

GE  
Automation & Controls  
General Motion Products

# PACMotion\*

# Variable Frequency Drives

# User Manual

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PK\*



*For Public Disclosure*



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PRELIMINARY



# Chapter 1 General Information

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## 1.1 About this documentation

This documentation is an integral part of the product. The documentation is written for all employees who assemble, install, start up, and service this product.

Make sure this documentation is accessible and legible. Ensure that persons responsible for the machinery and its operation, as well as persons who work on the product independently, have read through the documentation carefully and have understood it. If the reader is unclear about any of the information in this documentation or require further information, contact GE Automation & Controls.

This user guide, written in English, is the “original instructions” document. All non-English versions are translations of the “original instructions”. Refer to the English-language version if in doubt.

## 1.2 Revisions in this Manual

Rev	Date	Description
A	May-2018	<ul style="list-style-type: none"><li>• Added internal braking resistor and installation instructions</li><li>• Added USB 2.0 to RS 485 adaptor (removed Cable Set C)</li><li>• Added Modbus TCP timeout parameter setting and explanation</li><li>•</li></ul>
-	Apr-2018	<ul style="list-style-type: none"><li>• Initial publication.</li></ul>



### **1.3 Rights to Claim under Limited Warranty**

Read the information in this documentation. This is essential for proper operation and fulfillment of any rights to claim under limited warranty. Read the documentation before you start working with the product.

### **1.4 Exclusion of Liability**

Read the information in this documentation. You must comply with the information contained in this documentation to achieve the specified product characteristics and performance features. GE Automation & Controls assumes no liability for injury to persons or damage to equipment or property resulting from failure to observe the operating instructions provided. In such cases, GE Automation & Controls assumes no liability.

PRELIMINARY

## 1.5 PACSystems Documentation

### PACSystems Manuals

<i>PACSystems RX7i, RX3i and RSTi-EP CPU Reference Manual</i>	GFK-2222
<i>PACSystems RX7i, RX3i and RSTi-EP CPU Programmer's Reference Manual</i>	GFK-2950
<i>PACSystems RX7i, RX3i and RSTi-EP TCP/IP Ethernet Communications User Manual</i>	GFK-2224
<i>PACSystems TCP/IP Ethernet Communications Station Manager User Manual</i>	GFK-2225
<i>C Programmer's Toolkit for PACSystems</i>	GFK-2259
<i>PACSystems Hot Standby CPU Redundancy User Manual</i>	GFK-2308
<i>Proficy Machine Edition Logic Developer Getting Started</i>	GFK-1918
<i>PACSystems RXi, RX3i, RX7i and RSTi-EP Controller Secure Deployment Guide</i>	GFK-2830
<i>PACSystems RX3i &amp; RSTi-EP PROFINET I/O Controller Manual</i>	GFK-2571

### RX3i Manuals

<i>PACSystems RX3i System Manual</i>	GFK-2314
<i>PACSystems RX3i PROFINET Scanner Manual</i>	GFK-2737
<i>PACSystems RX3i CEP PROFINET Scanner User Manual</i>	GFK-2883

In addition to these manuals, datasheets and product update documents describe individual modules and product revisions. The most recent PACSystems documentation is available on the GE Automation & Controls support website <http://geautomation.com/support>.

## 1.6 Glossary of Terms

Term	Explanation
bar	Unit of measure of barometric pressure in the CGS system (not recognized in SI system of units). Standard atmospheric pressure at sea level is 1,013.2 millibars.
COB	Communication Object Identifier.
DHC	Dynamic Host Configuration Protocol is a protocol used to provide quick, automatic, and central management for the distribution of IP addresses within a network. DHCP is also used to configure the proper subnet mask, default gateway, and DNS server information on the device.
DSP	Digital Signal Processor
EDS	A file with the EDS file extension is an Electronic Data Sheet file. This plain text format is based on the CANopen standard and used to specify characteristics of a related device.
ESI	EtherCat Slave Information configuration file.
GFCI	Ground Fault Circuit Interrupter.
GSD	A General Station Description file, which is provided by the manufacturer of a device, contains a description of the PROFIBUS DP/PA or PROFINET device. GSD files provide a way for an open configuration tool to automatically extract the device characteristics.
GSDML	GSDML files are GSD files written in XML format. They describe the features of the PROFINET device model.
LSPM	Line Start Permanent Magnet motors Also, a Control Mode for asynchronous motors with synchronous characteristics. Refer to <a href="#">P4-01 Control Mode</a> in Section 11.2.5.
HTL	Type of encoder feedback.
TTL	Type of encoder feedback.
PELV	Protected Extra-Low Voltage.
PPR	Pulses per Revolution (for Encoder). Also called Counts per Revolution.
RCD	Residual Current Device.
IT	In an IT network, the electrical distribution system has no connection to earth at all, or has only a high impedance connection (IEC 60364).
TN	In a TN earthing system, one of the points in the generator or transformer is connected with earth, usually the star point in a 3-phase system. The chassis of the electrical device is connected with earth via this earth connection at the transformer. This arrangement is a current standard for residential and industrial electric systems particularly in Europe (IEC 60364).
TT	In a TT (Terra-Terra) earthing system, the protective earth connection for the consumer is provided by a local earth electrode, (sometimes referred to as the Terra-Firma connection) and there is another independently installed at the generator. There is no 'earth wire' between the two. The fault loop impedance is higher, and unless the electrode impedance is very low indeed, a TT installation should always have an RCD (GFCI) as its first isolator (IEC 60364).
HTL	Encoder Option Card (8-30Vdc): used to regulate speed control; cannot be used for positioning control.
TTL	Encoder Option Card(5Vdc): used to regulate speed control; cannot be used for positioning control.

## Chapter 2 System Overview

The PACMotion Variable Frequency Drives are offered as part of suite of products, as shown in the following System Diagram:

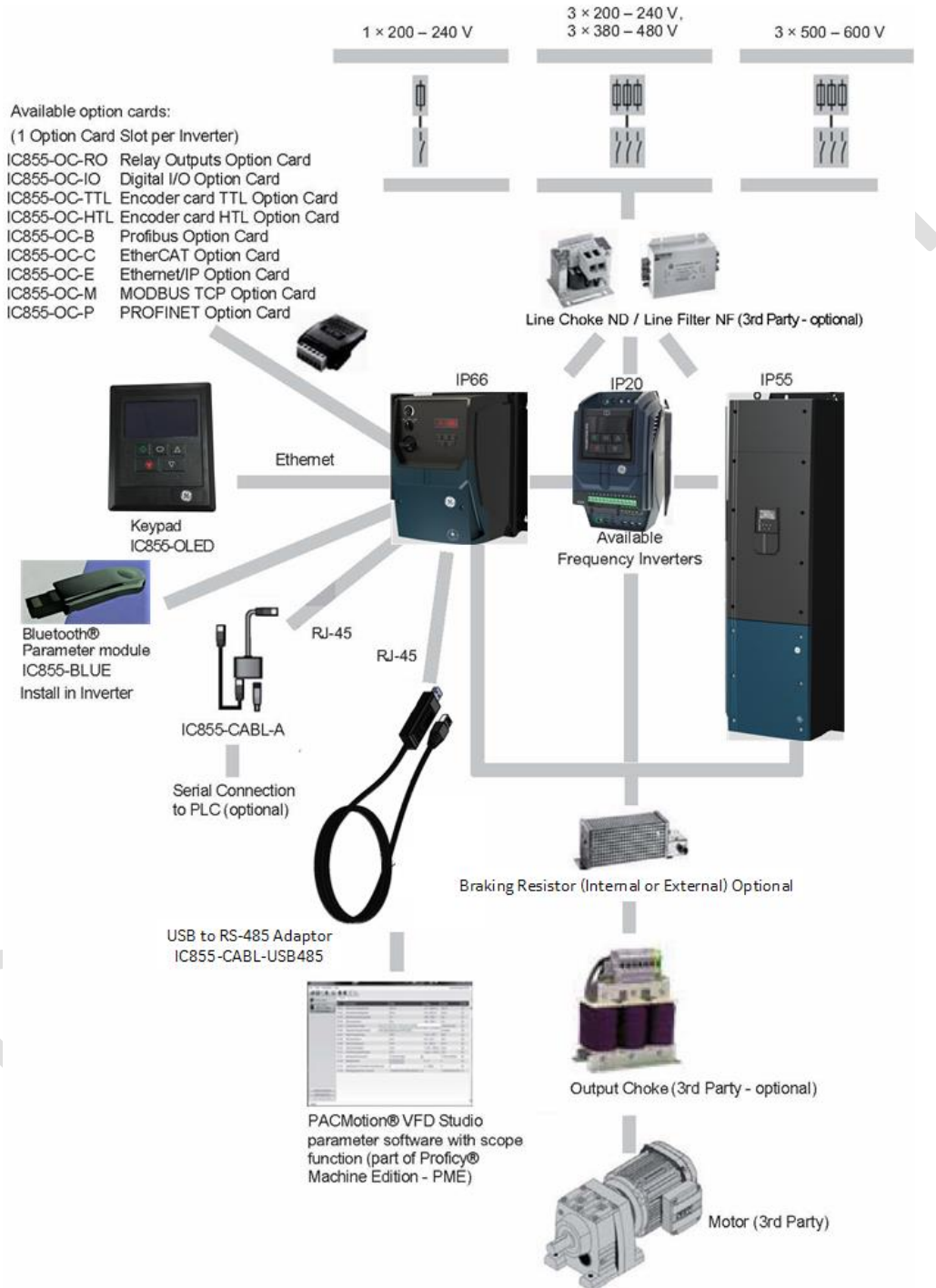


Figure 1: PACMotion System Diagram

A list of available inverters is provided in Appendix A (Section A-1).

A list of available options is provided in Appendix A (Section A-2). Each of these is discussed in Chapter 14, *Remote Keypads for PACMotion VFDs*, Chapter 15, *Option Cards for PACMotion VFDs*, Chapter 16, *Cable Sets*, or Chapter 17, *Braking Resistors*.

A typical system will consist of a suitable inverter for each motor to be controlled,

Each inverter:

- may contain one Option Card (optional)
- may contain a Bluetooth module (optional)
- may have a remote keypad attached (optional)
- may be attached to a braking resistor (may be internal or external and are optional)
- will communicate with a PC running PACMotion VFD Studio which is launched from GE's Programming and Configuration software, Proficy Machine Edition (PME). PACMotion VFD Studio is used to set up and monitor the VFD parameters. PME is used to configure and program any associated PACSystems Programmable Controllers (PLCs).

PACMotion VFD Studio is used to configure and monitor the parameters in the PACMotion Drives. This software is launched from GE's Programming and Configuration software, Proficy Machine Edition (PME). PME Release 9.50 SIM 10 is required.

## Chapter 3 Safety Notes

---

### 3.1 Preliminary Information

The following general safety notes have the purpose to avoid injury and damage to property. They primarily apply to the use of products described in this documentation. If you use additional components also observe the relevant warning and safety notes.

### 3.2 Operator's Duties

Make sure that the basic safety notes are read and observed. Make sure that persons responsible for the machinery and its operation as well as persons who work on the device independently have read through the documentation carefully and have understood it. If the reader is unclear about any of the information in this documentation, or requires further information, contact GE Automation & Controls.

The operator must ensure that the following activities are performed by qualified personnel only:

- Transport
- Storage
- Setup and assembly
- Installation and connection
- Start-up
- Maintenance and repair
- Shutdown
- Disassembly
- Waste disposal.

Make sure persons working on the product adhere to the following regulations, requirements, documentation, signage and information:

- National and regional safety and accident prevention regulations
- Warning and safety signs on the product
- All other relevant project planning documents, installation and start-up instructions, wiring diagrams and schematics
- Do not assemble, install or operate damaged products
- All specific specifications and requirements for the system.

Make sure that systems with the product installed are equipped with additional monitoring and protection devices. Observe the applicable safety regulations and legislation governing technical equipment and accident prevention regulations.

### 3.3 Target Groups

1. Specialist for mechanical work
2. Any mechanical work may only be performed by adequately qualified personnel. Qualified personnel in the context of this documentation are persons familiar with the design, mechanical installation, troubleshooting and maintenance of the product, who possess the following qualifications:
  - Qualification in the field of mechanics according to applicable national regulation.
  - They are familiar with this documentation
3. Specialist for electrotechnical work
4. Any electronic work may only be performed by adequately skilled persons (electrically). Qualified electricians in the context of this documentation are persons familiar with electrical installation, start-up, troubleshooting and servicing of the product who possess the following qualifications:
  - Qualification in the field of electrical engineering according to applicable national regulation.
  - They are familiar with this documentation
5. In addition, these persons must be familiar with the applicable safety regulations and laws, as well as with the requirements of the standards, directives and laws specified in this documentation. The above-mentioned persons must have the authorization expressly issued by the company to operate, program, configure, wire, label, interconnect and ground devices, systems and circuits in accordance with the standards of safety technology.
6. Instructed persons
7. All work in the areas of transportation, storage, operation and waste disposal must be carried out by persons who are trained appropriately. The purpose of the instruction is that the persons are capable of performing the required tasks and work elements in a safe and correct manner.

## 3.4 Designated Use

The product is intended for installation in electrical plants or machines.

In case of installation in electrical systems or machines, start-up of the product is prohibited until it is determined that the machine meets the requirements stipulated in the local laws and directives. For Europe, Machinery Directive 2006/42/EC as well as the EMC Directive 2014/30/EU apply. Observe EN 60204-1 (Safety of machinery - electrical equipment of machines). The product meets the requirements stipulated in the Low Voltage Directive 2014/35/EU.

The standards given in the declaration of conformity apply to the product.

The systems can be mobile or stationary. The motors must be suitable for operation with inverters. Do not connect any other loads to the product. Never connect capacitive loads to the product.

The product can be used to operate the following motors in industrial and commercial systems:

- AC asynchronous motors with squirrel-cage rotor
- Permanent-field AC synchronous motors

Technical data and information on the connection conditions are provided on the nameplate and in Chapter 12, *Technical Data*, in the documentation. Always comply with the data and conditions.

Unintended or improper use of the product may result in severe injury to persons and damage to property.

### 3.4.1 Hoist Applications

To avoid danger of fatal injury by falling hoists, observe the following points when using the product in lifting applications:

- Use mechanical protection devices.
- Perform a hoist start-up.



### 3.5 **Functional Safety Technology**

The product must not perform any safety functions without a higher-level safety system, unless explicitly allowed by the documentation.

### 3.6 **Transport**

Inspect the shipment for damage as soon as you receive the delivery. Inform the shipping company immediately about any damage. If the product is damaged, it must not be assembled, installed or started up.

Observe the following notes when transporting the device:

- Ensure that the product is not subject to mechanical impact during transportation.
- Before transportation, cover the connections with the supplied protection caps.
- Only place the product on the cooling fins or on the side without connectors during transportation.
- Always use lifting eyes if available.

If necessary, use suitable, sufficiently dimensioned handling equipment.

Observe the information on climatic conditions in Chapter 12, *Technical Data*, of the documentation.

## 3.7 Installation/Assembly

Ensure that the product is installed and cooled according to the regulations in the documentation.

Protect the product from excessive mechanical strain. The product and its mounted components must not protrude into the path of persons or vehicles. Ensure that components are not deformed and that insulation spaces are maintained, particularly during transportation. Electric components must not be mechanically damaged or destroyed.

Observe the notes in Section 5.3, *Mechanical Installation*.

### 3.7.1 Restrictions of Use

The following applications are prohibited unless explicitly permitted:

- Use in potentially explosive areas
- Use in areas exposed to harmful oils, acids, gases, vapors, dust, and radiation
- Operation in applications with impermissibly high mechanical vibration and shock loads in excess of the regulations stipulated in EN 61800-5-1
- Operation at installation altitudes above 4000m above sea level (abbreviated asl)

The product can be used at altitudes above 1000m asl up to 4000m asl under the following conditions:

- Taking the reduced continuous rated current into consideration. Refer to Chapter 12, *Technical Data*.
- Above 2000m asl, the air and creeping distances are only sufficient for overvoltage class II according to EN 60664. If the installation requires overvoltage category III according to EN 60664 you have to reduce the overvoltage in the system side from category III to II using additional external overvoltage protection.
- If a protective electrical separation is required, then implement this outside the product at altitudes of more than 2000m asl (protective separation in accordance with EN 61800-5-1 and EN 60204-1)

## 3.8 Electrical Connection

Make yourself familiar with the applicable national accident prevention guidelines before you work on the product.

Perform electrical installation according to the pertinent regulations (e.g. cable cross sections, fusing, protective conductor connection). The documentation at hand contains additional information.

Make sure that all required covers are installed correctly after electrical installation.

Make sure that preventive measures and protection devices comply with the applicable regulations (e.g. EN 60204-1 or EN 61800-5-1).

### 3.8.1 Required Preventive Measure

Make sure that the product is correctly attached to the ground connection.

### 3.8.2 Stationary Application

Necessary preventive measure for the product is:

Type of energy transfer	Preventive measure
Direct power supply	Ground connection

## 3.9 Protective Separation

The product meets all requirements for protective separation of power and electronics connections in accordance with EN 61800-5-1. To ensure protective separation, all connected circuits must also meet the requirements for protective separation.

### 3.10 Start-Up/Operation

Observe the safety notes in Chapter 8, *Operation*.

Make sure that the protective materials included for transportation are removed from all electrical apparatus.

Do not deactivate monitoring and protection devices of the machine or system even for a test run.

Make sure the connection boxes are closed and screwed before connecting the supply voltage.

Depending on the degree of protection, products may have live, uninsulated, and sometimes moving or rotating parts, as well as hot surfaces during operation.

Additional preventive measures may be required for applications with increased hazard potential. You have to check the protection devices after each modification.

When in doubt, switch off the product whenever changes occur in relation to normal operation. Possible changes are e.g. increased temperatures, noise, or oscillation. Determine the cause. Contact GE Automation & Controls if necessary.

When the device is switched on, dangerous voltages are present at all power connections as well as at any connected cables and terminals. This also applies even when the product is inhibited and the motor is at standstill.

Do not separate the connection to the product during operation.

This may result in dangerous electric arcs damaging the product.

If you disconnect the product from the voltage supply, do not touch any live components or power connections because capacitors might still be charged. Observe the following minimum switch-off time:

10 minutes.

Observe the corresponding information signs on the product.

The fact that the operation LED and other display elements are no longer illuminated does not indicate that the product has been disconnected from the supply system and no longer carries any voltage.

Mechanical blocking or internal safety functions of the product can cause a motor standstill. Eliminating the cause of the problem or performing a reset may result in the drive re-starting automatically. If, for safety reasons, this is not permitted for the drive-controlled machine, first disconnect the product from the supply system and then start troubleshooting.

Risk of burns: The surface temperature of the product can exceed 60 °C during operation.

Do not touch the product during operation.

Allow the product cool down before touching it.



## Chapter 4 Device Structure

### 4.1 Nameplate

Figure 2 shows an example of a nameplate.

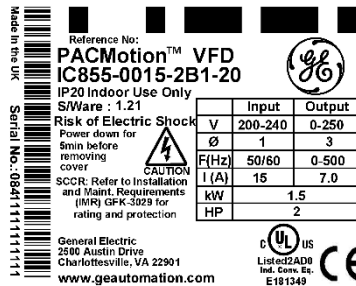


Figure 2: Nameplate Example

### 4.2 Type Designation & Decoding

#### Example: IC855-0015-4B1-2P

Product name	<b>IC855</b>	PACMotion Variable Frequency Drive (VFD)
Recommended motor power	<b>0015</b>	0015 = 1.5 kW 2 = 200 – 240V
Connection voltage	<b>4</b>	4 = 380 – 480V 6 = 500 – 600V 0 = None
Interference suppression on the input	<b>B</b>	A = Class C2 B = Class C1
Connection type	<b>1</b>	1 = 1-phase 3 = 3-phase
Design	<b>2</b>	2 = Standard IP20 housing 5 = IP55/NEMA-12K housing 6 = IP66/NEMA-4X housing
Option Card	<b>P</b>	P = PROFINET RT (Standard) 0 = Empty (Purchase separately)
Country-specific variant	<b>(60Hz)</b>	60Hz design variant

Refer to Appendix A for the PACMotion VSD Product Matrix.

### 4.3 Device Structure of the Standard Inverter

#### 4.3.1 Inverters with Degree of Protection IP20/NEMA 1

The following inverters have the housing shown in Figure 3:

Nominal line voltage	Power of the inverter
230V	0.75 – 5.5 kW
400V	0.75 – 11 kW
575V	0.75 – 15 kW

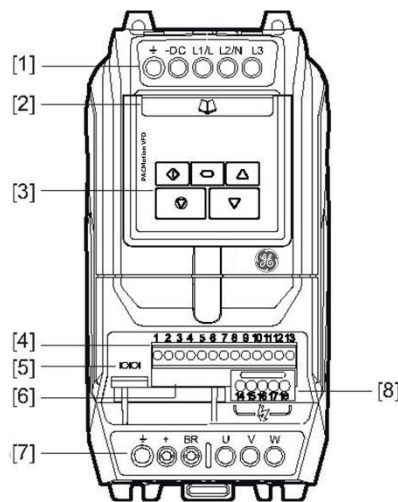


Figure 3: Housing for IP20/NEMA 1 Inverters

- [1] Connecting terminal strip PE, -DC, L1/L, L2/N, L3
- [2] Auxiliary card with terminal assignment and basic parameters
- [3] Keypad with a 6-digit 7-segment display
- [4] Control terminal strip (pluggable)
- [5] RJ45 communication socket
- [6] Option card slot
- [7] Connecting terminal strip PE, +, BR, U, V, W
- [8] Relay terminal strip (pluggable)

### 4.3.2 Inverters with Degree of Protection IP66/NEMA 4X

The following inverters have the housing shown in Figure 4:

Nominal line voltage	Power of the inverter
230V	0.75 – 4 kW
400V	0.75 – 7.5 kW
575V	0.75 – 11 kW

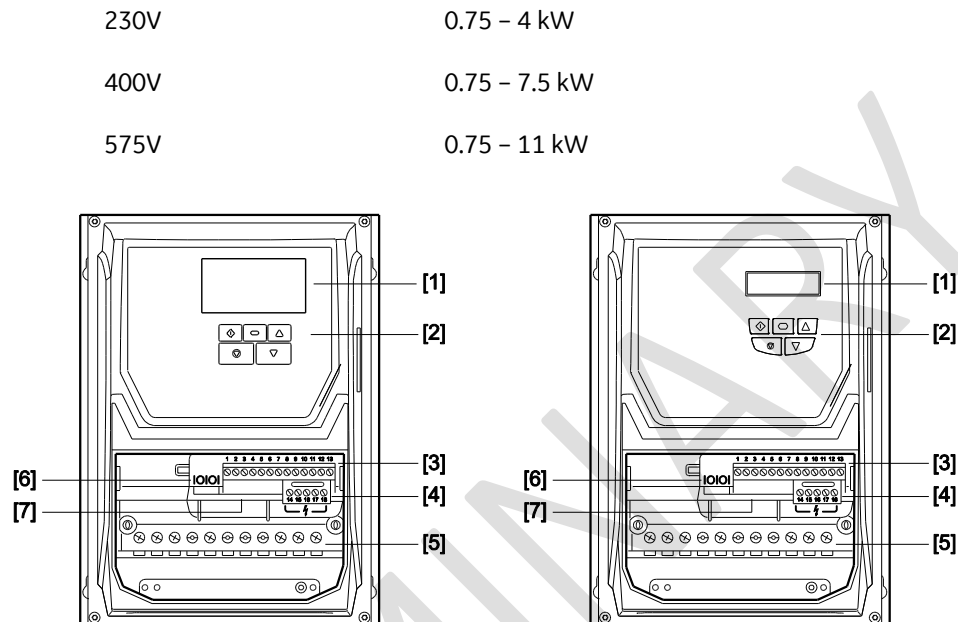


Figure 4: Housing for IP66/NEMA 4X Inverters

- [1] Full text display  
6-digit 7-segment display
- [2] Keypad
- [3] Control terminal strip (pluggable)
- [4] Relay terminal strip (pluggable)
- [5] Connecting terminal strip PE, L1/L, L2/N, L3, -DC, +, BR, U, V, W
- [6] RJ45 communication socket
- [7] Option card slot



### 4.3.3 Inverters with Degree of Protection IP55/NEMA 12K

The following inverters have the housing shown in Figure 5:

Nominal line voltage	Power of the inverter
230V	5.5 – 75 kW
400V	11 – 160 kW
575V	15 – 110 kW

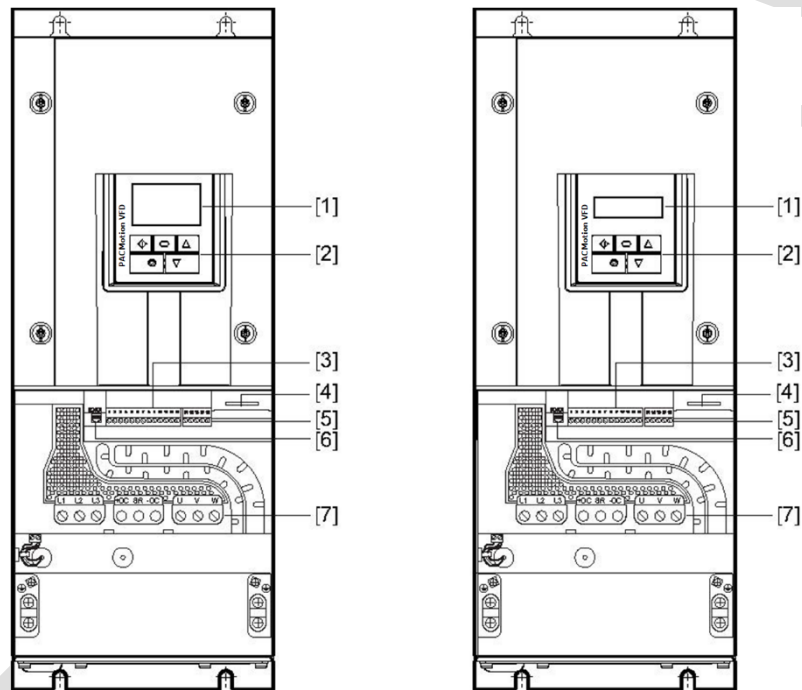


Figure 5: Housing for IP55/NEMA 12K Inverters

- [1] Full text display  
6-digit 7-segment display
- [2] Keypad
- [3] Control terminal strip (pluggable)
- [4] Option card slot
- [5] Relay terminal strip (pluggable)
- [6] RJ45 communication socket
- [7] Connecting terminal strip PE, L1/L, L2/N, L3, -DC, +, BR, U, V, W

## Chapter 5 Installation

### 5.1 General Information

- Before installation, carefully check the inverter for damage.
  - Store the inverter in its original packaging until it is ready to be installed. The storage location must be clean and dry with an ambient temperature between  $-40\text{ }^{\circ}\text{C}$  and  $+60\text{ }^{\circ}\text{C}$ .
  - Install the inverter in a suitable housing on a level, vertical, non-flammable, and vibration-free surface. If a certain IP degree of protection is required, observe EN 60529.
  - Keep flammable materials away from the inverter.
  - Prevent the ingress of conductive or flammable foreign objects.
  - The relative humidity must be kept below 95% (condensation is not permitted).
  - Protect the IP55/IP66 inverter from direct sunlight. Use a cover when using the inverter outdoors.
  - Inverters can be installed next to each other. Ensure sufficient ventilation space between the individual devices. If the inverter is to be installed above another inverter or another device that dissipates heat, then there must be a vertical minimum clearance of 150 mm. To enable self-cooling, the control cabinet must either be cooled through forced ventilation, or dimensioned accordingly. Refer to Section 5.3.1, *IP20 Housing: Installation and Clearance*.
  - The permitted ambient temperatures are defined in Section 12.2, *Ambient Conditions*.
  - The mounting rail installation is only possible for the following inverters with degree of protection IP20.
    - 230V: 0.75 – 2.2 kW
    - 400V: 0.75 – 4 kW
    - 575V: 0.75 – 5.5 kW
- The mounting rail must have the dimensions  $35 \times 15\text{ mm}$  or  $35 \times 7.5\text{ mm}$  and be designed according to EN 50022.
- Install the frequency inverter vertically, as depicted in Figure 6:

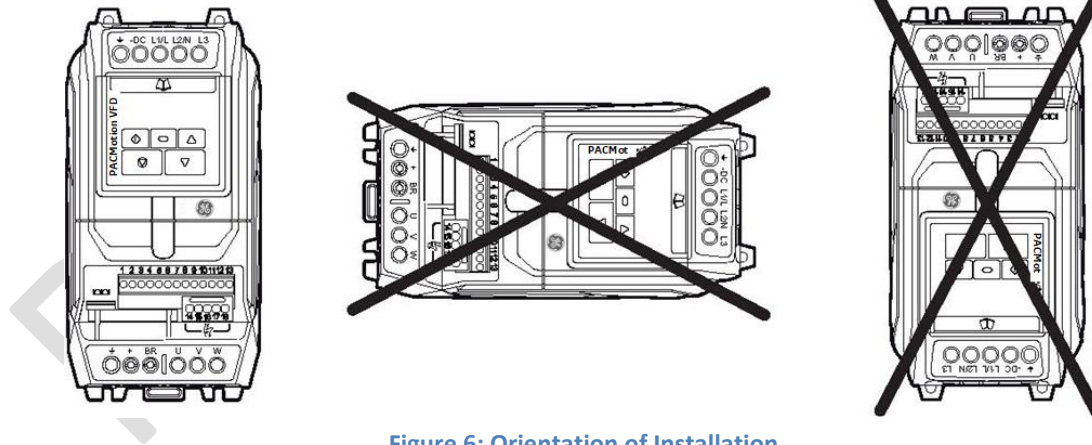


Figure 6: Orientation of Installation

## 5.2 Permitted Tightening Torques

Tightening torque in Nm for inverter		
Power of the inverter	Control terminals	Power terminals
Nominal line voltage 230V		
0.75 – 2.2 kW		1
3 – 5.5 kW (IP20)		1 (IP20)
3 – 4 kW (IP66)		1 (IP66)
5.5 kW (IP66)		4 (IP66)
7.5 – 11 kW	0.8	4
15 – 18.5 kW		15
22 – 45 kW		20
55 – 75 kW		20
Nominal line voltage 400V		
0.75 – 4 kW		1
5.5 – 11 kW (IP20)		1 (IP20)
5.5 – 7.5 kW (IP66)		1 (IP66)
11 kW (IP66)		4 (IP66)
15 – 22 kW	0.8	4
30 – 37 kW		15
45 – 90 kW		20
110 – 160 kW		20
Nominal line voltage 575V		
0.75 – 5.5 kW		1
7.5 – 15 kW (IP20)		1 (IP20)
7.5 – 11 kW (IP66)		1 (IP66)
15 kW (IP66)		4 (IP66)
18.5 – 30 kW	0.8	4
37 – 45 kW		15
55 – 110 kW		20

## 5.3 Mechanical Installation

### 5.3.1 IP20 Housing: Installation and Clearances

Inverters with degree of protection IP20 must be installed in a control cabinet. Observe the following requirements:

- The control cabinet must be made of a heat conductive material unless it has forced cooling.
- When using a control cabinet with ventilation openings, the openings must be provided above and underneath the inverter to allow for unobstructed circulation of air. The air must be supplied underneath the inverter and dissipated above it.
- If the inverter is operated in environments with particles of dirt (such as dust), ventilation openings either have to be equipped with a suitable particle filter or forced cooling has to be used. The filter has to be serviced and cleaned.
- In environments with a high level of humidity, salt or chemicals, a suitable enclosed control cabinet (without ventilation openings) must be used.
- The inverters with degree of protection IP20 can be installed right next to each other without clearance.

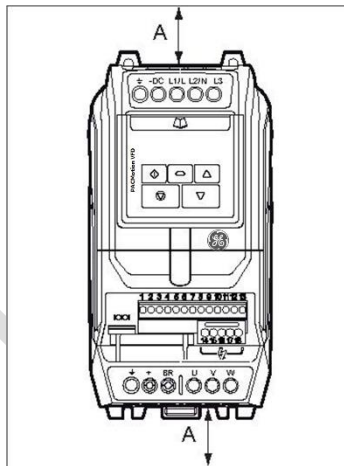


Figure 7: IP20 Clearance Diagram

Power of the inverter	A (in mm)	Air flow rate per inverter
<b>230V:</b> 0.75 kW, 1.5 kW	60	> 45 m <sup>3</sup> /h
<b>400V:</b> 0.75 kW, 1.5 kW, 2.2 kW		
<b>575V:</b> 0.75 – 5.5 kW		
<b>230V:</b> 2.2 kW	100	> 45 m <sup>3</sup> /h
All other power ranges	100	> 80 m <sup>3</sup> /h

### 5.3.2 IP55/IP66 Housing: Installation and Control Cabinet Dimensions

Inverters with degree of protection IP55/IP66 can be used indoors.

In control cabinets or in field installations, the following minimum clearances must be observed.

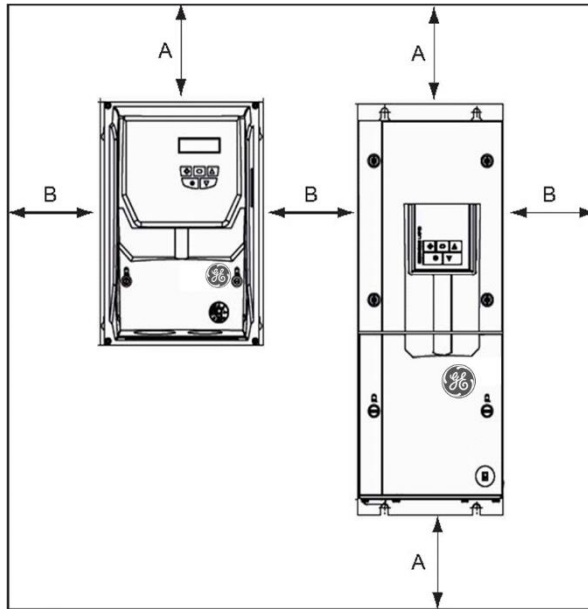


Figure 8: IP55/IP66 Clearance Diagram

Power of the Inverter	A (in mm)	B (in mm)
<b>230V</b>		
0.75 – 4 kW	100	10
5.5 – 75 kW	200	10
<b>400V</b>		
0.75 – 7.5 kW	100	10
11 – 160 kW	200	10
<b>575V</b>		
0.75 – 11 kW	100	10
15 – 110 kW	200	10

**Note:** If the IP55/IP66 inverter is installed in a control cabinet, sufficient control cabinet ventilation must be ensured.

## 5.4 Electrical Installation



### Warning

Electric shock due to charged capacitors. Dangerous voltage levels may still be present inside the device and at the terminals up to 10 minutes after disconnection from the power supply.

- Severe or fatal injuries may result.
- Wait 10 minutes after you have de-energized the inverter and have switched off the line voltage and the 24Vdc voltage. Do not start working on the device until you have made sure that it is de-energized.



### Warning

Danger of fatal injury due to falling hoist.

- Severe or fatal injuries may result.
- The inverter is not designed for use as a safety device in lifting applications. Use monitoring systems or mechanical protection devices to ensure safety.

- The inverters may only be installed by electrical specialists in compliance with the applicable directives and regulations.
- The grounding cable must be designed for the maximum fault current of the voltage source that is usually limited by fuses or motor protection switches.
- The inverter has the degree of protection IP20. For a higher IP degree of protection, a suitable enclosure or the IP55/NEMA 12K or the IP66/NEMA 4X variant has to be used.
- Make sure the devices are properly grounded. Refer to Section 5.5, [Wiring Diagrams](#).

### 5.4.1 Prior to Installation

- Make sure that supply voltage, frequency, and number of phases (single- or three-phase) correspond with the nominal values of the inverter on delivery.
- A disconnecting switch or similar disconnecting element must be installed between voltage supply and inverter.
- Never connect the power supply to the output terminals U, V or W of the inverter.
- Do not install contactors between inverter and motor. Adhere to a minimum clearance of 100 mm at points where control cables and electric power lines are installed close to each other, and an angle of 90° for crossing cables.
- The cables are only protected by slow-blow high-power fuses or motor circuit breaker. You find more information in Section 5.4.6, [Permitted Voltage Supply Systems](#).
- It is recommended that you use a 4-core PVC-insulated and shielded cable as the power cable. Route this cable according to the applicable national regulations of the industry sector as well as the rules and standards. Conductor end sleeves are required for connecting the power cables to the inverter.
- Make sure that shielding and sheaths of power cables are designed according to the wiring diagram shown in Figure 17 through Figure 21.
- The grounding terminal of each inverter must be connected individually and **directly** to the ground busbar (mass) of the installation site (via filter, if available).
- Do not loop the ground connections of the inverter from one inverter to the other. Neither route the ground connections to the inverters from other inverters.
- The impedance of the ground circuit must comply with the local safety regulations of the industry sector.
- Make sure that all terminals are tightened with the appropriate tightening torques. Refer to Section 5.2, [Permitted Tightening Torques](#).
- To comply with UL regulations, all earth connections must be designed with UL-listed crimping cable lugs. Inverters generate suitable fast-switching output voltages (PWM) to the motor. In the case of motors wound for operation with adjustable-speed drives, no further preventive actions are necessary. If the quality of the insulation is unknown, however, contact the manufacturer of the motor as preventive measures may be required.

**Note:** Make sure that the earth connections are properly connected. The inverter can generate leakage currents > 3.5mA. The grounding cable must be sufficiently dimensioned to carry the maximum fault current of the voltage source that is usually limited by fuses or miniature circuit breakers. Sufficiently rated fuses or miniature circuit breakers must be integrated into the inverter's mains supply in accordance with local laws and/or regulations.

## 5.4.2 Line Contactors

Use only line contactors in utilization category AC-3 (EN 60947-4-1).  
Make sure to wait at least 30 seconds between 2 switching cycles.

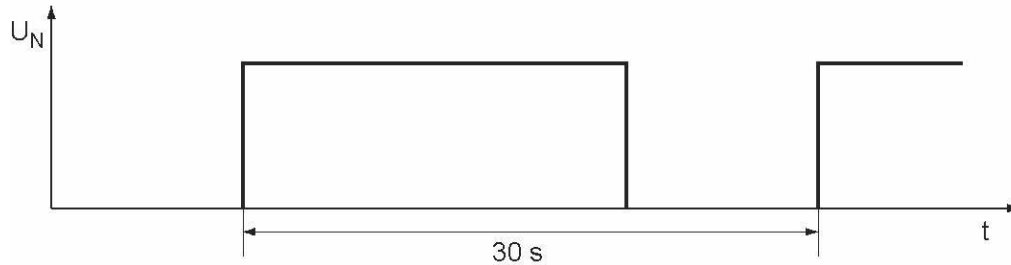


Figure 9: 30-second Switching Delay

## 5.4.3 Mains Fuses

Fuse types:

- Line protection types in operation classes gL, gG:
  - Rated fusing voltage  $\geq$  rated line voltage
  - The nominal fusing current must be designed for at least 100% of the inverter nominal input current depending on the inverter utilization.
- Power circuit breaker with characteristic B:
  - Nominal circuit breaker voltage  $\geq$  nominal line voltage
  - The nominal currents of the power circuit breakers must be 10% higher than the nominal inverter current.

### Residual Current Device



**Warning**

No protection against electric shock if an incorrect type of residual current device is used.

- Severe or fatal injuries may result.
- Use only universal current sensitive residual current devices of type B for inverters.

- Inverters generate a DC current component in the leakage current and can significantly reduce the sensitivity of a residual current device of type A. A type A residual current device is thus not permitted as protection device.
- If the use of a residual current device is not mandatory according to the standards, GE Automation & Controls recommends not to use a residual current device.



### 5.4.4 Operation on an IT System

- IP20 devices can be operated on the IT system as described below. Please contact GE Automation & Controls for all other devices.

For operation on the IT system, the connection of the overvoltage protection and the EMC filter to PE has to be separated. Unscrew the EMC and VAR screws from the side of the device (Figure 10).



**Warning**

Danger of electric shock.

Dangerous voltage levels may still be present inside the inverter and at the terminals for a period of up to 10 minutes after disconnecting the power supply.

- Severe or fatal injuries may result.
- Disconnect the inverter from the power supply at least 10 minutes prior to unscrewing the EMC and VAR screws.

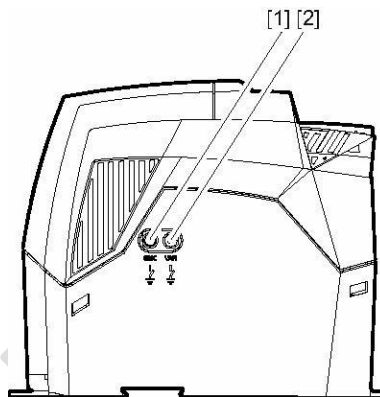


Figure 10: Location of EMC and VAR screws

[1] EMC screw

[2] VAR screw

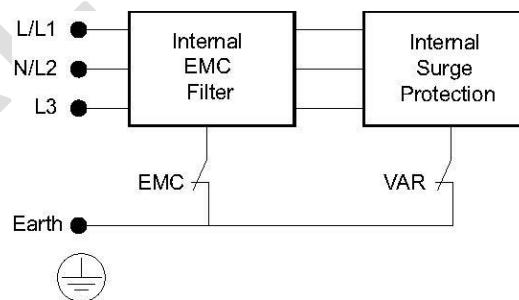


Figure 11: Installation with Respect to Earth Ground

GE Automation & Controls recommends using earth-leakage monitors with pulse code measurement in voltage supply systems with a non-grounded star point (IT systems). Use of such devices prevents the insulation monitor from inadvertently tripping due to the earth capacitance of the inverter.

### 5.4.5 Operation on a TN System with an RCD Switch (IP20)

IP20 inverters with an integrated EMC filter (such as PACMotion IC855-xxxx-xAx-2x or PACMotion IC855-xxxx-xBx-2x) have a higher leakage current than devices without EMC filter. The EMC filter may cause errors when operated with a RCCB. Deactivate the EMC filter to reduce the leakage current. To do so, unscrew the EMC and VAR screws from the side of the device. Refer to Figure 10.

### 5.4.6 Permitted Voltage Supply Systems

#### Voltage Supply Systems with Grounded Star Point

Inverters with all degrees of protection are intended for operation on TN and TT systems with directly grounded star point.

#### Voltage Supply Systems with Non-Grounded Star Point

Operation on voltage supply systems with non-grounded star point (for example IT systems) is only permitted for inverters with degree of protection IP20. Refer to Section 5.4.4, *Operation on an IT System*.

#### Voltage Systems with Grounded Outer Conductor

On voltage supply systems, the inverters with all degrees of protection may only be operated with a maximum phase-to-ground voltage of 300Vac.

### 5.4.7 Help Card

The help card contains an overview of the terminal assignment and additionally an overview of the basic parameters of parameter group 1.

In the IP55/IP66 housing, the help card is attached behind the removable front cover.

In the IP20 housing, the help card is inserted in a slot above the display.

### 5.4.8 Removing the Terminal Cover

To access the terminals of inverters with degree of protection IP55/IP66, remove the front cover of the frequency inverter. Only use cross-head or slot screwdrivers to open the terminal cover.

The connection terminals can be accessed when the screws on the front of the product are removed as shown below.

Reattach the front cover by proceeding in reverse order.

#### **Inverters with Degree of Protection IP66/NEMA 4X**

The following inverters have the housing shown in Figure 12:

Nominal line voltage	Power of the inverter
230V	0.75 – 4 kW
400V	0.75 – 7.5 kW
575V	0.75 – 11 kW

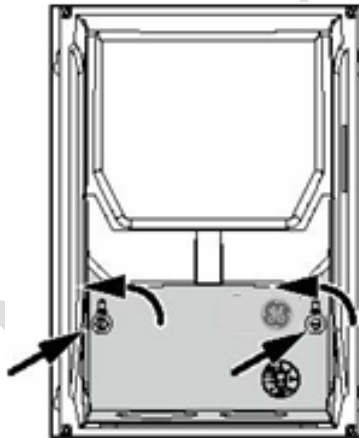


Figure 12: Remove Front Cover from IP66/NEMA 4X Inverter

### Inverters with Degree of Protection IP55/NEMA 12K

The following inverters have the housing shown in Figure 13:

Nominal line voltage	Power of the inverter
----------------------	-----------------------

230V	5.5 – 75 kW
------	-------------

400V	11 – 160 kW
------	-------------

575V	15 – 110 kW
------	-------------

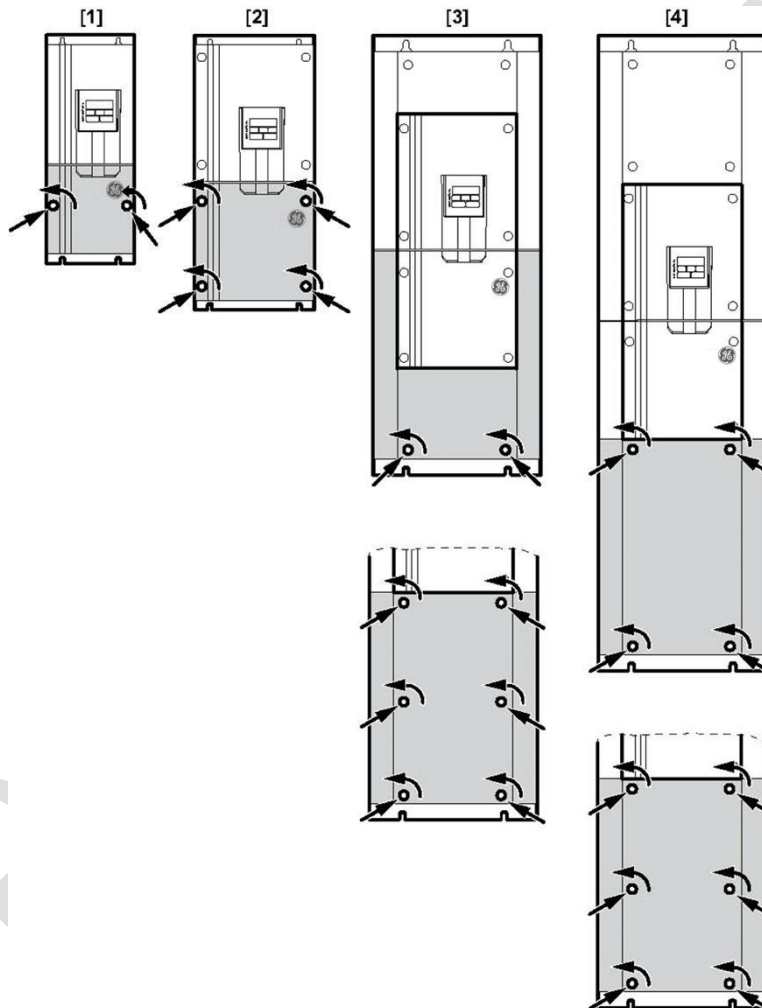


Figure 13: Remove Front Cover from IP55/NEMA 12K Inverter

- [1] • 230V 5.5 – 11 kW
- 400V: 11 – 22 kW
- 575V: 15 – 30 kW
- [2] • 230V: 15 – 18.5 kW
- 400V: 30 – 37 kW
- 575V: 37 – 45 kW

- [3] • 230V: 22 – 45 kW
- 400V: 45 – 90 kW
- 575V: 55 – 110 kW
- [4] • 230V: 55 – 75 kW
- 400V: 110 – 160 kW

### 5.4.9 Cable Gland Plate

A suitable cable gland system is required to maintain the respective IP/NEMA degree of protection. Cable entry holes have to be drilled that correspond to this system.



**Caution**

Drilling cable entry holes may lead to particles entering the inverter.

- Possible damage to property may result.
- When drilling holes, take care to prevent particles from entering the inverter.
- When drilling operation has been completed, remove all particles in and around the inverter.

Some guide sizes are listed below:

#### Recommended Hole Sizes and Hole Types for the Cable Gland

Power of the inverter	Hole size	Imperial	Metrical
230V: 0.75 – 4 kW 400V: 0.75 – 7.5 kW 575V: 0.75 – 11 kW	25 mm	PG16	M25

#### Hole Sizes for Flexible Electrical Installation Ducts

Power of the inverter	Hole size	Commercial size	Metrical
230V: 0.75 – 4 kW 400V: 0.75 – 7.5 kW 575V: 0.75 – 11 kW	35 mm	1 in	M25

An IP degree of protection is only ensured when the cables are installed with a bushing or sleeve for a flexible electrical installation duct approved by UL.

When installing electrical installation ducts, the insertion holes of the duct must have standard openings for the required sizes according to NEC specifications.

Not intended for rigid electrical installation ducts.

### 5.4.10 Connecting and Installing the Braking Resistor

Select an internal braking resistor (see Chapter 17) or an external braking resistor (discussed in this section). If using a third-party braking resistor, be sure to install according to the manufacturer's instructions. The braking resistor needs to be installed in a manner that will dissipate the heat which the braking resistor will experience. The resultant heat may endanger equipment operators and service technicians: take care to place the braking resistor where it will present the least risk.



#### Warning

Danger of electric shock.

The supply cables to the braking resistors carry a high voltage (approx. 900Vdc) during rated operation.

- Severe or fatal injuries may result.
- Before removing the supply cable, disconnect the inverter from the power supply and wait at least 10 minutes.



#### Warning

Risk of burns. The surfaces of the braking resistors get very hot when the braking resistors are loaded with  $P_N$ .

- Minor to significant injuries may result.
- Choose a suitable installation location.
- Do not touch the braking resistors.
- Install a suitable touch guard.

Connect the braking resistor between the inverter terminals "BR" and "+" (Figure 14). When shipped from the factory, these terminals are protected with a cover that needs to be broken out prior to first use.

- Shorten the cables on the braking resistor to the required length.
- Use two tightly twisted leads or a 2-core shielded power cable. The cable cross section has to be dimensioned according to the tripping current  $I_F$  of F16, the nominal voltage according to DIN VDE 0298.
- Protect the braking resistor with a bimetallic relay and set the tripping current  $I_F$  of the respective braking resistor.
- Certain flat-type external braking resistors have internal thermal overload protection (fuse cannot be replaced). Install the flatpack resistors using appropriate touch guards supplied by the manufacturer.
- For braking resistors in the IC855-BW... series<sup>1</sup>, you can connect the integrated temperature sensor using a 2-core, shielded cable as an alternative to a bimetallic relay.

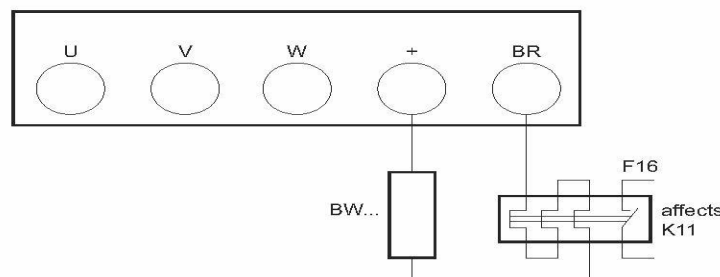


Figure 14: Connection of Braking Resistor

<sup>1</sup> For a complete list of available Braking Resistors, refer to [Appendix A](#).

### 5.4.11 Motor Temperature Protection TF, TH, KTY84, PT1000

Motors with internal temperature sensor (TF, TH, KTY84, PT1000 or similar) can be directly connected to the inverter.

If the thermal protection is triggered, the inverter displays the error "F-PTC".

For motor protection monitoring, the following types can be selected:

- PTC-th for thermal sensor TF or bimetallic switch TH with trigger threshold 2.5kΩ
- KTY84 in temperature classes B (120 °C), F (155 °C) and H (180 °C)
- PT1000 in temperature classes B (120 °C), F (155 °C) and H (180 °C)

When parameter P2-33 is configured for motor protection, this setting automatically overwrites the function selection of the digital inputs (P1-15) to analog input AI2 = motor protection.

**Note:** Configure the temperature sensor on the inverter using P2-33, before the temperature sensor is connected. Then, connect the temperature sensor according to the wiring diagram. Incorrect connection may lead to damage of sensor or inverter.

For information regarding the parameter P2-33, refer to Section [P2-33 Analog Input 2 Format / Motor Protection](#) in Chapter 11.

Connection examples for various temperature sensors:

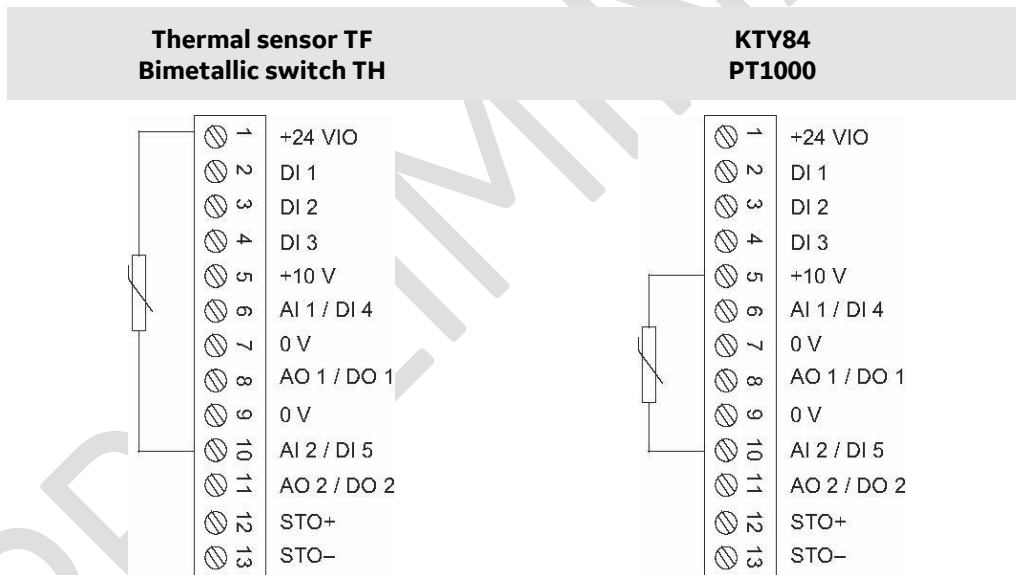


Figure 15: Temperature Sensor Connection Example 1

P2-33 = PTC-th

Figure 16: Temperature Sensor Connection Example 2

P2-33 = KTY84 or PT1000 (B, F, H)

### 5.4.12 Multi-Motor Drive/Group Drive

The total of the motor currents must not exceed the nominal current of the inverter. The maximum permitted cable length for the group is limited to the values of single connection. Refer to the group tables in Chapter 12, *Technical Data*.

The motor group is limited to five motors and must not differ by more than 3 frame sizes.

Multi-motor operation is only possible with AC asynchronous motors, not with synchronous motors.

GE Automation & Controls recommends use of an output choke, additionally unshielded cables, and a maximum permitted output frequency of 4kHz for groups of more than 3 motors.

### 5.4.13 Motor Cables and Fusing

Comply with the regulations issued by specific countries and for specific machines regarding fusing and the selection of supply system leads and motor cables.

Determine the permitted length of all motor cables connected in parallel as follows:

$$l_{tot} \leq \frac{l_{max}}{n}$$

where

$l_{tot}$  = Total length of the motor cables connected in parallel

$l_{max}$  = Recommended maximum motor cable length

$n$  = Number of motors connected in parallel

No additional fusing is required if the cross section of the motor cable corresponds to the cross section of the supply system lead. If the cross section of the motor cable is smaller than the cross section of the supply system lead, you must protect the motor cable against a short circuit for the corresponding cross section. Motor protection switches are suited to this purpose.

### 5.4.14 Connecting AC Brake Motors

AC Brake systems are disk brakes with a DC coil that releases electrically. The brake then engages using spring force. A brake rectifier supplies the brake with DC voltage.

**Note:** The brake rectifier must have a separate supply system cable for inverter operation. Supply via the motor voltage is expressly not permitted.



### 5.4.15 UL-Compliant Installation

Note the following information for UL-compliant installation:

#### Ambient Temperatures

The inverters can be operated at the following ambient temperatures:

Degree of protection	Ambient temperature
IP20/NEMA 1	-10 °C to 50 °C
IP55/NEMA 12K	-10 °C to 40 °C
IP66/NEMA 4X	

Use only copper connection cables suited for ambient temperatures up to 75°C.

#### Tightening Torques for the Power and Control Terminals

Refer to Section 5.2, *Permitted Tightening Torques* for the permitted tightening torques for the inverters.

#### External 24Vdc supply

Use only certified devices with a limited output voltage ( $U_{\max} = 30\text{Vdc}$ ) and limited output current ( $I \leq 8\text{ A}$ ) as an external 24Vdc voltage source.

#### Voltage Supply Systems and Fusing

The inverters are suitable for operation in voltage supply systems with earthed star point (TN and TT systems) that can supply a maximum line current and a maximum line voltage in accordance with the following table. The fuses listed in the following tables are the maximum permitted fuses for each inverter. Only use melting fuses.

UL certification does not apply to operation in voltage supply systems with a non-grounded star point (IT systems).

#### 1 × 200 – 240V devices

1 × 200 – 240V	Fuse or MCB (type B)	Max. supply short circuit current	Max. line voltage
0008	15 A	100 kA rms (AC)	240V
0015	20 A		
0022	25 A		

**3 × 200 – 240V devices**

<b>3 × 200 – 240V</b>	<b>Fuse or MCB (type B)</b>	<b>Max. supply short circuit current</b>	<b>Max. line voltage</b>
0008	10 A	100 kA rms (AC)	240V
0015	15 A		
0022	17.5 A		
0030	30 A		
0040	30 A		
0055	40 A		
0075	50 A		
0110	70 A		
0150	90 A		
0185	110 A		
0220	150 A		
0300	175 A		
0370	225 A		
0450	250 A		
0550	300 A		
0750	350 A		

**3 × 380 – 480V devices**

<b>3 × 380 – 480V</b>	<b>Fuse or MCB (type B)</b>	<b>Max. supply short circuit current</b>	<b>Max. line voltage</b>
0008	6 A	100 kA rms (AC)	480V
0015	10 A		
0022	10 A		
0040	15 A		
0055	25 A		
0075	30 A		
0110	40 A		
0150	50 A		
0185	60 A		
0220	70 A		
0300	80 A		
0370	100 A		
0450	125 A		
0550	150 A		
0750	200 A		
0900	250 A		
1100	300 A		
1320	350 A		
1600	400 A		

**3 × 500 – 600V devices**

<b>3 × 500 – 600V</b>	<b>Fuse or MCB (type B)</b>	<b>Max. supply short circuit current</b>	<b>Max. line voltage</b>
0008	6 A	100 kA rms (AC)	600V
0015	6 A		
0022	10 A		
0040	10 A		
0055	15 A		
0075	20 A		
0110	30 A		
0150	35 A		
0185	45 A		
0220	60 A		
0300	70 A		
0370	80 A		
0450	100 A		
0550	125 A		
0750	150 A		
0900	175 A		
1100	200 A		

**Thermal Motor Protection**

The inverter is provided with thermal motor overload protection according to NEC (National Electrical Code, US).

Thermal motor overload protection shall be provided by one of the following means:

- NEC compliant installation of a motor temperature sensor. Refer also to Section 5.4.11, *Motor Temperature Protection TF, TH, KTY84, PT1000*.
- Using internal thermal motor overload protection by activating parameter P4-17.

### 5.4.16 Information Regarding UL

**Note:** Due to UL requirements, the following sections are always printed in English, regardless of the language used in the revised document.

#### Thermal Motor Protection

Thermal motor overload protection shall be provided by one of the following means:

- NEC compliant installation of a motor temperature sensor. Refer also to Section 5.4.11, *Motor Temperature Protection TF, TH, KTY84, PT1000*.
- Using internal thermal motor overload protection according to NEC (National Electrical Code, US). Thermal motor overload protection can be activated via parameter P4-17.
- Implementing external measures to ensure thermal motor overload protection according to NEC (National Electrical Code).

#### Parameter

The following additional parameter was added to PACMotion inverters to implement internal thermal motor protection according to NEC:

- P4-17 Thermal motor protection according to NEC
  - 0: disabled
  - 1: enabled

#### Functional Principle

The motor current is accumulated in an internal memory over the course of time. The inverter goes to fault state as soon as the thermal limit is exceeded (I.t-trP).

Once the output current of the inverter is less than the set rated motor current, the internal memory is decremented depending on the output current.

- When P4-17 is disabled, thermal memory retention is reset upon shutdown or power loss.
- When P4-17 is enabled, thermal memory retention is maintained upon shutdown or power loss.

### 5.4.17 Electromagnetic Compatibility (EMC)

Inverters with EMC filters are designed for use in machines and drive systems. They meet the EMC product standard EN 61800-3 for drives with variable speed. Observe the specifications of Directive 2014/30/EU for EMC-compliant installation of the drive system.

#### Interference Immunity

With regard to interference immunity, the frequency inverter with an EMC filter meets the limit values defined in the standard EN 61800-3 and can therefore be used for both industrial and domestic (light industrial) applications.

#### Interference Emission

With regard to interference emission, the inverter meets the EMC limit values of the standard EN 61800-3:2004. The inverters are suitable for industrial as well as household applications (light industry).

Install the inverters as specified in Chapter 5, *Installation*, to ensure best possible electromagnetic compatibility. Ensure proper ground connections for the inverters. Use shielded motor cables to comply with the specifications on interference emission.

The conditions for use in drive applications are defined in the table below.

Inverter type	Cat. C1 (class B)	Cat. C2 (class A)	Cat. C3
<b>in accordance with EN 61800-3</b>			
230V, 1-phase IC855-xxxx 2B1-x-xx	No additional filtering required. Use a shielded motor cable.		
230V, 3-phase IC855-xxxx 2A3-x-xx	Use an external filter. Use a shielded motor cable.	No additional filtering required. Use a shielded motor cable.	
400V, 3-phase IC855-xxxx 5A3-x-xx			
575V, 3-phase IC855-xxxx 603-x-xx	If necessary, you can use a line filter to minimize the electromagnetic interference emission. However, compliance with the limit classes cannot be guaranteed. Use a shielded motor cable.		

## Best Practices for EMC Compliant Installations

Points to be observed with reference to Figure 17:

- Mounting panel should consist of electrically conductive metal.
- Mounting panel needs to be grounded.
- To ensure good grounding, remove excess paint at the point where the ground strap attaches, and use a star washer to ensure good contact between ground strap and metal panel. Tighten the connection in anticipation of vibration.
- Do not run signal and power signals in parallel. Maintain separation wherever they do come into close proximity. Preference is to have them cross at right angles, where crossing cannot be avoided.
- Use twisted pair shielded cables for analog control and motor feedback signals.
- Use shielded motor cables and take care to ensure good grounding of the shield (a) to the control system mounting panel and (b) to the motor chassis, as diagrammed.
- Maintain the shield as far as possible along the length of the cable run, right up to the terminals.
- Ensure the drain wire is secured to its designated terminal at both ends.

