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Electric Drives and Controls | Hydraulics | Linear Motion and Assembly Technologies | Pneumatics | Service

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Rexroth Frequency Converter Fe

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Instruction Manual

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Title Rexroth Frequency Converter Fe

Type of Documentation Operating Instructions

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Purpose of Documentation This documentation provides information on:

- Mechanical & electrical assembly
- Connection conditions
- Commissioning (trial run)
- Basic equipment data
- Fault causes and troubleshooting

History of Documentation

Edition	Release Date	Notes
DOK-RCON01-FE*********-IB01-EN-P	2007-08-28	Ver 1: Applicable to 0.75 - 7.5 kW
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Validity Unless specified otherwise in the contract, specified data in product description shall be only used for the purpose of this manual. Bosch Rexroth reserves the right to interpretation of the document and viability of products.

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Nederlands **Stel de producten pas in bedrijf nadat u de met het product geleverde documenten en de veiligheidsinformatie volledig gelezen, begrepen en in acht genomen heeft.**

Mocht u niet beschikken over documenten in uw landstaal, kunt u contact opnemen met uw plaatselijke Bosch Rexroth distributiepartner.

Svenska **Använd inte produkterna innan du har läst och förstått den dokumentation och de säkerhetsanvisningar som medföljer produkten, och följ alla anvisningar.**

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Amennyiben a csomagban nem talál az Ön nyelvén írt dokumentumokat, vegye fel a kapcsolatot az illetékes Bosch Rexroth-képviselővel.

Polski **Produkty wolno uruchamiać dopiero po przeczytaniu wszystkich dokumentów dostarczonych wraz z produktem oraz wskazówek dotyczących bezpieczeństwa i ich pełnym zrozumieniu. Wszystkich wskazówek tam zawartych należy przestrzegać.**

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귀하의 모국어로 된 안내서가 배송되지 않았다면 Bosch Rexroth 대리점에

Contents

1 Introduction

1.1 About this Documentation

WARNING

Personal injury and property damage caused by incorrect project planning for applications, machines and installations!

Do not attempt to install or put these products into operation until you have completely read, understood and observed the documents supplied with the product.
If no documents in your language were supplied, please consult your Bosch Rexroth sales partner.

Purpose of Documentation

This documentation provides information on:

- Introduction to Fe drive system
- Help information on selecting parts for Fe drive system

Content of this Documentation

This manual covers:

- Assembly and installation
- Technical data of each component (mainly regarding operation)
- Current, voltage and performance data
- Exterior measurements, weight, etc.
- Allocation of terminals

This manual covers safety instructions, technical data and use of Frequency Converter Fe. The chapters are summarized in the table below:

Chapters:

Chapter	Title	Description
1	Introduction	Overview
2	Safety Instructions for Electric Drives and Controls	Safety cautions
3	Important Directions for Use	
4	Fe Description	Product information (project specific)
5	Delivery and Storage	
6	Type Coding	
7	Frequency Converter Mounting	
8	Installation	
9	Operating Panel	Actual applications (for operators and repairers)
10	Commissioning	
11	Parameter Settings	
12	Fault Indication	
13	Technical Data	
14	Accessories	
15	Additional Information	
16	Communication Protocols	
17	Disposal and Environmental Protection	General Information
18	Service and Support	Service Information
19	Index	

Standards

Technical standards, codes and sheets referred herein are copyrighted, and Rexroth does not provide such documents in this manual.

You may contact an authorized distributor of such documents if necessary.

You may directly contact Bosch Rexroth (Xian) Electric Drives and Controls Co., Ltd. if you are located in China.

Website: Http://www.boschrexroth.com/fe

Feedback

Your experience is important for us to improve products and this manual. We will be pleased to receive your feedback on any mistake or request for variation.

Please send your feedback to:

Bosch Rexroth (Xian) Electric Drives and Controls Co., Ltd.

1.2 Introducing to the Drive System

Drive System

Rexroth Frequency Converter Fe drive system is composed of individual parts (components) for application in different circumstances.

Definition

- FEC: Rexroth Frequency Converter Fe
- FECC: Fe operating panel
- FSWA: Engineering software
- FELR: Fe braking resistor
- FELB: Fe braking unit

2 Safety Instructions for Electric Drives and Controls

2.1 General Information

Using the Safety Instructions and Passing them on to Others

Do not attempt to install or commission this device without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with the device. If you do not have the user documentation for the device, contact your responsible Bosch Rexroth sales representative. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the device. If the device is resold, rented and/or passed on to others in any other form, then these safety instructions must be delivered with the device.

WARNING

Improper use of these devices, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, may result in material damage, bodily harm, electric shock or even death!

- Read these instructions before the initial start-up of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.
- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this device.
- Only assign trained and qualified persons to work with electrical installations.
- Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations and to mark them according to the requirements of safe work practices.

They must have adequate safety equipment and be trained in first aid.

- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as practised in the country of use.
- The devices have been designed for installation in industrial machinery.
- The ambient conditions given in the product documentation must be observed.
- Only use safety-relevant applications that are clearly and explicitly approved in the Project Planning Manual. If this is not the case, they are excluded.
- Safety-relevant are all such applications which can cause danger to persons and material damage.
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.
- The machine and installation manufacturer must make sure that the delivered components are suited for each individual application. Check the information given in this document with regard to the use of the components.
- The machine and installation manufacturer shall also make sure that this application complies with the applicable safety regulations and standards and carry out required measures, modifications and complements.
- Start-up of the delivered components is only permitted after the machine or installation in which they are installed complies with the national standards, safety instructions and application standards.
- Operation is only permitted if the national EMC standards for the application are met.
- The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in national standards.

Technical data, connections and operational conditions are specified in the product documentation and must be followed at all times.

Explanation of Warning Symbols and Degrees of Hazard Seriousness

The safety instructions describe the following degrees of hazard seriousness. The degree of hazard seriousness informs about the consequences resulting from non-compliance with the safety instructions.

Warning symbol with signal word	Degree of hazard seriousness
 **DANGER**	Death or severe bodily harm will occur.
 **WARNING**	Death or severe bodily harm may occur.
 **CAUTION**	Bodily harm or material damage may occur.

2.2 Hazards by Improper Use

DANGER

High electric voltage and high working current! Risk of death or severe bodily injury by electric shock!

DANGER

Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!

CAUTION

Risk of injury by improper handling! Risk of bodily injury by bruising, shearing, cutting, hitting, or improper handling of pressurized lines!

CAUTION

Hot surfaces on device housing! Danger of injury! Danger of burns!

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

WARNING

High electric voltage because of incorrect connection! Risk of death or bodily injury by electric shock!

2.3 Instructions with Regard to Specific Dangers

Protection Against Contact with Electrical Parts

Note: This section only concerns devices and drive components with voltages of more than 50 volts.

Contact with parts conducting voltages above 50 volts can cause personal danger and electric shock. When operating electrical equipment, it is unavoidable that some parts of the devices conduct dangerous voltage.

DANGER

High electrical voltage! Danger to life, electric shock and severe bodily injury!

- Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and repair this equipment.
- Follow general construction and safety regulations when working on electrical power installations.
- Before switching on the device, the equipment grounding conductor must have been non-detachably connected to all electrical equipment in accordance with the connection diagram.
- Do not operate electrical equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.
- Before working with electrical parts with voltage potentials higher than 50 volts, the device must be disconnected from the mains voltage or power supply unit.
- With electrical drive and filter components, observe the following: Wait 30 minutes after switching off power to allow capacitors to discharge before beginning to work. Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.
- Never touch the electrical connection points of a component while power is turned on.
- Install the covers and guards provided with the equipment properly before switching the device on. Before switching the equipment on, cover and safeguard live parts safely to prevent contact with those parts.
- A residual-current-operated circuit-breaker cannot be used for electric drives! Indirect contact must be prevented by other means, for

example, by an over current protective device according to the relevant standards.

- Secure built-in devices from direct touching of electrical parts by providing an external housing, for example a control cabinet.
  Always observe the above requirements, in accordance with relevant international standards.

Always observe the above requirements, in accordance with relevant international standards. With electrical drive and filter components, observe the following:

DANGER

High housing voltage and large leakage current!
Risk of death or bodily injury by electric shock!

- Before switching on, the housings of all electrical equipment and motors must be connected or grounded with the equipment grounding conductor to the grounding points. This is also applicable before short tests.
- The equipment grounding conductor of the electrical equipment and the units must be non-detachably and permanently connected to the power supply unit at all times. The leakage current is greater than 3.5 mA.
- Over the total length, use copper wire of a cross section of a minimum of 10 mm^2 for this equipment grounding connection!
- Before start-up, also in trial runs, always attach the equipment grounding conductor or connect with the ground wire. Otherwise, high voltages may occur at the housing causing electric shock.

2.4 Protection Against Electric Shock by Protective Low Voltage (PELV)

WARNING

High electric voltage by incorrect connection!
Risk of death or bodily injury by electric shock!

- To all connections and terminals with voltages between 0 and 50 volts, only devices, electrical components, and conductors may be connected which are equipped with a PELV (Protective Extra-Low Voltage) system.
- Connect only voltages and circuits which are safely isolated from dangerous voltages. Safe isolation is achieved for example by isolating transformers, safe optocouplers or battery operation without mains connection.

2.5 Protection Against Dangerous Movements

Dangerous movements can be caused by faulty control of connected motors. Some common examples are:

- ★ Improper or wrong wiring of cable connections
- ★ Incorrect operation of the equipment components
- ★ Wrong input of parameters before operation
- ★ Malfunction of sensors, encoders and monitoring devices
- ★ Defective components
- ● Software or firmware errors

Dangerous movements can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.
The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily harm and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

DANGER

Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

- For the above reasons, ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation. They have to be provided for by the user according to the specific conditions within the installation and a hazard and fault analysis. The safety regulations applicable for the installation have to be taken into consideration. Unintended machine motion or other malfunction is possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, bodily harm and/or material damage:

- Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:
  - ★ use safety fences
  - ★ use of safety guard (cover)
  - ★ use of protective coverings
  - ★ install light curtains or light barrier
- Fences and coverings must be strong enough to resist maximum possible momentum.

- Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before start-up. Do not operate the device if the emergency stop is not working.
- Isolate the drive power connection by means of an emergency stop circuit or use a safety related starting lockout to prevent unintentional start.
- Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.

The standard equipment motor brake or an external brake controlled directly by the drive controller are not sufficient to guarantee personal safety!

- Disconnect electrical power to the equipment using a master switch and secure the switch against reconnection for:
  - ★ Maintenance and repair work
  - ★ Cleaning of equipment
  - ★ Long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near electronics circuits and supply leads. If the use of such devices cannot be avoided, verify the system and the installation for possible malfunctions in all possible positions of normal use before initial start-up. If necessary, perform a special electromagnetic compatibility (EMC) test on the Installation.

2.6 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors and permanent magnets in motors represent a serious personal danger to those with heart pacemakers, metal implants and hearing aids.

WARNING

Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electrical equipment!

- Persons with heart pacemakers and metal implants are not permitted to enter following areas:
  - ★ Areas in which electrical equipment and parts are mounted, being operated or commissioned.
  - ★ Areas in which parts of motors with permanent magnets are being stored, repaired or mounted.
- If it is necessary for somebody with a pacemaker to enter such an area, a doctor must be consulted prior to doing so. The interference immunity of present or future implanted heart pacemakers differs greatly, so that no general rules can be given.

- Those with metal implants or metal pieces, as well as with hearing aids must consult a doctor before they enter the areas described above. Otherwise health hazards may occur.

2.7 Protection Against Contact with Hot Parts

CAUTION

Hot surfaces at motor housings, on drive controllers or chokes! Danger of injury! Danger of burns!

- Do not touch surfaces of device housings and chokes in the proximity of heat sources! Danger of burns!
- Do not touch housing surfaces of motors! Danger of burns!
- According to operating conditions, temperatures can be higher than 60 ℃, 140 °F during or after operation.
- Before accessing motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require up to 140 minutes! Roughly estimated, the time required for cooling down is five times the thermal time constant specified in the Technical Data.
- After switching drive controllers or chokes off, wait for 15 minutes to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, the manufacturer of the end product, machine or installation, according to the respective safety regulations, has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: warnings, guards (shielding or barrier) technical documentation.

2.8 Protection During Handling and Mounting

In unfavorable conditions, handling and assembling certain parts and components in an improper way can cause injuries.

CAUTION

Risk of injury by improper handling! Bodily injury by bruising, shearing, cutting, hitting!

- Observe the general construction and safety regulations on handling and assembly.
- Use suitable devices for assembly and transport.
- Avoid jamming and bruising by appropriate measures.
- Always use suitable tools. Use special tools in different circumstances.

- Use lifting equipment and tools in the correct manner.
- If necessary, use suitable protective devices (for example safety goggles, safety shoes, safety gloves).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids because of the danger of skidding.

2.9 Protection Against Pressurized Systems

According to the information given in the Project Planning Manuals, motors cooled with liquid and compressed air, as well as drive controllers, can be partially supplied with externally fed of pressurized media, such as compressed air, hydraulics oil, cooling liquids, and cooling lubricating agents. In these cases, improper handling of external supply systems, power supply lines, or connections can cause injuries or damages.

CAUTION

Risk of injury by improper handling of pressurized Lines!

- Do not attempt to disconnect, open, or cut pressurized lines (risk of explosion).
- Observe the respective manufacturer's operating instructions.
- Before dismounting lines, relieve pressure and empty medium.
- Use suitable protective equipment devices (for example safety goggles, safety shoes, safety gloves).
- Immediately clean up any spilled liquids from the floor.

Note: Environmental protection and disposal! The agents used to operate the product might not be economically friendly. Dispose of ecologically harmful agents separate from other waste. Observe the local regulations in the country of assembly.

3 Important Directions for Use

3.1 Appropriate Use

Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.
The products may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.

Note: Rexroth shall not be held liable for any damages resulting from inappropriate use. In such cases, the guarantee and the right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

Before using Rexroth products, make sure that all the pre-requisites for appropriate use of the products are satisfied:

- ★ Personnel that in any way or form use our products must first read and understand the relevant safety instructions and be familiar with appropriate use.
- ★ If the products take the form of hardware, they must remain in their original state, in other words, no structural changes are permitted.
- ★ It is not permitted to decompile software products or alter source codes.
- ★ Do not mount damaged or faulty products or use them in operation.
- ★ Make sure that the products have been installed in the manner described in the relevant documentation.

3.2 Inappropriate Use

Using the drive controllers outside of the operating conditions described in this manual and outside of the indicated technical data and specifications is defined as "inappropriate use".

Drive controllers shall not be used in following conditions:

- ★ They are subject to operating conditions that do not meet the specified ambient conditions. These include, for example, operation under water, extreme temperature fluctuations or extremely high temperatures.
- ★ Furthermore, the drive controllers shall not be used in applications which have not been expressly authorized by Rexroth.
- ★ Please carefully follow the specifications outlined in the general Safety Instructions!

4 Fe Description

4.1 Properties of the Basic Device Fe

- Control mode: V/F
- Power range: 0.75 kW to 110 kW
- Power supply voltage: 3 AC 380 to 480 V (-15 % / +10 %)
- Output frequency: 0 to 650 Hz
- Overload capacity:
  G series: 200 % of rated current for 1s; 150 % of rated current for 60s
  P series: 120 % of rated current for 60s; 105 % of rated current for 60min
- Pulse width modulation (PWM) for converters with
  - ★ 0.75 to 7.5 kW: 1 to 15 kHz, adjustable in 1 kHz steps;
  - ★ 11 to 22 kW: 1 to 8 kHz, adjustable in 1 kHz steps;
  - ★ 30 to 45 kW: 1 to 6 kHz, adjustable in 1 kHz steps;
  - ★ 55 to 110 kW: 1 to 4 kHz, adjustable in 1 kHz steps;
- Integrated Brake Chopper (braking resistor connected externally, 0.75 to 15 kW only)
- Permitted ambient temperature: -10 to 40 °C (output must be reduced from 40 to 50 °C)
- Protection class: IP20 (for installation inside control cabinet)
- High start-up torque and precise motor speed control

4.2 Functions

- Programmable skip frequencies: See Parameters [E00]-[E03]
- Upper and lower frequency command, and highest frequency: See Parameters [b03], [b21] and [b22]
- DC braking for starting and stopping: See Parameters [H04]-[H07]
- PI control: See Parameters [E24]-[E30]
- Energy saving: See Parameters [H23]-[H29]
- ModBus and PROFIBUS communication: See Parameters [H08]-[H21]
- Fault reset: See Parameters [E42]-[E44]
- Drooping control: See Parameters [H37]

- Forward and reverse rotation dead zone setting and reverse rotation prevention: See Parameter [b18]
- Constant voltage control: See Parameter [b14]
- Jogging control: See Parameters [b35]-[b38]
- Automatic adjustment of PWM frequency according to temperature: See Parameter [H01]
- Current no-trip control: See Parameters [H30]-[H33]
- Dynamic braking point set with function code: See Parameter [H36]
- Zero speed control: See Parameters [b42] and [b43]
- Restart after power failure: See Parameter [H02]
- Multi-speed and simple PLC: See Parameters [P00]-[P37]
- S-curve/Linear acceleration/deceleration: See Parameter [b15]
- 3-wire/2-wire terminal function: See Parameter [E38]
- Automatic adjustment of cooling fan: See Parameter [H22]

4.3 Interfaces

- 8 digital inputs
- 3 analog inputs
- 1 encoder input for speed feedback
- 2 analog outputs
- 1 frequency output
- 2 open collector outputs
- 1 relay output AC 250 V / DC 30 V, 3 A
- 1 RS485 port

4.4 Cooling Types

- Air cooling
- Forced, temperature-controlled air cooling

5 Delivery and Storage

5.1 The Scope of Supply Consists of

1) Standard model:

- Frequency Converter Fe, IP20 protection
- Fe firmware
- Integrated brake chopper (0.75 to 15 kW only)
- Operating panel
- Instruction manual

2) Optional accessories:

- Operating panel for control cabinet mounting
- Operating panel with potentiometer for converters from 11 to 110 kW
- PROFIBUS adapter
- RS232/485 adapter
- Fe engineering software
- EMC filter (EN 61800-3 Environment 2)
- dV/dt filter
- Main choke
- Braking resistor
- Braking unit

Check the unit for transport damages, e.g. deformation or loose parts, **immediately** after receipt/ unpacking.
In case of damage, contact the forwarder at once and arrange for a thorough review of the situation.

