DR-63 Terminal 54 Switch Setting*

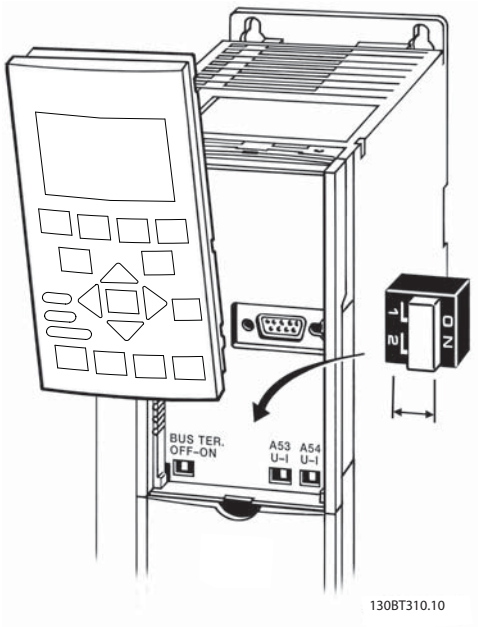


Illustration 2.36 Location of Terminals 53 and 54 Switches

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.

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

Table 2.8

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.	
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 to the Frequency Converter

⚠WARNING

HIGH VOLTAGE!

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

3

⚠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

NOTE

If the wizard is run, ignore the following.

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 .
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*

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

3.4 Auto Tune

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

- It does not cause the motor to run or harm to the motor
- Some motors may be unable to run the complete version of the test. In that case, select *Reduced Auto Tune*
- If an output filter is connected to the motor, select *[2] Reduced Auto Tune*
- If warnings or alarms occur, see *9 Warnings and Alarms*
- 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 *9 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 *9 Warnings and Alarms*.
- Check that motor data is entered correctly.
- Increase the decel time in *F-08 Decel Time 1*.

See *9.4 Warning and Alarm Definitions4.1.1 Local Control Panel Keypad* for resetting the frequency converter after a trip.

NOTE

***3.1 Pre-start* through *3.6 Local-control Test* in this chapter concludes 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 . The following procedure is recommended after application set-up by the user is completed.

3

⚠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 *9 Warnings and Alarms*.

4 User Interface

4.1 Keypad

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

The keypad has several user functions.

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

NOTE

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

4.1.1 Keypad Layout

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

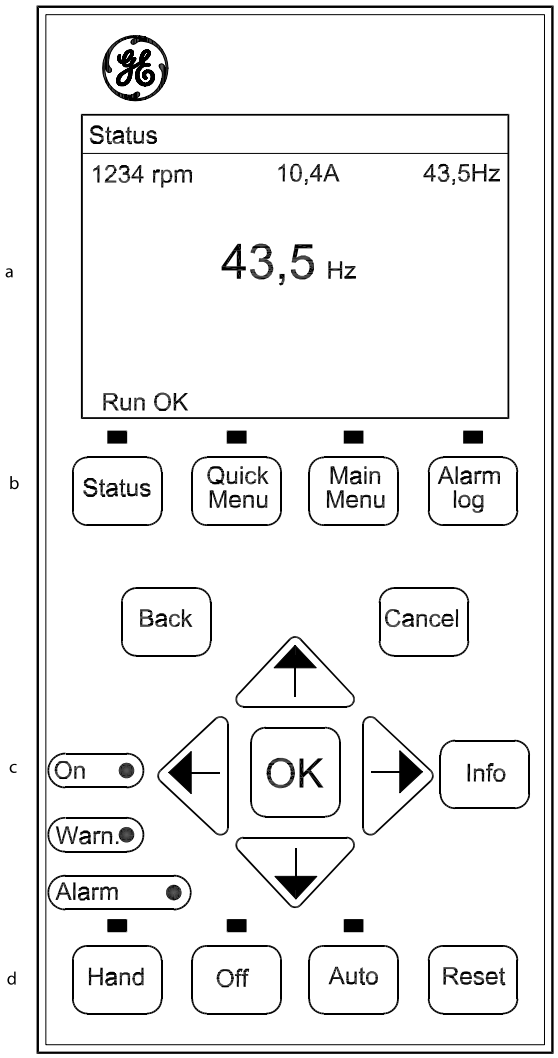


Illustration 4.1 keypad

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. Also included are the status indicator lights.

d. Operational mode keys and reset.

4.1.2 Setting Keypad Display Values

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

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

- Each display readout has a parameter associated with it.
- Options are selected in 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.

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

Table 4.1

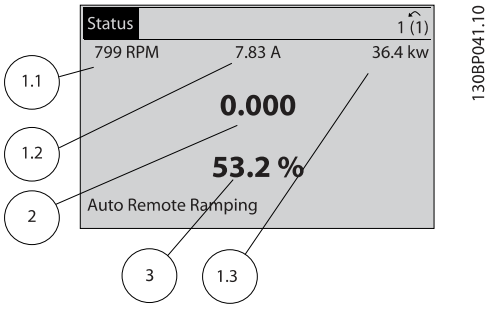


Illustration 4.2

4.1.3 Display

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

Illustration 4.3

Key	Function
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 4.2

4.1.4 Navigation Keys

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

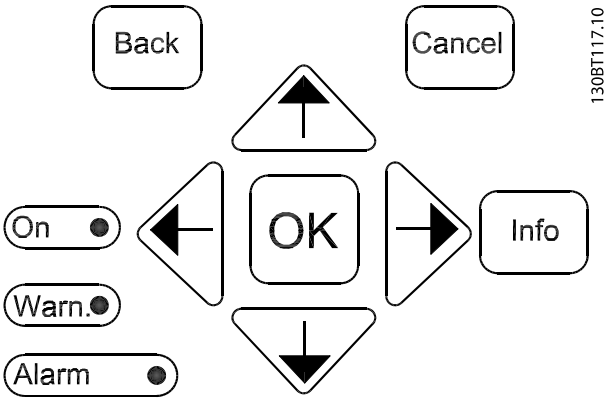


Illustration 4.4

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

Table 4.3

Light	Indicator	Function
Green	ON	The ON light activates when the 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 4.4

4.1.5 Operation Keys

Operation keys are found at the bottom of the keypad.

Illustration 4.5

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 4.5

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 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 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*

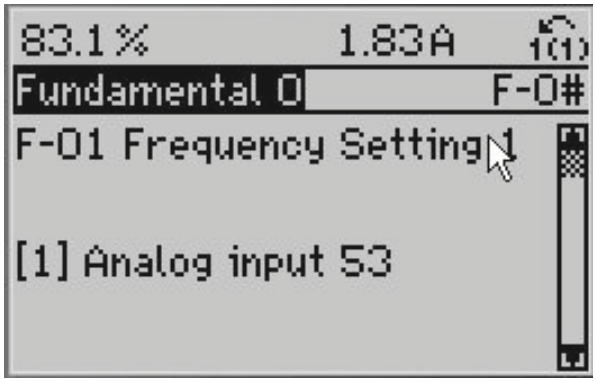


Illustration 5.1

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

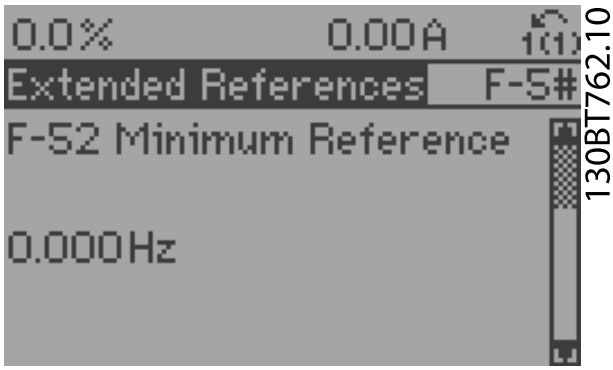


Illustration 5.2

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.)

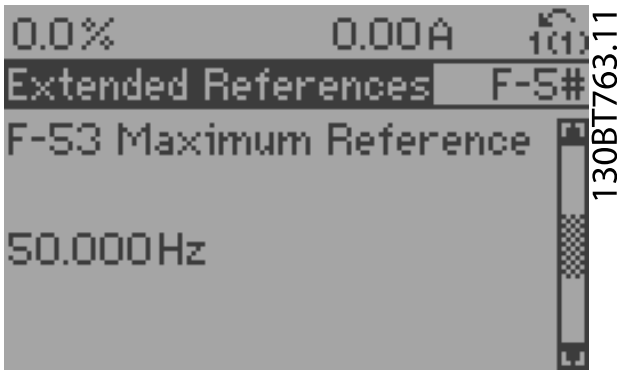


Illustration 5.3

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.)

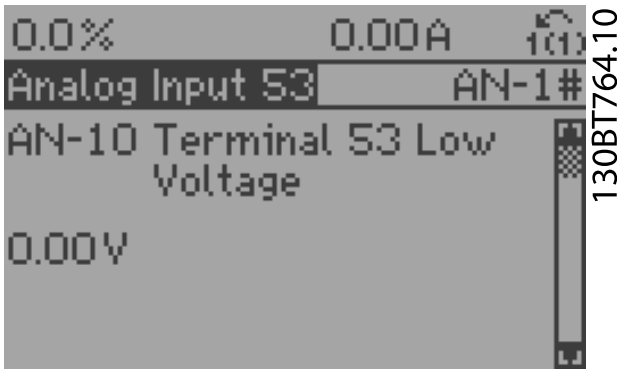


Illustration 5.4

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.)

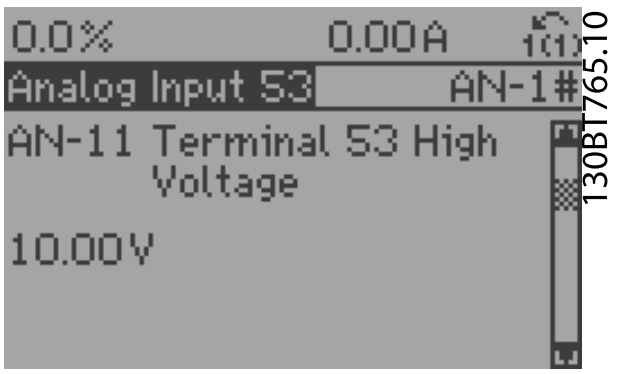


Illustration 5.5

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.)

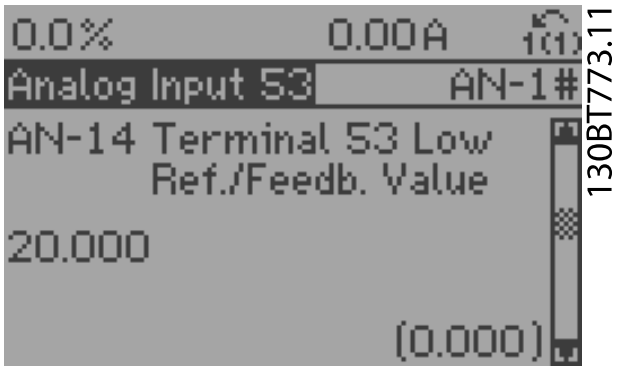


Illustration 5.6

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.)

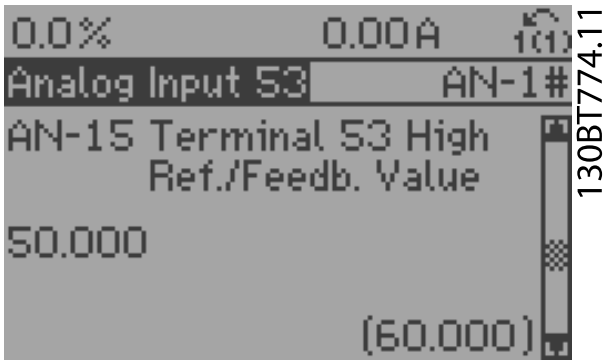


Illustration 5.7

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.

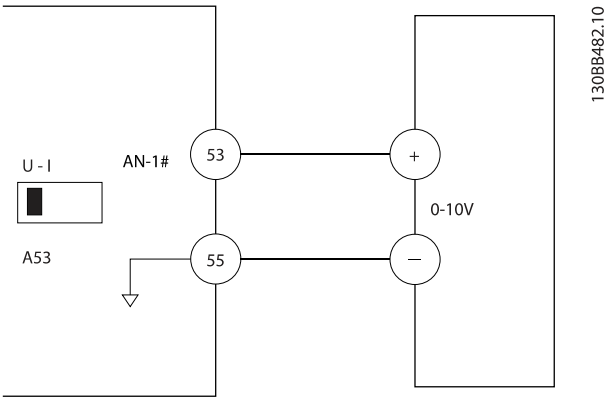


Illustration 5.8 Wiring Example for External Device Providing 0-10 V Control Signal (Frequency Converter Left, External Device Right)

5.3 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 2.4* for control terminal parameter number and default setting. (Default setting can change based on the selection in *K-03 Regional Settings*.)

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

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

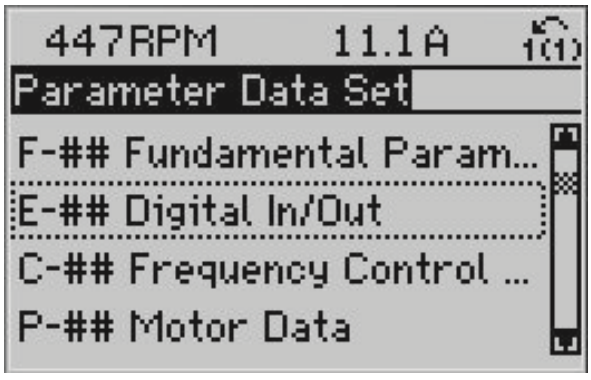


Illustration 5.9

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

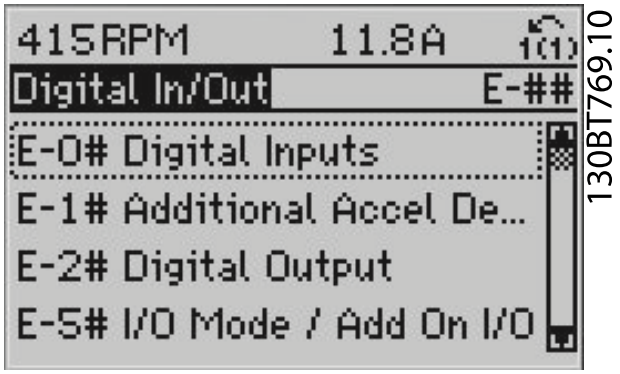


Illustration 5.10

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.

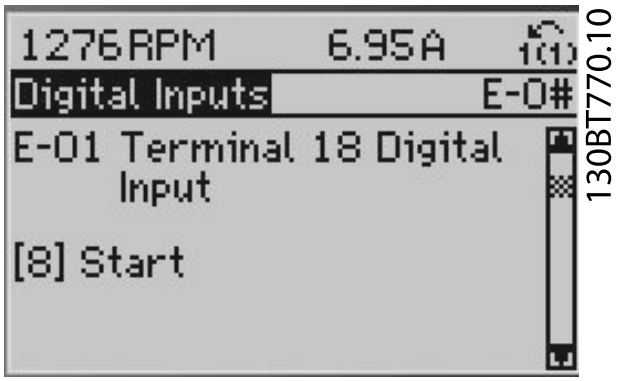


Illustration 5.11

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

Parameter	International default parameter value	North American default parameter value
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	132 Hz	120 Hz
H-73 Warning Speed High	1500 RPM	1800 RPM
E-03 Terminal 27 Digital Input	Coast inverse	External interlock
E-24 Function Relay	No operation	No alarm
AN-15 Terminal 53 High Ref./Feedb. Value	50	60
AN-50 Terminal 42 Output	No operation	Speed 4-20 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].

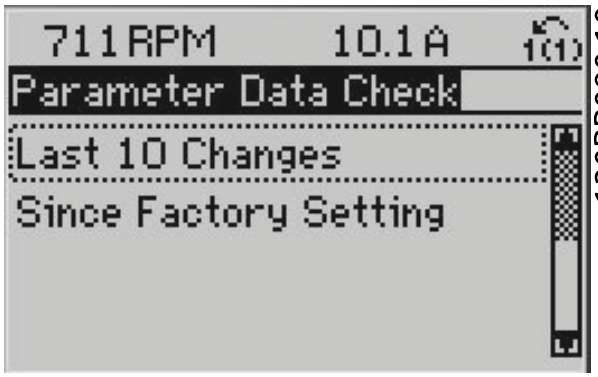


Illustration 5.12

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

Quick Start	
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

K-## Keypad Set-Up	K-37 Display Text 1	**K-8# Days and Date/Time Readout**	**F-2# Fundamental 2**	**E-## Digital In/Out**
K-0# Keypad Basic Settings	K-38 Display Text 2	K-81 Working Days	F-24 Holding Time	**E-0# Digital Inputs**
K-01 Language	K-39 Display Text 3	K-82 Additional Working Days	F-26 Motor Noise (Carrier Freq)	E-00 Digital I/O Mode
K-02 Motor Speed Unit	**K-4# Keypad Buttons**	K-83 Additional Non-Working Days	F-27 Motor Tone Random	E-01 Terminal 18 Digital Input
K-03 Regional Settings	K-40 [Hand] Button on Keypad	K-89 Date and Time Readout	**F-3# Fundamental 3**	E-02 Terminal 19 Digital Input
K-04 Operating State at Power-up	K-41 [Off] Button on Keypad	**F-## Fundamental Parameters**	F-37 Adv. Switching Pattern	E-03 Terminal 27 Digital Input
K-05 Local Mode Unit	K-42 [Auto] Button on Keypad	**F-0# Fundamental 0**	F-38 Overmodulation	E-04 Terminal 29 Digital Input
K-1# Keypad Set-Up Operations	K-43 [Reset] Button on Keypad	F-01 Frequency Setting 1	**F-4# Fundamental 4**	E-05 Terminal 32 Digital Input
K-10 Active Set-up	**K-5# Copy/Save**	F-02 Operation Method	F-40 Torque Limiter (Driving)	E-06 Terminal 33 Digital Input
K-11 Edit Set-up	K-50 Keypad Copy	F-03 Max Output Frequency 1	F-41 Torque Limiter (Braking)	**E-1# Additional Accel Decel Ramps**
K-12 This Set-up Linked to	K-51 Set-up Copy	F-04 Base Frequency	F-43 Current Limit	E-10 Accel Time 2
K-13 Readout: Linked Set-ups	**K-6# Password Protection**	F-05 Motor Rated Voltage	**F-5# Extended References**	E-11 Decel Time 2
K-14 Readout: Edit Set-ups / Channel	K-60 Main Menu Password	F-07 Accel Time 1	F-52 Minimum Reference	**E-2# Digital Outputs**
K-2# Keypad Display	K-61 Access to Main Menu w/o Password	F-08 Decel Time 1	F-53 Maximum Reference	E-20 Terminal 27 Digital Output
K-20 Display Line 1.1 Small	K-65 Quick Menu Password	**F-1# Fundamental 1**	F-54 Reference Function	E-21 Terminal 29 Digital Output
K-21 Display Line 1.2 Small	K-66 Access to Quick Menu w/o Password	F-10 Electronic Overload	**F-6# References**	E-24 Function Relay
K-22 Display Line 1.3 Small	**K-7# Clock Settings**	F-11 Motor External Fan	F-64 Preset Relative Reference	E-26 On Delay, Relay
K-23 Display Line 2 Large	K-70 Date and Time	F-12 Motor Thermistor Input	**F-9# Digital Pot.Meter**	E-27 Off Delay, Relay
K-24 Display Line 3 Large	K-71 Date Format	F-15 Motor Speed High Limit [Hz]	F-90 Step Size	**E-5# I/O Mode / Add On I/O**
K-25 Quick Start	K-72 Time Format	F-16 Motor Speed Low Limit [Hz]	F-91 Accel/Decel Time	E-51 Terminal 27 Mode
K-3# Keypad Custom Readout	K-74 DST/Summertime	F-17 Motor Speed High Limit [RPM]	F-92 Power Restore	E-52 Terminal 29 Mode
K-30 Unit for Custom Readout	K-76 DST/Summertime Start	F-18 Motor Speed Low Limit [RPM]	F-93 Maximum Limit	E-53 Terminal X30/2 Digital Input
K-31 Min Value of Custom Readout	K-77 DST/Summertime End		F-94 Minimum Limit	E-54 Terminal X30/3 Digital Input
K-32 Max Value of Custom Readout	K-79 Clock Fault		F-95 Accel/Decel Ramp Delay	E-55 Terminal X30/4 Digital Input