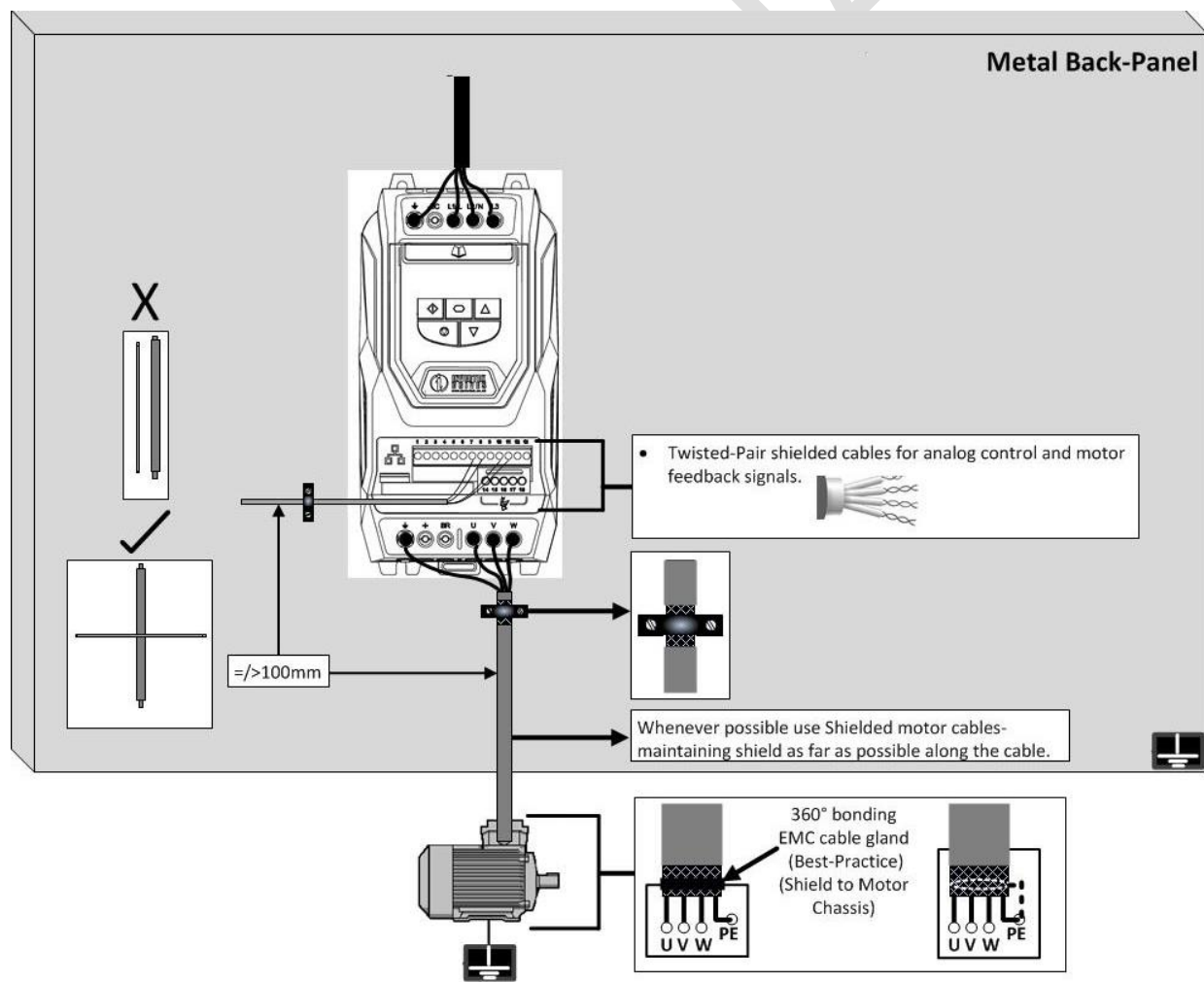


Figure 17: Best Practices for EMC-Compliant Installation

### General Information about Connecting the Motor Shield

Connect the shield by the shortest possible route and make sure it is earthed over a wide area at both ends. This also applies to cables with several shielded core strands.

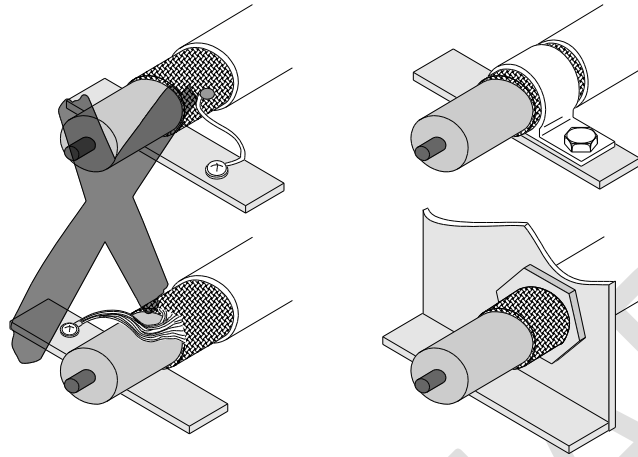


Figure 18: Recommended Usage of Shield Plate

PRELIMINARY

### Recommendation for Wire Dressing for IP20 Frequency Inverters

The following inverters have the housing shown in Figure 19:

#### Inverters with degree of protection IP20/NEMA 1

Nominal line voltage	Power of the inverter
230V	0.75 – 5.5 kW
400V	0.75 – 11 kW
575V	0.75 – 15 kW

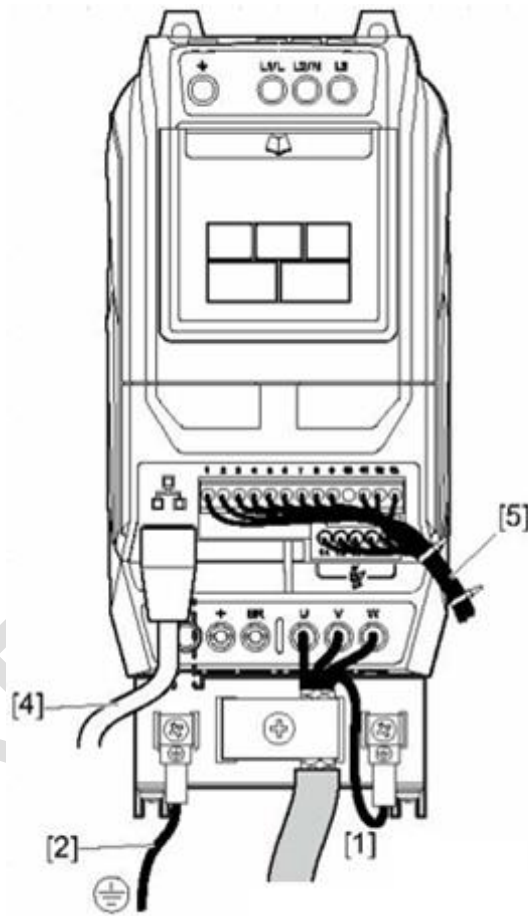


Figure 19: Example Cabling for IP20/NEMA 1 Inverters

- |                              |                              |
|------------------------------|------------------------------|
| [1] Motor cable              | [4] Communication cable RJ45 |
| [2] Additional PE connection | [5] Control cables           |



**Recommendation for Wire Dressing for IP55/IP66 Frequency Inverters**

The use of metal screw fittings is recommended to connect the motor shield to the device. For the inverters listed below, the threads must be at least 8 mm.

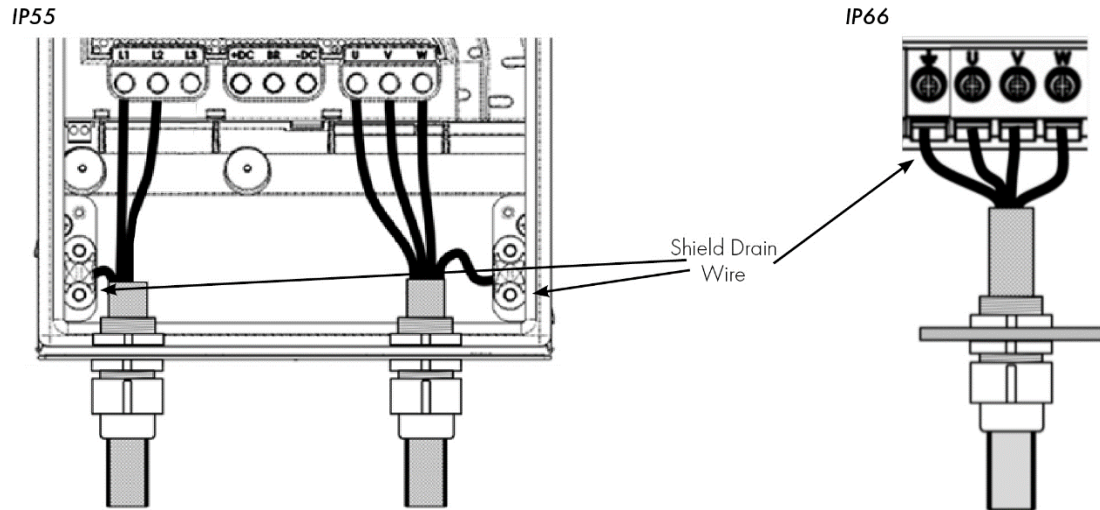


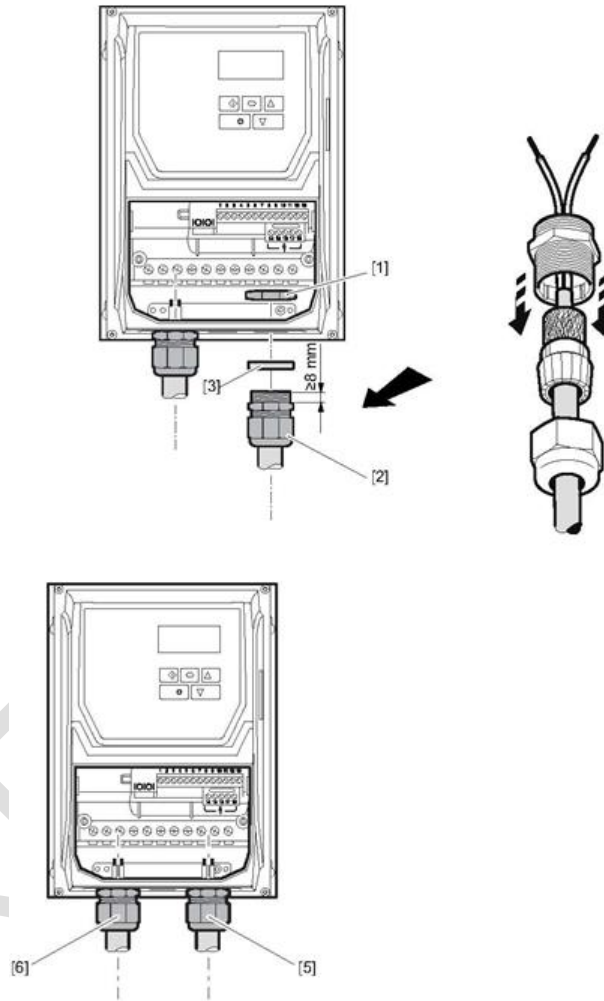
Figure 20: Enclosed Drives - Recommended Cable Connections

PRELIMINARY

The following inverters have the housing shown in Figure 21:

**Inverters with degree of protection IP66/NEMA 4X**

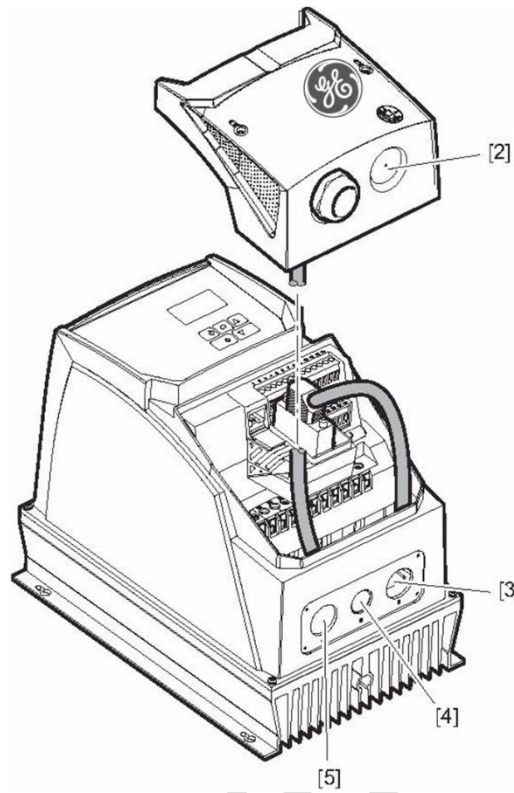
Nominal line voltage	Power of the inverter
230V	0.75 – 4 kW
400V	0.75 – 7.5 kW
575V	0.75 – 11 kW



**Figure 21: Example Cabling for IP66/NEMA 4X Inverters**

- |                            |                         |
|----------------------------|-------------------------|
| [1] Metal counter nut      | [4] Not shown           |
| [2] Metal cable gland      | [5] Motor cable         |
| [3] Enclosed rubber gasket | [6] Supply system cable |

**Recommendation for Routing the Control and Communication Cables**



**Figure 22: Routing the Control and Communication Cables**

- |                                   |                                   |
|-----------------------------------|-----------------------------------|
| [1] Not applicable.               | [4] Signal terminal/communication |
| [2] Signal terminal/communication | [5] Supply system cable           |
| [3] Motor cable                   |                                   |

The following inverters have the housing shown in Figure 23:

**Inverters with degree of protection IP55/NEMA 12K**

Nominal line voltage	Power of the inverter
230V	5.5 – 18.5 kW
400V	11 – 37 kW
575V	15 – 45 kW

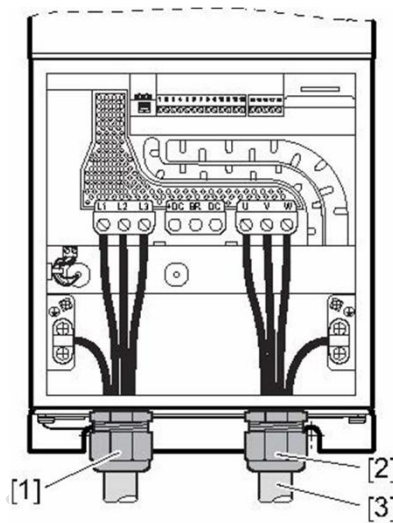


Figure 23: Example 1: Cabling for IP55/NEMA 12K Inverters

- [1] Supply system cable
- [2] Metal cable gland
- [3] Motor cable

The following inverters have the housing shown in Figure 24:

Inverters with degree of protection IP55/NEMA 12K	
Nominal line voltage	Power of the inverter
230V	22 – 75 kW
400V	45 – 160 kW
575V	55 – 110 kW

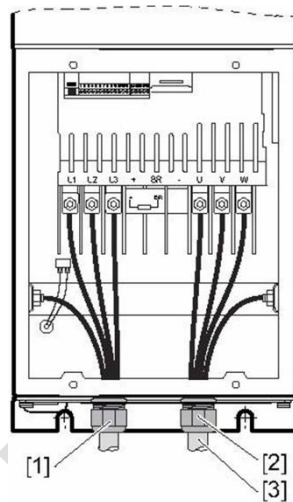


Figure 24: Example 2: Cabling for IP55/NEMA 12K Inverters

- [1]Supply system cable
- [2]Metal cable gland
- [3]Motor cable

## 5.4.18 Overview of Signal Terminals

### Main Terminals



#### Caution

Applying voltages of more than 30Vdc to the signal terminals can damage the controller.

- Possible damage to property may result.
- The voltage applied to the signal terminals must not exceed 30Vdc.

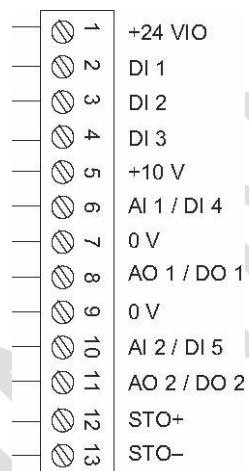


Figure 25: Signal Terminal Block

The signal terminal block (Figure 25) is equipped with the following connections:

Terminal	Signal	Connection	Description
1	+24 VIO	+24Vdc: Reference voltage /backup voltage	Reference voltage for controlling the digital inputs (max. 100mA) <sup>2</sup> Adhere to the <i>Note for Connecting the STO function</i> , below.
2	DI 1	Digital Input 1	Positive logic
3	DI 2	Digital Input 2	"Logic 1" input voltage range: 8 – 30Vdc "Logic 0" input voltage range: 0 – 2 Vdc
4	DI 3	Digital Input 3	Compatible with PLC requirement if 0V is connected to terminal 7 or 9.

<sup>2</sup> With inverter operation with fieldbus option, terminal 1 can be used to supply the backup voltage.

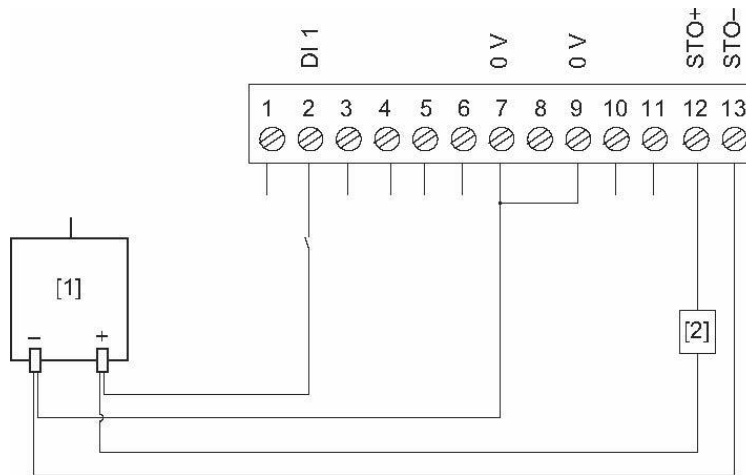
Terminal	Signal	Connection	Description
5	+10Vdc	Output +10Vdc: Reference voltage	10Vdc: Reference voltage for analog input (Potential supply +, 10mA max., 1 – 10kΩ)
6	AI 1 / DI 4	Analog Input 1 (12-bit) Digital Input 4	Analog: 0 – 10Vdc, 10 – 0Vdc, -10 – 10Vdc, 0 – 20mA, 4 – 20mA, 20 – 4mA Digital: "Logic 1" input voltage range: 8 – 30Vdc
7	0V	0V: Reference potential	Adhere to the <a href="#">Note for Connecting the STO function</a> , below.
8	AO 1 / DO 1	Analog Output 1 (10-bit) Digital Output 1	Analog: 0 – 10Vdc, 10 – 0Vdc, 0 – 20mA, 20 – 0mA, 4 – 20mA, 20 – 4mA Digital: 0 / 24Vdc maximum output current: 20mA
9	0V	0V: Reference potential	Adhere to the <a href="#">Note for Connecting the STO function</a> , below.
10	AI 2 / DI 5	Analog Input 2 (12-bit) Digital Input 5 / thermistor contact	Analog: 0 – 10Vdc, 10 – 0Vdc, PTC-th, 0 – 20mA, 4 – 20mA, 20 – 4mA, KTY84, PT1000 Digital: "Logic 1" input voltage range: 8 – 30Vdc
11	AO 2 / DO 2	Analog Output 2 (10-bit) Binary Output 2	Analog: 0 – 10Vdc, 10 – 0Vdc, 0 – 20mA, 20 – 0mA, 4 – 20mA, 20 – 4mA Digital: 0 / 24Vdc maximum output current: 20mA
12	STO+	Output stage enable	+24Vdc input, max. 100mA current consumption STO safety contact, high = 8 – 30Vdc Adhere to the <a href="#">Note for Connecting the STO function</a> , below.
13	STO-		GND reference potential for +24Vdc input STO safety contact Adhere to the <a href="#">Note for Connecting the STO function</a> , below.

All digital inputs are enabled with an input voltage in the range of 8 – 30Vdc. This means they are +24Vdc compatible.

The response time of the digital and analog inputs is less than 4ms. The resolution of the analog inputs is 12 bits at an accuracy of ±2% with reference to the configured maximum scaling.

**Note for Connecting the STO function**

If terminal 12 is permanently supplied with 24Vdc, and terminal 13 is permanently connected to GND, then the STO function is permanently disabled.



**Figure 26: Connections for Disabling the STO Function**

[1] External 24Vdc supply

[2] Optional safety relay



## Relay Terminals

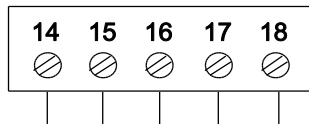


Figure 27: Relay Terminals



**Caution**

Possible damage to property may result.  
Do not connect any inductive loads to the relay contact.

Terminal	Signal	Relay function selection	Description
14	Relay Output 1 reference	<i>P2-15</i>	Relay contact (250Vac / 30Vdc, max. 5A)
15	Relay Output 1 NO contact		
16	Relay Output 1 NC contact		
17	Relay Output 2 reference	<i>P2-18</i>	
18	Relay Output 2 NO contact		

### 5.4.19 Communication Socket RJ45

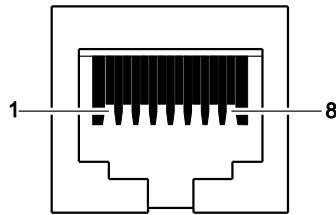


Figure 28: RJ45 Socket at the Device

- [1]Reserved
- [2]Reserved
- [3]0V
- [4]RS485- (engineering)
- [5]RS485+ (engineering)
- [6]+24Vdc (output voltage/backup voltage)
- [7]RS485- (Modbus RTU)
- [8]RS485+ (Modbus RTU)

### 5.4.20 24Vdc Backup Mode

The inverter allows for realizing a backup mode via external 24Vdc. This means the control electronics and the option cards such as the fieldbus cards are fully functional even when the power supply is switched off.

#### Requirements

Firmware version 1.20 (can be seen in PO-28).

#### Range of Functions

- Parameter access (reading only, no writing)
- Fieldbus communication

#### Setting up 24Vdc Backup Mode

All inverters that are connected to each other in a communication network and use the 24Vdc backup mode have to be supplied simultaneously with external 24Vdc. Make sure that individual devices that are connected in the network are not separated from 24Vdc.

**Note:** Errors in the fieldbus network may occur if the inverters are not supplied by the power supply and individual devices that are in the RJ45 network or the optional fieldbus network are separated from the 24Vdc supply. Make sure that all connected inverters are always supplied with external 24Vdc at the same time.

#### Example of a wiring diagram

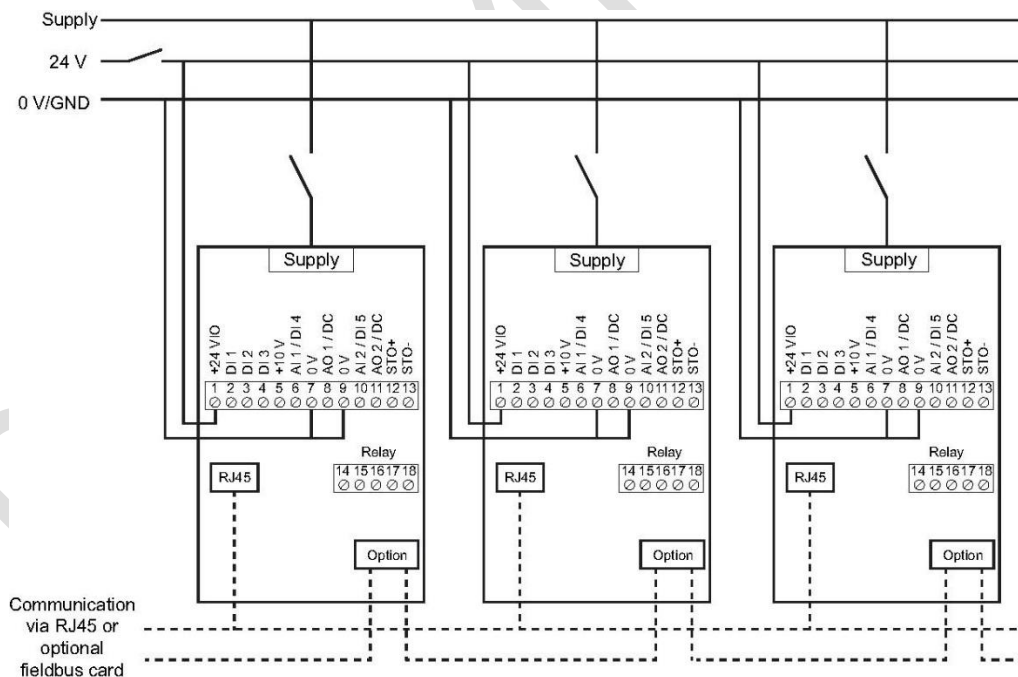


Figure 29: Example Wiring Diagram

### **5.4.21 DC Link Connection**

The DC link is routed on terminals for all power ratings. It is thus possible to couple all devices with a DC link connection or to directly supply them with DC voltage.

Contact GE Automation & Controls in such a case.

PRELIMINARY

## 5.5 Wiring Diagrams

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### Warning

Danger of electric shock.

Incorrect wiring can lead to dangerously high voltages.

- Severe or fatal injuries may result.
- Adhere to the following.

In the following applications, always cut-off the brake in the AC and DC circuits:

- All lifting applications.
  - Applications that require a quick brake reaction time.
- 

Please note the following:

- The following inverters with degree of protection IP66/NEMA 4X already have openings for supply system, motor and control cables.
  - 230V: 0.75 – 4 kW
  - 400V: 0.75 – 7.5 kW
  - 575V: 0.75 – 11 kW
- The following inverters with degree of protection IP55/NEMA 12K are equipped with a metal entry board. The user may drill the cable entries according to his requirements.
  - 230V: 5.5 – 75 kW
  - 400V: 11 – 160 kW
  - 575V: 15 – 110 kW
- Connect the brake rectifier using a separate supply system lead.
- Supply via the motor voltage is not permitted.

**Note:** In case of a new device, the terminal slots DC-, + (DC+) and BR have a cover installed that may be broken out, if required.

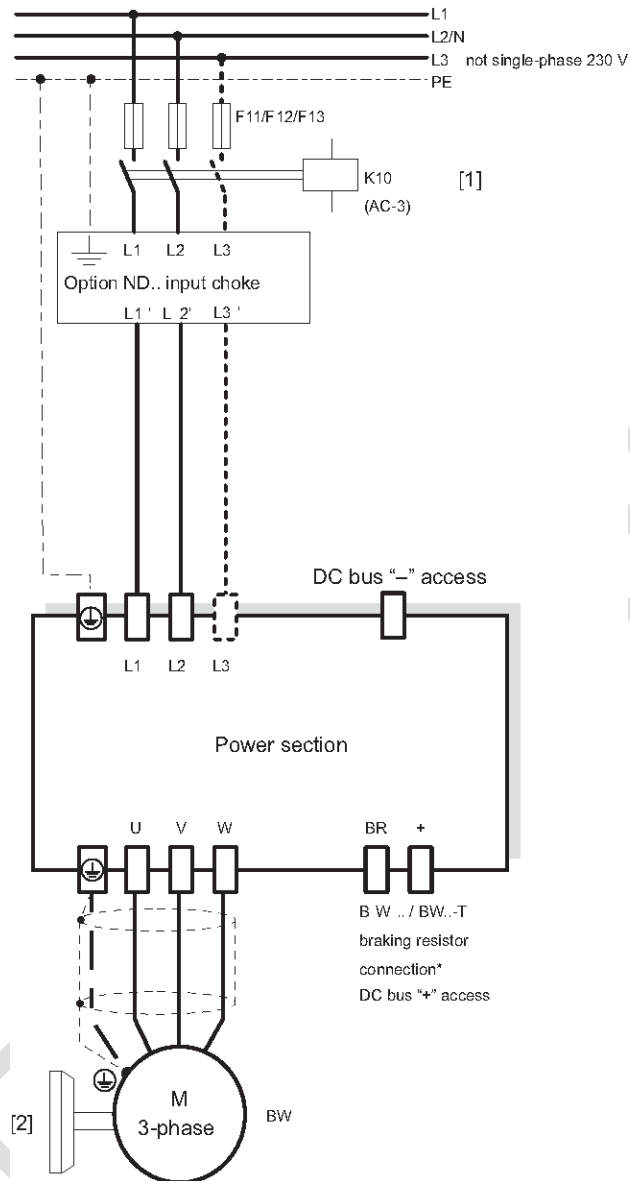


Figure 30: Inverter Power and Brake Power Wiring

[1] Line contactor between supply system and inverter.

[2] Brake

### 5.5.1 Brake Control

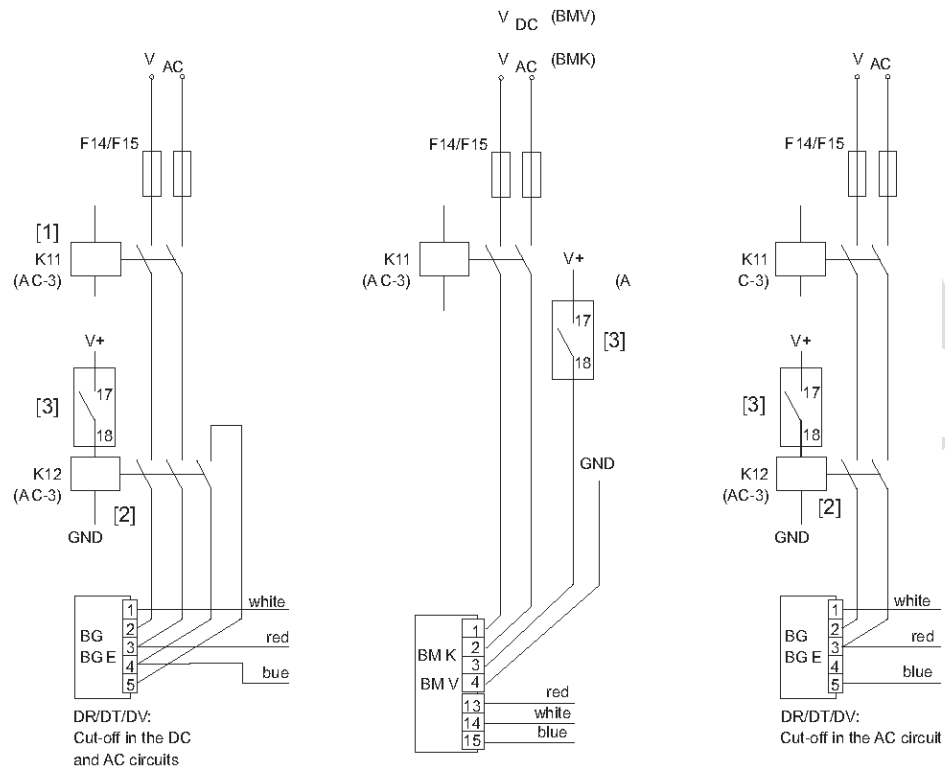


Figure 31: Wiring Options for Brake Control

- [1] Power supply of the brake rectifier, switched simultaneously via K10.
- [2] Control contactor/control relay, is powered by the internal relay contact [3] of the inverter and supplies the brake rectifier.
- [3] Isolated relay contact of the inverter.
- V+ External voltage supply 250Vac / 30Vdc at max. 5A
- V<sub>DC</sub> (BMV) DC voltage supply BMV.
- V<sub>AC</sub> (BMK) AC voltage supply BMK.

## Chapter 6 Configuration

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Drives, once equipped with an Option Card (refer to Appendix A-2), are capable of being installed on the corresponding network or fieldbus. Alternately, they may operate on an RS-485 network without an Option Card. The configuration required is different for each network or fieldbus. In this section, configuration for PROFINET is detailed, as it is the most likely configuration to be encountered.

A typical installation that involves one or more PACMotion Drives and PACSystems Controllers will involve PROFINET. This arrangement requires installing a PROFINET Option Card into each drive (refer to Section 15.4.5, *PROFINET IO Option Card* and Section 15.1, *Installation of an Option Card*, then configuring each device so it can operate on its intended network.

### 6.1 Configuration Tools

The following tools will be encountered:

- Proficy Machine Edition (PME): used to configure the PACSystems Controller and associated I/O. The VFD Drives will be treated as I/O Devices within the Controller framework. PME is also used to develop logic that resides in the controller, and to monitor the application. Refer to Section 6.2.
- PROFINET DCP: This is a discovery tool launched from within PME. It is used for PROFINET networks only. Refer to Section 6.2.
- PACMotion VFD Studio: this is also launched from within PME. It is used to perform PACMotion VFD commissioning activities. Refer to Section 6.3. Note that PME Release 9.50 SIM10 incorporates this functionality.

### 6.2 PROFINET Configuration Steps

The following steps are required:

- 1) Attach the computer running Proficy Machine Edition (PME) to the PACSystems Controller to be configured.
- 2) Configure the PROFINET Controller with which the drives will be communicating. This may be an embedded PROFINET Controller or a rack-mounted PROFINET Controller. Refer to the *PACSystems RX3i & RSTi-EP PROFINET I/O Controller Manual*, GFK-2571 for details.
- 3) Once the supervising PROFINET Controller has been set up, each associated drive may be set up as node on that network.
  - a. Attach the computer running PME to the PROFINET network to be configured.
  - b. Right-click on the target PROFINET Controller to bring up the drop-down menu below.



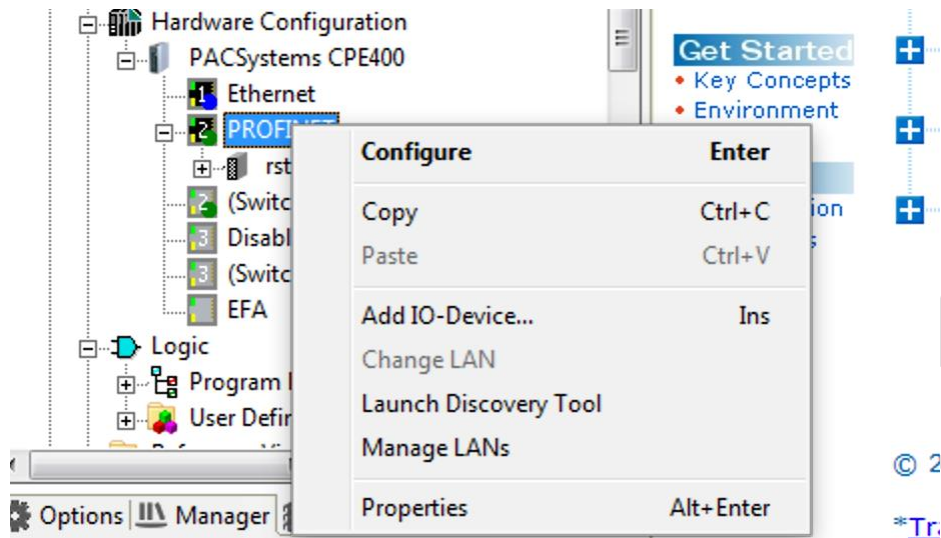


Figure 32: Adding an IO-Device to a PROFINET Network

- c. Click on Add IO-Device

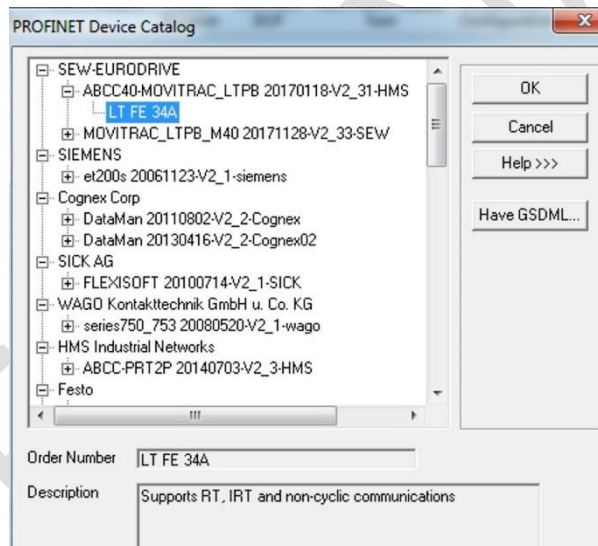


Figure 33: Select Drive from PROFINET Device Catalog

- d. From the PROFINET Device Catalog, select the model of the drive to be networked at the current node (Figure 33).
  - e. If the specific PACMotion VFD model does not show up in the Device Catalog. Access the GE Support website to download the corresponding PACMotion VFD GSDML file. Then select *Have GSDML*, then browse to the folder containing the GSDML file.<sup>3</sup>
  - f. Select the current version of the GSDML file, then add that device at the current node.
  - g. Click OK (Figure 33) to complete the device addition.
  - h. Repeat steps 3)a through 3)g until all drives have been attached to this particular network.
- 4) Under *Utilities*, launch the PROFINET Discovery Tool (PROFINET DCP - Figure 34).

<sup>3</sup> Current GSDML files are:

for Drives containing v40 PROFINET interface card: GSDML-V2.31-HMS-ABCC-PRT2P-20171021.xml



Figure 34: Launch PROFINET DCP Tool

- 5) Click on the *Refresh Device List* button to develop a list of devices on that network.

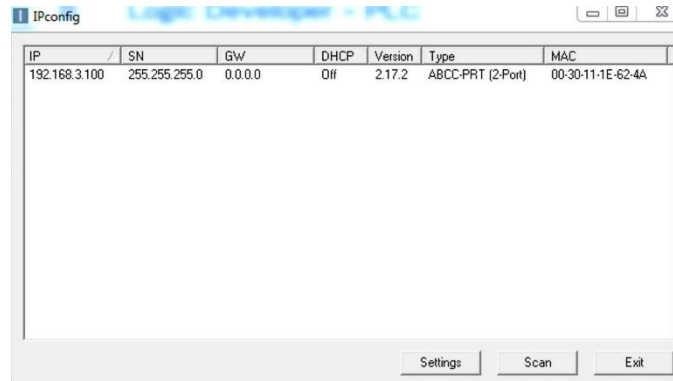


Figure 35: List of Discovered Devices on PROFINET Network

- 6) Click on the row (Figure 35) representing the drive to which a Device Name is to be assigned.

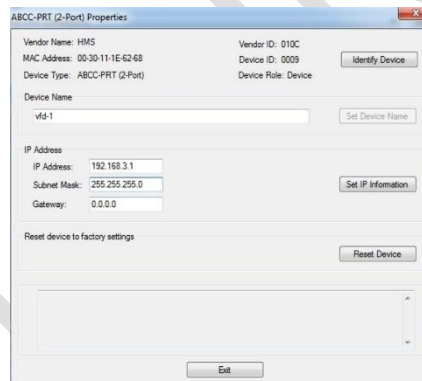


Figure 36: Set Device Name &amp; (Optionally) IP Address

- 7) Assign a valid Device Name (Figure 36) by keying in a suitable Device Name, then click on the *Set Device Name* button. Device names permitted consist of lower case alphas, combined with digits and hyphens. In the event an incompatible character is entered, the *Set Device Name* button will be grayed out.

**Note:** The Device Name must be unique on the PROFINET network to which the device will be connected.

- 8) It is possible to manually enter the IP Address and Subnet Mask on the same form (Figure 36). However, this can be done automatically at a later stage, and waiting till then will avoid the chance of assigning conflicting IP Addresses, which the network cannot tolerate.

**Note:** The IP Address must also be within the range of IP Addresses assigned to the supervising PROFINET Controller. This range is set within the PME Hardware Configuration.

- 9) The Device Name assigned to the device (in step 7) must also be entered into the PROFINET Network Configuration contained within PME's Hardware Configuration (Figure 37). It is critical that these two values match. To accomplish this, choose the VFD within the Network tree, choose the appropriate Device from the tree and assign the Device Name (Figure 37).



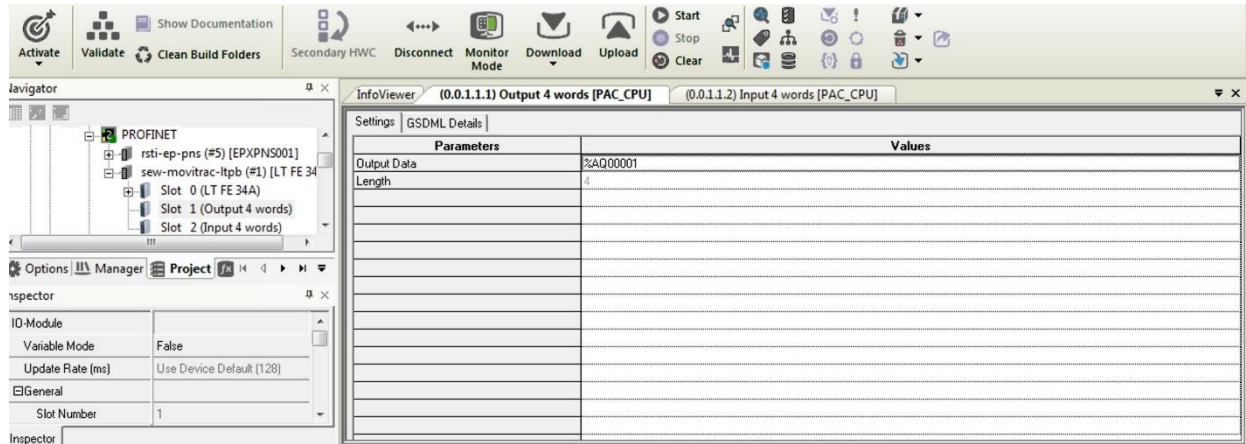


Figure 39: Analog Output (%AQ) Assignment

- 12) Once all devices connected to the PROFINET Controller have been assigned a valid Device Name, launch PACMotion VFD Studio from PME to perform VFD commissioning activities

## 6.3 Commissioning using PACMotion VFD Studio

Certain parameters in the drives need to be set up prior to operation. There are a number of ways to accomplish this:

- 1) VFD can be manually configured
  - a) via the built-in keypad (refer to Section 7.1.1, *Keypads*) or
  - b) via the OLED Keypad accessory (refer to Section 7.1.1, *Keypads*).
- 2) Via the Bluetooth Parameter Module (refer to Chapter 1. ).
- 3) Via PACMotion VFD Studio, which is a Utility launched from Proficy Machine Edition, and is discussed in this section.

### 6.3.1 Launch PACMotion VFD Studio

The PACMotion VFD Studio is launched in the same way as any other Utility in PME. Refer to Figure 34.

### 6.3.2 Connect PACMotion VFD Studio to Target Drive

The PC running PACMotion VFD Studio may be connected to the drive to be commissioned

- a) Via the USB to RS-485 adaptor (IC855-CABL-USB485) (refer to Figure 46)
- b) Via Bluetooth (refer to Figure 47).

### 6.3.3 Establish Communications between PACMotion VFD Studio & Drive

- 1) Once launched, use the drop-down menu to select the communication method already set up:

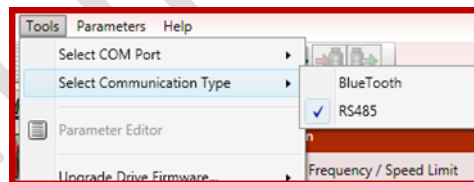


Figure 40: Select Communications Method for PACMotion VFD Studio

- 2) For RS-485, establish which PC port will be used:

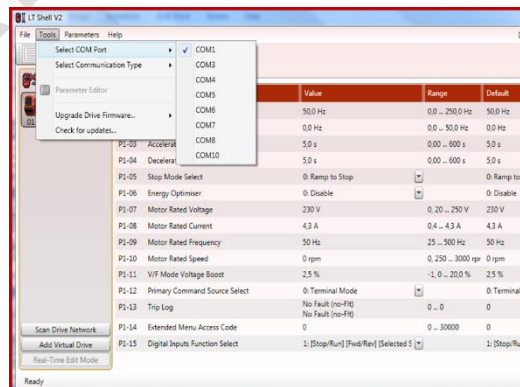


Figure 41: Select PC Comm Port

- 3) For Bluetooth, follow the procedure documented below Figure 47.

- 4) Scan the drive network



Figure 42: Scan Network Drive from PACMotion VFD Studio

### 6.3.4 PACMotion VFD Studio Functionality

#### Parameter Editor

- Write Parameters from PC to VFD drive
- Read Parameters from VFD Drive to PC device

#### Drive Monitor Tool

This feature allows the user to view all parameters live.

#### Scope Tool

Use the Scope tool to trigger and trace Actual Speed and Digital Inputs:

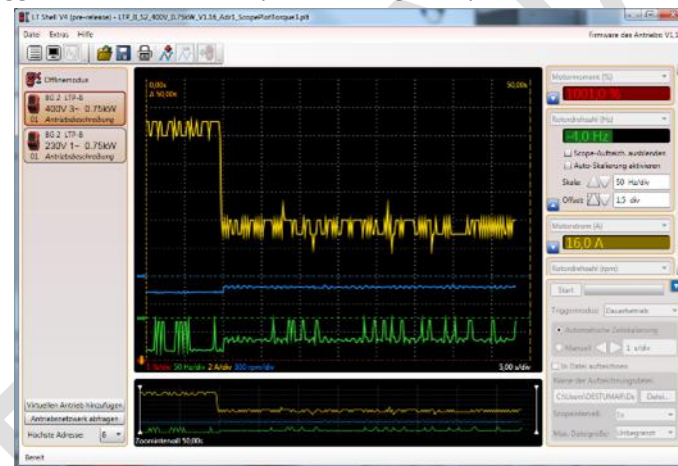


Figure 43: PACMotion VFD Studio Scope Tool

#### Next Steps

It is possible to set up all parameters from VFD Studio. Under some circumstances, it may be necessary to auto-tune the motor using the keypad on the drive.

Once all steps have been completed using VFD Studio, connect the motor to the drive and, using the built-in keypad on the drive, follow the instructions in Section 7.3, *Start-Up for Motors*.



## Chapter 7 Start-Up

### 7.1 User Interface

#### 7.1.1 Keypads

The inverters in IP20 design are equipped with a standard keypad.

The inverters in IP55/IP66 design are equipped with a full text display with language switching function.

Both keypads allow for operation and setup of the inverter without additional devices.

#### Standard Keypad

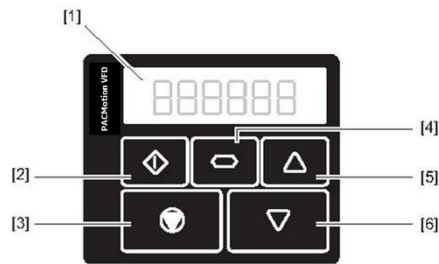


Figure 44: Standard Keypad

- |                               |                     |
|-------------------------------|---------------------|
| [1] 6-digit 7-segment display | [4] Navigate button |
| [2] Start button              | [5] Up button       |
| [3] Stop/Reset button         | [6] Down button     |

#### Keypad with Full Text Display

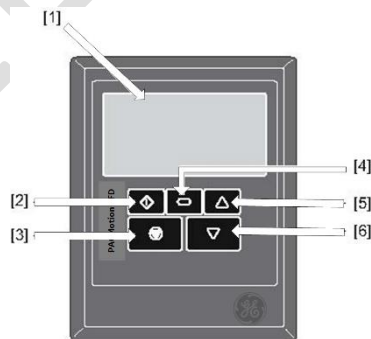







Figure 45: Keypad with full text display

- |                                      |                     |
|--------------------------------------|---------------------|
| [1] Full text display (multilingual) | [4] Navigate button |
| [2] Start button                     | [5] Up button       |
| [3] Stop/Reset button                | [6] Down button     |



## Operation

Both keypads have 5 keys with the following functions:

- |     |   |              |   |
|-----|---|--------------|---|
| Key |    | Start [2]    | <ul style="list-style-type: none"><li>• Enable drive</li><li>• Changing the direction of rotation</li></ul>                           |
| Key |    | Stop [3]     | <ul style="list-style-type: none"><li>• Stop drive</li><li>• Acknowledge error</li></ul>  |
| Key |    | Navigate [4] | <ul style="list-style-type: none"><li>• Switch menu</li><li>• Save parameter values</li><li>• Display real-time information</li></ul> |
| Key |    | Up [5]       | <ul style="list-style-type: none"><li>• Increase speed</li><li>• Increase parameter values</li></ul>                                  |
| Key |  | Down [6]     | <ul style="list-style-type: none"><li>• Decrease speed</li><li>• Decrease parameter values</li></ul>                                  |

The parameter edit menu can only be accessed by pressing the <Navigate> key [4].

- To switch between the menu for changing parameters and real-time display (operating speed/operating current): keep the key pressed for longer than 1 second.
- Switch between operating speed and operating current of the running inverter: press the key briefly (< 1 second).

The operating speed is only displayed if a nominal motor speed has been entered in P1-10. Otherwise, the electrical rotating field speed is displayed.





### **Switching the language at the keypad with full text display**

To switch the language in the full text display, press the <Start> key and the <Upwards arrow> key simultaneously. The inverter must not be enabled during this operation.

The list of available languages is now displayed.













### 7.1.2 Resetting Parameters to Default Settings

To reset the parameters to the factory setting, proceed as follows:

1. The inverter must not be enabled and the display must show "Inhibit".
2. Press the 3 keys , , and  simultaneously for at least 2 s.  
"P-deF" appears on the display.
3. Press the  key to acknowledge the "P-deF" message.

**Note:** If the inverter is set to the factory settings, the <Start> and <Stop> keys of the keypad are disabled. To enable using the <Start>/<Stop> keys on the keypad, set the parameter P-12 to "1" or "2".

### 7.1.3 Key Combinations

Function	The device displays:	Press:	Result	Example
Quick parameter group selection <sup>4</sup>	Px-xx	<Navigate> + <Up> keys  + 	The next higher parameter group is selected.	"P1-10" is displayed: <ul style="list-style-type: none"> <li>• Press the &lt;Navigate&gt; + &lt;Up&gt; keys.</li> <li>• Now, "P2-01" is displayed.</li> </ul>
	Px-xx	<Navigate> + <Down> keys  + 	The next lower parameter group is selected.	"P2-26" is displayed: <ul style="list-style-type: none"> <li>• Press the &lt;Navigate&gt; + &lt;Down&gt; keys.</li> <li>• "P1-01" is now displayed.</li> </ul>
Selection of the lowest group parameter	Px-xx	<Up> + <Down> keys  + 	The first parameter of a group is selected.	"P1-10" is displayed: <ul style="list-style-type: none"> <li>• Press the &lt;Up&gt; + &lt;Down&gt; keys.</li> <li>• "P1-01" is now displayed.</li> </ul>
Set the parameter to the lowest value	Numerical value (when changing a parameter value)	<Up> + <Down> keys  + 	The parameter is set to the lowest value.	When changing P1-01: <ul style="list-style-type: none"> <li>• "50.0" is displayed.</li> <li>• Press the &lt;Up&gt; + &lt;Down&gt; keys.</li> <li>• "0.0" is now displayed.</li> </ul>
Changing individual digits of a parameter value	Numerical value (when changing a parameter value)	<Stop/reset> + <Navigate> keys  + 	The individual parameter digits can be modified.	When changing P1-10: <ul style="list-style-type: none"> <li>• "0" is displayed.</li> <li>• Press the &lt;Stop/reset&gt; + &lt;Navigate&gt; keys.</li> <li>• "_0" is now displayed.</li> <li>• Press the &lt;Up&gt; key.</li> <li>• "10" is now displayed.</li> <li>• Press the &lt;Stop/reset&gt; + &lt;Navigate&gt; keys.</li> <li>• "_10" is now displayed.</li> <li>• Press the &lt;Up&gt; key.</li> <li>• "110" is now displayed.</li> </ul> etc.
Switching languages	Select language	<Start> and <Up>  + 	The desired language can be selected now.	<ul style="list-style-type: none"> <li>• English</li> <li>• German</li> <li>• French</li> <li>• Spanish</li> <li>• .....</li> </ul>

<sup>4</sup> Parameter group access must be activated: Set P1-14 to "101" or "201".

### 7.1.4 PACMotion VFD Studio

PACMotion VFD Studio is used to configure and monitor the parameters in the PACMotion Drives. This software is launched from GE's Programming and Configuration software, Proficy Machine Edition (PME). Using a GSDML file, data is exchanged between the drive and PACMotion VFD Studio. The nature of the data exchanged is configurable.

PME Version 9.50 SIM 10 is required for this functionality.

The physical connection between the computer running PME/ PACMotion VFD Studio and the drive may be

- a) via Ethernet or Ethernet-based Fieldbus (example discussed below)
- b) via a serial port (Figure 46)
- c) via Bluetooth (Figure 47)

Proficy Machine Edition (PME) software provides the user with a means of configuring the supervising Programmable Controller (PLC or PACSystem). For instance, the PACSystems CPU may have a PROFINET Controller within its configuration. The Inverters may then be attached as nodes on the available PROFINET network(s). Additionally, PME permits certain elements of the Inverter to be configured within tables associated with its supervising PROFINET Controller, which will then be downloaded and/or checked with the target device prior to data exchange.

PME software is also used to write the application-level program in the programmable controller. It may be written in a number of languages, including ladder logic or "C". It controls the overall application. For additional information on PLC programming, refer to the *PACSystems RX7i, RX3i and RSTi-EP CPU Programmer's Reference Manual*, GFK-2950.

Connect the inverter to the computer running PME as discussed below.

The maximum number of drives on a bus depends on the type of Fieldbus involved. For instance, on an RS-485 network, a maximum of 63 drives can be connected.

The PACMotion VFD Studio software may be used to carry out the following tasks:

- Observe, upload and download parameters.
- Save parameter settings.
- Firmware update (manual and automatic).
- Export inverter parameters to an rtf file, which may be imported into Microsoft® Word.
- Monitor the state of the inputs and outputs and the motor.
- Control inverter/manual mode.
- Scope.

### Connection to the Computer running PME

Connect the drive to the computer running PME in one of two ways:

- a) Via a USB to RS485 adapter (IC855-CABL-USB485), as shown in Figure 46. Connect the USB connector to the PC, and insert the jack end into the RS-485 port of the drive. This connection provides electrical isolation between the PC and the drive. Note that some PCs may not be able to supply sufficient power to the USB port. If that is the case, a powered USB hub will also be required.
- b) Via the Bluetooth® parameter module IC855-BLUE (Figure 47). This is a future product offering. It is presented here for completeness of connection methods. Further details will be provided once available.

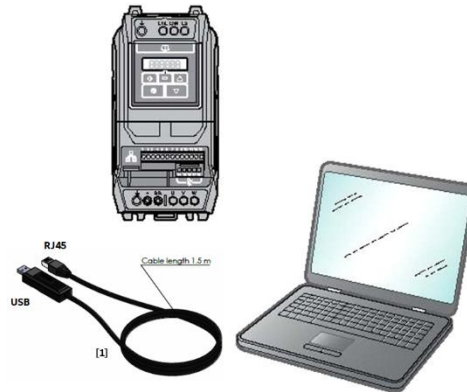


Figure 46: Isolated USB 2.0 to RS-485 Connection Drive to Computer

[1] IC855-CABL-USB485

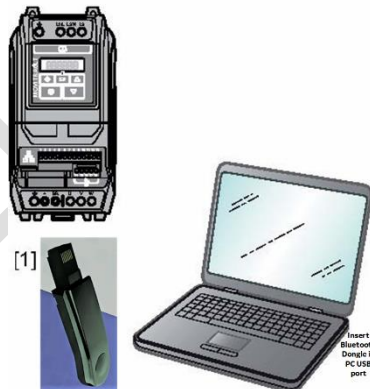


Figure 47: Bluetooth Connection Inverter to Computer

[1] IC855-BLUE Bluetooth module

### Bluetooth Communication

- Insert Bluetooth dongle (supplied with the Bluetooth Parameter Module) into any USB port on the PC. Pair Bluetooth stick with your PC: code „0000“
- Select comm port
- Select communication type – Bluetooth
- Read parameters from Bluetooth Parameter Module

- Save parameter set to Bluetooth Parameter Module
- Write parameter set to Bluetooth Parameter Module: press red dot on Bluetooth stick while performing this task.

PRELIMINARY

## 7.2 Auto Tune

With the automatic measuring procedure, the inverter can measure almost any motor to determine the motor data.

- After a reset to the factory settings, the measuring procedure starts automatically after the first enable and takes up to 2 minutes depending on the control type. Do not interrupt the measuring procedure.
- You can also start the automatic measuring procedure "Auto tune" manually with the parameter *P4-02* after entering the motor data. Only enable the inverter after you have entered all motor data correctly in the parameters.
- For STO, the terminals 12 and 13 have to be supplied with voltage. Enable is not required. "Stop" has to be displayed.

**Note:** Perform an automatic measuring procedure "Auto tune" after the initial start-up or after changing the control mode in *P4-01* when the motor is cold. You can also start auto-tuning manually via the parameter *P4-02* at any time.

## 7.3 Start-Up for Motors



### Warning

When parameter *P4-02* is set to "1" (auto tune) the motor may start up automatically.

- Severe or fatal injuries may result.
- Make sure that no persons are within reach of moving parts of the system.

**Note:** The ramp times in parameters *P1-03* and *P1-04* refer to 50Hz. If *P1-16* is set to "In-Syn", overload capacity is set to "150%" depending on *P1-08*.

### 7.3.1 Start-Up for Asynchronous Motors with V/f Control

1. Connect the motor to the inverter. During the connection, adhere to the nominal motor voltage.
2. Enter the motor data indicated on the motor nameplate:
  - *P1-07* = nominal voltage of the motor
  - *P1-08* = rated current of the motor
  - *P1-09* = rated frequency of the motor
  - *P1-10* = rated speed of the motor
    - Value = 0: Slip compensation deactivated
    - Value ≠ 0: Slip compensation activated
3. Set the maximum and minimum speed using *P1-01* and *P1-02*.
4. Set the acceleration and deceleration ramps using *P1-03* and *P1-04*.
5. Start the automatic measurement procedure as described in Section 7.2, *Auto Tune*.

### 7.3.2 Start-Up for Asynchronous Motors with VFC Speed Control

1. Connect the motor to the inverter. During the connection, adhere to the nominal motor voltage.
2. Enter the motor data indicated on the motor nameplate:
  - *P1-07* = nominal voltage of the motor
  - *P1-08* = rated current of the motor
  - *P1-09* = rated frequency of the motor
  - *P1-10* = rated speed of the motor
  - *P1-14* = 201 (Extended parameter menu)
  - *P4-01* = 0 (VFC speed control)
  - *P4-05* = power factor.
3. Set the maximum and minimum speed using *P1-01* and *P1-02*.
4. Set the acceleration and deceleration ramps using *P1-03* and *P1-04*.
5. Start the automatic motor measurement procedure as described in Section 7.2, *Auto Tune*.
6. In case of insufficient control performance, the control behavior can be optimized via the parameter *P7-10*.



### 7.3.3 Start-Up for Asynchronous Motors with VFC Torque Control

1. Connect the motor to the inverter. During the connection, adhere to the nominal motor voltage.
2. Enter the motor data indicated on the motor nameplate:
  - *P1-07* = nominal voltage of the motor
  - *P1-08* = rated current of the motor
  - *P1-09* = rated frequency of the motor
  - *P1-10* = rated speed of the motor
  - *P1-14* = 201 (Extended parameter menu)
  - *P4-01* = 1 (VFC torque control)
  - *P4-05* = power factor.
3. Set the maximum and minimum speed using *P1-01* and *P1-02*.
4. Set the acceleration and deceleration ramps using *P1-03* and *P1-04*.
5. Start the automatic motor measurement procedure as described in Section 7.2, [Auto Tune](#).
6. In case of insufficient control performance, the control behavior can be optimized via the parameter *P7-10*.

#### Example:

The following example shows analog input 2 as torque reference source, analog input 1 sets the speed:

- *P1-15* = 3 (input terminal assignment)
- *P4-06* = 2 (Torque reference via analog input 2)
- *P6-17* = 0 (Switching off the torque timeout threshold)  
= >0 (Adjusting the timeout time for the maximum torque limit)

### 7.3.4 Start-Up of Synchronous Motors without Encoder Feedback (PMVC Control)

Synchronous motors are permanent magnet motors.

**Note:** The operation of synchronous motors without encoder must be checked in a test application. Stable operation in this operating mode cannot be ensured for all application cases. Using this operating mode is thus in the sole responsibility of the user.

1. Connect the motor to the inverter. During the connection, adhere to the nominal motor voltage.
2. Enter the motor data indicated on the motor nameplate:
  - $P1-07$  = For synchronous motors, not the system voltage is set, but the internal voltage for nominal motor speed.
  - $P1-08$  = rated current of the motor
  - $P1-09$  = rated frequency of the motor
  - $P1-10$  = rated speed of the motor
  - $P1-14$  = 201 (Extended parameter menu)
  - $P4-01$  = 3 (PMVC speed control)
  - $P2-24$  = PWM frequency (at least 8–16kHz).
3. Set the maximum and minimum speed using  $P1-01$  and  $P1-02$ .
4. Set the acceleration and deceleration ramps using  $P1-03$  and  $P1-04$ .
5. Start the automatic motor measurement procedure as described in Section 7.2, [Auto Tune](#).
6. In case of insufficient control performance, the control behavior can be optimized via the parameter  $P7-10$ .  
In case of unexpected motor control problems, check or set the following:
  - To achieve a higher torque in the lower speed range, the parameters  $P7-14$  and  $P7-15$  must be increased. Note that the motor may heat up significantly due to the increased current flow.
  - Sometimes it may be required to align the rotor of motors with higher inertia before the start. The pre-magnetization time  $P7-12$  as well as the field strength during the pre-magnetization time can be slightly adjusted up or down in  $P7-14$ .

In rare cases, it can be helpful to compare the parameters determined in the automatic motor measurement procedure to the parameters of the motor data. Correct them if necessary. Note that the values may deviate in case of long motor cables.

No repeated measuring procedure is required:

- $P7-01$  = stator resistance of the motor ( $R_{\text{phase-phase}}$  or  $2 \times R_1(20^\circ\text{C})$ )
- $P7-02$  = 0 (Rotor resistance of the motor)
- $P7-03$  = Stator inductance (Lsd)
- $P7-06$  = Stator inductance (Lsq).

## 7.4 Start-Up of Control



### Warning

Installing sensors or switches at the terminals may cause an enable signal. The motor may start up automatically.