Note: This is also applicable if the packaging is undamaged.

5.2 Transport of the Components

Ambient and operating conditions - Transport

Description	Symbol	Unit	Value
Temperature range	T_{a_tran}	℃	-25...70
Relative humidity		%	5...95
Absolute humidity		g/m^3	1...60
Climate category (IEC 721)			2K3
Moisture condensation			not allowed
Icing			not allowed

5.3 Storage of the Components

CAUTION

Damage to the components caused by long storage periods!
Some components contain electrolytic capacitors which may deteriorate during storage.
When storing these components for a long period of time, operate them once a year for at least 1 hour with power on:

- Fe with mains voltage U_{LN}
- FELB with DC bus voltage U_{DC}

Ambient and operating conditions - Storage

Description	Symbol	Unit	Value
Temperature range	T_{a_store}	℃	-25...55
Relative humidity		%	5...95
Absolute humidity		g/m^3	1...29
Climate category (IEC 721)			1K3
Moisture condensation			not allowed
Icing			not allowed

6 Type Coding

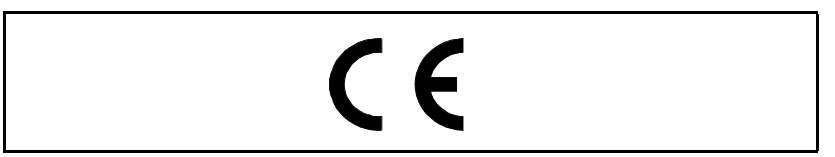
6.1 Certification

Declaration of conformity

For devices, there are declarations of conformity which confirm that the devices comply with the applicable EN standards and EC Directives. If required, you can ask our sales representative for the declarations of conformity.

Description	Standard
CE conformity regarding Low-Voltage Directive	EN 61800-5-1 (IEC 61800-5-1: 2007)
CE conformity regarding EMC product standard	EN 61800-3 (IEC 61800-3: 2004)

CE Label



High-Voltage Test

According to standard, the components of the Rexroth Fe are tested with high voltage.

Test	Test rate
High-voltage test	100 % (EN 61800-5-1)
High-voltage insulation test	100 % (EN 61800-5-1)

- Before making a high-voltage test for the installation in which the components are used, disconnect all connections to the components or disconnect the plug-in connections to protect the electronic components.

UL Listing

The components are listed by **UL** (underwriters Laboratories Inc. ®). You can find the evidence of certification on the Internet under http://www.ul.com under “Certifications” by entering the file number or the “Company Name: Rexroth”.

IND. CONT. EQ. 46PG

- UL standard: UL 508 C

Company Name
BOSCH REXROTH (XIAN) ELECTRIC DRIVES and CONTROLS Co., Ltd.
Category Name
Power Conversion Equipment
File Numbers
E328841

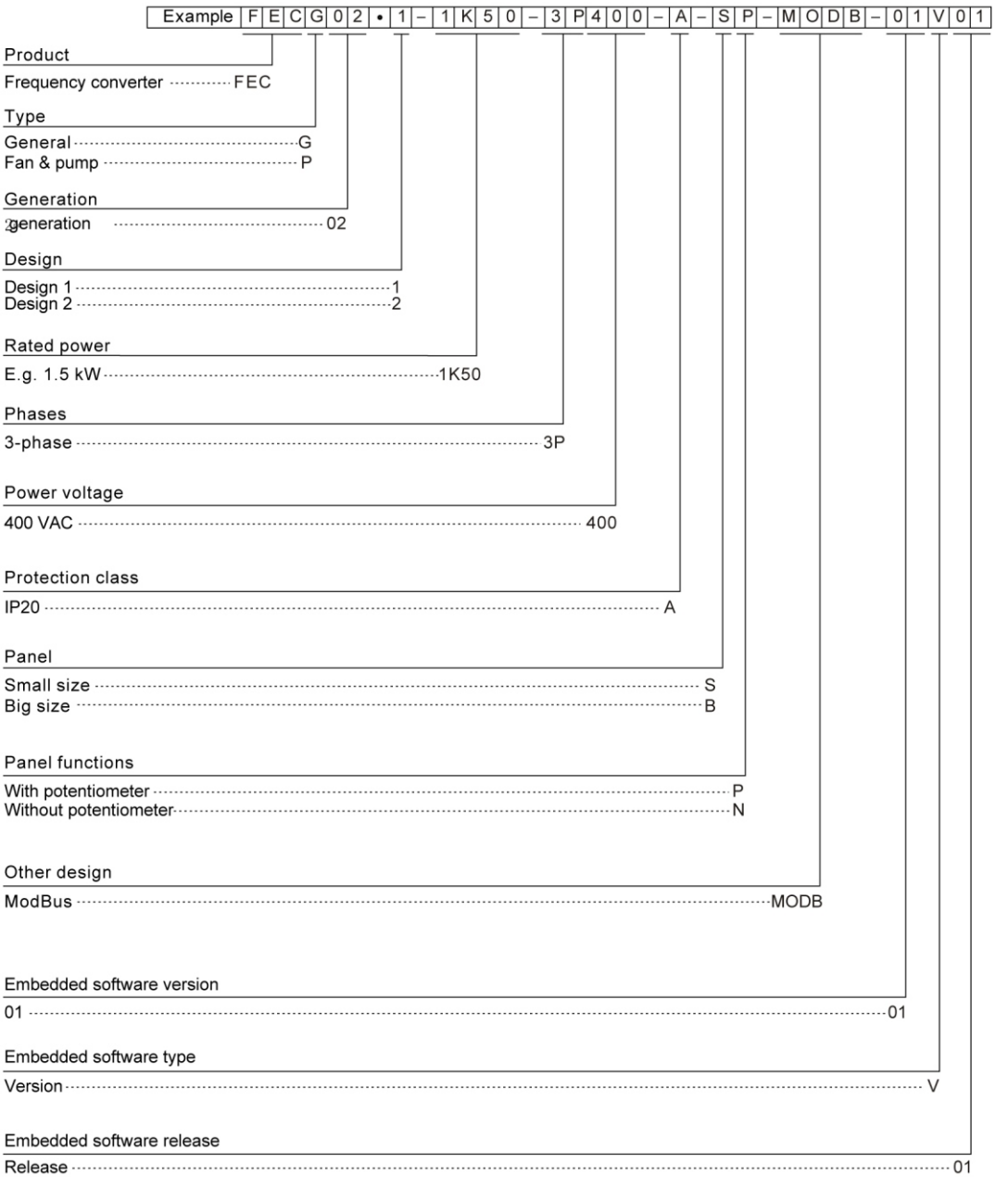
UL Listing

★UL ratings
For using the components in the scope of UL, take the UL ratings of the individual component into account.
Make sure that the indicated **short circuit rating SCCR** is not exceeded (5000 A_{rms}), e.g. by appropriate fuses in the mains supply of the supply unit.

★Wiring material UL
In the scope of UL, use copper 60/75 ℃ only.

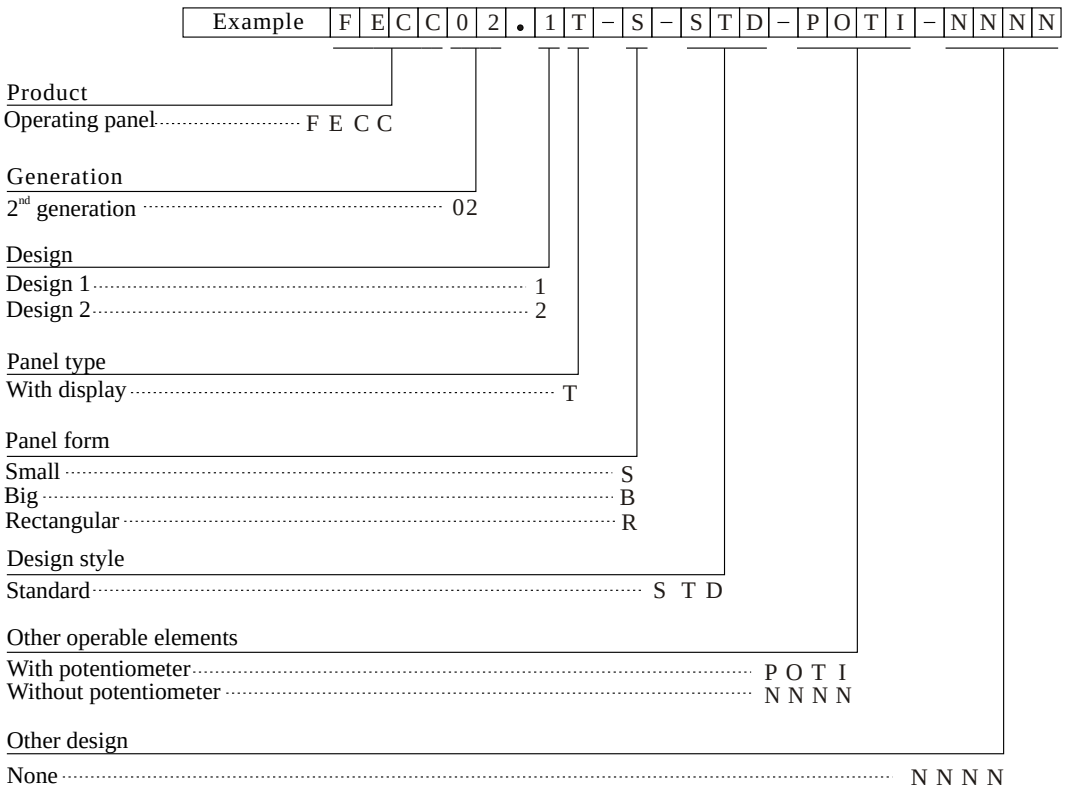
★Allowed pollution degree
Comply with the allowed pollution degree of the components (see “**Technical Data**”).