Table 5.3

E-56 Term X30/6 Digi Out (OPCGPIO)	E-96 Pulse Out #29 Timeout Preset	P-07 Motor Power [kW]	**H-5# Load Indep. Setting**	**AN-1# Analog Input 53**
E-57 Term X30/7 Digi Out (OPCGPIO)	E-97 Pulse Out #X30/6 Bus Control	P-08 Motor Rotation Check	H-58 Flystart Test Pulses Current	AN-10 Terminal 53 Low Voltage
E-6# Pulse Input	E-98 Pulse Out #X30/6 Timeout Preset	P-09 Slip Compensation	H-59 Flystart Test Pulses Frequency	AN-11 Terminal 53 High Voltage
E-60 Term. 29 Low Frequency	**C-## Frequency Control Functions**	P-10 Slip Compensation Time Constant	**H-6# Load Depen. Setting**	AN-12 Terminal 53 Low Current
E-61 Term. 29 High Frequency	**C-0# Frequency Control Functions**	**P-3# Adv. Motor Data**	H-64 Resonance Dampening	AN-13 Terminal 53 High Current
E-62 Term. 29 Low Ref./Feedb. Value	C-01 Jump Frequency From [Hz]	P-30 Stator Resistance (Rs)	H-65 Resonance Dampening Time Constant	AN-14 Terminal 53 Low Ref./Feedb. Value
E-63 Term. 29 High Ref./Feedb. Value	C-02 Jump Speed From [RPM]	P-31 Rotor Resistance (Rr)	**H-7# Adjustable Warnings**	AN-15 Terminal 53 High Ref./Feedb. Value
E-64 Pulse Filter Time Constant #29	C-03 Jump Speed To [RPM]	P-35 Main Reactance (Xh)	H-70 Warning Current Low	AN-16 Terminal 53 Filter Time Constant
E-65 Term. 33 Low Frequency	C-04 Jump Frequency To [Hz]	P-36 Iron Loss Resistance (Rfe)	H-71 Warning Current High	AN-17 Terminal 53 Live Zero
E-66 Term. 33 High Frequency	C-05 Multi-step Frequency 1 - 8	**H-## High Perf Parameters**	H-72 Warning Speed Low	**AN-2# Analog Input 54**
E-67 Term. 33 Low Ref./Feedb. Value	**C-2# Jog Setup**	**H-0# High Perf Operations**	H-73 Warning Speed High	AN-20 Terminal 54 Low Voltage
E-68 Term. 33 High Ref./Feedb. Value	C-20 Jog Speed [Hz]	H-03 Restore Factory Settings	H-74 Warning Reference Low	AN-21 Terminal 54 High Voltage
E-69 Pulse Filter Time Constant #33	C-21 Jog Speed [RPM]	H-04 Auto-Reset (Times)	H-75 Warning Reference High	AN-22 Terminal 54 Low Current
E-7# Pulse Output	C-22 Jog Accel/Decel Time	H-05 Auto-Reset (Reset Interval)	H-76 Warning Feedback Low	AN-23 Terminal 54 High Current
E-70 Terminal 27 Pulse Output Variable	**C-3# Frequency Setting 2 and 3**	H-06 Fan Operation	H-77 Warning Feedback High	AN-24 Terminal 54 Low Ref./Feedb. Value
E-71 Pulse Output Max Freq #27	C-30 Frequency Command 2	H-08 Reverse Lock	H-78 Missing Motor Phase Function	AN-25 Terminal 54 High Ref./Feedb. Value
E-72 Terminal 29 Pulse Output Variable	C-34 Frequency Command 3	H-09 Start Mode	**H-8# Stop Adjustments**	AN-26 Terminal 54 Filter Time Constant
E-74 Pulse Output Max Freq #29	**C-4# Semi-Auto Jump Freq Set-up**	**H-3# Stop Speed**	H-80 Function at Stop	AN-27 Terminal 54 Live Zero
E-75 Terminal X30/6 Pulse Output Variable	C-40 Semi-Auto Jump Freq Set-up	H-36 Trip Speed Low [RPM]	H-81 Min Speed for Function at Stop [RPM]	**AN-3# Analog Input X30/11**
E-76 Pulse Output Max Freq #X30/6	**P-## Motor Data**	H-37 Trip Speed Low [Hz]	H-82 Min Speed for Function at Stop [Hz]	AN-30 Terminal X30/11 Low Voltage
E-9# Bus Controlled	**P-0# Motor Data**	**H-4# Advanced Settings**	**AN-## Analog In/Out**	AN-31 Terminal X30/11 High Voltage
E-90 Digital & Relay Bus Control	P-02 Motor Power [HP]	H-40 Configuration Mode	**AN-0# Analog I/O Mode**	AN-34 Term. X30/11 Low Ref./Feedb. Value
E-93 Pulse Out #27 Bus Control	P-03 Motor Current	H-43 Torque Characteristics	AN-00 Live Zero Timeout Time	AN-35 Term. X30/11 High Ref./Feedb. Value
E-94 Pulse Out #27 Timeout Preset	P-04 Auto Tune	H-48 Clockwise Direction	AN-01 Live Zero Timeout Function	AN-36 Term. X30/11 Filter Time Constant
E-95 Pulse Out #29 Bus Control	P-06 Base Speed		AN-02 Fire Mode Live Zero Timeout Function	AN-37 Term. X30/11 Live Zero

Table 5.4

AN-4# Analog Input X30/12	SP-## Special Functions	SP-5# Environment	O-13 Configurable Status Word STW	O-8# Drive Port Diagnostics
AN-40 Terminal X30/12 Low Voltage	**SP-1# Line On/Off**	SP-50 RFI Filter	**O-3# Drive Port Settings**	O-80 Bus Message Count
AN-41 Terminal X30/12 High Voltage	SP-10 Line failure	SP-51 DC Link Compensation	O-30 Protocol	O-81 Bus Error Count
AN-44 Term. X30/12 Low Ref./Feedb. Value	SP-11 Line Voltage at Input Fault	SP-53 Fan Monitor	O-31 Address	O-82 Slave Messages Rcvd
AN-45 Term. X30/12 High Ref./Feedb. Value	SP-12 Function at Line Imbalance	SP-55 Output Filter	O-32 Drive Port Baud Rate	O-83 Slave Error Count
AN-46 Term. X30/12 Filter Time Constant	**SP-2# Reset Functions**	SP-59 Actual Number of Inverter Units	O-33 Drive Port Parity	O-89 Diagnostics Count
AN-47 Term. X30/12 Live Zero	SP-23 Typecode Setting	**SP-6# Automatic Derate**	O-34 Estimated cycle time	**O-9# Bus Jog / Feedback**
AN-5# Analog Output 42	SP-25 Trip Delay at Torque Limit	SP-60 Function at Over Temperature	O-35 Minimum Response Delay	O-90 Bus Jog 1 Speed
AN-50 Terminal 42 Output	SP-26 Trip Delay at Drive Fault	SP-61 Function at Drive Overload	O-36 Maximum Response Delay	O-91 Bus Jog 2 Speed
AN-51 Terminal 42 Output Min Scale	SP-28 Production Settings	SP-62 Drive Overload Derate Current	O-37 Maximum Inter-Char Delay	O-94 Bus Feedback 1
AN-52 Terminal 42 Output Max Scale	SP-29 Service Code	**O-## Options / Comms**	**O-4# Drive MC protocol set**	O-95 Bus Feedback 2
AN-53 Terminal 42 Output Bus Control	**SP-3# Current Limit Ctrl.**	**O-0#General Settings**	O-40 Telegram Selection	O-96 Bus Feedback 3
AN-54 Terminal 42 Output Timeout Preset	SP-30 Current Lim Ctrl, Proportional Gain	O-01 Control Site	O-42 PCD write configuration	**AO-## Analog I/O Option**
AN-6# Analog Output X30/8	SP-31 Current Lim Ctrl, Integration Time	O-02 Control Word Source	O-43 PCD read configuration	**AO-0# Analog I/O Mode**
AN-60 Terminal X30/8 Output	SP-32 Current Lim Ctrl, Filter Time	O-03 Control Word Timeout Time	**O-5# Digital/Bus**	AO-00 Terminal X42/1 Mode
AN-61 Terminal X30/8 Min. Scale	**SP-4# Energy Savings**	O-04 Control Word Timeout Function	O-50 Coasting Select	AO-01 Terminal X42/3 Mode
AN-62 Terminal X30/8 Max. Scale	SP-40 VT Level	O-05 End-of-Timeout Function	O-52 DC Brake Select	AO-02 Terminal X42/5 Mode
AN-63 Terminal X30/8 Output Bus Control	SP-41 Energy Savings Min. Magnetization	O-06 Reset Control Word Timeout	O-53 Start Select	**AO-1# Analog Input X42/1**
AN-64 Terminal X30/8 Output Timeout Preset	SP-42 Energy Savings Min. Frequency	O-07 Diagnosis Trigger	O-54 Reversing Select	AO-10 Terminal X42/1 Low Voltage
	SP-43 Motor Cosphi	**O-1# Control Settings**	O-55 Set-up Select	AO-11 Terminal X42/1 High Voltage
		O-10 Control Word Profile	O-56 Preset Reference Select	AO-14 Term. X42/1 Low Ref./Feedb. Value

Table 5.5

AO-15 Term. X42/1 High Ref./Feedb. Value	**AO-6# Analog Out X42/11**	PB-94 Changed Parameters (5)	EN-33 CIP Revision	BN-73 MS/TP Max Info Frames
AO-16 Term. X42/1 Filter Time Constant	AO-60 Terminal X42/11 Output	**EN-## Ethernet**	EN-34 CIP Product Code	BN-74 "I-Am" Service
AO-17 Term. X42/1 Live Zero	AO-61 Terminal X42/11 Min. Scale	**EN-0# IP Settings**	**EN-8# Other Ethernet Services**	BN-75 Initialization Password
AO-2# Analog Input X42/3	AO-62 Terminal X42/11 Max. Scale	EN-00 IP Address Assignment	EN-80 FTP Server	**DN-## DeviceNet Fieldbus**
AO-21 Terminal X42/3 High Voltage	AO-63 Terminal X42/11 Bus Control	EN-01 IP Address	EN-81 HTTP Server	**DN-0# Common Settings**
AO-21 Terminal X42/3 High Voltage	AO-64 Terminal X42/11 Timeout Preset	EN-02 Subnet Mask	EN-82 SMTP Service	DN-00 DeviceNet Protocol
AO-24 Term. X42/3 Low Ref./Feedb. Value	**PB-## Profibus**	EN-03 Default Gateway	EN-89 Transparent Socket Channel Port	DN-01 Baud Rate Select
AO-25 Term. X42/3 High Ref./Feedb. Value	PB-15 PCD Write Configuration	EN-04 DHCP Server	**EN-9# Advanced Ethernet Services**	DN-02 MAC ID
AO-26 Term. X42/3 Filter Time Constant	PB-16 PCD Read Configuration	EN-05 Lease Expires	EN-90 Cable Diagnostic	DN-05 Readout Transmit Error Counter
AO-27 Term. X42/3 Live Zero	PB-18 Node Address	EN-06 Name Servers	EN-91 MDI-X	DN-06 Readout Receive Error Counter
AO-3# Analog Input X42/5	PB-22 Telegram Selection	EN-07 Domain Name	EN-92 IGMP Snooping	DN-07 Readout Bus Off Counter
AO-30 Terminal X42/5 Low Voltage	PB-23 Parameters for Signals	EN-08 Host Name	EN-93 Cable Error Length	**DN-1# DeviceNet**
AO-31 Terminal X42/5 High Voltage	PB-27 Parameter Edit	EN-09 Physical Address	EN-94 Broadcast Storm Protection	DN-10 Process Data Type Selection
AO-34 Term. X42/5 Low Ref./Feedb. Value	PB-28 Process Control	**EN-1# Ethernet Link Parameters**	EN-95 Broadcast Storm Filter	DN-11 Process Data Config Write
AO-35 Term. X42/5 High Ref./Feedb. Value	PB-53 Profibus Warning Word	EN-10 Link Status	EN-98 Interface Counters	DN-12 Process Data Config Read
AO-36 Term. X42/5 Filter Time Constant	PB-63 Actual Baud Rate	EN-11 Link Duration	EN-99 Media Counters	DN-13 Warning Parameter
AO-37 Term. X42/5 Live Zero	PB-70 Edit Set-up	EN-12 Auto Negotiation	**LN-## LONWORKS**	DN-14 Net Reference
AO-4# Analog Out X42/7	PB-71 Profibus Save Data Values	EN-13 Link Speed	**LN-0# LonWorks ID**	DN-15 Net Control
AO-40 Terminal X42/7 Output	PB-72 ProfibusDriveReset	EN-14 Link Duplex	LN-00 Neuron ID	**DN-2# COS Filters**
AO-41 Terminal X42/7 Min. Scale	PB-75 DO Identification	**EN-2# Process Data**	**LN-1# LON Functions**	DN-20 COS Filter 1
AO-42 Terminal X42/7 Max. Scale	PB-80 Defined Parameters (1)	EN-20 Control Instance	LN-10 Drive Profile	DN-21 COS Filter 2
AO-43 Terminal X42/7 Bus Control	PB-81 Defined Parameters (2)	EN-21 Process Data Config Write	LN-15 LON Warning Word	DN-22 COS Filter 3
AO-44 Terminal X42/7 Timeout Preset	PB-82 Defined Parameters (3)	EN-22 Process Data Config Read	LN-17 XIF Revision	DN-23 COS Filter 4
AO-5# Analog Out X42/9	PB-83 Defined Parameters (4)	EN-28 Store Data Values	LN-18 LonWorks Revision	**DN-3# Parameter Access**
AO-50 Terminal X42/9 Output	PB-84 Defined Parameters (5)	EN-29 Store Always	**LN-2# LON Param. Access**	DN-30 Array Index
AO-51 Terminal X42/9 Min. Scale	PB-90 Changed Parameters (1)	**EN-3# EtherNet/IP**	LN-21 Store Data Values	DN-31 Store Data Values
AO-52 Terminal X42/9 Max. Scale	PB-91 Changed Parameters (2)	EN-30 Warning Parameter	**BN-## BACnet**	DN-32 Devicenet Revision
AO-53 Terminal X42/9 Bus Control	PB-92 Changed Parameters (3)	EN-31 Net Reference	BN-70 BACnet Device Instance	DN-33 Store Always
AO-54 Terminal X42/9 Timeout Preset	PB-93 Changed Parameters (4)	EN-32 Net Control	BN-72 MS/TP Max Masters	DN-34 DeviceNet Product Code

Table 5.6

ID-## Drive Information	ID-42 Voltage	DR-12 Motor Voltage	**DR-6# Inputs & Outputs**	DR-95 Ext. Status Word 2
ID-0# Operating Data	ID-43 Software Version	DR-13 Frequency	DR-60 Digital Input	DR-96 Maintenance Word
ID-00 Operating Hours	ID-44 GE Model Number	DR-14 Motor Current	DR-61 Terminal 53 Switch Setting	**LG-## Logs & I/O Opt Status**
ID-01 Running Hours	ID-45 Actual Typecode String	DR-15 Frequency [%]	DR-62 Analog Input 53	**LG-0# Maintenance Log**
ID-02 kWh Counter	ID-46 GE Product No.	DR-16 Torque [Nm]	DR-63 Terminal 54 Switch Setting	LG-00 Maintenance Log: Item
ID-03 Power Up's	ID-47 GE Power Card Model No	DR-17 Speed [RPM]	DR-64 Analog Input 54	LG-01 Maintenance Log: Action
ID-04 Over Temp's	ID-48 Keypad ID Number	DR-18 Motor Thermal	DR-65 Analog Output 42 [mA]	LG-02 Maintenance Log: Time
ID-05 Over Volt's	ID-49 SW ID Control Card	DR-22 Torque [%]	DR-66 Digital Output [bin]	LG-03 Maintenance Log: Date and Time
ID-06 Reset kWh Counter	ID-50 SW ID Power Card	**DR-3# Drive Status**	DR-67 Freq. Input #29 [Hz]	**LG-1# Fire Mode Log**
ID-07 Reset Running Hours Counter	ID-51 Drive Serial Number	DR-30 DC Link Voltage	DR-68 Freq. Input #33 [Hz]	LG-10 Fire Mode Log: Event
ID-08 Number of Starts	ID-53 Power Card Serial Number	DR-32 Brake Energy /s	DR-69 Pulse Output #27 [Hz]	LG-11 Fire Mode Log: Time
ID-1# Data Trending Settings	**ID-6# Option Ident**	DR-33 Brake Energy /2 min	DR-70 Pulse Output #29 [Hz]	LG-12 Fire Mode Log: Date and Time
ID-10 Trending Source	ID-60 Option Mounted	DR-34 Heatsink Temp.	DR-71 Relay Output [bin]	**LG-3# I/O Option Status**
ID-11 Trending Interval	ID-61 Option SW Version	DR-35 Drive Thermal	DR-72 Counter A	LG-30 Analog Input X42/1
ID-12 Trigger Event	ID-62 Option Ordering No	DR-36 Drive Nominal Current	DR-73 Counter B	LG-31 Analog Input X42/3
ID-13 Trending Mode	ID-63 Option Serial No	DR-37 Drive Max. Current	DR-75 Analog In X30/11	LG-32 Analog Input X42/5
ID-14 Samples Before Trigger	**ID-9# Parameter Info**	DR-38 Logic Controller State	DR-76 Analog In X30/12	LG-33 Analog Out X42/7 [V]
ID-2# Historic Log	ID-92 Defined Parameters	DR-39 Control Card Temp.	DR-77 Analog Out X30/8 [mA]	LG-34 Analog Out X42/9 [V]
ID-20 Historic Log: Event	ID-93 Modified Parameters	DR-40 Trending Buffer Full	**DR-8# Fieldbus & Drive Port**	LG-35 Analog Out X42/11 [V]
ID-21 Historic Log: Value	**DR-## Data Readouts**	DR-43 Timed Actions Status	DR-80 Fieldbus CTW 1	**AP-## HVAC Appl. Param.**
ID-22 Historic Log: Time	**DR-0# General Status**	DR-49 Current Fault Source	DR-82 Fieldbus REF 1	**AP-0# Miscellaneous**
ID-23 Historic Log: Date and Time	DR-00 Control Word	**DR-5# Ref. & Feedb.**	DR-84 Comm. Option STW	AP-00 External Interlock Delay
ID-3# Alarm Log	DR-01 Reference [Unit]	DR-50 External Reference	DR-85 Drive Port CTW 1	**AP-2# No-Flow Detection**
ID-30 Alarm Log: Error Code	DR-02 Reference [%]	DR-52 Feedback [Unit]	DR-86 Drive Port REF 1	AP-20 Low Power Auto Set-up
ID-31 Alarm Log: Value	DR-03 Status Word	DR-53 Digi Pot Reference	**DR-9# Diagnosis Readouts**	AP-21 Low Power Detection
ID-32 Alarm Log: Time	DR-05 Main Actual Value [%]	DR-54 Feedback 1 [Unit]	DR-90 Alarm Word	AP-22 Low Speed Detection
ID-33 Alarm Log: Date and Time	DR-09 Custom Readout	DR-55 Feedback 2 [Unit]	DR-91 Alarm Word 2	AP-23 No-Flow Function
ID-4# Drive Identification	**DR-1# Motor Status**	DR-56 Feedback 3 [Unit]	DR-92 Warning Word	AP-24 No-Flow Delay
ID-40 Drive Type	DR-10 Power [kW]	DR-58 PID Output [%]	DR-93 Warning Word 2	AP-26 Dry Pump Function
ID-41 Power Section	DR-11 Power [hp]		DR-94 Ext. Status Word	AP-27 Dry Pump Delay

Table 5.7

AP-3# No-Flow Power Tuning	AP-71 Compressor Start Max Speed [Hz]	FB-09 Fire Mode Alarm Handling	T-14 Maintenance Date and Time	CL-03 Feedback 2 Source
AP-30 No-Flow Power	AP-72 Compressor Start Max Time to Trip	**FB-1# Drive Bypass**	T-15 Reset Maintenance Word	CL-04 Feedback 2 Conversion
AP-31 Power Correction Factor	AP-73 Starting Acceleration Time	FB-10 Drive Bypass Function	T-16 Maintenance Text	CL-05 Feedback 2 Source Unit
AP-32 Low Speed [RPM]	AP-75 Short Cycle Protection	FB-11 Drive Bypass Delay Time	**T-5# Energy Log**	CL-06 Feedback 3 Source
AP-33 Low Speed [Hz]	AP-76 Interval between Starts	FB-20 Locked Rotor Function	T-50 Energy Log Resolution	CL-07 Feedback 3 Conversion
AP-34 Low Speed Power [kW]	AP-77 Minimum Run Time	FB-21 Locked Rotor Coefficient 1	T-51 Period Start	CL-08 Feedback 3 Source Unit
AP-35 Low Speed Power [HP]	**AP-8# Flow Compensation**	FB-22 Locked Rotor Coefficient 2	T-53 Energy Log	CL-12 Reference/Feedback Unit
AP-36 High Speed [RPM]	AP-80 Flow Compensation	FB-23 Locked Rotor Coefficient 3	T-54 Reset Energy Log	CL-13 Minimum Reference/Feedb.
AP-37 High Speed [Hz]	AP-81 Square-linear Curve Approximation	FB-24 Locked Rotor Coefficient 4	**T-6# Trending**	CL-14 Maximum Reference/Feedb.
AP-38 High Speed Power [kW]	AP-82 Work Point Calculation	FB-30 Missing Motor Function	T-60 Trend Variable	CL-20 Feedback Function
AP-39 High Speed Power [HP]	AP-83 Speed at No-Flow [RPM]	FB-31 Missing Motor Coefficient 1	T-61 Continuous Bin Data	CL-21 Setpoint 1
AP-4# Sleep Mode	AP-84 Speed at No-Flow [Hz]	FB-32 Missing Motor Coefficient 2	T-62 Timed Bin Data	CL-22 Setpoint 2
AP-40 Minimum Run Time	AP-85 Speed at Design Point [RPM]	FB-33 Missing Motor Coefficient 3	T-63 Timed Period Start	CL-23 Setpoint 3
AP-41 Minimum Sleep Time	AP-86 Speed at Design Point [Hz]	FB-34 Missing Motor Coefficient 4	T-64 Timed Period Stop	**CL-3# Feedback Adv. Conv**
AP-42 Wake-up Speed [RPM]	AP-87 Pressure at No-Flow Speed	**T-## Timed Functions**	T-65 Minimum Bin Value	CL-30 Refrigerant
AP-43 Wake-up Speed [Hz]	AP-88 Pressure at Rated Speed	**T-0# Timed Actions**	T-66 Reset Continuous Bin Data	CL-31 User Defined Refrigerant A1
AP-44 Wake-up Ref./FB Difference	AP-89 Flow at Design Point	T-00 ON Time	T-67 Reset Timed Bin Data	CL-32 User Defined Refrigerant A2
AP-45 Setpoint Boost	AP-90 Flow at Rated Speed	T-01 ON Action	**T-8# Payback Counter**	CL-33 User Defined Refrigerant A3
AP-46 Maximum Boost Time	**FB-## Fire/Bypass Operation**	T-02 OFF Time	T-80 Power Reference Factor	CL-34 Duct 1 Area [m2]
AP-5# End of Curve	**FB-0# Fire Mode**	T-03 OFF Action	T-81 Energy Cost	CL-35 Duct 1 Area [in2]
AP-50 End of Curve Function	FB-00 Fire Mode Function	T-04 Occurrence	T-82 Investment	CL-36 Duct 2 Area [m2]
AP-51 End of Curve Delay	FB-01 Fire Mode Configuration	T-08 Timed Actions Mode	T-83 Energy Savings	CL-37 Duct 2 Area [in2]
AP-6# Broken Belt Detection	FB-02 Fire Mode Unit	T-09 Timed Actions Reactivation	T-84 Cost Savings	CL-38 Air Density Factor [%]
AP-60 Broken Belt Function	FB-03 Fire Mode Min Reference	**T-1# Maintenance**	**CL-## PID Closed Loop**	**CL-7# PID Autotuning**
AP-61 Broken Belt Torque	FB-04 Fire Mode Max Reference	T-10 Maintenance Item	**CL-0# Feedback**	CL-70 Closed Loop Type
AP-62 Broken Belt Delay	FB-05 Fire Mode Preset Reference	T-11 Maintenance Action	CL-00 Feedback 1 Source	CL-71 PID Performance
AP-7# Compressor	FB-06 Fire Mode Reference Source	T-12 Maintenance Time Base	CL-01 Feedback 1 Conversion	CL-72 PID Output Change
AP-70 Compressor Start Max Speed [RPM]	FB-07 Fire Mode Feedback Source	T-13 Maintenance Time Interval	CL-02 Feedback 1 Source Unit	CL-73 Minimum Feedback Level