- Severe or fatal injuries may result.
- Make sure that no persons are within reach of moving parts of the system.
- Install the switches in open state.
- If installing a potentiometer, set it to 0 first.

### 7.4.1 Terminal Mode (Factory Setting) $P1-12 = 0$

For operation in terminal mode (factory setting):

- $P1-12$  must be set to "0" (factory setting).
- Change the input terminal configuration according to your demands in  $P1-15$ . Refer to Section [P1-15 Digital Input Function Selection](#) in Chapter 11 for the possible settings.
- Connect a switch between terminals 1 and 2 on the user terminal block.
- Connect a potentiometer (1 k – 10 k) between terminals 5, 6 and 7. The center tap is connected to terminal 6.
- Connect the terminals 12 and 13 of the STO input according to Section 13.3.2, [Disconnection of a Single Drive](#).
- Enable the inverter by establishing a connection between terminals 1 and 2.
- Set the speed using the potentiometer.

### 7.4.2 Keypad Mode ( $P1-12 = 1$ or $2$ )

For operation in keypad mode:

- Set  $P1-12$  to "1" (unidirectional) or "2" (bi-directional).
- Connect a jumper or switch between terminals 1 and 2 on the terminal block to enable the inverter.
- Connect the terminals 12 and 13 of the STO input according to Section 13.3.2, [Disconnection of a Single Drive](#).
- Press the <Start> key. The inverter is enabled with 0.0Hz.
- To increase the speed, press the <Up> key. To decrease the speed, press the <Down> key.
- To stop the inverter, press the <Stop/reset> key.
- To resume to the original speed, press the "Start" key again. If bi-directional mode is enabled ( $P1-12 = 2$ ), the direction is reversed by pressing the <Start> key again.

**Note:** Preset the required target speed by pressing the <Stop/reset> key at standstill. Pressing the <Start> key then moves the drive along the preset ramp until it has reached the required speed.

### 7.4.3 PID Controller Mode (P1-12 = 3)

The implemented PID controller can be used for temperature control, pressure control or other applications. The following figure shows the configuration options for the PID controller.

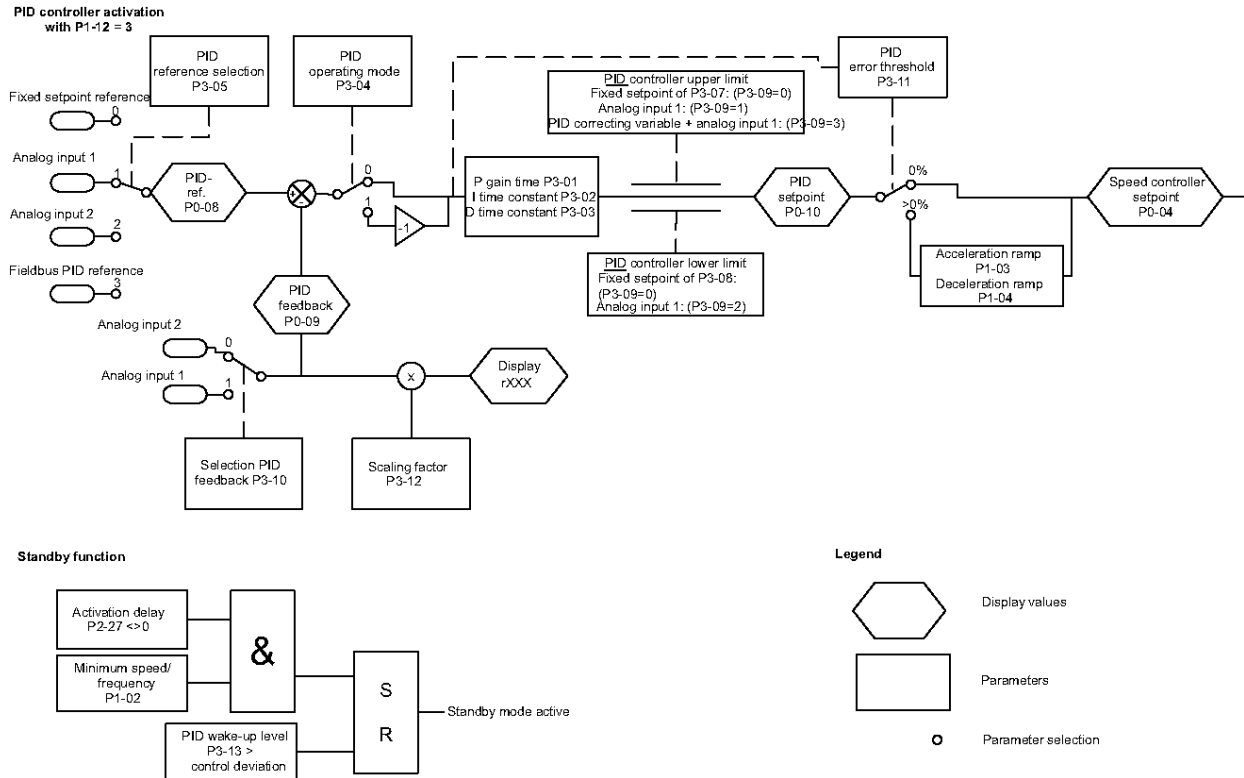


Figure 48: Configuration Options for the PID Controller

#### General information on usage

Connect the sensor for the controlled variable to analog input 1 or 2 depending on P3-10. You can scale the sensor value using parameter P3-12 in such a way that the value is indicated on the inverter display with the proper quantity, for example 0 – 10 bar.

You can set the target reference for the PID controller using P3-05.

The setting of the speed ramp times has no effect when the PID controller is active. Acceleration and deceleration ramps can be activated depending on the control deviation (target value – actual value) using P3-11.

### Fixed setpoint reference

The fixed setpoint reference entered in *P3-06* is used with the setting *P3-05* = 0. When the parameters *P9-34* and *P9-35* have another value than "OFF", 3 additional fixed setpoint references *P3-14* to *P3-16* are activated and are selected according to the table below:

Terminal selection via <i>P9-34</i>	Terminal selection via <i>P9-35</i>	Fixed setpoint reference
0 (LOW)	0 (LOW)	<i>P3-06</i>
1 (HIGH)	0 (LOW)	<i>P3-14</i>
0 (LOW)	1 (HIGH)	<i>P3-15</i>
1 (HIGH)	1 (HIGH)	<i>P3-16</i>

### Fieldbus PID Reference

The following parameters must be set in the inverter:

- P1-12* = 7 (e.g. control signal source is Modbus/FieldBus Option Module)
- P1-14* = 201 (extended parameter menu)
- P1-15* = 0 (free function selection of the digital inputs)
- P3-05* = 3 (PID reference via the fieldbus)
- P5-09 – 11* = 4 (selection of the process output data word for the PID reference)
- P9-01* = Selection of the digital input for enabling the inverter
- P9-10* = PID (speed source of the inverter)

### 7.4.4 Master-Slave Mode (P1-12 = 4)

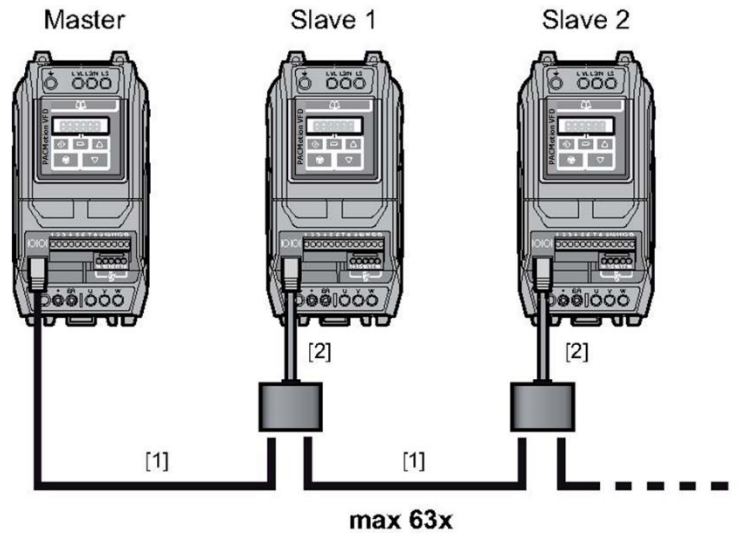


Figure 49: Master-Slave Drive Connections

[1] RJ45 to RJ45 cable: Select IC855-CABL-B-5 or IC855-CABL-B-10

[2] Cable splitter      A component of IC855-CABL-B-5 or IC855-CABL-B-10.  
May be ordered separately as IC855-CABL-SPLIT.

The inverter has an integrated master-slave function.

The master-slave communication is obtained via a special protocol. In this case, the inverter communicates via the RS485 engineering interface. Up to 63 inverters can be daisy-chained as shown above, using RJ45 connectors.

One inverter is configured as master, the remaining inverters as slaves. Each network may have only one master inverter. This master inverter sends its operating state (such as stopped, running) and output frequency every 30ms. The slave inverters then follow the state of the master frequency inverter.

**Note:** Cable set B (IC855-CABL-B-5 OR IC855-CABL-B-10) may be used for setting up the master-slave network. For information on the cable sets refer to Chapter 16.

**Note:** If the PC is to be connected to the daisy-chain, use IC855-CABL-USB485. This is a USB 2.0 to RS485 Adapter, as shown in Figure 46. Connect the jack end of this adapter to an unoccupied port in the cable splitter shown in Figure 49.

### **Configuring the Master Inverter**

The master inverter of each network must have the communication address "1". Set:

- $P1-12 \neq 4$  (control signal source)
- $P1-14 = 201$  (extended parameter menu)
- $P5-01 = 1$  (inverter address communication)

### **Configuring the Slave Inverters**

- Each connected slave must have a unique slave communication address that is set with the inverter address  $P5-01$ . You can assign slave addresses from 2 to 63. Set:
- $P1-12 = 4$  (control signal source)
- $P1-14 = 201$  (extended parameter menu)
- $P5-01 = 2 - 63$  (inverter address communication)
- the type of speed scaling in  $P2-28$
- the scaling factor in  $P2-29$ .
- Make sure that the ramps at the slave inverter are set equal to or smaller than the value at the master.

#### **7.4.5 Fieldbus Mode ( $P1-12 = 5, 6$ or $7$ )**

Refer to Chapter 9, *Fieldbus Mode*.

#### **7.4.6 Multi-Motion Mode ( $P1-12 = 8$ )**

Not Applicable.

## 7.5 Hoist function

The inverter is equipped with a hoist function. When the hoist function is active, all relevant parameters and functions are activated and locked, if necessary. For proper functioning, a correct motor start-up has to be performed as described in Section 7.5.2, *Start-up for the Hoist Function*.

Also observe the following points in particular:

- The motor brake control has to be performed by the inverter. Connect a brake rectifier between inverter relay 2 (terminal 17 and 18) and brake. Refer to Section 5.4, *Electrical Installation*.
- Use a sufficiently dimensioned braking resistor.
- GE Automation & Controls recommends not running the motor at very low speed ranges or to keep the load at zero speed without application of the brake.
- If you need sufficient torque, operate the motor within its nominal range.

To ensure safe operation when the hoist function is active, the following parameters are preset or ignored by the firmware in case of changes:

- *P1-06*: Energy-saving function is deactivated.
- *P2-09/P2-10*: Skip frequencies are ignored.
- *P2-26*: The flying start function is deactivated.
- *P2-27*: The standby mode is deactivated.
- *P2-36*: The start mode is edge-triggered (Edgr-r).
- *P2-38*: Voltage failure results in coast to a stop.
- *P4-06/P4-07*: Maximum torque limits are set to the maximum values.
- *P4-08*: Minimum torque limits are set to "0".
- *P4-09*: The upper limit for the regenerative torque is set to the maximum permitted value.

The following hoist parameters are already preset for motors of the same performance class. However, they can be changed at any time to optimize the system:

- *P2-07*: Fixed setpoint speed 7 is the brake release speed ( $\geq$  slip speed of the motor).
- *P2-08*: Fixed setpoint speed 8 is the brake application speed ( $\geq$  slip speed of the motor).
- *P2-23*: Zero speed holding time.
- *P4-13*: Release time of the motor brake.
- *P4-14*: Application time of the motor brake.
- *P4-15*: Torque threshold for the brake release.
- *P4-16*: Torque threshold timeout.

**The following parameters are locked:**

- *P2-18*: Relay contact 2 for controlling the brake rectifier.

### 7.5.1 General Information

- Clockwise rotating field of the motor corresponds to upward direction.
- Counterclockwise rotating field of the motor corresponds to downward direction.
- Stop the motor to reverse the direction of rotation. To do so, activate the brake. Set the controller inhibit before you reverse the direction of rotation.



## 7.5.2 Start-up for the Hoist Function

Refer to the following section for recommendations for the start-up.

### Motor data

- P1-03/04: Ramp time as short as possible
- P1-07: Nominal motor voltage
- P1-08: Nominal motor current
- P1-09: Rated motor frequency
- P1-10: Nominal motor speed

### Parameter activation

- P1-14 = 201 (extended parameter menu)

### Motor control

- P4-01 = 0 (VFC speed control)
- P4-05 = Cos  $\phi$

**In VFC operation, the automatic measuring procedure has to be performed. To do so, the motor should be as cold as possible.**

### Hoist parameter

P4-12 = 1 (hoist function activated)

### Thermal braking resistor protection

If no sensor is used for protecting the braking resistor, the following parameters can be used optionally for protection against overtemperature of the braking resistor. However, only a sensor provides adequate protection.

- P6-19: Braking resistance value
- P6-20: Braking resistance power

**Note:** When hoist mode is activated, the inverter has to be started with the enable. If the enable is set at the same time or prior to STO, the inverter remains in "STOP" mode.

To ensure fault-free operation, a braking resistor has to be installed.

### 7.5.3 Hoisting Mode

The following diagram shows hoisting mode.

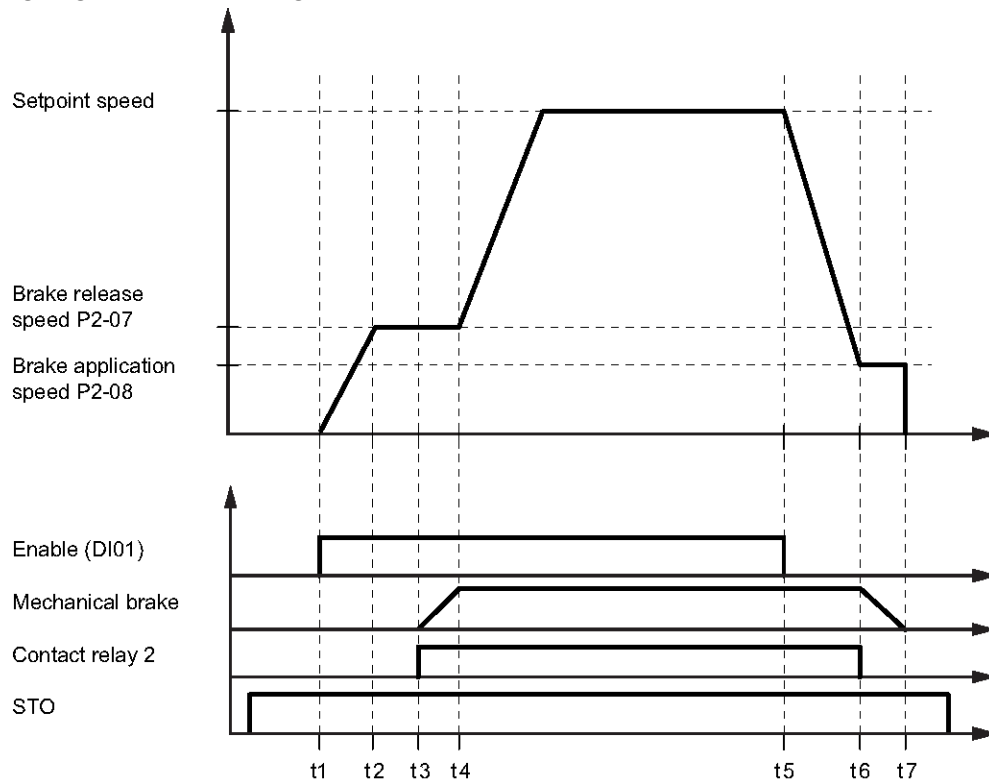


Figure 50: Hoisting Mode State Diagram

- $t_1$  Inverter enable
- $t_1 - t_2$  The motor runs up to brake release speed (fixed setpoint speed 7).
- $t_2$  Brake release speed is reached.
- $t_2 - t_3$  Torque threshold  $P4-15$  verified. The inverter indicates a fault if the torque threshold exceeds the timeout set in  $P4-16$ .
- $t_3$  Relay opens.
- $t_3 - t_4$  Brake opens within brake release time  $P4-13$ .
- $t_4$  Brake is released. The drive runs up to the setpoint speed.
- $t_4 - t_5$  Normal operation
- $t_5$  Inverter lock
- $t_5 - t_6$  Drive slows down to brake application speed (fixed setpoint speed 8).
- $t_6$  Relay closes.
- $t_6 - t_7$  Brake applied within brake application time  $P4-14$ .
- $t_7$  Brake is closed and drive stopped.

## 7.5.4 Troubleshooting and Optimizing the Hoist Function

### SP-Err / ENC02

Increase the speed error window in *P6-07* if this error message appears.

In case of problems such as sagging of the hoist, check the following parameters and/or adapt:

*P1-03/04* = Reduce ramp times, pass through slow speed ranges as quickly as possible.

*P7-10* = Adjustment of the stiffness, higher values increase the stiffness of the application.

*P4-15* = Increase torque threshold to brake release.

*P7-14/15* = In case of sagging of the hoist, it is recommended to increase the boost parameters.

*P7-07* = Set this parameter to 1.

PRELIMINARY

## 7.6 Fire Mode/Emergency Mode

Set the fire mode/emergency mode as follows:

- Perform a motor start-up.
- Set parameter *P1-14* to "201" to access further parameters.
- Set parameter *P1-15* to "0" to configure the digital inputs.
- Configure the inputs depending on the requirements in parameter group *P9-xx*. For control via terminals, set parameter *P9-09* to "9 = terminal control".
- Set parameter *P9-33 Fire mode/emergency mode input selection* to the required input.
- Set parameter *P6-13* to "0" or "1" depending on the wiring.
- Set parameter *P6-14* to the speed that is to be used in fire mode/emergency mode. You can specify a positive or a negative speed setpoint.

For evaluating the fire mode/emergency mode situation, the following two values can be read-out via index communication:

- SBus index 11358 is the fire mode/emergency mode start time: Time stamp related to (*P0-65*) at the time of activation of the fire mode/emergency mode.
- SBus index 11359 is the fire mode/emergency mode runtime (in minutes). It indicates how long the fire mode/emergency mode was active.

**Note:** Activating the fire mode/emergency mode causes the inverter drive the motor with the preset values. In this mode, the inverter ignores all faults, shutdowns, setpoints and enable signals, and operates the motor until it is destroyed or even until the loss of voltage supply. It is also not possible in this mode to perform a reset to the factory setting.

## 7.7 Operation at 87Hz Characteristic

The V/f ratio remains the same at 87Hz operation. However, higher power and speeds are generated which causes a higher current flow.

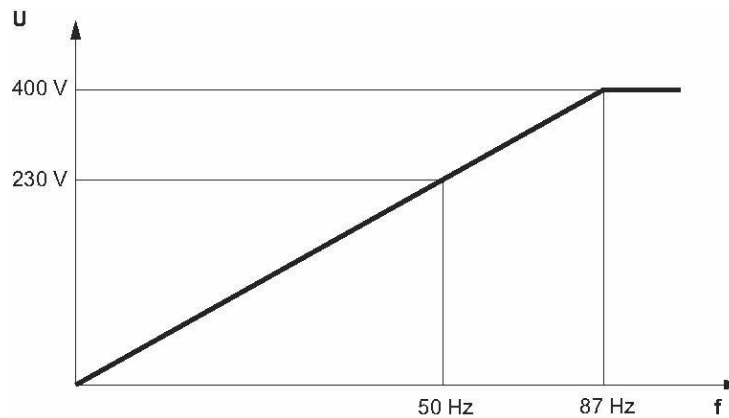


Figure 51: 87Hz Characteristic Operation

To set "87Hz characteristic" operation, proceed as follows:

- Set parameter *P1-07* to star voltage (data on the motor nameplate).
- Set parameter *P1-08* to delta current (data on the motor nameplate).
- Set parameter *P1-09* to "87Hz".
- Set parameter *P1-10* to "(synchronous speed at nominal frequency) × (87Hz / 50Hz) - (slip speed at nominal frequency)".

### Example for calculating P1-10:

DRN80M4: 0.75 kW, 50Hz

Nominal speed 1440 1/min

$$P1-10 = 1500 \text{ 1/min} \times (87\text{Hz} / 50\text{Hz}) - (1500 \text{ 1/min} - 1440 \text{ 1/min}) = 2550 \text{ 1/min}$$

**Note:** Set *P1-01 maximum speed* according to your requirements. In 87Hz operation, the inverter has to provide a current that is  $\sqrt{3}$ -times higher. For this purpose, select an inverter with a  $\sqrt{3}$ -times higher power rating.

## 7.8 Motor Potentiometer Function – Crane Application

The motor potentiometer works like an electromechanical potentiometer that increases or decreases the internal value depending on the signals at the inputs, and consequently increases or decreases the motor speed.

**Note:** In case of deviating terminal assignment, the inputs can also be configured individually.

### 7.8.1 Motor Potentiometer Operation

Figure 52 shows the basic function of the motor potentiometer. The description in Section 7.8.3, [Parameter Settings](#) is based on the frequently used crane function and operation according to the terminal assignments in Section 7.8.2, [Terminal Assignments](#).

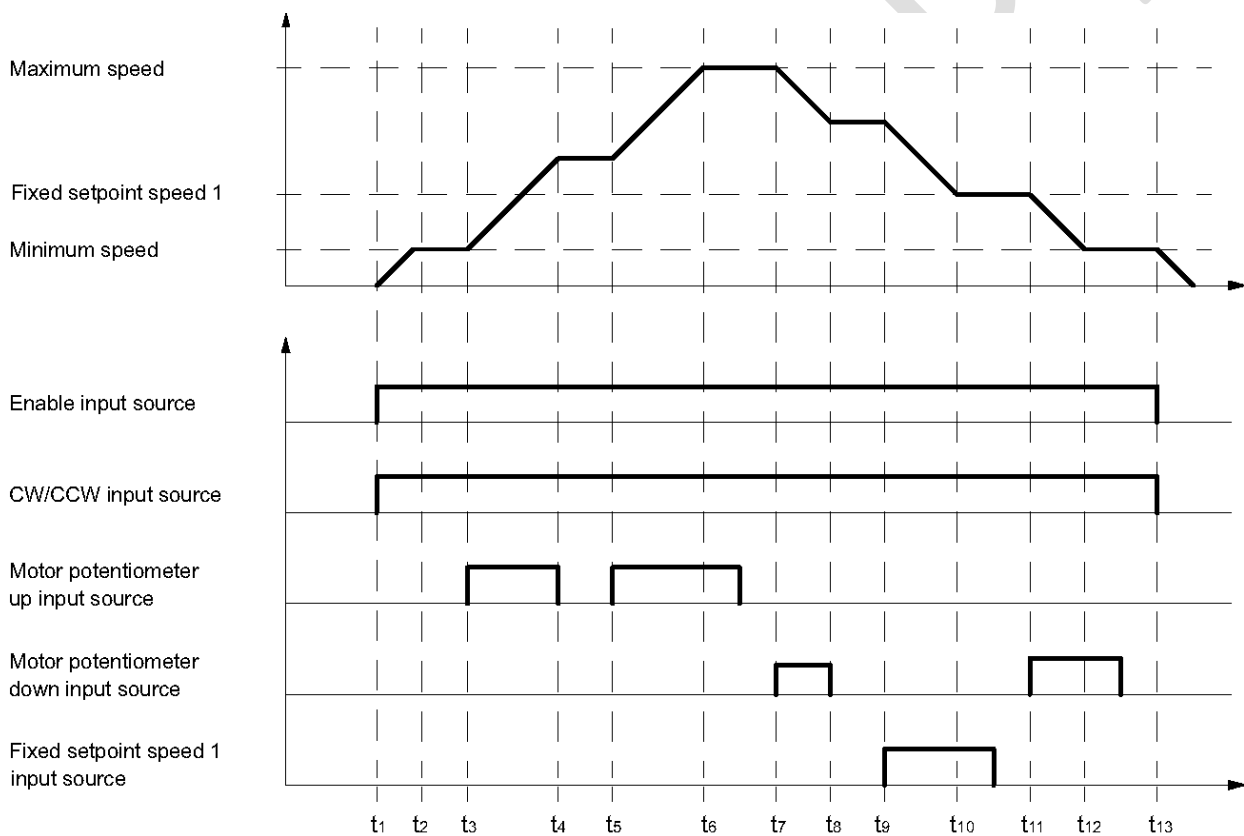


Figure 52: Motor Potentiometer State Diagram

- t<sub>1</sub> Inverter enable
- t<sub>1</sub> - t<sub>2</sub> Motor runs up to the set minimum speed (P1-02).
- t<sub>2</sub> - t<sub>3</sub> Motor maintains minimum speed.
- t<sub>3</sub> Motor potentiometer up (P9-28) is activated.
- t<sub>3</sub> - t<sub>4</sub> As long as the signal is present at P9-28, the motor speed is increased along acceleration ramp P1-03.
- t<sub>4</sub> - t<sub>5</sub> If no signal is present any longer at P9-28, the actual speed is maintained.
- t<sub>5</sub> Motor potentiometer up (P9-28) is activated.
- t<sub>5</sub> - t<sub>6</sub> As long as the signal is present at P9-28, the motor speed is increased along the acceleration ramp (P1-03) until it reaches maximum speed (P1-01).
- t<sub>6</sub> - t<sub>7</sub> The maximum speed is not exceeded and is maintained when the signal is no longer present at P9-28.
- t<sub>7</sub> Motor potentiometer down (P9-29) is activated.
- t<sub>7</sub> - t<sub>8</sub> As long as the signal is present at P9-29, the motor speed is decreased along deceleration ramp P1-04.
- t<sub>8</sub> - t<sub>9</sub> If no signal is present any longer at P9-28, the actual speed is maintained.
- t<sub>9</sub> Fixed setpoint speed is activated.
- t<sub>9</sub> - t<sub>11</sub> As long as the signal is present at fixed setpoint speed, the motor speed is decreased along deceleration ramp P1-04 until it reaches the fixed setpoint speed. This speed is then maintained.
- t<sub>11</sub> Motor potentiometer down (P9-29) is activated.
- t<sub>11</sub> - t<sub>12</sub> As long as the signal is present at P9-29, the motor speed is decreased along deceleration ramp P1-04, but not below the minimum speed P1-02.

## 7.8.2 Terminal Assignments

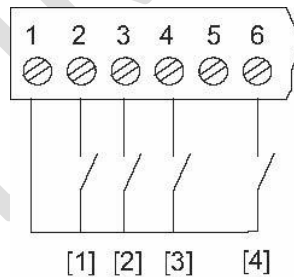


Figure 53: Terminal Assignments for Motor Potentiometer Function

- [1] DI1 Reduce enable/speed
- [2] DI2 Increase speed
- [3] DI3 Fixed setpoint speed 1
- [4] DI4 Change of direction (clockwise rotation/counterclockwise rotation)

### 7.8.3 Parameter Settings

Start up the motor as described in Section 7.3, *Start-Up for Motors*.

Make the following settings to being able to use the motor potentiometer:

- $P1-12 = 0$  (control signal source terminal mode)
- $P1-14 = 201$  (extended parameter menu)
- $P1-15 = 0$  (digital input function selection)
- $P2-37 = 6$  (keypad restart speed).

Input configuration:

- $P9-01 = \text{din-1}$  (input source enable)
- $P9-03 = \text{din-1}$  (input source for clockwise rotation)
- $P9-06 = \text{din-4}$  (direction of rotation reversal)
- $P9-09 = \text{on}$  (terminal control enable source)
- $P9-10 = \text{d-Pot}$  (speed source 1)
- $P9-11 = \text{PrE-1}$  (speed source 2)
- $P9-18 = \text{din-3}$  (input speed selection 0)
- $P9-28 = \text{din-2}$  (input source motor potentiometer open).

User settings:

- $P1-02 = \text{minimum speed}$
- $P1-03 = \text{acceleration ramp time}$
- $P1-04 = \text{deceleration ramp time}$
- $P2-01 = \text{fixed setpoint speed 1.}$



## 7.9 Examples of Analog Input Scaling and Offset Setting

Analog input format, scaling and offset are connected to each other.

Inverter setting:

P1-01 = 50Hz

### 7.9.1 Example 1: Analog Input Scaling

Control 0 – 40Hz with analog input 0 – 10Vdc:

$n_1 = 0\text{Hz}$ ,  $n_2 = 40\text{Hz}$

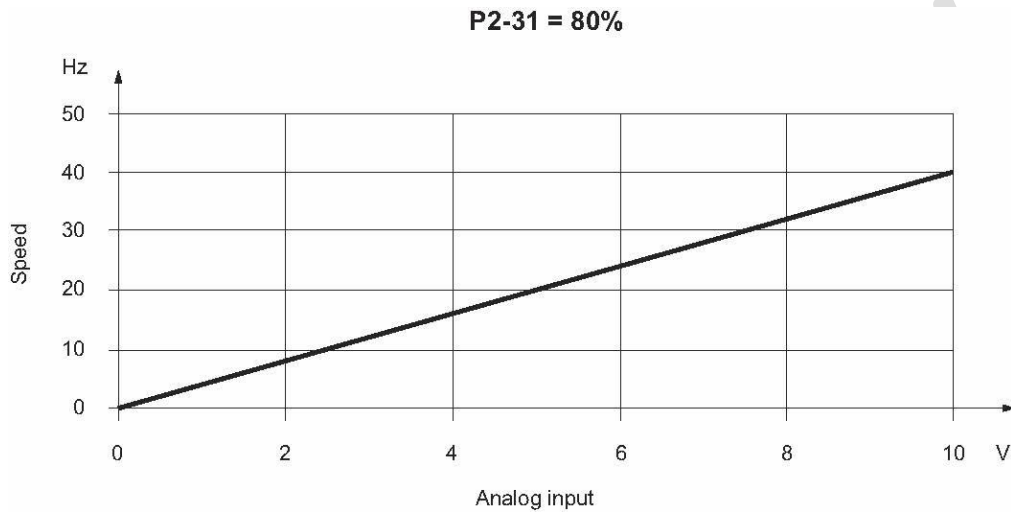


Figure 54: Example 1: Analog Input Scaling

$$P2-31 = \frac{n_2 - n_1}{P1-01} \times 100\% = \frac{40\text{Hz} - 0\text{Hz}}{50\text{Hz}} \times 100\% = 80\%$$

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### 7.9.2 Example 2: Analog Input Offset

Control 15 – 35Hz with analog input 0 – 10Vdc:

$$n_1 = n_{\text{Offset}} = 15\text{Hz}, n_2 = 35\text{Hz}$$

$$P2-31 = 40\%, P2-32 = -75\%$$

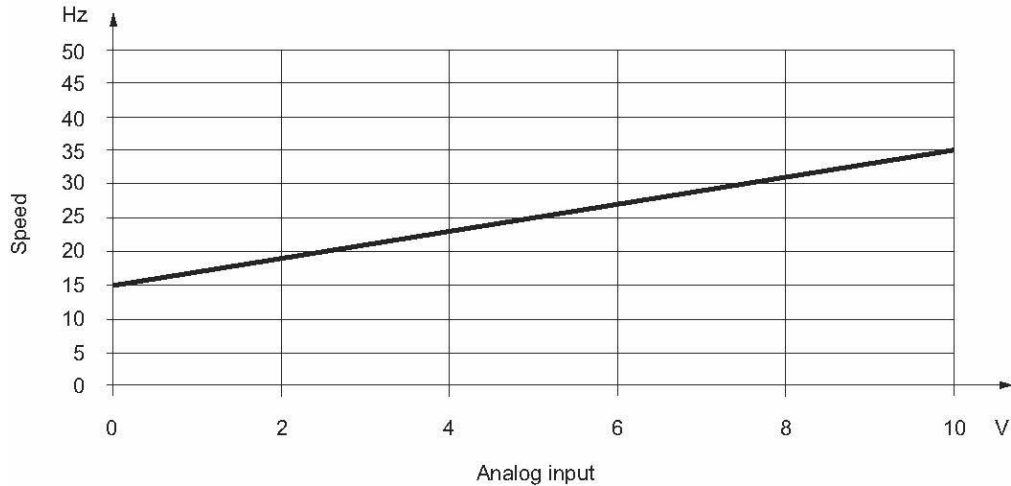


Figure 55: Example 2: Analog Input Offset

$$P2-31 = \frac{n_2 - n_1}{P1-01} \times 100\% = \frac{35\text{ Hz} - 15\text{ Hz}}{50\text{ Hz}} \times 100\% = 40\%$$

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$$P2-32 = \frac{\frac{-n_{\text{Offset}}}{P1-01} \times 100\%}{P2-31} = \frac{\frac{-15\text{ Hz}}{50\text{ Hz}} \times 100\%}{0.40} = -75\%$$

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### 7.9.3 Example 3: Analog Input Scaling and Offset

Control 15 - 45Hz with analog input 3 - 8Vdc:

P2-31 = 120%, P2-32 = 5%

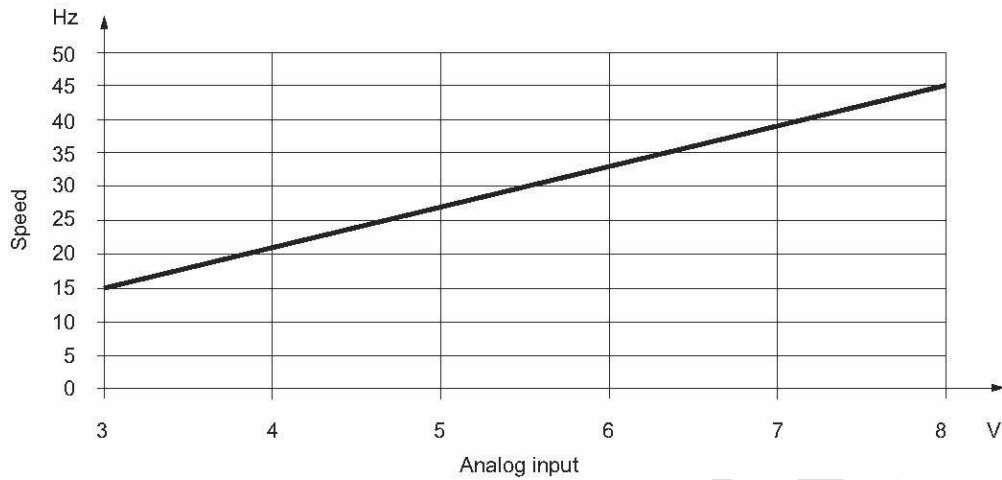


Figure 56: Example 3: Analog Input Scaling and Offset

$$P2-31 = \frac{n_2 - n_1}{P1-01} \times 100\% \times \frac{AI_{full\_range}}{AI_{control\_range}}$$

$$P2-31 = \frac{45\text{Hz} - 15\text{Hz}}{50\text{Hz}} \times 100\% \times \frac{100\%}{50\%}$$

$$P2-31 = 120\%$$

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$$P2-32 = AI_{min}(\%) - \frac{n_1}{(n_2 - n_1) \times AI_{control\_range}}$$

$$P2-32 = 30\% - \frac{15\text{Hz}}{(45\text{Hz} - 15\text{Hz}) \times 50\%}$$

$$P2-32 = 5\%$$

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## 7.10 Fans and Pumps

The following functions are available for applications with pumps or fans:

- Voltage increase/boost (P1-11)
- Adjustment of the V/f characteristic curve (P4-10, P4-11)
- Energy-saving function (P1-06)
- Flying start function (P2-26)
- Zero speed holding time (P2-23)
- Standby mode (P2-27)
- PID controller. Refer to Section 11.2.4, *Parameter Group 3: PID Controller (Level 2)*.
- Fire mode/emergency mode. Refer to Section 7.6, *Fire Mode/Emergency Mode*.
- Deactivating slip compensation via rated motor speed (P1-10)

PRELIMINARY

## 7.11 Motor Potentiometer

The motor potentiometer function lets the inverter respond to key commands.

If the digital inputs are activated that increase or decrease the speed, the speed changes along the preset ramp *P1-03* and *P1-04*.

If both digital inputs are activated at the same time, the inverter stops along the rapid stop ramp *P2-25*. If none of the two inputs are activated, the current speed and direction of rotation are maintained.

The enable is superordinate to this function and is necessary for the function.

To use the motor potentiometer function, select one of the possible function selections of the digital inputs with *P1-15* = 10 or 20. Refer also to Section *P1-15 Digital Input Function Selection* in Chapter 11.

When using this function, the arrow-up and arrow-down keys can be used directly at the inverter.

PRELIMINARY

## 7.12 3-Wire Control

The function is activated via the digital input function selection  $P1-15 = 21$ .

The 3-wire control principle determines the control.

The enable and direction of rotation signals of the inverter then react edge controlled.

- Connect start key <CW> with NO contact to digital input DI1.
- Connect start key <CCW> with NO contact to digital input DI3.
- Connect stop key as NC contact to digital input DI2.

If you connect <CW> and <CCW> at the same time, the drive decelerates along the rapid stop ramp  $P2-25$ .

### 7.12.1 Control Signal Source 3-Wire Control

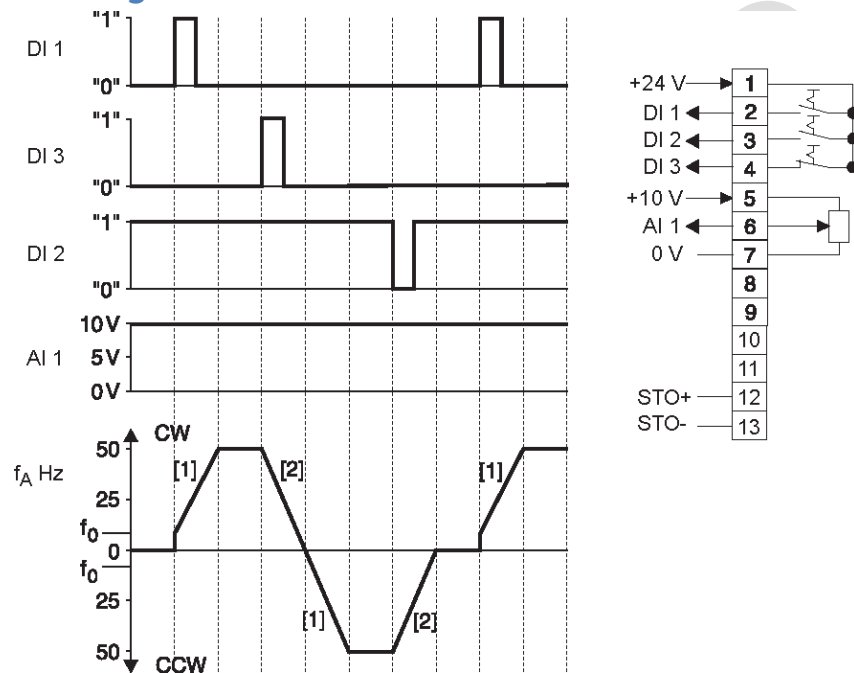


Figure 57: State Diagram for 3-Wire Control

DI 1	CW/stop	CW	Clockwise rotation
DI 3	CCW/stop	CCW	Counter-Clockwise rotation
DI 2	Enable/stop	[1]	Ramp up (P1-03)
AI 1	Setpoint input AI	[2]	Ramp down (P1-04)
$f_A$	Output frequency		
$f_0$	Start/stop frequency		



## Chapter 8 Operation

The following information is displayed to being able to read off the operating state of the inverter at any time:

Status	Abbreviation display
Drive OK	Static inverter status
Drive running	Operating state of the inverter
Fault / trip	Fault

### 8.1 Inverter Status

#### 8.1.1 Static Inverter Status

The list below shows the abbreviations that are displayed to indicate the inverter status when the motor is at standstill.

Abbreviation	Description
StoP	Power section of inverter disabled. This message is displayed when the inverter is at a standstill and no error is pending. The inverter is ready for normal operation. The inverter is not enabled.
P-deF	Preset parameters are loaded. This message appears when the user issues the command for loading the parameters set at the factory. You have to press the <Stop/reset> key before the inverter can resume operation.
Standby	The inverter is in standby mode. When $P2-27 > 0$ s, this message appears when the inverter has stopped and the setpoint is also "0".
Inhibit	Is displayed when 24Vdc and GND are not present at the STO contacts. The output stage is inhibited.
ETL 24	External voltage supply is connected. The functions are limited: refer to Section 5.4.20, <a href="#">24Vdc Backup Mode</a> .



## 8.1.2 Operating State of the Inverter

The list below shows the abbreviations that are displayed to indicate the inverter status when the motor is running.

Pressing the "Navigate" key on the keypad lets you toggle between output frequency, output current, output power and speed.

Abbreviation	Description
H xxx	Output frequency of the inverter (in Hz). This message is displayed while the inverter is running.
A xxx	Output current of the inverter (in Ampere). This message is displayed while the inverter is running.
P xxx	Current output power of the inverter (in kW). This message is displayed while the inverter is running.
L xxx	The parameter is locked for changes. Make sure that: <ul style="list-style-type: none"> <li>- The parameter lock <i>P2-39</i> is not activated.</li> <li>- The inverter is not enabled.</li> <li>- The inverter is supplied with line voltage.</li> </ul>
Auto-t	The motor parameters are measured automatically to configure the motor parameters. Auto tune runs automatically when receiving the first enable signal after operation with factory-set parameters. No hardware enable is required for running auto tune.
Ho-run	Reference travel started. Wait until the inverter has reached the reference position. After successful reference travel, "Stop" appears on the display.
xxxx	Output speed of the inverter (in 1/min). This message appears while the inverter is running if the rated speed of the motor was entered in parameter <i>P1-10</i> .
C xxx	Is the scaling factor "Speed" ( <i>P2-21</i> / <i>P2-22</i> ).
..... (flashing dots)	The output current of the inverter exceeds the current value entered in <i>P1-08</i> . The inverter monitors the extent and the duration of the overload. The inverter indicates fault "l.t-trP" depending on the extent of the overload.
FirE	Fire mode/emergency mode is active.
Select language	List to select one of the available languages. To select a language, use the <Navigate> key.

### 8.1.3 Status Displays of the Parameter Module

The parameter module status is displayed on the frequency inverter display.

Display	Description
<b>PASS-r</b>	The parameter module successful read/saved the frequency inverter parameters.
<b>OS-Loc</b>	The parameter module is locked. Attempt to read parameter from frequency inverter with activated parameter module lock.
<b>FAiL-r</b>	The parameter module could not read parameters from the frequency inverter.
<b>PASS-t</b>	The parameter module successfully transferred the parameters to the frequency inverter. Writing of parameters to the frequency inverter.
<b>FAiL-P</b>	The power ratings of the parameter stored in the parameter module do not match the power ratings of the programmed frequency inverter.
<b>FAiL-t</b>	The parameter module could not transfer the parameter set to the frequency inverter.
<b>no-dAt</b>	No parameter data was saved in the parameter module.
<b>dr-Loc</b>	The frequency inverter parameters were locked. No new parameter settings could be transferred. Unlock the parameter set of the frequency inverter.
<b>dr-rUn</b>	Frequency inverter is running and cannot accept any new parameter settings. Stop the frequency inverter before programming.
<b>tyPE-E</b>	The parameters for the frequency inverter type saved in the parameter module do not match the frequency inverter type to be programmed (only writing).
<b>tyPE-F</b>	The parameter module does not yet support the programmed frequency inverter type.

### 8.1.4 Fault Reset

You can reset a fault by pressing the <Stop/reset> key or by opening and closing digital input 1. For further information, refer to Section 8.4, [Error Codes](#).

## 8.2 Troubleshooting

Symptom	Cause and solution
Overload or overcurrent error of the unloaded motor during acceleration	Check the star/delta terminal connection in the motor. The nominal operating voltage of motor and inverter must match. Delta connection always yields the lower voltage of a multi-voltage motor.
Overload or overcurrent – motor does not turn	Check whether the rotor is blocked. Make sure that the mechanical brake is released (if installed).
No enable for the inverter – display shows "StoP"	<ul style="list-style-type: none"> <li>• Check whether the hardware enable signal is present at digital input 1.</li> <li>• Ensure proper +10Vdc user output voltage (between terminals 5 and 7).</li> <li>• If faulty, check the wiring of the user terminal strip.</li> <li>• Check <i>P1-12</i> for terminal mode/keypad mode.</li> <li>• If keypad mode is selected, press the "Start" key.</li> <li>• The line voltage must correspond with the specified values.</li> </ul>
The inverter does not start at extremely cold ambient conditions	The inverter might not start at ambient temperatures below $-10^{\circ}\text{C}$ . Under such conditions, provide a heat source that keeps the ambient temperature on site above $-10^{\circ}\text{C}$ .
No access to advanced menus	<i>P1-14</i> must be set to advanced access code. The value is "101" unless the user has changed the code in <i>P2-40</i> .

## 8.3 Error History

Parameter *P1-13* in parameter mode archives the four most recent errors and/or events. Each error is displayed in abbreviated form. The most recent error is shown first (when calling *P1-13*).

This means that any new error is entered at the top of the list followed by the subsequent errors in the order of their appearance. The oldest fault will be deleted from the error history.

- **INFORMATION**

**Note:** If the latest error in the error history is an under-voltage fault, no further under-voltage faults will be recorded in the error history. This is to avoid the situation whereby the error history would fill up with under-voltage faults, as would occur every time the inverter is switched off.

PRELIMINARY

## 8.4 Error Codes

Error message <sup>5</sup>	Error code <sup>6</sup>	Explanation	Solution
Inverter display	dec hex		
<b>4-20 F</b>	113 0x71	Signal loss 4 – 20mA	<ul style="list-style-type: none"> <li>• Check whether the input current in <i>P2-30</i> and <i>P2-33</i> lies within the defined range.</li> <li>• Check the connection cable.</li> </ul>
<b>AtF-01</b>	81 0x51	The measured stator resistance fluctuates between the phases.	<p>The measured stator resistance of the motor is asymmetrical. Check to see, if:</p> <ul style="list-style-type: none"> <li>• the motor is connected correctly and without error.</li> <li>• the winding has the correct resistance and symmetry.</li> </ul>
<b>AtF-02</b>	81 0x51	The measured stator resistance is too high.	<p>The measured stator resistance of the motor is too high. Check to see, if:</p> <ul style="list-style-type: none"> <li>• the motor is connected correctly and without error.</li> <li>• the power rating of the motor corresponds with the power rating of the connected inverter.</li> </ul>
<b>AtF-03</b>	81 0x51	Measured motor inductance is too low.	Make sure that the motor is connected correctly and without error.
<b>AtF-04</b>	81 0x51	Measured motor inductance is too high.	<p>Check to see, if:</p> <ul style="list-style-type: none"> <li>• the motor is connected correctly and without error.</li> <li>• the power rating of the motor corresponds with the power rating of the connected inverter.</li> </ul>
<b>AtF-05</b>	81 0x51	Timeout of inductance measurement	<p>The measured motor parameters are not convergent. Check to see, if:</p> <ul style="list-style-type: none"> <li>• the motor is connected correctly and without error.</li> <li>• the power rating of the motor corresponds with the power rating of the connected inverter.</li> </ul>
<b>dAtA-E</b>	98 0x62	Internal memory error (DSP)	Contact GE Automation & Controls Service.
<b>dAtA-F</b>	98 0x62	Internal memory error (IO)	Contact GE Automation & Controls Service.
<b>E-triP</b>	26 0x1A	External error at digital input 5.	<p>NC contact was opened.</p> <ul style="list-style-type: none"> <li>• Check motor thermistor (if connected).</li> </ul>
<b>Enc-01</b>	14 0x0E	Communication error between encoder card and card is plugged in or the encoder card is not recognized. inverter.	The encoder feedback is activated in <i>P6-05</i> , and no encoder between encoder card and card is plugged in or the encoder card is not recognized.

<sup>5</sup> Inverter display P0-13 error history.

<sup>6</sup> Status word **if Bit5 = 1**.

Error message <sup>5</sup>	Error code <sup>6</sup>	Explanation	Solution
Inverter display	dec hex		
<b>ENC02/ SP-Err</b>	14 0x0E	Speed fault (P6-07)	The difference between actual speed and setpoint speed is perceptually larger than the value set in P6-07. This error applies only to vector control or control with encoder feedback. Set a higher value in P6-07.  If you wish to deactivate the speed monitoring, set P6-07 to 100%.
<b>Enc-03</b>	14 0x0E	Incorrect PPR count setting.	Check the parameter settings in P6-06 and P1-10.
<b>Enc-04</b>	14 0x0E	Encoder channel A error	The A track of the encoder feedback is not present. Check the wiring.
<b>Enc-05</b>	14 0x0E	Encoder channel B error	The B track of the encoder feedback is not present. Check the wiring.
<b>Enc-06</b>	14 0x0E	Encoder channel A or B error	The A and B tracks of the encoder feedback are not present. Check the wiring.
<b>Enc-07</b>	14 0x0E	RS485 data channel error	Communication error between encoder card and encoder. Check the encoder card for correct seating and firm contact.
<b>Enc-08</b>	14 0x0E	Reserved Encoder I/O communication channel error	Communication error between encoder card and inverter. Check the encoder card for correct seating and firm contact.
<b>Enc-09</b>	14 0x0E	Encoder type not supported.	During the use of Smart Servo Package, a wrong motor/inverter combination was used. Check to see, if: <ul style="list-style-type: none"> <li>• The speed class of the motor is 4500 1/min.</li> <li>• The nominal motor voltage equals the nominal inverter voltage.</li> <li>• An unsupported encoder is used.</li> </ul>
<b>Enc-10</b>	14 0x0E	Trigger: KTY	KTY not triggered or not connected.
<b>Er-LED</b>		Display error	Contact GE Automation & Controls Service.
<b>Err-SC</b>		The keypad lost the communication connection to the inverter.	Press the STOP key to reset. Check the address of the frequency inverter.
<b>Etl-24</b>		External 24Vdc supply.	Line voltage supply not connected. The inverter is externally supplied with 24Vdc.
<b>FAULtY</b>		The communication between controller and power section is interrupted.	Contact GE Automation & Controls Service.
<b>F-Ptc</b>	31 0x1F	Motor protection triggered	The connected motor protection sensor is defined in P2-33 (PTC, TF, TH, KTY or PT1000), and connected to the analog input 2 (terminal 10).
<b>FAN-F</b>	50 0x32	Internal fan error.	Contact GE Automation & Controls Service.

Error message <sup>5</sup>	Error code <sup>6</sup>	Explanation	Solution
Inverter display	dec hex		
<b>FLt-dc</b>	7	0x07 DC link ripple too high.	Check the current supply.
<b>Ho-trP</b>	39	0x27 Error during reference travel.	<ul style="list-style-type: none"> <li>• Check reference cams</li> <li>• Check limit switch connection</li> <li>• Check reference travel type setting and the parameters required for it.</li> </ul>
<b>Inhibit</b>		STO safety circuit open.	Check to see if terminals 12 and 13 are connected correctly.
<b>Lag-Er</b>	42	0x2A Lag error	Check: <ul style="list-style-type: none"> <li>• the encoder connection</li> <li>• the wiring of encoder, motor and line phases</li> <li>• if the mechanical components can move freely and are not blocked.</li> <li>• Extend the ramps.</li> <li>• Set a higher P component.</li> <li>• Parameterize the speed controller again.</li> <li>• Extend the lag error tolerance.</li> <li>• Set PLC Prog Task Priority to 10ms</li> <li>• The inverter is operated in Derating and cannot provide the current for acceleration/constant travel.</li> </ul>
<b>I.t-trp</b>	8	0x08 Overload of inverter/motor (I2t error)	Make sure that: <ul style="list-style-type: none"> <li>• The motor nameplate parameters are correctly inserted in <i>P1-07</i>, <i>P1-08</i> and <i>P1-09</i>.</li> <li>• In vector mode (<i>P4-01</i> = 0 or 1), the motor power factor in <i>P4-05</i> is correct.</li> <li>• Auto Tune has correctly been performed.</li> </ul> Check to see, if: <ul style="list-style-type: none"> <li>• The decimals flash (inverter overloaded), increase the acceleration ramp (<i>P1-03</i>) or decrease the motor load.</li> <li>• The length of the cable meets the requirements.</li> <li>• The load can move freely and there are no blockages or other mechanical faults (mechanically check the load).</li> <li>• The thermal motor protection to UL508C is activated in <i>P4-17</i>.</li> </ul>
<b>O-I</b>	1	0x01 Short-term overcurrent at the inverter output. High motor overload.	<b>Fault during stop procedure:</b> Check for premature brake application.

Error message <sup>5</sup>	Error code <sup>6</sup>	Explanation	Solution
Inverter display	dec hex		
<b>hO-I</b>	1 0x01	Hardware overcurrent error at the inverter output (IGBT self-protection in case of overload).	<p><b>Fault while enabling the inverter:</b></p> <p>Check to see, if:</p> <ul style="list-style-type: none"> <li>The motor nameplate parameters are correctly inserted in <i>P1-07</i>, <i>P1-08</i> and <i>P1-09</i>.</li> <li>In vector mode (<i>P4-01</i> = 0 or 1), the motor power factor in <i>P4-05</i> is correct.</li> <li>Auto Tune has correctly been performed.</li> <li>The load can move freely and there are no blockages or other mechanical faults (mechanically check the load).</li> <li>A short circuit between the phases or a ground fault of a phase occurred at the motor and motor connection cable.</li> <li>The brake is connected correctly, controlled correctly and correctly releases when the motor has a holding brake.</li> </ul> <p>Reduce the settings of the voltage enhancement in <i>P1-11</i>. Set a longer run-up time in <i>P1-03</i>. Disconnect the motor from the inverter. Enable the inverter again. If the inverter trips with no motor connected, it must be replaced and the system fully checked and retested before a replacement unit is installed.</p> <p><b>Fault during operation:</b></p> <p>Check:</p> <ul style="list-style-type: none"> <li>For sudden overload or malfunction.</li> <li>the cable connection between inverter and motor.</li> </ul> <p>The acceleration/deceleration time is too short and requires too much power. If you cannot increase <i>P1-03</i> or <i>P1-04</i>, use a larger inverter.</p>
<b>O-hEAt</b>	124 0x7C	Ambient temperature too high.	Check if the ambient conditions are within the range specified for inverters.
<b>O-t</b>	11 0x0B	Heat sink overtemperature	<p>The heat sink temperature can be displayed via <i>P0-21</i>. A historical protocol is saved in parameter <i>P0-38</i> in 30 s intervals prior to a switch off with error. This error message is displayed at a heat sink temperature of <math>\geq 90</math> °C.</p> <p>Check:</p> <ul style="list-style-type: none"> <li>The ambient temperature of the inverter.</li> <li>The inverter cooling and housing dimensions.</li> <li>The function of the internal cooling fan of the inverter.</li> </ul> <p>Reduce the settings of the effective clock frequency in parameter <i>P2-24</i>, or the load at motor/inverter.</p>
<b>O-torq</b>	52 0x34	Maximum torque limit timeout.	<p>Check the motor load.</p> <p>Set a higher value in <i>P6-17</i> if required.</p> <p>If you wish to deactivate the torque monitoring, set <i>P6-07</i> to 0.0 s.</p>



Error message <sup>5</sup>	Error code <sup>6</sup>	Explanation	Solution
Inverter display	dec hex		
<b>O-Volt</b>	7	0x07 DC link overvoltage	<p>The error occurs if a high flywheel load or overhauling load is connected, and the excess regenerative energy is transferred back to the inverter.</p> <p>If an error occurs while stopping or during deceleration, increase the deceleration ramp time <i>P1-04</i> or connect a suitable braking resistor to the inverter.</p> <p>The proportional gain in <i>P4-03</i> is reduced in vector mode.</p> <p>In PID control mode ensure that the ramps are active by reducing <i>P3-11</i>.</p> <p>Additionally, check if the supply voltage is within the specified range.</p> <p>Information: The value of the DC bus voltage can be displayed on <i>P0-20</i>. A historical protocol is saved in parameter <i>P0-36</i> in 256ms intervals prior to a switch off with error.</p>
<b>OI-b</b>	4	0x04 Brake channel overcurrent	Make sure that the connected braking resistor does not fall below the minimum value approved for the inverter (see technical data). Check the braking resistor and the wiring for possible short circuits.
<b>OL-br</b>	4	0x04 Brake resistor overload	The software detected an overload at the braking resistor and switches the motor off to protect the equipment. Make sure that the braking resistor is operated within the planned parameters before performing any changes to parameters or system. To reduce the load at the resistor, increase the deceleration time, reduce the loads mass moment of inertia, or connect additional braking resistors in parallel. Note the minimum resistor values for the drive used in the application.
<b>OF-01</b>	28	0x1C Internal connection to option module error.	Contact GE Automation & Controls Service.
<b>OF-02</b>	28	0x1C Option module error	Contact GE Automation & Controls Service.
<b>Out-F</b>	82	0x52 Inverter output stage error	Contact GE Automation & Controls Service.
<b>P-LOSS</b>	6	0x06 Input phase failure	An input phase has been separated or interrupted at an inverter planned for a 3-phase supply.
<b>P-dEF</b>	9	0x09 Factory settings are restored.	
<b>Ph-Ib</b>		Unequal voltage at the input phases	<ul style="list-style-type: none"> <li>• Check the device input voltage.</li> <li>• Check the values in <i>P0-22</i>, <i>P0-23</i>, <i>P0-24</i>.</li> </ul> <p>The values may deviate maximum <math>\pm 10\%</math>. Use an input choke if required.</p>
<b>PS-trP</b>	200	0xC8 Output stage error (IGBT self-protection in case of overload)	See error <b>O-I</b> .

Error message <sup>5</sup>	Error code <sup>6</sup>	Explanation	Solution
Inverter display	dec hex		
<b>SC-0b5</b>	29 1D	Connection between inverter and keypad interrupted.	Connection between inverter and keypad.
<b>SC-F03</b>	41 0x29	Fieldbus module communication error (fieldbus side)	Contact GE Automation & Controls Service.
<b>SC-F04</b>	41 0x29	Communication error IO option card	Contact GE Automation & Controls Service.
<b>SC-F01</b>	43 0x2B	Modbus communication error	Check the communication settings.
<b>SC-F02</b>	47 0x2F	Reserved	•
<b>SC-LoS</b>		The communication between controller and power section is interrupted.	Contact GE Automation & Controls Service.
<b>SC-OBS</b>		The keypad lost the communication connection to the frequency inverter.	Press the <Stop> key to reset. Check the address of the inverter.
<b>Sto-F</b>	115 0x73	STO circuit error	Inverter is defective, replace device.
<b>StoP</b>		The inverter is not enabled.	Activate the enable. Make sure that the enable is switched on after the STO for the hoist function.
<b>th-Flt</b>	31 0x1F	Faulty thermistor at heat sink.	Contact GE Automation & Controls Service.
<b>type-f</b>		Parameter module and inverter are not compatible.	The used parameter module is not of type LT BP C.
<b>U-dEF</b>		User settings loaded.	The parameter set saved in P6-26 has been restored.
<b>U-torq</b>	52 0x34	Minimum torque limit timeout (hoist).	The torque threshold has not been exceeded in time. Increase the time in P4-16 or the torque limit in P4-15.
<b>U-t</b>	117 0x75	Undertemperature	Occurs at an ambient temperature below -10 °C. Increase the temperature to above -10 °C to start the inverter.
<b>U-Volt</b>	198 0xC6	DC link undervoltage	Occurs routinely when switching off the inverter. Check line voltage if this occurs while the inverter is running.
<b>USr-cL</b>		Parameter backup successfully deleted.	The parameter set was successfully deleted using P6-26.
<b>USr-PS</b>		Parameter backup successfully completed.	The parameter set was successfully saved using P6-26.



## Chapter 9 Fieldbus Mode

### 9.1 General Information

#### 9.1.1 Structure and Settings of Process Data Words

Control and status word have a fixed assignment. All the other process data words can be freely configured as required, using parameter group *P5-xx*.

The following applies to Modbus RTU as well as to networks supported by any of the Fieldbus Option Cards (refer to Section 15.4, *Fieldbus Option Cards*).

	Low byte	High byte
Bit	0 - 7	8 - 15

#### Process Output Words

Description	Bit		Settings
PO1 Control word	0	Output stage inhibit (the motor coasts to a stop), for brake motors the brake is applied immediately.	0: Start 1: Stop
	1	Rapid stop along the second deceleration ramp/rapid stop ramp ( <i>P2-25</i> )	0: Rapid stop 1: Start
	2	Stop along process ramp <i>P1-03</i> / <i>P1-04</i> or <i>PO3</i>	0: Stop 1: Start
	3 - 5	Reserved	0
	6	Error reset	Edge 0 set to 1 = error reset
	7 - 15	Reserved	0

PO2 Setpoint speed in % (default setting), may be configured via *P5-09*

PO3 No function, may be configured via *P5-10*

PO4 No function, may be configured via *P5-11*

For *P5-09* through *P5-11*, refer to Section 11.2.6, sub-section *P5-09 - P5-11 Fieldbus Process Output Data (POx) Definition*.

## Process Input Words

Description	Bit		Settings	Byte
PI1 Status word	0	Output stage enable	0: Disabled 1: Enabled	Low byte
	1	Frequency inverter ready for operation	0: Not ready 1: Ready	
	2	PO data enabled	1 if P1-12 = 5	
	3 – 4	Reserved		
	5	Fault/warning	0: No error 1: Fault	
	6	Positive limit switch active (limit switch assignment can be set via P1-15 or P9-30/P9-31).	0: Disabled 1: Enabled	
	7	Negative limit switch active (limit switch assignment can be set via P1-15 or P9-30/P9-31).	0: Disabled 1: Enabled	
	8 – 15	Frequency inverter status if bit 5 = 0 0x01 = STO – Safe torque off active 0x02 = no enable 0x05 = speed control 0x06 = torque control 0x0A = technology function 0x0C = reference travel  Frequency inverter status if bit 5 = 1		
PI2 Actual speed	May be configured via P5-12			
PI3 Actual current	May be configured via P5-13			
PI4 No function, may be configured via P5-14				

For P5-12 through P5-14, refer to Section 11.2.6, sub-section [P5-12 – P5-14 Fieldbus Process Input Data \(PIx\) Definition](#).