6.2 Type Coding of Fe Series Converters

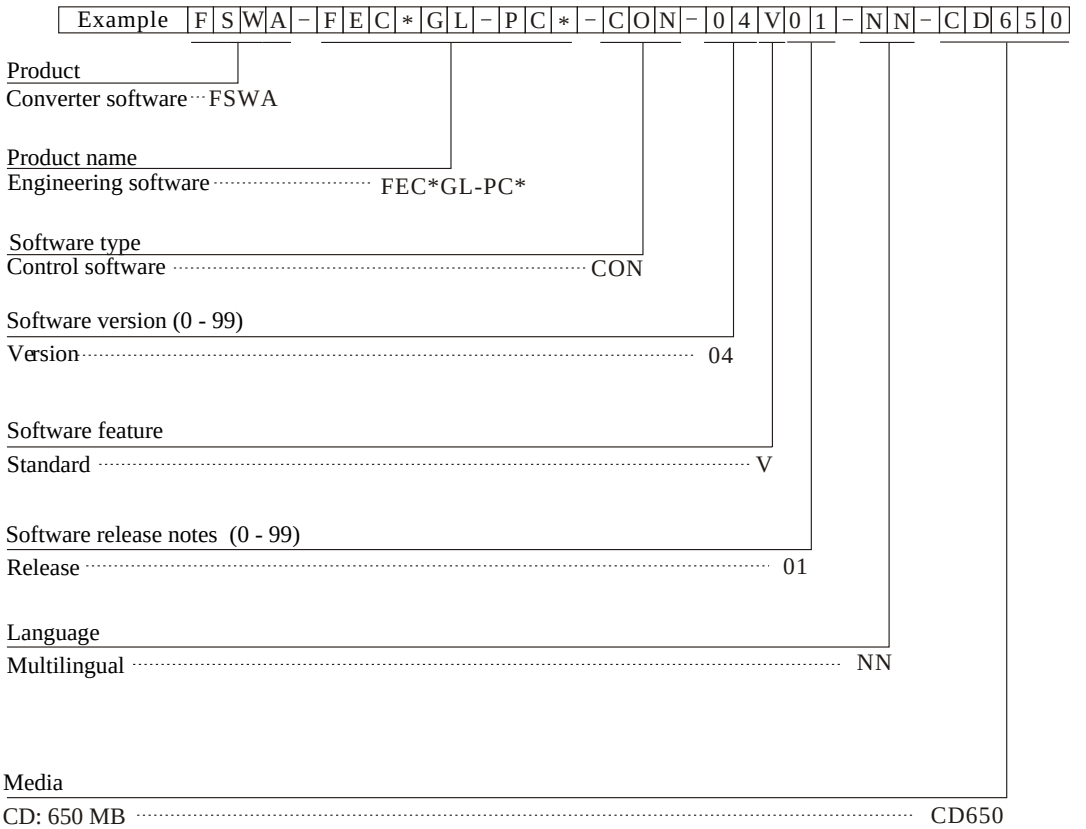


6.3 Type Coding of Fe Function Modules

Operating panel coding

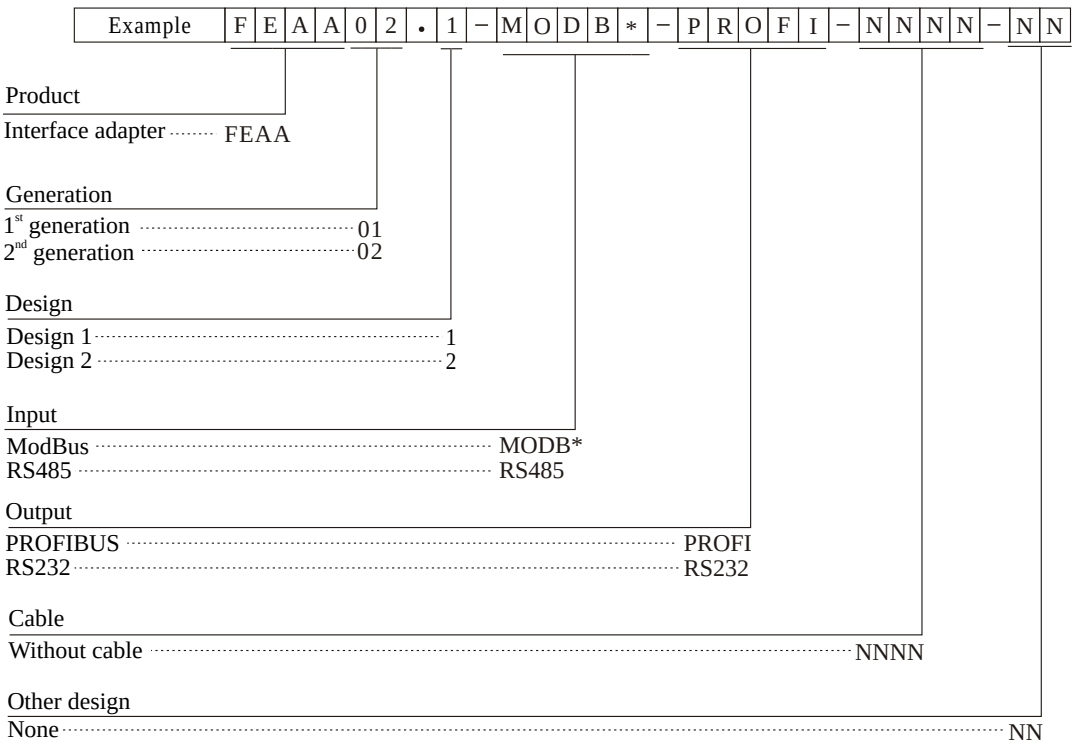


Software coding

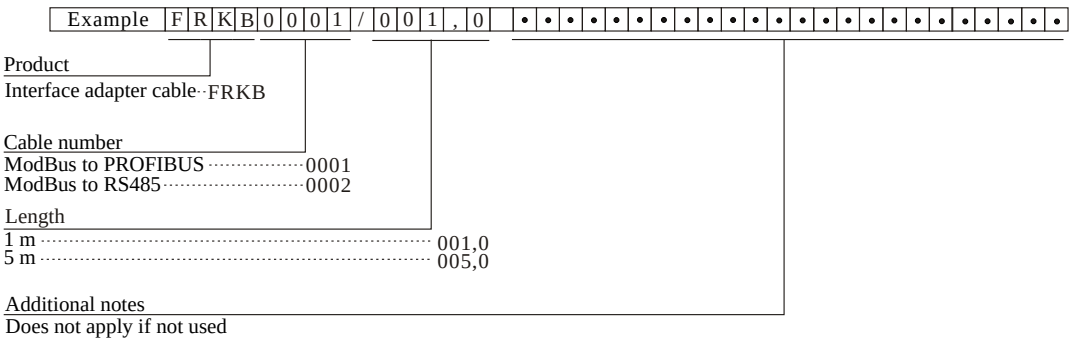


6.4 Type Coding of Fe Accessories

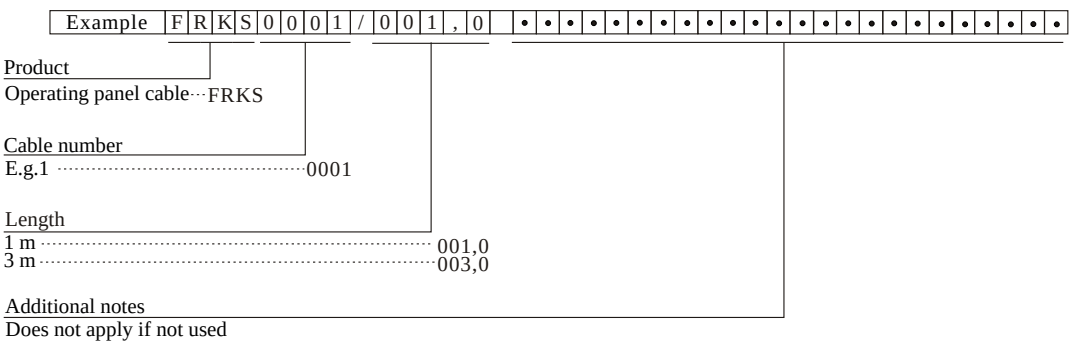
Interface adapter coding



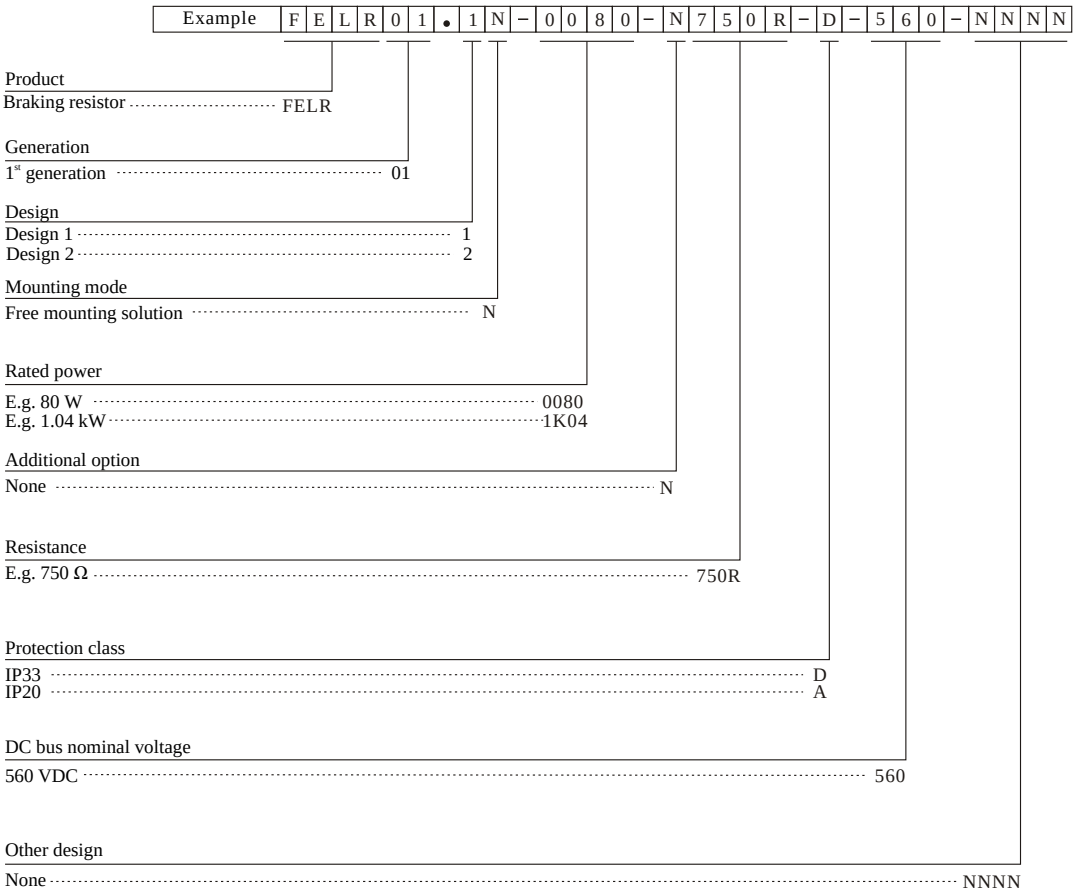
Interface adapter cable coding



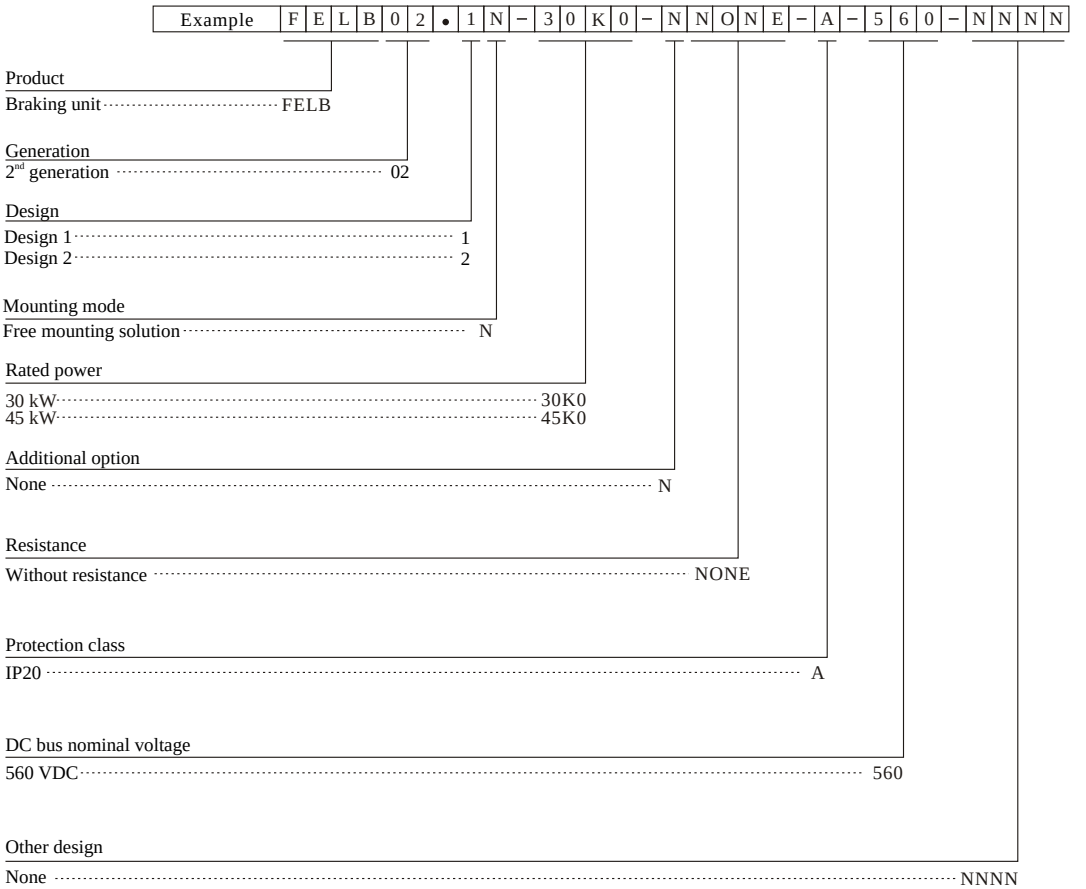
Operating panel cable coding



Braking resistor coding



Braking unit coding

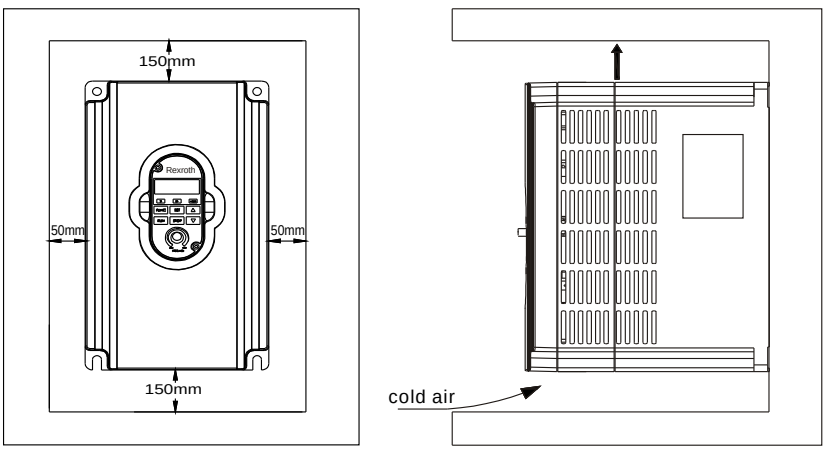


7 Frequency Converter Mounting

7.1 Mounting

The equipment must be sufficiently ventilated, to avoid overheating. The recommended minimum clearances between the frequency converter and adjacent items which may disturb the free flow of air are given below.

Note: The frequency converter must be vertically installed. (Applicable to: 0.75 to 110 kW frequency converters)



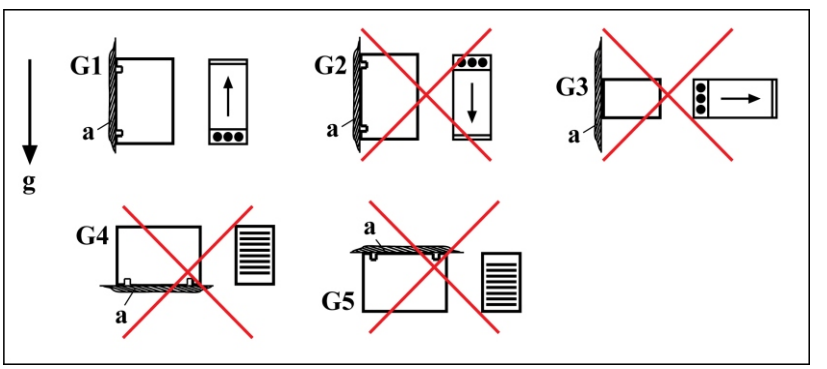
If one frequency converter is arranged above the other, make sure that the upper limit of air temperature into the inlet is not exceeded (Note: See **Chapter 13 "Technical Data"**). A baffle plate is recommended between the frequency converters, to prevent the rising hot air being drawn into the upper converter.

CAUTION

Risks of damage to the components!

Allowed Mounting Position of the components

Only operate the components in their allowed mounting positions.
Only the mounting position G1 is allowed for Fe components.



a Mounting surface

g Direction of gravitational force

G1 Normal mounting positions. The natural convention supports the forced cooling air current. This avoids the generation of pockets of heat in the component.

G2 180° to normal mounting position

G3 Turned by 90° from vertical to horizontal mounting position

G4 Bottom mounting; mounting surface on bottom of control cabinet

G5 Top mounting; mounting surface at top of control cabinet

Efficiency:

Ensure sufficient ventilation for installation in a cabinet. During operation, heat loss is about 5 % of the rated power of the frequency converter, depending on unit dimensions and equipment.

7.2 Dimensions

G/P Series	Dimensions[mm]							Weight [kg]	Screw size
	B	H	T	b	h	ø	t		
FECG02 • 1-0K75-3P400-A-SP-MODB-01V01	125	220	176	109	204	6	10	3.0	M5
FECG02 • 1-1K50-3P400-A-SP-MODB-01V01								3.0	
FECG02 • 1-2K20-3P400-A-SP-MODB-01V01								3.2	
FECG02 • 1-4K00-3P400-A-SP-MODB-01V01								3.2	
FECG02 • 1-5K50-3P400-A-SP-MODB-01V01								3.5	
FECG02 • 1-7K50-3P400-A-SP-MODB-01V01								3.5	
FECG02 • 1-11K0-3P400-A-BN-MODB-01V01	220	392	218	180	372	9.5	2.5	10.7	M8
FECG02 • 1-15K0-3P400-A-BN-MODB-01V01								10.9	
FECG02 • 1-18K5-3P400-A-BN-MODB-01V01	275	463	218	200	443	9.5	2.5	16.2	
FECG02 • 1-22K0-3P400-A-BN-MODB-01V01								16.9	
FECG02 • 1-30K0-3P400-A-BN-MODB-01V01	290	574	236	200	550	11	2.5	21.5	
FECG02 • 1-37K0-3P400-A-BN-MODB-01V01								22.0	
FECG02 • 1-45K0-3P400-A-BN-MODB-01V01	364	602	260	260	576	11	4.5	33.2	
FECG02 • 1-55K0-3P400-A-BN-MODB-01V01								33.8	
FECG02 • 1-75K0-3P400-A-BN-MODB-01V01	455	682	290	375	650	11	4.5	50.9	
FECG02 • 1-90K0-3P400-A-BN-MODB-01V01								52.5	
FECG02 • 1-110K-3P400-A-BN-MODB-01V01	570	850	360	450	825	11	4.5	96.5	
FECP02 • 1-5K50-3P400-A-SP-MODB-01V01	125	220	176	109	204	6	10	3.5	M5
FECP02 • 1-7K50-3P400-A-SP-MODB-01V01								3.5	
FECP02 • 1-11K0-3P400-A-BN-MODB-01V01	220	392	218	180	372	9.5	2.5	10.7	M8
FECP02 • 1-15K0-3P400-A-BN-MODB-01V01								10.9	
FECP02 • 1-18K5-3P400-A-BN-MODB-01V01	275	463	218	200	443	9.5	2.5	16.2	
FECP02 • 1-22K0-3P400-A-BN-MODB-01V01								16.9	
FECP02 • 1-30K0-3P400-A-BN-MODB-01V01	290	574	236	200	550	11	2.5	21.5	
FECP02 • 1-37K0-3P400-A-BN-MODB-01V01								22.0	
FECP02 • 1-45K0-3P400-A-BN-MODB-01V01	364	602	260	260	576	11	4.5	33.2	
FECP02 • 1-55K0-3P400-A-BN-MODB-01V01								33.8	
FECP02 • 1-75K0-3P400-A-BN-MODB-01V01	455	682	290	375	650	11	4.5	50.9	
FECP02 • 1-90K0-3P400-A-BN-MODB-01V01								52.5	
FECP02 • 1-110K-3P400-A-BN-MODB-01V01	570	850	360	450	825	11	4.5	96.5	

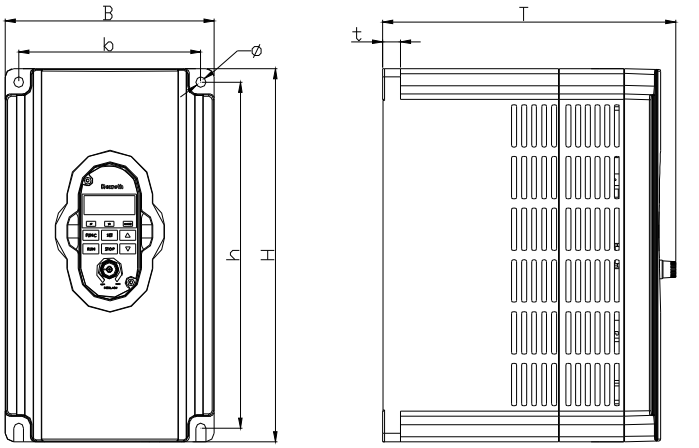
Note 1: G series include 0.75 to 110 kW; P series include 5.5 to 110 kW.

Note 2: Fix the mounting screws with the following typical tightening torque:

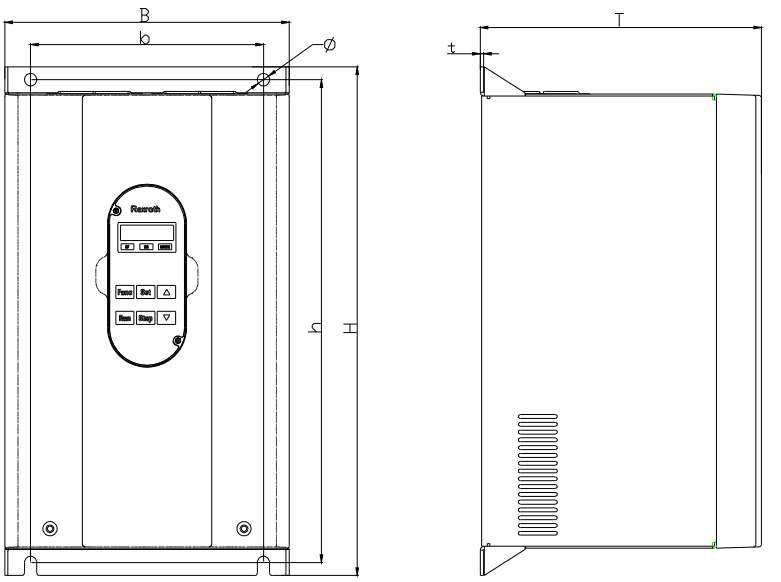
M5: 4 Nm / 35 lb-in

M8: 12 Nm/ 110 lb-in

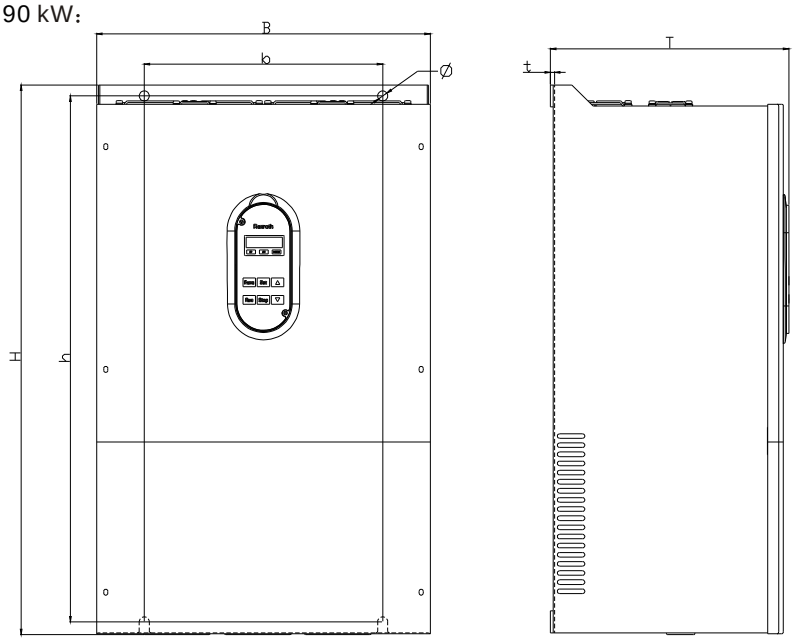
Applicable to：0.75 to 7.5 kW



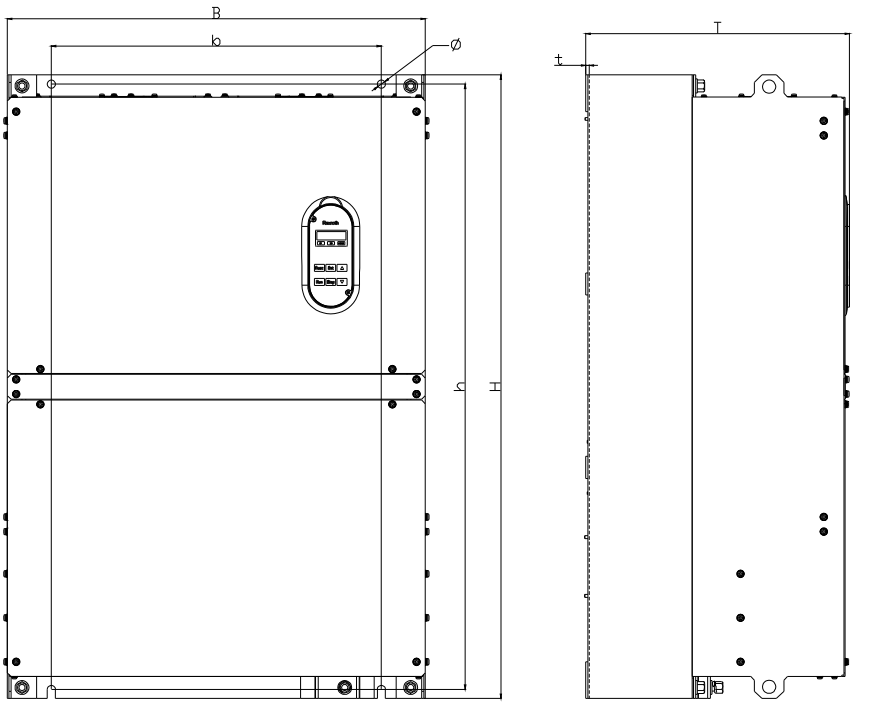
Applicable to：11 to 37 kW



Applicable to: 45 to 90 kW:



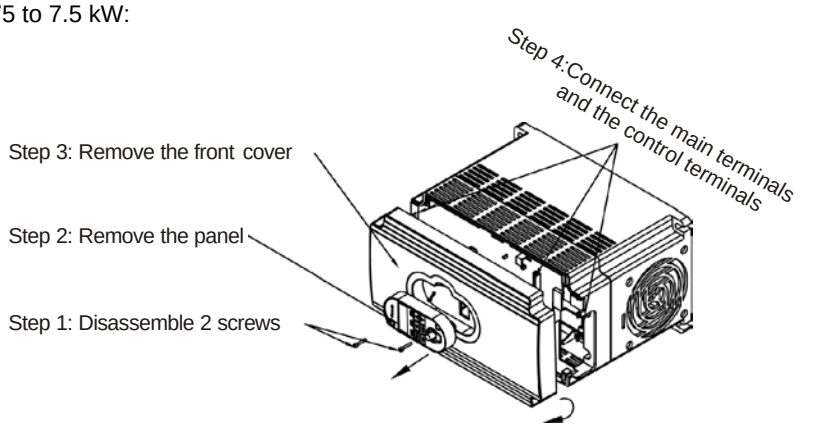
Applicable to 110 kW:



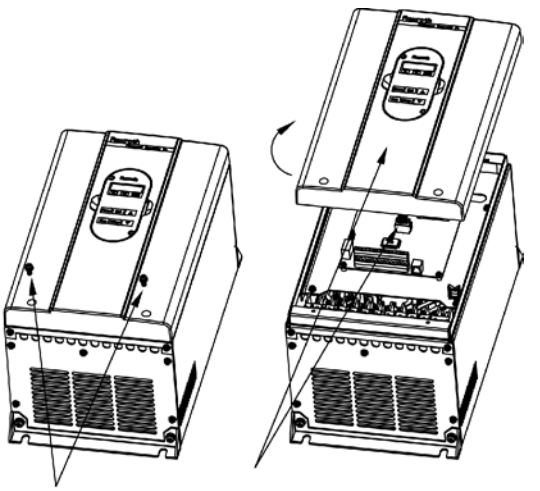
8 Installation

8.1 Converter Opening Instruction

Applicable to 0.75 to 7.5 kW:



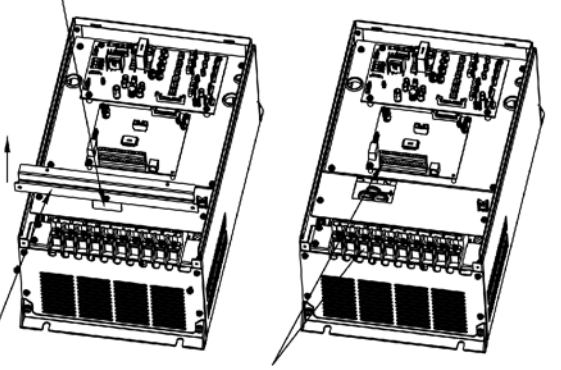
Applicable to 11 to 15 kW:



Step 1: Disassemble 2 screws

Step 2: Lift the cover and remove the panel cable, then remove the cover

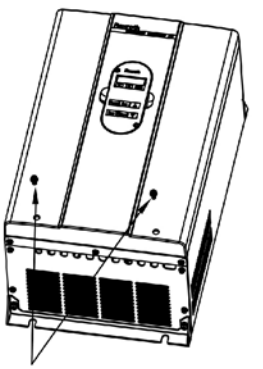
Notice: When using (+), PB, (-) remove the small metal cover



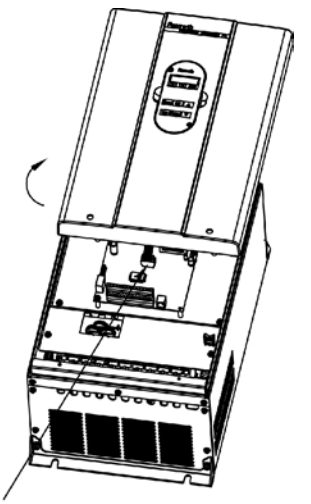
Step 3: Remove the front bottom cover

Step 4: Connect the main terminals and the control terminals

Applicable to 18.5 to 37 kW:

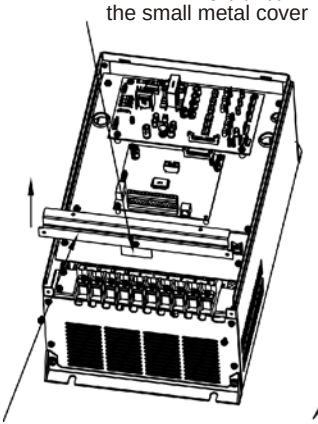


Step 1: Disassemble 2 screws

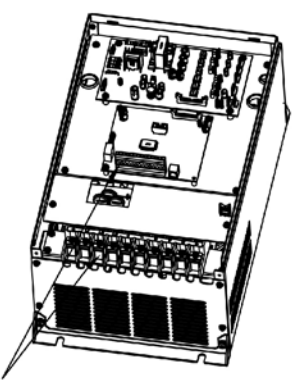


Step 2: Lift the cover remove the panel cable, then remove the cover

Notice: When using (+), (-) remove the small metal cover

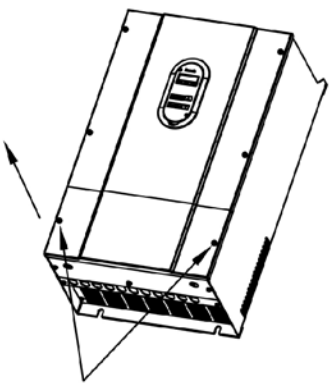


Step3: Remove the front bottom cover

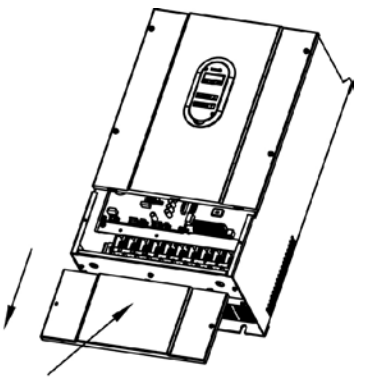


Step 4: Connect the main terminals and the control terminals

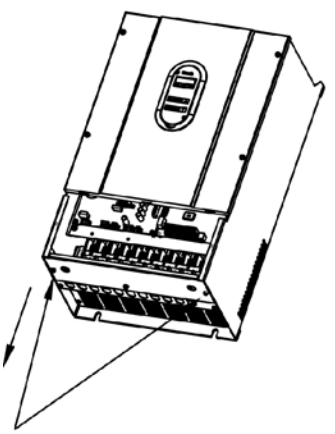
Applicable to 45 to 55 kW:



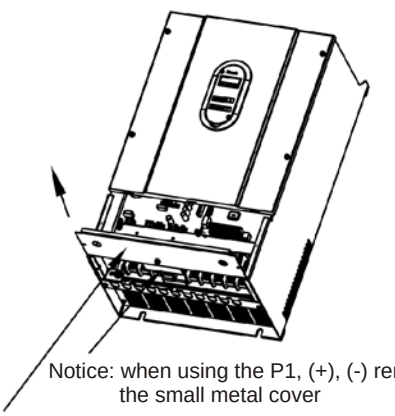
Step 1: Disassemble 2 screws



Step 2: Remove the lower cover

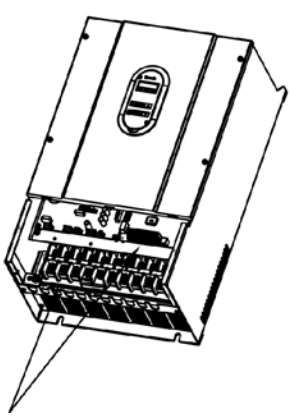


Step 3: Disassemble 2 screws



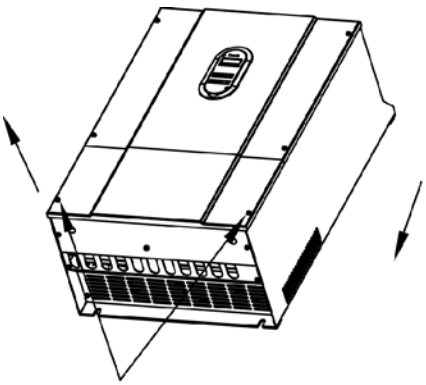
Notice: when using the P1, (+), (-) remove the small metal cover

Step 4: Remove the front bottom cover

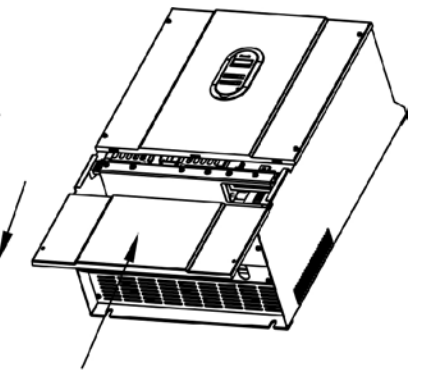


Step 5: Connect the main terminals and control terminals

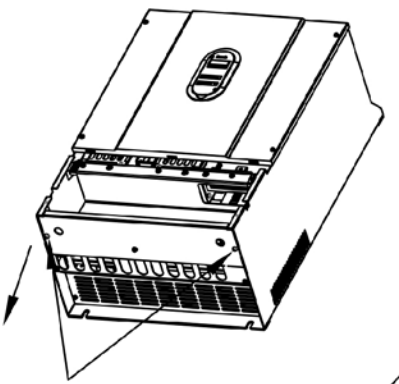
Applicable to 75 to 90 kW:



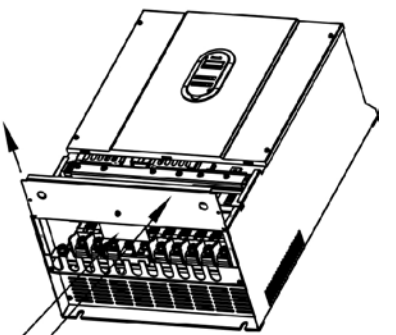
Step 1: Disassemble 2 screws



Step 2: Remove the lower cover

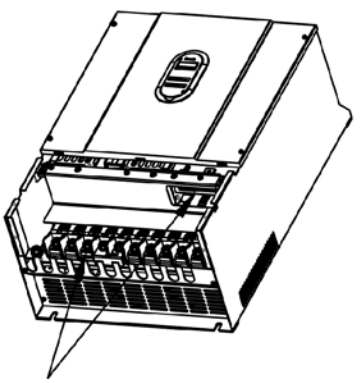


Step 3: Disassemble 2 screws



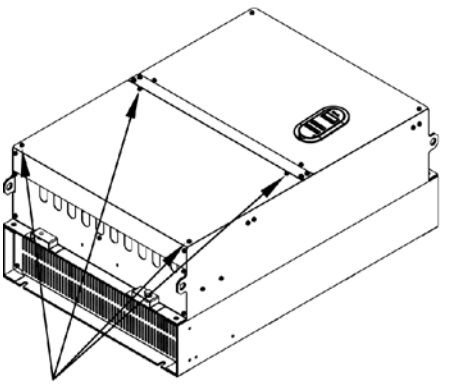
Notice: when using the P1, (-)
remove the small metal cover

Step 4: Remove the front bottom cover

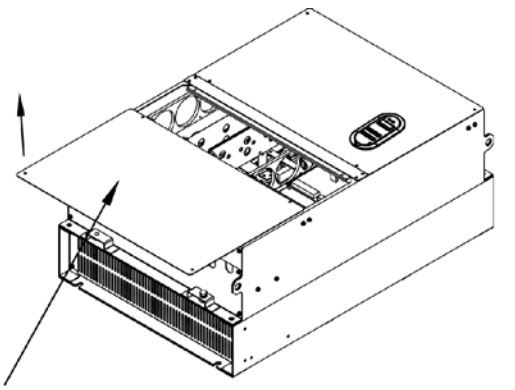


Step 5: Connect the main terminals
and control terminals

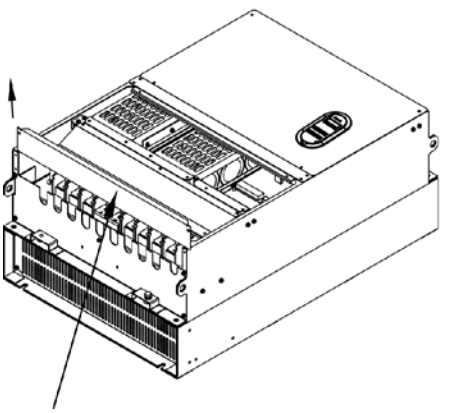
Applicable to 110 kW:



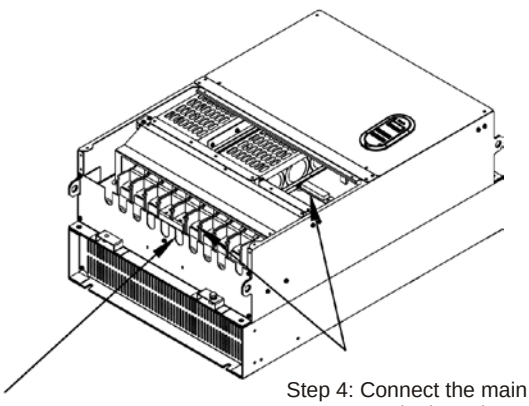
Step 1: Disassemble 4 screws



Step 2: Remove the lower cover



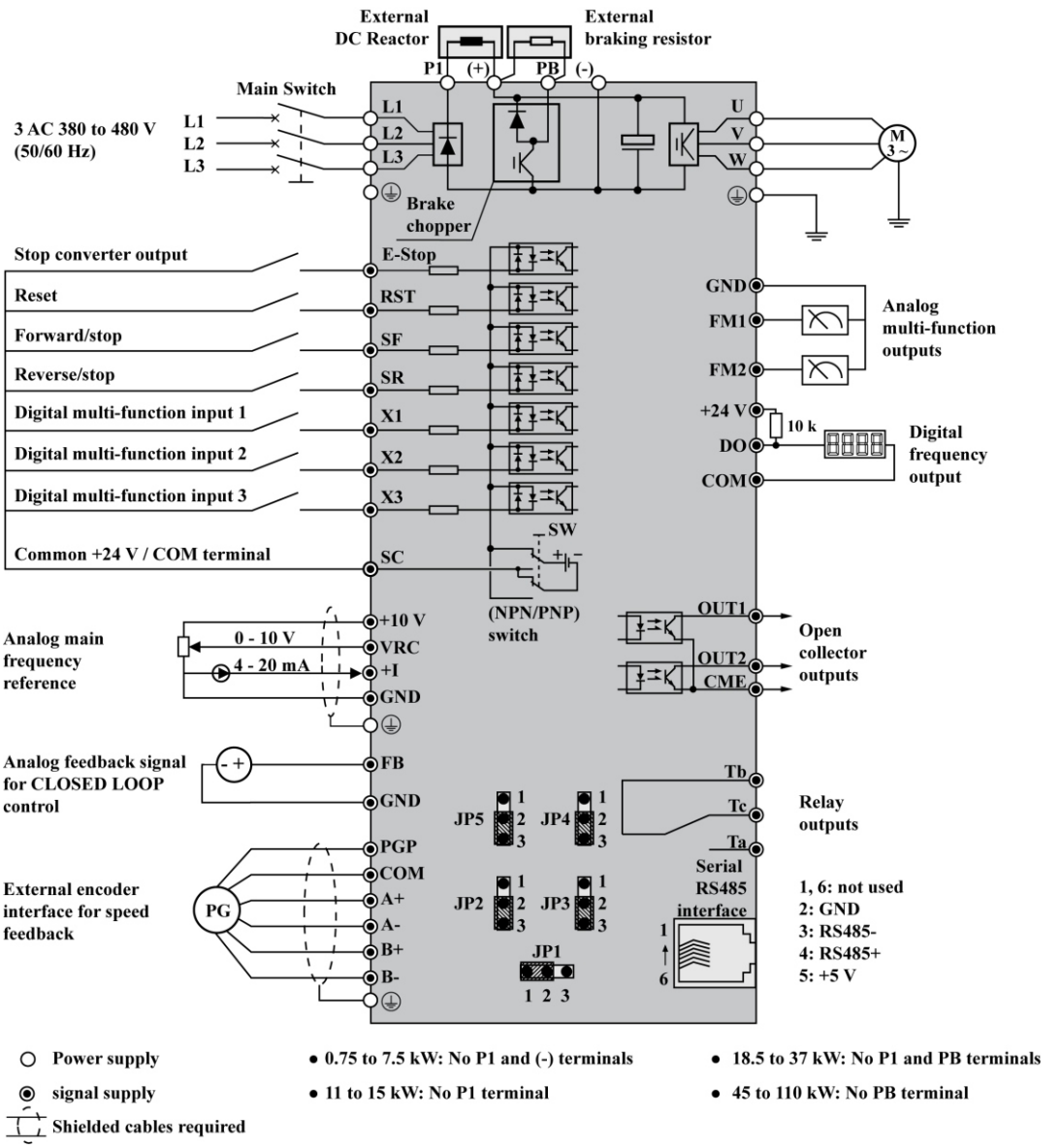
Step 3: Remove the front bottom cover



Notice: when using the P1, (+), (-) remove the small metal cover

Step 4: Connect the main terminals and control terminals

8.2 Block Diagram

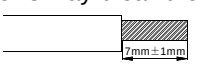


8.3 Main Circuit Wiring

- Connect power supply only to the main power supply terminals L1, L2 and L3. Connecting power supply to other terminals will damage the frequency converter. Ensure that the power supply voltage is within the allowable voltage range specified on the nameplate.
- The grounding terminal must be properly grounded to avoid electric shock and fire and reduce interference noise.
- Insulated crimp terminals must be used to connect terminals and conductors, to ensure the reliability of connection.
- After wiring connection, remove all residual loose wires, which may fall into the frequency converter and cause a failure. Be careful not to allow swarf from drilling entering the frequency converter. Check the following points after the circuit connection is completed.
  ① Are all connections correct?
  ② Are there any missing connections?
  ③ Do short circuits exist between terminals and wires or ground?
- To make changes in wiring, disconnect the power and wait for 30 minutes to allow the capacitor of the DC circuit to discharge.
- Wiring shall be carried out with wire sizes in accordance with relevant electrical codes.
- A fuse must be provided between the main power supply terminals (L1, L2 and L3) and the 3-phase AC input power supply. It is preferable to connect a magnetic contactor (MC) in series to ensure both the action of frequency converter protection and shutting off of power supply (Surge absorbers should be added at both sides of the magnetic contactor).
- If the wire between the frequency converter and the motor is very long, particularly with low output power, the voltage drop may lead to a reduced torque output by the motor.
- Nothing other than the braking resistor may be connected between the terminal (+) and PB. Do not short circuit!
- Electromagnetic interference: The 3-phase inputs/outputs of frequency converter contain harmonic components, which may interfere with nearby communication devices (e.g. AM radio receiver). Therefore, an optional radio noise filter (only for the input side) or line noise filter may be installed to minimize interference.
- Do not attach power capacitor, surge suppressor or radio noise filter to the output side of frequency converter. This may cause frequency converter failure or damage the capacitor or suppressor. Immediately remove any such device which has been installed.