Table 5.8

CL-74 Maximum Feedback Level	XC-22 Ext. 1 Integral Time	XC-64 Ext. 3 Dif. Gain Limit	PC-52 Alternation Time Interval	LC-43 Logic Rule Operator 2
CL-79 PID Autotuning	XC-23 Ext. 1 Differentation Time	**PC-## Pump Controller**	PC-53 Alternation Timer Value	LC-44 Logic Rule Boolean 3
CL-8# PID Basic Settings	XC-24 Ext. 1 Dif. Gain Limit	**PC-0# System Settings**	PC-54 Alternation Predefined Time	**LC-5# States**
CL-81 PID Normal/ Inverse Control	**XC-3# Ext. CL 2 Ref./Fb.**	PC-00 Pump Controller	PC-55 Alternate if Load < 50%	LC-51 Logic Controller Event
CL-82 PID Start Speed [RPM]	XC-30 Ext. 2 Ref./Feedback Unit	PC-02 Motor Start	PC-56 Staging Mode at Alternation	LC-52 Logic Controller Action
CL-83 PID Start Speed [Hz]	XC-31 Ext. 2 Minimum Reference	PC-04 Pump Cycling	PC-58 Run Next Pump Delay	**B-## Braking Functions**
CL-84 On Reference Bandwidth	XC-32 Ext. 2 Maximum Reference	PC-05 Fixed Lead Pump	PC-59 Run on Line Delay	**B-0# DC-Brake**
CL-9# PID Controller	XC-33 Ext. 2 Reference Source	PC-06 Number of Pumps	**PC-8# Status**	B-00 DC Hold Current
CL-91 PID Anti Windup	XC-34 Ext. 2 Feedback Source	PC-10 Minimum Run Time Override	PC-80 Pump Status	B-01 DC Brake Current
CL-93 PID Proportional Gain	XC-35 Ext. 2 Setpoint	PC-11 Minimum Run Time Override Value	PC-81 Pump Status	B-02 DC Braking Time
CL-94 PID Integral Time	XC-37 Ext. 2 Reference [Unit]	**PC-2# Bandwidth Settings**	PC-82 Lead Pump	B-03 DC Brake Cut In Speed [RPM]
CL-95 PID Differentiation Time	XC-38 Ext. 2 Feedback [Unit]	PC-20 Staging Bandwidth	PC-83 Relay Status	B-04 DC Brake Cut In Speed [Hz]
CL-96 PID Diff. Gain Limit	XC-39 Ext. 2 Output [%]	PC-21 Override Bandwidth	PC-84 Pump ON Time	**B-1# Brake Energy Funct.**
XC-## Ext. PID Closed Loop	**XC-4# Ext. CL 2 PID**	PC-22 Fixed Speed Bandwidth	PC-85 Relay ON Time	B-10 Brake Function
XC-0# Ext. CL Autotuning	XC-40 Ext. 2 Normal/Inverse Control	PC-23 SBW Staging Delay	PC-86 Reset Relay Counters	B-16 AC brake Max. Current
XC-00 Closed Loop Type	XC-41 Ext. 2 Proportional Gain	PC-24 SBW Destaging Delay	**PC-9# Service**	B-17 Over-voltage Control
XC-01 PID Performance	XC-42 Ext. 2 Integral Time	PC-25 OBW Time	PC-90 Pump Interlock	
XC-02 PID Output Change	XC-43 Ext. 2 Differentation Time	PC-26 Destage At No-Flow	PC-91 Manual Alternation	
XC-03 Minimum Feedback Level	XC-44 Ext. 2 Dif. Gain Limit	PC-27 Stage Function	**LC-## Logic Controller**	
XC-04 Maximum Feedback Level	**XC-5# Ext. CL 3 Ref./Fb.**	PC-28 Stage Function Time	**LC-0# LC Settings**	
XC-09 PID Autotuning	XC-50 Ext. 3 Ref./Feedback Unit	PC-29 Destage Function	LC-00 Logic Controller Mode	
XC-1# Ext. CL 1 Ref./Fb.	XC-51 Ext. 3 Minimum Reference	PC-30 Destage Function Time	LC-01 Start Event	
XC-10 Ext. 1 Ref./Feedback Unit	XC-52 Ext. 3 Maximum Reference	**PC-4# Staging Settings**	LC-02 Stop Event	
XC-11 Ext. 1 Minimum Reference	XC-53 Ext. 3 Reference Source	PC-40 Decel Ramp Delay	LC-03 Reset Logic Controller	
XC-12 Ext. 1 Maximum Reference	XC-54 Ext. 3 Feedback Source	PC-41 Accel Ramp Delay	**LC-1# Comparators**	
XC-13 Ext. 1 Reference Source	XC-55 Ext. 3 Setpoint	PC-42 Staging Threshold	LC-10 Comparator Operand	
XC-14 Ext. 1 Feedback Source	XC-57 Ext. 3 Reference [Unit]	PC-43 Destaging Threshold	LC-11 Comparator Operator	
XC-15 Ext. 1 Setpoint	XC-58 Ext. 3 Feedback [Unit]	PC-44 Staging Speed [RPM]	LC-12 Comparator Value	
XC-17 Ext. 1 Reference [Unit]	XC-59 Ext. 3 Output [%]	PC-45 Staging Speed [Hz]	**LC-2# Timers**	
XC-18 Ext. 1 Feedback [Unit]	**XC-6# Ext. CL 3 PID**	PC-46 Destaging Speed [RPM]	LC-20 Logic Controller Timer	
XC-19 Ext. 1 Output [%]	XC-60 Ext. 3 Normal/Inverse Control	PC-47 Destaging Speed [Hz]	**LC-4# Logic Rules**	
XC-2# Ext. CL 1 PID	XC-61 Ext. 3 Proportional Gain	**PC-5# Alternation Settings**	LC-40 Logic Rule Boolean 1	
XC-20 Ext. 1 Normal/Inverse Control	XC-62 Ext. 3 Integral Time	PC-50 Lead Pump Alternation	LC-41 Logic Rule Operator 1	
XC-21 Ext. 1 Proportional Gain	XC-63 Ext. 3 Differentation Time	PC-51 Alternation Event	LC-42 Logic Rule Boolean 2	

Table 5.9

5.6 Remote Programming with DCT-10

GE has a software program available for developing, storing, and transferring frequency converterprogramming. 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 are available for connecting to the frequency converter.

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

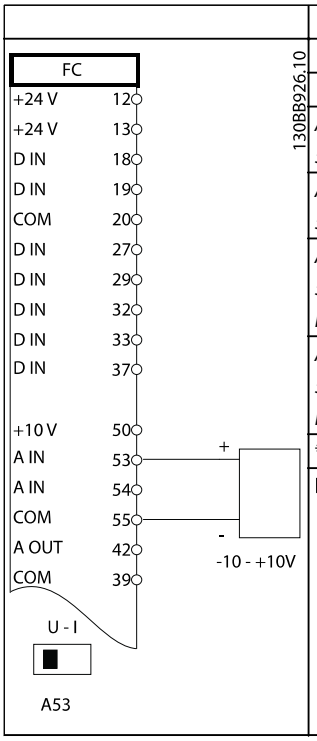
6 Application Set-Up Examples

6.1 Introduction

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

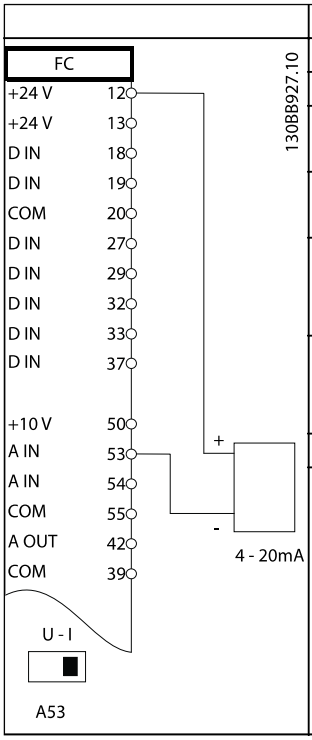
- Parameter settings are the regional default values unless otherwise indicated (selected in *K-03 Regional Settings*)
- Parameters associated with the terminals and their settings are shown next to the drawings
- Where switch settings for analog terminals A53 or A54 are required, these are also shown

6.2 Application Examples



	Parameters	
	Function	**Setting**
	AN-10 Terminal 53 Low Voltage	0.07V*
	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 6.1 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)

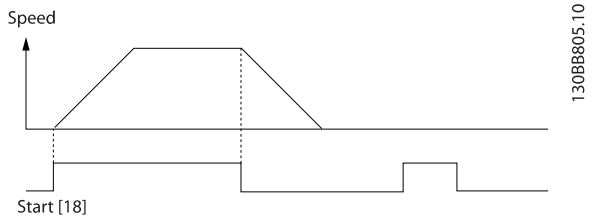
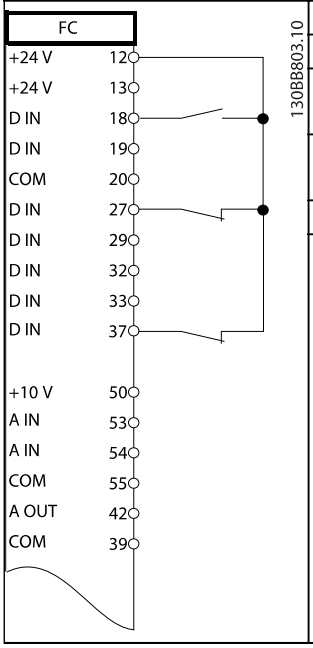


Illustration 6.1



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

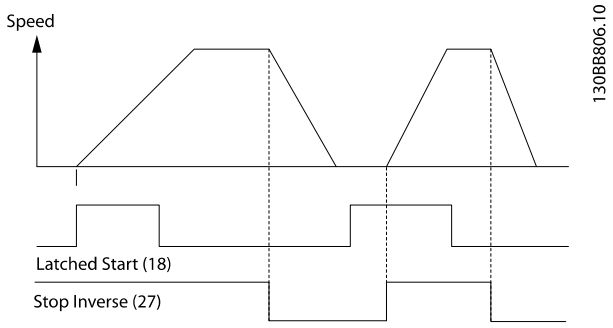
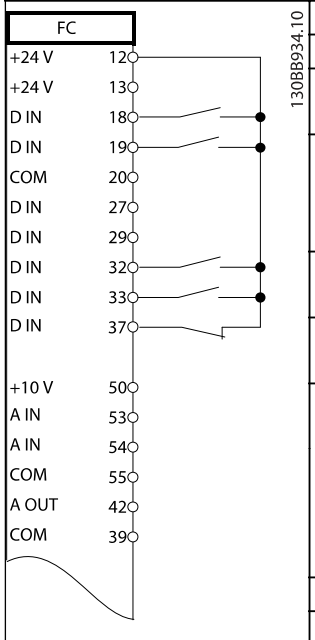
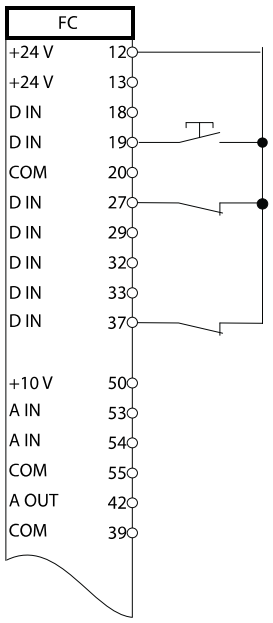


Illustration 6.2



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:	

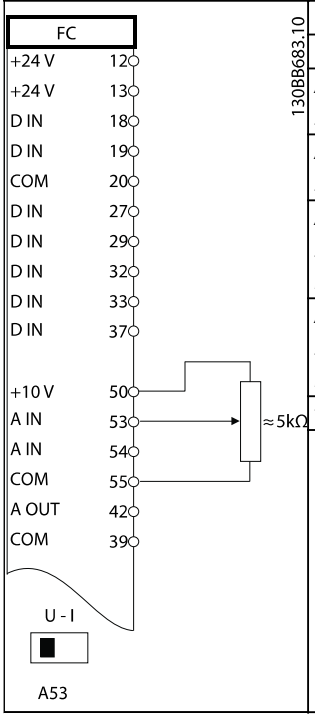
Table 6.4 Start/Stop with Reversing and 4 Preset Speeds



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

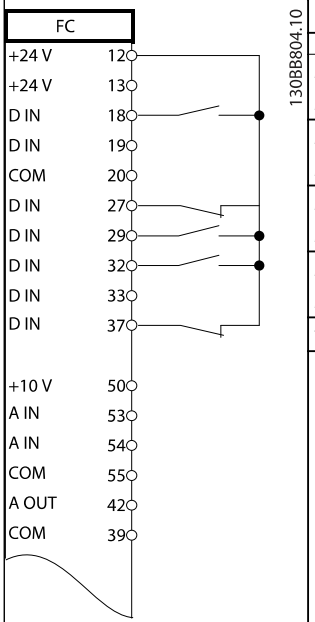
Table 6.5 External Alarm Reset

6



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

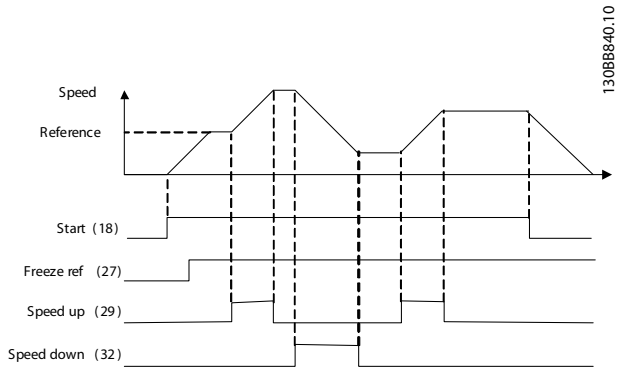
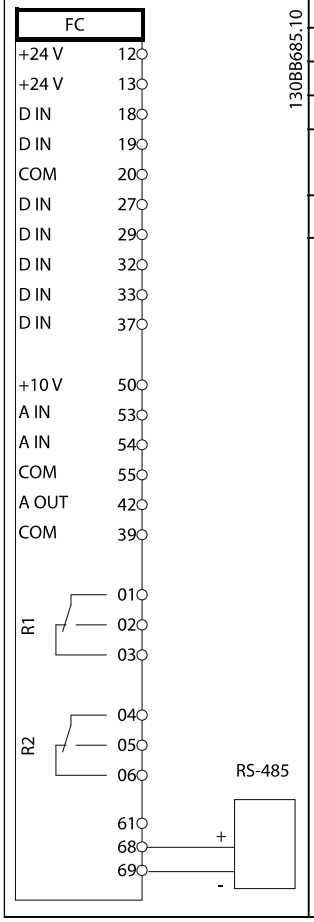


Illustration 6.3

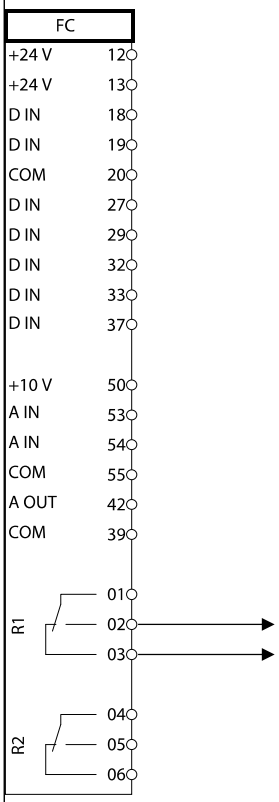


Parameters	
Function	**Setting**
O-30 Protocol	Modbus*
O-31 Address	1*
O-32 Drive Port Baud Rate	9600*
* = Default Value	
Notes/comments: Select protocol, address and baud rate in the above mentioned parameters.	

Table 6.8 RS-485 Network Connection

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.		

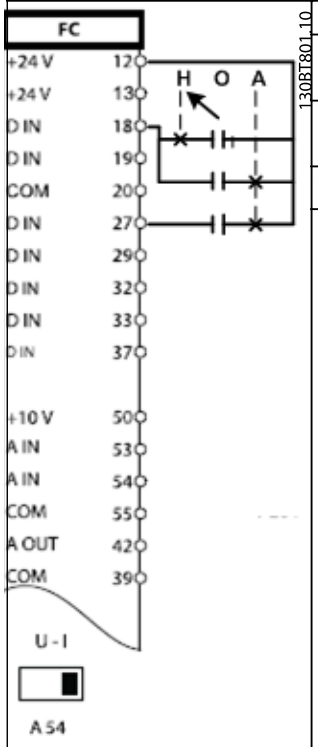
Table 6.9 Using Logic Controller to Set a Relay

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

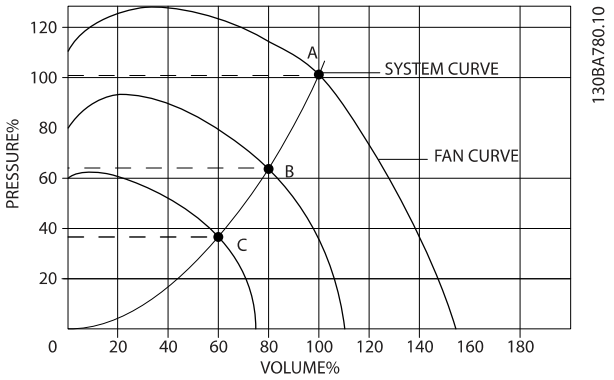


Illustration 6.4 The graph is showing fan curves (A, B and C) for reduced fan volumes.

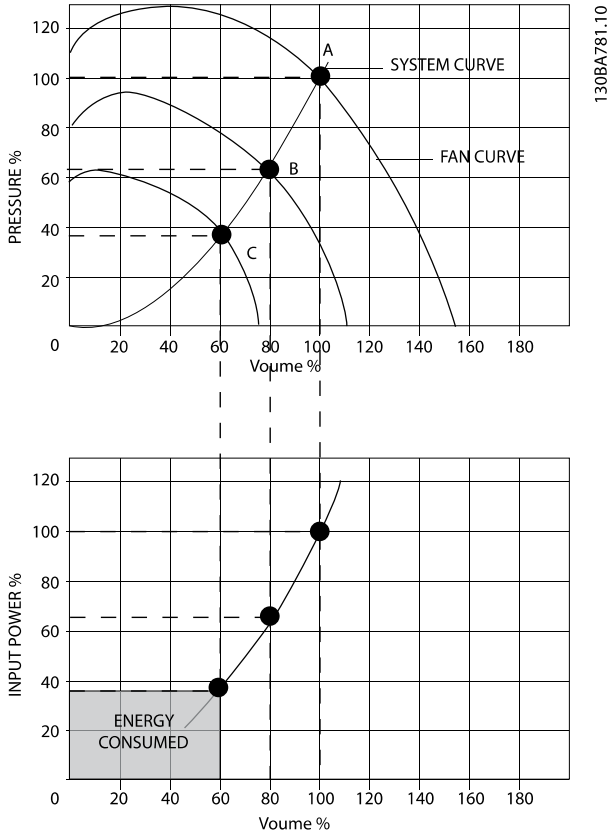


Illustration 6.5 When using a frequency converter to reduce fan capacity to 60% - more than 50% energy savings may be obtained in typical applications.

6.3 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.

6.3.3 Example of Energy Savings

As can be seen from the figure (the laws of proportionality), 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.

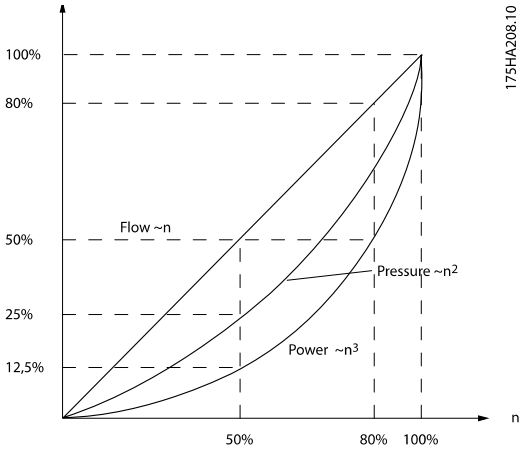


Illustration 6.6 The laws of proportionality

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

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

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

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.