## 9.1.2 Communication Example

The following information is sent to the inverter if

- The digital inputs have been configured and wired properly to enable the inverter.

Description	Value	Description
PO1Control word	0x0000	Stop along the second Deceleration ramp ( <i>P2-25</i> ).
	0x0001	Coast to a stop
	0x0002	Stop along the process ramp ( <i>P1-04</i> ) or ( <i>PO3</i> ).
	0x0003 - 0x0005	Reserved
	0x0006	Accelerate along a ramp ( <i>P1-03</i> ) or ( <i>PO3</i> ) and run at setpoint speed ( <i>PO2</i> )
PO2Setpoint speed	0x4000	= 16384 = max. speed, e.g. 50Hz ( <i>P1-01</i> ) CW
	0x2000	= 8192 = 50% of the max. speed, e.g. 25Hz CW
	0xC000	= -16384 = max. speed, e.g. 50Hz ( <i>P1-01</i> ) CCW
	0x0000	= 0 = min. speed, set in <i>P1-02</i>
	0xF100	= 8192 = 50% of the max. speed, e.g. 25Hz CCW

The process data sent by the inverter should look as follows during operation:

Description	Value	Description
PI1 Status word	0x0407	Status = running, output stage enabled; inverter ready, PO data enabled
PI2 Actual speed	Should correspond to PO2 (setpoint speed)	
PI3 Actual current	Depends on speed and load	

### 9.1.3 Parameter Settings for the Inverter

- Start inverter operation as described in Section 7.3, *Start-Up for Motors*.
- Set the following parameters:

Parameters	Modbus RTU
P1-12 (control signal source)	7
P1-14 (extended parameter menu)	201
P1-15 (function selection digital inputs)	1 <sup>7</sup>
P5-01 (inverter address)	1 – 63
P5-02 (Reserved)	--
P5-03 (Modbus baud rate)	Baud rate
P5-04 (Modbus data format)	Data format
P5-05 <sup>8</sup> (behavior in the event of communication failure)	0-1-2-3
P5-06 <sup>8</sup> (communication failure timeout)	0.0 – 1.0 – 5.0 s
P5-07 <sup>8</sup> (ramp specified via fieldbus)	0 = specified via P1-03/04 1 = specified via fieldbus <sup>9</sup>
P5-XX <sup>10</sup> (fieldbus parameter)	More setting options

### 9.1.4 Connecting the Signal Terminals at the Inverter

For bus mode, you can connect the signal terminals using the default setting of P1-15 as described in Section 5.4.18, *Overview of Signal Terminals*. When the DI3 signal level changes, the system toggles between the speed setpoint source fieldbus (low) and fixed setpoint 1 (high).

<sup>7</sup> Default setting; for more setting options, refer to Refer to Section *P1-15 Digital Input Function Selection* in Chapter 11.

<sup>8</sup> These parameters can remain set to their default values for the time being.

<sup>9</sup> When specifying the ramp via fieldbus, P5-10 = 3 must be set (PO3 = ramp time).

<sup>10</sup> You can create more Fieldbus settings and define the process data in detail in parameter group P5-xx. Refer to Section 11.2.6, *Parameter Group 5: Fieldbus Communication (Level 2)*.

## 9.2 Modbus RTU

The inverters support communication via Modbus RTU. Holding registers (03) are used for reading, and single holding registers (06) for writing. For using Modbus RTU, configure the inverter as described in Section 9.1.3, *Parameter Settings for the Inverter*.

### 9.2.1 Specification

<b>Protocol</b>	Modbus RTU
<b>Error checking</b>	CRC
<b>Baud rate</b>	9600 bps, 19200 bps, 38400 bps, 57600 bps, 115200 bps (default)
<b>Data format</b>	1 start bit, 8 data bits, 1 stop bit, no parity
<b>Physical format</b>	RS485 2 core
<b>User interface</b>	RJ45

### 9.2.2 Electrical Installation

The maximum number of bus nodes is 32. The permitted cable length depends on the baud rate. With a baud rate of 115200 bps and a 0.5 mm<sup>2</sup> cable, the maximum cable length is 1200m. For the pin assignments for the RJ45 communication socket, refer to Section 5.4.19, *Communication Socket RJ45*.



### 9.2.3 Register Allocation of the Process Data Words

The process data words are allocated to the Modbus registers shown in the table. The status and control words have a fixed allocation. The other process data words can be configured as required in parameter group P5-xx.

The table shows the default allocation of process data words. All other registers are usually allocated in such a way that they correspond to the parameter number (101 = P1-01). However, this does not apply to parameter group 0.

Register	Upper byte	Lower byte	Command Type	
1	PO1 control word (fixed)		03, 06	Read / Write
2	PO2 (default setting in P5-09 =1; speed setpoint)		03, 06	Read / Write
3	PO3 (default setting in P5-10 =7; no function)		03, 06	Read / Write
4	PO4 (default setting in P5-11 =7; no function)		03, 06	Read / Write
5	Reserved	-	03	Read
6	PI1 status word (fixed)		03	Read
7	PI2 (default setting in P5-12 =1; actual speed)		03	Read
8	PI3 (default setting in P5-13 =2; actual current)		03	Read
9	PI4 (default setting in P5-14 =4; power)		03	Read
...	For more registers, refer to Section 11.1.2, <a href="#">Parameter Register</a> .			

You find the complete allocation of parameters and registers as well as the scaling of data in the memory allocation plan in Section 11.1.2, [Parameter Register](#).

**Note:** Many bus masters address the first register as register 0. It might therefore be necessary to deduct the value "1" from the register number given below to obtain the correct register address.

## 9.2.4 Data Flow Example

In this example, the following parameters are read by the controller (PLC address base = 1):

- P1-07 (rated motor voltage, Modbus register 107)
- P1-08 (rated motor current, Modbus register 108).

Request master → slave (Tx)

### Reading register information

Address	Function	Data				CRC check
		Start address		Number of registers		
	Read	High byte	Low byte	High byte	Low byte	crc16
01	03	00	6A	00	02	E4 17

Response slave → master (Rx)

Address	Function	Data		Information		CRC check
		Number of data bytes (n)		n/2 register		
	Read	High byte	Low byte	Register 107 / 108		crc16
01	03	04		00 E6	00 2B	5B DB

Explanation to the communication example:

Tx = Send from perspective of the bus master.

<b>Address</b>	Device address 0x01 = 1
<b>Function</b>	03 read/06 write
<b>Start address</b>	Register start address = 0x006A = 106
<b>Number of registers</b>	Number of requested registers from start address (register 107/108).
<b>2 × CRC bytes</b>	CRC_high, CRC_low

Rx = Received from perspective of the bus master.

<b>Address</b>	Device address 0x01 = 1
<b>Function</b>	03 read/06 write
<b>Number of data bytes</b>	0x04 = 4
<b>Register 108 high byte</b>	0x00 = 0
<b>Register 108 low byte</b>	0x2B = 43% of the nominal inverter current
<b>Register 107 high byte</b>	0x00 = 0
<b>Register 107 low byte</b>	0xE6 = 230V
<b>2 × CRC bytes</b>	CRC_high, CRC_low

The following example describes the second process data word of the inverter (PLC address base = 1):

Process output data word 2 = Modbus register 2 = setpoint speed.

Request master → slave (Tx)

**Sending register information**

Address	Function	Start address		Data Information		CRC check
		High byte	Low byte	High byte	Low byte	
01	06	00	01	07	00	crc16 DB 3A

Response slave → master (Rx)

Address	Function	Start address		Data Information		CRC check
		High byte	Low byte	High byte	Low byte	
01	06	00	01	07	00	crc16 DB 3A

Explanation to the communication example:

Tx = Send from perspective of the bus master.

<b>Address</b>	Device address 0x01 = 1
<b>Function</b>	03 read/06 write
<b>Start address</b>	Register start address = 0x0001 = 1 (first register to be written on = 2 PA2)
<b>Information</b>	0700 (setpoint speed)
<b>2 × CRC bytes</b>	CRC_high, CRC_low

## Chapter 10 Service

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To ensure fault-free operation, GE Automation & Controls recommends that you check the ventilation openings in the housing at regular intervals and clean them if necessary.

### 10.1 Electronics Service by GE Automation & Controls

If you are unable to rectify a fault, contact GE Automation & Controls Service. For contact information, refer to [www.geautomation.com](http://www.geautomation.com).

When contacting the GE Automation & Controls Service, always specify the following information so that our service personnel can assist you more effectively:

- Information on the device type on the nameplate (e.g. type designation, serial number, part number, product key, purchase order number)
- Brief description of the application
- Error message on the status display
- Nature of the fault
- Accompanying circumstances
- Unusual events preceding the problem

## 10.2 Extended Storage

If the device is stored for a long time, connect it to the supply system voltage for at least 5 minutes every 2 years. Otherwise, the service life of the device may be reduced.

### 10.2.1 Procedure when Maintenance has been Neglected

Electrolytic capacitors are used in the frequency inverters. They are subject to aging effects when de-energized. This effect can damage the capacitors if the device is connected using the nominal voltage after a longer period of storage.

If you have not performed maintenance regularly, GE Automation & Controls recommends that you increase the line voltage slowly up to the maximum voltage. This can be done, for example, by using a variable transformer for which the output voltage has been set according to the following overview.

The following steps are recommended:

230Vac devices:

- Step 1: 170Vac for 15 minutes
- Step 2: 200Vac for 15 minutes
- Step 3: 240Vac for 1 hour

400Vac devices:

- Step 1: 0Vac to 350Vac within a few seconds
- Step 2: 350Vac for 15 minutes
- Step 3: 420Vac for 15 minutes
- Step 4: 480Vac for 1 hour

575Vac devices:

- Step 1: 0Vac to 350Vac within a few seconds
- Step 2: 350Vac for 15 minutes
- Step 3: 420Vac for 15 minutes
- Step 3: 500Vac for 15 minutes
- Step 4: 600Vac for 1 hour

After you have completed the regeneration process, the device can be used immediately or stored again for an extended period with maintenance.

### **10.3 Waste Disposal**

Please observe current regulations. Dispose of the following materials in accordance with the regulations in force:

- Electronics scrap (printed circuit boards)
- Plastic (housing)
- Sheet metal
- Copper
- Aluminum

PRELIMINARY



# Chapter 11 Parameters

## 11.1 Overview of Parameters

### 11.1.1 Parameters for Real-Time Monitoring (Read Only)

Parameter group 0 gives access to internal inverter parameters for monitoring purposes. These parameters cannot be changed.

Parameter group 0 is visible if P1-14 is set to "101" or "201".

Parameters	Modbus register	Description	Display range	Explanation
	TBD	Fire mode/emergency mode start time		Time stamp related to (P0-65) at the time of activation of the fire mode/emergency mode
	TDB	Fire mode/emergency mode		Runtime in minutes how long the fire mode/emergency mode was active
	10	Output power		100 = 1.00 kW
	18	Scope channel 1		Selected channel assignment LT shell scope (permanent).
	19	Scope channel 2		Selected channel assignment LT shell scope (permanent).
P0-01	20	Value of analog input 1	0 – 100 %	1000 = 100% $\triangleq$ max input voltage or input current.
P0-02	21	Value of analog input 2	0 – 100 %	1000 = 100% $\triangleq$ max input voltage or input current.
P0-03	11	Digital input state	Binary value	Status of the digital inputs of the basic device and option DI8*; DI7*; DI6*; DI5; DI4; DI3; DI2; DI1 *Only available with the matching option module.
P0-04	22	Speed controller setpoint	0 – 100 %	68 = 6.8Hz; 100% = base frequency (P1-09)
P0-05	41	Torque controller setpoint	0 – 100 %	2000 = 200.0%; 100% = nominal motor torque
P0-06		Digital speed setpoint in keypad mode	-P1-01 – P1-01 in Hz	Speed displayed in Hz or cycles per min
P0-07		Speed setpoint via communication connection	-P1-01 – P1-01 in Hz	-
P0-08		PID reference	0 – 100 %	PID reference
P0-09		Actual PID value	0 – 100 %	Actual PID value
P0-10		PID output	0 – 100 %	PID output



Parameters	Modbus register	Description	Display range	Explanation
P0-11		Present motor voltage	V rms	Effective voltage value at the motor
P0-12		Output torque	0 – 200.0%	Torque output in %
P0-13		Error log	Latest 4 error messages with time stamp	Shows the last 4 errors. You can toggle between sub-items by pressing the <Up>/<Down> keys.
P0-14		Magnetizing current (Id)	Arms	Magnetizing current in A rms
P0-15		Rotor current (Iq)	Arms	Rotor current in A rms
P0-16		Magnetic field strength	0 – 100 %	Magnetic field strength
P0-17		Reserved		
P0-18		Reserved		
P0-19		Reserved		
P0-20	23	DC link voltage	Vdc	600 = 600V (internal DC link voltage)
P0-21	24	Inverter temperature	°C	40 = 40 °C (temperature inside the inverter)
P0-22		DC link voltage ripple	Vrms	Internal DC link voltage ripple
P0-23		Total time over 80 °C (heat sink)	Hours and minutes	Time during which the inverter was operated at > 80 °C
P0-24		Total time over 60 °C (ambient)	Hours and minutes	Time during which the inverter was operated at > 60 °C
P0-25		Rotor speed (calculated via motor model)	Hz	Applies only to vector mode Accuracy 0.5%
P0-26	30	kWh counter (can be reset)	0.0 – 999.9 kWh	100 = 10.0 kWh (cumulative energy consumption)
	32	kWh counter		
P0-27	31	MWh counter	0.0 – 65535 MWh	100 = 10.0 MWh (cumulative energy consumption)
	33	MWh counter (can be reset)		
P0-28		Software version and checksum	e.g. "1 1.00", "1 4F3C" "2 1.00", "2 Ed8A"	Version number and checksum, firmware.
P0-29		Inverter type	e.g. "HP 2", "2 400", "3-PhASE"	Version number and checksum.

Parameters	Modbus register	Description	Display range	Explanation
P0-30	25	Inverter serial number 4	000000 – 000000 (SN grp 1)	31 → 561723/01/ <b>031</b>
	26	Inverter serial number 3	000-00 – 999-99 (SN grp 2, 3)	1 → 561723/ <b>01</b> /031
	27	Inverter serial number 2		1723 → 56 <b>1723</b> /01/031
	28	Inverter serial number 1		56 → <b>56</b> 1723/01/031
	29	Status relay output		- ; - ; - ; RL5; RL4; RL3; RL2; RL1 The relay status is also displayed without relay option depending on the setting in P5-15 thru P5-20.
P0-31	34	Inverter operating time (hours)	Hours and minutes	Ex: 6 = <b>6h</b> 39m 07s
	35	Inverter operating time (minutes/seconds)		Ex: 2347 = 2347s = 39m 07s → 6h <b>39m 07s</b>
P0-32		Runtime since the last fault (1)	Hour/min/sec	Runtime after the inverter enable until the first fault occurred. If the inverter is not enabled, the runtime clock is stopped. The counter is reset the first time the inverter is enabled after an error is acknowledged or the first time the inverter is enabled after a power failure
P0-33		Runtime since the last fault (2)	Hour/min/sec	Runtime after the inverter enable until the first fault occurred. If the inverter is not enabled, the runtime clock is stopped. The counter is reset the first time the inverter is enabled after an error is acknowledged or the first time the inverter is enabled after a power failure.
P0-34	36	Inverter runtime after last controller inhibit (hours)	Hour/min/sec	6 = <b>6h</b> 11s – runtime clock is reset after inverter inhibit.
	37	Inverter runtime after last controller inhibit (minutes/seconds)		11 = 6h <b>11s</b> – runtime clock is reset after inverter inhibit.
P0-35		Inverter inhibit, inverter fan runtime	Hour/min/sec	Runtime clock for internal fan.
P0-36		DC link voltage log (256ms)	The last 8 values prior to the fault	The last 8 values prior to the fault.
P0-37		DC link voltage ripple log (20ms)	The last 8 values prior to the fault	The last 8 values prior to the fault.

Parameters	Modbus register	Description	Display range	Explanation
P0-38		Temperature sensor power electronics	The last 8 values prior to the fault	The last 8 values prior to the fault.
P0-39		Temperature sensor control electronics	The last 8 values prior to the fault	The last 8 values prior to the fault.
P0-40		Motor current log (256ms)	The last 8 values prior to the fault	The last 8 values prior to the fault.
P0-41		Counter for critical faults -O-I	-	Counter for overcurrent faults.
P0-42		Counter for critical faults -O-Volt	-	Counter for overvoltage faults.
P0-43		Counter for critical faults -U-Volt	-	Counter for undervoltage faults. Also during power off.
P0-44		Counter for critical faults -O-T	-	Counter for overtemperature faults of the heat sink.
P0-45		Counter for critical faults -b O-I	-	Counter for short-circuit faults of the brake chopper.
P0-46		Counter for critical faults O-heat	-	Counter for overtemperature faults due to high ambient temperature.
P0-47		Counter for internal I/O communication errors	0 – 65535	-
P0-48		Counter for internal DSP communication errors	0 – 65535	-
P0-49		Counter for Modbus communication errors	0 – 65535	-
P0-50		Counter for CAN bus communication errors	0 – 65535	-
P0-51		Incoming process data PI1, PI2, PI3	Hex value	3 entries; incoming process data from the perspective of the controller.
P0-52		Outgoing process data PO1, PO2, PO3	Hex value	3 entries; outgoing process data from the perspective of the controller.
P0-53		Current phase offset and reference value for U	Internal value	2 entries; first is reference value, second is measured value; no decimal place for both values.
P0-54		Current phase offset and reference value for V	Internal value	2 entries; first is reference value, second is measured value; no decimal place for both values.

Parameters	Modbus register	Description	Display range	Explanation
P0-55		Current phase offset and reference value for W	Internal value (not available for some inverters)	2 entries; first is reference value, second is measured value; no decimal place for both values.
P0-56		Max. switch-on time of braking resistor, operating cycle of braking resistor	Internal value	2 entries
P0-57		Ud/Uq	Internal value	2 entries
P0-58		Encoder speed	Hz, 1/min	Scaling with 3000 = 50.0Hz with one decimal place. 0.0Hz ~ 999.0Hz, 1000Hz ~ 2000Hz Can be displayed in 1/min if P1-10 ≠ 0.
P0-59		Frequency input speed	Hz, 1/min	Scaling with 3000 = 50.0Hz with one decimal place. 0.0Hz ~ 999.0Hz, 1000Hz ~ 2000Hz Can be displayed in 1/min if P1-10 ≠ 0.
P0-60		Calculated slip speed value	Internal value (only with V/f control) Hz, 1/min	Scaling with 3000 = 50.0Hz with one decimal place. 0.0Hz ~ 999.0Hz, 1000Hz ~ 2000Hz Can be displayed in 1/min if P1-10 ≠ 0.
P0-61		Value for speed hysteresis/relay control	Hz, 1/min	Scaling with 3000 = 50.0Hz with one decimal place. 0.0Hz ~ 999.0Hz, 1000Hz ~ 2000Hz Can be displayed in 1/min if P1-10 ≠ 0.
P0-62		Speed static	Internal value	Scaling with 3000 = 50.0Hz with one decimal place. 0.0Hz ~ 999.0Hz, 1000Hz ~ 2000Hz Can be displayed in 1/min if P1-10 ≠ 0.
P0-63		Speed setpoint after the ramp	Hz, 1/min	Scaling with 3000 = 50.0Hz with one decimal position. 0.0Hz ~ 999.0Hz, 1000Hz ~ 2000Hz Can be displayed in 1/min if P1-10 ≠ 0.
P0-64		Internal PWM frequency	4 – 16kHz	0 = 2kHz 1 = 4kHz 2 = 6kHz 3 = 8kHz 4 = 12kHz 5 = 16kHz
P0-65		Inverter service life	Hour/min/sec	2 entries; first for hour, second for minute and second.

Parameters	Modbus register	Description	Display range	Explanation
P0-66		I.t_trip counter	0 – 100 %	The value increases as soon as the i.t model is effective. When reaching 100%, the inverter switches off with "I.t_trp".
P0-67		Fieldbus torque setpoint/limit value	Internal value	
P0-68		User ramp value		<p>The indicating accuracy on the inverter display depends on the ramp time received via the fieldbus.</p> <p>For the inverters:</p> <ul style="list-style-type: none"> <li>• 230V: 0.75 – 5.5 kW</li> <li>• 400V: 0.75 – 11 kW</li> <li>• 575V: 0.75 – 15 kW</li> </ul> <p>Ramp &lt;0.1 s: Display with 2 decimal positions                      0.1 s ≤ ramp &lt;10 s: Display with 1 decimal position                      10 s ≤ ramp &lt;65 s: Display with 0 decimal positions</p> <p>For the inverters:</p> <ul style="list-style-type: none"> <li>• 230V: 7.5 – 75 kW</li> <li>• 400V: 15 – 160 kW</li> <li>• 575V: 18.5 – 110 kW</li> </ul> <p>0.0 s ≤ ramp &lt;10 s: Display with 1 decimal position                      10 s ≤ ramp &lt;65 s: Display with 0 decimal positions</p>
P0-69		Counter for I2C faults	0 ~ 65535	
P0-70		Module identification code	List	PL-HFA: Reserved Encoder module PL-Enc: Encoder module PL-EIO: IO expansion module PL-BUS: HMS fieldbus module PL-UnF: no module connected PL-UnA: unknown module connected
P0-71		Fieldbus module ID / fieldbus module status	List / value	N.A.: no fieldbus module connected. Prof-b: PROFIBUS module connected. Eth-IP: EtherNet/IP™ module connected. nu-nEt: Module of a new type (not detected). Eth-cAt: EtherCAT® module connected. PrF-nEt: PROFINET module connected. Modbus: Modbus TCP module connected.

Parameters	Modbus register	Description	Display range	Explanation
P0-72	39	Process temperature Room temperature	C	42 = 42 °C
P0-73		Encoder status / error codes For incremental encoders: 1=EnC-04 Signal A/A error 2=EnC-05 Signal B/B error 3=EnC-06 Signal A+B error	Internal value	
P0-74		L1 input voltage		
P0-75		L2 input voltage		
P0-76		L3 input voltage	Internal value	
P0-77		Reserved		
P0-78		Reserved		
P0-79		IO version and DSP bootloader version for motor control	Example: L 1.00 Example: b 1.01	2 entries; first for library version of the motor control (example is 1.00), second for DSP bootloader version (example is 1.01). 2 decimal positions.
P0-80		Reserved		

### 11.1.2 Parameter Registers

The following table lists all parameters together with their factory settings (indicated in bold). Numerical values are displayed with the complete setting range.

Modbus register	Associated parameter	Range/factory setting
101	<i>P1-01 Maximum Speed</i>	<i>P1-02</i> – <b>50.0Hz</b> – 5 × <i>P1-09</i>
102	<i>P1-02 Minimum Speed</i>	<b>0</b> – <i>P1-01Hz</i>
103	<i>P1-03 Acceleration Ramp Time</i>	IP20                      IP66 For the inverters:    For the inverters: • 230V:                      • 230V: 0.75 – 5.5 kW              0.75 – 4 kW • 400V:                      • 400V: 0.75 – 11 kW              0.75 – 7.5 kW • 575V:                      • 575V: 0.75 – 15 kW              0.75 – 11 kW 0.00 –                      0.00 – <b>5.0</b> – 600 s <b>5.0</b> – 600 s For the inverters:    For the inverters: • 230V:                      • 230V: 7.5 – 75 kW              5.5 – 75 kW • 400V:                      • 400V: 15 – 160 kW              11 – 160 kW • 575V:                      • 575V: 18.5 – 110 kW              15 – 110 kW 0.0 –                      0.0 – <b>5.0</b> – 6000 s <b>5.0</b> – 6000 s
104	<i>P1-04 Deceleration Ramp Time</i>	IP20                      IP66 For the inverters:    For the inverters: • 230V:                      • 230V: 0.75 – 5.5 kW              0.75 – 4 kW • 400V:                      • 400V: 0.75 – 11 kW              0.75 – 7.5 kW • 575V:                      • 575V: 0.75 – 15 kW              0.75 – 11 kW coast/0.01 – <b>5.0</b> –    coast/0.01 – <b>5.0</b> – 600 s                      600 s For the inverters:    For the inverters: • 230V:                      • 230V: 7.5 – 75 kW              5.5 – 75 kW • 400V: 1                      • 400V: 5 – 160 kW              11 – 160 kW • 575V:                      • 575V: 18.5 – 110 kW              15 – 110 kW coast/0.1 – <b>5.0</b> –    coast/0.1 – <b>5.0</b> – 6000 s                      6000 s
105	<i>P1-05 Stop Mode</i>	<b>0: Stop ramp</b> / 1: Coast to a stop

Modbus register	Associated parameter	Range/factory setting
106	<i>P1-06 Energy Saving Function</i>	<b>0: off</b> / 1: on
107	<i>P1-07 Rated Motor Voltage</i>	<ul style="list-style-type: none"> <li>• 230V inverter: 20 – <b>230</b> – 250V</li> <li>• 400V inverter: 20 – <b>400</b> – 500V</li> <li>• 575V inverter: 20 – <b>575</b> – 600V</li> </ul>
108	<i>P1-08 Rated Motor Current</i>	20 – 100% of the inverter current
109	<i>P1-09 Rated Motor Frequency</i>	25 – <b>50/60</b> – 500Hz
110	<i>P1-10 Rated Motor Speed</i>	<b>0</b> – 30000 1/min
111	<i>P1-11 Voltage Increase, Boost</i>	0 – 30% (factory setting depends on inverter)
112	<i>P1-12 Control Signal Source</i>	<b>0: Terminal mode</b>
113	<i>P1-13 Error History</i>	Last 4 errors
114	<i>P1-14 Extended Parameter Access</i>	<b>0</b> – 30000
115	<i>P1-15 Digital Input Function Selection</i>	0 – <b>1</b> – 26
116	<i>P1-16 Motor Type</i>	In-Syn
117	<i>Reserved</i>	0 – <b>1</b> – 8
118	<i>Reserved</i>	<b>0: Inhibited</b>
119	<i>Reserved</i>	0 – <b>1</b> – 63
120	<i>Reserved</i>	125, 250, <b>500</b> , 1000 kBaud
121	<i>Reserved</i>	0.50 – <b>1.00</b> – 2.00
122	<i>Reserved</i>	0 – <b>1</b> – 30
201	<i>P2-01 Fixed Setpoint Speed 1</i>	-P1-01 – <b>5.0Hz</b> – +P1-01
202	<i>P2-02 Fixed Setpoint Speed 2</i>	-P1-01 – <b>10.0Hz</b> – +P1-01
203	<i>P2-03 Fixed Setpoint Speed 3</i>	-P1-01 – <b>25.0Hz</b> – +P1-01
204	<i>P2-04 Fixed Setpoint Speed 4</i>	-P1-01 – <b>50.0Hz</b> – +P1-01
205	<i>P2-05 Fixed Setpoint Speed 5</i>	-P1-01 – <b>0.0Hz</b> – +P1-01
206	<i>P2-06 Fixed Setpoint Speed 6</i>	-P1-01 – <b>0.0Hz</b> – +P1-01
207	<i>P2-07 Fixed Setpoint Speed 7 /brake release speed</i>	-P1-01 – 0.0Hz – +P1-01
208	<i>P2-08 Fixed Setpoint Speed 8 /brake application speed</i>	-P1-01 – 0.0Hz – +P1-01
209	<i>P2-09 Skip Frequency</i>	P1-02 – P1-01
210	<i>P2-10 Skip Frequency Range</i>	<b>0.0Hz</b> – P1-01
211	<i>P2-11 Analog Output 1 Function Selection</i>	0 – <b>8</b> – 13
212	<i>P2-12 Analog Output 1 Format</i>	<b>0 – 10Vdc</b>
213	<i>P2-13 Analog Output 2 Function Selection</i>	0 – <b>9</b> – 13



Modbus register	Associated parameter	Range/factory setting
214	<i>P2-14 Analog Output 2 Format</i>	<b>0 – 10Vdc</b>
215	<i>P2-15 User Relay Output 1 Function Selection</i>	0 – <b>1</b> – 11
216	<i>P2-16 Upper Limit of User Relay 1: Analog Output 1</i>	0.0 – <b>100.0</b> – 200.0 %
217	<i>P2-17 Lower Limit of User Relay 1: Analog Output 1</i>	<b>0.0</b> – P2-16
218	<i>P2-18 User Relay Output 2 Function Selection</i>	0 – <b>3</b> – 11
219	<i>P2-19 Upper Limit of User Relay 2: Analog Output 2</i>	0.0 – <b>100.0</b> – 200.0 %
220	<i>P2-20 Lower Limit of User Relay 2: Analog Output 2</i>	<b>0.0</b> – P2-19
221	<i>P2-21 Display Scaling Factor</i>	-30000 – <b>0,000</b> – 30000
222	<i>P2-22 Display Scaling Source</i>	0 – 2
223	<i>P2-23 Zero Speed Holding Time</i>	0.0 – <b>0.2</b> – 60.0 s
224	<i>P2-24 PWM Switching Frequency</i>	2 – 16kHz (depends on inverter)
225	<i>P2-25 Second Deceleration Ramp, Rapid Stop Ramp</i>	IP20      IP66 For the inverters:      For the inverters: • 230V:      • 230V: 0.75 – 5.5 kW      0.75 – 4 kW • 400V:      • 400V: 0.75 – 11 kW      0.75 – 7.5 kW • 575V:      • 575V: 0.75 – 15 kW      0.75 – 11 kW coast/0.01 – <b>2.0</b> – 600 s      coast/0.01 – <b>2.0</b> – 600 s For the inverters:      For the inverters: • 230V:      • 230V: 7.5 – 75 kW      5.5 – 75 kW • 400V:      • 400V: 15 – 160 kW      11 – 160 kW • 575V:      • 575V: 18.5 – 110 kW      15 – 110 kW coast/0.1 –      coast/0.1 – <b>2.0</b> – 6000 s <b>2.0</b> – 6000 s
226	<i>P2-26 Flying Start Enable</i>	<b>0: Disabled</b>
227	<i>P2-27 Standby Mode</i>	<b>0.0</b> – 250 s
228	<i>P2-28 Slave Speed Scaling</i>	<b>0: Disabled</b>
229	<i>P2-29 Slave Speed Scaling Factor</i>	-500 – <b>100</b> – 500 %
230	<i>P2-30 Analog Input 1 Format</i>	<b>0 – 10Vdc</b>
231	<i>P2-31 Analog Input 1 Scaling</i>	0 – <b>100</b> – 500 %
232	<i>P2-32 Analog Input 1 Offset</i>	-500 – <b>0</b> – 500 %
233	<i>P2-33 Analog Input 2 Format / Motor Protection</i>	<b>0 – 10Vdc</b>

Modbus register	Associated parameter	Range/factory setting
234	<i>P2-34 Analog Input 2 Scaling</i>	0 – <b>100</b> – 500 %
235	<i>P2-35 Analog Input 2 Offset</i>	-500 – <b>0</b> – 500 %
236	<i>P2-36 Start Mode Selection</i>	<b>Auto – 0</b>
237	<i>P2-37 Keypad Restart Speed</i>	0 – 7
238	<i>P2-38 Mains Loss Stop Control</i>	<b>0 – 3</b>
239	<i>P2-39 Parameter Lock</i>	<b>0: Disabled</b>
240	<i>P2-40 Extended Parameter Access Code Definition</i>	0 – <b>101</b> – 9999
301	<i>P3-01 PID Proportional Gain</i>	0 – <b>1</b> – 30
302	<i>P3-02 PID Integral Time Constant</i>	0 – <b>1</b> – 30 s
303	<i>P3-03 PID Differential Time Constant</i>	<b>0.00</b> – 1.00 s
304	<i>P3-04 PID Operating Mode</i>	<b>0: Direct operation</b>
305	<i>P3-05 PID Reference Selection</i>	<b>0: Fixed setpoint reference</b>
306	<i>P3-06 PID Fixed Setpoint Reference 1</i>	<b>0.0</b> – 100.0%
307	<i>P3-07 PID Controller Upper Limit</i>	P3-08 – <b>100.0%</b>
308	<i>P3-08 PID Controller Lower Limit</i>	<b>0.0 %</b> – P3-07
309	<i>P3-09 PID Correcting Variable Limitation</i>	<b>0: Fixed setpoint reference</b>
310	<i>P3-10 PID Feedback Selection</i>	<b>0: Analog input 2</b>
311	<i>P3-11 PID Ramp Activation Error</i>	<b>0.0</b> – 25.0%
312	<i>P3-12 PID Actual Value Display Scaling Factor</i>	<b>0.0</b> – 50000
313	<i>P3-13 PID Feedback Wake-Up Level</i>	<b>0.0</b> – 100.0%
314	<i>P3-14 PID Fixed Setpoint Reference 2</i>	<b>0.0</b> – 100.0%
315	<i>P3-15 PID Fixed Setpoint Reference 3</i>	<b>0.0</b> – 100.0%
316	<i>P3-16 PID Fixed Setpoint Reference 4</i>	<b>0.0</b> – 100.0%
401	<i>P4-01 Control Mode</i>	<b>2: Speed control – Enhanced V/f</b>
402	<i>P4-02 Auto Tune</i>	<b>0: Inhibited</b>
403	<i>P4-03 Speed Controller Proportional Gain</i>	0.1 – <b>50</b> – 400 %
404	<i>P4-04 Speed Controller Integral Time Constant</i>	0,001 – <b>0,100</b> – 1,000 s
405	<i>P4-05 Motor Power Factor</i>	0.50 – 0.99 (depends on inverter)
406	<i>P4-06 Torque Reference/Limit Value Source</i>	<b>0: Fixed torque reference/limit value</b>
407	<i>P4-07 Max. Motor Torque Limit</i>	P4-08 – <b>200</b> – 500%
408	<i>P4-08 Min. Torque Limit</i>	<b>0.0%</b> – P4-07
409	<i>P4-09 Max. Regenerative Torque Limit</i>	P4-08 – <b>200</b> – 500%
410	<i>P4-10Vdc/f Characteristic Adjustment Frequency</i>	<b>0.0</b> – 100.0 % of P1-09
411	<i>P4-11 V/f Characteristic Adjustment Voltage</i>	<b>0.0</b> – 100.0 % of P1-07

Modbus register	Associated parameter	Range/factory setting
412	<i>P4-12 Motor Brake Control</i>	<b>0: Disabled</b>
413	<i>P4-13 Brake Release Time</i>	0.0 – 5.0 s
414	<i>P4-14 Brake Application Time</i>	0.0 – 5.0 s
415	<i>P4-15 Torque Threshold for Brake Release</i>	0.0 – 200%
416	<i>P4-16 Hoist Torque Threshold Timeout</i>	0.0 – 25.0 s
417	<i>P4-17 Thermal Motor Protection to UL508C</i>	<b>0: Disabled</b>
501	<i>P5-01 Inverter Address</i>	0 – <b>1</b> – 63
502	<i>P5-02</i>	Reserved
503	<i>P5-03 Modbus RTU Baud Rate</i>	9.6 – <b>115.2 / 115200 Bd</b>
504	<i>P5-04 Modbus RTU Data Format</i>	<b>n-1: no parity, 1 stop bit</b>
505	<i>P5-05 Response to Communication Failure</i>	<b>2: Stop ramp (without fault)</b>
506	<i>P5-06 Communication Failure Timeout for Modbus</i>	0.0 – <b>1.0</b> – 5.0 s
507	<i>P5-07 Ramp Specified via Fieldbus</i>	<b>0: Disabled</b>
508	<i>P5-08 Synchronization Duration</i>	<b>0, 5</b> – 20ms
509	<i>P5-09 Fieldbus PO2 Definition</i>	0 – 7
510	<i>P5-10 Fieldbus PO3 Definition</i>	0 – 7
511	<i>P5-11 Fieldbus PO4 Definition</i>	0 – 7
512	<i>P5-12 Fieldbus PI2 Definition</i>	0 – 11
513	<i>P5-13 Fieldbus PI3 Definition</i>	0 – 11
514	<i>P5-14 Fieldbus PI4 Definition</i>	0 – 11
515	<i>P5-15 Expansion Relay 3 Function Selection</i>	0 – 10
516	<i>P5-16 Relay 3 Upper Limit</i>	0.0 – <b>100.0</b> – 200.0%
517	<i>P5-17 Relay 3 Lower Limit</i>	<b>0.0</b> – 200.0%
518	<i>P5-18 Expansion Relay 4 Function Selection</i>	see P5-15
519	<i>P5-19 Relay 4 Upper Limit</i>	0.0 – <b>100.0</b> – 200.0%
520	<i>P5-20 Relay 4 Lower Limit</i>	<b>0.0</b> – 200.0%
601	<i>P6-01 Firmware Upgrade Enable</i>	<b>0: Disabled</b>
602	<i>P6-02 Automatic Thermal Management</i>	<b>1: Enabled</b>
603	<i>P6-03 Auto-Reset Delay Time</i>	1 – <b>20</b> – 60 s
604	<i>P6-04 Hysteresis Band User Relay</i>	0.0 – <b>0.3</b> – 25.0%
605	<i>P6-05 Encoder Feedback Enable</i>	<b>0: Disabled</b>
606	<i>P6-06 Encoder PPR</i>	<b>0</b> – 65535 PPR
607	<i>P6-07 Trigger Threshold Speed Error/Speed Monitoring</i>	1.0 – <b>5.0</b> – 100%
608	<i>P6-08 Max. Frequency for Speed Setpoint</i>	0; <b>5</b> – 20kHz

Modbus register	Associated parameter	Range/factory setting
609	<i>P6-09 Droop Speed/Load Distribution Control</i>	<b>0.0</b> – 25.0%
610	<i>P6-10 Reserved</i>	
611	<i>P6-11 Speed Holding Time on Enable (Fixed Setpoint Speed 7)</i>	<b>0.0</b> – 250 s
612	<i>P6-12 Speed Holding Time on Inhibit (Fixed Setpoint Speed 8)</i>	<b>0.0</b> – 250 s
613	P6-13 Fire Mode Logic/Emergency Mode	<b>0: Open trigger: Fire mode</b>
614	P6-14 Fire Mode/Emergency Mode Speed	-P1-01 – <b>0</b> – P1-01Hz
615	<i>P6-15 Analog Output 1 Scaling</i>	0.0 – <b>100.0</b> – 500.0%
616	<i>P6-16 Analog Output 1 Offset</i>	-500.0 – <b>0.0</b> – 500.0%
617	<i>P6-17 Max. Torque Limit Timeout</i>	0.0 – <b>0.5</b> – 25.0 s
618	<i>P6-18 DC Braking Voltage Level</i>	Auto, <b>0.0</b> – 30.0%
619	<i>P6-19 Braking Resistor Value</i>	<b>0</b> , Min-R – 200Ω
620	<i>P6-20 Braking Resistor Power</i>	<b>0.0</b> – 200 kW
621	<i>P6-21 Brake Chopper Operating Cycle at Under-Temperature</i>	<b>0.0</b> – 20.0%
622	<i>P6-22 Reset Fan Runtime</i>	<b>0: Disabled</b>
623	<i>P6-23 Reset kWh Meter</i>	<b>0: Disabled</b>
624	<i>P6-24 Parameter Default Settings</i>	<b>0: Disabled</b>
625	<i>P6-25 Access Code Level 3</i>	0 – <b>201</b> – 9 999
626	<i>P6-26 Parameter Backup</i>	0: Basic setting of the parameter
701	<i>P7-01 Motor Stator Resistance (Rs)</i>	depending on the motor
702	<i>P7-02 Motor Rotor Resistance (Rr)</i>	depending on the motor
703	<i>P7-03 Motor Stator Inductance (Lsd)</i>	depending on the motor
704	<i>P7-04 Motor Magnetization Current (Id rms)</i>	10% × P1-08 – 80% × P1-08
705	<i>P7-05 Motor Leakage Loss Coefficient (sigma)</i>	0,025 – <b>0.10</b> – 0.25
706	<i>P7-06 Motor Stator Inductance (Lsq) – Only for Synchronous Motors</i>	depending on the motor
707	<i>P7-07 Enhanced Generator Control</i>	<b>0: Disabled</b>
708	<i>P7-08 Parameter Adjustment</i>	<b>0: Disabled</b>
709	<i>P7-09 Overvoltage Current Limit</i>	0.0 – <b>1.0</b> – 100%
710	<i>P7-10 Stiffness (for Vector Control)</i>	0 – <b>10</b> – 600
711	<i>P7-11 Pulse Width Min. Limit</i>	0 – 500
712	<i>P7-12 Pre-Magnetization Time</i>	0 – 5000ms
713	<i>P7-13 D-Gain Vector Speed Controller</i>	<b>0.0</b> – 400%

Modbus register	Associated parameter	Range/factory setting
714	<i>P7-14 Low-Frequency Torque Boost/Pre-Magnetization Current</i>	<b>0.0</b> – 100%
715	<i>P7-15 Torque Boost Frequency Limit</i>	<b>0.0</b> – 50%
716	<i>Reserved</i>	
801	<i>Reserved</i>	
802	<i>Reserved</i>	
803	<i>Reserved</i>	
804	<i>Reserved</i>	
805	<i>Reserved</i>	
806	<i>Reserved</i>	
807	<i>Reserved</i>	
808	<i>Reserved</i>	
809	<i>Reserved</i>	
810	<i>Reserved</i>	
811	<i>Reserved</i>	
812	<i>Reserved</i>	
813	<i>Reserved</i>	
814	<i>Reserved</i>	
901	<i>P9-01 Enable Input Source</i>	SAFE, din-1 – din-8
902	<i>P9-02 Rapid Stop Input Source</i>	OFF, din-1 – din-8, On
903	<i>P9-03 Input Source for Clockwise Rotation (CW)</i>	OFF, din-1 – din-8, On
904	<i>P9-04 Input Source for Counterclockwise Rotation (CCW)</i>	OFF, din-1 – din-8, On
905	<i>P9-05 Latch Function Enable</i>	OFF, ON
906	<i>P9-06 Direction of Rotation Reversal</i>	OFF, din-1 – din-8, On
907	<i>P9-07 Reset Input Source</i>	OFF, din-1 – din-8, On
908	<i>P9-08 External Fault Input Source</i>	OFF, din-1 – din-8, On
909	<i>P9-09 Terminal Control Enable Source</i>	OFF, din-1 – din-8, On
910	<i>P9-10 Speed Source 1</i>	Ain-1, Ain-2, speed 1–8, d-Pot, PID, Sub-dr, F-bus, user, pulse
911	<i>P9-11 Speed Source 2</i>	Ain-1, Ain-2, speed 1–8, d-Pot, PID, Sub-dr, F-bus, user, pulse
912	<i>P9-12 Speed Source 3</i>	Ain-1, Ain-2, speed 1–8, d-Pot, PID, Sub-dr, F-bus, user, pulse
913	<i>P9-13 Speed Source 4</i>	Ain-1, Ain-2, speed 1–8, d-Pot, PID, Sub-dr, F-bus, user, pulse

<b>Modbus register</b>	<b>Associated parameter</b>	<b>Range/factory setting</b>
914	<i>P9-14 Speed Source 5</i>	Ain-1, Ain-2, speed 1–8, d-Pot, PID, Subdr, F-bus, user, pulse
915	<i>P9-15 Speed Source 6</i>	Ain-1, Ain-2, speed 1–8, d-Pot, PID, Subdr, F-bus, user, pulse
916	<i>P9-16 Speed Source 7</i>	Ain-1, Ain-2, speed 1–8, d-Pot, PID, Subdr, F-bus, user, pulse
917	<i>P9-17 Speed Source 8</i>	Ain-1, Ain-2, speed 1–8, d-Pot, PID, Subdr, F-bus, user, pulse
918	<i>P9-18 Input Speed Selection 0</i>	OFF, din-1 – din-8, On
919	<i>P9-19 Input Speed Selection 1</i>	OFF, din-1 – din-8, On
920	<i>P9-20 Input Speed Selection 2</i>	OFF, din-1 – din-8, On
921	<i>P9-21 Fixed Setpoint Speed Selection Input 0</i>	OFF, din-1 – din-8, On
922	<i>P9-22 Fixed Setpoint Speed Selection Input 1</i>	OFF, din-1 – din-8, On
923	<i>P9-23 Fixed Setpoint Speed Selection Input 2</i>	OFF, din-1 – din-8, On
924	<i>P9-24 Positive Jog Mode Input</i>	OFF, din-1 – din-8
925	<i>P9-25 Negative Jog Mode Input</i>	OFF, din-1 – din-8
926	<i>P9-26 Reference Travel Enable Input</i>	OFF, din-1 – din-8
927	<i>P9-27 Reference Cam Input</i>	OFF, din-1 – din-8
928	<i>P9-28 Motor Potentiometer Up Input Source</i>	OFF, din-1 – din-8
929	<i>P9-29 Motor Potentiometer Down Input Source</i>	OFF, din-1 – din-8
930	<i>P9-30 Positive Limit Switch CW</i>	OFF, din-1 – din-8
931	<i>P9-31 Negative Limit Switch CCW</i>	OFF, din-1 – din-8
932	<i>P9-32 Enable Second Deceleration Ramp, Rapid Stop Ramp</i>	OFF, din-1 – din-8
933	<i>P9-33 Fire Mode/Emergency Mode Input Selection</i>	OFF, din-1 – din-5
934	<i>P9-34 PID Fixed Setpoint Reference Selection Input 0</i>	<b>OFF</b> , din-1 – din-8
935	<i>P9-35 PID Fixed Setpoint Reference Selection Input 1</i>	<b>OFF</b> , din-1 – din-8

## 11.2 Explanation of the Parameters

### 11.2.1 Parameter Group 1: Basic Parameters (Level 1)

#### P1-01 Maximum Speed

Setting range: P1-02 – **50.0Hz** –  $5 \times P1-09$  (max. 500Hz)

Specifies the upper limit for the frequency (speed) that can be applied to the motor in any operating mode. This parameter is displayed in Hz in factory default state or when the parameter for the rated motor speed (P1-10) is set to zero. If the rated motor speed was entered in rpm in P1-10, this parameter will be displayed in rpm.

The maximum speed is also limited by the switching frequency set in P2-24. The limit is determined by the maximum output frequency to the motor = P2-24: 16.

#### P1-02 Minimum Speed

Setting range: **0** – P1-01Hz

Specifies the lower limit for the frequency (speed) that can be applied to the motor in any operating mode. This parameter is displayed in Hz in factory default state or when the parameter for the rated motor speed (P1-10) is set to zero. If the rated motor speed was entered in rpm in P1-10, this parameter will be displayed in rpm.

The speed drops below this limit only when the inverter enable signal is removed and the inverter decreases the output frequency to zero.

#### P1-03 Acceleration Ramp Time

Setting range:

For the inverters:

##### IP20

- 230V: 0.75 – 5.5 kW
  - 400V: 0.75 – 11 kW
  - 575V: 0.75 – 15 kW
- 0.00 – **5.0** – 600 s

##### IP66

- 230V: 0.75 – 4 kW
  - 400V: 0.75 – 7.5 kW
  - 575V: 0.75 – 11 kW
- 0.00 – **5.0** – 600 s

For the inverters:

##### IP20

- 230V: 7.5 – 75 kW
  - 400V: 15 – 160 kW
  - 575V: 18.5 – 110 kW
- 0.0 – **5.0** – 6000 s

##### IP66

- 230V: 5.5 – 75 kW
  - 400V: 11 – 160 kW
  - 575V: 15 – 110 kW
- 0.0 – **5.0** – 6000 s

Specifies the time in seconds during which the output frequency (speed) increases from 0 to 50Hz. Note that the ramp time is not affected by changing either the maximum or minimum speed limit. The reason is that the ramp time refers to 50Hz, not to the speed P1-01 / P1-02.

### P1-04 Deceleration Ramp Time

Setting range:

For the inverters:

IP20	IP66
<ul style="list-style-type: none"> <li>• 230V: 0.75 – 5.5 kW</li> <li>• 400V: 0.75 – 11 kW</li> <li>• 575V: 0.75 – 15 kW</li> </ul>	<ul style="list-style-type: none"> <li>• 230V: 0.75 – 4 kW</li> <li>• 400V: 0.75 – 7.5 kW</li> <li>• 575V: 0.75 – 11 kW</li> </ul>
Coast – 0.01 – <b>5.0</b> – 600 s	Coast – 0.01 – <b>5.0</b> – 600 s

For the inverters:

IP20	IP66
<ul style="list-style-type: none"> <li>• 230V: 7.5 – 75 kW</li> <li>• 400V: 15 – 160 kW</li> <li>• 575V: 18.5 – 110 kW</li> </ul>	<ul style="list-style-type: none"> <li>• 230V: 5.5 – 75 kW</li> <li>• 400V: 11 – 160 kW</li> <li>• 575V: 15 – 110 kW</li> </ul>
Coast – 0.1 – <b>5.0</b> – 6000 s	Coast – 0.1 – <b>5.0</b> – 6000 s

Specifies the time in seconds during which the output frequency (speed) decreases from 50 to 0Hz. Note that the ramp time is not affected by changing either the maximum or minimum speed limit. The reason is that the ramp time refers to 50Hz, not to *P1-01* / *P1-02*.

A ramp of 0 s is displayed as "coast" as this value leads to coast to a stop.

### P1-05 Stop Mode

- **0: Stop ramp:** The speed is decreased to zero along the ramp set in *P1-04* when the inverter enable signal is removed. The output stage is only inhibited when the output frequency is zero. If a zero-speed holding time is set in *P2-23*, the inverter will hold zero speed during this time before it is disabled.
- **1: Coast to a stop:** In this case, the inverter output is disabled as soon as the enable signal is removed. The motor then coasts to stop in a non-controlled manner.

### P1-06 Energy Saving Function

- **0: Off**
- **1: On**

If this function is activated, the inverter continuously monitors the motor load condition by comparing the output current with the nominal motor current. If the motor rotates with a constant speed in the partial load range, the inverter automatically reduces the output voltage, thus reducing the motor's energy consumption. If the motor load increases or the frequency setpoint changes, the output voltage increases immediately. The energy-saving function works only if the inverter setpoint remains constant over a certain period of time.

Application examples include, for example, fan applications or conveyor belts for which the energy requirement in the range between full, empty or partial load trips is optimized.

This function is only applicable for asynchronous motors.



### **P1-07 Rated Motor Voltage**

Setting range:

- 230V inverter: 20 – **230** – 250V
- 400V inverter: 20 – **400** – 500V
- 575V inverter: 20 – **575** – 600V

Specifies the nominal voltage of the motor connected to the inverter (in accordance with the motor nameplate). The parameter value is used in V/f speed control for controlling the output voltage applied to the motor. In V/f speed control, the output voltage of the inverter amounts to the value set in P1-07 if the output speed corresponds to the motor base frequency set in P1-09.

"OV" = DC link compensation is disabled. When braking, the V/f ratio shifts as a result of the voltage increase in the DC link, resulting in greater motor losses. The motor heats up more. The additional motor losses during braking might make a braking resistor redundant.

### **P1-08 Rated Motor Current**

Setting range: 20 – 100% of the inverter output current. Is given as absolute value in ampere.

Specifies the rated current of the motor connected to the inverter (according to the motor nameplate). This allows the inverter to match its internal thermal motor protection (I x t protection) to the motor.

If the inverter output current is > 100% of the nominal motor current, the inverter switches off the motor after a certain amount of time (I.-trP) before there is any thermal damage to the motor.

### **P1-09 Rated Motor Frequency**

Setting range: 25 – **50/60<sup>11</sup>** – 500Hz

Specifies the rated frequency of the motor connected to the inverter (according to the motor nameplate). This is the frequency at which the maximum (rated) output voltage is applied to the motor. Above this frequency, the voltage applied to the motor remains constant at its maximum value.

### **P1-10 Rated Motor Speed**

Setting range: **0** – 30 000 1/min

Specifies the rated speed of the motor. When the parameter is ≠ 0, all speed-related parameters, such as minimum and maximum speed are displayed in "rpm".

The slip compensation is activated at the same time. The frequency or speed shown on the display of the inverter corresponds to the calculated rotor frequency or rotor speed.

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<sup>11</sup> 60Hz (American version only)

### P1-11 Voltage Increase, Boost

Setting range: Auto / 0 – 30% (default value depends on inverter voltage and power rating)

Determines the voltage increase at low speeds in order to facilitate the removal of applied loads. Modifies the V/f limit values by  $\frac{1}{2} P1-07$  and  $\frac{1}{2} P1-09$ .

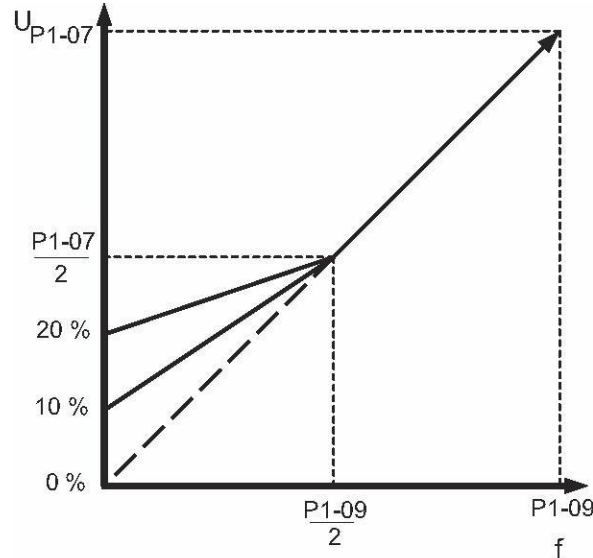


Figure 58: Effect of Parameters in Voltage Boost

For the "Auto" setting, a value based on the motor data measured during auto tune is set automatically.

### P1-12 Control Signal Source

The user can use this parameter to determine whether the inverter is controlled by the:

- User terminals
- Keypad at the front of the device
- Internal PID controller
- Fieldbus

Refer also to Section 7.4, [Start-Up of Control](#).

- **0: Terminal mode**
- 1: Keypad mode unipolar
- 2: Keypad mode bipolar
- 3: PID controller mode
- 4: Master-slave operation
- 5: Reserved
- 6: Reserved
- 7: Fieldbus, Modbus, communication option
- 8: Not supported

**Note:** Once a Fieldbus option card or an encoder card is installed in the option card slot, communications via Modbus are no longer possible.

### **P1-13 Error History**

Includes the four most recent faults and/or events that have occurred. Each fault is displayed with abbreviated text. The most recent fault is displayed first. When a new fault occurs, it will be entered at the top of the list. All other faults are shifted downwards. The oldest fault will be deleted from the error history. Under-voltage faults are only archived if the inverter is enabled. If the inverter is separated from the supply system without enable, no under-voltage fault is archived.

### **P1-14 Extended Parameter Access**

Setting range: **0** – 30000

This parameter allows users to access parameter groups other than the basic parameters (parameters *P1-01* – *P1-15*). Access is possible when the following values are valid.

- **0: P1-01 – P1-15** (basis parameter)
- **1: P1-01 – P1-22** (basis + servo parameter)
- **101: P0-01 – P5-20** (extended parameters)
- **201: P0-01 – P9-33** (extended parameter menu → full access)

### P1-15 Digital Input Function Selection

Setting range: 0 – 1 – 26

Users can set the function of the digital inputs of the inverter, that is the user can select functions required for the application.

The following tables list the functions of the digital inputs depending on the value set in parameters *P1-12* (terminal/keypad control) and *P1-15* (selection of the digital input functions).

**Note:** Individual configuration of digital inputs:

To individually configure the digital input assignment, set parameter *P1-15* to "0". This setting means that the input terminals for *DI1* – *DI5* are set to "no function".

P1-15	Digital input 1	Digital input 2	Digital input 3	Analog input 1: Digital input 4	Analog input 2: Digital input 5	Remarks / preset value
0	No function P9-xx	No function P9-xx	No function P9-xx	No function P9-xx	No function P9-xx	Configuration via parameter group P9-xx.
1	<b>0: Stop (controller inhibit)</b> <b>1: Start (enable)</b>	<b>0: Clockwise rotation</b> <b>1: Counter-clockwise rotation</b>	<b>0: Selected speed setpoint</b> <b>1: Fixed setpoint speed 1, 2</b>	<b>Analog 1 speed setpoint</b>	<b>0: Fixed setpoint speed 1</b> <b>1: Fixed setpoint speed 2</b>	–
2	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	0: Open 1: Closed 0: Open 1: Applied 0: Open 1: Closed 0: Open 1: Closed	0: Open 0: Open 1: Closed 1: Closed 0: Open 0: Open 1: Closed 1: Closed	0: Open 0: Open 0: Open 0: Open 1: Applied 1: Closed 1: Closed 1: Closed	Fixed setpoint speed 1 Fixed setpoint speed 2 Fixed setpoint speed 3 Fixed setpoint speed 4 Fixed setpoint speed 5 Fixed setpoint speed 6 Fixed setpoint speed 7 Fixed setpoint speed 8
3	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	0: Selected speed setpoint 1: Fixed setpoint speed 1	Analog 1 speed setpoint	Analog torque reference Set <i>P4-06</i> = 2 here.	–
4	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	0: Selected speed setpoint 1: Fixed setpoint speed 1	Analog 1 speed setpoint	0: Decel. ramp 1 1: Decel. ramp 2	–

P1-15	Digital input 1	Digital input 2	Digital input 3	Analog input 1: Digital input 4	Analog input 2: Digital input 5	Remarks / preset value
5	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	0: Selected speed setpoint 1: Analog input 2	Analog 1 Speed setpoint	Analog 2 speed setpoint	-
6	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	0: Selected speed setpoint 1: Fixed setpoint speed 1	Analog 1 speed setpoint	External fault <sup>12</sup> 0: Error 1: Start	-
7	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	0: Open 1: Applied 0: Open 1: Applied	0: Open 0: Open 1: Applied 1: Applied	External fault <sup>12</sup> 0: Error 1: Start	Fixed setpoint speed 1 Fixed setpoint speed 2 Fixed setpoint speed 3 Fixed setpoint speed 4
8	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	0: Open 1: Applied 0: Open 1: Applied	0: Open 0: Open 1: Applied 1: Applied	0: Decel. ramp 1 1: Decel. ramp 2	Fixed setpoint speed 1 Fixed setpoint speed 2 Fixed setpoint speed 3 Fixed setpoint speed 4
9	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	0: Open 1: Applied 0: Open 1: Applied	0: Open 0: Open 1: Applied 1: Applied	0: Selected speed setpoint 1: Fixed setpoint speed 1 – 4	Fixed setpoint speed 1 Fixed setpoint speed 2 Fixed setpoint speed 3 Fixed setpoint speed 4
10	0: Stop (controller inhibit) 1: Start (enable)	0: Clockwise rotation 1: CCW rotation	N.O. contact The speed increases when closing.	N.O. contact The speed decreases when closing.	0: Selected speed setpoint 1: Fixed setpoint speed 1	-
11	0: Stop (controller inhibit) 1: CW rotation	0: Stop (controller inhibit) 1: CCW rotation	0: Selected speed setpoint 1: Fixed setpoint speed 1, 2	Analog 1 speed setpoint	0: Fixed setpoint speed 1 1: Fixed setpoint speed 2	-
12			0: Open 1: Applied	0: Open 0: Open	0: Open 0: Open	Fixed setpoint speed 1 Fixed setpoint speed 2

<sup>12</sup> The external fault is defined in parameter P2-33.

P1-15	Digital input 1	Digital input 2	Digital input 3	Analog input 1: Digital input 4	Analog input 2: Digital input 5	Remarks / preset value
	0: Stop (controller inhibit)	0: Stop (controller inhibit)	0: Open	1: Applied	0: Open	Fixed setpoint speed 3
			1: Applied	1: Applied	0: Open	Fixed setpoint speed 4
	1: CW rotation	1: CCW rotation	0: Open	0: Open	1: Applied	Fixed setpoint speed 5
			1: Applied	0: Open	1: Applied	Fixed setpoint speed 6
			0: Open	1: Applied	1: Applied	Fixed setpoint speed 7
			1: Applied	1: Applied	1: Applied	Fixed setpoint speed 8
13	0: Stop (controller inhibit)	0: Stop (controller inhibit)	0: Selected speed setpoint	Analog 1 speed setpoint	Analog torque reference	–
	1: CW rotation	1: CCW rotation	1: Fixed setpoint speed 1		Set P4-06 = 2 here.	
14	0: Stop (controller inhibit)	0: Stop (controller inhibit)	0: Selected speed setpoint	Analog 1 speed setpoint	0: Decel. ramp 1	–
	1: CW rotation	1: CCW rotation	1: Fixed setpoint speed 1		1: Decel. ramp 2	
15	0: Stop (controller inhibit)	0: Stop (controller inhibit)	0: Selected speed setpoint	Analog 1 speed setpoint	Analog 2 speed setpoint	–
	1: CW rotation	1: CCW rotation	1: Analog input 2			
16	0: Stop (controller inhibit)	0: Stop (controller inhibit)	0: Selected speed setpoint	Analog 1 speed setpoint	External fault <sup>12</sup>	–
	1: CW rotation	1: CCW rotation	1: Fixed setpoint speed 1		0: Error	
					1: Start	
17	0: Stop (controller inhibit)	0: Stop (controller inhibit)	0: Open	0: Open	External fault <sup>12</sup>	Fixed setpoint speed 1
			1: Applied	0: Open	0: Error	Fixed setpoint speed 2
	1: CW rotation	1: CCW rotation	0: Open	1: Applied	1: Start	Fixed setpoint speed 3
			1: Applied	1: Applied		Fixed setpoint speed 4
18	0: Stop (controller inhibit)	0: Stop (controller inhibit)	0: Open	0: Open	0: Decel. ramp 1	Fixed setpoint speed 1
			1: Applied	0: Open	1: Decel. ramp 2	Fixed setpoint speed 2
	1: CW rotation	1: CCW rotation	0: Open	1: Applied		Fixed setpoint speed 3
			1: Applied	1: Applied		Fixed setpoint speed 4
19	0: Stop (controller inhibit)	0: Stop (controller inhibit)	0: Open	0: Open	0: Selected speed setpoint	Fixed setpoint speed 1
			1: Applied	0: Open		Fixed setpoint speed 2
			0: Open	1: Applied		Fixed setpoint speed 3

P1-15	Digital input 1	Digital input 2	Digital input 3	Analog input 1: Digital input 4	Analog input 2: Digital input 5	Remarks / preset value
	1: CW rotation	1: CCW rotation	1: Applied	1: Applied	1: Fixed setpoint speed 1 – 4	Fixed setpoint speed 4
20	0: Stop (controller inhibit) 1: CW rotation	0: Stop (controller inhibit) 1: CCW rotation	N.O. contact The speed increases when closing.	N.O. contact The speed decreases when closing.	0: Selected speed setpoint 1: Fixed setpoint speed 1	Used for motor potentiometer operation.
21	0: Stop (controller inhibit) 1: Clockwise rotation (latching)	0: Stop (controller inhibit) 1: Start	0: Stop (controller inhibit) 1: Counterclockwise rotation (latching)	Analog 1 speed setpoint	0: Selected speed setpoint 1: Fixed setpoint speed 1	Function enabled if $P1-12 = 0$
22	Reserved					
23	Reserved					
24	Reserved					
25	Reserved					

**Note:** When using a TF/TH, KTY or PT1000, set P2-33 to PTC-th, KTY or PT1000. Also observe the connection information in Section 5.4.11, [Motor Temperature Protection TF, TH, KTY84, PT1000](#).