8.4 Control Circuit Wiring

- Terminal GND is the common terminal for analogue signals, and SC is the common terminal for switch values. Do not ground these terminals. Shielded or twisted-pair cables should be used for wiring terminals for the control circuit and must be separated from the wiring of main circuit and high current circuits (including the control circuit of 200 V relay).
- Since the frequency control input signals are low power signals, two contacts in parallel or a twin contact should be used for low power signal current to avoid loose contact.
- 0.3 to 1.0 mm^2 cables are recommended for wiring of the control circuit.
- Please strip the wire insulation for wiring of the control circuit. according to the dimensions given below. Too long stripping may cause short circuit of adjacent wires, and too short stripping may lead wires becoming loose.
- If a post terminal or single-conductor wire is used, use a cable with a diameter of less than 1.0 mm. If the cable is larger than 1.0 mm, the screw may be stripped when being tightened up.
- Tighten up screws with typically 0.8 Nm / 7 lb-in torque after the cables are inserted into the terminals.
- Cables may become disconnected and cause incorrect operation if not tightened. However, over-tightening screws may break the component to cause short circuit and incorrect operation.



8.5 Cable and Fuse Dimensions

The power cable dimensions and the fuse dimensions are based on the VDE 0298 (part 4) and the standard for the European countries EN 60204-1.
The dimension for flexible wiring is according to VDE 0298 (part 4) and for fix wiring according to VDE 0298 (part 4) or IEC 60364-5 (operating temperature at the conductor 90 ℃).
The cable and fuse dimensions for USA/Canada are based on UL 508A.

- The manufacturer of the machine/installation is responsible for conformity with regional provisions and other standards that are relevant for the respective application and the place of installation. Also factors, such as installation methods, grounding, insulation and over-voltage protection must be taken into consideration.

National standards, such as NFPA in the USA, regional provisions, ground, operating temperature, operating cycles, over-voltage protection and system configuration can have a decisive impact on the dimensioning of the cables and therefore they must be given priority over the above factors.

- If, as a consequence of this, further requirement and cable designs arise that are not mentioned in this documentation, contact your Bosch Rexroth sales partner.

Cable dimensioning:

1. Determines the power size of the frequency converter;
2. Determines country of use (e.g. “International without USA/Canada”);
3. Determines installation type (e.g. B1 or B2);
4. In table row “Nominal current fuse”, read corresponding fuse.

Input Side				
International without USA/Canada				
kW	Nominal current of Fuse in A	Installation mode B1	Installation mode B2	Installation mode E
		Cable size in mm^2	Cable size in mm^2	Cable size in mm^2
0.75	10	1.5	1	1
1.5	10	1.5	1	1
2.2	16	1.5	1	1
4	20	1.5	1.5	1.5
5.5	25	2.5	2.5	2.5
7.5	25	4	4	2.5
11	35	6	6	6
15	50	10	10	10
18.5	63	10	16	10
22	80	16	16	10
30	100	25	25	16
37	125	25	25	25
45	160	50	50	35
55	200	50	2x 35	50
75	250	95 / 2x 50	2x 50	70 / 2x 35
90	315	2x 50	2x 70	95 / 2x 50
110	350	2x 70	2x 95	120 / 2x 70

Note 1: Input Side and Output Side: The dimensioning is based on the supply voltage of 3x 380 VAC

Note 2: For screw torque information, please refer to the table on next page.

Input Side					
kW	USA/Canada		Screw torque for power cable terminals in Nm / lb-in (screw size)	Input PE	
	Nominal current of fuse in A	Cable size in AWG		Cable size in mm^2/AWG	Torque in Nm / lb-in (screw size)
0.75	6	AWG14	1.7/15 (M4)	6 / 8	1.7/15 (M4)
1.5	10	AWG14	1.7/15 (M4)	6 / 8	1.7/15 (M4)
2.2	16	AWG14	1.7/15 (M4)	6 / 8	1.7/15 (M4)
4	25	AWG12	1.7/15 (M4)	6 / 8	1.7/15 (M4)
5.5	40	AWG10	1.7/15 (M4)	6 / 8	1.7/15 (M4)
7.5	40	AWG10	1.7/15 (M4)	6 / 8	1.7/15 (M4)
11	70	AWG8	2.7/24 (M5)	10 / 7	2.7/24 (M5)
15	80	AWG6	2.7/24 (M5)	10 / 7	2.7/24 (M5)
18.5	80	AWG6	5/40 (M6)	16 / 6	5/40 (M6)
22	80	AWG6	5/40 (M6)	16 / 6	5/40 (M6)
30	100	AWG4	5/40 (M6)	25 / 4	5/40 (M6)
37	125	2x AWG6	5/40 (M6)	25 / 2x6	5/40 (M6)
45	150	AWG1	6/55 (M8)	50 / 1	6/55 (M8)
55	175	AWG1/0	6/55 (M8)	2x35 / 1/0	6/55 (M8)
75	225	AWG3/0 / 2x AWG1	10/90 (M10)	95 / 3/0	10/90 (M10)
90	300	2x AWG1/0	10/90 (M10)	2x70 / 2x 1/0	10/90 (M10)
110	300	300 kcmil / 2x AWG3/0	10/90 (M10)	2x95 / 2x 3/0	10/90 (M10)

Output Side					
kW	International without USA /Canada	USA/Canada			
	Cable size in mm^2	Cable size in AWG	Screw torque for power cable terminals in Nm / lb-in (screw size)	Output PE	
				Cable size in mm^2/AWG	Torque in Nm / lb-in (screw size)
0.75	1 (1)	AWG14	1.7/15 (M4)	10 / 7	1.7/15 (M4)
1.5	1 (1)	AWG14	1.7/15 (M4)	10 / 7	1.7/15 (M4)
2.2	1 (1)	AWG14	1.7/15 (M4)	10 / 7	1.7/15 (M4)
4	1 (1)	AWG14	1.7/15 (M4)	10 / 7	1.7/15 (M4)
5.5	1 (1)	AWG12	1.7/15 (M4)	10 / 7	1.7/15 (M4)
7.5	2.5 (1)	AWG10	1.7/15 (M4)	10 / 7	1.7/15 (M4)
11	6 (1)	AWG8	2.7/24 (M5)	10 / 7	2.7/24 (M5)
15	6 (1)	AWG8	2.7/24 (M5)	10 / 7	2.7/24 (M5)
18.5	10 (1)	AWG6	5/40 (M6)	10 / 7	5/40 (M6)
22	10 (1)	AWG6	5/40 (M6)	10 / 7	5/40 (M6)
30	16 (1)	AWG3	5/40 (M6)	16 / 3	5/40 (M6)
37	25 (1)	2x AWG6	5/40 (M6)	25 / 2x 6	5/40 (M6)
45	35 (2)	AWG1/0	6/55 (M8)	35 / 1/0	6/55 (M8)
55	35 (2)	AWG2/0 / 2x AWG3	6/55 (M8)	35 / 2/0	6/55 (M8)
75	70 / 2x 35 (2)	AWG4/0 / 2x AWG1/0	10/90 (M10)	70 / 2x 1/0	10/90 (M10)
90	95 / 2x 35 (2)	2x AWG2/0	10/90 (M10)	95 / 2x 2/0	10/90 (M10)
110	120 / 2x 50 (2)	2x AWG3/0	10/90 (M10)	2x 50 / 2x 3/0	10/90 (M10)

Note: (1) Installation Mode E

Note: (2) Installation Mode B2

Dimensioning variables of the table values

1. Installation types:

   - B1 according to IEC 60364-5-52, e.g. stranded wires routed in cable duct;
   - B2 according to IEC 60364-5-52, e.g. multi-core line routed in cable duct;
   - E according to EN 60204-1, e.g. multi-core line routed on open cable tray
   - According to NFPA 79 (external wiring), UL 508A (internal wiring), NEC, NFPA 70:
     - 1 cable with 3 conductors, 1 neutral conductor and 1 equipment grounding conductor;
     - Routed in pipe on the wall.

     Internal wiring: Routing inside of control cabinet or inside of devices;
     Field wiring: Routing of cross sections of terminal connectors wired by the user (in the field).

2. Recommendation for design of the fuses:

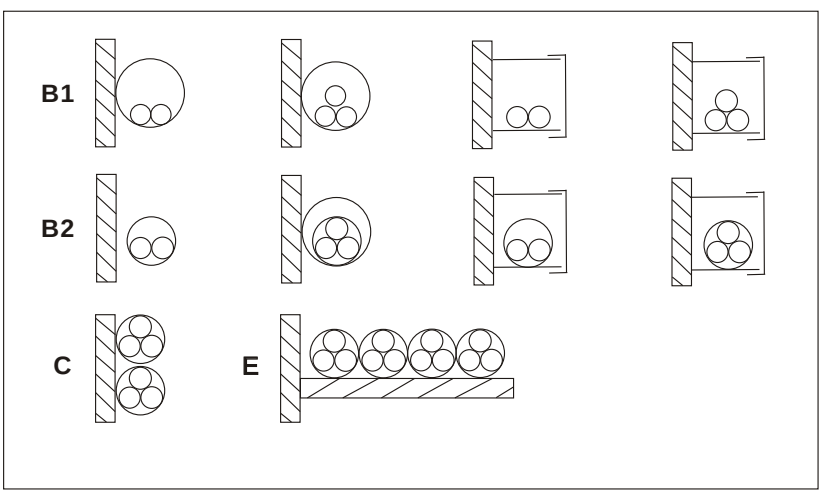
- **International except for USA/Canada:**
  Class gL-gG; 500 V, 690 V; design NH, D (DIAZED) or D0 (NEOZED).

★ **Characteristic**

In the case of error (e.g. ground fault at connections L+, L-), fuses of characteristic **gL** (general-purpose fuse link for cables and lines) and **gG** (general-purpose fuse link for general installations) protect the **lines** in the frequency converter system.

To **protect the semiconductors** in the input of supply units and converters, you can use fuses of characteristic **gR**.

- **USA/Canada:**
  Class J; 600 V



B1 Conductors in installation pipes and in installation channels that can be opened

B2 Cables or lines in installation pipes and in installation channels that can be opened

C Cables or lines on walls

E Cables or lines on open cable trays

Installation Types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)

8.6 Connection of Electrical Power

WARNING

The equipment must be grounded.

- Professional mounting and commissioning by qualified personnel in accordance with the instructions in this manual is a precondition for the safe operation of the equipment. Especially, observe the general and local mounting instructions, safety instructions for working with the power supply, and professional rules concerning the use of tools. Dangerous voltage may exist at the power input and motor terminals, even the converter is deactivated. Generally, use insulated screwdrivers when working with such terminals. Ensure that the power is shut off and check the actual voltage of the converter and motor, before connection and making any change to the connection.

After connecting the power supply terminals, the motor and the control terminals, replace the cover back before switching on the power.

Take account of the following instructions:

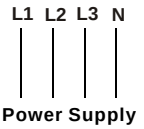
- Ensure that the power supply can provide appropriate voltage and current. Ensure that the rated current range is within that of the converter and power supply.
- It is recommended to use 4-core cables to connect the motor. Cables are connected to motor terminals PE-U-V-W.
- If shielded cables are used, the shield layer should securely connected to the metal surface of cable control cabinet.

Note: It is recommended to use shielded cables in accordance with specified EMC classification.

Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.

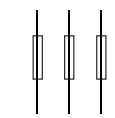
Wire range for field wiring terminals:

Frame Size	Terminal Type	Wire Range (AWG)
A (0.75 - 7.5 kW)	Input Terminal Block (DW2) BTB-750	10 - 18
	Output Terminal Block (DW1) BTB-750	10 - 18
	Terminal Block (CPU Board) Type JTB870	12 - 30
B (11 - 15 kW)	Main Terminal Block Type OK-050	6 - 12
	Terminal Block (CPU Board) Type JTB870	12 - 30
C (18.5 - 22 kW)	Main Terminal Block Type OK-080	6 - 12
	Terminal Block (CPU Board) Type JTB870	12 - 30
D (30 - 37 kW)	Main Terminal Block Type OK-080	(2) 6
	Terminal Block (CPU Board) Type JTB870	12 - 30
E (45 - 55 kW)	Main Terminal Block HP-RT150-71	2/0-6, STR
	Terminal Block (CPU Board) Type JTB870	12 - 30
F (75 - 90 kW)	Main Terminal Block HP-RT200-71	4/0-4, STR
	Terminal Block (CPU Board) Type JTB870	12 - 30
G (110 kW)	Main Terminal Block HP-RT300-71	350 kcmil-4, STR
	Terminal Block (PU Board) Type JTB870	12 - 30



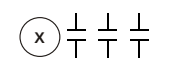
Power supply

Ensure that the power supply meets the rated values in this manual.



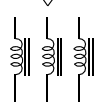
Fuse

The converter may take a high input current when being switched on. Select an appropriate fuse in accordance with the table in **8.5**.



Electromagnetic contactor

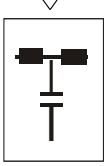
Do not use an electromagnetic contactor as the power switch, because it will shorten the service life of the converter.



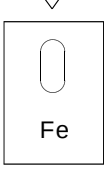
AC reactor

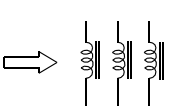
An AC reactor is recommended to improve power factors.

The wiring length must be less than 10 m.



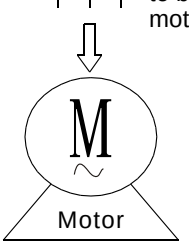
AC filter

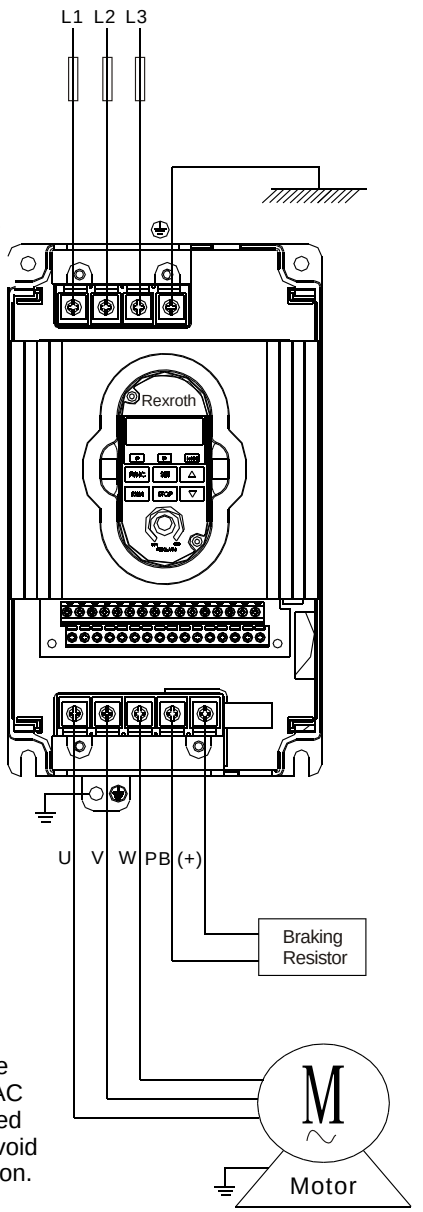




AC output reactor

When the connecting wire is longer than 80 m, an AC output reactor is suggested to be added in order to avoid motor insulation destruction.





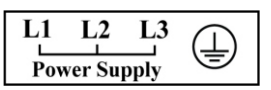
8.7 Wiring Terminals

- **Main circuit terminals**

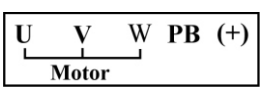
Terminal	Description
L1 L2 L3	Main power supply inputs
U V W	Frequency converter outputs (to be connected to the motor)
PB	Reserved terminal for external braking resistor (applicable to 0.75 to 15 kW frequency converters)
P1, (+)	DC positive bus outputs
(-)	DC negative bus output
⏚	Grounding

Applicable to: 0.75 kW to 7.5 kW

Converter Top:

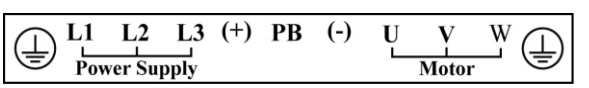


Converter Bottom:

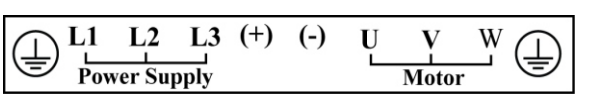


Note: There are separate ground connections (for motor cable shield and PE) at the converter bottom.