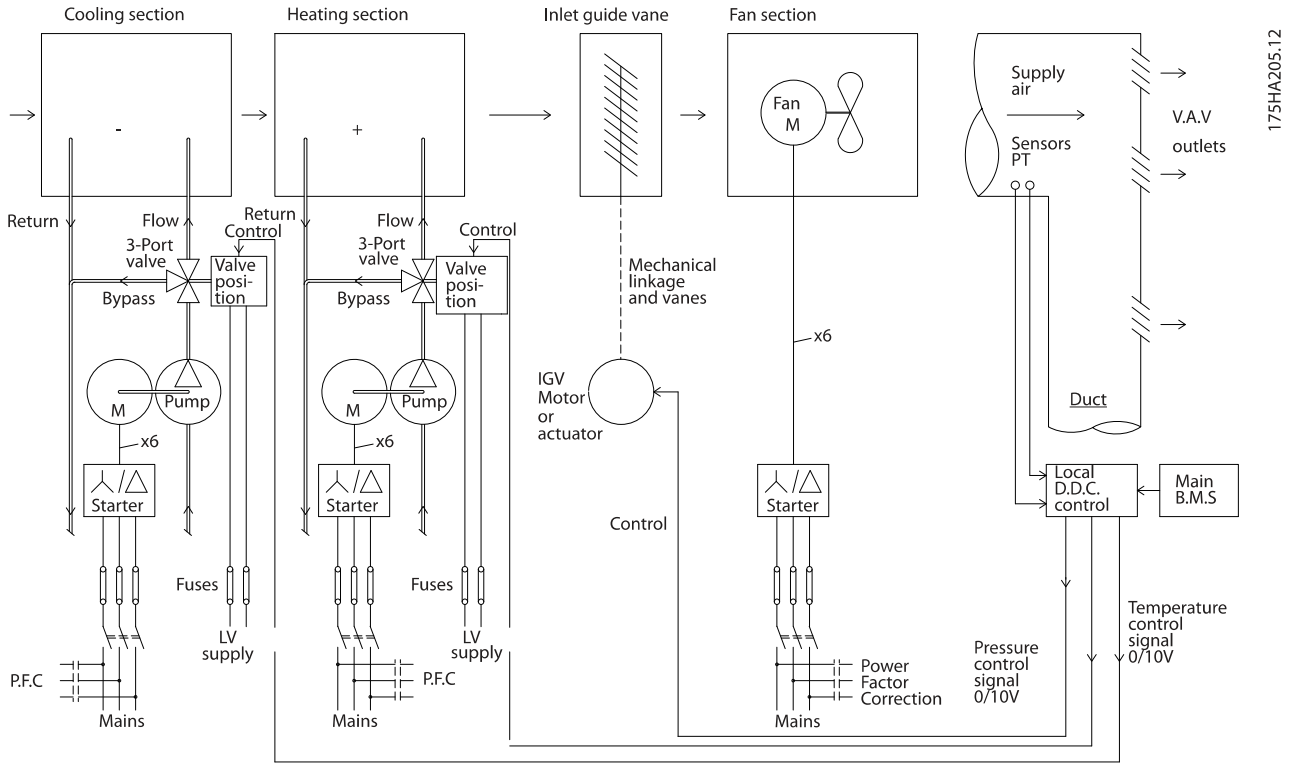


Illustration 6.7

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

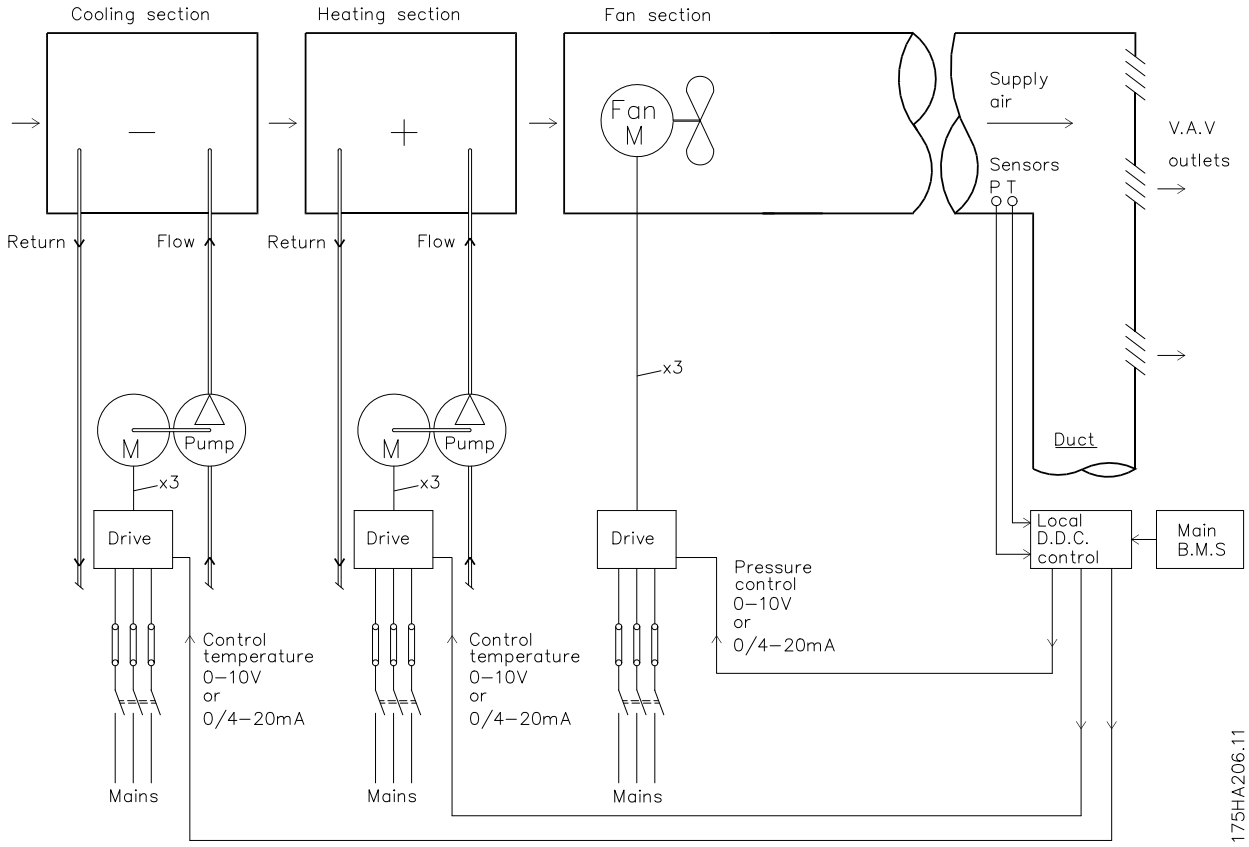


Illustration 6.8

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.

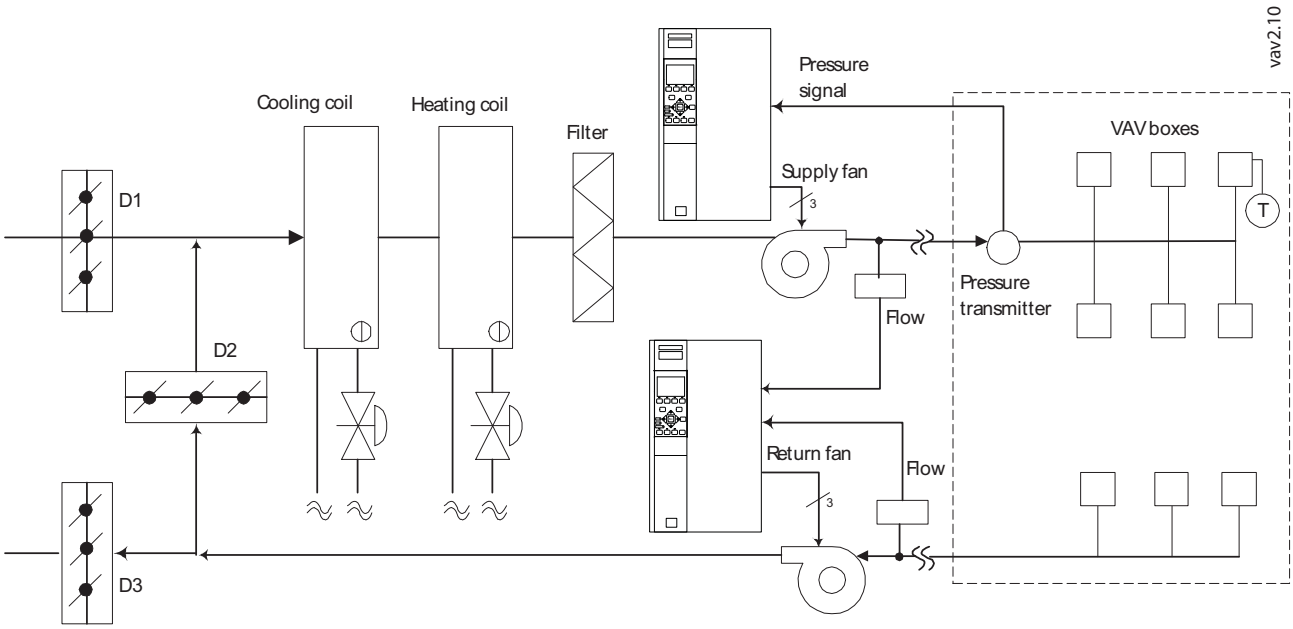


Illustration 6.9

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.

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.

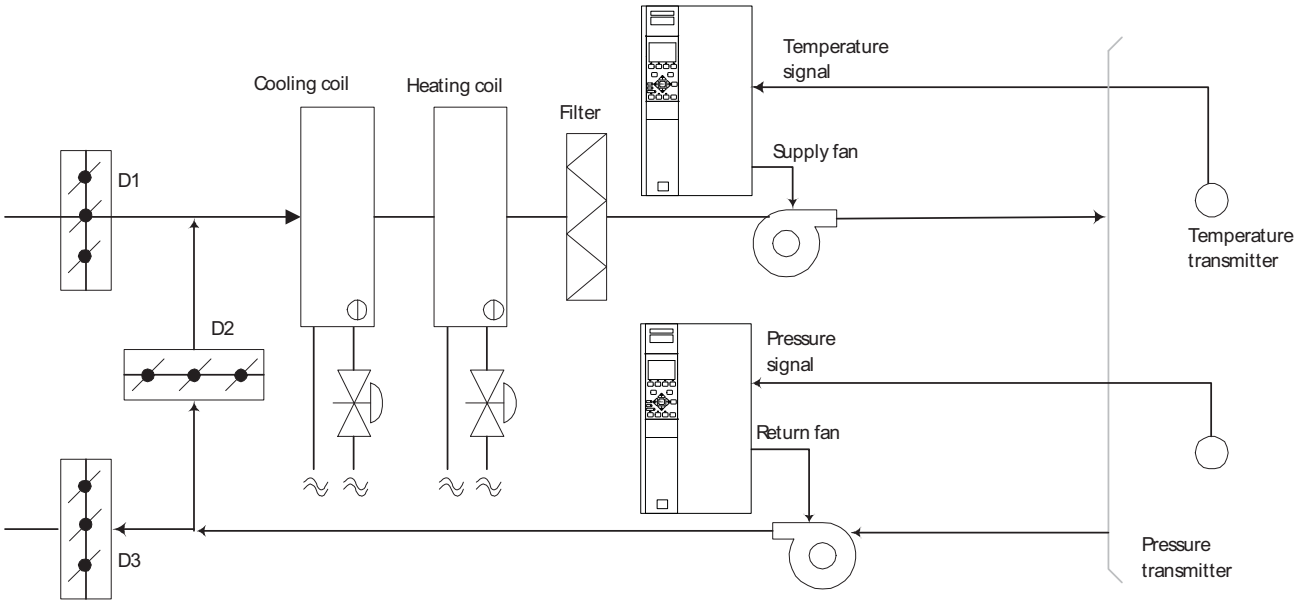


Illustration 6.10

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

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.

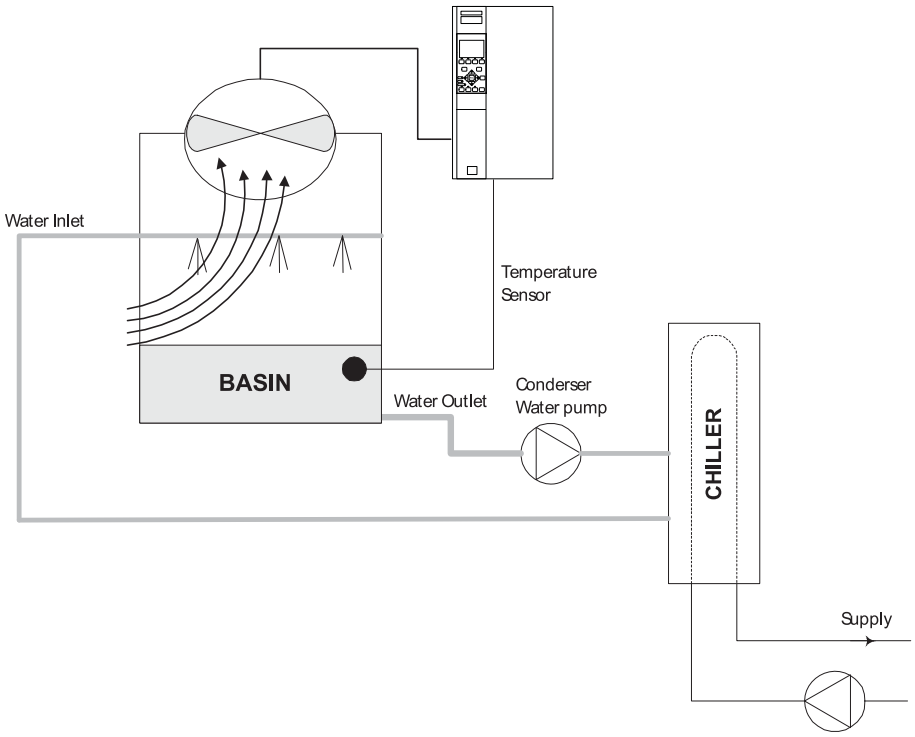


Illustration 6.11

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.

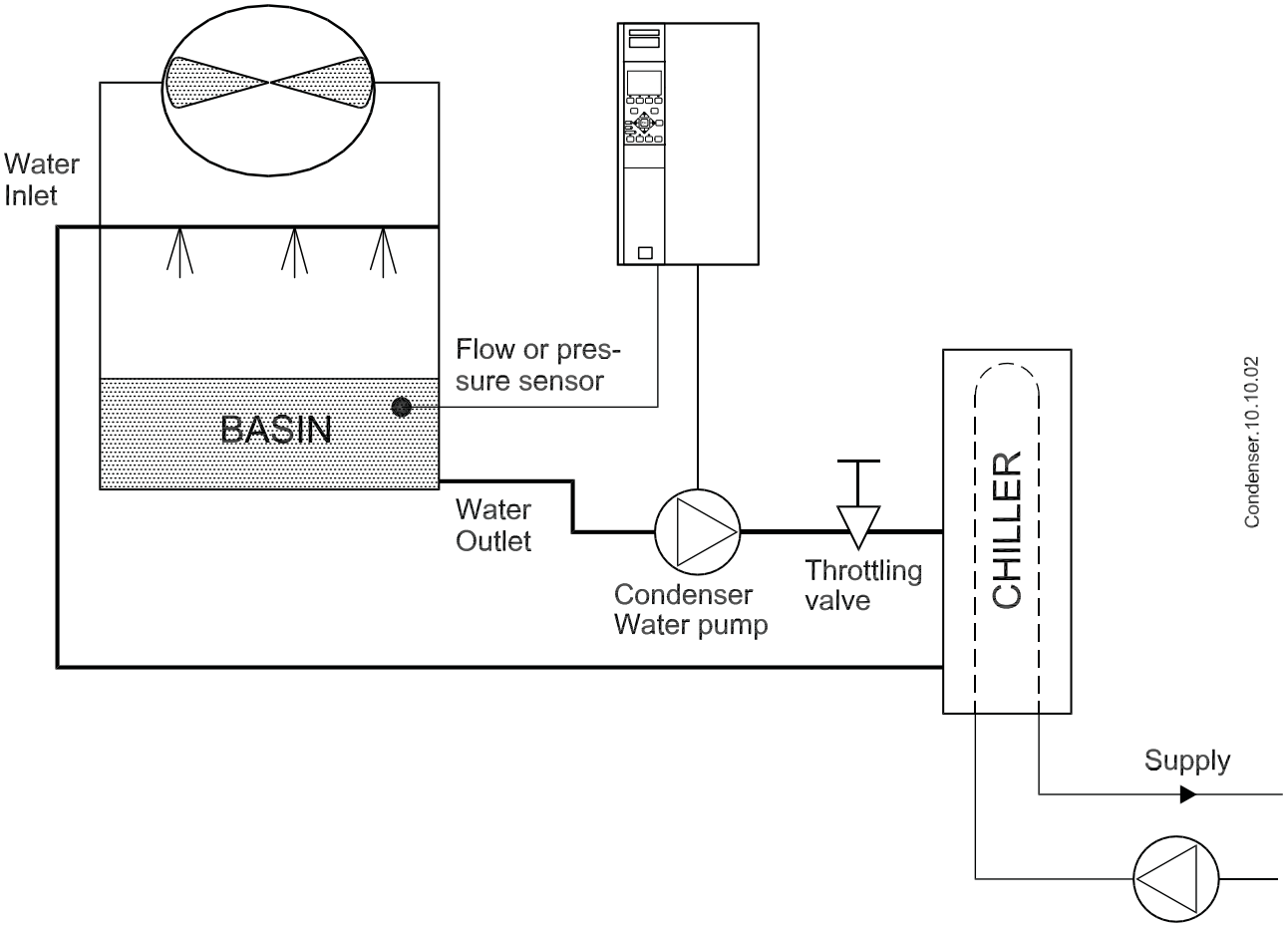


Illustration 6.12

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.

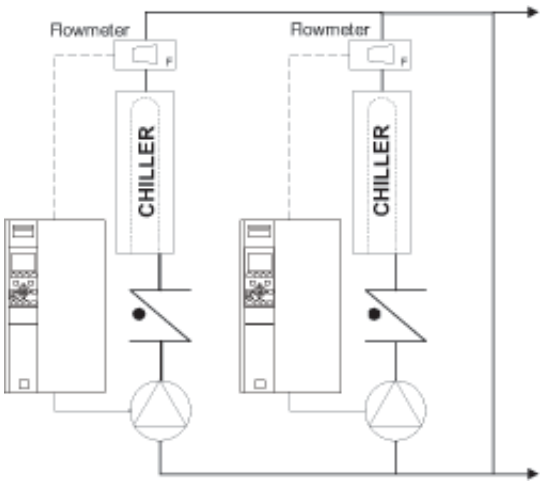


Illustration 6.13

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.

Please note that 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.

6

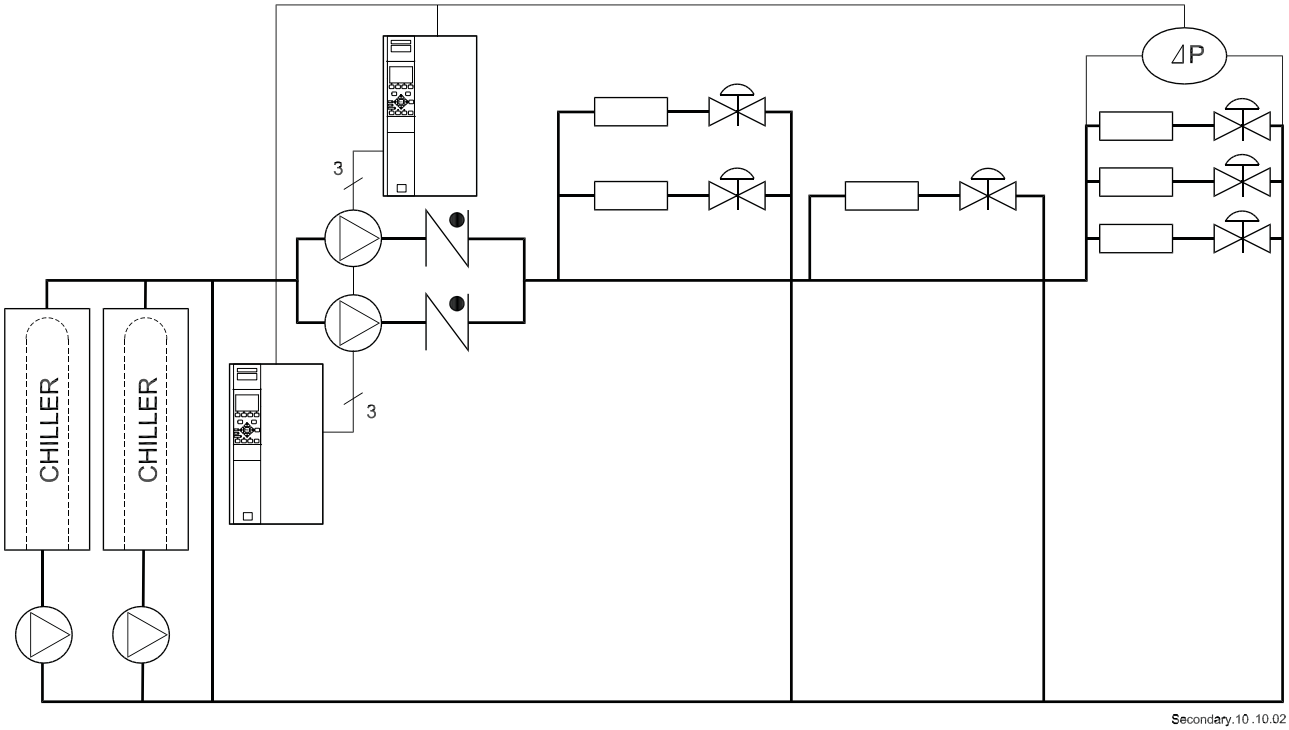


Illustration 6.14

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.
As shown in the illustration below, 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 in principle only be a small electro-magnetic field (I_4) from the screened motor cable according to the below figure.