## 11.2.2 Parameter Group 1: Servo-Specific Parameters (Level 1)

### P1-16 Motor Type

Setting the motor type:

Display Value	Motor Type	Explanation
In-Syn	Induction motor	Default setting. Do not change if none of the selection options match. Choose induction motor or permanent magnet motor in parameter <i>P4-01</i> .
Syn	Undefined servomotor	Undefined servomotor. You must set special servo parameters during start-up. In this case, you have to set <i>P4-01</i> to synchronous motor control.
gf-2	reserved	
gf-4	reserved	
gf-4Ht	reserved	

When a permanent magnet motor is connected and the drive is operating in inverter mode, *P1-16* does not have to be changed. In this case, *P4-01* determines the motor type ("auto tune" required).

This parameter is available for the following inverters:

#### IP20

- 230V: 0.75 – 5.5 kW
- 400V: 0.75 – 11 kW

#### IP66

- 230V: 0.75 – 4 kW
- 400V: 0.75 – 7.5 kW



### 11.2.3 Parameter Group 2: Extended Parameter Setting (Level 2)

#### P2-01 – P2-08

If parameter  $P1-10$  is set to "0", parameters  $P2-01$  to  $P2-08$  can be changed in steps of 0.1Hz each.

If parameter  $P1-10 \neq 0$ , the following parameters  $P2-01$  to  $P2-08$  can be changed in the following steps if:

- $P1-09 \leq 100\text{Hz} \rightarrow$  in 1 (rpm)
- $100\text{Hz} < P1-09 \leq 200\text{Hz} \rightarrow$  in 2 (rpm)
- $P1-09 > 200\text{Hz} \rightarrow$  in 4 (rpm)

Negative speeds or frequencies can also be set.

#### P2-01 Fixed Setpoint Speed 1

Setting range:  $-P1-01 - 5.0\text{Hz} - P1-01$

Is also used as jog speed.

#### P2-02 Fixed Setpoint Speed 2

Setting range:  $-P1-01 - 10.0\text{Hz} - P1-01$

#### P2-03 Fixed Setpoint Speed 3

Setting range:  $-P1-01 - 25.0\text{Hz} - P1-01$

#### P2-04 Fixed Setpoint Speed 4

Setting range:  $-P1-01 - 50.0\text{Hz} - P1-01$

#### P2-05 Fixed Setpoint Speed 5

Setting range:  $-P1-01 - 0.0\text{Hz} - P1-01$

Is also used as reference travel speed.

#### P2-06 Fixed Setpoint Speed 6

Setting range:  $-P1-01 - 0.0\text{Hz} - P1-01$

Is also used as reference travel speed.

#### P2-07 Fixed Setpoint Speed 7

Setting range:  $-P1-01 - 0.0\text{Hz} - P1-01$

Used for brake release speed in hoist mode.

#### P2-08 Fixed Setpoint Speed 8

Setting range:  $-P1-01 - 0.0\text{Hz} - P1-01$

Used for brake application speed in hoist mode.

### P2-09 Skip Frequency

Setting range: P1-02 – P1-01

The skip window center and skip width are values and automatically have an effect on positive and negative setpoints when activated. You can disable the function by setting the skip width to 0.

If the upper or lower limit values are violated, the hidden frequency band will travel through using the ramp times set in P1-03 / P1-04.

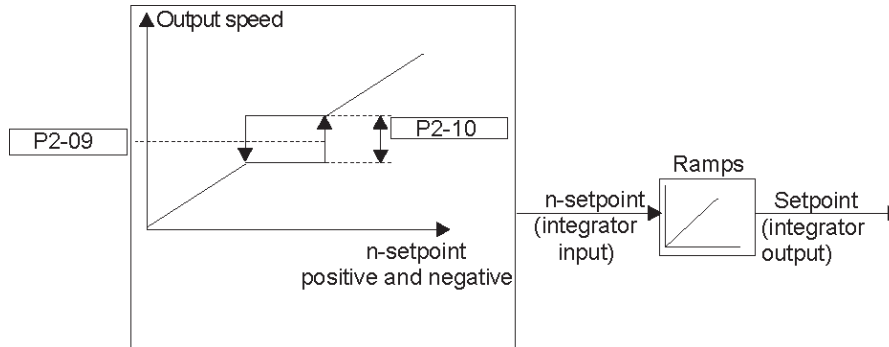


Figure 59: Skip Frequency Parameters Diagram

### P2-10 Skip Frequency Range

Setting range: **0.0Hz** – P1-01

**P2-11: P2-13 Analog Outputs****Digital Output Mode: 0V / 24Vdc**

Setting Function	Explanation
0	Inverter enabled Logic 1 when inverter is enabled (running).
1	Inverter ok (digital) Logic 1 when there is no inverter fault.
2	Motor operates at setpoint speed (digital) Logic 1 when motor speed corresponds to setpoint.
3	Motor speed > 0 (digital) Logic 1 when motor runs above 0 speed.
4	Motor speed ≥ limit value (digital) Digital output enabled with level set in "User relay/analog output upper limit" and "User relay/analog output lower limit".
5	Motor current ≥ limit value (digital)
6	Motor torque ≥ limit value (digital)
7	Analog input 2 ≥ limit value (digital)
13	Fieldbus (digital) Digital output value (value 1 corresponds to 24Vdc, all other values correspond to 0Vdc)

**Analog Output Mode: 0 - 10Vdc or 0 / 4 - 20mA**

Setting Function	Explanation
8	Motor speed (analog) The amplitude of the analog output signal represents the motor speed. It is scaled from 0 to the maximum speed limit defined in P1-01. Note that the absolute value is determined, so if motor speed is negative, the output will still be positive.
9	Motor current (analog)
10	Motor torque (analog) The amplitude of the analog output signal represents the inverter output current (torque). It is scaled from 0 to 200% of the rated motor current defined in P1-08. Note that velocity direction is irrelevant here: positive and negative velocities are resolved to their absolute value (amplitude, which is how speed is defined) and this is reflected in the unipolar analog output.
11	Motor power (analog) The amplitude of the analog output signal represents the apparent output power of the inverter. It is scaled from 0 to 200% of the inverter nominal power.
12	Fieldbus (analog) Analog output value.

### **P2-11 Analog Output 1 Function Selection**

Setting range: 0 – **8** – 13

Refer to Section *P2-11: P2-13 Analog Outputs*, above.

### **P2-12 Analog Output 1 Format**

- **0: 0 – 10Vdc**
- 1: 10 – 0V
- 2: 0 – 20mA
- 3: 20 – 0mA
- 4: 4 – 20mA
- 5: 20 – 4mA

### **P2-13 Analog Output 2 Function Selection**

Setting range: 0 – **9** – 13

Refer to Section *P2-11: P2-13 Analog Outputs*, above.

### **P2-14 Analog Output 2 Format**

- **0: 0 – 10Vdc**
- 1: 10 – 0V
- 2: 0 – 20mA
- 3: 20 – 0mA
- 4: 4 – 20mA
- 5: 20 – 4mA

### P2-15 – P2-20 Relay Outputs

The function of the relay outputs can be selected according to the table below. If a relay is controlled depending on a limit value, it reacts as follows:

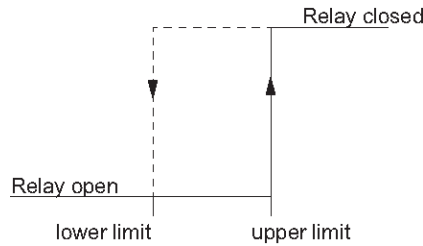


Figure 60: Relay Response to Limit Settings

Settings	Function	Explanation
0	Inverter enabled	Relay contacts closed when inverter is enabled.
1	Inverter ok (digital) = no error	Relay contacts closed when inverter is ok (no error).
2	Motor operates at setpoint speed (digital)	Relay contacts closed when output frequency = setpoint frequency $\pm$ 0.1Hz.
3	Motor speed $\geq$ 0 (digital)	Relay contacts closed when output frequency is greater than "zero frequency" (0.3% of base frequency)
4	Motor speed $\geq$ limit value (digital)	Relay contacts closed when output frequency is greater than the value set in parameter "User relay upper limit". Relay contacts open when the value is smaller than the value set in parameter "User relay lower limit"
5	Motor current $\geq$ limit value (digital)	Relay contacts closed when motor current/torque is greater than the current limit set in parameter "User relay upper limit". Relay contacts open when the value is smaller than the value set in parameter "User relay lower limit"
6	Motor torque $\geq$ limit value (digital)	
7	Analog input 2 $\geq$ limit value (digital)	Relay contacts closed when second analog input value is greater than the value set in parameter "User relay upper limit". Relay contacts open when the value is smaller than the value set in parameter "User relay lower limit"
8	Hoist (only for P2-18)	This parameter is displayed when P4-12 hoist function is set to 1. The inverter now controls the relay contact for hoist mode. (Value cannot be changed if P4-12 = 1)
9	STO status	Relay contacts open if STO circuit is open (inverter indicates "inhibit")
10	PID error $\geq$ limit value	If the control error is greater than the "user relay upper limit", the relay output is closed. If the control error is lower than the "user relay lower limit", the relay output is opened. The relay opens also with negative control errors.

**P2-15 User Relay Output 1 Function Selection**

Setting range: 0 – **1** – 11

Refer to Section *P2-15 – P2-20 Relay Outputs*, above.

**P2-16 Upper Limit of User Relay 1: Analog Output 1**

Setting range: 0.0 – **100.0** – 200.0%

**P2-17 Lower Limit of User Relay 1: Analog Output 1**

Setting range: **0.0** – P2-16%

**P2-18 User Relay Output 2 Function Selection**

Setting range: 0 – **3** – 11

Refer to Section *P2-15 – P2-20 Relay Outputs*, above.

**P2-19 Upper Limit of User Relay 2: Analog Output 2**

Setting range: 0.0 – **100.0** – 200.0%

**P2-20 Lower Limit of User Relay 2: Analog Output 2**

Setting range: **0.0** – P2-19%

PRELIMINARY

### **P2-21: P2-22 Display Scaling**

P2-21 lets users scale the data from a selected source to provide a displayed value that better represents the controlled process. The source value to be used for scaling calculation is defined in P2-22.

If  $P2-21 \neq 0$ , the scaled value will be shown on the display in addition to motor speed, motor current, and motor power. Pressing the "Navigate" key toggles the display between real-time values. A lowercase letter "c" on the left side of the display indicates that the scaled value is being displayed. The scaled display value is calculated using the following equation:

Scaled display value =  $P2-21 \times$  scaling source

#### **P2-21 Display Scaling Factor**

Setting range: -30,000 – **0,000** – 30,000

If the value is negative, the velocity control is inverted.

#### **P2-22 Display Scaling Source**

- 0: Motor speed information is used as the scaling source.
- 1: Motor current information is used as the scaling source.
- 2: The value of the second analog input is used as the scaling source. In this case, the range of input values is 0 to 4096.

### **P2-23 Zero Speed Holding Time**

Setting range: 0.0 – **0.2** – 60.0 s

You can use this parameter to have the motor hold zero speed (0Hz) for a certain time before it is shut down whenever it receives a stop command and reduces the output speed to zero.

When  $P2-23 = 0$ , the output of the inverter is disabled immediately once the output speed reaches zero.

When  $P2-23 \neq 0$ , the motor holds zero speed for a certain time (defined in P2-23 in seconds) before the output of the inverter is disabled. This function is usually used together with the relay output function to have the inverter issue a relay control signal before the inverter output is disabled.

### **P2-24 PWM Switching Frequency**

Setting range: 2 – 16kHz (depending on rated inverter power)

Specifies the pulse width modulated switching frequency. A higher switching frequency means less motor noise, but also higher losses in the output stage. The maximum switching frequency depends on the inverter power rating.

The inverter reduces the switching frequency automatically when the heat sink temperature is excessively high.

### P2-25 Second Deceleration Ramp, Rapid Stop Ramp

Setting range:

For the inverters:

IP20	IP66
<ul style="list-style-type: none"> <li>• 230V: 0.75 – 5.5 kW</li> <li>• 400V: 0.75 – 11 kW</li> <li>• 575V: 0.75 – 15 kW</li> </ul> Coast – 0.01 – <b>2.0</b> – 600 s	<ul style="list-style-type: none"> <li>• 230V: 0.75 – 4 kW</li> <li>• 400V: 0.75 – 7.5 kW</li> <li>• 575V: 0.75 – 11 kW</li> </ul> Coast – 0.01 – <b>2.0</b> – 600 s

For the inverters:

IP20	IP66
<ul style="list-style-type: none"> <li>• 230V: 7.5 – 75 kW</li> <li>• 400V: 15 – 160 kW</li> <li>• 575V: 18.5 – 110 kW</li> </ul> Coast – 0.1 – <b>2.0</b> – 6000 s	<ul style="list-style-type: none"> <li>• 230V: 5.5 – 75 kW</li> <li>• 400V: 11 – 160 kW</li> <li>• 575V: 15 – 110 kW</li> </ul> Coast – 0.1 – <b>2.0</b> – 6000 s

Ramp time 2nd deceleration ramp, rapid stop ramp. Is selected automatically in the event of a power failure if  $P2-38 = 2$ .

Can also be selected using digital inputs depending on other parameter settings. If set to "0", the motor decelerates as quickly as possible without overvoltage fault.

### P2-26 Flying Start Enable

When this function is enabled, the motor starts from the detected rotor speed. Short delay possible if rotor is at standstill. Only possible, if  $P4-01 = 0$  or  $2$ . If the motor rotates against the speed enabled by the inverter, the flying start function is enabled. The motor then decelerates to zero speed before accelerating in the opposite direction.

- **0: Disabled**
- 1: Enabled

### P2-27 Standby Mode

Setting range: **0.0** – 250 s

When  $P2-27 > 0$ , the inverter goes to standby mode (output disabled) if the minimum speed is maintained for the time specified in  $P2-27$ . This function is disabled when  $P2-23 > 0$  or  $P4-12=1$ .

### P2-28: P2-29 Master/Slave Parameter

The inverter uses parameter  $P2-28$ :  $P2-29$  to scale the setpoint speed received from the master of the network.

This function is particularly suited for applications where all motors in a network are synchronized but run at different speeds based on a fixed scaling factor.

For example, if a slave motor is set in  $P2-29 = 80\%$  and  $P2-28 = 1$  and the master motor in the network runs at 50Hz, then the slave motor will run at 40Hz after being enabled.



### **P2-28 Slave Speed Scaling**

- **0: Disabled**
- 1: Actual speed = digital speed × P2-29
- 2: Actual speed = (digital speed × P2-29) + analog input 1 reference
- 3: Actual speed = digital speed × P2-29 × analog input 1 reference

### **P2-29 Slave Speed Scaling Factor**

Setting range: -500 – **100** – 500%

PRELIMINARY

## P2-30 – P2-35 Analog Inputs

These parameters enable users to configure analog inputs 1 and 2 to suit the signal format present at the analog input control terminals. When set to 0 – 10Vdc, all negative input voltages result in zero speed. When set to -10 – 10Vdc, all negative voltages result in the inverter running at negative speed, which is proportional to the magnitude of the input voltage.

### P2-30 Analog Input 1 Format

- **0: 0 – 10Vdc / unipolar voltage range**
- 1: 10 – 0Vdc / unipolar voltage range
- 2: -10 – 10Vdc / bipolar voltage input
- 3: 0 – 20mA / current input
- 4: t4 – 20mA / current input
- 5: r4 – 20mA / current input
- 6: t20 – 4mA / current input
- 7: r20 – 4mA / current input

"t.." indicates that the inverter shuts down when the signal is removed while the inverter is enabled. t4 – 20mA, t20 – 4mA

"r.." indicates that the inverter moves along a ramp to P1-02 when the signal is removed while the inverter is enabled. r4 – 20mA, r20-4mA

### P2-31 Analog Input 1 Scaling

Setting range: 0 – **100** – 500%

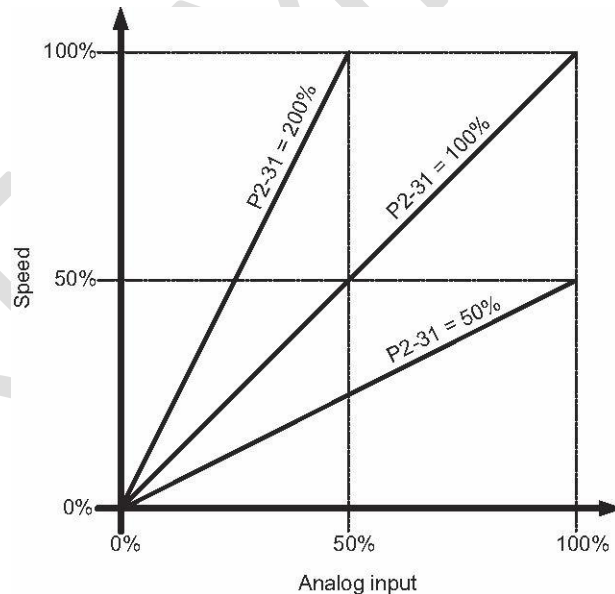


Figure 61: Analog Input Scaling using Parameter P2-31

### P2-32 Analog Input 1 Offset

Setting range: -500 – 0 – 500%

Specifies an offset as a percentage of the entire input range applied to the analog input signal.

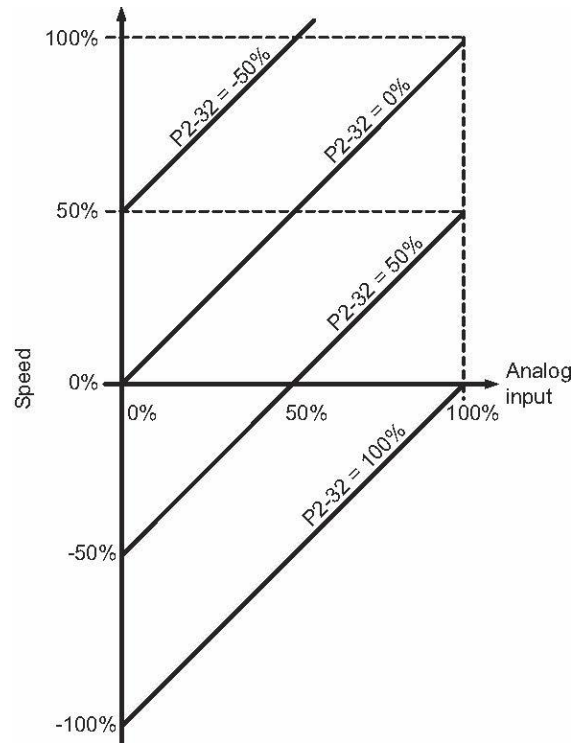


Figure 62: Analog Input Offset using Parameter P2-32

### P2-33 Analog Input 2 Format / Motor Protection

- 0: 0 – 10Vdc / unipolar voltage input
- 1: 10 – 0Vdc / unipolar voltage input
- 2: PTC-th / motor thermistor input
- 3: 0 – 20mA / current input
- 4: t4 – 20mA / current input
- 5: r4 – 20mA / current input
- 6: t20 – 4mA / current input
- 7: r 20 – 4mA / current input
- 8: ty-b KTY84 motor temperature sensor, 120 °C trigger, 100 °C reset
- 9: ty-F KTY84 motor temperature sensor, 155 °C trigger, 125 °C reset
- 10: ty-H KTY84 motor temperature sensor, 180 °C trigger, 160 °C reset
- 11: Pt-b PT1000 motor temperature sensor, 120 °C trigger, 100 °C reset
- 12: Pt-F PT1000 motor temperature sensor, 155 °C trigger, 125 °C reset
- 13: Pt-H PT1000 motor temperature sensor, 180 °C trigger, 160 °C reset

"t.." indicates that the inverter shuts down when the signal is removed while the inverter is enabled.

"r.." indicates that the inverter moves along a ramp to P1-02 when the signal is removed while the inverter is enabled.

**P2-34 Analog Input 2 Scaling**

Setting range: 0 – **100** – 500%

**P2-35 Analog Input 2 Offset**

Setting range: -500 – **0** – 500%

Specifies an offset as a percentage of the entire input range applied to the analog input signal.

**P2-36 Start Mode Selection**

The selection of the start mode defines the inverter behavior with reference to the enable digital input and configures the automatic restart function.

Selection:

- Edge-r
- **Auto-0** – Auto-5

**Edge-r**

- Edge-r: The inverter does not start after switching-on or reset if digital input 1 remains closed. To start the inverter, the input must be closed after switching on or resetting the inverter.

**Auto-0****Warning**

With the setting "Auto-0" and set enable signal, there is a danger of an automatic restart of the drive after an error message has been acknowledged (reset) or after switch-on (voltage on).

- Fatal or severe injuries and damage to property may result.
- Disconnect the device from the power supply before rectifying a fault if automatic restart of the driven machine after fault elimination is not permitted for safety reasons.
- After a reset, make sure that the drive can start up automatically depending on the setting.
- Prevent the drive from starting up inadvertently, for example by activating STO.

- **Auto-0:** The inverter starts automatically after switching-on or reset and set enable signal if digital input 1 is closed.

### Auto-1 – Auto-5

---



#### Warning

With the setting "Auto-1 – Auto-5" and set enable signal, there is a danger of an automatic restart of the drive after fault elimination or after switch-on (voltage on) as the inverter tries 1 - 5 times to automatically acknowledge the error.

- Fatal or severe injuries and damage to property may result.
  - Disconnect the device from the power supply before rectifying a fault if automatic restart of the driven machine after fault elimination is not permitted for safety reasons.
  - After a reset, make sure that the drive can start up automatically, depending on the setting.
  - Prevent the drive from starting up inadvertently, for example by activating STO.
- 

- Auto-1 – Auto-5: After being switched off due to error (trip), the inverter tries to restart up to 5 times (in intervals of 20 seconds). The duration of the intervals is defined in *P6-03*. The number of attempted restarts is counted. If the inverter fails to start on the final attempt, the inverter goes to error state and prompts the user to reset the fault manually. Upon reset, the counter is reset.

### P2-37 Keypad Restart Speed

This parameter is only active if *P1-12* = "1" or "2".

- 0: Minimum speed. Following a stop or restart, the motor runs at the minimum speed set in *P1-02*.
- 1: Last speed. Following a stop or restart, the inverter returns to the value prior to stopping that was last set using the keypad.
- 2: Current speed. If the inverter is configured for several speed references (generally manual/automatic control or local/decentralized control), a digital input ensures that, when switching the keyboard mode, the inverter continues to run with the last operating speed.
- 3: Fixed setpoint speed 8. Following a stop or restart, the inverter always runs at the fixed setpoint speed 8 (*P2-08*).
- 4: Minimum speed (terminal mode). Following a stop or restart, the inverter always runs at the minimum speed set in *P1-02*.
- 5: Last speed (terminal mode). Following a stop or restart, the inverter returns to the value prior to stopping that was last set.
- 6: Current speed (terminal mode). If the inverter is configured for several speed references (generally manual/automatic control or local/decentralized control), a digital input ensures that, when switching the keyboard mode, the inverter continues to run with the last operating speed.
- 7: Fixed setpoint speed 8 (terminal mode). Following a stop or restart, the inverter always runs at the fixed setpoint speed 8 (*P2-08*).

The option 4 – 7 "Operation with terminal" applies to all operating modes.

### **P2-38 Mains Loss Stop Control**

The control behavior of the inverter as response to a power failure while the inverter is enabled.

- **0:** The inverter attempts to continue operation by recovering energy from the motor under load. If the power failure lasts only briefly and if sufficient energy can be recovered before control electronics shuts down, the inverter will restart as soon as the power supply is resumed.
- **1:** The inverter immediately disables the output to the motor resulting in coasting or freewheeling of the load. If you use this setting for loads with a high inertia, it might be necessary to activate the flying start function (P2-26).
- **2:** The inverter stops along the rapid stop ramp set in P2-25.
- **3:** DC bus supply, if the inverter is supplied directly via the DC+ and DC-terminal, the power failure detection can be deactivated with this function.

### **P2-39 Parameter Lock**

Locking parameters means that no parameters can be changed (indicated by "L").

- **0: Disabled**
- **1: Enabled**

### **P2-40 Extended Parameter Access Code Definition**

Setting range: 0 – **101** – 9999

Access to the advanced menu (parameter groups 2, 3, 4, 5) is only possible when the value entered in P1-14 is the same as the one in P2-40. In this way, users can change the default value "101" of the code to any other value.

## 11.2.4 Parameter Group 3: PID Controller (Level 2)

### P3-01 PID Proportional Gain

Setting range: 0.0 – **1.0** – 30.0

PID Controller proportional gain. Higher values result in a greater change of the inverter output frequency as response to minor changes of the feedback signal. If the value is too high, it can cause instability.

### P3-02 PID Integral Time Constant

Setting range: 0.0 – **1.0** – 30.0 s

PID controller integral time constant. Higher values result in a damped response to systems in which the overall process responds slowly.

### P3-03 PID Differential Time Constant

Setting range: **0.00** – 1.00 s

### P3-04 PID Operating Mode

- **0: Direct operation** – The motor speed decreases with increasing feedback signal.
- **1: Inverse operation** – The motor speed increases with increasing feedback signal.

### P3-05 PID Reference Selection

Selects the source for the PID reference/setpoint.

- **0: Fixed setpoint reference** (P3-06) or P3-06, P3-14 - P3-16 (depending on the PID controller setting).
- **1: Analog input 1**
- **2: Analog input 2**
- **3: Fieldbus PID:** refer to Section [P5-09 – P5-11 Fieldbus Process Output Data \(POx\) Definition](#), below.

### P3-06 PID Fixed Setpoint Reference 1

Setting range: **0.0** – 100.0%

Sets the preset digital PID reference/setpoint.

### P3-07 PID Controller Upper Limit

Setting range: P3-08 – **100.0%**

PID controller upper limit output. This parameter specifies the maximum output value of the PID controller. The upper limit is calculated as follows:

$$\text{Upper limit} = P3-07 \times P1-01$$

A value of 100% corresponds to the maximum speed limit defined in P1-01.

### P3-08 PID Controller Lower Limit

Setting range: **0.0%** – P3-07

Specifies the minimum output value of the PID controller. The lower limit is calculated as follows:

$$\text{Lower limit} = P3-08 \times P1-01.$$

### **P3-09 PID Correcting Variable Limitation**

- **0: Fixed setpoint limit** – PID output range limited by P3-07 and P3-08.
- 1: Analog input 1 variable upper limit – PID maximum output limited by the signal present at analog input 1.
- 2: Analog input 1 variable lower limit – PID minimum output limited by the signal present at analog input 1.
- 3: PID output + analog input 1 – PID output is added to the speed reference present at analog input 1.

### **P3-10 PID Feedback Selection**

Selects the source for the PID feedback signal.

- **0: Analog input 2**
- 1: Analog input 1

### **P3-11 PID Ramp Activation Error**

Setting range: **0.0** – 25.0%

Defines a PID error threshold. If the difference between setpoint and actual value is less than the threshold, the internal ramps of the inverter are disabled.

If the PID deviation is greater, the ramps are activated to limit the rate of change of the motor speed and to respond quickly to minor deviations.

### **P3-12 PID Actual Value Display Scaling Factor**

Setting range: **0,000** – 50,000

This parameter is used to scale the actual value of the PID display. This enables users to have displayed the current signal level of a transducer, for instance 0 - 10 bar, etc. Scaled display value = P3-12 × PID output (= actual value), scaled display value (rxxx).

### **P3-13 PID Feedback Wake-Up Level**

Setting range: **0.0** – 100.0%

Sets a programmable level. When the inverter is in standby or PID mode, the selected feedback signal must fall below this threshold before the inverter returns to normal operation.

### **P3-14 PID Fixed Setpoint Reference 2**

Setting range: **0.0** – 100%

Sets the preset digital PID reference/setpoint.

### **P3-15 PID Fixed Setpoint Reference 3**

Setting range: **0.0** – 100%

Sets the preset digital PID reference/setpoint.

### **P3-16 PID Fixed Setpoint Reference 4**

Setting range: **0.0** – 100%

Sets the preset digital PID reference/setpoint.



## 11.2.5 Parameter Group 4: Motor Control (Level 2)

### P4-01 Control Mode

- 0: VFC speed control  
Vector speed control for induction motors with calculated rotor speed feedback control. Field oriented control algorithms are used for motor speed control. As the calculated rotor speed is used to internally close the speed loop, this control mode effectively provides a closed loop control without physical encoder. With a properly tuned speed controller, the static speed change is usually better than 1%. For optimal control, "auto tune" (P4-02) should be carried out prior to first operation.
- 1: VFC torque control  
Instead of the motor speed, the motor torque is controlled directly. In this operating mode, the speed is not specified but changes depending on the load. The maximum speed is limited by P1-01. This operating mode is often used for winding applications where a constant torque is required to maintain cable tension. For optimal control, "auto tune" (P4-02) should be carried out prior to first operation.
- **2: Speed control - Enhanced V/f**  
This operating mode basically corresponds to voltage control where the applied motor voltage is controlled rather than the torque-generating current. The magnetizing current is controlled directly, which means no voltage increase is required. The voltage characteristics can be selected using the energy saving function in parameter P1-06. The default setting provides a linear characteristic where the voltage is proportional to the frequency. The magnetizing current is controlled independently. Enabling the energy saving function selects a reduced voltage characteristic where the applied motor voltage is reduced at low speeds. The function is usually used for fans to save energy consumption. The "auto tune" function should also be enabled in this operating mode. In this case, the tuning process is less complex and can be carried out more quickly.
- 3: Synchronous motor speed control (PMVC)  
Speed control for synchronous motors. The same properties apply as for VFC speed control.
- 4: Synchronous motor torque control  
Torque control for synchronous motors. The same properties apply as for VFC torque control.
- 5: Synchronous motor position control  
Position control for synchronous motors. Speed and torque setpoints are provided via process data in Motion Protocol (P1-12 = 8). An encoder is required for this purpose.
- 6: LSPM motor speed control  
The LSPM control is a control type for asynchronous motors with synchronous characteristics.

**Note:** "Auto tune" has to be performed after each control mode change.

### P4-02 Auto Tune

- **0: Inhibited**
- 1: Enable

Enable the inverter only after you have entered all nominal motor data correctly in the parameters. You can also start the automatic measuring procedure "Auto tune" manually with the parameter *P4-02* after entering the motor data.

After a reset to the factory settings, the measuring procedure starts automatically after the first enable and takes up to 2 minutes depending on the control type.

**Note:** After changing the nominal motor data, auto tune has to be started again. The inverter must not be in "inhibit" mode

### P4-03 Speed Controller Proportional Gain

Setting range: 0.1 – **50** – 400%

Defines the proportional gain for the speed controller. Higher values provide for better output frequency regulation and response. If the value is too high, it can cause instability or even an overcurrent fault. For applications that require the best possible control, you can adapt the value to the connected load by gradually increasing the value and observing the actual speed of the load. Continue this process until you have achieved the required dynamics without or with only slightly exceeding the control range, i.e. the setpoint value of the output speed.

In general, higher friction loads can tolerate higher values of proportional gain. It might be necessary to reduce the gain for loads with high inertia and low friction.

**Note:** Controller optimization should always initially take place via parameter *P7-10*. This parameter affects parameters *P4-03/P4-04* internally.

### P4-04 Speed Controller Integral Time Constant

Setting range: 0.001 – **0.100** – 1.000 s

Defines the integral time for the speed controller. Small values result in a faster response to changes in the motor load but bear the risk that they cause instability. For optimal dynamics, the value must be adjusted to match the connected load.

**Note:** Controller optimization should always initially take place via parameter *P7-10*. This parameter affects parameters *P4-03/P4-04* internally.

### P4-05 Motor Power Factor

Setting range: 0.00, 0.50 – 0.99 (depending on the motor)

Power factor on the nameplate. Is required for vector control (*P4-01* = 0 or 1).

## P4-06 Torque Reference/Limit Value Source

If  $P4-01 = 0$  or  $3$  (VFC speed control), this parameter defines the source for the maximum torque limit value.

If  $P4-01 = 1$  or  $4$  (VFC torque control), this parameter defines the source for the torque reference value (setpoint).

If  $P4-01 = 2$  (V/f open-loop speed control), this parameter defines the source for the maximum torque limit value.

However, compliance with the torque limit is less dynamic in V/f control mode.

The torque reference/limit value source can be determined by the selection possibilities mentioned below.

The motor torque reference value is determined as a percentage of the rated motor torque in  $P4-07$ . The rated motor torque is determined automatically by "Auto tune".

The motor torque limit value is always specified as a percentage of  $0 - P4-07$ .

- **0: Fixed torque reference/limit as defined in P4-07.**

- 1: Analog input 1 determines the torque reference/limit.

- 2: Analog input 2 determines the torque reference/limit.

If an analog input is used as a torque reference/limit value source, observe the following:

- Selection of the desired analog input signal format in parameter  $P2-30 / P2-33$ . The input format must be unipolar. The scaling depends on the value set in  $P4-07$ .  $0 - 10Vdc = 0 - 200\%$  of  $P4-07$ .

- Selection of the desired digital input function such as  $P1-15 = 3$  (torque specification via analog input 2).

- Adjusting the timeout time for the maximum torque limit in  $P6-17$  analog input 2.

- 3: Fieldbus communication

Fieldbus torque setpoint. When this option is selected, the torque limit is provided by the fieldbus master. A value between 0 and 200% can be entered in  $P4-07$ .

- 4: Master inverter

The master inverter in a master slave network provides the torque setpoint.

- 5: PID output

The output of the PID controller provides the torque setpoint.

### P4-07 – P4-09 Motor Torque Limit Settings

These parameters are used to adjust the torque limits of the motor.

The maximum torque limit can also be specified directly via process data communication.

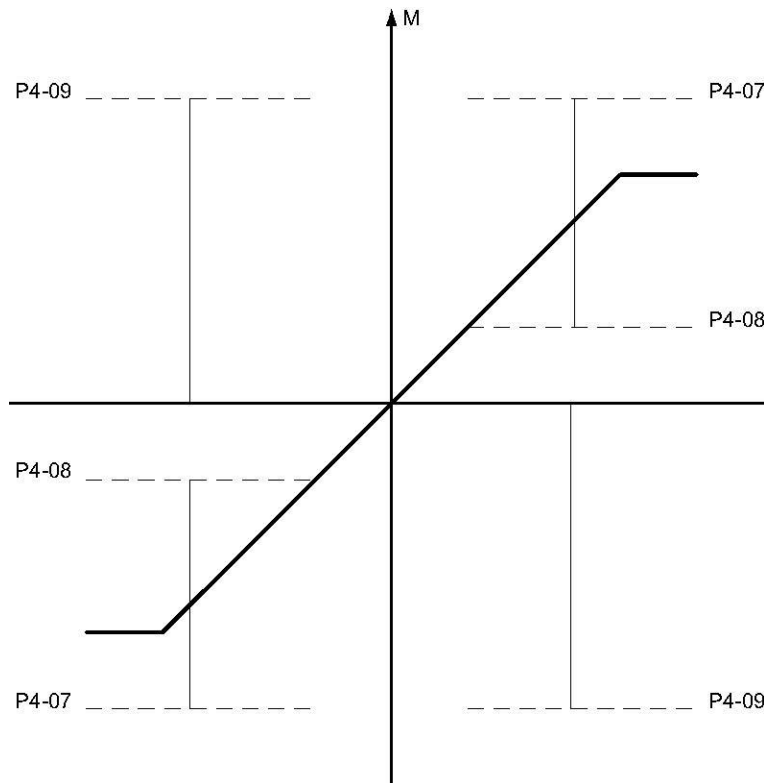


Figure 63: Adjust Torque Limits of Motor using Parameter P4-07 through P4-09

#### P4-07 Max. Motor Torque Limit

Setting range: P4-08 – 200 – 500%

This parameter is used to set the upper torque limit. The limit value source is specified with parameter P4-06.

Depending on the operating mode, the parameter refers to the torque-generating current (vector operation) or the apparent output current (V/f operation).

Vector operation: P4-07 limits the torque-generating current  $I_q$  (P0-15).

V/f operation: P4-07 limits the inverter output current to the specified limit value before the inverter output frequency is reduced for current limitation.

#### Example asynchronous motors:

Setting and verifying the torque limit (P4-07) for asynchronous motors:

Data of the asynchronous motor:

$P_n = 1.1 \text{ kW}$ ,  $I_n = I_s = 2.4 \text{ A}$ ,  $n_n = 1420 \text{ 1/min}$ ,  $\cos \phi = 0.79$

$$M_n = \frac{1.1 \text{ kW} \times 9550}{1420 \frac{1}{\text{min}}} = 7.4 \text{ Nm}$$

The torque is limited to  $M_{\text{max}} = 8.1 \text{ Nm}$ .

$$P407 = \frac{M_{\text{max}}}{M_n} \times 100 \% = 109.45 \%$$

**For verification of the torque-generating inverter current in P0-15:**

$$I_q = \cos(\phi) \times I_s = \cos(0.79) \times 2.4 \text{ A} = 1.89 \text{ A}$$

For a calculated torque limit of 109.45%, P0-15 should display the following

$$P0-15 = \frac{M_{\max}}{M_n} \times I_q = 2.06 \text{ A}$$

**Example synchronous motors:**

Setting and verifying the torque limit (P4-07) for synchronous motors:

The torque is limited to  $M_{\max} = 1.6 \text{ Nm}$ .

Data of the synchronous motor:  $I_0 = 1.5 \text{ A}$ ,  $M_0 = 0.8 \text{ Nm}$

$$P407 = \frac{M_{\max}}{M_0} \times 100\% = 200\%$$

**For verification of the torque-generating inverter current in P0-15:**

$I_d = 0$ , standard for synchronous motors with vector control, leads to  $I_q \approx M$ .

For a calculated torque limit of 200%, P0-15 should display the following:

$$P0-15 = I_0 \times 200\% = 3 \text{ A}$$

**P4-08 Min. Torque Limit**

Setting range: **0.0** – P4-07 %

Sets the minimum torque limit. As long as the motor speed is below the maximum speed defined in P1-01, the inverter attempts to maintain this torque at any time during operation on the motor.

If this parameter is set >0 and the maximum speed of the inverter is additionally increased to a value that is not reached during the travel cycle, the inverter is always in motor mode. Depending on the application, a braking resistor is thus not necessary.

**Note:** Use this parameter with the utmost care because the output frequency of the inverter will increase (to reach the torque) and the selected setpoint speed might be exceeded.

**P4-09 Max. Regenerative Torque Limit**

Setting range: P4-08 – **200** – 500%

Defines the current limit in regenerative mode. The value of this parameter represents the percentage value of the rated motor current defined in P1-08. The current limit specified in this parameter overrides the normal torque-generating current limit when the motor operates in regenerative mode. If the value is too high, the result is an excessive motor current distortion causing the motor to behave unstable in regenerative mode. If the value is too small, the output torque of the motor might drop in regenerative mode.

### P4-10: P4-11 V/f Characteristic Settings

The voltage/frequency characteristic curve determines the voltage level applied to the motor at a given frequency. Parameters *P4-10* and *P4-11* let you change the V/f characteristic curve if required.

Parameter *P4-10* can be set to any frequency between 0 and the base frequency (*P1-09*). It represents the frequency at which the percentage adjustment level set in *P4-11* is used. This function is only active when *P4-01* = 2.

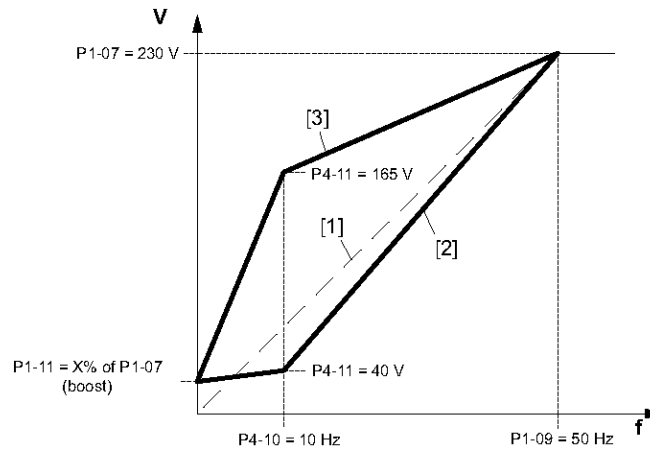


Figure 64: Adjust V/f Characteristic Settings using Parameters *P4-10* & *P4-11*

- [1] Normal V/f characteristic curve
- [2] Adjusted V/f characteristic curve
- [3] Adjusted V/f characteristic curve

#### P4-10Vdc/f Characteristic Adjustment Frequency

Setting range: **0.0** – 100.0% of *P1-09*

#### P4-11 V/f Characteristic Adjustment Voltage

Setting range: **0.0** – 100.0% of *P1-07*

### **P4-12 Motor Brake Control**

Enables the hoist function of the inverter.

Parameters *P4-13* through *P4-16* are enabled.

Relay contact 2 is set to hoist. The function cannot be changed.

- **0: Disabled**
- 1: Activated

Refer to examples in Section 7.5, *Hoist function*.

### **P4-13 Brake Release Time**

Setting range: 0.0 – 5.0 s

This parameter is used to set the time required for the mechanical brake to release. This parameter prevents a sagging of the drive especially in hoists.

### **P4-14 Brake Application Time**

Setting range: 0.0 – 5.0 s

This parameter is used to set the time required for the mechanical brake to apply. This parameter prevents a sagging of the drive in particular in hoists.

### **P4-15 Torque Threshold for Brake Release**

Setting range: 0.0 – 200%

Defines the torque in % of the maximum torque. This percentage torque must be generated before the motor brake is released.

This is to ensure that the motor is connected and torque is generated to prevent the load from dropping when the brake is released. For V/f control, the torque proof is not activated. This is only recommended for applications with horizontal movement.

### **P4-16 Hoist Torque Threshold Timeout**

Setting range: 0.0 – 25.0 s

Sets the time the inverter takes after a start command to attempt to generate enough motor torque to exceed the brake release threshold set in *P4-15*. If the torque threshold is not reached within this time, the inverter issues a fault.

### **P4-17 Thermal Motor Protection to UL508C**

- 0: Disabled
- 1: Activated

The inverters come equipped with a thermal motor protection function according to NEC to protect the motor from overload. In an internal memory, the motor current is accumulated over time.

The inverter goes to fault state as soon as the thermal limit is exceeded (I.t-trP).

Once the output current of the inverter is less than the set rated motor current, the internal memory is decremented depending on the output current.

When P4-17 is disabled, the thermal overload memory is reset when switching power off and on again.

When P4-17 is enabled, the memory is maintained even after power off and on again.

For inverters that are operated with a line frequency of 50Hz, the factory setting is 0 = disabled.

For inverters that are operated with a line frequency of 60Hz, the factory setting is 1 = enabled.

### **11.2.6 Parameter Group 5: Fieldbus Communication (Level 2)**

#### **P5-01 Inverter Address**

Setting range: 0 – 1 – 63

This parameter is used to set the inverter address for Modbus, fieldbus and master/slave.

#### **P5-02 Reserved**

#### **P5-03 Modbus RTU Baud Rate**

Sets the expected Modbus baud rate.

- 0: 9.6: 9600 Bd
- 1: 19.2: 19200 Bd
- 2: 38.4: 38400 Bd
- 3: 57.6: 57600 Bd
- **4: 115.2: 115200 Bd**

#### **P5-04 Modbus RTU Data Format**

Sets the expected Modbus data format.

- **0: n-1: no parity, 1 stop bit**
- 1: n-2: no parity, 2 stop bits
- 2: O-1: odd parity, 1 stop bit
- 3: E-1: even parity, 1 stop bit

#### **P5-05 Response to Communication Failure**

This parameter is used to specify the inverter behavior after a communication failure and the following timeout set in P5-06.

- 0: Fault and coast to stop
- 1: Stop ramp and error
- **2: Stop ramp (without fault)**
- 3: Fixed setpoint speed 8



### P5-06 Communication Failure Timeout for Modbus

Setting range: 0.0 – **1.0** – 5.0 s

Specifies the time in seconds after which the inverter performs the response set in P5-05. When set to "0.0 s", the inverter maintains the actual speed even if communication fails.

**Note:** P5-05 and P5-06 (above) do not apply to Modbus TCP. For Modbus TCP, it is necessary to configure the Modbus TCP Interface Card in the drive, using the web interface for that card, as follows:

Modbus TCP Interface Card Command Tree: Network Interface->Network Configuration, then enter a value (in ms) for the Modbus Process tmo as shown in Figure 65.

The setting in question is *Process tmo (ms)*. Whenever this parameter is set to a non-zero value, it defines a time period (in ms) that the drive is prepared to wait without a command from the client. The timer is reset whenever communications are received from the client. In the event that no communications is received from the client and the timeout timer is exceeded, the drive errors out on a communications failure (SC-F03).

The screenshot displays three configuration panels in a web interface. The top panel is titled 'SMTP Settings' and contains three input fields for 'SMTP Server:', 'SMTP User:', and 'SMTP Pswd:', with a 'Store settings' button below. The middle panel is titled 'Ethernet Configuration' and has two dropdown menus for 'Comm 1:' and 'Comm 2:', both set to 'Auto', with a 'Store settings' button below. The bottom panel is titled 'Modbus Configuration' and includes three fields: 'Conn tmo (s):' with the value '60', 'Process tmo (ms):' with the value '1000', and 'Word order:' with a dropdown menu set to 'Little-endian'. A 'Store settings' button is located at the bottom of this panel. Below the panels, there is a breadcrumb trail: 'Main > Network interface'.

Figure 65: Process TMO (ms) Timer Parameter for Modbus TCP Interface Card

### P5-07 Ramp Specified via Fieldbus

This parameter is used to enable internal or external ramp control. If enabled, the inverter follows the external ramps specified by MOVILINK® process data (PO3).

- **0: Disabled**
- 1: Activated

### P5-08 Synchronization Duration

Setting range: **0**, 5 – 20ms

Defines the duration of the sync message from MOVI-PLC®. This value must correspond to the one set in MOVI-PLC®. When P5-08 = 0, the inverter ignores synchronization.

### **P5-09 – P5-11 Fieldbus Process Output Data (POx) Definition**

This parameter is used to define the process data words sent from the PLC or the gateway to the inverter.

- 0: Speed U/min (1 = 0.2 1/min) → only possible, if P1-10 ≠ 0
- 1: Speed % (0x4000 = 100% P1-01)
- 2: Torque setpoint/limit value % (1 = 0.1%) → Set inverter to P4-06 = 3.
- 3: Ramp time (1 = 1ms) to maximum 65535ms.
- 4: PID reference (0x1000 = 100%) → P1-12 = 3 (control signal source).
- 5: Analog output 1 (0x1000 = 100%)<sup>13</sup>  
Digital output 4 (0x0001 = 24Vdc, other values = 0V)<sup>14</sup>
- 6: Analog output 2 (0x1000 = 100%)<sup>13</sup>  
Digital output 5 (0x0001 = 24Vdc, other values = 0V)<sup>14</sup>
- 7: No function

#### **P5-09 Fieldbus PO2 Definition**

Definition of output 2, 3, 4 for transmitted process data

Parameter description like P5-09 – P5-11

#### **P5-10 Fieldbus PO3 Definition**

Definition of output 2, 3, 4 for transmitted process data

Parameter description like P5-09 – P5-11

#### **P5-11 Fieldbus PO4 Definition**

Definition of output 2, 3, 4 for transmitted process data

Parameter description like P5-09 – P5-11

<sup>13</sup> When the analog outputs are controlled by fieldbus, parameter P2-11 or P2-13 = 12 (fieldbus (analog)) must be set additionally.

<sup>14</sup> When the digital outputs are controlled by fieldbus, parameter P2-11 or P2-13 = 13 (fieldbus (digital)) must be set additionally.

### P5-12 – P5-14 Fieldbus Process Input Data (PIx) Definition

Definition of process data words sent from the inverter to the PLC or gateway.

- 0<sup>15</sup>: Speed: rpm (1 = 0.2 rpm)
- 1: Speed % (0x4000 = 100% in relation to the maximum speed P1-01)
- 2: Current % (1 = 0.1% in relation to the nominal inverter current)
- 3: Torque % (1 = 0.1% in relation to the nominal motor torque, calculated from P1-08)
- 4: Power % (1 = 0.1% in relation to the rated inverter power)
- 5: Temperature (1 = 0.01 °C)
- 6: DC link voltage (1 = 1 V)
- 7: Analog input 1 (0x1000 = 100%)
- 8: Analog input 2 (0x1000 = 100%)
- 9: IO status of basic device and option

High byte					Low byte <sup>16</sup>										
-	-	-	RL5*	RL4*	RL3*	RL2	RL1	DI8*	DI7*	DI6*	DI5	DI4	DI3	DI2	DI1

### P5-12 Fieldbus PI2 Definition

Definition of input 2, 3, 4 for transmitted process data

Parameter description like P5-12 – P5-14.

### P5-13 Fieldbus PI3 Definition

Definition of input 2, 3, 4 for transmitted process data

Parameter description like P5-12 – P5-14

### P5-14 Fieldbus PI4 Definition

Definition of input 2, 3, 4 for transmitted process data

Parameter description like P5-12 – P5-14

<sup>15</sup> Only possible if P1-10 ≠ 0.

<sup>16</sup> RL = Relay; DI = Digital Input; \*Only available with a suitable option module.

### **P5-15 Expansion Relay 3 Function Selection**

**Note:** Only available and possible when I/O expansion module is connected.

Defines the function of expansion relay 3.

- 0: Inverter enabled
- 1: Inverter ok
- 2: Motor operates at setpoint speed.
- 3: Motor speed > 0
- 4: Motor speed > limit value
- 5: Motor current > limit value
- 6: Motor torque > limit value
- 7: Analog input 2 > limit value
- 8: Fieldbus control
- 9: STO status
- 10: PID error  $\geq$  limit value

### **P5-16 Relay 3 Upper Limit**

Setting range: 0.0 – **100.0** – 200.0%

### **P5-17 Relay 3 Lower Limit**

Setting range: **0.0** – 200.0%

### **P5-18 Expansion Relay 4 Function Selection**

Defines the function of expansion relay 4.

Parameter description like P5-15.

### **P5-19 Relay 4 Upper Limit**

Setting range: 0.0 – **100.0** – 200.0%

### **P5-20 Relay 4 Lower Limit**

Setting range: **0.0** – 200.0%

**Note:** The function of expansion relay 5 is fixed to "Motor speed > 0".

## 11.2.7 Parameter Group 6: Extended Parameters (Level 3)

### P6-01 Firmware Upgrade Enable

Enables firmware upgrade mode that lets the user upgrade the firmware of the user interface and/or firmware for output stage control. Is usually performed by the PC software.

- **0: Disabled**
- 1: Enabled (DSP + I/O)
- 2: Enabled (I/O only)
- 3: Enabled (DSP only)

**Note:** This parameter should not be changed by the user. If attempted from keypad, a warning is issued, but action is not prevented. Any firmware upgrade performed by the PC software needs to handle this mode flag automatically.

### P6-02 Automatic Thermal Management

Enables automatic thermal management. The inverter automatically reduces the output switching frequency at excessive heat sink temperature to reduce the risk of an overtemperature fault.

- 0: Disabled
- **1: Activated**

Temperature limits	Action
70 °C	Automatic reduction from 16kHz to 12kHz.
75 °C	Automatic reduction from 12kHz to 8kHz.
80 °C	Automatic reduction from 8kHz to 6kHz.
85 °C	Automatic reduction from 6kHz to 4kHz.
90 °C	Automatic reduction from 4kHz to 2kHz.
97 °C	Error message overtemperature

### P6-03 Auto-Reset Delay Time

Setting range: 1 – **20** – 60 s

Sets the delay time that elapses between consecutive reset attempts of the inverter, if auto reset is enabled in P2-36.

### P6-04 Hysteresis Band User Relay

Setting range: 0.0 – **0.3** – 25.0%

This parameter is used together with P2-11 and P2-13 = 2 or 3 to set a band around the setpoint speed (P2-11 = 2) or to set zero speed (P2-11 = 3). When the speed is within this band, the inverter runs at setpoint speed or at zero speed. This function prevents "chatter" on the relay output when the operating speed coincides with the value at which the state of the digital output/relay output changes.

Example: When P2-13 = 3, P1-01 = 50Hz and P6-04 = 5%, the relay contacts close above 2.5Hz.

### P6-05 Encoder Feedback Enable

When set to "1", encoder feedback is enabled.

- **0: Disabled**
- 1: Activated

### P6-06 Encoder PPR

Setting range: **0** – 65535 PPR (pulses per revolution)

When encoder feedback mode is enabled ( $P6-05 = 1$ ), set the parameter to the number of impulses per revolution for the connected encoder. Improper setting of this parameter can result in loss of motor control and/or a fault. When set to "0", encoder feedback is disabled.

**Note:** For HTL/TTL encoders, a minimum of 512 increments are necessary for operation.

### P6-07 Trigger Threshold Speed Error/Speed Monitoring

Setting range: 1.0 – **5.0** – 100%

This parameter specifies the maximum permitted speed error between the speed setpoint and the actual speed value.

The parameter is enabled for all operating modes with encoder feedback (HTL/TTL) and for the hoist function without encoder feedback. If the speed error exceeds this limit value, the inverter is switched off and goes to speed error depending on the firmware status (SP-Err or ENC02). When set to "100%", speed monitoring is disabled.

### P6-08 Max. Frequency for Speed Setpoint

Setting range: 0; **5** – 20kHz

Use this parameter if the motor speed setpoint is to be controlled by a frequency input signal (connected to digital input 3).

You can use this parameter to determine the input frequency that corresponds to the maximum motor speed (set in  $P1-01$ ). The maximum frequency that can be set in this parameter must be within a range of 5kHz and 20kHz.

When set to "0", this function is disabled.

### P6-09 Droop Speed/Load Distribution Control

Setting range: **0.0** – 25.0%

This function requires one motor for each inverter. In applications where several motors drive a common load, but different motor loads occur due to mechanical reasons, this function can balance the load of individual motors. Group drives are not possible.

This parameter only works in VFC speed control  $P4-01 = 0$ .

With setting  $P6-09 = 0.0$ , the speed droop/load distribution control function is disabled. With setting  $P6-09 > 0.0$ , this function induces a reduction of the actual speed compared to the setpoint speed for increased load.

Actual speed = setpoint speed -  $P6-09 \times P1-09 \times (\text{current application torque of the motor}) / \text{nominal motor torque}$

In most cases, a small value in  $P6-09$  is sufficient to achieve an adequate load distribution. If the value is too high, the actual speed controls towards 0 for small setpoint speeds or high loads.

### P6-10 Reserved

### P6-11 Speed Holding Time on Enable (Fixed Setpoint Speed 7)

Setting range: **0.0** – 250 s

Defines the time during which the inverter runs at fixed setpoint speed 7 (P2-07) when the enable signal is applied to the drive. The fixed setpoint speed can be any value from the minimum to the maximum frequency and in either direction.

This function can be useful in applications where controlled start behavior is required regardless of normal system operation. This function allows the user to program the inverter in such a way that it always starts at the same frequency and in the same direction of rotation for a specified period of time before returning to normal operation.

When set to "0.0", this function is disabled.

### **P6-12 Speed Holding Time on Inhibit (Fixed Setpoint Speed 8)**

Setting range: **0.0** – 250 s

Defines the time during which the inverter runs at fixed setpoint speed 8 (P2-08) after having removed the enable signal and before the stop ramp.

**Note:** Setting this parameter to a value > 0 lets the inverter continue to run at the fixed setpoint speed for the set time after having removed the enable signal. It is important that you make sure that this operating mode is safe before you use this function.

When set to "0.0", this function is disabled.

### **P6-13 Fire Mode Logic/Emergency Mode**

Enables fire mode/emergency mode. In this mode, the inverter ignores most faults. When the inverter is in fault condition, it resets itself every 5 s until total failure or lack of power.

Do not use this function for servo applications or lifting applications.

- **0: Open trigger: Fire mode/emergency mode**
- 1: Close trigger: Fire mode/emergency mode

### **P6-14 Fire Mode/Emergency Mode Speed**

Setting range: -P1-01 – **0** – P1-01Hz

The speed used in fire mode/emergency mode.

### P6-15 Analog Output 1 Scaling

Setting range: 0.0 – **100.0** – 500.0%

Specifies the scaling factor in % used for analog output 1.

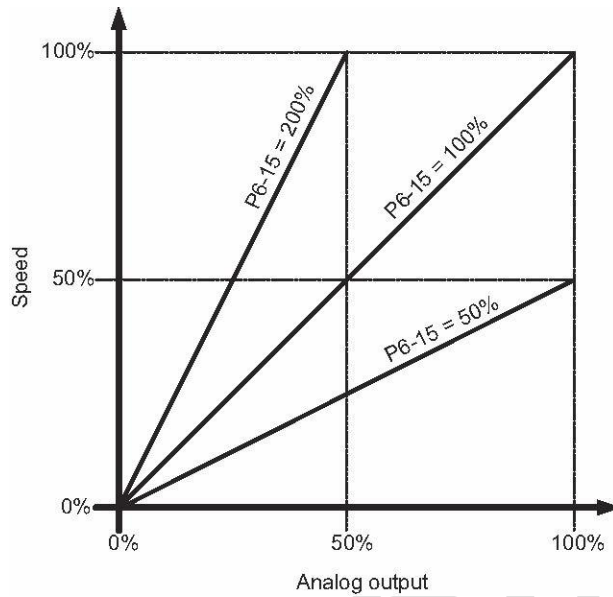


Figure 66: Analog Output 1 Scaling Factor (%) Specified by P6-15

### P6-16 Analog Output 1 Offset

Setting range: -500.0 – **0.0** – 500.0%

This parameter specifies the offset in % used for analog output 1.

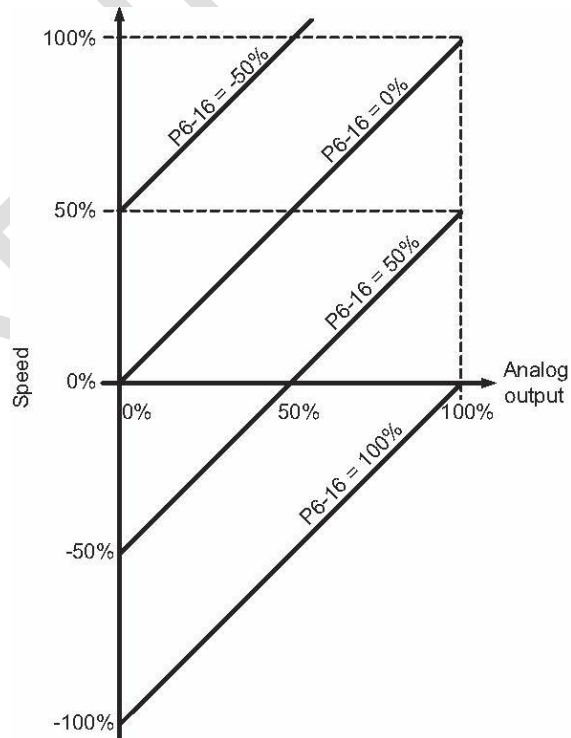


Figure 67: Analog Output 1 Offset (%) Specified by P6-16



### **P6-17 Max. Torque Limit Timeout**

Setting range: 0.0 – **0.5** – 25.0 s

Specifies the maximum time allowed for the motor to run at the torque limit for motor/generator mode (P4-07: P4-09) before issuing a fault. This parameter is only enabled for operation with vector control.

When set to "0.0", this function is disabled.

### **P6-18 DC Braking Voltage Level**

Setting range: Auto, **0.0** – 30.0%

Specifies the amount of DC voltage as a percentage of the nominal voltage (P1-07) applied to the motor when a stop command is received. This parameter is activated for V/f control only.

### **P6-19 Braking Resistor Value**

Setting range: **0**; Min-R – 200Ω

Sets the braking resistor value in ohms. This value is used for thermal protection of the braking resistor. Min-R depends on the inverter.

Setting this parameter to "0" disables the protection function for the braking resistor.

### **P6-20 Braking Resistor Power**

Setting range: **0.0** – 200.0 kW

Sets the braking resistor power in kW with a resolution of 0.1 kW. This value is used for thermal protection of the braking resistor.

When set to "0.0", the protection function for the braking resistor is disabled.

### **P6-21 Brake Chopper Operating Cycle at Under-Temperature**

Setting range: **0.0** – 20.0%

This parameter is used to specify the duty cycle for the brake chopper when the inverter is in under-temperature fault state. To heat the inverter, install a braking resistor at the heat sink of the inverter until the correct operating temperature is reached.

Use this parameter with the utmost care. An incorrect setting might result in exceeding the rated power capacity of the braking resistor.

Use external thermal protection for the braking resistor to avoid this risk.

When set to "0.0", this function is disabled.

### **P6-22 Reset Fan Runtime**

- **0: Disabled**
- 1: Reset runtime

Setting this parameter to "1" resets the internal runtime counter of the fan to "0" (as displayed in P0-35).

### **P6-23 Reset kWh Meter**

- **0: Disabled**
- 1: Reset kWh counter

Setting this parameter to "1" resets the internal kWh counter to "0" (as displayed in P0-26 and P0-27).

### P6-24 Parameter Default Settings

Inverter factory settings:

The inverter must not be enabled and the display must show "Inhibit".

- **0: Disabled**
- 1: Factory settings except for bus parameters.
- 2: Factory settings for all parameters.

### P6-25 Access Code Level 3

Setting range: 0 – **201** – 9999

User-defined access code that has to be entered in *P1-14* to allow access to the advanced parameters in groups 6 to 9.

### P6-26 Parameter Backup

- **0: Output value**
- 1: Save parameters
- 2: Delete parameter

Selection 0: The output value is always displayed.

Selection 1: Saving the current parameterization.