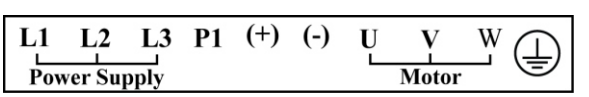
Applicable to: 11 kW to 15 kW



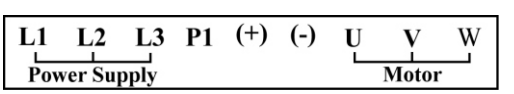
Applicable to: 18.5 kW to 37 kW



Applicable to: 45 kW to 90 kW



Applicable to: 110 kW

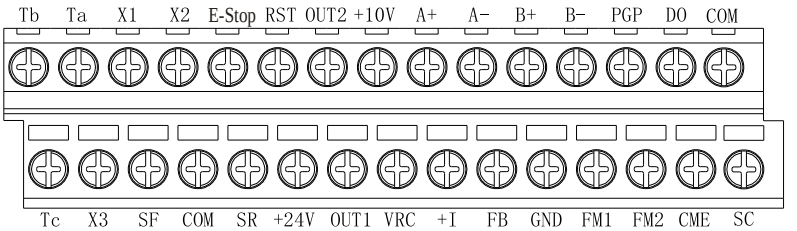


Note 1: For 11 - 110 kW frequency converters, the main circuit terminals are on the bottom of the converter.

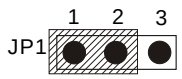
Note 2: For 45 - 110 kW frequency converters, UL marked connectors and cables should be used for wiring of the terminal blocks. The connectors may be of crimp, ring or fork types or other similar types.

Note 3: There are two ground connections, one for the input side, the other for the output side.

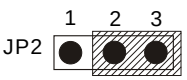
- **Control terminal diagram (applicable to 0.75 to 110 kW CPU board)**



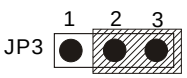
- **Switch Wiring (Shown are factory defaults)**



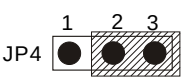
(Programming jumper, not to be modified by the user)



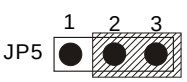
Position 2-3: encoder signals are input at A+, A-, B+ and B- in a differential manner
position 1-2: encoder signals are input at A- and B- by open collector.



position 2-3: external voltmeter at FM2 side
position 1-2: external ammeter at FM2 side

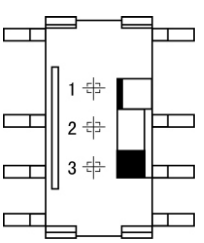


position 2-3: external voltmeter at FM1 side
position 1-2: external ammeter at FM1 side



position 2-3: 0 to 10 V analog signal input at VRC side
position 1-2: 0 to 5 V analog signal input at VRC side

- **NPN/ PNP Switch**

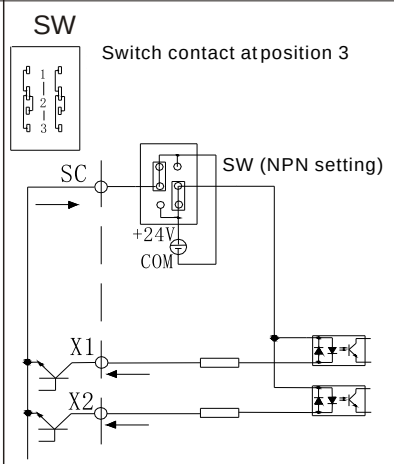
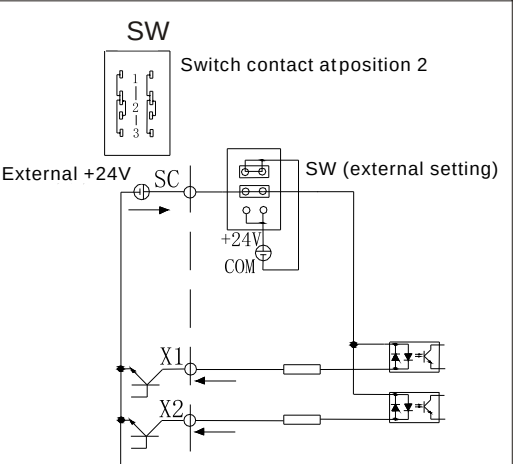


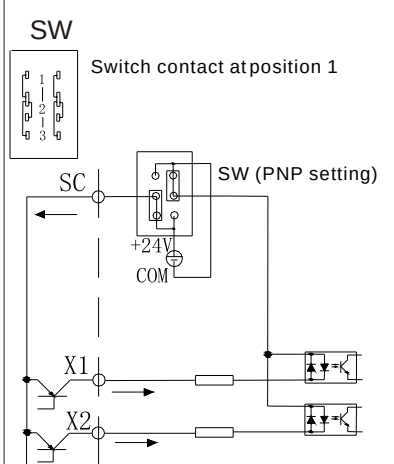
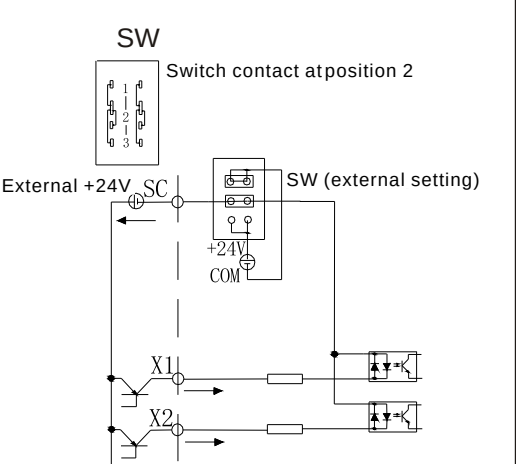
A three position switch determines:

1. The internal 24 V power supply or an external 24 V power supply is used for the inputs.
2. The inputs are activated by connection of 24 V to an input (PNP/ active input) or connection of 0 V to an input (NPN/ passive input).

Note: The factory default for the three position switch is NPN (Switch contact at position 3).

• NPN and PNP Modes and Signal Input

	Internal Power Supply	External Power Supply
NPN		

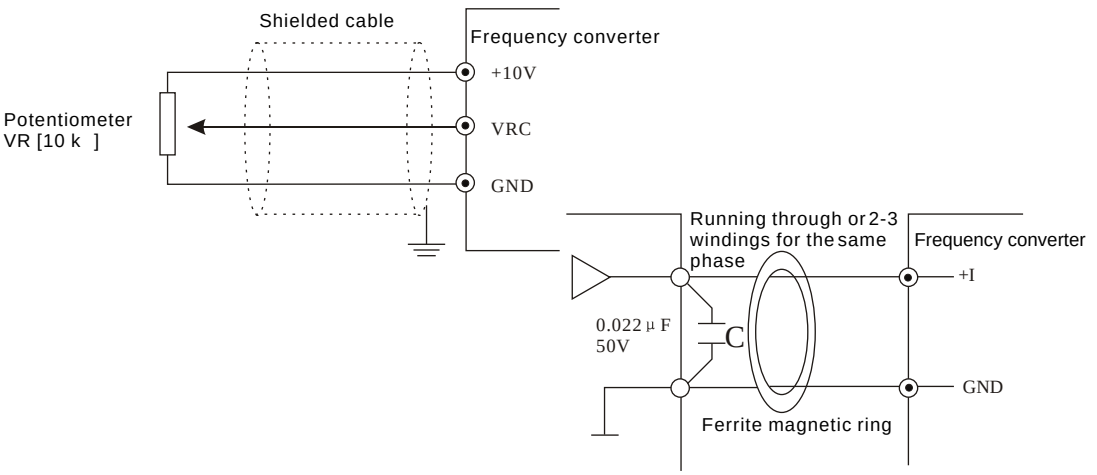
	Internal Power Supply	External Power Supply
PNP		

- **Analog input terminal (+10V, VRC, GND, +I)**

(1) For connection of low level analog signals, which are easily affected by external interference, the wiring length should be as short as possible (less than 20 m), shielded cables must be used.

(2) Use twin contacts to handle low level signals if contacts are used in the circuit. In addition, do not ground the GND terminal.

(3) Incorrect operation may occur due to interference on the analog signal. In such cases, connect a capacitor and ferrite core at the output side of the analog signal, as shown below.



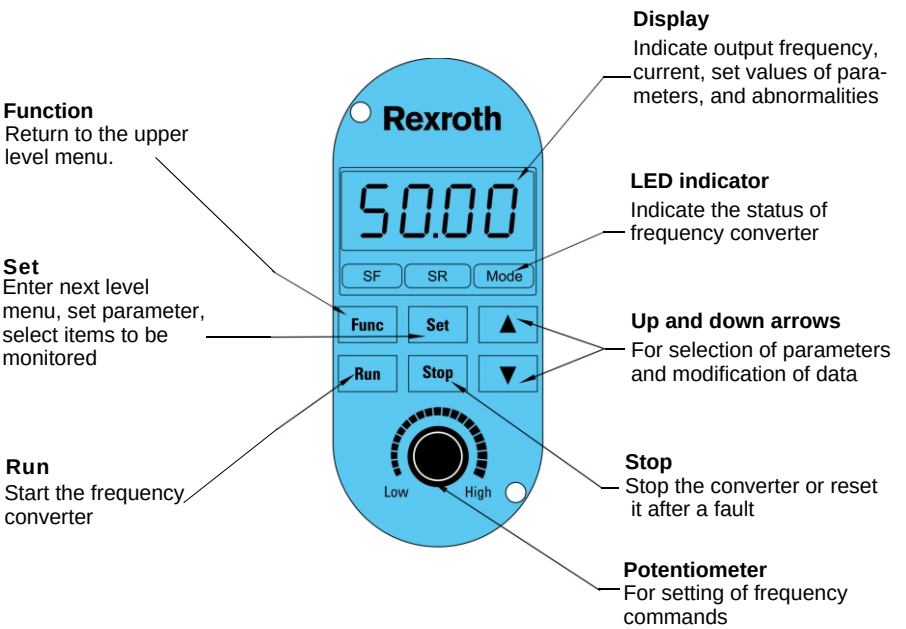
• Control circuit terminals

Type	Terminals	Signal Function	Description	Signal Requirement
Digital input signals	SF	Forward/stop	See parameters [b00] and [E38]	Depend on the position of the NPN/PNP switch
	SR	Reverse/stop	See parameters [b00] and [E38]	
	RST	Error reset	"closed" for reset	
	E-Stop	Stop converter output	See parameters [E32], [E33] and [E34]	
	X1, X2, X3	Multi-function inputs	See parameters [b00], [b34], [b35], [E39], [H07] and [H23]	
	SC	Shared +24 V/COM connection for digital input signals	The common terminal for SF\SR\RST\E-Stop\X1-X3	
Analog input signals	FB	Analog feedback signal for CLOSED LOOP control	Feedback signal, analog voltage input.	Input voltage range: 0 to 5 V Input resistance: 100 kΩ Resolution: 1:1000
	+10 V	Supply voltage for external frequency setpoint value specified	Power supply for speed commands	10 V (max. current 10 mA)
	VRC	Analog main frequency reference	Analog frequency command	JP5, position 2-3 Input voltage range: 0 to 10 V Input resistance: 100 kΩ Resolution: 1:2000 JP5, position 1-2 Input voltage range: 0 to 5 V Input resistance: 50 kΩ Resolution: 1:2000
	+I		Analog actual frequency feedback signal	Input current range: 4 to 20 mA Input resistance: 165 Ω Resolution: 1:1000
	GND	Frame potential (0 V)	Isolated from COM	–
Digital output signals	OUT1	Open collector output 1	Programmable output with multiple functions. See parameters [E16], [E17] for details.	Open collector outputs insulated via opto-electric couplers: Max. output voltage: 24 VDC Max. output current: 50 mA
	OUT2	Open collector output 2		
	CME	Common terminal for OUT1 and OUT2	For internal 24 V power supply: to be short circuited to the COM terminal For external power supply: to be short circuited to the "earth" of the power supply	
	DO-COM	Digital frequency output	Programmable to be pulse output with multiple functions. See parameters [E09] and [E10]	Open collector outputs insulated via opto-electric couplers: Max. output voltage: 24 VDC Max. output frequency: 50 mA
	Ta	Relay changeover contacts	Ta-Tb: N.O; Tb-Tc: N.C (Tb is the common terminal) Programmable relay output with multiple functions. See parameter [E18]	Contact transmitter capacity: 250 VAC, 3 A 30 VDC, 3 A
	Tc			
	Tb	Shared relay contact		
	+24 V	Shared +24 V connection for digital output signals	–	+24 VDC
Analog output Signals	FM1-GND	Analog multi-function output 1	Programmable analog output with multiple functions. See parameters [E04]-[E08]	Output voltage/current settable via JP4 for FM1 and via JP3 for FM2: Output voltage: 0 or 2 to 10 V Output current: 0 or 4 to 20 mA
	FM2-GND	Analog multi-function output 2		
Encoder signal	PGP/COM	Supply voltage +24 VDC	Power supply for the encode	Max. output current: 100 mA
	A+	Encoder signal A	Short JP2-3 to select encoder differential inputs from A+, A-, B+ and B-; Short JP1-2 to select open collector inputs from A-, B-.	Connection voltage: 8 to 24 V Max. input frequency: 200 kHz
	A-			
	B+	Encoder signal B		
	B-			
Communi cation	485+	RS485 interface	Standard 485 communication port. Use twisted pair or shielded cables.	–
	485-			

9 Operating Panel

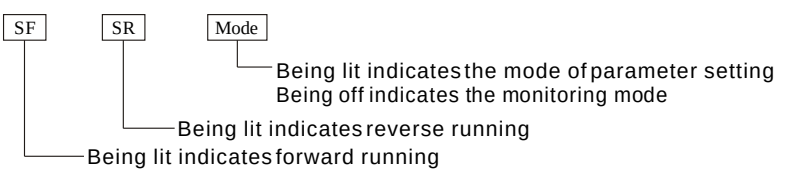
9.1 Overview

The operating panel is at the center of the converter and composed of two areas: display and keys. The display shows mode settings and state of the converter. The keys allow the user to program the converter.

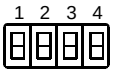


Note: 0.75 to 7.5 kW frequency converters have potentiometer as a standard configuration, and 11 to 110 kW frequency converters have optional potentiometer.