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 on 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.

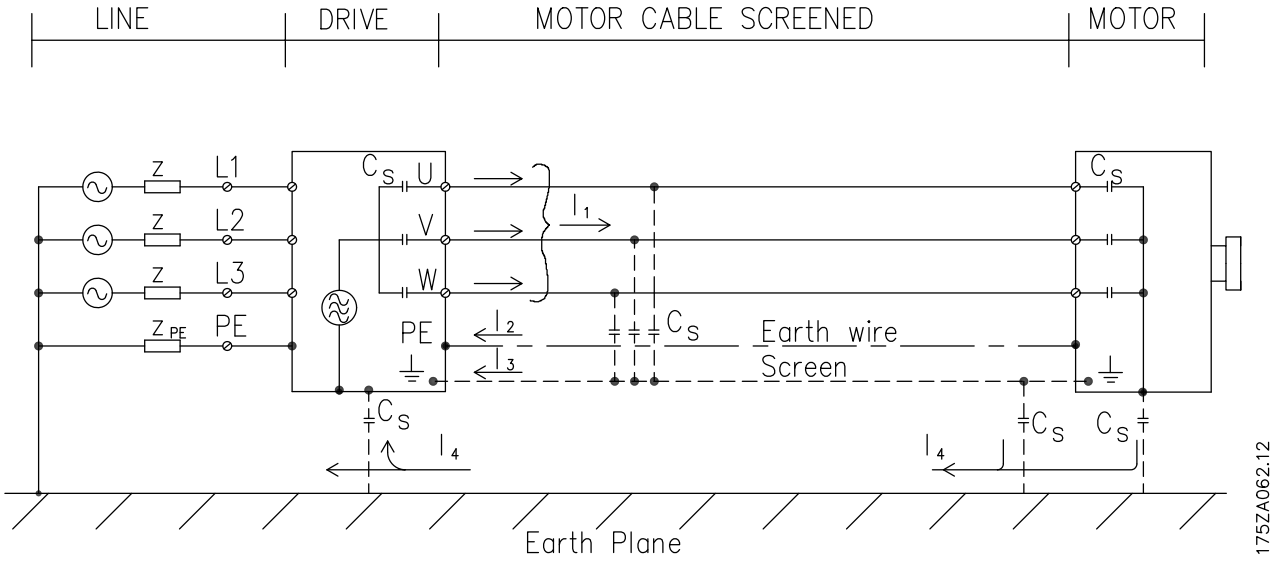


Illustration 7.1

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 the table below:

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 7.1

When the generic emission standards are used the frequency converters are required to comply with the following limits:

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 7.2

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
5.5-45 kW 200-240 V	25 m	No	No	No	No
0.75-7.5 kW 380-480 V	5 m	No	No	No	No
11-90 kW 380-480 V	25 m	No	No	No	No
110-1000 kW 380-480 V	150 m	No	No	No	No
110-1200 kW 525-690 V	150 m	No	No	No	No
No RFI Filter installed					
0.75-90 kW 525-600 V	-	-	-	-	-

Table 7.3 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 7.4*.

7

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 7.4 EMC Immunity Form

7.2.1 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.
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7

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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

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.

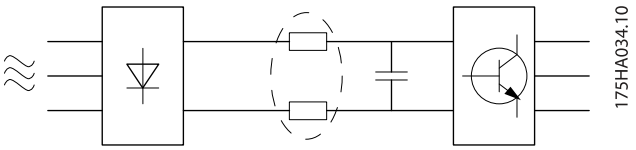


Illustration 7.2

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

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

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.

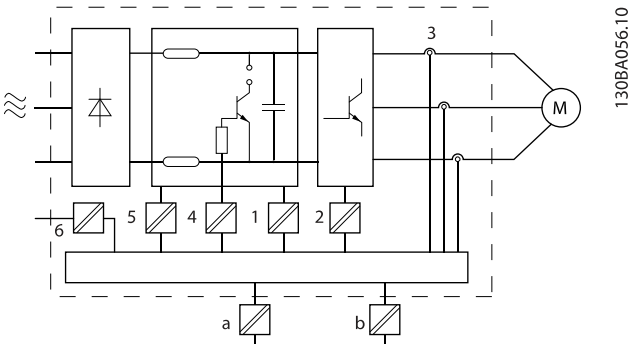


Illustration 7.3 Galvanic isolation

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.

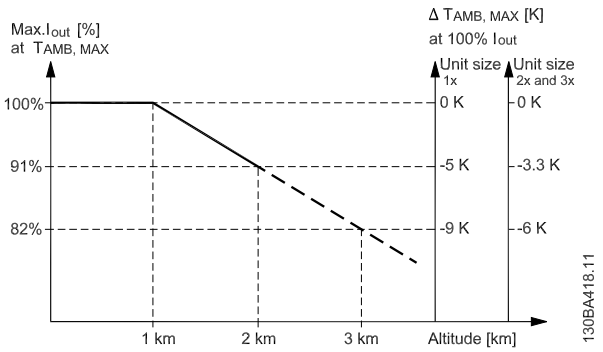


Illustration 7.4 Derating of output current versus altitude at $T_{AMB, MAX}$ for unit sizes 1x, 2x and 3x. At altitudes above 2 km, please contact GE regarding PELV.

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.

Derating of output current versus altitude at $T_{AMB, MAX}$ for unit sizes 4x, 5x and 6x.

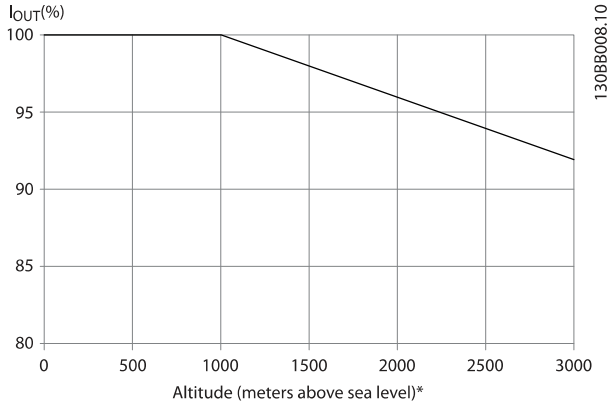


Illustration 7.5

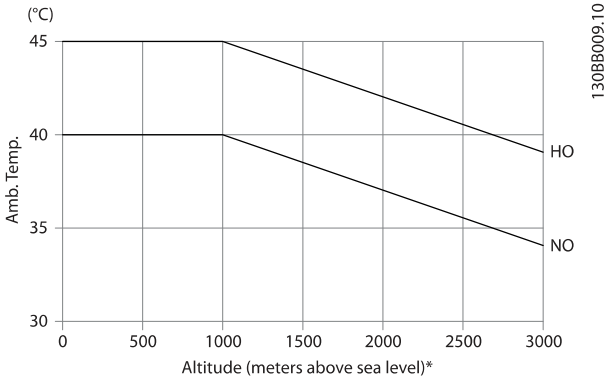


Illustration 7.6

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.

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.

7

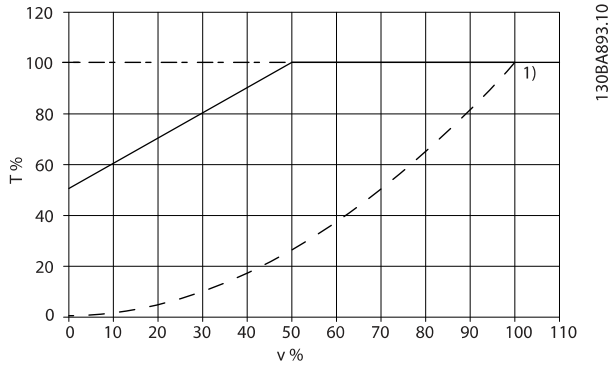


Illustration 7.7 Maximum load for a standard motor at 40 °C driven by an AF-600 FP drive

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

Table 7.8

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 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

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

8 Status Messages

8.1 Status Display

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

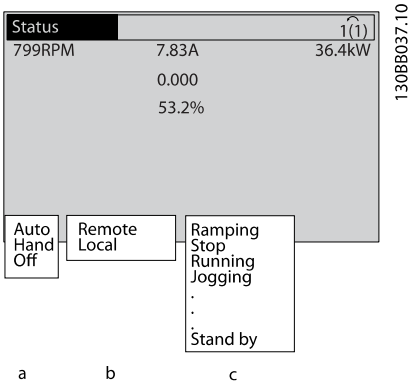


Illustration 8.1 Status Display

a. The first part of the status line indicates where the stop/start command originates.

b. The second part of the status line indicates where the speed control originates.

c. The last part of the status line gives the present frequency converter status. These show the operational mode the frequency converter is in.

NOTE

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

8.2 Status Message Definitions Table

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

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

Table 8.1

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

Table 8.2

	Operation Status
AC Brake	AC Brake was selected in *B-10 Brake Function*. The AC brake over-magnetizes the motor to achieve a controlled slow down.
Auto Tune finish OK	Automatic motor adaptationAuto 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

	Operation Status
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 feedback is above the feedback limit set in *H-77 Warning Feedback High*.
Feedback low	The sum of all active feedback 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 until a run permissive signal is received, the motor remains stopped.
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 until a run permissive signal is received via a digital input, the motor is stopped

	Operation Status
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 (for example, 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 (for example, No signal). The monitoring function is active.
OVC control	*Overvoltage* control was activated in *B-17 Overvoltage Control*. The connected motor is supplying the frequency converter with generative energy. The overvoltage control adjusts the V/Hz ratio to run the motor in controlled mode and to prevent the frequency converter from tripping.
PowerUnit Off	(For frequency converters with an external 24 V power supply installed only.) 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.

	Operation Status
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 frequency converter runs the motor.
Sleep Mode	The energy saving function is enabled. The motor has stopped, but 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 On Auto mode, the frequency converter starts 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 starts 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 8.3

9 Warnings and Alarms

9.1 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.

9.2 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.

9

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

Trip-lock
An alarm that causes the frequency converter to trip-lock requires that input power is cycled. The motor will coast to a stop. The frequency converter logic 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.

9.3 Warning and Alarm Displays

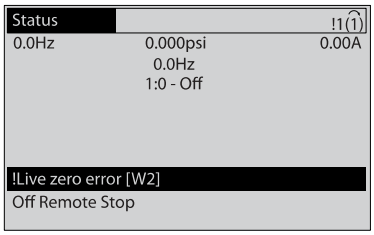


Illustration 9.1

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

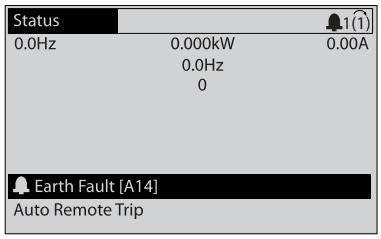


Illustration 9.2

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

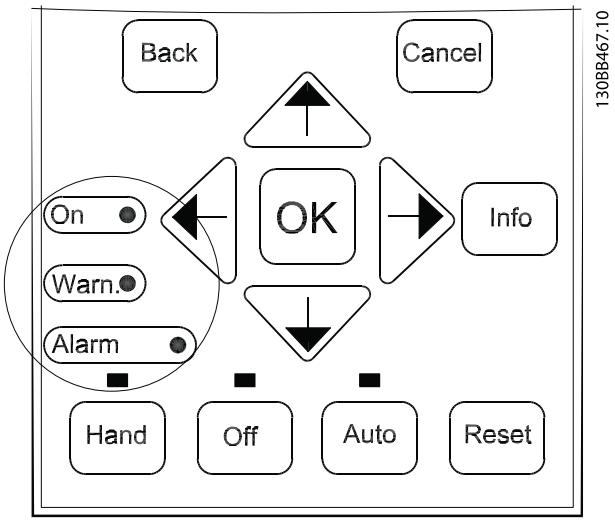


Illustration 9.3

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

Table 9.1

9.4 Warning and Alarm Definitions

Table 9.2 defines whether a warning is issued before an alarm, and whether the alarm trips the unit or trip locks the unit.

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
1	10 Volts low	X			
2	Live zero error	(X)	(X)		*AN-01 Live Zero Timeout Function*
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 overload	(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 (Ground) fault	X	X	X	
15	Hardware mismatch		X	X	
16	Short Circuit		X	X	
17	Control word timeout	(X)	(X)		*O-04 Control Word Timeout Function*
18	Start Failed				
23	Internal Fan Fault	X			
24	External Fan Fault	X			*SP-53 Fan Monitor*
29	Drive over temperature	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	Fieldbus communication fault	X	X		
35	Option Fault	X	X		
36	Mains failure	X	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	Overload of Digital Output On X30/6	(X)			*E-56 Term X30/6 Digi Out (OPCGPIO)*

No.	Description	Warning	Alarm/Trip	Alarm/Trip Lock	Parameter Reference
42	Overload of Digital Output On X30/7	(X)			*E-57 Term X30/7 Digi Out (OPCGPIO)*
45	45 Earth (Ground) Fault 2				
46	Pwr. card supply		X	X	
47	24V supply low	X	X	X	
48	1.8V supply low		X	X	
49	Speed limit	X	(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 timeout		X		
58	Auto tune internal fault	X	X		
59	Current limit	X			
60	External Interlock	X			
62	Output Frequency at Maximum Limit	X			
64	Voltage Limit	X			
65	Control Board Over-temperature	X	X	X	
66	Heat sink Temperature Low	X			
67	Option Configuration has Changed		X		
69	Pwr. Card Temp		X	X	
70	Illegal Drive configuration			X	
76	Power Unit Setup	X			
79	Illegal PS config		X	X	
80	Drive Initialized to Default Value		X		
91	Analog input 54 wrong settings			X	
92	NoFlow	X	X		AP-2#
93	Dry Pump	X	X		AP-2#
94	End of Curve	X	X		AP-5#
95	Broken Belt	X	X		AP-6#
96	Start Delayed	X			AP-7#
97	Stop Delayed	X			AP-7#
98	Clock Fault	X			K-7#
201	Fire M was Active				
202	Fire M Limits Exceeded				
203	Missing Motor				
204	Locked Rotor				
243	Brake IGBT	X	X		
244	Heatsink temp	X	X	X	
245	Heatsink sensor		X	X	
246	Pwr.card supply		X	X	
247	Pwr.card temp		X	X	
248	Illegal PS config		X	X	
250	New spare parts			X	
251	New Type Code		X	X	

Table 9.2 Alarm/Warning code list

(X) Dependent on parameter

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

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

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

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

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

WARNING/ALARM 2, Live zero error
This warning or alarm only appears if programmed by the user in *AN-01 Live Zero Timeout Function*. The signal on one of the analog inputs is less than 50% of the minimum value programmed for that input. 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

Connect a brake resistor

Extend the ramp time

Change the ramp type

Activate the functions in *B-10 Brake Function*

Increase *SP-26 Trip Delay at Drive Fault*

If the alarm/warning occurs during a power sag the solution is to 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 backup supply is connected. If no 24 V DC backup 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 from a warning only condition to a warning followed by an alarm.

Troubleshooting

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

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

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

Check the application for excessive current draw on the motor.

WARNING/ALARM 13, Over current
The inverter peak current limit (approximately 200% of the rated current) is exceeded. The warning lasts about 1.5 s, then the frequency converter trips and issues an alarm. This fault may be caused by shock loading or quick acceleration with high inertia loads. It may 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 will only be 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.

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 power supply to the unit.

ALARM 38, Internal fault
When an internal fault occurs, a code number defined in *Table 9.3* 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
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
1302	Option SW in slot C1 is too old
1315	Option SW in slot A is not supported (not allowed)
1316	Option SW in slot B is not supported (not allowed)
1318	Option SW in slot C1 is not supported (not allowed)
1379-2819	Internal fault. Contact your GE supplier or GE Service Department.
2820	Keypad stack overflow
2821	Serial port overflow

No.	Text
2822	USB port overflow
3072-5122	Parameter value is outside its limits
5123	Option in slot A: Hardware incompatible with control board hardware
5124	Option in slot B: Hardware incompatible with control board hardware
5125	Option in slot C0: Hardware incompatible with control board hardware
5126	Option in slot C1: Hardware incompatible with control board hardware
5376-6231	Internal fault. Contact your GE supplier or GE Service Department.

Table 9.3 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 backup 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 will trip.

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

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

ALARM 52, Auto tune low I_{nom}
The motor current is too low. Check the 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 will not run.

56 ALARM, 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, Auto tune internal fault
Contact your GE supplier.

WARNING 59, Current limit
The current is higher than the value in *F-43 Current Limit*. Ensure that Motor data in parameters P-02, P-03, P-06, P-07, F-04 and F-05 are set correctly. Possibly increase the current limit. Be sure 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 cutout temperature of the control card is 80 °C.

Troubleshooting

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

WARNING 66, Heatsink temperature low
The 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 frequency converterdrive configuration
The control card and power card are incompatible. Contact your supplier with the model number of the unit from the nameplate and the part numbers of the cards to check compatibility.

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

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.

10 Basic Troubleshooting

10.1 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 terminal 12/13 to 20-39 or 10 V supply for terminal 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		See *3.5 Check Motor Rotation* in this manual.
Motor is not reaching maximum speed	Frequency limits set wrong	Check output limits in *F-17 Motor Speed High Limit [RPM]*, *F-15 Motor Speed High Limit [Hz]* and *F-03 Max Output Frequency 1*	Program correct limits.
	Reference input signal not scaled correctly	Check reference input signal scaling in AN-## Reference limits in parameter group 3-0*.	Program correct settings.
Motor speed unstable	Possible incorrect parameter settings	Check the settings of all motor parameters, including all motor compensation settings. For closed loop operation, check PID settings.	Check settings in parameter group 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 4-6*.	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 14-0*.	
		Increase Resonance Dampening in *H-64 Resonance Dampening*.	

Table 10.1

11 Terminal and Applicable wire

11.1 Cables

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)	
	110-132kW 150-200HP		110-160kW 150-250HP	all	19 / 168	2x70 (2x2/0)	19 / 168	2x70 (2x2/0)	9.5 / 84 (19 / 168**) A	2x70 (2x2/0)	9.5 / 84 (8.5 / 75**)	2x70 (2x2/0)	19 / 168
	160-250kW 250-350HP		200-400kW 300-550HP	all		2x185 (2x350mcm)		2x185 (2x350mcm)		2x185 (2x350mcm)		2x185 (2x350mcm)	
	315-450kW 450-600HP		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

** Exception of unit sizes 41h, 42h, 43h, and 44h

Table 11.1

12 Specifications

12.1 Power-dependent Specifications

12.1.1 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	12	15	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	23	21	21
15	11	46.2	42	0.96			
20	15	59.4	54	0.96	24	22	22
25	18	74.8	68	0.96		31	31
30	22	88	80	0.96	33		
40	30	115	104	0.96			
50	37	143	130	0.96	34	32	32
60	45	170	154	0.96			

Table 12.1 200-240 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		12		15	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		12		15	15
7.5	5.5	13	11	11.7	0.97		13			
10	7.5	16	14.5	14.4	0.97					
15	11	24	21	22	0.98		23		21	21
20	15	32	27	29	0.98					
25	18	37.5	34	34	0.98					
30	22	44	40	40	0.98		24		22	22
40	30	61	52	55	0.98					
50	37	73	65	66	0.98				31	31
60	45	90	80	82	0.98		33			
75	55	106	105	96	0.98					
100	75	147	130	133	0.98		34		32	32
125	90	177	160	161	0.98					
150	110	212	190	204	0.98	43	43h	41h/41	41h/41	
200	132	260	240	251	0.98					
250	160	315	302	304	0.98	44	44h	41h/42	41h/42	
300	200	395	361	381	0.98			42h/42	42h/42	
350	250	480	443	463	0.98					

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	530	590	0.98	52		42h/51	42h/51	
500	355	658	590	647	0.98			51	51	
550	400	745	678	733	0.98					
600	450	800	730	787	0.98					
650	500	880	780	857	0.98			61/63	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			62/64	62/64	
1350	1000	1720	1530	1675	0.98					

Table 12.2 380-480 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	13	15	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	23	21	21
20	15	23	22	22	0.98			
25	18	28	27	27	0.98			
30	22	36	34	34	0.98	24	22	22
40	30	43	41	41	0.98			
50	37	54	52	52	0.98			
60	45	65	62	62	0.98	33	31	31
75	55	87	83	83	0.98			
100	75	105	100	100	0.98	34	32	32
125	90	137	131	131	0.98			

Table 12.3 525-600 V

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			22	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			32	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	43	43h	41h/41	41h/41
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	44	44h	42h/42	42h/42
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	52		51	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			61/63	61/63
1200	800	889	850	850	0.98				
1250	900	988	945	945	0.98				
1350	1000	1108	1060	1060	0.98			62/64	62/64
1600	1200	1317	1260	1260	0.98				
1900	1400	1479	1415	1415	0.98				