The entire parameter settings are saved to a secured memory. Upon successful completion of the backup, the display shows "USr-PS".

The memory content is preserved also when the device is de-energized and when the factory settings are activated.

Selection 2: Deleting the saved parameterization from the secure memory.

The internal memory is deleted again. The display shows "USr-cL".

Restoring the saved parameterization from the memory:

By pressing the four keys "Start + Stop + Up + Down" simultaneously for at least 2 seconds, the saved parameter setting can be restored. This overwrites the parameter data in the device and resets it to the value at the time of the backup. The display shows "U-dEF" upon successful completion of the restoring.

Establishing the delivery state (no change to preceding versions):

To reset the inverter to the factory settings (delivery state), press the three keys "Stop + Up + Down" for at least 2 seconds until "P-dEF" appears on the display. This process overwrites the current parameterization without deleting the saved data in the secure memory with the parameter backup.

## 11.2.8 Parameter Group 7: Motor Control Parameters (Level 3)



### Caution

#### Possible inverter damage:

The following parameters are used internally by the inverter to provide for optimum motor control. Incorrect settings of the parameters can result in poor performance and unexpected behavior of the motor. Adjustments may be made only by experienced users who fully understand the functionality of these parameters.

Equivalent wiring diagram for AC motors.

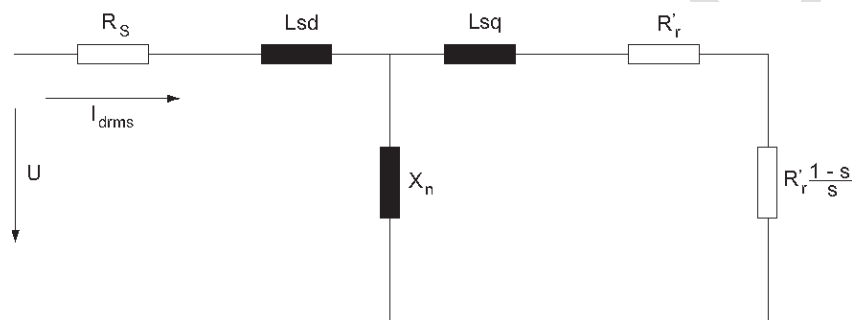


Figure 68: Equivalent Wiring Diagram for AC Motors

#### P7-01 Motor Stator Resistance ( $R_s$ )

Setting range: depends on the motor ( $\Omega$ )

The stator resistance value is the ohmic phase-to-phase resistance of the copper winding. This value is determined and set automatically during "auto tune".

Instead, you can enter this value manually.

#### P7-02 Motor Rotor Resistance ( $R_r$ )

Setting range: depends on the motor ( $\Omega$ )

For induction motors: Phase-to-phase rotor resistance value in ohms.

For synchronous motors: Value has to be set to 0 ohm.

#### P7-03 Motor Stator Inductance ( $L_{sd}$ )

Setting range: depends on the motor (H)

For induction motors: Phase stator inductance value.

For synchronous motors: Phase d-axis stator inductance in Henry.

#### P7-04 Motor Magnetization Current ( $I_{d\ rms}$ )

Setting range:  $10\% \times P1-08 - 80\% \times P1-08$  (A)

For induction motors: Magnetizing current/no-load current. Before auto tune, this value is approximated to 60% of the rated motor current ( $P1-08$ ) assuming a motor power factor of 0.8.

#### P7-05 Motor Leakage Loss Coefficient ( $\sigma$ )

Setting range: 0.025 – **0.10** – 0.25

For induction motors: Leakage loss coefficient of the motor.

### **P7-06 Motor Stator Inductance (Lsq) – Only for Synchronous Motors**

Setting range: depends on the motor (H)

For synchronous motors: Phase q-axis stator inductance in Henry.

### **P7-07 Enhanced Generator Control**

Use this parameter when stability problems occur in extremely regenerative applications. When this function is enabled, regenerative operation is possible at low speeds.

- **0: Disabled**
- 1: Enabled

### **P7-08 Parameter Adjustment**

Use this parameter for small motors ( $P < 0.75$  kW) with high impedance. When this function is enabled, the thermal motor model can adjust rotor and stator resistance during operation. In this way, impedance effects occurring with vector control and caused by heating are compensated.

- **0: Disabled**
- 1: Enabled

### **P7-09 Overvoltage Current Limit**

Setting range: 0.0 – **1.0** – 100%

This parameter is only applicable in vector speed control mode and takes effect when the DC link voltage of the inverter exceeds a preset limit. This voltage level is set internally exactly below the trigger threshold for overvoltage.

When set to "0.0", this function is disabled.

Procedure:

- The motor with high inertia is decelerated. Regenerative energy flows back to the inverter.
- The DC link voltage increases and reaches the  $U_{Zmax}$  level.
- To discharge the DC link, the frequency inverter delivers current (P7-09) and the motor accelerates again.
- The DC link voltage falls below  $U_{Zmax}$  again.
- The motor is continued to be decelerated.

### **P7-10 Stiffness (for Vector Control)**

Setting range: 0 – **10** – 600

P7-10 is used to improve the control response for control modes without encoder feedback. P7-10 has an internal effect on the P and I components of the control. This value can usually remain set to the default value "10".

Increasing P7-10 increases the stiffness of the motor. Decreasing this parameter has the opposite effect.

### **P7-11 Pulse Width Min. Limit**

Setting range: 0 – 500

This parameter is used to limit the minimum output pulse width. The minimum output pulse width can be used for applications with long cables. Increasing the value of this parameter reduces the risk of overcurrent faults with long motor cables. The reason is that the number of voltage edges and consequently load peaks are reduced. At the same time, however, also the maximum available output motor voltage is reduced for a certain input voltage.

The factory setting depends on the inverter.

Time = value × 16.67 ns

### P7-12 Pre-Magnetization Time

Setting range: 0 – 5000ms

Use this parameter to define a pre-magnetization time. Consequently, there is a corresponding start delay when the inverter is enabled. If the value is too small, the inverter might generate an overcurrent fault when the acceleration ramp is very short.

In the case of operating modes for synchronous motors, this parameter, together with P7-14, is used for the initial rotor alignment. In particular, it must be adjusted for high moments of mass inertia.

The factory setting depends on the inverter.

### P7-13 D-Gain Vector Speed Controller

Setting range: 0.0 – 400%

This parameter is used to set the differential gain (%) for the speed controller in vector mode operation.

### P7-14 Low-Frequency Torque Boost/Pre-Magnetization Current

Setting range: 0.0 – 100%

The boost current applied at start-up as a % of the rated motor current (P1-08). The inverter has a boost function. Current can be injected into the motor at low speed in order to ensure that the rotor alignment is maintained and the motor operates efficiently at low speeds.

For a boost at a low speed, run the inverter at the lowest frequency required for the application. Increase the values to provide the required torque and to ensure smooth operation.

P7-14 (Figure 69) is used in conjunction with P7-12 to align the rotor initially.

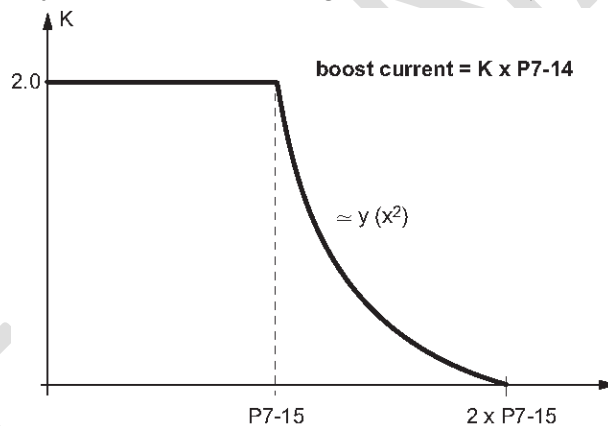


Figure 69: Align Rotor Initially using P7-14 & P7-12 and P7-15

### P7-15 Torque Boost Frequency Limit

Setting range: 0.0 – 50%

Frequency range for the applied boost current (P7-14) in % of the rated motor frequency (P1-09).

This parameter is diagrammed in Figure 69 above.

### P7-16 Motor Nameplate Speed

The parameter is reserved.

### 11.2.9 Parameter Group 9: Digital Inputs Defined by the User (Level 3)

The purpose of parameter group 9 is to give the user full flexibility to control the inverter behavior in complex applications that require specific parameter settings. Use the parameters of this group with utmost care. Only users that are absolutely familiar with the use of the inverter and its control functions should adjust the parameters of this group.

#### Overview of Functions

Parameter group 9 allows for the advanced programming of the inverter including user defined functions for the digital and analog inputs of the inverter as well as control of the speed setpoint source.

The following rules apply to parameter group 9:









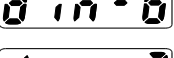
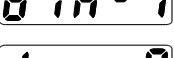
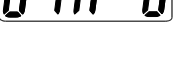
- The parameters of this group cannot be changed unless  $P1-15 = 0$ .
- Changing the value  $P1-15$  clears all the previous settings made in parameter group 9.
- Parameter group 9 has to be configured individually by the user.

**Note:** Be sure to record your settings.

#### Logic Source Selection Parameters

The parameters for selecting a logic source let users directly define the source for a control function in the inverter. These parameters can only be linked to digital values, which either enable or disable the function depending on their state.

Parameters defined as logic sources have the following range of possible settings:

Inverter display Setting	Function
	STO input Linked to the status of STO inputs, if allowed.
	Always OFF Function permanently disabled.
	Always ON Function permanently enabled.
	Digital input 1 Function linked to digital input 1 status.
	Digital input 2 Function linked to digital input 2 status.
	Digital input 3 Function linked to digital input 3 status.
	Digital input 4 Function linked to digital input 4 (analog input 1) status.
	Digital input 5 Function linked to digital input 5 (analog input 2) status.
	Digital input 6 Function linked to digital input 6 (requires extended I/O option).
	Digital input 7 Function linked to digital input 7 (requires extended I/O option).
	Digital input 8 Function linked to digital input 8 (requires extended I/O option).

The control sources for the inverter are handled in the following order of priority (from highest to lowest priority):

- STO circuit
- External fault
- Rapid stop
- Enable
- Terminal control override
- CW/CCW operation
- Reset

### Data Source Selection Parameters

Parameters for selecting a data source define the signal source for speed source 1 – 8. Parameters defined as data sources have the following range of possible settings:

Inverter display	Setting	Function
<b>A in-1</b>	Analog input 1	Analog input 1 signal level (P0-01).
<b>A in-2</b>	Analog input 2	Analog input 2 signal level (P0-02).
<b>PrESET</b>	Fixed setpoint speed	Selected fixed setpoint speed.
<b>d-Pot</b>	Keypad (motorized potentiometer)	Keypad speed setpoint (P0-06).
<b>P id</b>	PID controller output	PID controller output (P0-10).
<b>SUB-dr</b>	Master speed setpoint	Master speed setpoint (master/slave operation).
<b>F-bUS</b>	Fieldbus speed setpoint	Fieldbus speed setpoint PE2.
<b>USEr</b>	User defined speed setpoint	User defined speed setpoint (PLC function).
<b>PULSE</b>	Frequency input	Pulse frequency input reference.

**P9-01 Enable Input Source**

Setting range: SAFE, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

This parameter specifies the source of the frequency inverter enable function. This function is usually assigned to digital input 1. It allows the use of a hardware enable signal in different situations where, for example, the commands for run forward or run reverse from external sources such as fieldbus controls signals or a PLC program.

**P9-02 Rapid Stop Input Source**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On

Specifies the source of the rapid stop input. As response to a rapid stop command, the motor stops using the deceleration time set in P2-25.

**P9-03 Input Source for Clockwise Rotation (CW)**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On

Specifies the source of the CW rotation command.

**P9-04 Input Source for Counterclockwise Rotation (CCW)**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On

Specifies the source of the CCW rotation command.

**Note:** Whenever the CW rotation and CCW rotation commands are applied to the motor simultaneously, the inverter executes a rapid stop.

**P9-05 Latch Function Enable**

Setting range: OFF, ON

Enables the latching function of the digital inputs.

The latching function makes it possible to use momentary start signals to start and stop the motor in any direction. In this case, the enable input source (P9-01) must be linked to a normally closed control source (open for stop).

This control source must be logic "1" to allow the motor to start. The inverter then responds to momentary or pulse start and stop signals as defined in parameters P9-03 and P9-04.

**P9-06 Direction of Rotation Reversal**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On

Specifies the source of the input for the direction of rotation reversal.

**P9-07 Reset Input Source**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On

Specifies the source of the reset command.

**P9-08 External Fault Input Source**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On

Specifies the source of the external fault command.

**P9-09 Terminal Control Enable Source**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On

Defines the source of the command used to select terminal control operation of the inverter. This parameter takes effect only when  $P1-12 > 0$ . It allows terminal control to be selected in order to override the control signal source defined in P1-12.



### **P9-10 – P9-17 Speed Source**

Up to 8 speed setpoint sources can be defined for the inverter and can be selected during operation using P9-18 – P9-20. When changing the setpoint source, the new source is applied immediately during ongoing operation. The inverter need not have to be stopped and restarted.

#### **P9-10 Speed Source 1**

Setting range: Ain-1, Ain-2, fixed setpoint speed 1 – 8, d-Pot, PID, Sub-dr, F-bus, user, pulse  
Specifies the source of the speed.

#### **P9-11 Speed Source 2**

Setting range: Ain-1, Ain-2, fixed setpoint speed 1 – 8, d-Pot, PID, Sub-dr, F-bus, user, pulse  
Specifies the source of the speed.

#### **P9-12 Speed Source 3**

Setting range: Ain-1, Ain-2, fixed setpoint speed 1 – 8, d-Pot, PID, Sub-dr, F-bus, user, pulse  
Specifies the source of the speed.

#### **P9-13 Speed Source 4**

Setting range: Ain-1, Ain-2, fixed setpoint speed 1 – 8, d-Pot, PID, Sub-dr, F-bus, user, pulse  
Specifies the source of the speed.

#### **P9-14 Speed Source 5**

Setting range: Ain-1, Ain-2, fixed setpoint speed 1 – 8, d-Pot, PID, Sub-dr, F-bus, user, pulse  
Specifies the source of the speed.

#### **P9-15 Speed Source 6**

Setting range: Ain-1, Ain-2, fixed setpoint speed 1 – 8, d-Pot, PID, Sub-dr, F-bus, user, pulse  
Specifies the source of the speed.

#### **P9-16 Speed Source 7**

Setting range: Ain-1, Ain-2, fixed setpoint speed 1 – 8, d-Pot, PID, Sub-dr, F-bus, user, pulse  
Specifies the source of the speed.

#### **P9-17 Speed Source 8**

Setting range: Ain-1, Ain-2, fixed setpoint speed 1 – 8, d-Pot, PID, Sub-dr, F-bus, user, pulse  
Specifies the source of the speed.

### **P9-18 – P9-20 Input Speed Selection**

The active speed setpoint can be selected during operation by means of the status of the above-mentioned parameters for the logic source. The speed setpoints are selected according to the following logic:

<b>P9-20</b>	<b>P9-19</b>	<b>P9-18</b>	<b>Speed Setpoint Source</b>
0	0	0	1 (P9-10)
0	0	1	2 (P9-11)
0	1	0	3 (P9-12)
0	1	1	4 (P9-13)
1	0	0	5 (P9-14)
1	0	1	6 (P9-15)
1	1	0	7 (P9-16)
1	1	1	8 (P9-17)

#### **P9-18 Input Speed Selection 0**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On "Bit 0" logic source for selecting the speed setpoint

#### **P9-19 Input Speed Selection 1**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On "Bit 1" logic source for selecting the speed setpoint

#### **P9-20 Input Speed Selection 2**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On "Bit 2" logic source for selecting the speed setpoint

### P9-21–P9-23 Fixed Speed Selection Input

When a fixed speed setpoint is to be used for the speed setpoint, you can select the active fixed speed setpoint based on the status of these parameters. The following logic is used for selection:

P9-23	P9-22	P9-21	Fixed Setpoint Speed
0	0	0	1 (P2-01)
0	0	1	2 (P2-02)
0	1	0	3 (P2-03)
0	1	1	4 (P2-04)
1	0	0	5 (P2-05)
1	0	1	6 (P2-06)
1	1	0	7 (P2-07)
1	1	1	8 (P2-08)

#### P9-21 Fixed Setpoint Speed Selection Input 0

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On  
Specifies input source 0 for the fixed setpoint speed.

#### P9-22 Fixed Setpoint Speed Selection Input 1

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On  
Specifies input source 1 for the fixed setpoint speed.

#### P9-23 Fixed Setpoint Speed Selection Input 2

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On  
Specifies input source 2 for the fixed setpoint speed.

**P9-24 Positive Jog Mode Input**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

Specifies the signal source for operation in positive jog mode.

The jog speed is specified in parameter P2-01.

**P9-25 Negative Jog Mode Input**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

Specifies the signal source for operation in negative jog mode.

The jog speed is specified in parameter P2-01.

**P9-26 Reference Travel Enable Input**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

Specifies the source of the enable signal for the reference travel function.

**P9-27 Reference Cam Input**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

Specifies the source of the cam input.

**P9-28 Motor Potentiometer Up Input Source**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

Specifies the source of the logic signal used to increase the speed setpoint with the keypad/motorized potentiometer. When the specified signal source is logic 1, the value increases by the ramp defined in P1-03.

**P9-29 Motor Potentiometer Down Input Source**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

Specifies the source of the logic signal used to decrease the speed setpoint with the keypad/motorized potentiometer. When the specified signal source is logic 1, the value decreases by the rate defined in P1-04.

**P9-30 Positive Limit Switch CW**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

The parameter defines the digital input for the positive limit switch. The signal has to be wired safe against wire breakage as NC contact. Upon activation of the limit switch, a 0V level is present at the DI and the inverter reduces the speed along the ramp P1-04 to 0Hz.

As long as the enable persists at the inverter, the inverter stays enabled at 0Hz.

The status of the limit switch is also depicted in the status word.

**P9-31 Negative Limit Switch CCW**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

The parameter defines the digital input for the negative limit switch. The signal has to be wired safe against wire breakage as NC contact. Upon activation of the limit switch, a 0V level is present at the DI and the inverter reduces the speed along the ramp P1-04 to 0Hz.

As long as the enable persists at the inverter, the inverter stays enabled at 0Hz.

The status of the limit switch is also depicted in the status word.

### **P9-32 Enable Second Deceleration Ramp, Rapid Stop Ramp**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

Specifies the source of the logic signal used to enable the rapid deceleration ramp defined in P2-25.

### **P9-33 Fire Mode/Emergency Mode Input Selection**

Setting range: OFF, din-1, din-2, din-3, din-4, din-5. Specifies the source of the logic signal used to enable fire mode/emergency mode. In this mode, the inverter ignores all faults and/or disconnections and operates until total failure or power failure. During this phase, the start time and subsequent run time of the motor are recorded.

### **P9-34 PID Fixed Setpoint Reference Selection Input 0**

Setting range: **OFF**, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

### **P9-35 PID Fixed Setpoint Reference Selection Input 1**






Setting range: **OFF**, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

**Note:** Parameters P3-14 – P3-16 cannot be used while P9-34 and P9-35 are set to "OFF".

## Chapter 12 Technical Data

### 12.1 Markings

The following table lists all markings that can be given on a nameplate or attached to the motor and an explanation of what they mean.

Mark	Meaning
	CE mark to state compliance with the Low Voltage Directive 2014/35/EU. EU directive 2011/65/EU (RoHS) serves for limiting the use of hazardous substances in electric and electronic equipment.
	FS mark with code number to identify functional safety relevant components.
	UL logo to confirm that a component is UL (Underwriters Laboratory) tested, also valid for CSA in conjunction with the register number.
	EAC mark (EurAsian Conformity) Confirms compliance with the technical regulations of the economic and customs union of Russia, Belarus, Kazakhstan, Armenia.
	RCM logo (Regulatory Compliance Mark). Confirmation of compliance with technical regulations of the Australian Communications and Media Authority ACMA.

All products meet the following international standards:

- UL 508C power converter
- EN 61800-3:2004/A1:2012 Variable-speed electrical drives – part 3
- EN ISO 13849-1 Safe Torque Off (STO) to PL d
- Degree of protection according to NEMA 250, EN 60529
- Flammability class according to UL 94

## 12.2 Ambient Conditions

Ambient temperature range during operation	-10 °C to +50 °C (IP20/NEMA 1)
(For PWM frequency 2kHz)	-10 °C to +40 °C (IP55/NEMA 12K)
	-10 °C to +40 °C (IP66/NEMA 4X)
Derating depending on the ambient temperature	2.5%/°C to 60 °C for the following inverters with degree of protection IP20/NEMA 1: 230V: 0.75 – 5.5 kW 400V: 0.75 – 11 kW 500V: 0.75 – 15 kW
	2.5%/°C to 50 °C for the following inverters with IP degree of protection IP66/NEMA 4X: 230V: 0.75 – 4 kW 400V: 0.75 – 7.5 kW 500V: 0.75 – 11 kW
	1.5%/°C to 50 °C for the following inverters with IP degree of protection IP55/NEMA 12K: 230V: 5.5 – 75 kW 400V: 11 – 160 kW 500V: 15 – 110 kW
Storage temperature	-40 °C to +60 °C
Maximum installation altitude for nominal operation	1000 m
Derating above 1000 m	1%/100m to max. 2000m with UL 1%/100m to max. 4000m without UL
Maximum relative humidity	95% (condensation not permitted)
Device designs	IP20/NEMA 1 IP55/NEMA 12K IP66/NEMA 4X

## 12.3 Technical Data

The "Horsepower" (HP) specification is defined as follows:

- 200 – 240V devices: NEC2002, table 430-150, 230V
- 380 – 480V devices: NEC2002, table 430-150, 460V
- 500 – 600V devices: NEC2002, table 430-150, 575V

### 12.3.1 1-Phase System 200 – 240Vac

**Note:** The cable cross sections and fusing recommended below apply to the use of copper conductors with PVC insulation laid in cable ducts at an ambient temperature of 25° C. Also comply with the regulations issued by specific countries and for specific machines regarding power supply system and motor cable.

<b>PACMotion VFD EMC filter class C1 according to EN 61800-3</b>				
<b>Power in kW</b>		<b>0.75</b>	<b>1.5</b>	<b>2.2</b>
		IP20/NEMA 1		
IC855-		0008-2B1-2x	0015-2B1-2x	0022-2B1-2x
		IP66/NEMA 4X		
IC855-		0008-2B1-6x	0015-2B1-6x	0022-2B1-6x
<b>INPUT</b>				
Nominal line voltage $V_{line}$ according to EN 50160	V	1 × AC 200 – 240 ±10%		
Line frequency $f_{line}$	Hz	50 / 60 ±5%		
Recommended power supply cable cross section	mm <sup>2</sup>	1.5		2.5
	AWG	14		12
Line fuse	A	16		25 (35) <sup>17</sup>
Nominal input current	A	8.5	13.9	19.5
<b>OUTPUT</b>				
Recommended motor power	kW	0.75	1.5	2.2
	HP	1	2	3
Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$		
Output current	A	4.3	7	10.5
PWM frequency	kHz	2/4/6/8/12/16		
Speed range	1/min	-30000 – 0 – +30000		
Maximum output frequency	Hz	500		
Cross section of motor cable Cu 75C	mm <sup>2</sup>	1.5		2.5

<sup>17</sup> Recommended values for UL compliance.



**PACMotion VFD EMC filter class C1 according to EN 61800-3**

<b>Power in kW</b>		<b>0.75</b>	<b>1.5</b>	<b>2.2</b>
	AWG	14		12
Maximum motor cable length shielded	m	100		
Maximum motor cable length unshielded		150		

**GENERAL INFORMATION**

Size		2		
Nominal power loss 24Vdc	W	8		
Nominal power loss power section	W	22	45	66
Minimum braking resistance value	$\Omega$	27		
Maximum device terminal cross section	mm <sup>2</sup>	10		
	AWG	8		
Maximum control terminal cross section	mm <sup>2</sup>	0.05 – 2.5		
	AWG	30 – 12		

### 12.3.2 3-Phase System 200 – 240Vac

**Note:** All inverters with a power supply of  $3 \times \text{AC } 200 - 240\text{V}$  can also be operated with  $1 \times \text{AC } 200 - 240\text{V}$  when observing a derating of 50% of the output current.

#### Power 0.75 – 5.5 kW

##### PACMotion VFD EMC filter class C2 according to EN 61800-3

Power in kW	0.75	1.5	2.2	3	4	5.5
	IP20/NEMA 1					
IC855-	0008-2A3-2x	0015-2A3-2x	0022-2A3-2x	0030-2A3-2x	0040-2A3-2x	0055-2A3-2x
	IP66/NEMA 4X					IP55/NEMA 12K
IC855-	0008-2A3-6x	0015-2A3-6x	0022-2A3-6x	0030-2A3-6x	0040-2A3-6x	0055-2A3-5x

##### INPUT

Nominal line voltage	V	$3 \times \text{AC } 200 - 240 \pm 10\%$						
$V_{\text{line}}$ according to EN 50160								
Line frequency $f_{\text{line}}$	Hz	50 / 60 $\pm 5\%$						
Recommended power supply cable cross section	mm <sup>2</sup>	1.5		2.5		4.0	6.0	
	AWG	16		14		12	10	
Line fuse	A	10		16		20 (35) <sup>17</sup>	25 (35) <sup>17</sup>	35
Nominal input current	A	4.5	7.3	11	16.1	18.8	24.8	

##### OUTPUT

Recommended motor power	kW	0.75	1.5	2.2	3	4	5.5
	HP	1	2	3	4	5	7.5
Output voltage $V_{\text{motor}}$	V	$3 \times 20 - V_{\text{line}}$					
Output current	A	4.3	7	10.5	14	18	24
PWM frequency	kHz	2/4/6/8/12/16					2/4/6/8
Speed range	1/mi	-30000 – 0 – +30000					
	n						
Maximum output frequency	Hz	500					
Cross section of motor cable Cu 75C	mm <sup>2</sup>	1.5		2.5		4.0	6.0
	AWG	16		14		12	10
Max. motor cable length shielded	m	100					
Max. motor cable length unshielded		150					

PACMotion VFD EMC filter class C2 according to EN 61800-3							
Power in kW		0.75	1.5	2.2	3	4	5.5
<b>GENERAL INFORMATION</b>							
Size		2			3		3 / 4 <sup>18</sup>
Nominal power loss 24Vdc	W	8					8/11 <sup>18</sup>
Nominal power loss power section	W	22	45	66	90	120	165
Minimum braking resistance value	Ω	27					22
Maximum device terminal cross section	mm <sup>2</sup>	10					10 / 16 <sup>18</sup>
	AWG	8					8/6 <sup>18</sup>
Maximum control terminal cross section	mm <sup>2</sup>	0.05 – 2.5					
	AWG	30 – 12					

<sup>18</sup> IP20 housing: Size 3 / IP55 housing: Size 4.

**Power 7.5 – 18.5 kW****PACMotion VFD EMC filter class C2 according to EN 61800-3**

Power in kW	7.5	11	15	18.5
	IP55/NEMA 12K			
IC855-	0075-2A3-5x	0110-2A3-5x	0150-2A3-5x	0185-2A3-5x

**INPUT**

Nominal line voltage $V_{line}$ according to EN 50160	V	3 × AC 200 – 240 ±10%			
Line frequency $f_{line}$	Hz	50 / 60 ±5%			
Recommended power supply cable cross section	mm <sup>2</sup>	10	16	25	35
	AWG	8	6	4	2
Line fuse	A	50	63	80	100
Nominal input current	A	40	47.1	62.4	74.1

**OUTPUT**

Recommended motor power	kW	7.5	11	15	18.5
	HP	10	15	20	25
Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$			
Output current	A	39	46	61	72
PWM frequency	kHz	2/4/6/8/12			
Speed range	1/min	-30000 – 0 – +30000			
Maximum output frequency	Hz	500			
Cross section of motor cable Cu 75C	mm <sup>2</sup>	10	16	25	35
	AWG	8	6	4	2
Maximum motor cable length shielded	m	100			
Maximum motor cable length unshielded		150			

**GENERAL INFORMATION**

Size		4		5	
Nominal power loss 24Vdc	W	11		11.3	
Nominal power loss power section	W	225	330	450	555
Minimum braking resistance value	Ω	22	12		6
Maximum device terminal cross section	mm <sup>2</sup>	16		35	
	AWG	6		2	
Maximum control terminal cross section	mm <sup>2</sup>	0.05 – 2.5			
	AWG	30 – 12			

## Power 22 – 45 kW

**PACMotion VFD EMC filter class C2 according to EN 61800-3**

Power in kW	22	30	37	45
	IP55/NEMA 12K			
IC855-	0220-2A3-5x	0300-2A3-5x	0370-2A3-5x	0450-2A3-5x

**INPUT**

Nominal line voltage $V_{line}$ according to EN 50160	V	3 × AC 200 – 240 ±10%			
Line frequency $f_{line}$	Hz	50 / 60 ±5%			
Recommended power supply cable cross section	mm <sup>2</sup>	35	50	95	
	AWG	2	1	3 / 0	
Line fuse	A	100	150	200	
Nominal input current	A	92.3	112.7	153.5	183.8

**OUTPUT**

Recommended motor power	kW	22	30	37	45
	HP	30	40	50	60
Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$			
Output current	A	90	110	150	180
PWM frequency	kHz	2/4/6/8		2/4/6	2/4
Speed range	1/min	-30000 – 0 – +30000			
Maximum output frequency	Hz	500			
Cross section of motor cable Cu 75C	mm <sup>2</sup>	35	50	95	
	AWG	2	1	3 / 0	
Maximum motor cable length shielded	m	100			
Maximum motor cable length unshielded		150			

**GENERAL INFORMATION**

Size		6			
Nominal power loss 24Vdc	W	11.6			
Nominal power loss power section	W	660	900	1110	1350
Minimum braking resistance value	Ω	6	3		
Maximum device terminal cross section		M10 stud with nut max. 95 mm <sup>2</sup>			
		M8 braking resistor connector max. 70 mm <sup>2</sup>			
		Crimping cable lug DIN 46235			
Maximum control terminal cross section	AWG	-			
	mm <sup>2</sup>	0.05 – 2.5			
	AWG	30 – 12			

**Power 55 – 75 kW****PACMotion VFD EMC filter class C2 according to EN 61800-3**

Power in kW	55	75
	IP55/NEMA 12K	
IC855-	0550-2A3-5x	0750-2A3-5x

**INPUT**

Nominal line voltage $V_{line}$ according to EN 50160	V	3 × AC 200 – 240 ±10%	
Line frequency $f_{line}$	Hz	50 / 60 ±5%	
Recommended power supply cable cross section	mm <sup>2</sup>	120	150
	AWG	4 / 0	–
Line fuse	A	250	315
Nominal input current	A	206.2	252.8

**OUTPUT**

Recommended motor power	kW	55	75
	HP	75	100
Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$	
Output current	A	202	248
PWM frequency	kHz	2/4/6/8	2/4/6
Speed range	1/min	-30000 – 0 – +30000	
Maximum output frequency	Hz	500	
Cross section of motor cable Cu 75C	mm <sup>2</sup>	120	150
	AWG	4 / 0	–
Maximum motor cable length shielded	m	100	
Maximum motor cable length unshielded		150	

**GENERAL INFORMATION**

Size		7	
Nominal power loss 24Vdc	W	11.9	
Nominal power loss power section	W	1650	2250
Minimum braking resistance value	Ω	3	
Maximum device terminal cross section		M10 stud with nut max. 95 mm <sup>2</sup>	
		M8 braking resistor connector max. 70 mm <sup>2</sup>	
		Crimping cable lug DIN 46235	
Maximum control terminal cross section	AWG	–	
	mm <sup>2</sup>	0.05 – 2.5	
	AWG	30 – 12	

### 12.3.3 3-Phase System 380 – 480Vac

#### Power 0.75 – 11 kW

PACMotion VFD EMC filter class C2 according to EN 61800-3									
Power in kW		0.75	1.5	2.2	4	5.5	7.5	11	
		IP20/NEMA 1							
IC855-		0008-4A3-2x	0015-4A3-2x	0022-4A3-2x	0040-4A3-2x	0055-4A3-2x	0075-4A3-2x	0110-4A3-2x	
		IP66/NEMA 4X							IP55/NEMA 12K
IC855-		0008-4A3-6x	0015-4A3-6x	0022-4A3-6x	0040-4A3-6x	0055-4A3-6x	0075-4A3-6x	0110-4A3-5x	
INPUT									
Nominal line voltage $V_{line}$ according to EN 50160	V	3 × AC 380 – 480 ±10%							
Line frequency $f_{line}$	Hz	50 / 60 ±5%							
Recommended power supply cable cross section	mm <sup>2</sup> AWG16	1.5			2.5			6	
					14			10	
Line fuse	A	10			16 (15) <sup>17</sup>	16	20	35	
Nominal input current	A	2.4	4.3	6.1	9.8	14.6	18.1	24.7	
OUTPUT									
Recommended motor power	kW HP	0.75 1	1.5 2	2.2 3	4 5	5.5 7.5	7.5 10	11 15	
Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$							
Output current	A	2.2	4.1	5.8	9.5	14	18	24	
PWM frequency	kHz	2/4/6/8/12/16				2/4/6/8/12		2/4/6/8	
Speed range	1/min								
Maximum output frequency	Hz	500							
Cross section of motor cable Cu 75C	mm <sup>2</sup> AWG16	1.5			2.5			6	
					14			10	
Max. motor cable length shielded	m	100							
Max. motor cable length unshielded		150							

**PACMotion VFD EMC filter class C2 according to EN 61800-3**

<b>Power in kW</b>	<b>0.75</b>	<b>1.5</b>	<b>2.2</b>	<b>4</b>	<b>5.5</b>	<b>7.5</b>	<b>11</b>
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**GENERAL INFORMATION**

Size	2				3		3 / 4 <sup>18</sup>
Nominal power W loss 24Vdc	8				10		10/16.7 <sup>18</sup>
Nominal power W loss power section	22	45	66	120	165	225	330
Minimum braking resistance value	$\Omega$ 68				39		
Maximum device terminal cross section	mm <sup>2</sup> 10 AWG8						10 / 16 <sup>18</sup> 8/6 <sup>18</sup>
Maximum control terminal cross section	mm <sup>2</sup> 0.05 – 2.5 AWG30 – 12						

PRELIMINARY



## Power 15 – 37 kW

**PACMotion VFD EMC filter class C2 according to EN 61800-3**

Power in kW	15	18.5	22	30	37
	IP55/NEMA 12K				
IC855-	0150-5A3-4-5x	0185-5A3-4-5x	0220-5A3-4-5x	0300-5A3-4-5x	0370-5A3-4-5x

**INPUT**

Nominal line voltage $V_{line}$ V according to EN 50160		3 × AC 380 – 480 ±10%				
Line frequency $f_{line}$ Hz		50 / 60 ±5%				
Recommended power supply cable cross section	mm <sup>2</sup> / AWG	6 / 10	10 / 8	16 / 6	25 / 4	35 / 2
Line fuse	A	35	50	63	80	100
Nominal input current	A	30.8	40	47.1	62.8	73.8

**OUTPUT**

Recommended motor power	kW / HP	15 / 20	18.5 / 25	22 / 30	30 / 40	37 / 50
Output voltage $V_{motor}$ V		3 × 20 - $V_{line}$				
Output current	A	30	39	46	61	72
PWM frequency	kHz	2/4/6/8/12				
Speed range	1/min	-30000 – 0 – +30000				
Maximum output frequency	Hz	500				
Cross section of motor cable Cu 75C	mm <sup>2</sup> / AWG	6 / 10	10 / 8	16 / 6	25 / 4	35 / 2
Max. motor cable length shielded	m	100				
Max. motor cable length unshielded		150				

**GENERAL INFORMATION**

Size		4			5	
Nominal power loss 24Vdc	W	16.7			19.8	
Nominal power loss power section	W	450	555	660	900	1110
Minimum braking resistance value	Ω	22			12	
Maximum device terminal cross section	mm <sup>2</sup> / AWG	16 / 6			35 / 2	
Maximum control terminal cross section	mm <sup>2</sup> / AWG	0.05 – 2.5 / 30 – 12				

## Power 45 – 90 kW

## PACMotion VFD EMC filter class C2 according to EN 61800-3

Power in kW	45	55	75	90
	IP55/NEMA 12K			
IC855-	0450-4A3-5x	0550-4A3-5x	0750-4A3-5x	0900-4A3-5x

## INPUT

Nominal line voltage $V_{line}$	V	3 × AC 380 – 480 ±10%			
according to EN 50160					
Line frequency $f_{line}$	Hz	50 / 60 ±5%			
Recommended power	mm <sup>2</sup>	50	70	95	120
supply cable cross section	AWG	1	2 / 0	3 / 0	4 / 0
Line fuse	A	125	150	200	250
Nominal input current	A	92.2	112.5	153.2	183.7

## OUTPUT

Recommended motor power	kW	45	55	75	90
	HP	60	75	100	150
Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$			
Output current	A	90	110	150	180
PWM frequency	kHz	2/4/6/8		2/4/6	2/4
Speed range	1/min	-30000 – 0 – +30000			
Maximum output frequency	Hz	500			
Cross section of motor cable Cu 75C	mm <sup>2</sup>	50	70	95	120
	AWG	1	2 / 0	3 / 0	4 / 0
Max. motor cable length shielded	m	100			
Max. motor cable length unshielded		150			

## GENERAL INFORMATION

Size		6			
Nominal power loss 24Vdc	W	31.1			
Nominal power loss power section	W	1350	1650	2250	2700
Minimum braking resistance value	Ω	6			
Maximum device terminal cross section		M10 stud with nut max. 95 mm <sup>2</sup> M8 braking resistor connector max. 70 mm <sup>2</sup> Crimping cable lug DIN 46235			
	AWG	-			
Maximum control terminal cross section	mm <sup>2</sup>	0.05 – 2.5			
	AWG	30 – 12			

## Power 110 – 160 kW

**PACMotion VFD EMC filter class C2 according to EN 61800-3**

Power in kW	110	132	160
	IP55/NEMA 12K		
IC855-	1100-5A3-4-5x	1320-5A3-4-5x	1600-5A3-4-5x

**INPUT**

Nominal line voltage $V_{line}$ according to EN 50160	V	3 × AC 380 – 480 ±10%		
Line frequency $f_{line}$	Hz	50 / 60 ±5%		
Recommended power supply cable cross section	mm <sup>2</sup>	120	150	185
	AWG	4 / 0	–	–
Line fuse	A	250	315	355
Nominal input current	A	205.9	244.5	307.8

**OUTPUT**

Recommended motor power	kW	110	132	160
	HP	175	200	250
Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$		
Output current	A	202	240	302
PWM frequency	kHz	2/4/6/8	2/4/6	2/4
Speed range	1/min	-30000 – 0 – +30000		
Maximum output frequency	Hz	500		
Cross section of motor cable Cu 75C	mm <sup>2</sup>	120	150	185
	AWG	4 / 0	–	–
Maximum motor cable length shielded	m	100		
Maximum motor cable length unshielded		150		

**GENERAL INFORMATION**

Size		7		
Nominal power loss 24Vdc	W	38.5		
Nominal power loss power section	W	3300	3960	4800
Minimum braking resistance value	Ω	6		
Maximum device terminal cross section		M10 stud with nut max. 95 mm <sup>2</sup>		
		M8 braking resistor connector max. 70 mm <sup>2</sup>		
		Crimping cable lug DIN 46235		
Maximum control terminal cross section	AWG	–		
	mm <sup>2</sup>	0.05 – 2.5		
	AWG	30 – 12		

### 12.3.4 3-Phase System 500 – 600Vac

#### Power 0.75 – 5.5 kW

##### PACMotion VFD EMC filter class 0 according to EN 61800-3

Power in kW	0.75	1.5	2.2	4	5.5
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	IP20/NEMA 1				
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IC855-	0008-603-2x	0015-603-2x	0022-603-2x	0040-603-2x	0055-603-2x
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	IP66/NEMA 4X				
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IC855-	0008-603-6x	0015-603-6x	0022-603-6x	0040-603-6x	0055-603-6x
--------	-------------	-------------	-------------	-------------	-------------

##### INPUT

Nominal line voltage $V_{line}$	V	3 × AC 500 – 600 ±10%			
---------------------------------	---	-----------------------	--	--	--

according to EN 50160

Line frequency $f_{line}$	Hz	50 / 60 ±5%			
---------------------------	----	-------------	--	--	--

Recommended power	mm <sup>2</sup>	1.5			2.5
-------------------	-----------------	-----	--	--	-----

supply cable cross section	AWG	16			14
----------------------------	-----	----	--	--	----

Line fuse	A	10 / (6) <sup>17</sup>		10	16 / (15) <sup>17</sup>
-----------	---	------------------------	--	----	-------------------------

Nominal input current	A	2.5	3.7	4.9	7.8	10.8
-----------------------	---	-----	-----	-----	-----	------

##### OUTPUT

Recommended motor power	kW	0.75	1.5	2.2	4	5.5
-------------------------	----	------	-----	-----	---	-----

	HP	1	2	3	5	7.5
--	----	---	---	---	---	-----

Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$			
----------------------------	---	---------------------	--	--	--

Output current	A	2.1	3.1	4.1	6.5	9
----------------	---	-----	-----	-----	-----	---

PWM frequency	kHz	2/4/6/8/12			
---------------	-----	------------	--	--	--

Speed range	1/min	-30000 – 0 – +30000			
-------------	-------	---------------------	--	--	--

Maximum output frequency	Hz	500			
--------------------------	----	-----	--	--	--

Cross section of motor	mm <sup>2</sup>	1.5			2.5
------------------------	-----------------	-----	--	--	-----

cable Cu 75C	AWG	16			14
--------------	-----	----	--	--	----

Max. motor cable length shielded	m	100			
----------------------------------	---	-----	--	--	--

Max. motor cable length unshielded		150			
------------------------------------	--	-----	--	--	--

		150			
--	--	-----	--	--	--

##### GENERAL INFORMATION

Size		2			
------	--	---	--	--	--

Nominal power loss 24Vdc	W	8			
--------------------------	---	---	--	--	--

Nominal power loss power section	W	22	45	66	120	165
----------------------------------	---	----	----	----	-----	-----

Minimum braking resistance value	Ω	68			
----------------------------------	---	----	--	--	--

Maximum device terminal cross section	mm <sup>2</sup>	10			
---------------------------------------	-----------------	----	--	--	--

	AWG	8			
--	-----	---	--	--	--

Maximum control terminal cross section	mm <sup>2</sup>	0.05 – 2.5			
--	-----------------	------------	--	--	--

	AWG	30 – 12			
--	-----	---------	--	--	--

**Power 7.5 – 30 kW**

<b>PACMotion VFD EMC filter class 0 according to EN 61800-3</b>							
<b>Power in kW</b>		<b>7.5</b>	<b>11</b>	<b>15</b>	<b>18.5</b>	<b>22</b>	<b>30</b>
		IP20/NEMA 1					
IC855		0075-603-2x	0110-603-2x	0150-603-2x	-	-	-
		IP66/NEMA 4X			IP55/NEMA 12K		
IC855		0075-603-6x	0110-603-6x	0150-603-5x	0185-603-5x	0220-603-5x	0300-603-5x
<b>INPUT</b>							
Nominal line voltage	V	3 × AC 500 – 600 ±10%					
$V_{line}$ according to EN 50160							
Line frequency $f_{line}$	Hz	50 / 60 ±5%					
Recommended power supply cable cross section	mm <sup>2</sup> AWG	2.5 14	4 12	6 10		10 8	14 6
Line fuse	A	20	25 / (30) <sup>17</sup>	35	40 / (45) <sup>17</sup>	50 / (60) <sup>17</sup>	63 / (70) <sup>17</sup>
Nominal input current	A	14.4	20.6	26.7	34	41.2	49.5
<b>OUTPUT</b>							
Recommended motor power	kW HP	7.5 10	11 15	15 20	18.5 25	22 30	30 40
Output voltage $V_{motor}$	V	3 × 20 - $V_{line}$					
Output current	A	12	17	22	28	34	43
PWM frequency	kHz	2/4/6/8/12					
Speed range	1/min	-30000 – 0 – +30000					
Maximum output frequency	Hz	500					
Cross section of motor cable Cu 75C	mm <sup>2</sup> AWG	2.5 14	4 12	6 10		10 8	14 6
Max. motor cable length shielded	m	100					
Max. motor cable length unshielded	m	150					
<b>GENERAL INFORMATION</b>							
Size		3		3 / 4 <sup>18</sup>	4		
Nominal power loss 24Vdc	W	10		10/16.7 <sup>18</sup>	16.7		
Nominal power loss power section	W	225	330	450	555	660	900
Minimum braking resistance value	Ω	39			22		
Maximum device terminal cross section	mm <sup>2</sup> AWG	10 8		10 / 16 <sup>18</sup> 8/6 <sup>18</sup>	16 6		
Maximum control terminal cross section	mm <sup>2</sup> AWG	0.05 – 2.5 30 – 12					

## Power 37 – 110 kW

## PACMotion VFD EMC filter class 0 according to EN 61800-3

Power in kW	37	45	55	75	90	110
	IP55/NEMA 12K					
IC855-	0370-603-5x	0450-603-5x	0550-603-5x	0750-603-5x	0900-603-5x	1100-603-5x

## INPUT

Nominal line voltage	V	3 × AC 500 – 600 ±10%					
V <sub>line</sub> according to EN 50160							
Line frequency f <sub>line</sub>	Hz	50 / 60 ±5%					
Recommended power supply cable cross section	mm <sup>2</sup> AWG	25 4	35 2		50 1	70 2 / 0	95 3 / 0
Line fuse	A	80	100		125/(150) <sup>17</sup>	160/(175) <sup>17</sup>	200
Nominal input current	A	62.2	75.8	90.9	108.2	127.7	158.4

## OUTPUT

Recommended motor power	kW HP	37 50	45 60	55 75	75 100	90 125	110 150
Output voltage V <sub>motor</sub>	V	3 × 20 - V <sub>line</sub>					
Output current	A	54	65	78	105	130	150
PWM frequency	kHz	2/4/6/8/12		2/4/6/8		2/4/6	
Speed range	1/min	-30000 – 0 – +30000					
Maximum output frequency	Hz	500					
Cross section of motor cable Cu 75C	mm <sup>2</sup> AWG	25 4	35 2		50 1	70 2 / 0	95 3 / 0
Max. motor cable length shielded	m	100					
Max. motor cable length unshielded		150					

## GENERAL INFORMATION

Size		5		6			
Nominal power loss 24Vdc	W	19.8		31.1			
Nominal power loss power section	W	1110	1350	1650	2250	2700	3300
Minimum braking resistance value	Ω	22		12		6	
Maximum device terminal cross section	mm <sup>2</sup>	35		M10 stud with nut max. 95 mm <sup>2</sup> M8 braking resistor connector max. 70 mm <sup>2</sup> Crimping cable lug DIN 46235			
	AWG	2		-			
Maximum control terminal cross section	mm <sup>2</sup> AWG	0.05 – 2.5 30 – 12					

## 12.4 Input Voltage Ranges

Depending on the model, the inverters are designed for direct connection to the following voltage sources:

PACMotion VFD			
Nominal voltage according to EN 50160	Power	Connection type	Rated frequency
200 – 240V ± 10%	0.75 – 2.2 kW	1-phase <sup>19</sup>	50 – 60Hz ± 5%
200 – 240V ± 10%	All	3-phase	
380 – 480V ± 10%			
500 – 600V ± 10%			

Units that are connected to a 3-phase supply system are designed for a maximum power grid imbalance of 3% between the phases. For supply systems with a power grid imbalance of more than 3% (for example, in India and parts of the Asia-Pacific region including China), GE Automation & Controls recommends that you use input chokes.

<sup>19</sup> Single-phase inverters can also be connected to 2 phases of a 3-phase power supply system of 200 – 240Vac.

## 12.5 Overload Capacity

The inverter supplies a constant output current of 100%.

### Inverter

Overload capacity based on nominal inverter current	60 seconds	2 seconds
PACMotion VFD	150%	175%

### Motors

Overload capacity based on nominal motor current	60 seconds	2 seconds
Asynchronous motors	150%	175%
Synchronous motors	200%	250% <sup>20</sup>

<sup>20</sup> Only 200% for inverters with 5.5 kW.



## 12.6 Housing Variants and Dimensions

### 12.6.1 Housing Variants

The inverter is available with the following housing variants:

- IP20/NEMA-1 housing for use in control cabinets
- IP55/NEMA-12K housing
- IP66/NEMA-4X housing

The housings with degree of protection IP55/NEMA 12K and IP66/NEMA 4X are protected against humidity and dust. This allows for operating the inverter indoors under difficult conditions. The inverter functions are identical.

PRELIMINARY

## 12.6.2 Dimensions

### Inverters with Degree of Protection IP20/NEMA 1

The following inverters have the housing shown below:

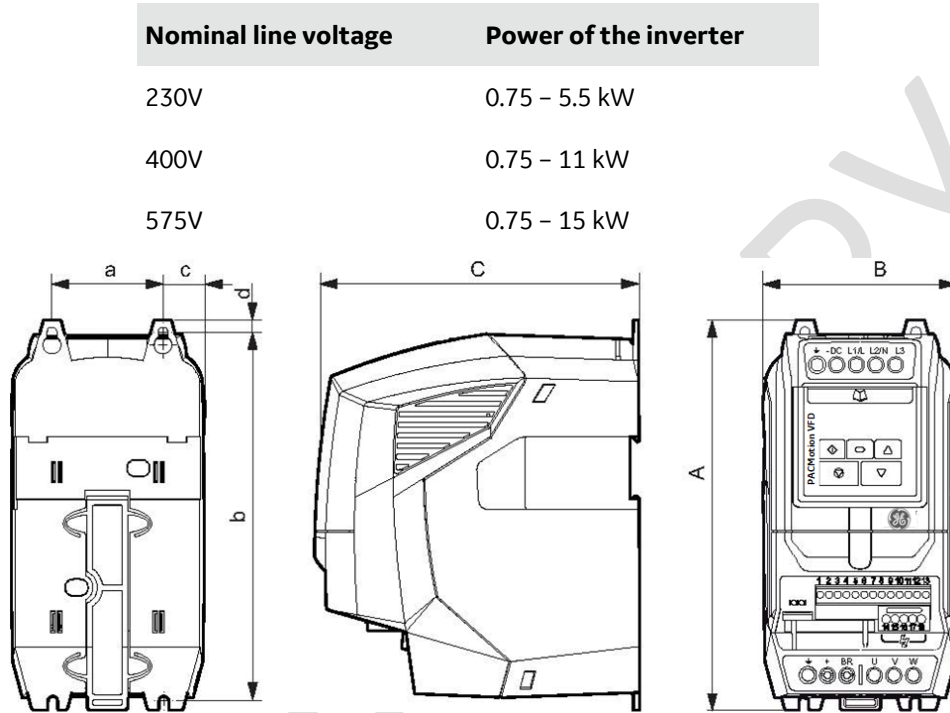


Figure 70: Dimensions IP20/NEMA 1 Inverter

Dimension	230V: 0.75 – 2.2 kW		230V: 3 – 5.5 kW	
	400V: 0.75 – 4 kW		400V: 5.5 – 11 kW	
	575V: 0.75 – 5.5 kW		575V: 7.5 – 15 kW	
Height (A)	mm	221	261	
Width (B)	mm	110	131	
Depth (C)	mm	185	205	
Weight	kg	1.8	3.5	
a	mm	63.0	80.0	
b	mm	209	247	
c	mm	23	25.5	
d	mm	7.00	7.75	
Recommended screw size		4 × M4		

### Inverters with Degree of Protection IP66/NEMA 4X

The following inverters have the housing shown below:

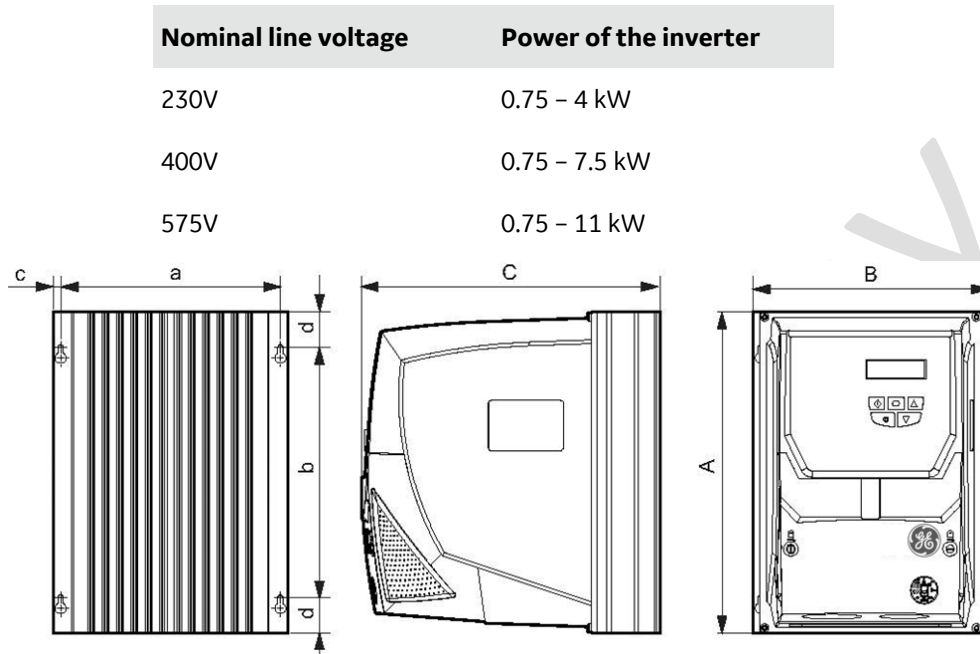


Figure 71: Dimensions IP66/NEMA 4X Inverter

Dimension	230V: 0.75 – 2.2 kW		230V: 3 – 4 kW	
	400V: 0.75 – 4 kW		400V: 5.5 – 7.5 kW	
	575V: 0.75 – 5.5 kW		575V: 7.5 – 11 kW	
Height (A)	mm	257	310	
Width (B)	mm	188	211	
Depth (C)	mm	239	270	
Weight	kg	4.8	7.3	
a	mm	178	200	
b	mm	200	252	
c	mm	5	5.5	
d	mm	28.5	29	
Recommended screw size 4 × M4				

### Inverters with Degree of Protection IP55/NEMA 12K

The following inverters have the housing shown below:

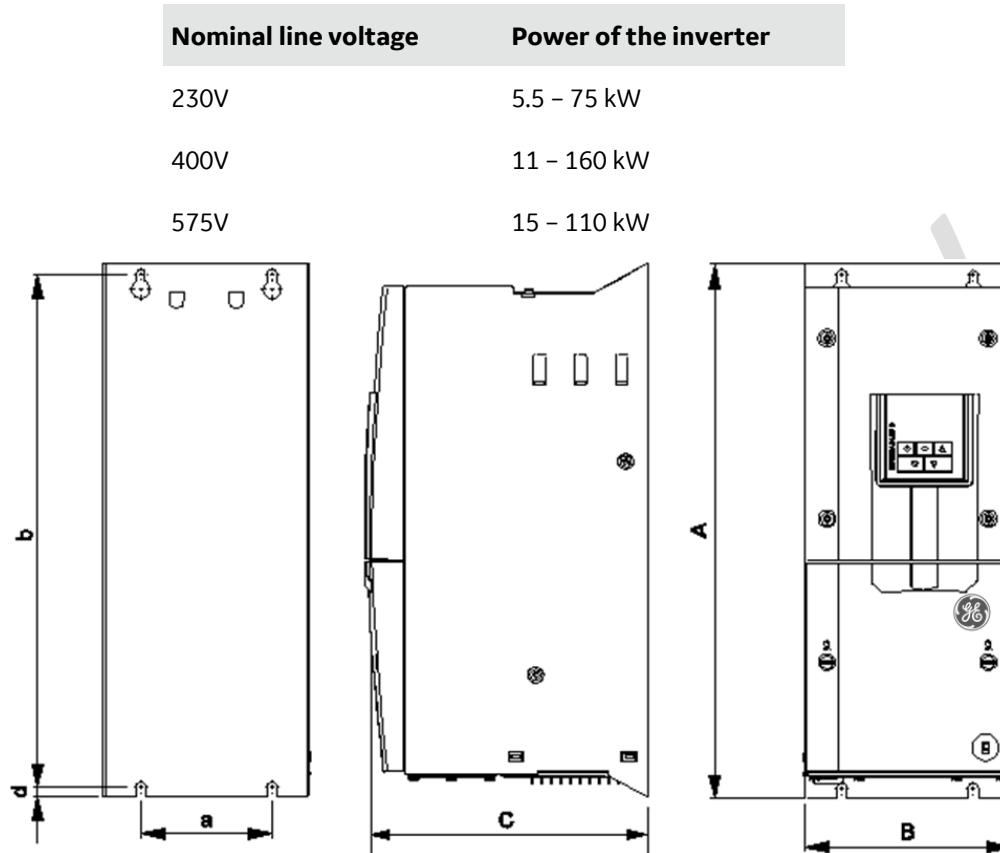


Figure 72: Dimensions IP55/NEMA 12X Inverter

Dimension	230V: 5.5 – 11 kW		230V: 15 – 18.5 kW		230V: 22 – 45 kW		230V: 55 – 75 kW	
	400V: 11 – 22 kW		400V: 30 – 37 kW		400V: 45 – 90 kW		400V: 110 – 160 kW	
	575V: 15 – 30 kW		575V: 37 – 45 kW		575V: 55 – 110 kW			
Height (A)	mm	450	540	865	1280			
Width (B)	mm	171	235	330	330			
Depth (C)	mm	235	268	335	365			
Weight	kg	11.5	22.5	47	80			
a	mm	110	175	200	200			
b	mm	423	520	840	1255			
c	mm	61	60	130	130			
d	mm	8	8	10	10			
Recommended screw size		4 × M8		4 × M10				

## 12.7 Protection Function

- Output short circuit, phase-phase, phase-ground
- Output overcurrent
- Overload protection
  - Inverter responds to overload as described in Section 12.5, *Overload Capacity*.
- Overvoltage fault
  - Set to 123% of the maximum nominal line voltage of the inverter.
- Undervoltage fault
- Overtemperature fault
- Undertemperature fault
  - The inverter is shut down at a temperature of under -10 °C.
- Line phase failure
  - A running inverter shuts down when one phase of a three-phase system fails for longer than 15 seconds.
- Thermal motor overload protection according to NEC (National Electrical Code, US).
- Evaluation of TF, TH, KTY84 and PT1000

## Chapter 13 Functional Safety (STO)

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Safe Torque Off is abbreviated to STO for the remainder of this section.

### 13.1 Integrated Safety Technology

The safety technology of PACMotion VFD described below has been developed and tested in accordance with the following safety requirements:

Underlying standards	Safety class
EN 61800-5-2:2007	SIL 2
EN ISO 13849-1:2006	PL d
EN 61508:2010 part 1 – 7	SIL 2
EN 60204-1:2006	Stop category 0
EN 62061:2005	SIL CL 2

STO certification was conducted by TÜV Rheinland. It is valid only for devices that have the TÜV logo imprinted on the nameplate. Copies of the TÜV certificate can be obtained from GE Automation & Controls.

#### 13.1.1 Safe Condition

For the safety-related use of PACMotion VFD, "Safe Torque Off" is defined as a safe state. The underlying safety concept is based on this.

#### 13.1.2 Safety Concept

- In case of danger, any potential risk to a machine must be eliminated as quickly as possible. Bringing the unit to a standstill and preventing a restart is generally the safe state for preventing dangerous movements.
- The STO function is available irrespective of the operating mode or parameter settings.
- It is possible to connect an external safety relay to the frequency inverter. This safety relay activates the STO function when a connected control device (for example, EMERGENCY STOP button with a latching function) is activated. The motor coasts to a halt and is now in the "Safe Torque Off" state.
- The active STO function prevents the frequency inverter from supplying a torque-generating rotating field to the motor.

## Safe Disconnection Function

The safe disconnection function locks the frequency inverter's performance level, thus preventing it from supplying a torque-generating rotating field to the motor. The motor coasts to a halt.

Restarting the motor is possible only if:

- A voltage of 24Vdc is present between STO+ and STO-, as shown in Section 5.4.18, [Overview of Signal Terminals](#).
- All error messages are acknowledged.

Using the STO function makes it possible to integrate the drive into a safety system in which the STO function must be fully compliant.

The STO function makes the use of electro-mechanical protection with self-checking auxiliary contacts for implementing safety functions redundant.

## Safe Torque Off Function (STO)

**Note:** The STO function does not prevent the frequency inverter from restarting unintentionally. An automatic restart may occur as soon as the STO inputs obtain a valid signal (depending on the parameter settings). For this reason, do not use this function to carry out brief non-electrical work (for example, cleaning or maintenance).

The STO function integrated into the frequency inverter meets the definition of "Safe Torque Off" in accordance with IEC 61800-5-2:2007.

The STO function corresponds to an uncontrolled stop in accordance with category 0 (emergency off) of IEC 60204-1. If the STO function is activated, the motor coasts to a stop. This stop procedure must be in accordance with the system that drives the motor.

The STO function is recognized as a fail-safe method even if the STO signal is not present and an individual fault occurs in the drive. The frequency inverter is tested in accordance with the safety standards specified below:

	<b>SIL Safety integrity level</b>	<b>PFH<sub>D</sub> Probability of dangerous failure per hour</b>	<b>SFF Safe failure fraction</b>	<b>Assumed service life</b>
EN 61800-5:-2	2	1.23 x 10 <sup>-9</sup> 1/h (0.12% of SIL 2)	50%	20 years

	<b>PL Performance Level</b>	<b>CCF (%) Common cause failure</b>
EN ISO 13849-1	PL d	1

	<b>SILCL</b>
EN 62061	SILCL 2

**Note:** The above values are not achieved if the frequency inverter is installed in an environment whose limit values lie outside those specified in Section 12.2, [Ambient Conditions](#).

**Note:** Some applications require additional measures in order to satisfy the requirements of the system's safety function. The STO function does not have a motor brake. If a motor brake is required, it is necessary to use a delayed safety relay and/or a mechanical braking device or similar. It is necessary to establish which protective function is required when braking. The brake control in the frequency inverter has not been evaluated from a safety technology perspective and therefore cannot be used to safely control the brake without the use of additional measures.