LED indication description

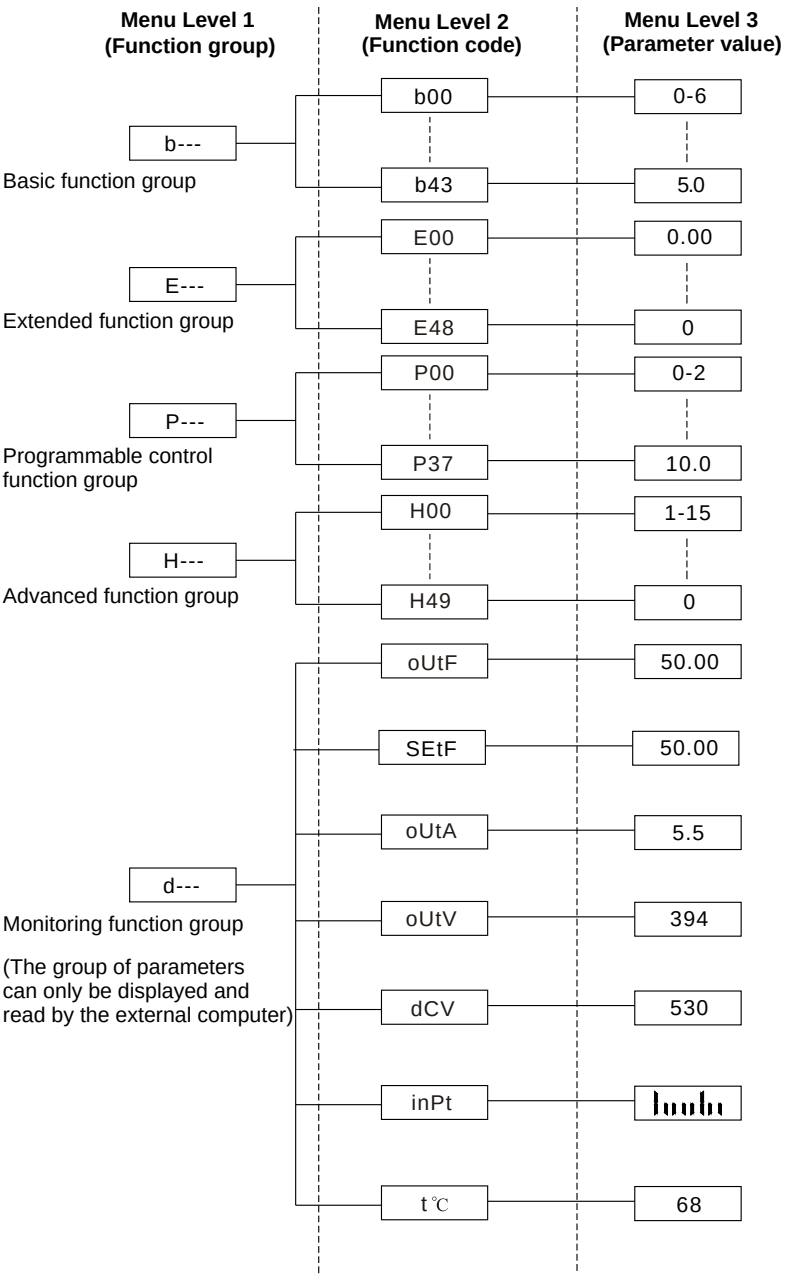


Digital indication description

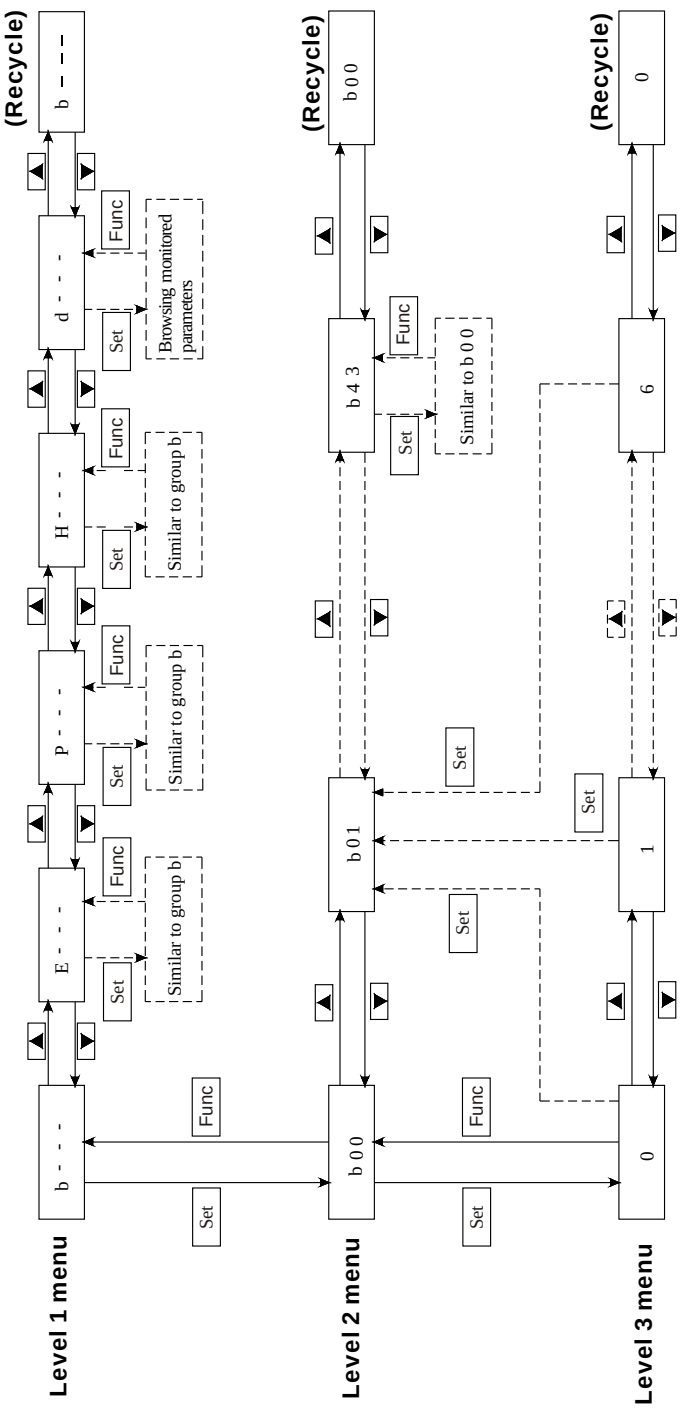


- The LEDs display has four digits, it is sometimes used to show 5 significant digits.
- In parameter setting mode, if LED 1 flashes, this indicates the highest place of the 5 significant digits is hidden, to view this press down both **Func** and ▲ to show the 4 most significant digits; if LED 4 flashes, this indicates the lowest place of the 5 significant digits is hidden, press down both **Func** and ▼ to show the 4 least significant digits.
- In the running monitoring mode, no LED flashes; if LED 4 is displayed as a decimal point, it indicates there are 5 significant digits, and the digit of the lowest place is hidden.

9.2 3-Level Menu Structure



Note: The digital operating panel can be used to toggle between menu options, set parameters, and reset the converter after fault with the **Func**, **Set**, ▲ and ▼ buttons.



Note ①: The default monitored parameters of menu level 3 group d will be displayed automatically on the panel, when power is on or if no key is pressed over 2 minutes.

Note ②: The values on the digital display during running do not flash under menu level 2 and 3 of group d (during monitoring.) The values flash when the converter is not running.

Fast setting:

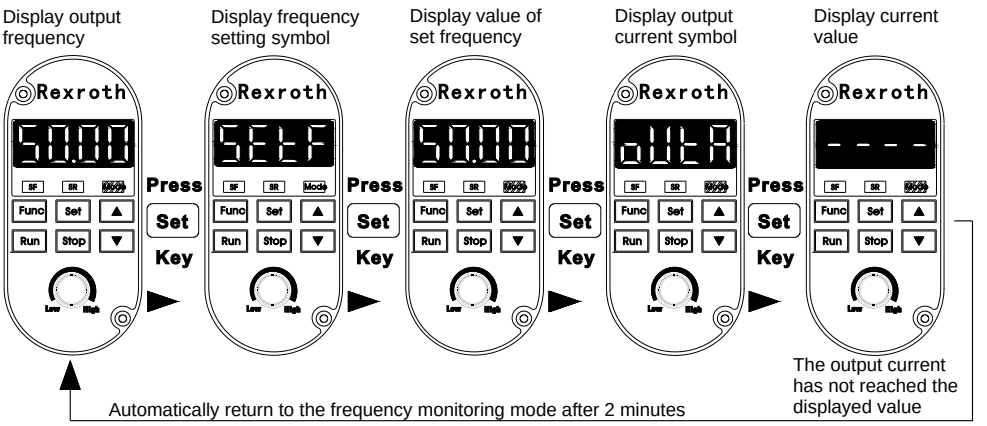
(1) Press **Func** under nenu level 1 to display the default monitored parameters (depending on parameter [E21] of the displayed items while running) of menu level 3 of group d;

(2) In case of fault, press **Func** to toggle between the fault display and menu level 1 (it is possible to make operations after entering the menu level 1);

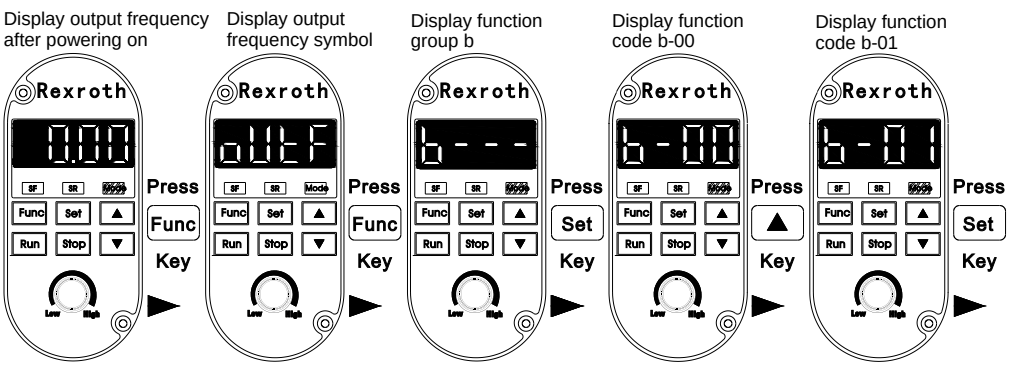
(3) Press **Func** in menu level 2 of group d to enter level 1 of group b.

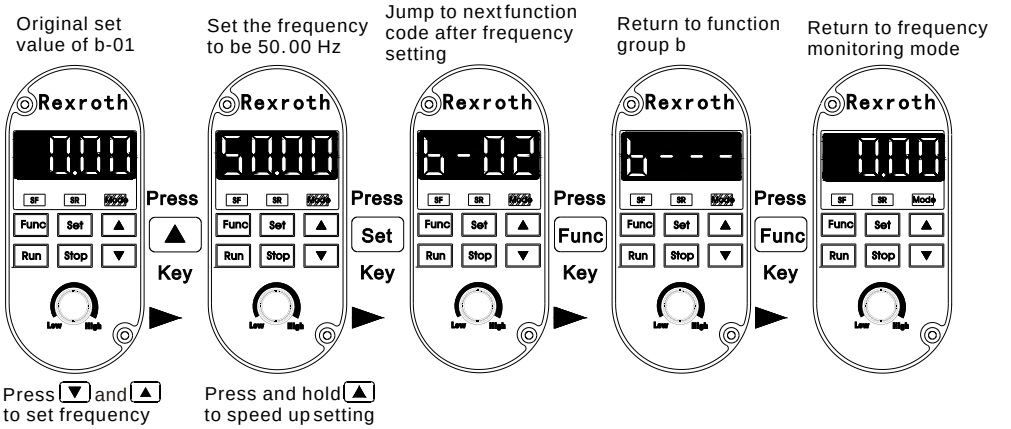
9.3 Example of Operating Panel Operation

- Under the frequency monitoring mode, follow the steps to view output current as shown below:



- Under output frequency monitoring mode, follow the steps to frequency given by the digital operating panel to be 50 Hz ([b01]=50.00 Hz) as shown below:

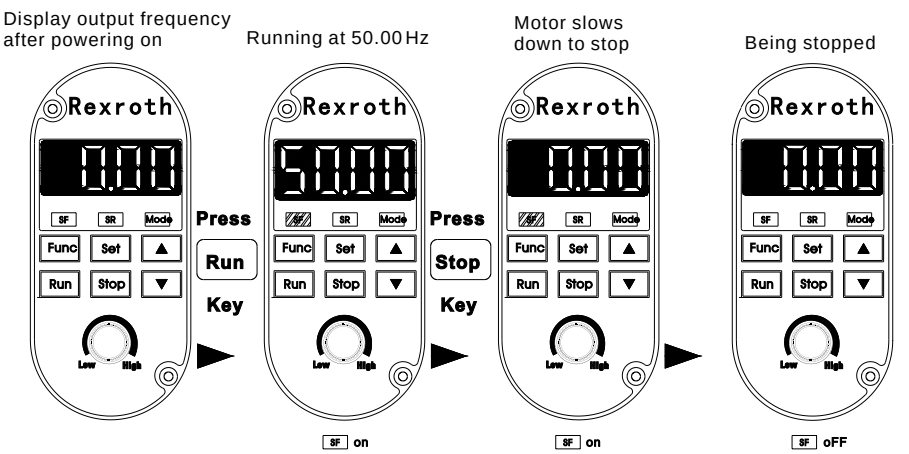




Note ①: To set frequency with the digital operating panel, [b02]=0;

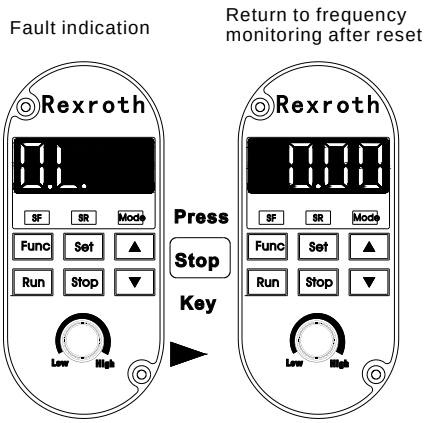
Note ②: Frequency setting can be done during stop or running of the converter.

- **Run/Stop** operation example: [b00]=0, [b02]=1



Note: By factory default, SF/SC is closed, and the displayed output will be 50.00 Hz after pressing down **Run** key and rotating the potentiometer knob to the maximum position.

- Operation and resetting in case of fault



Note ①: A fault code will be displayed in case of fault. In case of several faults, corresponding fault codes will be displayed alternatively.

Note ②: Press **Stop** to reset after fault, and the fault code will not be displayed any longer. **Stop** key is valid if the cause of fault has not been removed.

Note ③: If a fault code OC-1, OC-2 or OC-3 is displayed, wait for 5 seconds before pressing **Stop** key to activate resetting.

Note ④: In case of fault, use **Func** to directly re-enter level 1 menu to work with most of the function codes.

10 Commissioning

10.1 Check and Preparation before Commissioning

Make the following checks before commissioning

(1) Check if the wiring is correct. Particularly, ensure that the output terminals U, V and W of the converter are not connected to the power supply and that the ground terminal is well grounded.

(2) Ensure that there are no short circuits between terminals, live terminals or short circuit to ground.

(3) Ensure that terminal connections, connectors and screws are secure.

(4) Ensure the motor is not connected to other loads.

(5) Check that all inputs are off before powering on, to ensure that the converter will be started as expected and no unexpected action occurs.

(6) Make following checks after powering on:

★ 0.00 flashes on the display (without fault indication)

★ The cooling fan in the converter works normally (factory default [H22]=0)

10.2 Commissioning

10.2.1 Overview

(1) The converter has no internal contactor, and will be energized once the main power supply is connected. When the **Run** key is pressed down (or the control through terminals is selected), the converter will give output.

(2) By factory default, the converter initially displays output frequency after being energized. You may change it to another parameter as instructed in Chapter 11 "**Parameter Settings**". The factory defaults are based on standard applications with standard motors.

(3) The frequency command of the converter is set to be 0.00 Hz upon delivery, meaning that the motor will remain static. Use▲to change the value to start the motor.

Note ①: Ensure the plastic enclosure is in place before the device is powered on. Wait for 30 minutes after powering off, to allow the DC capacitor being discharged, and do not remove the upper cover during the period.

Note ②: The starting and stopping of the converter is controlled by the panel as a factory default, and terminal SF and SC are linked.

Note ③: The frequency is 0.00 Hz by factory default. This is to avoid uncontrolled motor running during the initial setting. For the motor to run, enter a frequency value by pressing▲under the monitoring mode or in [b01].

10.2.2 Fe Basic Parameter Fast Setting

Use the operating panel to set the necessary parameters based on the application loads and specifications, to allow the converter to start rapidly. A basic generic parameter fast setting table is given below.

Function Code	Function	Parameter Range and Description		Factory Default
b03	Highest frequency - HF	50.00 - 650.00 Hz	●	50.00
b04	Base frequency - BF	20.00 - HF	●	50.00
b05	Base voltage - BV	400 V class 240.0 V - 480.0 V	●	380.0
b16	Acceleration time	0.1 - 6500.0s		10.0
b17	Deceleration time	0.1 - 6500.0s		10.0
b21	Upper frequency - UF	LF-HF	●	50.00
b22	Lower frequency - LF	0.00-UF	●	0.50
b40	Converter input power supply voltage	400 V model: 380.0 - 480.0 V	●	380.0
E32	E-Stop command input modes in the case of external problem	0: Stopping due to connected E-Stop/SC 1: Stopping due to disconnected E-Stop/SC		0
H38	Motor poles	2 - 14 (input an even number)	●	4
H39	Rated motor power	0.4 - 999.9 kW	●	Depending on model
H40	Rated motor current	0.1 - 999.9 A	●	Depending on model
H47	Auto-tuning of motor parameters	0: no auto-tuning of parameters 1: auto-tuning when the motor is static 2: auto-tuning when the motor is running. After auto-tuning, [H47] is automatically set to be 0.	●	0

Commissioning may be conducted after checks have been done as per section **10.1**. The factory default for the converter is set that it will be controlled by the digital operating panel. Terminals SF and SC have to be shorted.

10.2.3 Example: Commissioning of converter with potentiometer (up to 7.5 kW)

Fe series frequency converter up to 7.5 kW can use the front mounted potentiometer to set the frequency output by the following procedure.

Sequence	Operation	Description
1	Rotate the potentiometer counterclockwise to the greatest extent.	The initial frequency value is 0.00
2	Press **Run**	Enter the command for running, with 0.00 displayed
3	Rotate the potentiometer clockwise (rightwards) slowly and the displayed value starts to change, until 5.00 is displayed	The motor starts to run.
4	Observe: ★ Whether the motor runs in the correct direction ★ Whether the motor runs smoothly ★ Whether there is any abnormal noise or problem	Observe the running, and immediately stop the motor by shutting off the power if any abnormality occurs. Restart commissioning only after the fault causes have been removed.
5	Rotate the potentiometer clockwise (rightwards)	The motor accelerates.
6	Rotate the potentiometer counterclockwise (leftwards)	The motor decelerates.
7	Press **Stop**	Enter the command for stopping. The motor stops.

10.3 Restore Factory Defaults

If the converter fails to run the motor due to incorrect parameters, a simple solution is to initialize the parameters to factory defaults.
Set [b39] = 2 will start initialization to restore factory defaults at 50 Hz. Set [b39] = 3 will start initialization to restore factory defaults at 60 Hz.
For a fast setting use the basic parameter list once again.

10.4 Solutions for Simple Fault during Commissioning

(1) Over current occurs during acceleration --- Increase the acceleration time.
(2) Over voltage occurs during deceleration --- Increase the deceleration time.
(3) Over current occurs immediately after pressing the **Run** key --- Incorrect wiring. Check if U, V, W outputs of the main circuit are shorted or grounded.
(4) The motor runs in the direction opposite to the desired one --- Change the sequence of any two phases of U, V and W.
(5) The motor vibrates and runs in uncertain directions after each starting --- A phase of U, V and W is disconnected (output phase loss).

10.5 Notes on Frequent Starting and Stopping

(1) Do not use the electromagnetic contactor connected prior to L1, L2 and L3 terminals to start and stop the converter to avoid early aging and damage of the filter capacitor. External terminals SF, SR and X1-X3 may be used to start and stop the converter.
(2) The current limiting resistor for capacitor recharging may be damaged due to frequent starting and stopping with the electromagnetic contactor connected prior L1, L2 and L3 terminals.

11 Parameter Settings

11.1 Converter Functions

Basic Function Group (group b)

Function	Function Code	Function Code Description	Parameter Range and Description		Factory Default①
Running command source	b00	Set the source of commands for running (Option 1 and 3 have frequency command source)	0: **Run/Stop** control with operating panel 1: External via control terminals, **Up/Down** control 2: External via control terminals (including multi-speed), while **Stop** key is activated 3: Internal PLC control 4: External via control terminals (X3 is used to switch between internal/external sources of frequency command, while **Stop** key is activated) 5: External computer controls **Run/Stop**, while **Stop** key is activated 6: External computer controls **Run/Stop**, while **Stop** key is deactivated	●	0
Frequency command source	b01	Frequency command given by digital operating panel	0.00 - HF		0.00
	b02	Set the source of commands for frequency	0: Given by the digital operating panel 1: By the operating panel's potentiometer 0 - 5 V 2: Reverse action of the digital operating panel's potentiometer 5 - 0 V 3: Direct action of external terminal 0 - 5 V 4: Reverse action of external terminal 5 - 0 V 5: Direct action of external terminal 0 -10 V 6: Reverse action of external terminal 10 - 0 V 7: Direct action of external terminal 4 - 20 mA 8: Reverse action of external terminal 20 - 4 mA 9: External terminal (0 - 5 V)＋(4 - 20 mA) 10: VRC terminal -10 V - ＋10 V 11: Pulse frequency setting 12: External computer frequency setting	●	1

Note: ● indicates a parameter cannot be modified when the converter is in operation. Without the symbol, it indicates a parameter can be modified during running.

Note: ① indicates values that correspond to the factory default upon initialization at 50 Hz.