Table 12.4 525-690 V

12.1.2 Dimensions, Unit Size 1x

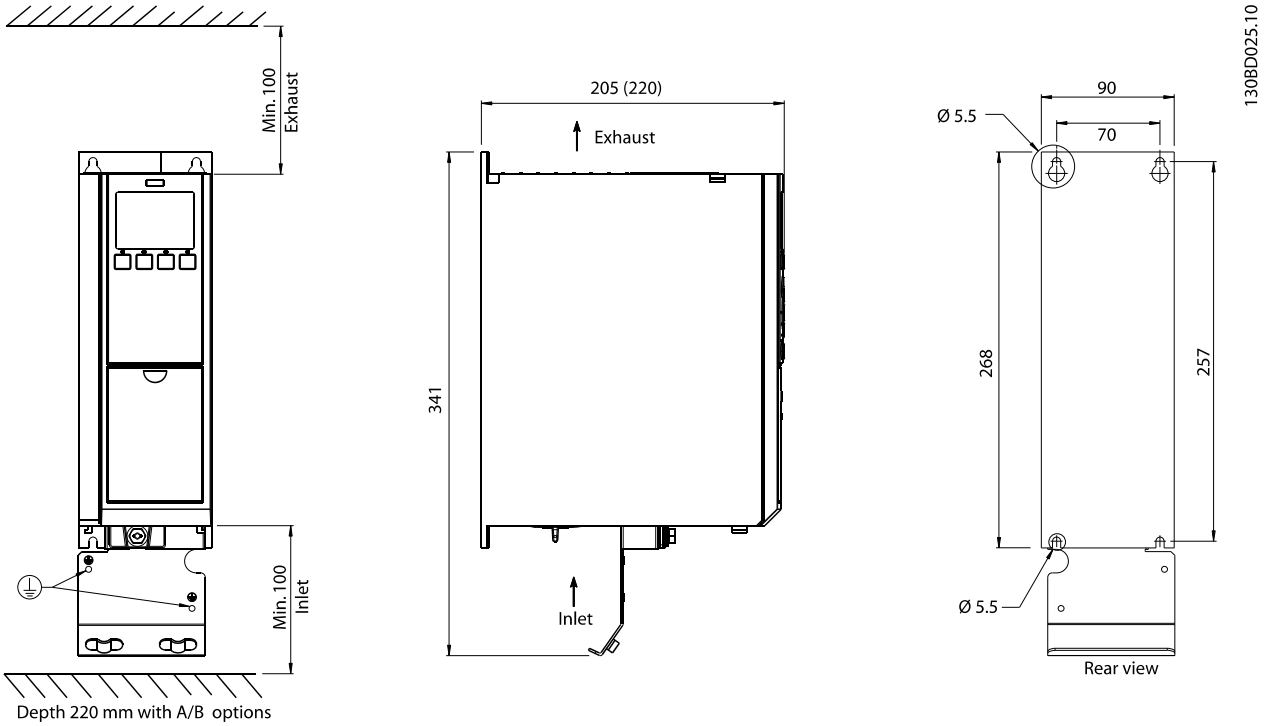


Illustration 12.1 Unit Size 12

12

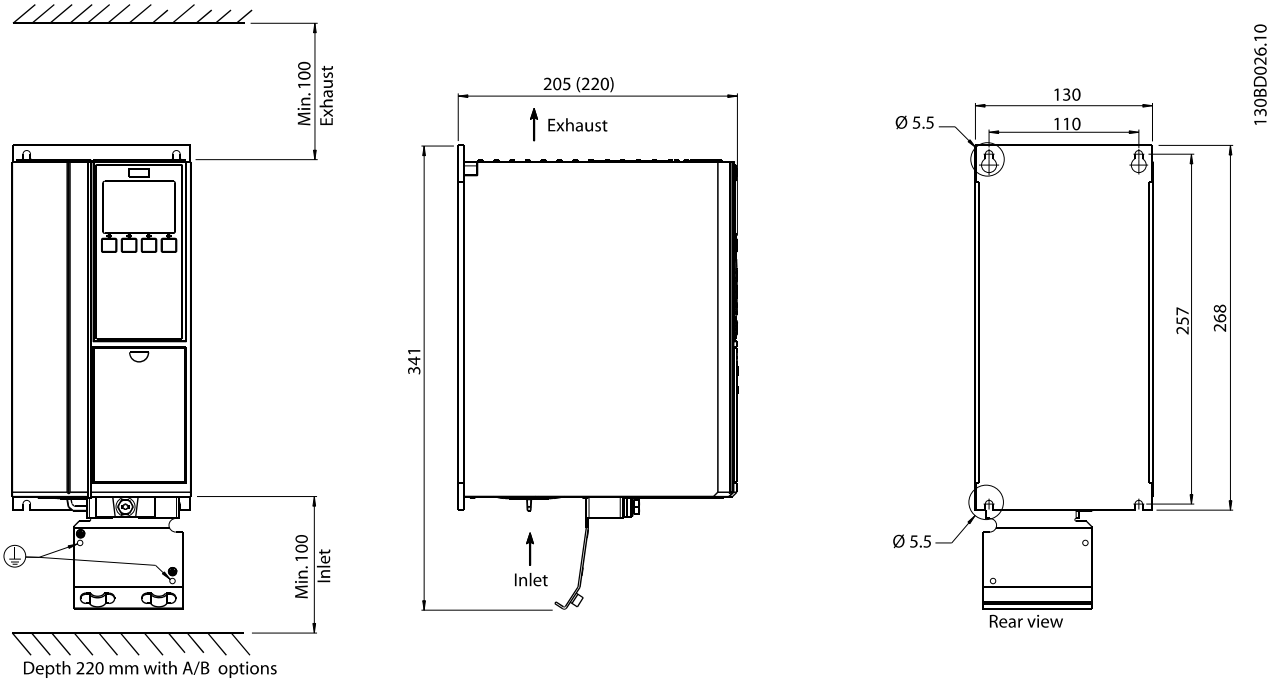


Illustration 12.2 Unit Size 13

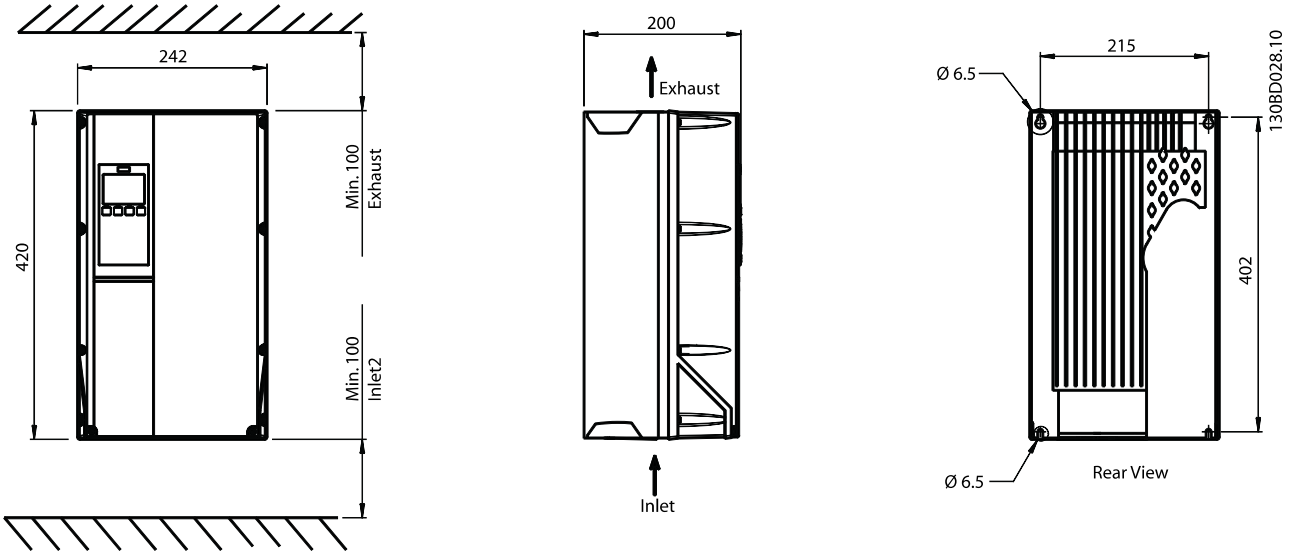


Illustration 12.3 Unit Size 15

12

12.1.3 Dimensions, Unit Size 2x

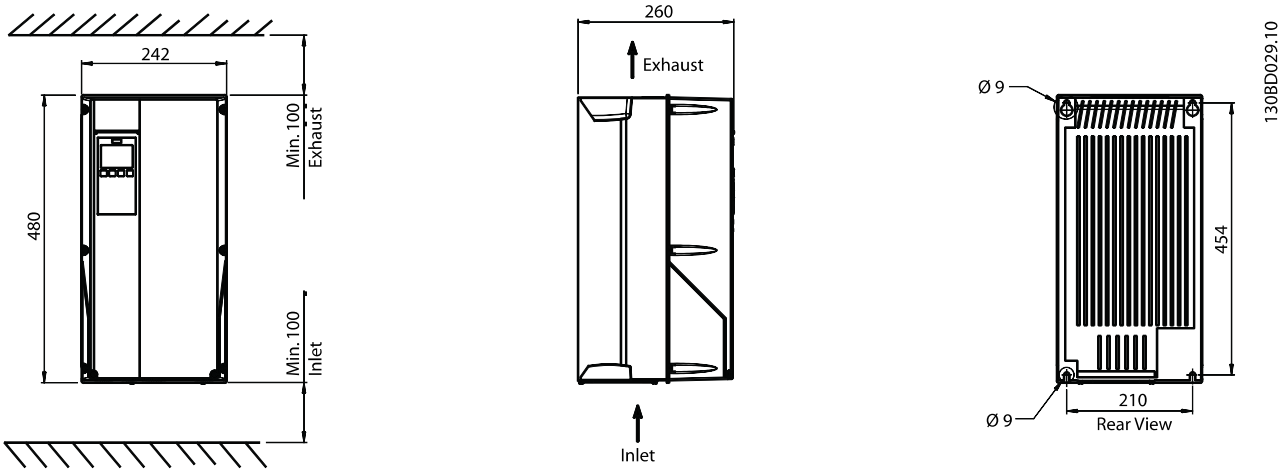


Illustration 12.4 Unit Size 21

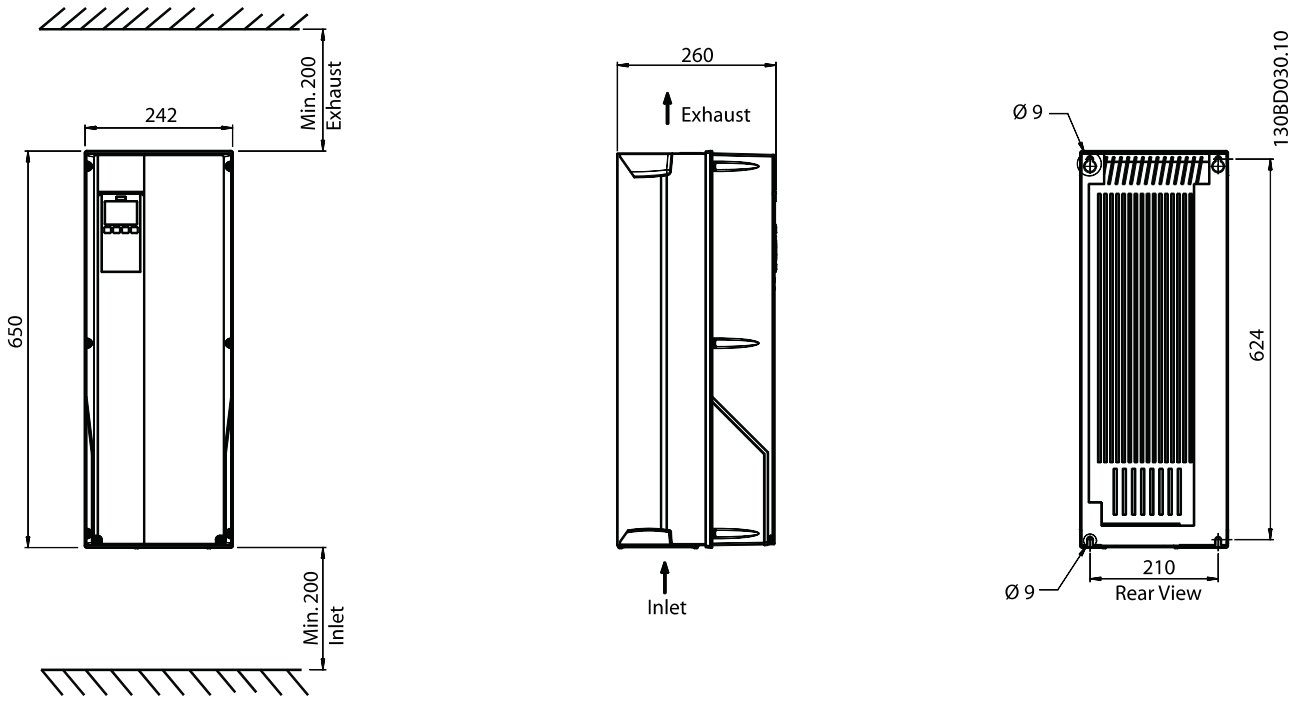


Illustration 12.5 Unit Size 22

12

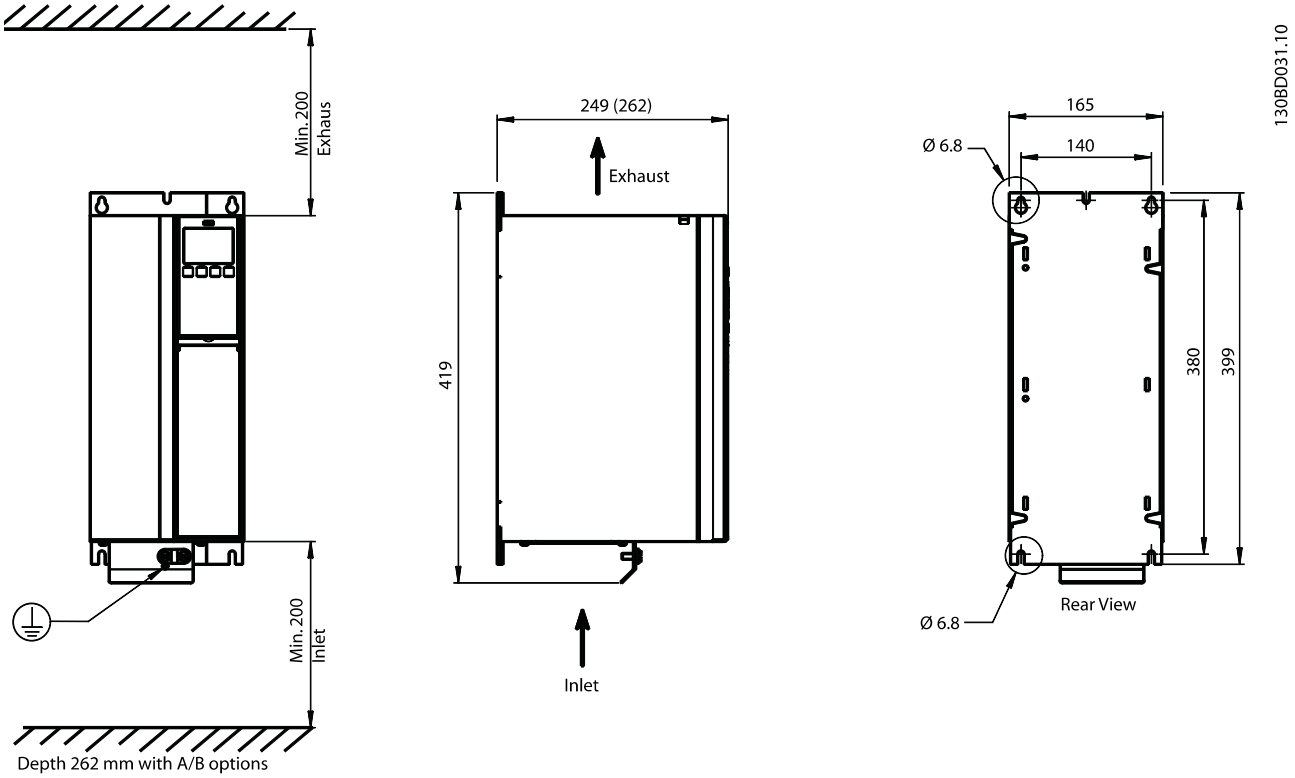


Illustration 12.6 Unit Size 23

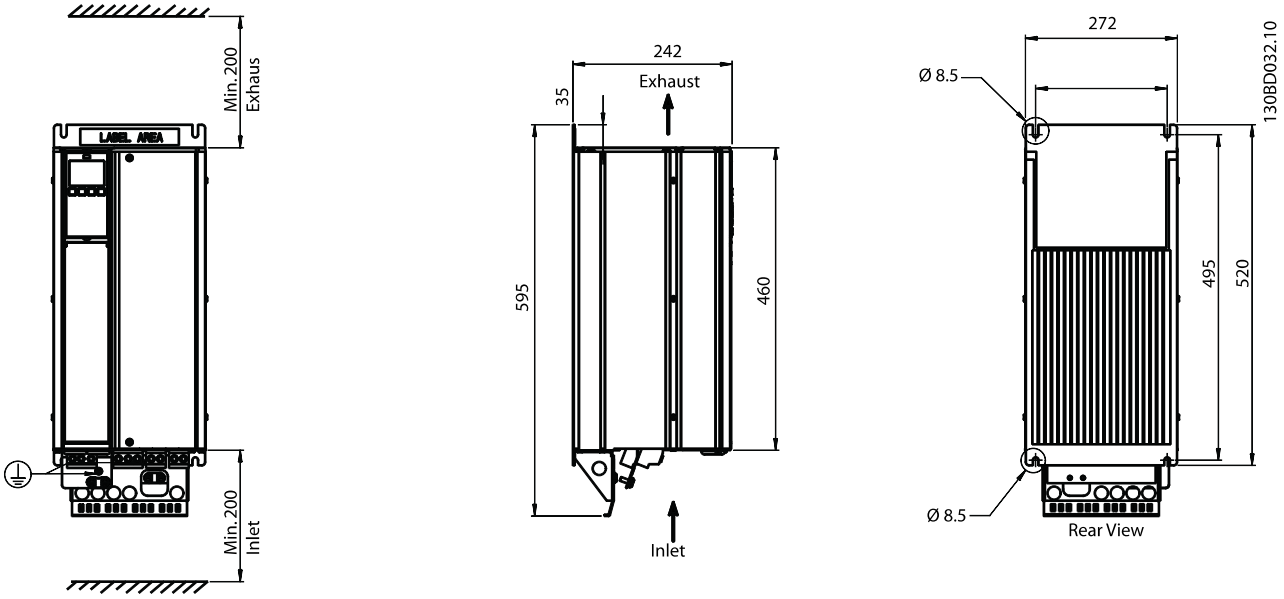


Illustration 12.7 Unit Size 24

12

12.1.4 Dimensions, Unit Size 3x

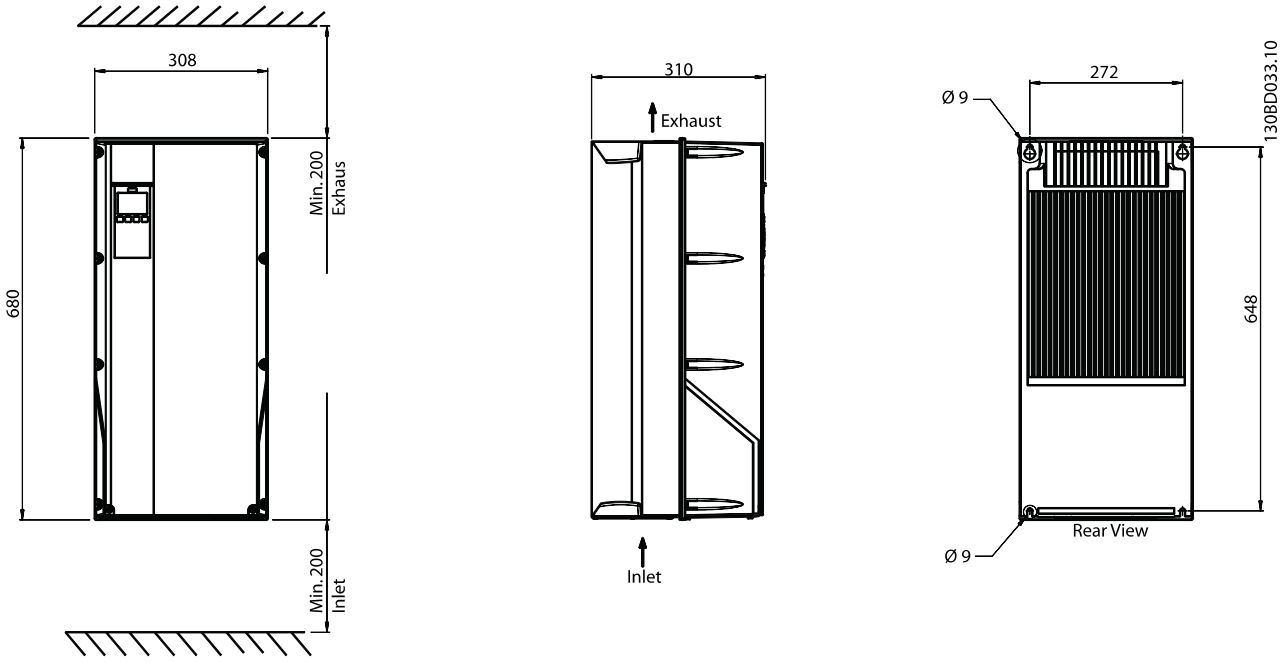


Illustration 12.8 Unit Size 31