**Safety Functions**

The following figure shows the STO function:

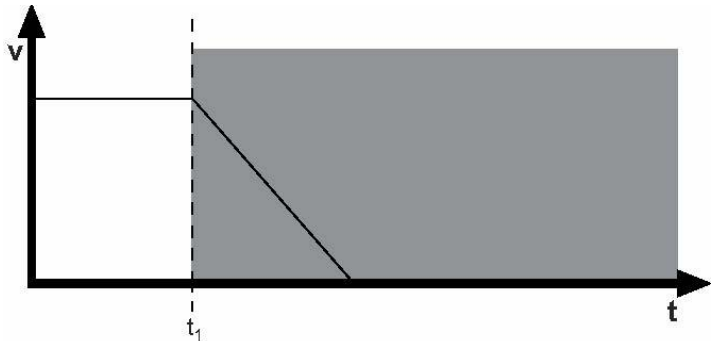


Figure 73: Operation of the STO Function

- v Speed
- t Time
- t<sub>1</sub> Time at which STO is triggered
- Switch-off range

**STO Status and Diagnostics**

**Frequency Inverter Display**

Frequency inverter display "**Inhibit**": The STO function is active due to signals present at the safety inputs. If, at the same time, the frequency inverter switches to a fault status, the relevant error message is displayed instead of "Inhibit".

Frequency inverter display "**STo-F**": Refer to Section 8.4, *Error Codes*.

**Frequency Inverter Output Relay**

Frequency inverter relay 1: If P2-15 is set to "9", the relay opens when the STO function is activated.

Frequency inverter relay 2: If P2-18 is set to "9", the relay opens when the STO function is activated.

Frequency inverter  
output relay



### Response Times of STO Function

The entire response time is the time from when a safety-relevant event occurs on the system components (total) until they are in a safe state (stop category 0 in accordance with IEC 60204-1).

Response time	Description
< 1ms	From the time <ul style="list-style-type: none"> <li>when the STO inputs are no longer energized.</li> </ul> Until the time <ul style="list-style-type: none"> <li>when the motor can no longer generate torque.</li> </ul>
< 20ms	From the time <ul style="list-style-type: none"> <li>when the STO inputs are no longer energized.</li> </ul> Until the time <ul style="list-style-type: none"> <li>when the STO monitoring status changes.</li> </ul>
< 20ms	From detection <ul style="list-style-type: none"> <li>of a fault in the STO circuit.</li> </ul> Until display <ul style="list-style-type: none"> <li>of the fault in the frequency inverter display or the digital output.</li> </ul> Status: "Frequency inverter fault"

### 13.1.3 Restrictions



**Warning**

The safety concept is only suitable for performing mechanical work on the system/machine components.

If the STO signal is disconnected, the line voltage is still present at the frequency inverter DC link.

- Before working on the electric part of the drive system, disconnect it from the supply system using an appropriate external disconnecting device and secure it against unintentional reconnection to the voltage supply.
- The STO function does not prevent an unintentional restart. As soon as the STO inputs receive the corresponding signal, the drive can restart automatically. Do not use the STO function for maintenance work.

- The STO function does not have a motor brake. If the motor coasts to a halt, this must not cause a further hazard. Take this into account during a risk assessment of the system/machine. Additional safety measures (for example, safety brake system) may need to be implemented.

In the case of application-specific safety functions that require active deceleration (braking) of a dangerous movement, the frequency inverter cannot be used without an additional brake system.

- When using a permanent-field motor, a multiple output stage error – which is extremely rare – may cause the rotor to rotate by  $180^\circ/p$  ( $p$  = number of pole pairs).

**Note:** The brake is always applied if a safety-related disconnection of the 24Vdc supply voltage occurs at terminal 12 (STO activated). The brake control in the frequency inverter is not safety-related.

### 13.1.4 Responsibilities

The overall system designer is responsible for defining the requirements of the overall “Safety Control System” within which the drive will be incorporated; furthermore, the system designer is responsible for ensuring that the complete system is risk assessed and that the “Safety control System” requirements have been entirely met and that the function is fully verified, this must include confirmation testing of the STO function before drive commissioning.

The system designer shall determine the possible risks and hazards within the system by carrying out a thorough risk and hazard analysis, the outcome of the analysis should provide an estimate of the possible hazards, furthermore determine the risk levels and identify any needs for risk reduction. The STO function should be evaluated to ensure it can sufficiently meet the risk level required.

### 13.1.5 What STO Provides

The purpose of the STO function is to provide a method of preventing the drive from creating torque in the motor in the absence of the STO input signals (Terminal 12 with respect to Terminal 13), this allows the drive to be incorporated into a complete safety control system where STO requirements need to be fulfilled. (See Note1, below)

The STO function can typically eliminate the need for electro-mechanical contactors with cross-checking auxiliary contacts as per normally required to provide safety functions. (See Note2, below).

The drive has the STO function built-in as standard and complies with the definition of “Safe Torque Off“, as defined by IEC 61800-5-2:2007.

The STO function also corresponds to an uncontrolled stop in accordance with category 0 (Emergency Off), of IEC 60204-1. This means that the motor will coast to a stop when the STO function is activated, this method of stopping should be confirmed as being acceptable to the system the motor is driving.

The STO function is recognized as a fail-safe method even in the case where the STO signal is absent and a single fault within the drive has occurred, the drive has been proven in respect of this by meeting the following safety standards referenced in Section 13.1, *Integrated Safety Technology*.

**Note:** The results may be jeopardized if the drive is installed outside of the environmental limits detailed in Section 12.2, *Ambient Conditions*.

### 13.1.6 What STO Does Not Provide



**Warning**

Disconnect and ISOLATE the drive before attempting any work on it. The STO function does not prevent high voltages from being present at the drive power terminals.

**Note1:** The STO function does not prevent the drive from an unexpected restart. As soon as the STO inputs receive the relevant signal it is possible (subject to parameter settings) to restart automatically. Based on this, the function should not be used for carrying out short-term non-electrical machinery operations (such as cleaning or maintenance work).

**Note2:** In some applications additional measures may be required to fulfil the systems safety function needs: the STO function does not provide motor braking. In the case where motor braking is required a time delay safety relay and/or a mechanical brake arrangement or similar method should be adopted, consideration should be made over the required safety function when braking as the drive braking circuit alone cannot be relied upon as a fail-safe method.



**Caution**

When using permanent magnet motors and in the unlikely event of a multiple output power devices failing then the motor could effectively rotate the motor shaft by  $180/p$  degrees (where  $p$  denotes number of motor pole pairs).

### 13.1.7 STO Operation

When the STO inputs are energized, the STO function is in a standby state, if the drive is then given a “Start signal/command” (as per the start source method selected in P1-13) then the drive will start and operate normally.

When the STO inputs are de-energized then the STO Function is activated and stops the drive (Motor will coast), the drive is now in “Safe Torque Off” mode.

To get the drive out of “Safe Torque Off” mode then any Fault messages need to be reset and the drive STO input needs to be re-energized.

### 13.1.8 STO Status and Monitoring

There are a number of methods for monitoring the status of the STO input. These are detailed below:

#### Drive Display

In Normal drive operation (Mains AC power applied), when the drives STO input is de-energized (STO Function activated) the drive will highlight this by displaying “InHibit”.

**Note:** If the drive is in a tripped condition, then the relevant trip will be displayed. “InHibit” will not be displayed.

#### Drive Output Relay

- Drive Relay 1: Setting P2-15 to a value of “13” will result in relay opening when the STO function is activated.
- Drive Relay 2: Setting P2-18 to a value of “13” will result in relay opening when the STO function is activated.

#### STO Fault Codes

Fault Code	Code Number	Description	Corrective Action
Sto-F	29	A fault has been detected within either of the internal channels of the STO circuit.	Refer to Section 8.4, <a href="#">Error Codes</a>

### 13.1.9 STO Function Response Time

The total response time is the time from a safety related event occurring to the components (sum of) within the system responding and becoming safe. (Stop Category 0 in accordance with IEC 60204-1).

- The response time from the STO inputs being de-energized to the output of the drive being in a state that will not produce torque in the motor (STO active) is less than 1ms.
- The response time from the STO inputs being de-energized to the STO monitoring status changing state is less than 20ms.
- The response time from the drive sensing a fault in the STO circuit to the drive displaying the fault on the display/Digital output showing drive not healthy is less than 20ms.

### 13.1.10 STO Electrical Installation

The STO wiring shall be protected from inadvertent short circuits or tampering which could lead to failure of the STO input signal, further guidance is given in the diagrams below.

In addition to the wiring guidelines for the STO circuit below, recommended installation for EMC Compliance should also be followed. Refer to Section 5.4.17, *Electromagnetic Compatibility (EMC)*.

The drive should be wired as illustrated below; the 24Vdc signal source applied to the STO input can be either from the 24Vdc on the drive or from an External 24Vdc power supply.

#### Using an External 24Vdc Power Supply

#### Using the Drives On-board 24Vdc Supply

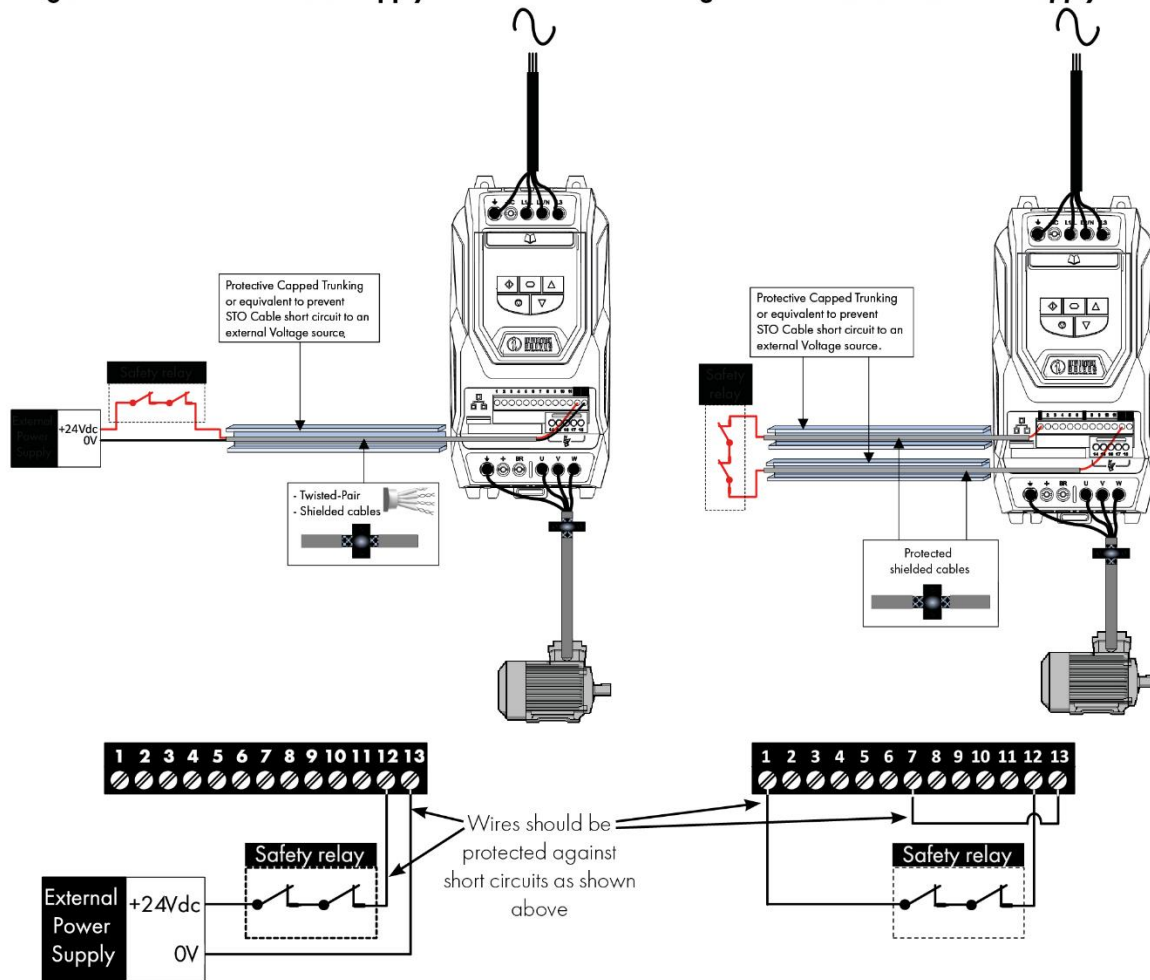


Figure 74: Recommended STO Circuit Wiring

**Note:** Maximum cable length from voltage source to drive terminals should not exceed 25m.

### 13.1.11 External Power Supply Specification

<b>Voltage Rating (Nominal)</b>	24Vdc
<b>STO Logic High</b>	18-30Vdc (Safe Torque Off in standby)
<b>Current Consumption (Maximum)</b>	100mA

### 13.1.12 Safety Relay Specification

The safety relay should be chosen so that at minimum it meets the safety standards in which the drive meets.

<b>Standard Requirements</b>	SIL2 or PLd SC3 or better (with forcibly-guided contacts)
<b>Number of Output Contacts</b>	2 independent
<b>Switching Voltage Rating</b>	30Vdc
<b>Switching Current</b>	100mA

### 13.1.13 Enabling the STO Function

The STO function is always enabled in the drive regardless of operating mode or parameter changes made by the user.

### 13.1.14 Testing the STO Function

Before commissioning the system, the STO function should always be tested for correct operation, this should include the following tests:

- With the motor at standstill, and a stop command given to the drive (as per the start source method selected in P1-13):
  - De-energize the STO inputs (drive will display “InHibit”).
  - Give a start command (as per the start source method selected in P1-13) and check that the drive still displays “Inhibit” and that the operation is in line with Section 13.1.7. *STO Operation* and Section 13.1.8. *STO Status and Monitoring*.
- With the motor running normally (from the drive):
  - De-energize the STO inputs.
  - Check that the drive displays “Inhibt” and that the motor stops and that the operation is in line with Section 13.1.7. *STO Operation* and Section 13.1.8. *STO Status and Monitoring*.

### 13.1.15 STO Function Maintenance

The STO function should be included within the control systems scheduled maintenance program so that the function is regularly tested for integrity (minimum once per year), furthermore the function should be integrity tested following any safety system modifications or maintenance work. If drive fault messages are observed refer to Section 8.4, *Error Codes* for further guidance.

## 13.2 Safety Conditions

The requirement for safe operation is that the safety functions of the frequency inverter are properly integrated into an application-specific higher-level safety function. In each case, a system/machine-specific risk assessment must be carried out by the system/machine manufacturer and taken into account when using the drive system with a frequency inverter.

The system/machine manufacturer and the operator are responsible for ensuring that the system/machine complies with the relevant safety regulations.

### Approved devices:

All available PACMotion VFD inverters have the STO function.

The requirements below are mandatory when installing and operating the frequency inverter in safety-related applications.

### 13.2.1 Storage Requirements

To avoid accidental damage, GE Automation & Controls recommends keeping the inverter in its original packaging until you are going to install it. The storage location must be dry and clean. The temperature range at the storage location must be between  $-40^{\circ}\text{C}$  and  $+60^{\circ}\text{C}$ .

### 13.2.2 Installation Requirements



#### Caution

The STO wiring must be protected against accidental short circuits or external influences. Otherwise, it may cause the STO input signal to fail.

---

In addition to the wiring guidelines for the STO circuit, the requirements in Section 5.4.17, *Electromagnetic Compatibility (EMC)* must also be observed.

Shielded twisted-pair cables are always recommended here.

Requirements:

- The safety-related 24Vdc supply voltage must be EMC-compliant and routed as follows:
  - Outside an electrical installation space, shielded cables must be routed permanently (fixed) and protected against external damage, or other equivalent measures have to be taken.
  - Inside an electrical installation space: Individual conductors can be routed.
  - Adhere to the relevant regulations in force for the application.
- Make sure that you apply shielding for the safety-related 24Vdc supply cable at both ends.
- Power cables and safety-related control cables must be installed in separate cables.
- Make sure that no parasitic voltages can be generated in the safety-related control cables.
- The wiring technology used must comply with EN 60204-1.
- Use only grounded voltage sources with safe isolation (PELV) according to VDE0100 and EN 60204-1. In case of a single fault, the voltage between the outputs or between any output and grounded parts must not exceed 60Vdc.
- The safety-related 24Vdc supply voltage may not be used for feedback.

- You can supply power to the 24Vdc STO input either via an external 24Vdc supply or via the internal 24Vdc supply of the inverter. If an external voltage source is used, its cable length to the inverter must not exceed 25 meters.
  - Nominal voltage: +24Vdc
  - STO Logic High: 18 – 30Vdc (Safe Torque Off in standby)
  - Maximum current consumption: 100mA
- When planning the installation, observe the technical data of the frequency inverter.
- Observe the values specified for safety components when designing the safety circuits.
- Frequency inverters with degree of protection IP20 must be installed in an IP54 control cabinet (minimum requirement) in an environment with degree of pollution 1 or 2.
- The safe 24Vdc must be connected between the safety relay and STO+ input in such a way that a fault can be ruled out.

The fault assumption "short circuit between any two conductors" can be excluded in accordance with EN ISO 13849-2: 2008 under the following conditions:

The conductors are:

- Permanently (fixed) installed and protected against external damage (for example, using a cable duct or armored conduit)
- Installed in different light plastic-sheathed cables in an electrical installation space provided that both the lines and the installation space meet the relevant requirements, refer to EN 60204-1
- Protected individually by a ground connection

The fault assumption "short circuit between any conductor and an exposed conductive part or ground or a protective conductor" can be excluded under the following condition:

- Short circuits between a conductor and any exposed conductive part within an installation space.



### 13.2.3 Requirements on the External Safety Controller

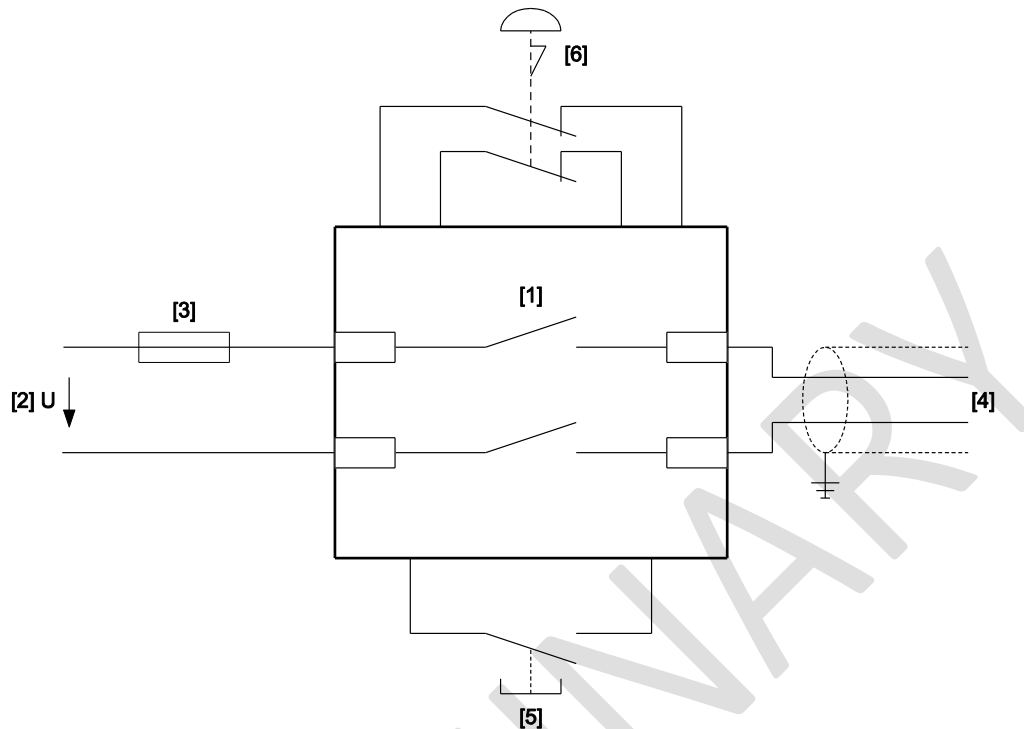


Figure 75: External Safety Controller Features

- [1] Safety relay with approval
- [2] 24Vdc voltage supply
- [3] Fuses in accordance with the manufacturer's specifications of the safety relay
- [4] Safety-related 24Vdc voltage supply
- [5] Reset button for manual reset
- [6] Approved EMERGENCY STOP actuating device

A safety relay can be used as an alternative to a safety controller. The following requirements apply analogously:

- The safety controller and all other safety-related subsystems must be approved for at least that safety class which is required in the overall system for the respective, application-related safety function.

The following table shows an example of the required safety class of the safety controller:

Application	Safety controller requirements
Performance level d in accordance with EN ISO 13849-1	Performance level d in accordance with EN ISO 13849-1 SIL 2 in accordance with EN 61508

- The wiring of the safety controller must be suitable for the required safety class (refer to manufacturer’s documentation).
  - When disconnected, test pulses on the supply cable are not permitted.
- The values specified for the safety controller must be strictly adhered to when designing the circuit.
- The switching capacity of the safety relays or the relay outputs of the safety controller must, at the very least, correspond to the maximum permitted, limited output current of the 24Vdc supply voltage.

Observe the manufacturer’s instructions concerning the permitted contact loads and fusing that may be required for the safety contacts. If the manufacturer does not provide any specific information on this matter, the contacts must be protected with 0.6 times the nominal value of the maximum contact load specified by the manufacturer.
- To ensure protection against an unintentional restart in accordance with EN 1037, the safe control system must be designed and connected in such a way that resetting the control device alone does not result in a restart. In other words, a restart may only be carried out after the safety circuit has been manually reset.

**Note:** It is not possible to control the STO inputs via pulsed signals (for example, self-testing digital outputs of safety controllers).

### 13.2.4 Requirements for Safety Relays

The requirements of the manufacturers of safety relays, such as protecting the output contacts against welding or other safety components, must be strictly observed. For cable routing, the basic requirements apply as described in this publication.

Other instructions by the manufacturer on the use of safety relays for specific applications must also be observed.

Choose the safety relay in such a way that it has at least the same safety standards as the required PLd/SIL of the application.

<b>Minimum requirements</b>	SIL2 or PLd SC3 or higher (with force-guided contacts)
<b>Number of output contacts</b>	2 independent
<b>Rated switching voltage</b>	30Vdc
<b>Switching current</b>	100mA

### 13.2.5 Requirements on Start-Up

- To validate the implemented safety functions, they must be documented and checked after successful start-up (validation).  
Observe the limitations for safety functions in Section 13.1.3, *Restrictions*. Non-safety-related parts and components that affect the result of the validation (e.g. motor brake) must be deactivated, if necessary.
- For using PACMotion VFD in safety-relevant applications, it is essential that you perform and record start-up checks for the disconnecting device and correct wiring.

### 13.2.6 Requirements on Operation

- Operation is only allowed within the limits specified in the data sheets. This principle applies to the external safety controller as well as to PACMotion VFD Inverters and approved options.
- Ambient temperature is maintained at or below that specified in Section 12.2, *Ambient Conditions*.
- The fans must be able to rotate freely. The heat sink must be kept clear of dust and dirt.
- The space in which the inverter is installed must be free of dust and condensation. Check the fans and air filters regularly to ensure that adequate air flow is sustained.
- Regularly check all electrical connections. Ensure all screw terminals are correctly torqued. Refer to Section 5.2, *Permitted Tightening Torques*.
- Check power cables for damage caused by heat and investigate if observed.

#### Testing the STO Function

Before starting up the system, perform the following tests to ensure that the STO function is working properly. Here, the configured enable source must be taken into account in accordance with the settings in P1-15.

- 1. Initial situation:  
The frequency inverter is not enabled. Therefore, the motor is at a standstill.
  - The STO inputs are no longer energized ("Inhibit" displayed on the frequency inverter display).
  - Enable the frequency inverter. Since the STO inputs continue to not be energized, "Inhibit" continues to be displayed on the frequency inverter display.
- 2. Initial situation:  
The frequency inverter is enabled. The motor rotates.
  - Disconnect the STO inputs from the power supply.
  - Check whether "Inhibit" is displayed on the frequency inverter display, the motor is stopped, and the operation runs in accordance with sections *Safe Disconnection Function* and *STO Status and Diagnostics* above.

#### Maintaining the STO Function

Test the safety functions at regular intervals (at least once per year) to ensure that they are working properly. The test intervals must be specified on the basis of the risk assessment.

Furthermore, test the integrity of the STO function after each change to the safety system or following any maintenance work.

If error messages occur, determine their significance by referring to Section 8.4, *Error Codes*.

### 13.3 Connection Variants

#### 13.3.1 General Information

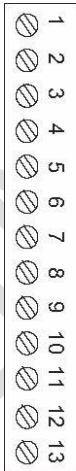
Generally, all the connection variants listed in this documentation are permitted for safety-relevant applications as long as the basic safety concept is fulfilled. This means you have to make sure that the 24Vdc safety inputs are operated by an external safety relay or a safety controller, thus preventing an automatic restart.

All safety conditions mentioned in chapters 2, 3 and 4 of the present documentation must be met for the basic selection, installation, and application of the safety components (for example, safety relay, EMERGENCY STOP switch, and so on), and the approved connection variants.

The wiring diagrams are block diagrams whose only purpose is to show the safety function(s) with the relevant components. Circuit-related measures, which usually always have to be implemented additionally, are not shown in the diagrams to enhance clarity. Such measures are taken, for example, to ensure protection against contact, to handle overvoltage and undervoltage, to detect insulation faults, line-to-ground faults and short circuits, which can occur on externally installed lines, or to ensure the necessary immunity against electromagnetic interference.

#### Connection Options of PACMotion VFD

The following illustration shows an overview of the signal terminals.



1	+24 VIO
2	DI 1
3	DI 2
4	DI 3
5	+10 V
6	AI 1 / DI 4
7	0 V
8	AO 1 / DO 1
9	0 V
10	AI 2 / DI 5
11	AO 2 / DO 2
12	STO+
13	STO-

Figure 76: Signal Terminals

### 13.3.2 Disconnection of a Single Drive

#### STO According to PL d (EN ISO 13849-1)

The procedure is as follows:

- The STO input 12 is disconnected.
- The motor coasts to a halt, if no brake is installed.

#### STO - Safe Torque Off (EN 61800-5-2)

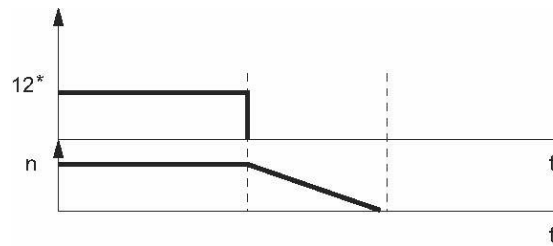


Figure 77: Safe Torque Off (STO) Function

- \* Safety input (terminal 12)
- n Speed

**Note:** The displayed STO disconnections can be used up to PL d according to EN ISO 13849-1. Refer to Section 13.2.4, [Requirements for Safety Relays](#).

**Digital Control using Safety Relay with External 24Vdc Supply**

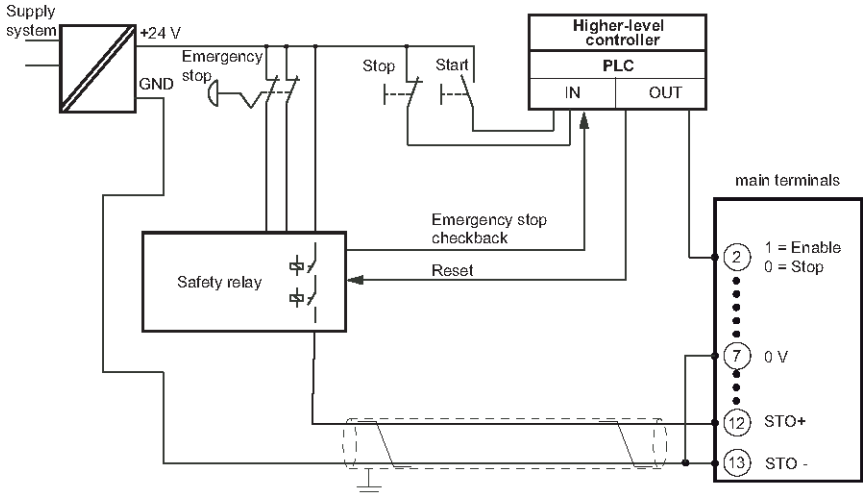


Figure 78: Digital Control using Safety Relay with External 24Vdc Supply

**Digital Control using Safety Relay with Internal 24Vdc Supply**

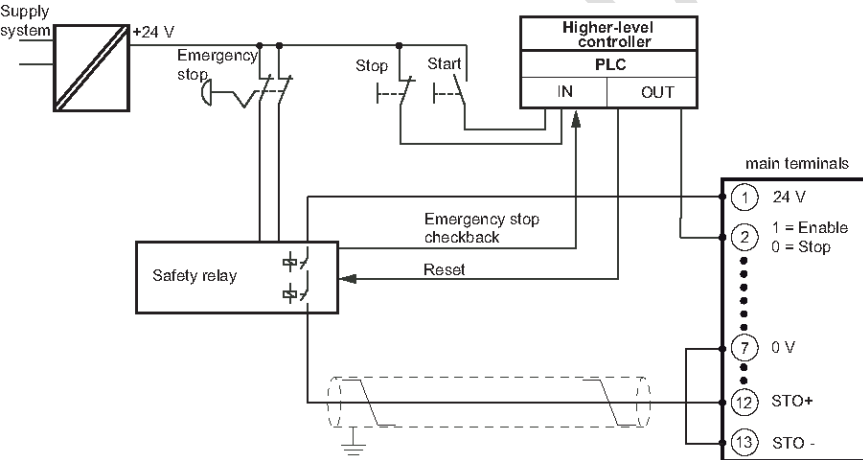


Figure 79: Digital Control using Safety Relay with Internal 24Vdc Supply

**Note:** With single-channel disconnection, you have to make certain fault assumptions and provide for corresponding fault exclusions. Observe Section 13.2.4, *Requirements for Safety Relays*.

### SS1(c) According to PL d (EN ISO 13849-1)

The procedure is as follows:

- Terminal 2 is disconnected, e.g. in case of an emergency stop/halt.
- During the safety time interval  $t_1$ , the motor decelerates to a complete stop along the ramp.
- After  $t_1$  has elapsed, the safety input disconnects terminal 12. The safety time interval  $t_1$  must be sufficient for the motor to reach a complete stop.

### SS1(c) – Safe Stop 1 (EN 61800-5-2)

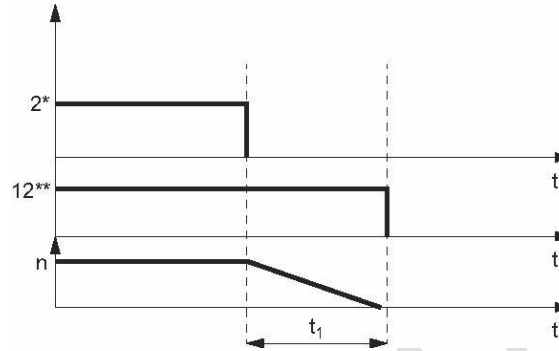


Figure 80: Diagram of SS1(c) – Safe Stop 1 (EN 61800-5-2)

- \* Digital input 1 (terminal 2)
- \*\* Safety input (terminal 12)
- n Speed

**Note:** The displayed SS1(c) disconnections can be used up to PL d according to EN ISO 13849-1. Observe Section 13.2.4, [Requirements for Safety Relays](#).

**Digital Control using Safety Relay with External 24Vdc Supply**

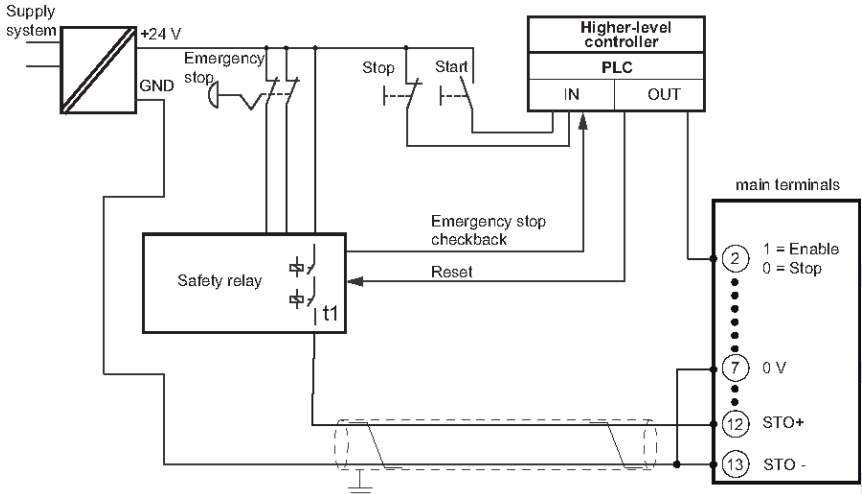


Figure 81: Digital Control using Safety Relay with External 24Vdc Supply

**Digital Control using Safety Relay with Internal 24Vdc Supply**

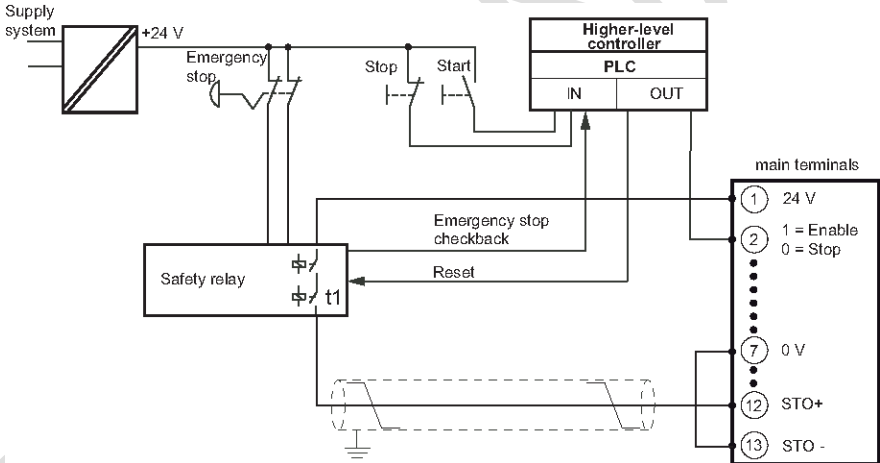


Figure 82: Digital Control using Safety Relay with Internal 24Vdc Supply

**Note:** With single-channel disconnection, you have to make certain fault assumptions and provide for corresponding fault exclusions. Observe Section 13.2.4, *Requirements for Safety Relays*.



## 13.4 Safety Characteristics

Characteristic values in accordance with:	EN 61800-5-2	EN ISO 13849-1	EN 62061
Classification/underlying standards	SIL 2 (Safety Integrity Level)	PL d (Performance Level)	SILCL 2
(PFHd value) <sup>21</sup>	$1.23 \times 10^{-9}$ 1/h		
Service life / mission time	20 years, then the components must be replaced with new components.		
Proof test interval	20 years	-	20 years
Safe state	Safe Torque Off (STO)		
Safety functions	STO, SS1 <sup>22</sup> in accordance with EN 61800-5-2		

<sup>21</sup> Probability of dangerous failure per hour.

<sup>22</sup> With suitable external control.

## 13.5 Signal Terminal Block for STO Safety Contact

PACMotion VFD	Terminal	Function	General electronics data
Safety contact	12	STO+	+24Vdc input, max. 100mA, STO safety contact
	13	STO-	Reference potential for +24Vdc input
Permissible cable cross section			One core per terminal: 0.05 – 2.5 mm <sup>2</sup> (AWG 30 – 12).

	Min.	Typical	Max.
Input voltage range	18 Vdc	24Vdc	30Vdc
Time to inhibit output stage	-	-	1ms
Time until Inhibit is shown on the display when STO is active	-	-	20ms
Time until an STO switching time error is detected and displayed	-	-	20ms

**Note:** It is not possible to control the STO inputs via pulsed signals (for example, self-testing digital outputs of safety controllers).



## Chapter 14 Remote Keypads for PACMotion VFDs

### 14.1 Remote Keypad OLED A

The full text OLED keypad is as an available option. It may be used in conjunction with the standard keypad which is attached to the drive unit.

Option Category	Catalog Number	Description
VFD Option	IC855-OLED	External OLED Keypad for VFD



Figure 83: Remote Keypad OLED A

#### 14.1.1 Installation in the Control Cabinet or Control Panel

To install an OLED A keypad in the door of a control cabinet or in a control panel, cut the panel per Figure 84. The installed keypad meets standard IP54 / NEMA 13, provided the self-adhesive gasket shipped along with the keypad is utilized.

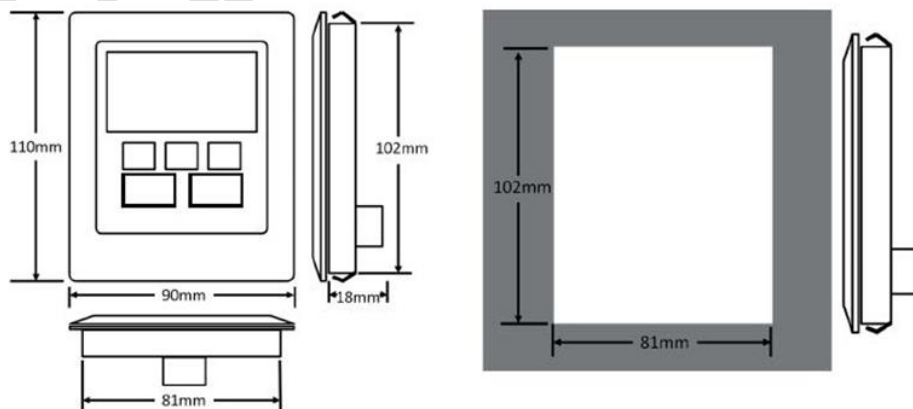


Figure 84: Cutouts Required for Panel Mounting OLED A Keypad

### 14.1.2 Technical Data

<b>Unit connections</b>	RJ45
<b>Supply voltage</b>	24Vdc $\pm$ 10%
<b>Supply current</b>	30 mA
<b>Degree of protection</b>	IP20 (if not installed in the control cabinet) IP54 / NEMA 13 (if installed in the control cabinet door)
<b>Ambient temperature during operation</b>	-10 °C – +50 °C
<b>Maximum relative humidity</b>	95%, condensation not permitted

### 14.1.3 Display Messages

The remote keypad displays information for the error code of the connected frequency inverter in case of a frequency inverter failure or switch-off responses. For a complete list with codes and information for diagnostics and troubleshooting, refer to Section 8.4, [Error Codes](#).

The remote keypad uses different messages to display various operating states:

<b>Display message</b>	<b>Meaning</b>
Scanning for drive XX	The remote keypad scans the network for frequency inverters.
LOAD..	The remote keypad has detected frequency inverters in the network. The frequency inverter is loading relevant start-up information.
SC-OBS	The remote keypad has lost the communication connection with the frequency inverter. Press the <Stop> key to reset. Check the frequency inverter address.
Select language	List to select one of the available languages. To select a language, use the <Navigate> key.
Select drive address XX	Displays while selecting the address of the target frequency inverter. It will be selected for communicating with the remote keypad.
Select VFD-Pad ID	Displays while selecting the ID of the remote keypad (1 or 2). This way, two remote keypads may be connected to one frequency inverter or a network consisting of several frequency inverters.

## 14.2 Electrical Installation

The remote keypad can be connected directly to the frequency inverter using a standard RJ45 cable. Voltage supply and data transmission is realized via the interface.

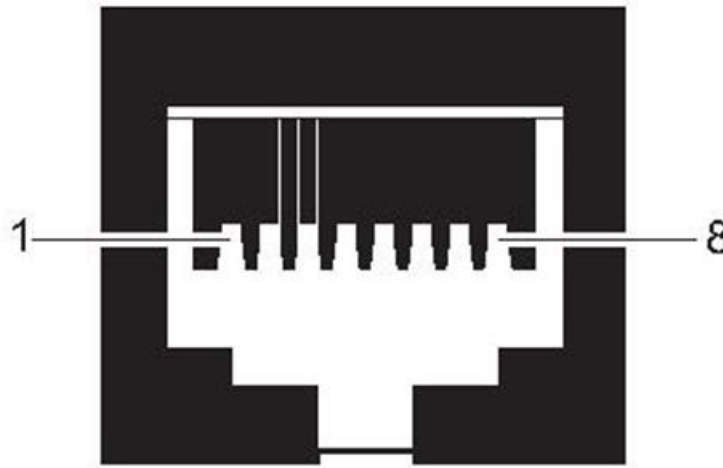


Figure 85: RJ45 Socket Pinout (on Keypad Assembly)

[1]	Not connected
[2]	Not connected
[3]	0 V
[4]	RS485- (engineering)
[5]	RS485+ (engineering)
[6]	+24Vdc (voltage supply)
[7]	Not connected
[8]	Not connected

### 14.3 System structure

As soon as the physical connection is established, the keypad can be used. The keypad supports a network of PACMotion VFDs, with communications determined via the respective communication addresses. Refer to Section 14.4.1, *Setting the Communication Address*.

A maximum of two keypads may be integrated into an existing network.

One keypad can be used for controlling up to 63 frequency inverters. All devices must be connected on the same network. The keypad displays and controls one frequency inverter at any given time.

Typical keypad usage includes:

- One PACMotion VFD with one (or a maximum of two) remote keypads (Figure 86).
- Any combination of PACMotion VFDs with one (or a maximum of two) remote keypads (Figure 87). The drives on the network may consist of any combination of drive types. The network is limited to 64 devices maximum.

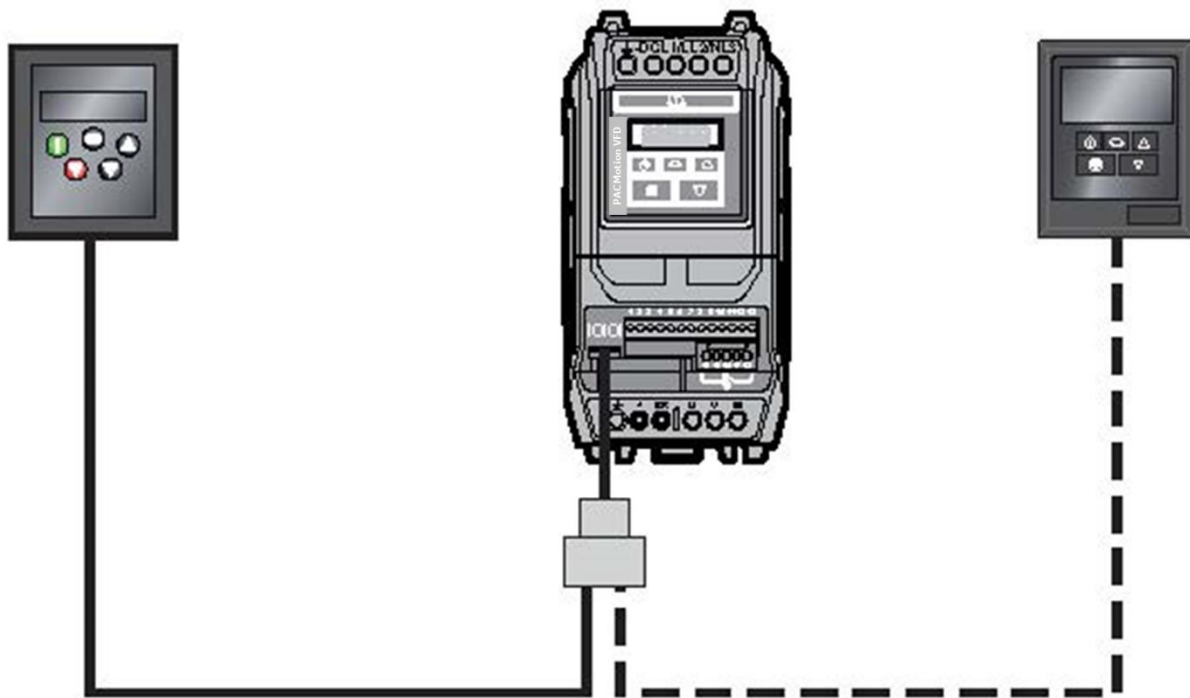


Figure 86: One PACMotion Drive Connected to Two Remote Keypads

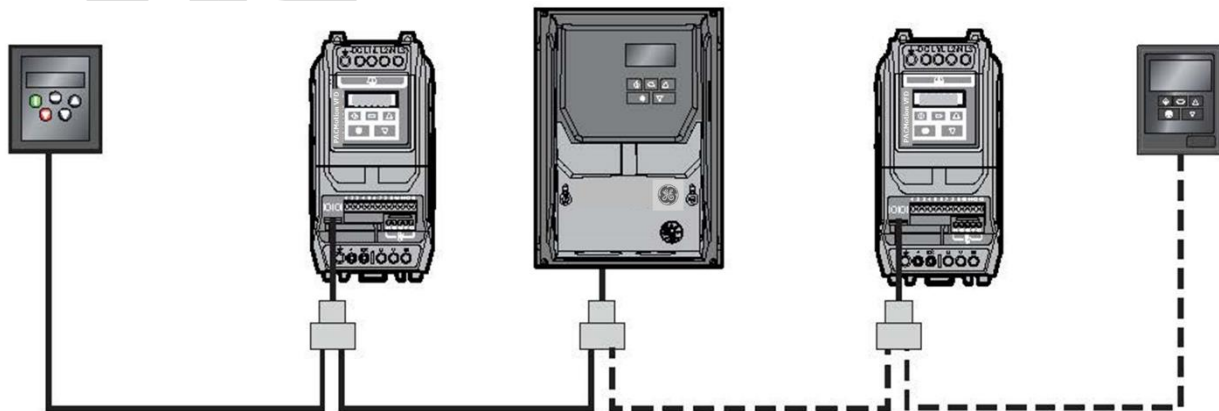


Figure 87: Networked PACMotion Drives Communicating with Two Remote Keypads

## 14.4 Start-Up

### 14.4.1 Setting the Communication Address

The remote keypad tries to reach the frequency inverter with address 1 during the first start-up.

- After start-up, "SCAN.." is displayed.
- The remote keypad scans the network for frequency inverters with address 1.
- If the frequency inverter is found, the message "Load.." is displayed. The remote keypad then reads the configuration information from that frequency inverter. This process takes approx. 1-2 seconds.
- After that, the remote keypad shows the real-time state of the frequency inverter.
- If the keypad cannot find a frequency inverter with address 1, meaning none of the frequency inverters on the network has address 1, the remote keypad displays "Adr-01" as the communication address.
- The user can change the address from 1 to 63 via the <Up> and <Down> keys.
- If the displayed address matches the address of a frequency inverter in the network, the configuration data of the frequency inverter can be loaded using the <Stop/Reset> key.

As soon as communication between the remote keypad and the frequency inverter is established, the user can change the address displayed on the remote keypad to establish communication with another frequency inverter in the same network.

- Pressing the <Stop/Reset> and <Down> key at the same time, causes the current "Adr-XX" to be displayed.
- To select a target frequency inverter address, press the <Up>/<Down> keys until the desired target is displayed.
- Press the <Stop/Reset> keys simultaneously in order to establish communications between the remote keypad and the target frequency inverter.

### Settings for Two Remote Keypads

To change the unit number of the keypad, proceed as follows:

- Press the <Navigate>, <Stop/Reset> and <Down> key at the same time. "Port-x" (x = 1 or 2) is displayed.
- Switch to the respective keypad using the <Up> and <Down> keys.
- Press the <Navigate>, <Stop/Reset> and <Down> key at the same time to switch to normal operation.

**Note:** If two remote keypads are communicating with the same target device, the last-issued command received by the target device will prevail.

### 14.4.2 Changing/Monitoring the Parameters

For monitoring or changing a parameter value:

- If the frequency inverter displays "Stop" or "Inhibit", press the <Navigate> key for more than 1 s. The display changes to P1-01.
- Press the <Navigate> key to have the parameter value displayed.
- Use the <Up> and <Down> keys to enter the required value.
- Press the <Navigate> key again to save the changes.
- To return to the real-time mode, press the <Navigate> key for more than 1 second.

If the drive is at a standstill, "Stop" is displayed. If the drive is running, the real-time information is displayed (e.g. speed, frequency, current, or power).

### 14.4.3 Preset Setpoint Speed for Operation with Remote Keypad

- For unipolar or bipolar control of the drive with the remote keypad, set the parameter P1-12 to 1 (unipolar) or 2 (bipolar).
- To start the drive with the preset speed, set the parameter P2-37 to 1 or 3.
- If the drive is at a standstill, press the <Stop> key. The value of the digital potentiometer ( $\triangleq$  setpoint speed) is displayed. For PACMotion VFD, the value is only displayed if P2-37 = 1.
- Using the <Up>/<Down> keys, you can set the required speed.
- Press the <Stop> key to return to real-time mode. "Stop" is displayed.
- Press the <Start> key. The drive accelerates until it reached the setpoint speed.



#### 14.4.4 Speed Change in Real-Time Mode with Remote Keypad

- For unipolar or bipolar control of the drive from the remote keypad, set the parameter P1-12 to 1 (unipolar) or 2 (bipolar).
- To start the drive with the preset speed, set the parameter P2-37 to 1 or 3.
- Press the <Start> key.
- To increase speed, use the <Up> key. The drive accelerates until you stop pressing the key or until the maximum speed is reached. The maximum speed is set via P1-01.
- To decrease speed, use the <Down> key. The drive decelerates until you stop pressing the key or until the minimum speed is reached. The minimum speed is set via P1-02.
- To stop the drive, press the <Stop> key. The speed is reduced with the selected deceleration ramp until the drive comes to a standstill.
- "Stop" is displayed. The drive is deactivated.

#### 14.4.5 Direction of Rotation Reversal

- For unipolar or bipolar control of the drive with the remote keypad, set the parameter P1-12 to 1 (unipolar) or 2 (bipolar).
- To start the drive with the preset speed, set the parameter P2-37 to 1 or 3. Refer to *P2-37 Keypad Restart Speed* above.
- Press the <Start> key. The drive accelerates until it reaches the preset speed (digital potentiometer).
- Using the <Up>/<Down> keys, you can set the required speed.
- Press the <Start> key again to change the direction of rotation.
- To stop the drive, press the <Stop> key. The speed is reduced with the selected deceleration ramp until the drive comes to a standstill.
- If no signal is present at the digital input for direction of rotation reversal, the drive starts with a positive speed.

#### 14.4.6 Lock/Enable Parameter Access

- To prevent unauthorized access to the parameters, set P2-39 = 1. The operator can set or remove the parameter lock via the frequency inverter keypad or via the remote keypad.
- The control and operation information of the drive are still displayed.
- To enable parameter access, set P2-39 = 0 directly via the frequency inverter keypad.

## Chapter 15 Option Cards for PACMotion VFDs

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The following Option Cards are available. Only one option card may be installed in any given drive.

Option Category	Catalog Number	Description	Reference Section
<b>Option Cards</b>			
	IC855-OC-RO	Relay Outputs Option Card for VFD	15.2.3
	IC855-OC-IO	Digital I/O Option Card for VFD	15.2.4
	IC855-OC-TTL	Encoder card TTL Option Card for VFD	15.3.3
	IC855-OC-HTL	Encoder card HTL Option Card for VFD	15.3.4
	IC855-OC-B	Profibus Option Card for VFD	15.4.4
	IC855-OC-P	PROFINET Option Card for VFD	15.4.5

Each option card is enclosed in a plastic case (see Figure 91, for instance). All option cards are installed and removed in the same fashion, as discussed in Section 15.1, *Installation of an Option Card*.

Each option card provides a unique feature set, as discussed in the individual sections listed above.

It is also possible to operate the drive without any option card.

## 15.1 Installation of an Option Card

Disconnect the PACMotion VFD from the supply system before starting to work. Observe the corresponding operating instructions.



### Warning

#### Electric shock due to charged capacitors.

Dangerous voltage levels may still be present inside the unit and at the terminals up to ten minutes after disconnecting from the power supply.

#### Severe or fatal injuries.

Wait ten minutes after disconnecting the frequency inverter from the power supply as well as disconnecting the line voltage and the 24Vdc voltage. Then, establish that the unit has been de-energized. Only then, start to work on the unit.

For installation of the respective option card, proceed as follows.

### 15.1.1 Removing the Terminal Cover

To access the terminals, remove the front cover of the frequency inverter. To open the terminal cover, use a Phillip's head screwdriver. Once the screws have been removed (as shown in Figure 88) the terminals can be accessed. For IP55 enclosures, refer to Figure 13.

Reattach the front cover by proceeding in the reverse order.

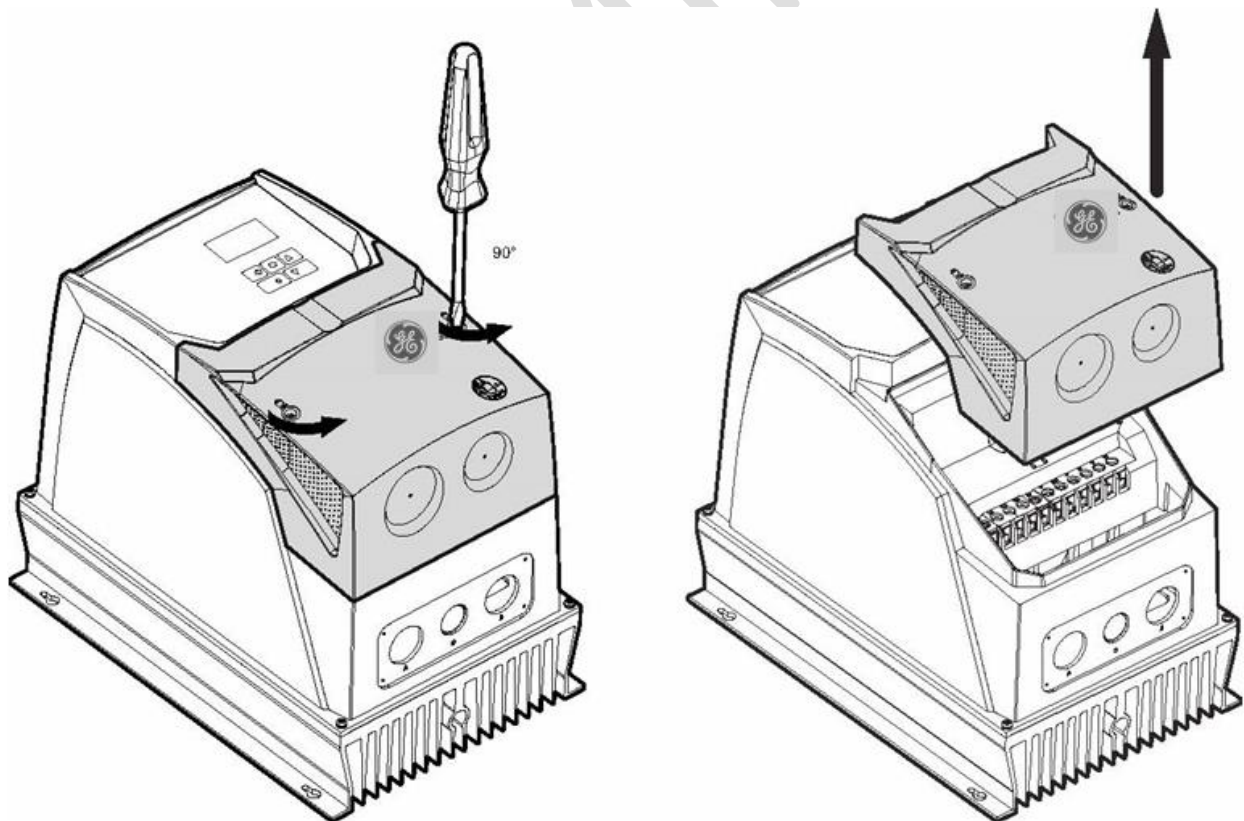


Figure 88: Front Cover Removal (IP66 NEMA 4x)

### 15.1.2 Removing the Option Card Circuit Board Cover

Remove the cover for option card slot, as shown in Figure 89. For IP20, IP55, and IP66 frequency inverters, the option card slot and cover are located beside the signal terminals.

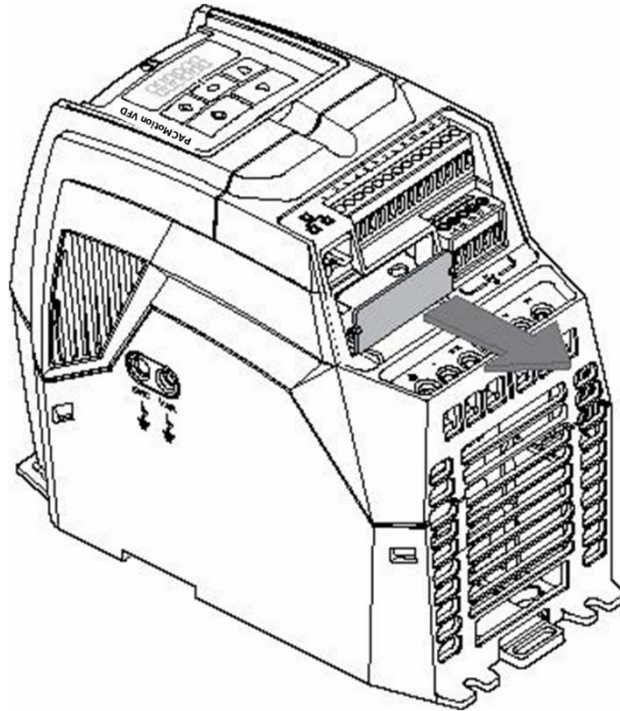


Figure 89: Circuit Board Cover Removal

### 15.1.3 Inserting the Option Card

Carefully slide in the option card into the option slot until it is seated. To avoid damaging the contacts, make sure to slide the option card evenly into the slot.

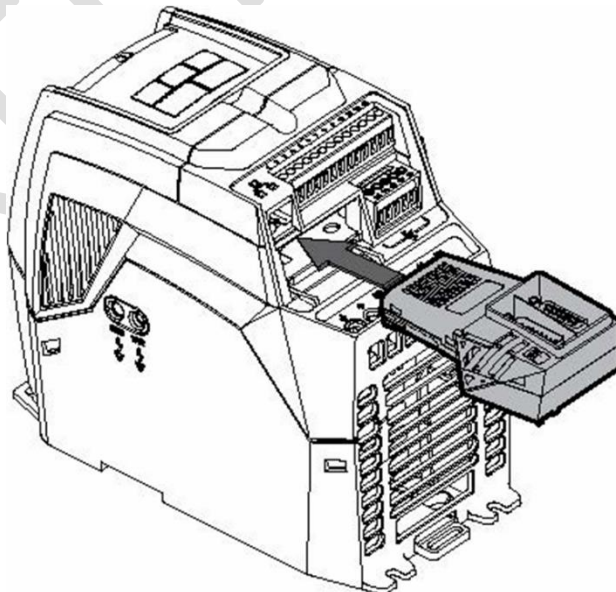


Figure 90: Slide Option Card Assembly into Position

### 15.1.4 Securing the Option Card

Tighten the two screws on the option card assembly faceplate (Figure 91), using a T8 screwdriver. Apply a tightening torque of 0.25 Nm.

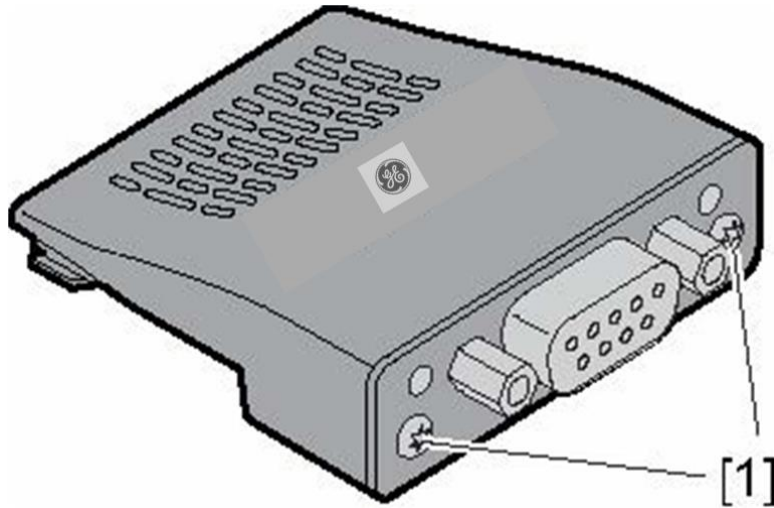


Figure 91: Tighten Option Card Assembly T8 Screws

[1] T8 screw

## 15.2 Interface Extension Option Cards

### 15.2.1 Overview

Option Category	Catalog Number	Description	Reference Section
<b>Option Cards</b>			
	IC855-OC-RO	Relay Outputs Option Card for VFD	15.2.3
	IC855-OC-IO	Digital I/O Option Card for VFD	15.2.4

### 15.2.2 Technical Data

<b>Maximum input voltage</b>	250Vac/30Vdc
<b>Maximum relay switching current</b>	AC: 6 A (250 Vac) DC: 5 A (30 Vdc)
<b>Digital input</b>	8 – 30 Vdc
<b>Digital input response time</b>	< 8 ms
<b>Conformity</b>	IP20, UL94V-0, IP55 (for IP55 devices)
<b>Ambient temperature</b>	-10 °C to +50 °C
<b>Storage temperature</b>	-40 °C to +60 °C
<b>Tightening torque of terminal strip</b>	0.5 Nm

### 15.2.3 Relay Outputs Option Card

Option Category	Catalog Number	Description	Reference Section
<b>Option Cards</b>			
	IC855-OC-RO	Relay Outputs Option Card for VFD	15.2.3

Where an application requires more relay outputs than that provided by the frequency inverter, the Relay Outputs Option Card may be used.

The Relay Outputs Option Card offers three additional relay outputs.

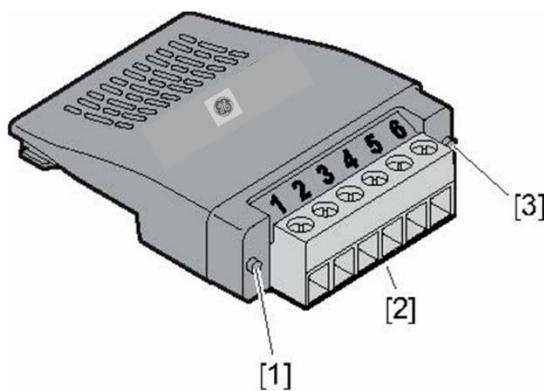


Figure 92: Relay Outputs Option Card



Figure 93: Relay Outputs Option Card Terminal Assignments

- [1] LED A
- [2] Labeling: Cascade Control
- [3] LED B

## Start-Up and Operation

Function and limit settings for the following parameters:

Parameters	Description
P5-15	Expansion relay 3 function selection
P5-16	Relay 3 upper limit 0.0 – <b>100.0</b> – 200.0%
P5-17	Relay 3 lower limit 0.0 – <b>0.0</b> – 200.0%
P5-18	Expansion relay 4 function selection
P5-19	Relay 4 upper limit 0.0 – <b>100.0</b> – 200.0%
P5-20	Relay 4 lower limit 0.0 – <b>0.0</b> – 200.0%

Relay outputs 3 and 4 can be individually programmed according to the parameters specified in the table below. Relay output 5 is permanently set to function 3 motor speed  $\geq 0$ .

Setting	Function	Description
0	Inverter enabled	Relay contacts closed when inverter is enabled.
1	Inverter ok (digital), no error	Relay contacts closed when inverter is ok (no error).
2	Motor operates at setpoint speed (digital)	Relay contacts closed when output frequency = setpoint frequency $\pm 0.1$ Hz.
3	Motor speed $\geq 0$ (digital)	Relay contacts closed when output frequency is greater than "zero frequency" (0.3% of base frequency).
4	Motor speed $\geq$ limit value (digital)	If the output frequency is higher than set in the parameter "upper limit of user relay", the relay is closed. Relay contacts open when the value is smaller than the value set in parameter "User relay lower limit".
5	Motor current $\geq$ limit value (digital)	If the motor current / motor torque is higher than set in the parameter "upper limit of user relay", the relay is closed. Relay contacts open when the value is smaller than the value set in parameter "User relay lower limit".
6	Motor torque $\geq$ limit value (digital)	
7	Analog input 2 $\geq$ limit value (digital)	Relay contacts closed when the value at the second analog input is above the limit value.
8	Fieldbus control	Relay contacts via fieldbus control.
9	STO status	Relay contacts open if STO circuit is open. Inverter indicates "inhibit".
10	PID error $\geq$ limit value	Relay contacts closed when the control error is higher than the user relay upper limit. The relay opens also with negative control errors.



### LEDs

The relay output card has two LEDs, designated as LED A and LED B, per Figure 92.

LED Status A	Description
Lights up green	No fault, card ready for operation.
Flashing green	No connection to the frequency inverter.
Off	No supply voltage.

LED Status B	Description
Off	No function.

PRELIMINARY

## 15.2.4 Digital I/O Option Card

Option Category	Catalog Number	Description	Reference Section
<b>Option Cards</b>			
	IC855-OC-IO	Digital I/O Option Card for VFD	15.2.4

Whenever an application requires more digital inputs/outputs than that which the frequency inverter supplies, the Digital I/O Option Card can be used. The option card provides three additional digital inputs and one additional relay output. The digital inputs can be assigned to various functions in the frequency inverter. In addition, their status can be read by the higher-level controller via process data communication.

The option card digital I/O supports:

- 3 digital inputs/outputs (DIO6, DIO7, DIO8)
- 1 relay output (Relay 3)

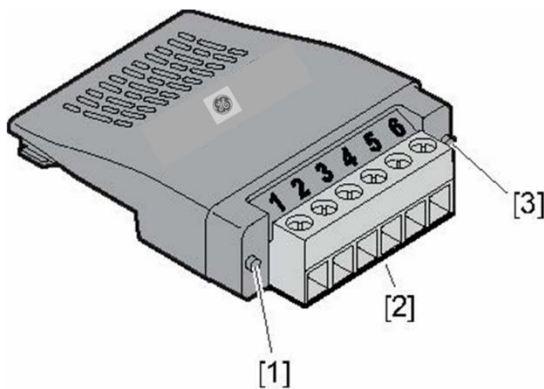


Figure 94: Digital I/O Option Card

- [1] LED A
- [2] Labeling: Digital I/O
- [3] LED B



Figure 95: Digital I/O Option Card Terminal Assignments

### Start-Up and Operation

Function and limit settings for the following parameters:

Parameters	Description
P5-15	Expansion relay 3 function selection
P5-16	Relay 3 upper limit 0.0 – <b>100.0</b> – 200.0%
P5-17	Relay 3 lower limit 0.0 – <b>0.0</b> – 200.0%

Relay 3 can be individually programmed according to the parameters specified in the table below.

Setting	Function	Description
0	Inverter enabled	Relay contacts closed when inverter is enabled.
1	Inverter ok (digital), no error	Relay contacts closed when inverter is ok (no error).
2	Motor operates at setpoint speed (digital)	Relay contacts closed when output frequency = setpoint frequency $\pm$ 0.1 Hz.
3	Motor speed $\geq$ 0 (digital)	Relay contacts closed when output frequency is greater than "zero frequency" (0.3% of base frequency).
4	Motor speed $\geq$ limit value (digital)	If the output frequency is higher than set in the parameter "upper limit of user relay", the relay is closed. Relay contacts open when the value is smaller than the value set in parameter "User relay lower limit".
5	Motor current $\geq$ limit value (digital)	If the motor current / motor torque is higher than set in the parameter "upper limit of user relay", the relay is closed. Relay contacts open when the value is smaller than the value set in parameter "User relay lower limit".
6	Motor torque $\geq$ limit value (digital)	
7	Analog input 2 $\geq$ limit value (digital)	Relay contacts closed when the value at the second analog input is above the limit value.
8	Fieldbus control	Relay contacts via fieldbus control.
9	STO status	Relay contacts open if STO circuit is open. Inverter indicates "inhibit".
10	PID error $\geq$ limit value	Relay contacts closed when the control error is higher than the user relay upper limit. The relay opens also with negative control errors.

The functions of the digital inputs can be individually programmed according to the parameters specified in the following table.

To do so, set parameter *P1-15* to 0. All digital inputs at the frequency inverter are then set to no function and must be defined via parameter group 9.

Parameters	Range of values
P9-01 Enable input source	SAFE, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-02 Rapid stop input source	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-03 Input source for clockwise rotation (CW)	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-04 Input source for counterclockwise rotation (CCW)	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-05 Latch function enable	OFF, ON
P9-06 Direction of rotation reversal	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-07 Reset input source	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-08 External fault input source	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-09 Terminal control enable source	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-10 Speed source 1	Ain-1, Ain-2, preset speed 1--8, d-Pot, PID, Sub-dr, F-bus, user, pulse
P9-11 Speed source 2	Ain-1, Ain-2, preset speed 1--8, d-Pot, PID, Sub-dr, F-bus, user, pulse
P9-12 Speed source 3	Ain-1, Ain-2, preset speed 1--8, d-Pot, PID, Sub-dr, F-bus, user, pulse
P9-13 Speed source 4	Ain-1, Ain-2, preset speed 1--8, d-Pot, PID, Sub-dr, F-bus, user, pulse
P9-14 Speed source 5	Ain-1, Ain-2, preset speed 1--8, d-Pot, PID, Sub-dr, F-bus, user, pulse
P9-15 Speed source 6	Ain-1, Ain-2, preset speed 1--8, d-Pot, PID, Sub-dr, F-bus, user, pulse
P9-16 Speed source 7	Ain-1, Ain-2, preset speed 1--8, d-Pot, PID, Sub-dr, F-bus, user, pulse
P9-17 Speed source 8	Ain-1, Ain-2, preset speed 1--8, d-Pot, PID, Sub-dr, F-bus, user, pulse
P9-18 Speed selection input 0	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-19 Speed selection input 1	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On

Parameters	Range of values
P9-20 Speed selection input 2	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-21 Preset speed selection input 0	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-22 Preset speed selection input 1	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-23 Preset speed selection input 2	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8, On
P9-24 Positive jog mode input	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-25 Negative jog mode input	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-26 Reference travel enable input	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-27 Reference cam input	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-28 Motor potentiometer up input source	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-29 Motor potentiometer down input source	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-30 Speed-limit switch CW	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-31 Speed-limit switch CCW	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-32 Enable second deceleration ramp, rapid stop ramp	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P9-33 Fire mode input selection	OFF, din-1, din-2, din-3, din-4, din-5
P3-34 PID fixed setpoint reference selection input 0	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8
P3-35 PID fixed setpoint reference selection input 1	OFF, din-1, din-2, din-3, din-4, din-5, din-6, din-7, din-8

### LEDs

The option card digital I/O has two LEDs, designated as LED A and LED B, per Figure 94.

LED Status A	Description
Lights up green	No fault, option card ready for operation
Flashing green	No connection to the frequency inverter.
Off	No supply voltage.

LED Status B	Description
Off	No function.

## 15.3 Encoder Option Cards

### 15.3.1 Overview

Option Category	Catalog Number	Description	Reference Section
<b>Option Cards</b>			
	IC855-OC-TTL	Encoder card TTL Option Card for VFD	15.3.3
	IC855-OC-HTL	Encoder card HTL Option Card for VFD	15.3.4

### 15.3.2 Technical Data

<b>Compatible encoders</b>	TTL: 5 V, channel A and B with complement HTL: 30 V, channel A and B with complement <b>Note:</b> The HTL encoder card requires an external 24Vdc power supply.
<b>Minimal and maximal PPR count</b>	TTL/HTL: 512 – 4096
<b>Maximum input frequency</b>	TTL/HTL: 500 kHz
<b>Maximum input voltage</b>	TTL: DC 5.5 V HTL: 30Vdc
<b>Maximum output voltage/current</b>	TTL: DC 5.5 V, 5.5 V, 200 mA HTL: external voltage supply
<b>Maximum cable length</b>	LTX: 30 m, twisted in pairs, shielded TTL: 100 m, twisted in pairs, shielded HTL: 200 m, twisted in pairs, shielded
<b>Relative humidity</b>	95% (without condensation)
<b>Conformity</b>	IP20, IP55 (for IP55 devices)
<b>Ambient temperature</b>	0 °C to +50 °C
<b>Storage temperature</b>	-20 °C to +60 °C
<b>Dimensions (L × W × H)</b>	52 × 50 × 22 mm
<b>Tightening torque of terminal strip</b>	0.5 Nm

### 15.3.3 TTL Encoder Option Card

Option Category	Catalog Number	Description	Reference Section
Option Cards	IC855-OC-TTL	Encoder card TTL Option Card for VFD	15.3.3

The TTL encoder card serves only to regulate speed control with the frequency inverter and cannot be used for positioning. The TTL encoder card permits detailed speed control under 1 Hz and full torque control from a speed of 0 on.

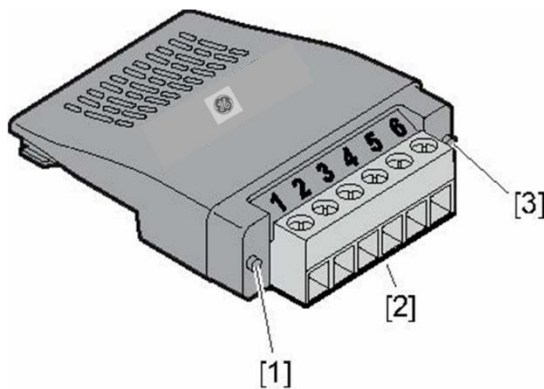


Figure 96: TTL Encoder Option Card Assembly

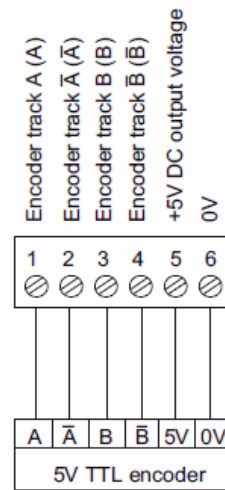


Figure 97: TTL Encoder Wiring Diagram

- [1] LED A
- [2] Labeling: Line Encoder
- [3] LED B

### Start-Up and Operation

Use shielded encoder cables only, both cable ends must be grounded over a large surface area. Adhere to the technical data.

To ensure fault-free operation of the encoder card, the following parameters must be correctly set:

- *P1-09* Rated motor frequency
- *P1-10* Nominal motor speed
- *P6-06* PPR count

Note the correct direction of rotation when wiring motor cable and encoder cable.

- Perform a start-up for asynchronous motors with VFC speed control, according to the operating instructions "PACMotion Drive". Start the automatic measuring procedure via *P4-02*.
- Check the correct direction of rotation, by testing the value *P0-58* at slow speed in clockwise rotation (2 – 5 Hz). The parameter should show a positive value. If this is not the case, turn the A and B track of the encoder.
- Set the parameter *P6-05* "Active encoder feedback" to "1".

### LEDs

The TTL encoder card has two LEDs, designated as LED A and LED B, per Figure 96.

#### LED A

Status	Description
Lights up green	No fault, card ready for operation.
Off	No supply voltage.

#### LED B

Status	Description
Constant red	The error will be shown on the display of the frequency inverter
Flashing red	Card error, wrong cabling
Off	Encoder OK



### 15.3.4 HTL Encoder Option Card

Option Category	Catalog Number	Description	Reference Section
Option Cards	IC855-OC-HTL	Encoder card HTL Option Card for VFD	15.3.4

The HTL encoder card serves only to regulate speed control with the frequency inverter and cannot be used for positioning. The HTL encoder card permits detailed speed control under 1 Hz and full torque control from a speed of 0 on.

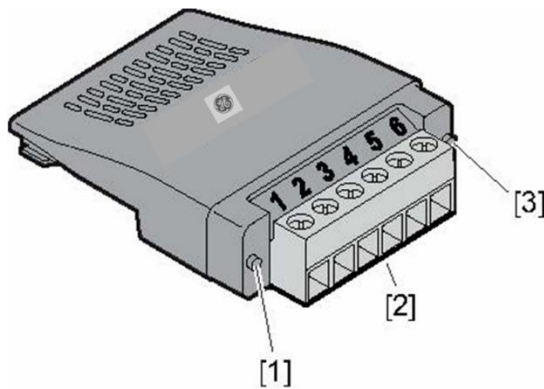


Figure 98: HTL Encoder Option Card Assembly

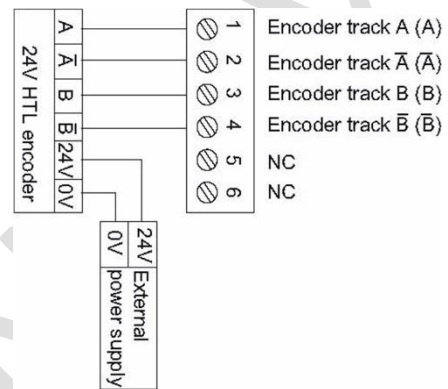


Figure 99: HTL Encoder Wiring Diagram

- [1] LED A
- [2] Labeling: Line Encoder
- [3] LED B

### Start-Up and Operation

Use shielded encoder cables only, both cable ends must be grounded over a large surface area. Adhere to the technical data.

To ensure fault-free operation of the encoder card, the following parameters must be correctly set:

- *P1-09* Rated motor frequency
- *P1-10* Nominal motor speed
- *P6-06* PPR count

Note the correct direction of rotation when wiring motor cable and encoder cable.

- Perform a start-up for asynchronous motors with VFC speed control, according to the operating instructions "PACMotion Drive". Start the automatic measuring procedure via *P4-02*.
- Check the correct direction of rotation, by testing the value *P0-58* at slow speed in clockwise rotation (2 – 5 Hz). The parameter should show a positive value. If this is not the case, turn the A and B track of the encoder.
- Set the parameter *P6-05* "Active encoder feedback" to "1".

### LEDs

The HTL encoder card has two LEDs, designated as LED A and LED B, per Figure 98.

#### LED A

Status	Description
Lights up green	No fault, card ready for operation.
Off	No supply voltage.

#### LED B

Status	Description
Constant red	The error will be shown on the display of the frequency inverter
Flashing red	Card error, wrong cabling
Off	Encoder OK

### 15.3.5 Errors and Status Codes

Refer to Section 8.4, *Error Codes*.

## 15.4 Fieldbus Option Cards

### 15.4.1 Overview

The option cards listed below are available at time of publication. Additional option cards will be introduced subsequently. Please refer to the most recent edition of this document for an up-to-date listing of available option cards.

Option Category	Catalog Number	Description	Reference Section
<b>Option Cards</b>			
	IC855-OC-B	Profibus Option Card for VFD	15.4.4
	IC855-OC-P	PROFINET Option Card for VFD	15.4.5

### 15.4.2 Technical Data

<b>Ambient temperature during operation</b>	-40 °C (no hoarfrost) to +70 °C
<b>Storage temperature</b>	-40 °C to +85 °C
<b>Relative humidity</b>	5% to 95%, without condensation
<b>Conformity</b>	IP20, IP55 (select models), IP66 (select models), RoHS, UL
<b>Voltage supply via backplane</b>	3.3 ±0.15 Vdc
<b>Power consumption</b>	<500 mA
<b>Network interface</b>	galvanically isolated
<b>Dimensions (L × W × H)</b>	52 × 50 × 22 mm
<b>Tightening torque of terminal strip</b>	0.5 Nm

For bus-specific technical data, refer to the respective section.

### 15.4.3 General Information

The respective option cards offer the following functionality:

- Cyclic process data exchange
- 4 Process Input Words (Refer to Section 9.1.1, [Structure and Settings of Process Data Words](#))
- 4 Process Output Words (Refer to Section 9.1.1, [Structure and Settings of Process Data Words](#))

**Note:** Whenever a fieldbus option card is installed, the Modbus RTU is no longer available via the RJ45 bushing at the frequency inverter.

### 15.4.4 PROFIBUS DP Option Card

Option Category	Catalog Number	Description	Reference Section
Option Cards	IC855-OC-B	Profibus Option Card for VFD	15.4.4

The PROFIBUS DP option card permits the PACMotion Drive to connect to a PROFIBUS DP network.

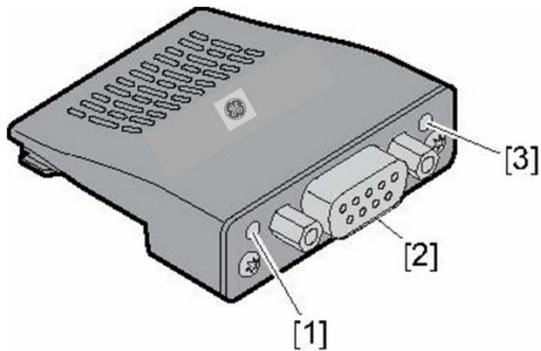


Figure 100: PROFIBUS DP Option Card

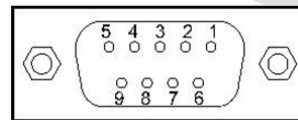


Figure 101: Pinout for PROFIBUS DP Option Card

[1]	LED A	1	N/C
[2]	Labeling: PROFIBUS DP	2	N/C
[3]	LED B	3	Receiving/sending data P RxD/TxD-P (not B/B)
		4	Repeater control signal (TTL) CNTR-P
		5	Data reference potential (5 Vdc) DGND
		6	Data reference potential (5 Vdc) insulated and short-circuit protection
		7	N/C
		8	Receiving/sending data P RxD/TxD-P (not A/A)
		9	N/C

#### Bus Specific Technical Data

<b>Automatic baud rate detection</b>	9.6 – 12 Mbaud
<b>Connection technology</b>	9-pin D-sub connector
<b>Bus termination</b>	Not integrated, implement using suitable PROFIBUS connector with terminating resistors that can be switched on
<b>Tightening torque of the connecting terminal</b>	0.5 Nm

## Start-Up and Operation

	<b>PROFIBUS DP</b>
Parameter setting	<i>P1-12</i> = 7 (Fieldbus) <i>P1-14</i> = 101 (Extended parameter description)
Address	<i>P5-01</i> = frequency inverter address
General station description	The GSDML file can be downloaded from the GE Automation & Controls support website <a href="http://www.geautomation.com/support">www.geautomation.com/support</a> .
DP ident number	6003
Bus structure and bus termination	Connect the PROFIBUS DP units according to applicable regulations. If the PACMotion Drive is situated at the beginning or end of a PROFIBUS segment, and if only one PROFIBUS cable leads to the PROFIBUS card, terminate the bus at this node by installing a PROFIBUS connector with integrated bus terminating resistor

### LEDs

The PROFIBUS DP option card has two LEDs, designated per Figure 100 as:

- OP for Operating mode and
- ST for Status.

### Operating Mode LED

<b>Status</b>	<b>Explanation</b>
Off	No supply voltage available.
Lights up green	Connection established, communication available.
Flashing green	Connection established, communication not available
Flashing red, 1 ×	Parameterization error in DP master
Flashing red, 2 ×	Network error

### Status LED

<b>Status</b>	<b>Explanation</b>
Off	No supply voltage available.
Lights up green	Initialization
Flashing green	Initialization, self test
Lights up red	Fault.

### 15.4.5 PROFINET IO Option Card

Option Category	Catalog Number	Description	Reference Section
<b>Option Cards</b>			

IC855-OC-P	PROFINET Option Card for VFD	15.4.5
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The PROFINET IO option card permits the PACMotion Drive to connect to a PROFINET network.

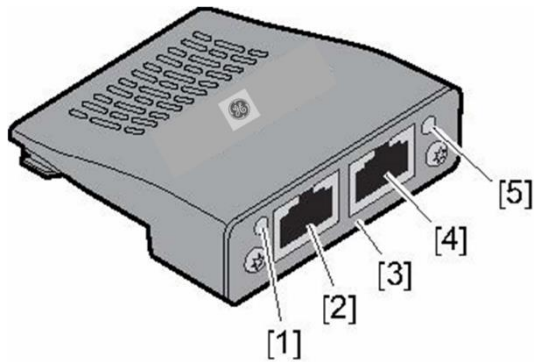


Figure 102: PROFINET IO Option Card

[1]	LED: NS	[A]	LED: Activity
[2]	RJ45: P1	[B]	LED: Link
[3]	Labeling: PROFINET IO		
[4]	RJ45: P2		
[5]	LED: MS		

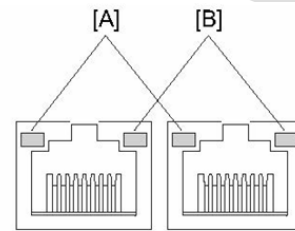


Figure 103: RJ45 Connectors & Network Activity LEDs, PROFINET IO Option Card

#### Bus Specific Technical Data

<b>Baud rate</b>	10/100 Mbaud in full duplex mode
<b>Connection technology</b>	2 × RJ45

**Start-Up and Operation**

	<b>PROFINET IO</b>
<b>Parameter setting</b>	<i>P1-12</i> = 7 (Fieldbus) <i>P1-14</i> = 101 (Extended parameter description)
<b>PROFINET device name</b>	The PROFINET device name can be assigned using PME. The PROFINET device name is saved on the option card.
<b>IP address</b>	The basic setting of the option card is the DHC protocol. To establish communication with the network, set the IP address using the "Anybus IPconfig" software. The freeware is available at <a href="http://www.anybus.com">www.anybus.com</a> .
<b>General station description</b>	The GSDML file may be downloaded from the GE Automation & Controls support website <a href="http://www.geautomation.com/support">www.geautomation.com/support</a> .
<b>Bus structure</b>	You can use the integrated Ethernet switch to achieve line topologies known from the fieldbus technology. Other bus topologies, such as star or tree, are also possible. Ring topologies are not supported.

## LEDs

The PROFINET IO option card has two LEDs, designated per Figure 102 as:

- NS for Network Status and
- MS for Module Status.

### Network Status LED

Status	Explanation
Off	No supply voltage available.
Lights up green	Connection established, communication available
Flashing green	Connection established, communication not available.

### Module Status LED

Status	Explanation
Off	No supply voltage available.
Lights up green	Normal operation.
Flashing green, 1 ×	Diagnostic result available.
Flashing green, 2 ×	Network node identification.
Lights up red	Fault.
Flashing red, 1 ×	The hardware configuration differs from the existing configuration.
Flashing red, 2 ×	The IP address has not been assigned correctly.
Flashing red, 3 ×	PROFINET device name has not been assigned.
Flashing red, 4 ×	An internal error has occurred.

## 15.4.6 Errors and Status Codes

Refer to Section 8.4, *Error Codes*.





# Chapter 16 Cable Sets

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The following cable sets are available:

Option Category	Catalog Number	Description
<b>Cable Sets</b>		
	IC855-CABL-B-5	Connect Multiple VFDs 0.5m
	IC855-CABL-B-10	Connect Multiple VFDs 1m
	IC855-CABL-SPLIT	RJ Cable Splitter
	IC855-CABL-PC	Connect RJ Adapter to PC
	IC855-CABL-USB485	USB 2.0 to RS485 Adapter 1.5m (for PC)

## 16.1 Cable Set B: Drive Interconnect Cabling

Cable Set B is used to interconnect multiple frequency inverters on the network.

Note that the final connection on the network requires a terminating resistor. This is provided as part number IC855-CABL-TR.

Cable set B also contains a heat shrink tubing for insulation of the cable splitter.

Part Number	Quantity	Description	Length
IC855-CABL-B-5	1	RJ45 to RJ45 cable	0.5 m
	1	Cable splitter	-
IC855-CABL-B-10	1	RJ45 to RJ45 cable	1 m
	1	Cable splitter	-

### 16.1.1 Daisy Chain Example

The following example shows the first drive connected to an RS-485 device, then each subsequent drive interconnected via Cable Set B. The connector containing the terminating resistor is installed in the unused connector attached to VFD#n, the drive furthest away from the network starting location.

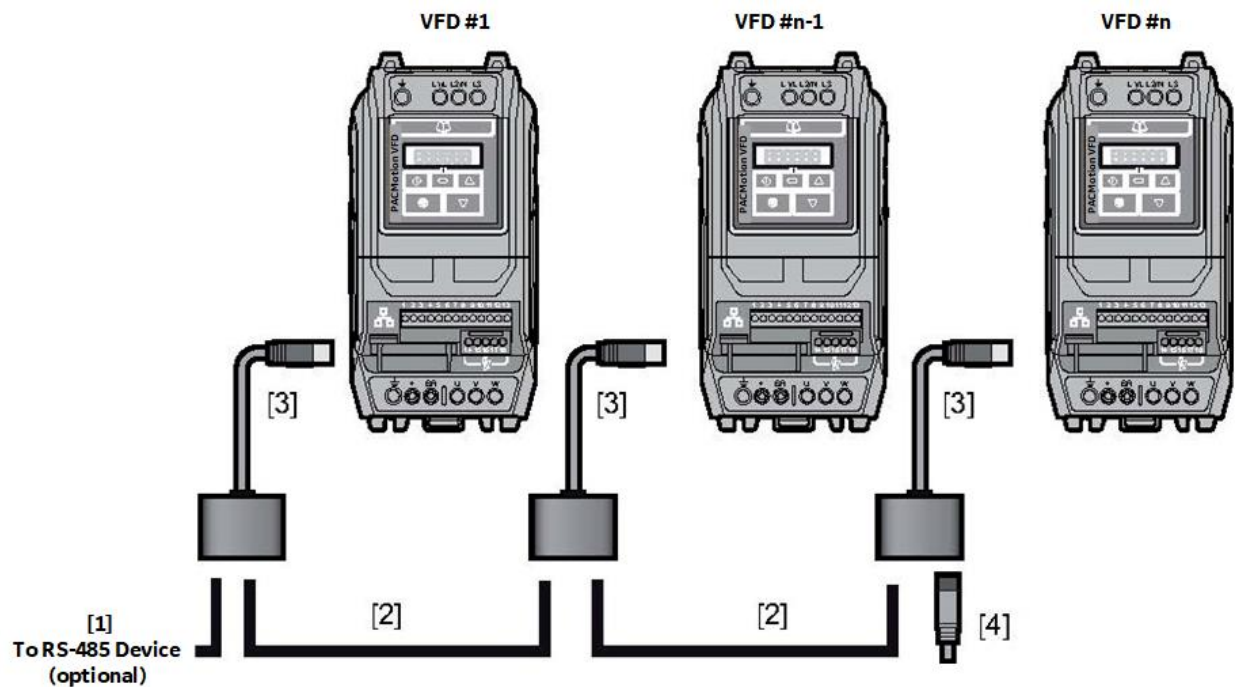


Figure 104: VFDs Connected over RS-485

- [1] Typically USB to RS-485 adaptor when connected to a PC (IC855-CABL-USB485)
- [2] RJ45 to RJ45 cable:  
Select IC855-CABL-B-5 or IC855-CABL-B-10
- [3] Cable splitter: A component of IC855-CABL-B-5 or IC855-CABL-B-10.  
May be ordered separately as IC855-CABL-SPLIT.
- [4] Terminating connector (120 Ω)

16.1.2 Master-Slave Example

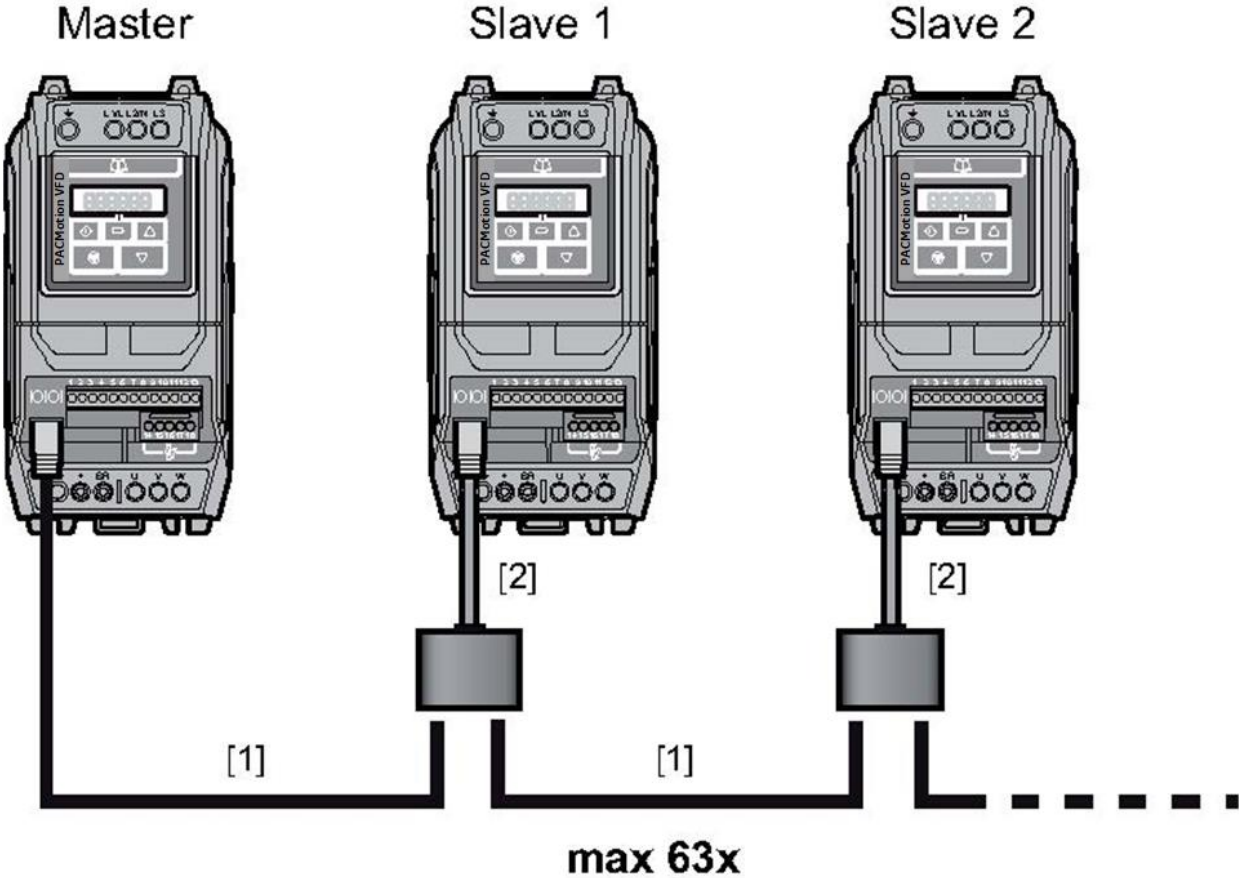


Figure 105: Master-Slave Drive Interconnect

- [1]RJ45 to RJ45 cable: Select IC855-CABL-B-5 or IC855-CABL-B-10
- [2]Cable splitter      A component of IC855-CABL-B-5 or IC855-CABL-B-10. May be ordered separately as IC855-CABL-SPLIT.

## 16.2 Connection to PC using USB to RS-485 Adapter

The IC855-CBL-USB485 is an adapter which provides electrical isolation between the PC and the drive. Refer to Figure 46. Connect the USB end to the PC (USB 2.0 interface required) and connect the jack to the drive.

Part Number	Quantity	Description	Length
IC855-CBL-USB485	1	USB 2.0 to RS485 Adapter	1.5m

PRELIMINARY

## Chapter 17 Braking Resistors

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Braking resistors are used to dissipate energy that is transferred from the motor to the drive during regeneration – for example when stopping or slowing down high inertia loads. Braking resistors are suitable for light duty braking (5%), without high repeat cycle times. For applications which require high braking power or frequent repeated usage, alternative resistors should be used.

Braking resistors may be mounted internally or externally.

### 17.1 Internal Braking Resistors

GE offers one braking resistor: IC855-BW100-002. This is compatible with Size 2 or 3 IP20 enclosures.

#### 17.1.1 Important Safety Information

Internal braking resistors are specifically designed to be used with the PACMotion variable speed drive product range and are intended for professional incorporation into complete equipment or systems. If installed incorrectly they may present a safety hazard.

PACMotion drives use high voltages and currents, carry high levels of stored electrical energy, and are typically used to control mechanical equipment that may cause injury. Close attention is required to system design and electrical installation to avoid hazards in either normal operation or in the event of equipment malfunction. PACMotion Drives and the Options should be installed by qualified electrical persons only and in accordance with local and national regulations and codes of practice.



#### Warning

Danger of electric shock.

The supply cables to the braking resistors carry a high voltage (approx. 900Vdc) during rated operation.

- Severe or fatal injuries may result.
- Before removing the supply cable, disconnect the inverter from the power supply and wait at least 10 minutes.



#### Warning

Risk of burns. The surfaces of the braking resistors get very hot when the braking resistors are loaded with  $P_N$ .

- Minor to significant injuries may result.
  - Choose a suitable installation location.
  - Do not touch the braking resistors.
  - Install a suitable touch guard.
- 

It is the responsibility of the installer to ensure that the equipment or system into which the product is incorporated complies with the EMC legislation of the country of use. Within the European Union, equipment into which this product is incorporated must comply with 2004/108/EC, Electromagnetic Compatibility. Within the European Union, all machinery in which this product is used must comply with the Directive 98/37/EC, Safety of Machinery. In particular, the equipment should comply with EN60204-1. The manufacturer accepts no liability for any consequences resulting from inappropriate, negligent or incorrect installation. The contents of this User Guide are believed to be correct at the time of printing. In the interests of a commitment to a policy of continuous improvement, the manufacturer reserves the right to change the specification of the product or its performance or the contents of the User Guide without notice.

### 17.1.2 Specifications

Catalog Number	Drive Size	Resistance	Rated Voltage	Rated Power (W)		L (mm)	H (mm)	W (mm)
				Cont.	Peak			
IC855-BW100-002	2,3	100 Ω	900 Vdc	200	12,000	188	40	9

### 17.1.3 Mounting Instructions

Mount the IC855-BW100-002 braking resistor to the drive heatsink. The rated power capacity shown above can only be achieved if the resistor is mounted in this manner. Slide the braking resistor into position via the rearmost slot at the bottom of the drive (Figure 106). The flat face of the resistor must face the front of the drive. The braking resistor can then be held in place, using two supplied screws inserted into the threaded holes marked "A" (Figure 107).

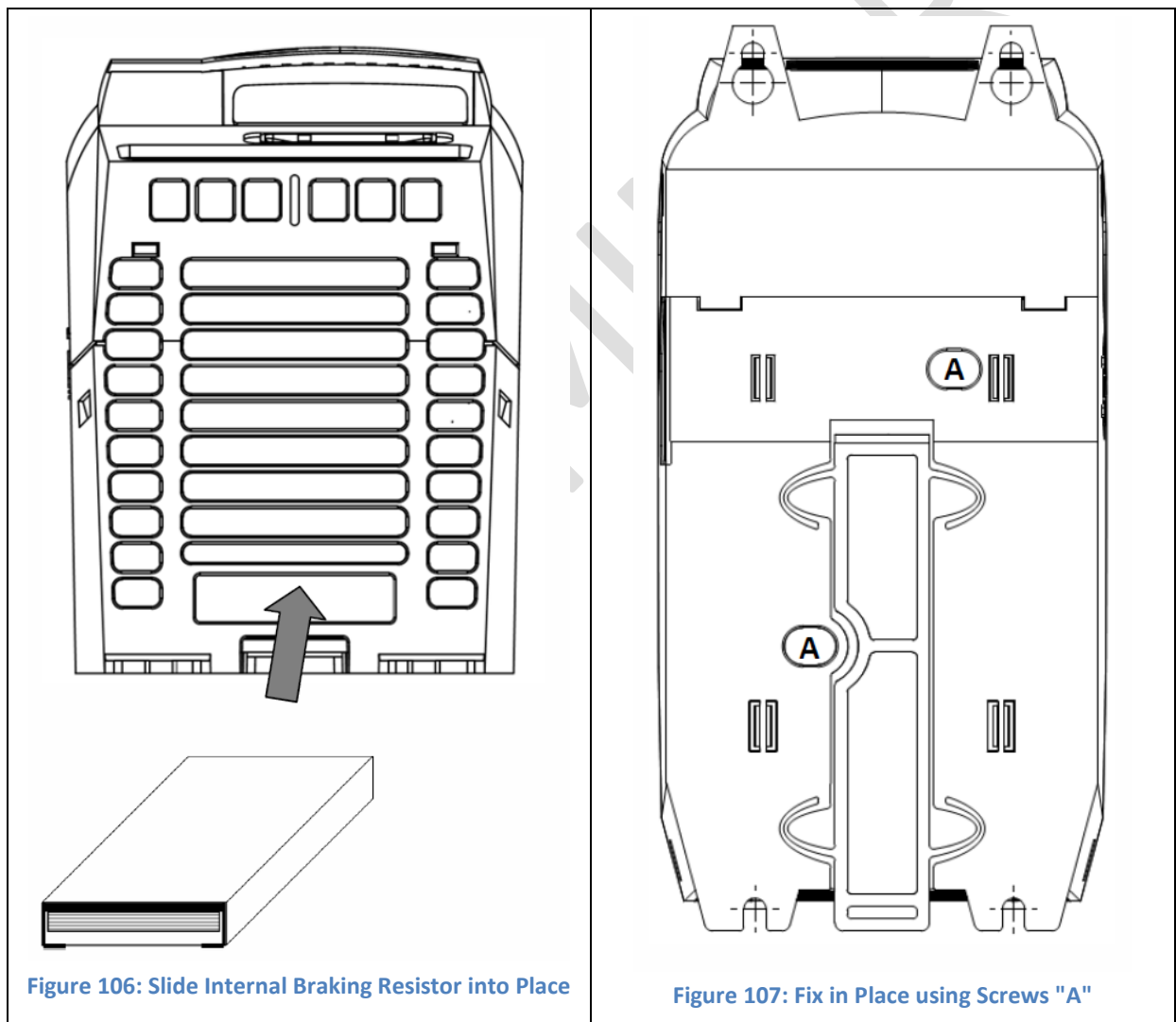


Figure 106: Slide Internal Braking Resistor into Place

Figure 107: Fix in Place using Screws "A"

## 17.2 External Braking Resistors

External braking resistors are available from third-party manufacturers. Refer to Section 5.4.10.

## 17.3 Electrical Installation

The braking resistor (both internal and external) connects to the terminals marked “+” or “DC+” and “BR”. Refer to Figure 14.

### 17.3.1 Activating the Braking Resistor

The braking resistor is activated as follows:

- 1) Enable the brake circuit by setting P1-05 = 2.
- 2) If using non-standard resistors (those not supplied by GE), it is necessary to enter the correct data for the resistor into parameters as follows:
  - a. Select Advanced Parameter Access by setting P1-14 = 201
  - b. Enter the resistance of the connected resistor into parameter P6-19
  - c. Enter the power rating of the connected resistor into P6-20

**Note:** Only those braking resistors designated as Internal Braking Resistors should be mounted inside the drive.





## ***Chapter 18 Declaration of Conformity***

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Declarations of Conformity may be downloaded from the GE Automation and Controls web-site [www.geautomation.com/support](http://www.geautomation.com/support).

PRELIMINARY



## Appendix A VFD Product Matrix

Catalog Number	Motor Power (kW / HP)	Voltage	Interference Suppression	Connection Type	Design	Nominal Output Current (A)	IP20 Size (WxHxD)	IP55/IP66 Size (WxHxD)
IC855-0008-2B1-XX	0.75 / 1	2 = 200-240V	B = Class C1	1 = 1-phase	2 = IP20 6 = IP66	4.3	4.3x8.7x7.3 in 110x221x185 mm	7.4x10.1x9.4 in 188x257x239 mm
IC855-0015-2B1-XX	1.5 / 2					7		
IC855-0022-2B1-XX	2.2 / 3					10.5		
IC855-0008-2A3-XX	0.75 / 1					4.3		
IC855-0015-2A3-XX	1.5 / 2					7		
IC855-0022-2A3-XX	2.2 / 3					10.5		
IC855-0030-2A3-XX	3 / 4		14	A = Class C2	3 = 3-phase	5 = IP55	5.2x10.3x8.1 in 131x261x205 mm	8.3x12.2x10.6 in 211x310x270 mm
IC855-0040-2A3-XX	4 / 5		18					
IC855-0055-2A3-XX	5.5 / 7.5		24					
IC855-0075-2A3-XX	7.5 / 10		39					
IC855-0110-2A3-XX	11 / 15		46					
IC855-0150-2A3-XX	15 / 20		61					
IC855-0185-2A3-XX	18.5 / 25		72				9.3x21.3x10.6 in 235x540x268 mm	
IC855-0220-2A3-XX	22 / 30		90					
IC855-0300-2A3-XX	30 / 40		110					13x34.1x13.2 in 330x865x335 mm
IC855-0370-2A3-XX	37 / 50		150					
IC855-0450-2A3-XX	45 / 60		180					
IC855-0550-2A3-XX	55 / 75		202					
IC855-0750-2A3-XX	75 / 100	248	13x50.4x14.4 in 330x1280x365 mm					
IC855-0900-2A3-XX	90 / 120	302						

Catalog Number	Motor Power (kW / HP)	Voltage	Interference Suppression	Connection Type	Design	Nominal Output Current (A)	IP20 Size (WxHxD)	IP55/IP66 Size (WxHxD)
IC855-0008-4A3-XX	0.75 / 1	4 = 380-480V	A = Class C2	3 = 3-phase	2 = IP20 6 = IP66	2.2	4.3x8.7x7.3 in 110x221x185 mm	7.4x10.1x9.4 in 188x257x239 mm
IC855-0015-4A3-XX	1.5 / 2					4.1		
IC855-0022-4A3-XX	2.2 / 3					5.8		
IC855-0040-4A3-XX	4 / 5					9.5		
IC855-0055-4A3-XX	5.5 / 7.5					14		
IC855-0075-4A3-XX	7.5 / 10					18		
IC855-0110-4A3-XX	11 / 15				5.2x10.3x8.1 in 131x261x205 mm	8.3x12.2x10.6 in 211x310x270 mm	5 = IP55	24
IC855-0150-4A3-XX	15 / 20							30
IC855-0185-4A3-XX	18.5 / 25							39
IC855-0220-4A3-XX	22 / 30							46
IC855-0300-4A3-XX	30 / 40							61
IC855-0370-4A3-XX	37 / 50							72
IC855-0450-4A3-XX	45 / 60				13x34.1x13.2 in 330x865x335 mm	9.3x21.3x10.6 in 235x540x268 mm	5 = IP55	90
IC855-0550-4A3-XX	55 / 75							110
IC855-0750-4A3-XX	75 / 100							150
IC855-0900-4A3-XX	90 / 120							180
IC855-1100-4A3-XX	110 / 150							202
IC855-1320-4A3-XX	132 / 175							240
IC855-1600-4A3-XX	160 / 210				13x50.4x14.4 in 330x1280x365 mm	18.9x39.6x18.9 in 480x1005x480 mm	2 = IP20	302
IC855-2000-4A3-XX <sup>23</sup>	200 / 300							370
IC855-2500-4A3-XX <sup>23</sup>	250 / 350	450						

<sup>23</sup> External Braking Resistor Required.

Catalog Number	Motor Power (kW / HP)	Voltage	Interference Suppression	Connection Type	Design	Nominal Output Current (A)	IP20 Size (WxHxD)	IP55/IP66 Size (WxHxD)
IC855-0008-603-XX	0.75 / 1	6 = 500-600V	0 = Class 0	3 = 3-phase	2 = IP20 6 = IP66	2.1	4.3x8.7x7.3 in 110x221x185 mm	7.4x10.1x9.4 in 188x257x239 mm
IC855-0015-603-XX	1.5 / 2					3.1		
IC855-0022-603-XX	2.2 / 3					4.1		
IC855-0040-603-XX	4 / 5					6.5		
IC855-0055-603-XX	5.5 / 7.5					9		
IC855-0075-603-XX	7.5 / 10					12		
IC855-0110-603-XX	11 / 15				5.2x10.3x8.1 in 131x261x205 mm	8.3x12.2x10.6 in 211x310x270 mm		
IC855-0150-603-XX	15 / 20						17	
IC855-0185-603-XX	18.5 / 25						22	
IC855-0220-603-XX	22 / 30						28	
IC855-0300-603-XX	30 / 40						34	
IC855-0370-603-XX	37 / 50						43	
IC855-0450-603-XX	45 / 60				6.7x17.7x9.3 in 171x450x235 mm	9.3x21.3x10.6 in 235x540x268 mm		
IC855-0550-603-XX	55 / 75						54	
IC855-0750-603-XX	75 / 100						65	
IC855-0900-603-XX	90 / 120						78	
IC855-1100-603-XX	110 / 150						105	
							130	
		150	13x34.1x13.2 in 330x865x335 mm					

## A-1 PACMotion Inverters by Catalog Number

Part Number	Description
IC855-0008-2A3-20	VFD 1HP 240V 3PH IP20 NO CARD
IC855-0008-2A3-2P	VFD 1HP 240V 3PH IP20 PROFINET
IC855-0008-2A3-60	VFD 1HP 240V 3PH IP66 NO CARD
IC855-0008-2A3-6P	VFD 1HP 240V 3PH IP66 PROFINET
IC855-0008-2B1-20	VFD 1HP 240V 1PH IP20 NO CARD
IC855-0008-2B1-2P	VFD 1HP 240V 1PH IP20 PROFINET
IC855-0008-2B1-60	VFD 1HP 240V 1PH IP66 NO CARD
IC855-0008-2B1-6P	VFD 1HP 240V 1PH IP66 PROFINET
IC855-0008-4A3-20	VFD 1HP 480V 3PH IP20 NO CARD
IC855-0008-4A3-2P	VFD 1HP 480V 3PH IP20 PROFINET
IC855-0008-4A3-60	VFD 1HP 480V 3PH IP66 NO CARD
IC855-0008-4A3-6P	VFD 1HP 480V 3PH IP66 NO CARD
IC855-0008-603-20	VFD 1HP 575V 3PH IP20 NO CARD
IC855-0008-603-2P	VFD 1HP 575V 3PH IP20 PROFINET
IC855-0008-603-60	VFD 1HP 575V 3PH IP66 NO CARD
IC855-0008-603-6P	VFD 1HP 575V 3PH IP66 PROFINET
IC855-0015-2A3-20	VFD 2HP 240V 3PH IP20 NO CARD
IC855-0015-2A3-2P	VFD 2HP 240V 3PH IP20 PROFINET
IC855-0015-2A3-60	VFD 2HP 240V 3PH IP66 NO CARD
IC855-0015-2A3-6P	VFD 2HP 240V 3PH IP66 PROFINET
IC855-0015-2B1-20	VFD 2HP 240V 1PH IP20 NO CARD
IC855-0015-2B1-2P	VFD 2HP 240V 1PH IP20 PROFINET
IC855-0015-2B1-60	VFD 2HP 240V 1PH IP66 NO CARD
IC855-0015-2B1-6P	VFD 2HP 240V 1PH IP66 PROFINET
IC855-0015-4A3-20	VFD 2HP 480V 3PH IP20 NO CARD
IC855-0015-4A3-2P	VFD 2HP 480V 3PH IP20 PROFINET
IC855-0015-4A3-60	VFD 2HP 480V 3PH IP66 NO CARD
IC855-0015-4A3-6P	VFD 2HP 480V 3PH IP66 PROFINET
IC855-0015-603-20	VFD 2HP 575V 3PH IP20 NO CARD
IC855-0015-603-2P	VFD 2HP 575V 3PH IP20 PROFINET
IC855-0015-603-60	VFD 2HP 575V 3PH IP66 NO CARD
IC855-0015-603-6P	VFD 2HP 575V 3PH IP66 PROFINET
IC855-0022-2A3-20	VFD 3HP 240V 3PH IP20 NO CARD
IC855-0022-2A3-2P	VFD 3HP 240V 3PH IP20 PROFINET
IC855-0022-2A3-60	VFD 3HP 240V 3PH IP66 NO CARD
IC855-0022-2A3-6P	VFD 3HP 240V 3PH IP66 PROFINET
IC855-0022-2B1-20	VFD 3HP 240V 1PH IP20 NO CARD
IC855-0022-2B1-2P	VFD 3HP 240V 1PH IP20 PROFINET

Part Number	Description
IC855-0022-2B1-60	VFD 3HP 240V 1PH IP66 NO CARD
IC855-0022-2B1-6P	VFD 3HP 240V 1PH IP66 PROFINET
IC855-0022-4A3-20	VFD 3HP 480V 3PH IP20 NO CARD
IC855-0022-4A3-2P	VFD 3HP 480V 3PH IP20 PROFINET
IC855-0022-4A3-60	VFD 3HP 480V 3PH IP66 NO CARD
IC855-0022-4A3-6P	VFD 3HP 480V 3PH IP66 PROFINET
IC855-0022-603-20	VFD 3HP 575V 3PH IP20 NO CARD
IC855-0022-603-2P	VFD 3HP 575V 3PH IP20 PROFINET
IC855-0022-603-60	VFD 3HP 575V 3PH IP66 NO CARD
IC855-0022-603-6P	VFD 3HP 575V 3PH IP66 PROFINET
IC855-0030-2A3-20	VFD 4HP 240V 3PH IP20 NO CARD
IC855-0030-2A3-2P	VFD 4HP 240V 3PH IP20 PROFINET
IC855-0030-2A3-60	VFD 4HP 240V 3PH IP66 NO CARD
IC855-0030-2A3-6P	VFD 4HP 240V 3PH IP66 PROFINET
IC855-0040-2A3-20	VFD 5HP 240V 3PH IP20 NO CARD
IC855-0040-2A3-2P	VFD 5HP 240V 3PH IP20 PROFINET
IC855-0040-2A3-60	VFD 5HP 240V 3PH IP66 NO CARD
IC855-0040-2A3-6P	VFD 5HP 240V 3PH IP66 PROFINET
IC855-0040-4A3-20	VFD 5HP 480V 3PH IP20 NO CARD
IC855-0040-4A3-2P	VFD 5HP 480V 3PH IP20 PROFINET
IC855-0040-4A3-60	VFD 5HP 480V 3PH IP66 NO CARD
IC855-0040-4A3-6P	VFD 5HP 480V 3PH IP66 PROFINET
IC855-0040-603-20	VFD 5HP 575V 3PH IP20 NO CARD
IC855-0040-603-2P	VFD 5HP 575V 3PH IP20 PROFINET
IC855-0040-603-60	VFD 5HP 575V 3PH IP66 NO CARD
IC855-0040-603-6P	VFD 5HP 575V 3PH IP66 PROFINET
IC855-0055-2A3-20	VFD 7.5HP 240V 3PH IP20 NO CARD
IC855-0055-2A3-2P	VFD 7.5HP 240V 3PH IP20 PROFINET
IC855-0055-2A3-50	VFD 7.5HP 240V 3PH IP55 NO CARD
IC855-0055-2A3-5P	VFD 7.5HP 240V 3PH IP55 PROFINET
IC855-0055-4A3-20	VFD 7.5HP 480V 3PH IP20 NO CARD
IC855-0055-4A3-2P	VFD 7.5HP 480V 3PH IP20 PROFINET
IC855-0055-4A3-60	VFD 7.5HP 480V 3PH IP66 NO CARD
IC855-0055-4A3-6P	VFD 7.5HP 480V 3PH IP66 PROFINET
IC855-0055-603-20	VFD 7.5HP 575V 3PH IP20 NO CARD
IC855-0055-603-2P	VFD 7.5HP 575V 3PH IP20 PROFINET
IC855-0055-603-60	VFD 7.5HP 575V 3PH IP66 NO CARD
IC855-0055-603-6P	VFD 7.5HP 575V 3PH IP66 PROFINET
IC855-0075-2A3-50	VFD 10HP 240V 3PH IP55 NO CARD
IC855-0075-2A3-5P	VFD 10HP 240V 3PH IP55 PROFINET



Appendix A. VFD Product Matrix

Part Number	Description
IC855-0075-4A3-20	VFD 10HP 480V 3PH IP20 NO CARD
IC855-0075-4A3-2P	VFD 10HP 480V 3PH IP20 PROFINET
IC855-0075-4A3-60	VFD 10HP 480V 3PH IP66 NO CARD
IC855-0075-4A3-6P	VFD 10HP 480V 3PH IP66 PROFINET
IC855-0075-603-20	VFD 10HP 575V 3PH IP20 NO CARD
IC855-0075-603-2P	VFD 10HP 575V 3PH IP20 PROFINET
IC855-0075-603-60	VFD 10HP 575V 3PH IP66 NO CARD
IC855-0075-603-6P	VFD 10HP 575V 3PH IP66 PROFINET
IC855-0110-2A3-50	VFD 15HP 240V 3PH IP55 NO CARD
IC855-0110-2A3-5P	VFD 15HP 240V 3PH IP55 PROFINET
IC855-0110-4A3-20	VFD 15HP 480V 3PH IP20 NO CARD
IC855-0110-4A3-2P	VFD 15HP 480V 3PH IP20 PROFINET
IC855-0110-4A3-60	VFD 15HP 480V 3PH IP55 NO CARD
IC855-0110-4A3-6P	VFD 15HP 480V 3PH IP66 PROFINET
IC855-0110-603-20	VFD 15HP 575V 3PH IP20 NO CARD
IC855-0110-603-2P	VFD 15HP 575V 3PH IP20 PROFINET
IC855-0110-603-60	VFD 15HP 575V 3PH IP66 NO CARD
IC855-0110-603-6P	VFD 15HP 575V 3PH IP66 PROFINET
IC855-0150-2A3-50	VFD 20HP 240V 3PH IP55 NO CARD
IC855-0150-2A3-5P	VFD 20HP 240V 3PH IP55 PROFINET
IC855-0150-4A3-50	VFD 20HP 480V 3PH IP55 NO CARD
IC855-0150-4A3-5P	VFD 20HP 480V 3PH IP55 PROFINET
IC855-0150-603-20	VFD 20HP 575V 3PH IP20 NO CARD
IC855-0150-603-2P	VFD 20HP 575V 3PH IP20 PROFINET
IC855-0150-603-60	VFD 20HP 575V 3PH IP66 NO CARD
IC855-0150-603-6P	VFD 20HP 575V 3PH IP66 PROFINET
IC855-0185-2A3-50	VFD 25HP 240V 3PH IP55 NO CARD
IC855-0185-2A3-5P	VFD 25HP 240V 3PH IP55 PROFINET
IC855-0185-4A3-50	VFD 25HP 480V 3PH IP55 NO CARD
IC855-0185-4A3-5P	VFD 25HP 480V 3PH IP55 PROFINET
IC855-0185-603-50	VFD 25HP 575V 3PH IP55 NO CARD
IC855-0185-603-5P	VFD 25HP 575V 3PH IP55 PROFINET
IC855-0220-2A3-50	VFD 30HP 240V 3PH IP55 NO CARD
IC855-0220-2A3-5P	VFD 30HP 240V 3PH IP55 PROFINET
IC855-0220-4A3-50	VFD 30HP 480V 3PH IP55 NO CARD
IC855-0220-4A3-5P	VFD 30HP 480V 3PH IP55 PROFINET
IC855-0220-603-50	VFD 30HP 575V 3PH IP55 NO CARD
IC855-0220-603-5P	VFD 30HP 575V 3PH IP55 PROFINET
IC855-0300-2A3-50	VFD 40HP 240V 3PH IP55 NO CARD
IC855-0300-2A3-5P	VFD 40HP 240V 3PH IP55 PROFINET

Part Number	Description
IC855-0300-4A3-50	VFD 40HP 480V 3PH IP55 NO CARD
IC855-0300-4A3-5P	VFD 40HP 480V 3PH IP55 PROFINET
IC855-0300-603-50	VFD 40HP 575V 3PH IP55 NO CARD
IC855-0300-603-5P	VFD 40HP 575V 3PH IP55 PROFINET
IC855-0370-2A3-50	VFD 50HP 240V 3PH IP55 NO CARD
IC855-0370-2A3-5P	VFD 50HP 240V 3PH IP55 PROFINET
IC855-0370-4A3-50	VFD 50HP 480V 3PH IP55 NO CARD
IC855-0370-4A3-5P	VFD 50HP 480V 3PH IP55 PROFINET
IC855-0370-603-50	VFD 50HP 575V 3PH IP55 NO CARD
IC855-0370-603-5P	VFD 50HP 575V 3PH IP55 PROFINET
IC855-0450-2A3-50	VFD 60HP 240V 3PH IP55 NO CARD
IC855-0450-2A3-5P	VFD 60HP 240V 3PH IP55 PROFINET
IC855-0450-4A3-50	VFD 60HP 480V 3PH IP55 NO CARD
IC855-0450-4A3-5P	VFD 60HP 480V 3PH IP55 PROFINET
IC855-0450-603-50	VFD 60HP 575V 3PH IP55 NO CARD
IC855-0450-603-5P	VFD 60HP 575V 3PH IP55 PROFINET
IC855-0550-2A3-50	VFD 75HP 240V 3PH IP55 NO CARD
IC855-0550-2A3-5P	VFD 75HP 240V 3PH IP55 PROFINET
IC855-0550-4A3-50	VFD 75HP 480V 3PH IP55 NO CARD
IC855-0550-4A3-5P	VFD 75HP 480V 3PH IP55 PROFINET
IC855-0550-603-50	VFD 75HP 575V 3PH IP55 NO CARD
IC855-0550-603-5P	VFD 75HP 575V 3PH IP55 PROFINET
IC855-0750-2A3-50	VFD 100HP 240V 3PH IP55 NO CARD
IC855-0750-2A3-5P	VFD 100HP 240V 3PH IP55 PROFINET
IC855-0750-4A3-50	VFD 100HP 480V 3PH IP55 NO CARD
IC855-0750-4A3-5P	VFD 100HP 480V 3PH IP55 PROFINET
IC855-0750-603-50	VFD 100HP 575V 3PH IP55 NO CARD
IC855-0750-603-5P	VFD 100HP 575V 3PH IP55 PROFINET
IC855-0900-2A3-50	VFD 120HP 240V 3PH IP55 NO CARD
IC855-0900-2A3-5P	VFD 120HP 240V 3PH IP55 PROFINET
IC855-0900-4A3-50	VFD 120HP 480V 3PH IP55 NO CARD
IC855-0900-4A3-5P	VFD 120HP 480V 3PH IP55 PROFINET
IC855-0900-603-50	VFD 120HP 575V 3PH IP55 NO CARD
IC855-0900-603-5P	VFD 120HP 575V 3PH IP55 PROFINET
IC855-1100-4A3-50	VFD 150HP 480V 3PH IP55 NO CARD
IC855-1100-4A3-5P	VFD 150HP 480V 3PH IP55 PROFINET
IC855-1100-603-50	VFD 150HP 575V 3PH IP55 NO CARD
IC855-1100-603-5P	VFD 150HP 575V 3PH IP55 PROFINET
IC855-1320-4A3-50	VFD 175HP 480V 3PH IP55 NO CARD
IC855-1320-4A3-5P	VFD 175HP 480V 3PH IP55 PROFINET

Appendix A. VFD Product Matrix

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Part Number	Description
IC855-1600-4A3-50	VFD 210HP 480V 3PH IP55 NO CARD
IC855-1600-4A3-5P	VFD 210HP 480V 3PH IP55 PROFINET
IC855-2000-4A3-20	VFD 300HP 480V 3PH IP20 NO CARD
IC855-2000-4A3-2P	VFD 300HP 480V 3PH IP20 PROFINET
IC855-2500-4A3-20	VFD 350HP 480V 3PH IP20 NO CARD
IC855-2500-4A3-2P	VFD 350HP 480V 3PH IP20 PROFINET

PRELIMINARY

## A-2 PACMotion VFD Options

Option Category	Catalog Number	Description
<b>VFD Option</b>		
	IC855-OLED	External OLED Keypad for VFD
<b>Option Cards</b>		
	IC855-OC-RO	Relay Outputs Option Card for VFD
	IC855-OC-IO	Digital I/O Option Card for VFD
	IC855-OC-TTL	Encoder card TTL Option Card for VFD
	IC855-OC-HTL	Encoder card HTL Option Card for VFD
	IC855-OC-B	Profibus Option Card for VFD
	IC855-OC-P	PROFINET Option Card for VFD
<b>Cable Sets</b>		
	IC855-CABL-B-5	Connect Multiple VFDs 0.5m
	IC855-CABL-B-10	Connect Multiple VFDs 1m
	IC855-CABL-SPLIT	RJ Cable Splitter
	IC855-CABL-USB485	USB 2.0 to RS485 Adapter 1.5m (for PC)
	IC855-CABL-TR	RJ45 Terminating Resistor

Option Category	Catalog Number	Description
<b>Braking Resistors</b>	<b>(Internal)</b>	
	IC855-BW100-002	Internal Braking Resistor Size 2 100Ω 200W
<b>Braking Resistors</b>	<b>(External)</b>	
		Supplied by 3 <sup>rd</sup> Party Manufacturers

PRELIMINARY



PRELIMINARY

**GE Automation and Controls  
Information Centers**

**Headquarters:**

1-800-433-2682 or 1-434-978-5100

Global regional phone numbers  
are available on our web site

[www.geautomation.com](http://www.geautomation.com)

**Additional Resources**

For more information, please visit  
our web site:

[www.geautomation.com](http://www.geautomation.com)



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