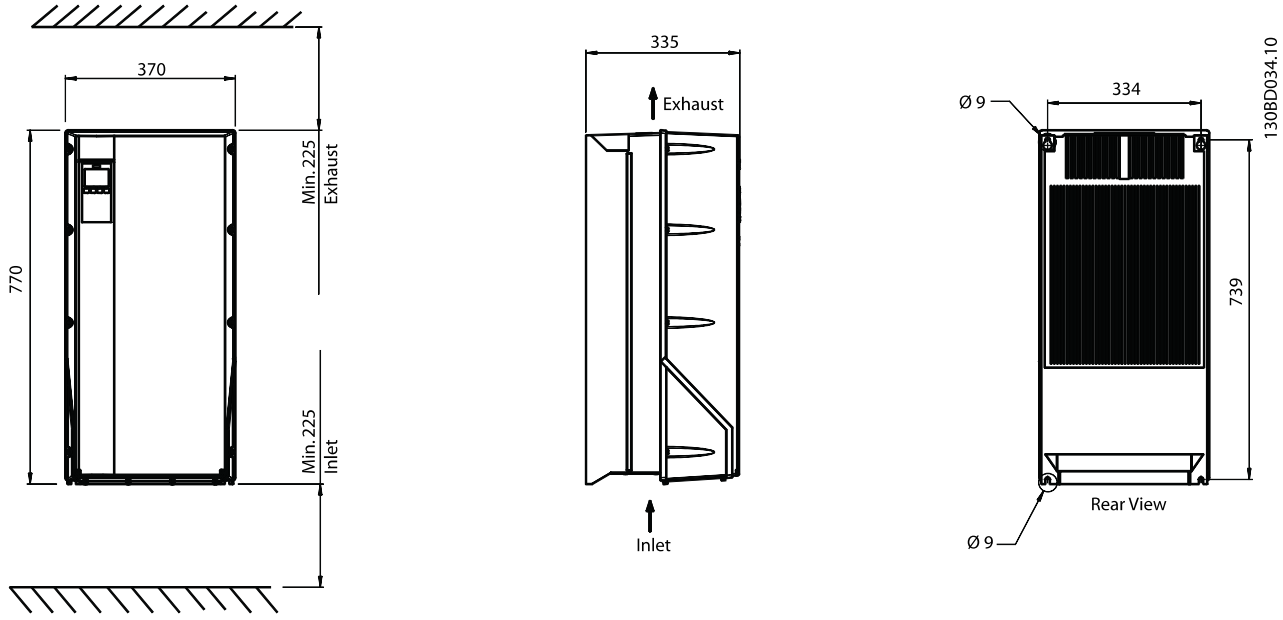


Illustration 12.9 Unit Size 32

12

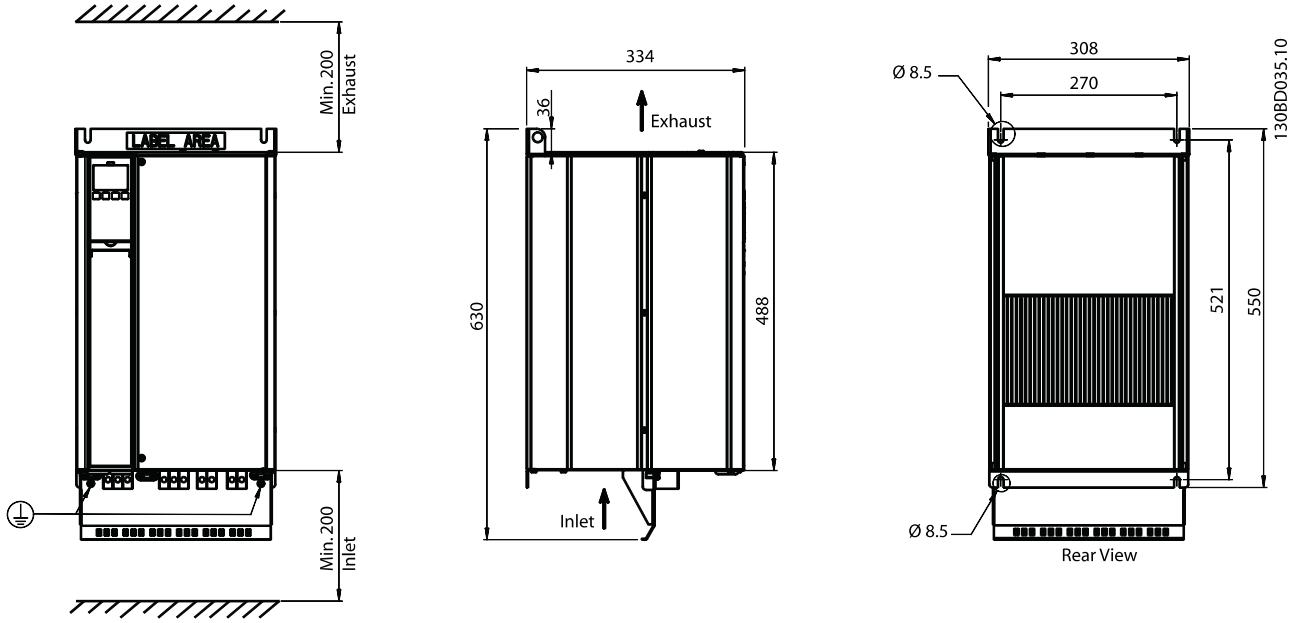


Illustration 12.10 Unit Size 33

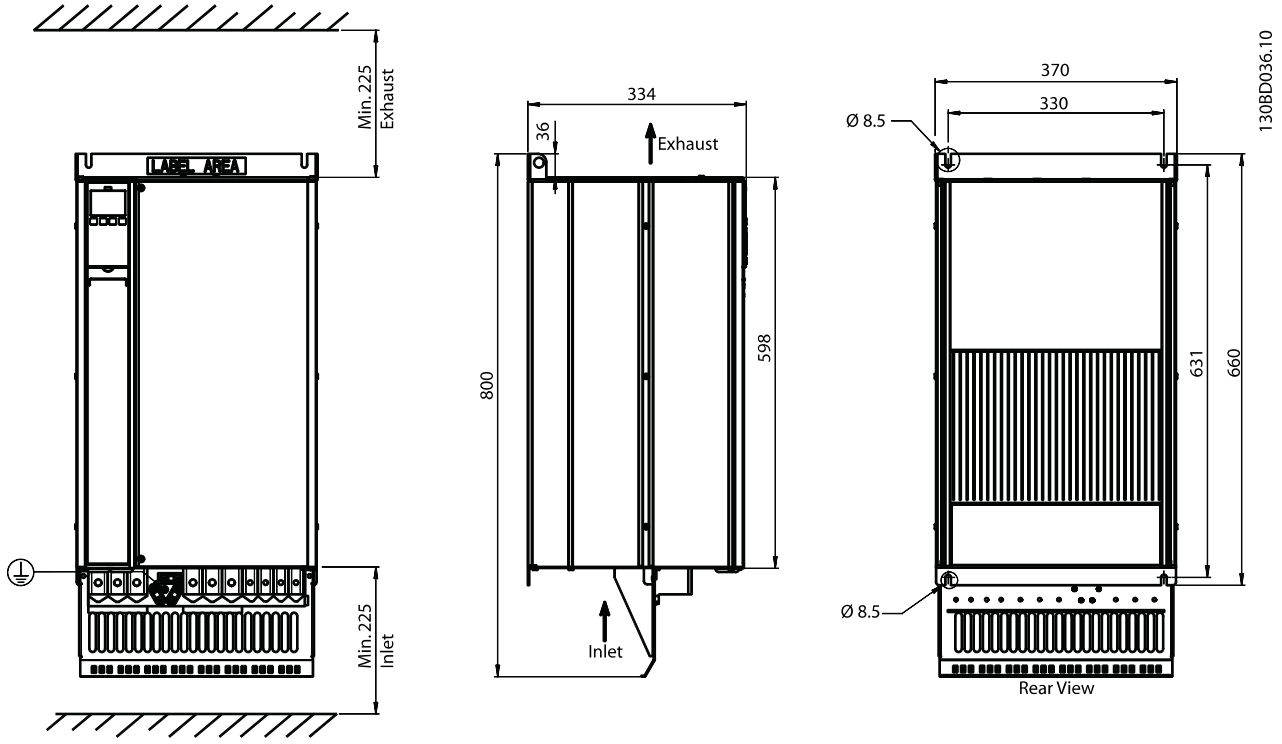


Illustration 12.11 Unit Size 34

12

12.1.5 Dimensions, Unit Size 4x

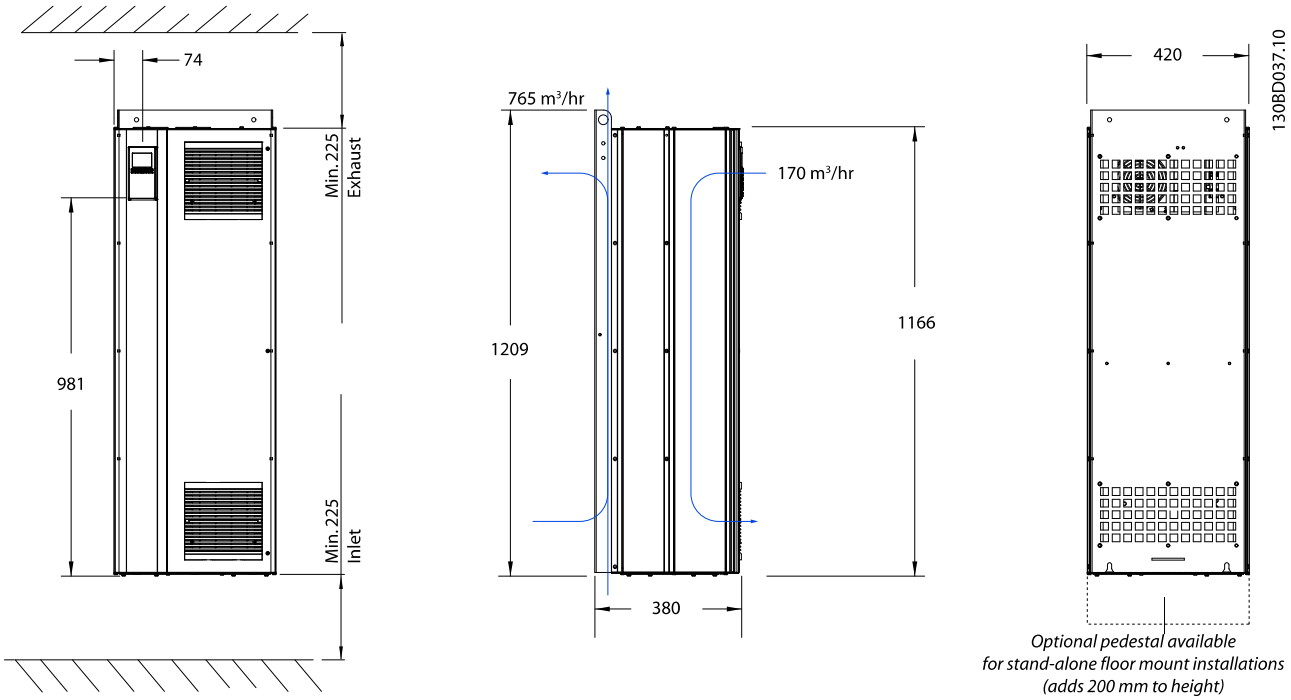


Illustration 12.12 Unit Size 41 (Floor- or Cabinet Mount)

12

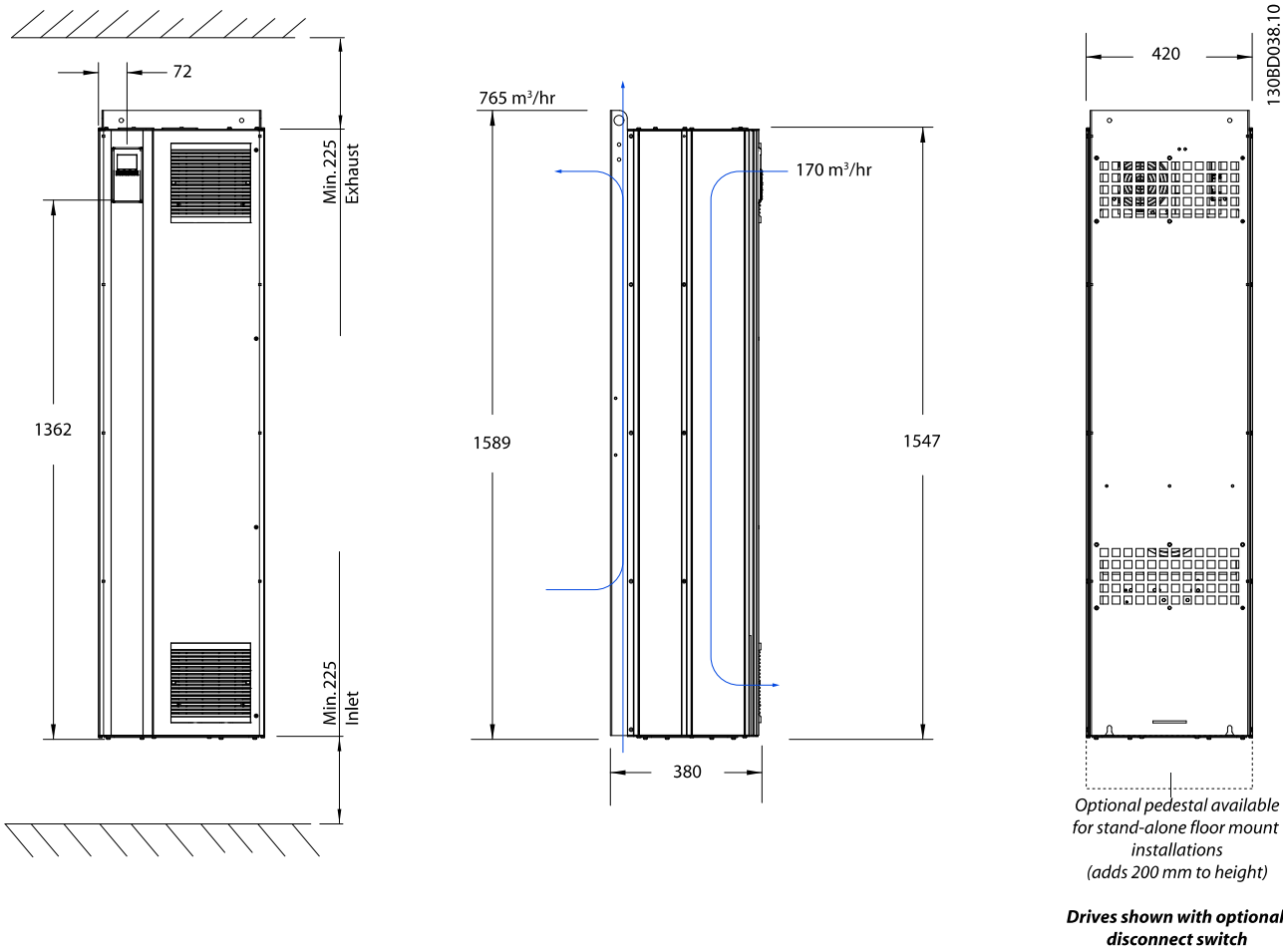


Illustration 12.13 Unit Size 42 (Floor- or Cabinet Mount)

12

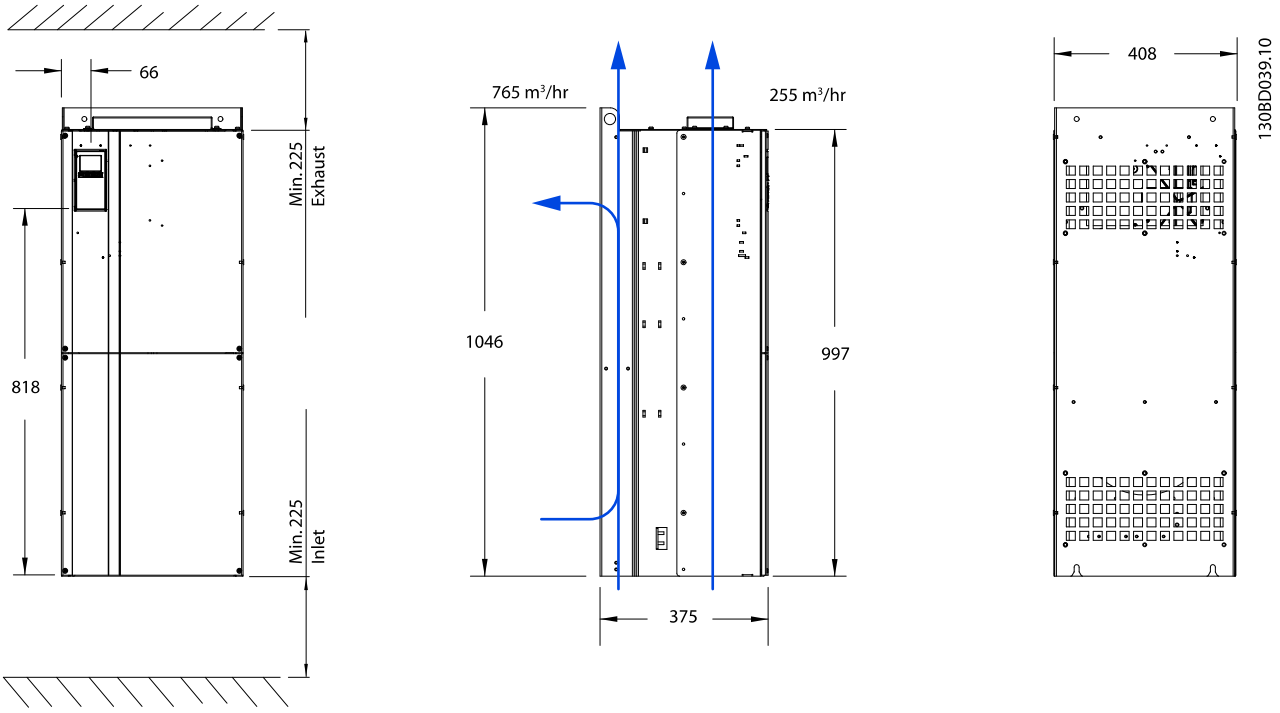
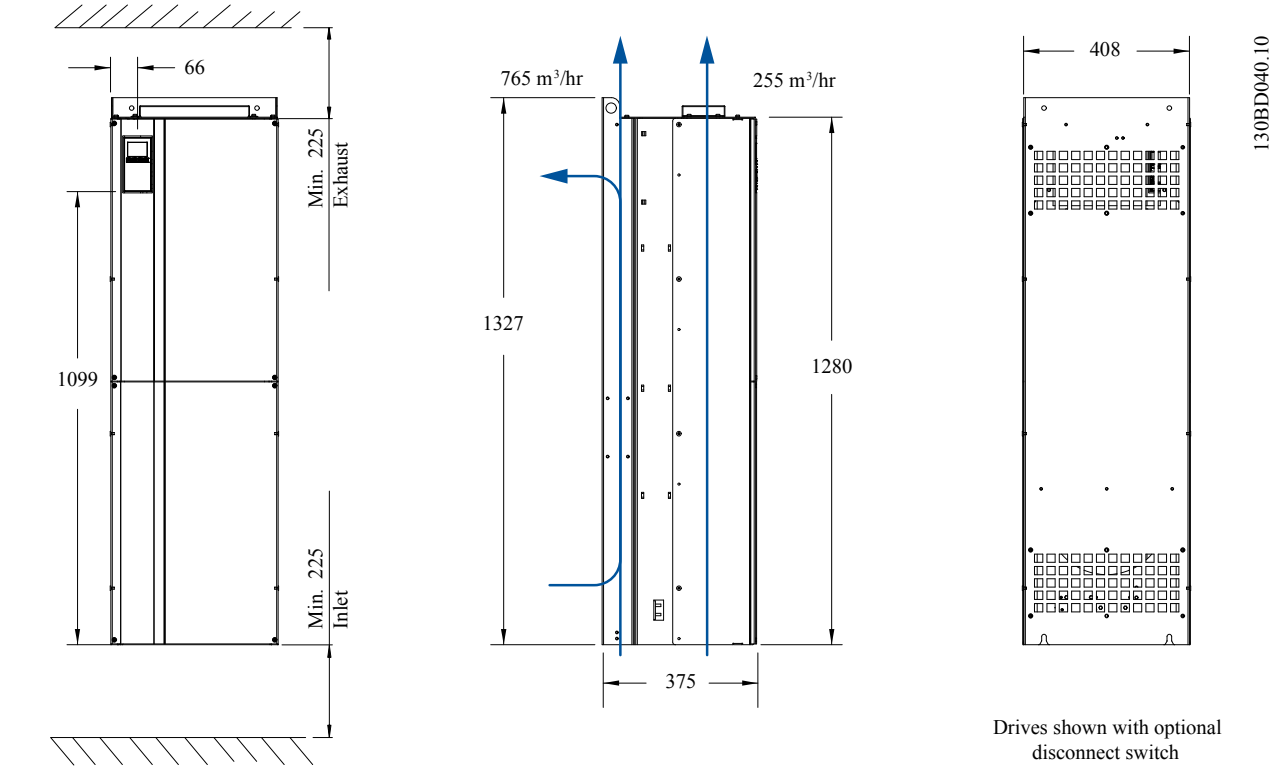


Illustration 12.14 Unit Size 43 (Cabinet Mount)



Drives shown with optional disconnect switch

Illustration 12.15 Unit Size 44 (Cabinet Mount)

12.1.6 Dimensions, Unit Size 5x

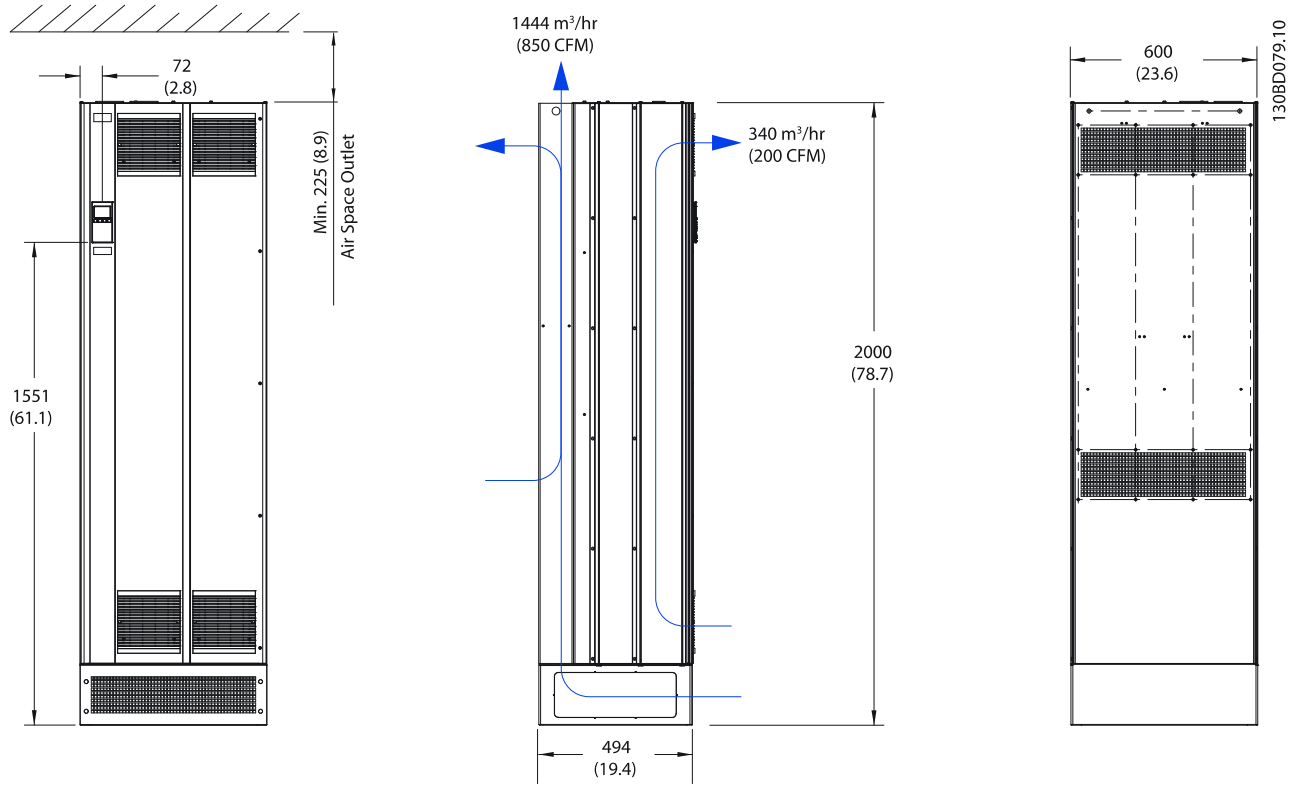


Illustration 12.16 Unit Size 51 (Floor Mount)

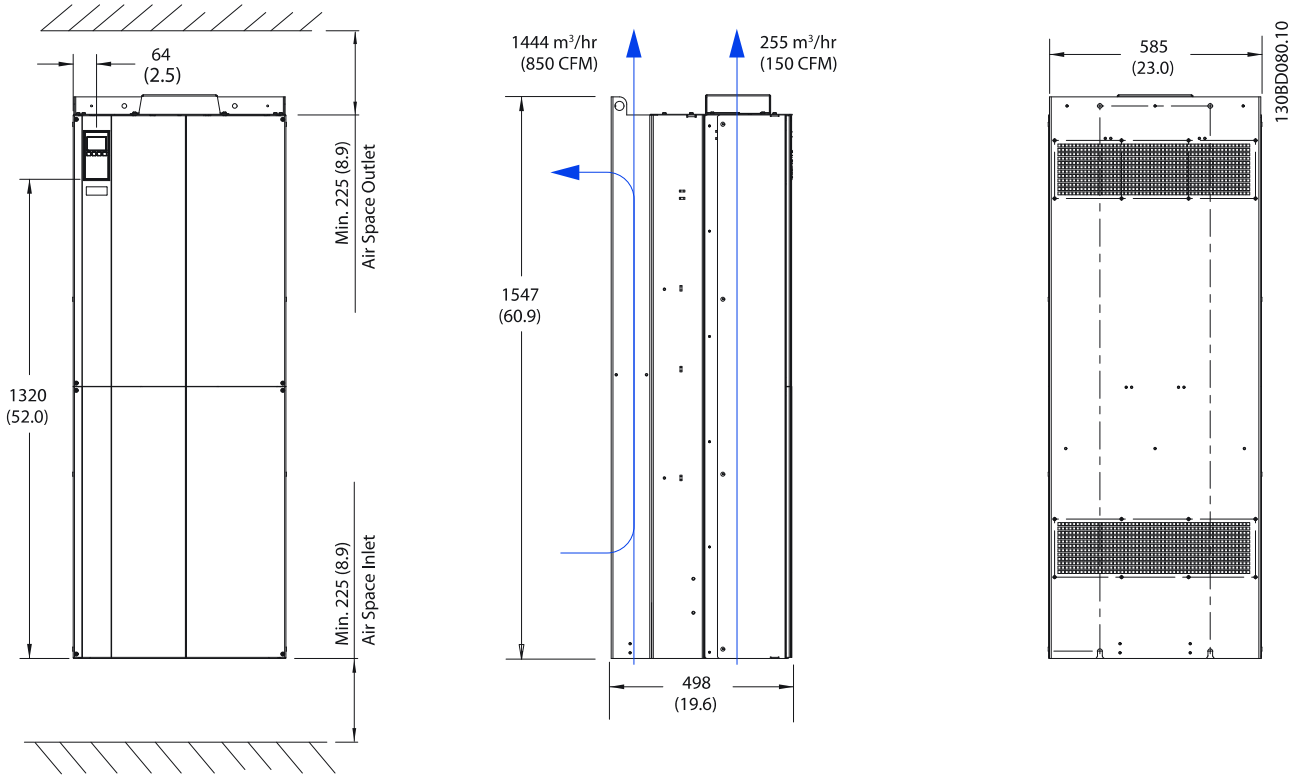


Illustration 12.17 Unit Size 52 (Cabinet Mount)

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12.1.7 Dimensions, Unit Size 6x

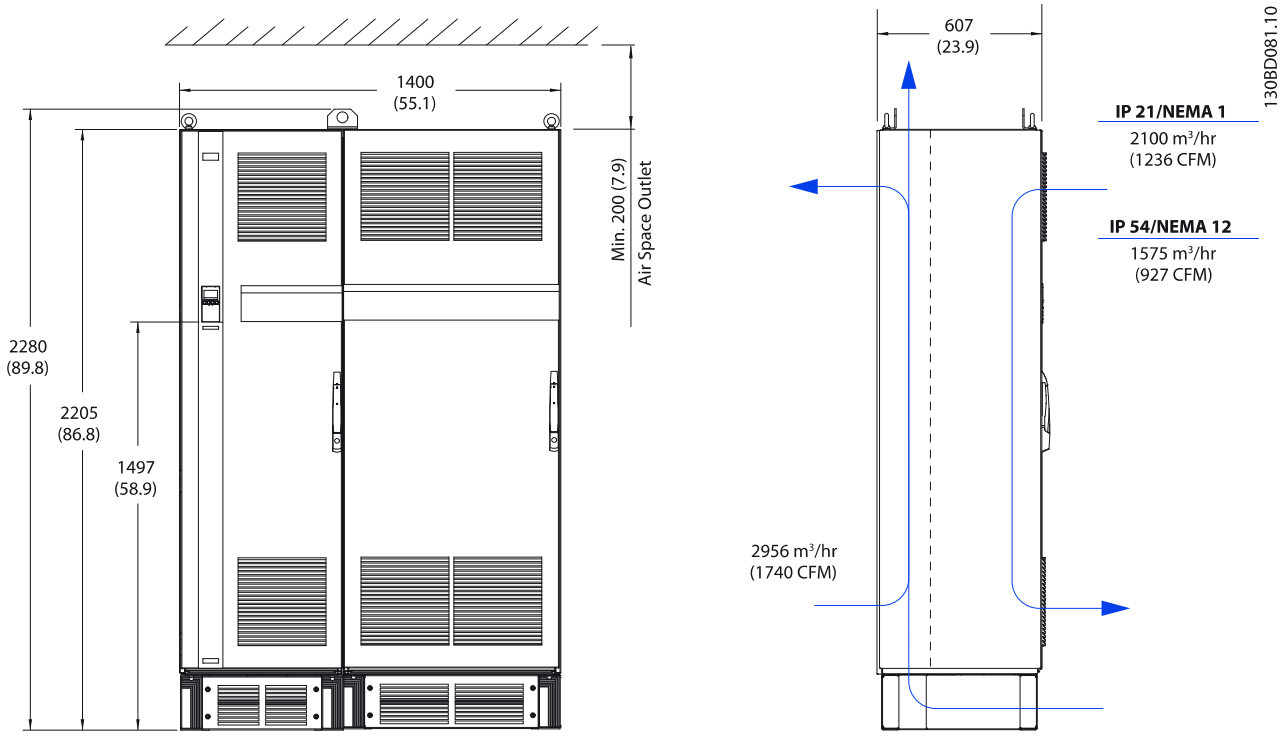

Illustration 12.18 Unit Size 61 (Floor Mount)

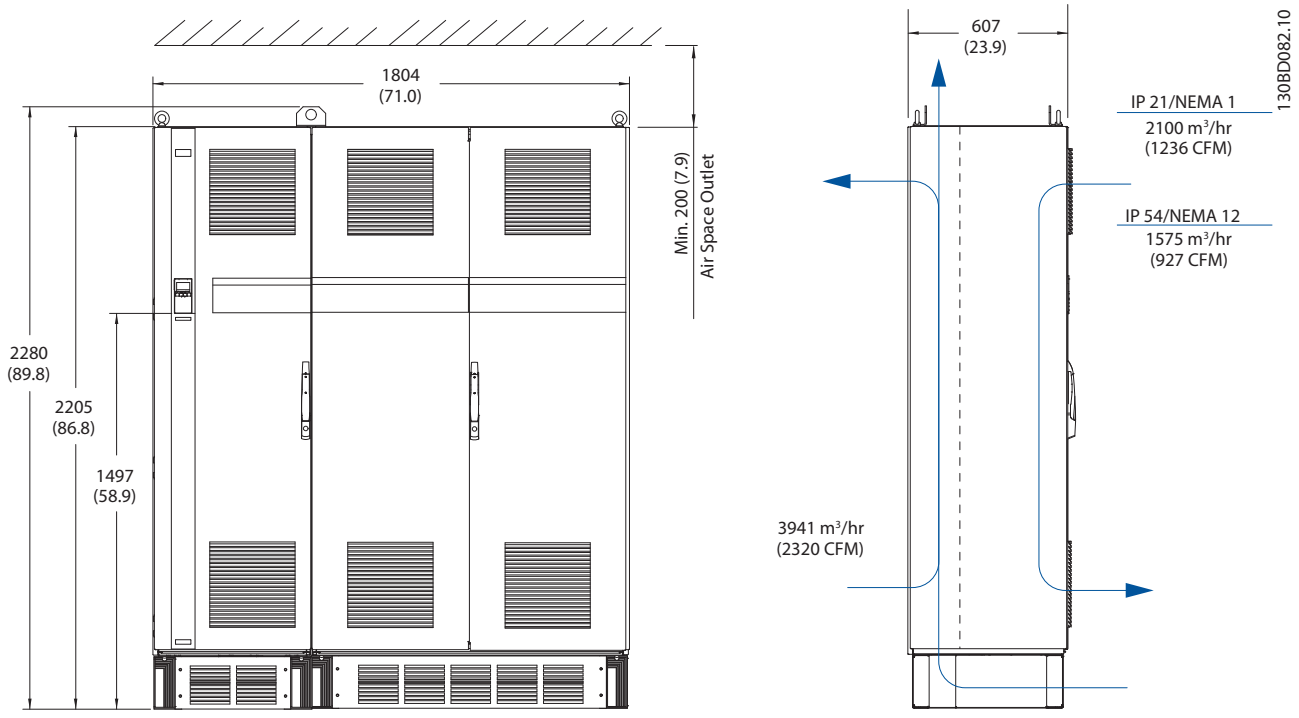

Illustration 12.19 Unit Size 62 (Floor Mount)

12

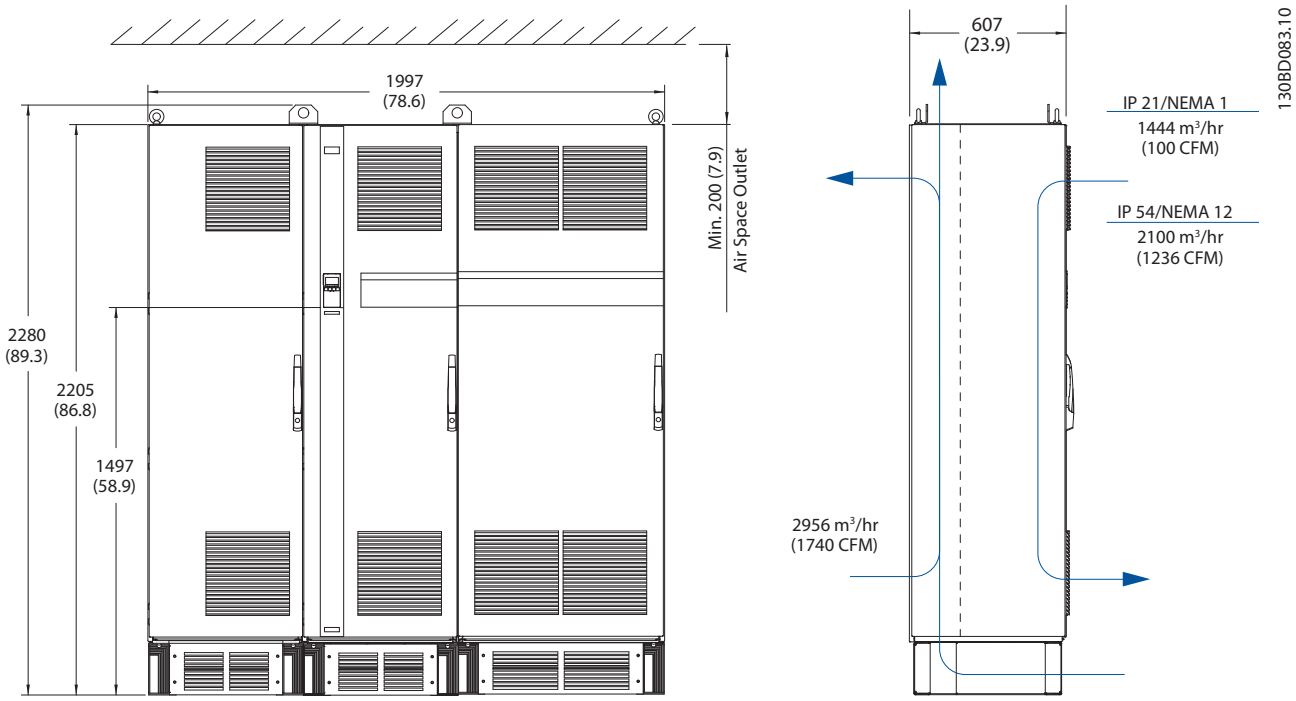

Illustration 12.20 Unit Size 63 (Floor Mount)

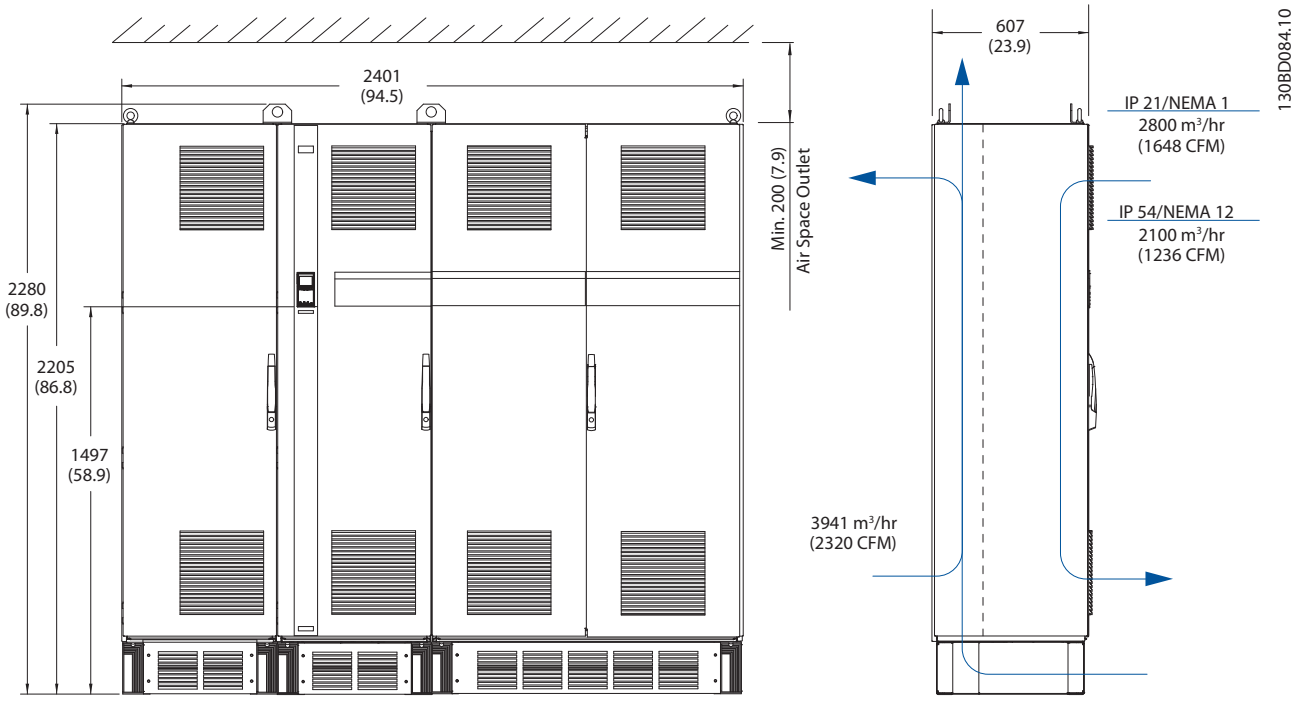

Illustration 12.21 Unit Size 64 (Floor Mount)

12

12.2 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	0-800* Hz
Switching on output	Unlimited
Accel/Decel Times	1-3600 s

* Voltage and power dependent

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.

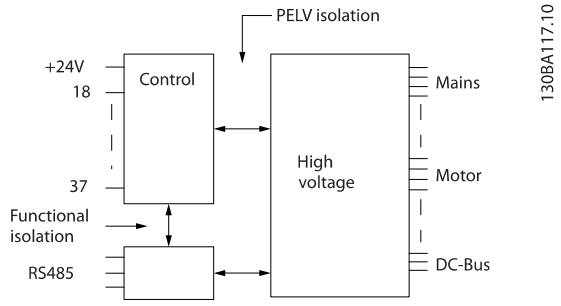

Illustration 12.22

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 *12.2.1 Digital Inputs*
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

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

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Control card, 10 V DC output

Terminal number	50
Output voltage	10.5 V ±0.5 V
Max. load	25 mA

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

Control characteristics

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

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

Surroundings

Enclosure, 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.

12.3 Fuse Tables

12.3.1 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 drive and other equipment.

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

12.3.2 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 drive to an equal or lower level than the compliant circuit breakers.

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

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

12.3.4 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 12.5 200-240 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 12.6 200-240 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	gG-300	gG-300
132/200	gG-350	gG-350
160/250	gG-400	gG-400
200/300	gG-500	gG-500
250/350	gG-630	gG-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 12.7 380-480V, IP20/Open Chassis

12

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	gG-300	gG-300
132/200	gG-350	gG-350
160/250	gG-400	gG-400
200/300	gG-500	gG-500
250/350	gG-630	gG-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 12.8 380-480 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 12.9 525-600 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 12.10 525-600 V, IP55/Nema 12

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 12.11 525-690 V, IP21/Nema 1 and IP55/Nema 12

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12.3.5 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), 240V, or 480V, or 600V depending on the drive voltage rating. With the proper fusing the drive Short Circuit Current Rating (SCCR) is 100,000 Arms.

Recommended max. fuse							
AF-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 12.12 200-240 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 12.13 200-240V

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 12.14 200-240V

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

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

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

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

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 12.15 380-480V, 125HP 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 12.16 380-480V, 125HP 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 12.17 380-480V, 125HP 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 12.18 525-600V, 125HP 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 12.19 525-600V, 125HP 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 12.20 525-690, 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	Type JFHR2	
110/ 150	170M3017	FWH-300	20 610 31.315	L50-S-300	A50-P-300	6.9URD31D08A0315
132/ 200	170M3018	FWH-350	20 610 31.350	L50-S-350	A50-P-350	6.9URD31D08A0350
160/ 250	170M4012	FWH-400	20 610 31.400	L50-S-400	A50-P-400	6.9URD31D08A0400
200/ 300	170M4014	FWH-500	20 610 31.550	L50-S-500	A50-P-500	6.9URD31D08A0550
250/ 350	170M4016	FWH-600	20 610 31.630	L50-S-600	A50-P-600	6.9URD31D08A0630
315/ 450	170M4017	FWH-800	20 610 32.700	L50-S-800	A50-P-800	6.9URD31D08A0700
355/ 500	170M6013		22 610 32.900			6.9URD33D08A0900
400/ 550	170M6013		22 610 32.900			6.9URD33D08A0900
450/ 600	170M6013		22 610 32.900			6.9URD33D08A0900
500/ 650	170M7081					
560/ 750	170M7081					
630/ 900	170M7082					
710/ 1000	170M7082					
800/ 1200	170M7083					
1000/ 1350	170M7083					

Table 12.21 380-480V, above 125HP

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 12.22 380-480V, Frame Size 6, Inverter Module DC Link Fuses

AF-600	Bussmann PN	Alternate External Siba PN	Alternate External Ferraz-Shawmut PN
[kW]/[HP]		Type JFHR2	Type JFHR2
132/200	170M3017	2061032,315	6.9URD30D08A0315
160/250	170M3018	2061032,35	6.9URD30D08A0350
200/300	170M4011	2061032,35	6.9URD30D08A0350
250/350	170M4012	2061032,4	6.9URD30D08A0400
315/450	170M4014	2061032,5	6.9URD30D08A0500
400/550	170M5011	2062032,55	6.9URD32D08A0550
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 12.23 525-690V, above 125HP

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 12.24 525-690V, 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 500V UL listed fuse with associated current rating may be used to meet UL requirements.*

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