Function	Function Code	Function Code Description	Parameter Range and Description		Factory Default
V/F curve setting	b03	Highest frequency - HF	50.00 - 650.00 Hz	●	50.00
	b04	Base frequency - BF	20.00 - HF	●	50.00
	b05	Base voltage - BV	400 V class: 240.0 V - 480.0 V	●	380.0
	b06	V/F curve mode	OFF: User-defined V/F curve H-00 - H-15: Constant torque characteristic P-00 - P-15: Square descending torque characteristic	●	H-03
	b07	Lowest output frequency - LLF	0.00 - [b09]	●	0.00
	b08	Lowest output voltage - LLV	0 - 120 %BV	●	1
	b09	Middle frequency1 - Mf1	LLF - BF	●	0.00
	b10	Middle voltage1 - MV1	0 - 120 %BV	●	1
	b11	Middle frequency2 - MF2	BF - HF	●	50.00
	b12	Middle voltage2 - MV2	0 - 120 %BV	●	100
	b13	Highest voltage - HV	0 - 120 %BV	●	100
Constant voltage control	b14	Constant voltage control	OFF/ON	●	OFF
Acceleration/ deceleration time and type	b15	Acceleration/ deceleration curve	0: Linear; 1: S curve		0
	b16	Acceleration time	0.1 - 6500.0s		10.0
	b17	Deceleration time	0.1 - 6500.0s		10.0
Forward and reverse rotation dead zone time	b18	Forward and reverse rotation dead zone time	0.0 - 10.0s	●	1.0
Torque increasing	b19	Automatic torque increasing	OFF / 1 - 10 % ①	●	OFF
Electronic thermal relay	b20	Electronic thermal relay	50 - 110 % / OFF ②	●	100
Output frequency limits	b21	Upper frequency - UF	LF - HF	●	50.00
	b22	Lower frequency - LF	0.00 - UF	●	0.50
LF mode	b23	LF mode	0：Stop; 1：Run	●	0
	b24	Hysteresis frequency width	0.10 - HF	●	1.00
Analog frequency setting adjustment	b25	Gain of given channel	0.00 - 9.99		1.00
	b26	Analog input channel filtering time constant	0.0 - 10.0s		0.5
	b27	Minimum curve setting	0.0 - 100.0 %		0.0
	b28	Frequency corresponding to minimum curve setting	0.00 - 650.00 Hz		0.00
	b29	Maximum curve setting	0.0 - 100.0 %		100.0
	b30	Frequency corresponding to maximum curve setting	0.00 - 650.00 Hz		50.00
Slip frequency compensation	b31	Slip frequency compensation	0.00 - 5.00 Hz	●	0.00

Function	Function Code	Function Code Description	Parameter Range and Description		Factory Default
Starting	b32	Starting frequency	0.00 - 60.00 Hz		0.50
	b33	Starting holding time	0.0 - 10.0s		0.0
Stopping mode	b34	Stopping mode selection	0: OFF; 1: X1; 2: X2; 3: X3; 4: ON	●	0
Jogging control	b35	Jogging mode selection	0: OFF; 1: X1; 2: X2; 3: X3	●	0
	b36	Jogging frequency	0.00 - HF		0.00
	b37	Jogging acceleration time	0.1 - 6500.0s		0.1
	b38	Jogging deceleration time	0.1 - 6500.0s		0.1
Data protection options and initialization	b39	Data protection options and initialization	0: All parameters are readable and rewritable. 1: All parameters are read-only except [b01] and [b39] 2: Initialization to factory defaults at 50 Hz ③ 3: Initialization to factory defaults at 60 Hz 4: Clear all fault records	●	0
Converter input power supply voltage setting	b40	Converter input power supply voltage setting	400 V model: 380.0 V - 480.0 V	●	380.0
Frequency setting saving in case of power down	b41	Frequency setting saving in case of power down	0: Not saved when power is off or the converter is stopped 1: Not saved when power is off; saved when the converter is stopped 2. Saved when power is off; not saved when the converter is stopped 3. Saved when power is off or the converter is stopped	●	1
Zero speed control selection	b42	Zero speed control selection	0: No output 1: Output DC voltage as per [b43] as holding torque 2: Output DC voltage as per V/F curve	●	0
Voltage command for zero speed control	b43	Voltage command for zero speed control	0.0 - 20.0 %BV	●	5.0
Changing rate of **Up/Down**	b44	Changing rate of **Up/Down**	0.01 99.99 Hz / s		1.00

Note ①: "OFF" at the beginning indicates that it represents "OFF" when the external computer reads "0".

②: "OFF" at the end indicates that it represents "OFF" when the external computer reads "111".

③: Hold ▲ key for 2 seconds to change [b39] from 1 to 2, 3 or 4.

Extended Function Group (group E)

Function	Function Code	Function Code Description	Parameter Range and Description	Factory Default
Skip frequency	E00	Skip frequency 1	0.00 - HF	0.00
	E01	Skip frequency 2	0.00 - HF	0.00
	E02	Skip frequency 3	0.00 - HF	0.00
	E03	Skip frequency range	0.00 - 10.00 Hz	0.00
FM1and FM2 analog output selection	E04	FM1 selection	0: Output frequency 1: Output voltage 2: Output current 3: PI feedback signal	0
	E05	FM1 gain setting	0.50 - 1.20	1.00
	E06	FM2 selection	0: Output frequency 1: Output voltage 2: Output current 3: PI feedback signal	1
	E07	FM2 gain setting	0.50 - 1.20	1.00
FM channel mode	E08	FM channel mode	0: FM1 outputs 0 - 20mA or 0 - 10V, FM2 outputs 0 - 20mA or 0 - 10V 1: FM1 outputs 4 - 20mA or 2 - 10V, FM2 outputs 4 - 20mA or 2 - 10V 2: FM1 outputs 0 - 20mA or 0 - 10V, FM2 outputs 4 - 20mA or 2 - 10V 3: FM1 outputs 4 - 20mA or 2 - 10V, FM2 outputs 0 - 20mA or 0 - 10V	0
DO pulse output	E09	Pulse output selection	0: Output frequency 1: Output voltage; 2: Output current	2
	E10	Maximum output pulse frequency	0.1 - 50.0 kHz	10.0
OUT open collector output	E11	Frequency level detection FDT1	0.00 - 650.00 Hz	50.00
	E12	FDT1 lagging frequency	0.00 - 650.00 Hz	1.00
	E13	Frequency level detection FDT 2	0.00 - 650.00 Hz	25.00
	E14	FDT 2 lagging Frequency	0.00 - 650.00 Hz	1.00
	E15	Frequency to reach detection range	0.00 - 650.00 Hz	2.00

Function	Function Code	Function Code Description	Parameter Range and Description		Factory Default
OUT open collector output	E16	Open collector output OUT1	0: Running 1: Frequency level detection signal 1 (FDT 1) 2: Frequency level detection signal 2 (FDT 2) 3: Frequency arrive signal (FAR) 4: Reserved 5: Under voltage 6: Overload 7: Reserved 8: Zero speed (lower than starting frequency) 9: E-Stop 10: Lower voltage 11: No trip action 12: Fault 13: Programmable program running 14: Programmable program run 15: Run for one stage 16: Over current stall 17: Over voltage stall 18: In forward rotation command indication 19: In reverse rotation command indication 20: Zero speed (incl. Stop) 21: Being braked 22: Accelerating 23: Decelerating 24: Fan action 25: Reserved		6
	E17	Open collector output OUT2			0
Relay output selection	E18	Relay Ry output selection			12
Stall over current protection	E19	Stall over current protection level during running	50 - 200 % of rated current / OFF		OFF
	E20	Stall over current protection level during acceleration	50 - 200 % of rated current / OFF		OFF
Running monitoning display	E21	Running monitoring display	0: Display output frequency 1: Display set frequency 2: Display output current 3: Display output voltage 4: Display DC bus voltage 5: Display input signal 6: Display radiator temperature		0
Display factor	E22	Display factor A	-99.9 - 6000.0 ④		1.0
	E23	Display factor B	-99.9 - 6000.0 ⑤		0.0

Note ④⑤: “0” read by the external computer corresponds to “-99.9”, and “60999” corresponds to “6000.0”.

Function	Function Code	Function Code Description	Parameter Range and Description		Factory Default
PI regulator selection	E24	PI adjustment selection	0: No PI; 1: Direct action; 2: Inverse action	●	0
	E25	PI adjustment feedback channel selection	0: Control terminal FB direct action (voltage input 0 - 5 V) 1: Control terminal FB inverse action (voltage input 5 - 0 V) 2: Control terminal +I direct action (current input 4 - 20 mA) 3: Control terminal +I inverse action (current input 20 - 4 mA) 4: Single phase pulse feedback 5: Orthogonal pulse feedback	●	0
	E26	Proportional gain	0.01 - 99.99 times		10.00
	E27	Integration time constant	0.1 - 60.0s		1.0
	E28	Sampling period	0.1 - 60.0s	●	0.1
	E29	PI adjustment upper factor	0 - 100 / OFF	●	OFF
	E30	PI adjustment lower factor	0 - 100	●	0
Maximum input pulse	E31	Maximum input pulse frequency	1.0 kHz - 200.0 kHz	●	20.0
Handing of stopping in the case of external problem	E32	E-Stop command input modes in the case of external problem	0: Stopping due to connected E-Stop/SC 1: Stopping due to disconnected E-Stop/SC	●	0
	E33	E-Stop modes in the case of external problem	0: Coasting to stop 1: Deceleration to stop	●	0
	E34	E-Stop alarm modes in the case of external problem	0: No alarm output 1: Alarm output		1
Lower voltage and under voltage protection	E35	Lower voltage protection mode	0: Coasting to stop 1: Deceleration to stop 2: Resume with previous speed	●	2
	E36	Under voltage protection alarm	0: No alarm output 1: Alarm output		0
Starting upon powering on	E37	Converter automatically starts after powering on	0: Forbidden 1: Allowed	●	0
SF and SR terminal function	E38	SF and SR terminal function	0: Forward/reverse mode 1: **Run/stop**, forward/reverse mode 2: Key control holding mode	●	0
Self-holding function	E39	Self-holding function	0:OFF 1:X1 2:X2 3:X3	●	0

Function	Function Code	Function Code Description	Parameter Range and Description		Factory Default
Input phase loss protection enabling	E40	Input phase loss protection enabling	0: Input phase loss protection disabled 1: Input phase loss protection enabled		1
Output phase loss protection enabling	E41	Output phase loss protection enabling	0: Output phase loss protection disabled 1: Output phase loss protection enabled		1
Fault retry	E42	Fault retry options	0: Fault retry disabled 1: Retry from over current at constant speed 2: Retry from over current during acceleration 3: Retry from over current during deceleration 4: Retry from over voltage at constant speed 5: Retry from over voltage during acceleration 6: Retry from over voltage during deceleration 7: Retry from overload 8: Retry from overheat 9: Retry from drive protection 10: Retry from EMI 11: Retry from input phase loss 12: Retry from output phase loss 13: Retry from stop after response to internal abnormality command 14: Retry from any fault	●	0
	E43	Waiting time for fault retry	2.0 - 60.0s	●	10.0
	E44	Number of fault retries	0 - 3	●	0
Fault records	E45	Current fault record	0: No fault record 1: O.C.-1, over current at constant speed 2: O.C.-2, over current during acceleration 3: O.C.-3, over current during deceleration 4: O.E.-1, over voltage at constant speed 5: O.E.-2, over voltage during acceleration 6: O.E.-3, over voltage during deceleration 7: O.L., overload 8: O.H., overheat 9: d.r., drive protection; 10:CPU-, EMI 11: IPH.L., input phase loss 12: oPH.L., output phase loss 13: E.-St., stopping by external abnormality command	☆	0
	E46	Last fault record		☆	0
	E47	Last 2 fault records		☆	0
	E48	Last 3 fault records		☆	0

Note: ☆ indicates that direct modification is not allowed.

Progammable Control Function Group (group P)

Function	Function code	Function Code Description	Parameter Range and Description		Factory Default
PLC working mode	P00	PLC working mode	0: Stop after one cycle 1: Cycle operation 2: Running at the last frequency after one cycle	●	0
Speed 0 setting	P01	Speed 0 running direction	SF: Forward; SR: Reverse		SF
	P02	Speed 0 holding time	OFF/1 - 65000s	●	OFF
Speed 1 setting	P03	Speed 1 frequency setting	0.00Hz - HF		5.00
	P04	Speed 1 running direction	SF: Forward; SR: Reverse		SF
	P05	Speed 1 holding time	OFF/1 - 65000s	●	OFF
	P06	Speed 1 acceleration time	0.1 - 6500.0s		10.0
	P07	Speed 1 deceleration time	0.1 - 6500.0s		10.0
Speed 2 setting	P08	Speed 2 frequency setting	0.00Hz - HF		10.00
	P09	Speed 2 running direction	SF: Forward; SR: Reverse		SF
	P10	Speed 2 holding time	OFF/1 - 65000s	●	OFF
	P11	Speed 2 acceleration time	0.1 - 6500.0s		10.0
	P12	Speed 2 deceleration time	0.1 - 6500.0s		10.0
Speed 3 setting	P13	Speed 3 frequency setting	0.00Hz - HF		20.00
	P14	Speed 3 running direction	SF: Forward; SR: Reverse		SF
	P15	Speed 3 holding time	OFF/1 - 65000s	●	OFF
	P16	Speed 3 acceleration time	0.1 - 6500.0s		10.0
	P17	Speed 3 deceleration time	0.1 - 6500.0s		10.0
Speed 4 setting	P18	Speed 4 frequency setting	0.00Hz - HF		30.00
	P19	Speed 4 running direction	SF: Forward; SR: Reverse		SF
	P20	Speed 4 holding time	OFF/1 - 65000s	●	OFF
	P21	Speed 4 acceleration time	0.1 - 6500.0s		10.0
	P22	Speed 4 deceleration time	0.1 - 6500.0s		10.0
Speed 5 setting	P23	Speed 5 frequency setting	0.00Hz - HF		40.00
	P24	Speed 5 running direction	SF: Forward; SR: Reverse		SF
	P25	Speed 5 holding time	OFF/1 - 65000s	●	OFF
	P26	Speed 5 acceleration time	0.1 - 6500.0s		10.0
	P27	Speed 5 deceleration time	0.1 - 6500.0s		10.0
Speed 6 setting	P28	Speed 6 frequency setting	0.00Hz - HF		50.00
	P29	Speed 6 running direction	SF: Forward; SR: Reverse		SF
	P30	Speed 6 holding time	OFF/1 - 65000s	●	OFF
	P31	Speed 6 acceleration time	0.1 - 6500.0s		10.0
	P32	Speed 6 deceleration time	0.1 - 6500.0s		10.0
Speed 7 setting	P33	Speed 7 frequency setting	0.00Hz - HF		50.00
	P34	Speed 7 running direction	SF: Forward; SR: Reverse		SF
	P35	Speed 7 holding time	OFF/1 - 65000s	●	OFF
	P36	Speed 7 acceleration time	0.1 - 6500.0s		10.0
	P37	Speed 7 deceleration time	0.1 - 6500.0s		10.0

Advanced Function Group (group H)

Function	Function code	Function code description	Parameter range and description		Factory default
PWM frequency	H00	PWM frequency	1 - 15 kHz (range depends on frequency converter rated power)	●	Depending on model
Automatic adjustment of PWM frequency	H01	Automatic adjustment of PWM frequency	OFF/ON	●	ON
Restarting after transient stopping	H02	Delay for restarting after transient stopping	OFF/0.1 - 20.0s	●	OFF
	H03	Reserved		●	
DC braking	H04	DC braking time	OFF/0.1 - 10.0s	●	OFF
	H05	DC braking initial frequency	0.00 - 60.00 Hz	●	3.00
	H06	DC braking voltage	1 - 15 % of rated voltage	●	10
	H07	DC braking hoding options	0:OFF 1:X1 2:X2 3:X3 4:ON		0
Communication parameters	H08	Communication protocol selection	0: ModBus; 1: PROFIBUS		0
	H09	Local address	ModBus:1 - 247; PROFIBUS:1 - 126		1
	H10	Baud rate selection	0: 1200 bps 1: 2400 bps 2: 4800 bps 3: 9600 bps 4: 19200 bps 5: 38400 bps		3
	H11	Data format	0: N, 8, 2 (1 start bit, 8 data bits, 2 stop bits, without check) 1: E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even) 2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd)		0
	H12	Communication disruption action	0: Stop; 1: Keep running		0
	H13	Communication disruption detection time	0.0 (ineffective), 0.1 - 60.0s		0.0
	H14	PZD3 settings	0: Output frequency 1: Frequency setting 2: Output current 3: Output voltage 4: Bus voltage 5: Switch value input signal 6: Module temperature 7: PI controlled feedback quantity		0
	H15	PZD4 settings			1
	H16	PZD5 settings			2
	H17	PZD6 settings			3
	H18	PZD7 settings			4
	H19	PZD8 settings			5
	H20	PZD9 settings			6
	H21	PZD10 settings			7
Fan control	H22	Fan control	0: Auto control; 1: No control		0

Function	Function code	Function code description	Parameter range and description		Factory default
Energy saving	H23	Energy saving mode	0: Disabled; 3: X3 1: X1; 4: Automatic 2: X2; energy saving	●	0
	H24	Voltage resumption time	0.0 - 5.0s	●	2.0
	H25	Voltage gain for energy saving under external terminal control	50 - 100 %	●	80
	H26	Energy saving initial frequency	0.00 - 650.00 Hz	●	0.00
	H27	Automatic energy saving control gain	0.0 - 10.0	●	0.5
	H28	Automatic energy saving time constant	0.00 - 10.00	●	1.00
	H29	Automatic energy saving rated percentage slip	0.1 - 50.0 %	●	5.0
No-trip control	H30	Automatic current limitation level	G series: 20 % - 250 % OFF; P series: 20 % - 170 % OFF	●	150
	H31	Current regulator proportion factor	0.000 - 1.000	●	0.060
	H32	Current regulator integrating time constant	0.001 - 10.000	●	0.200
	H33	Auto current limitation at constant speed	ON/OFF	●	ON
Stall over voltage level selection	H34	Stall over voltage selection	400 V model: 710 - 800 V / OFF	●	OFF
Over voltage protection point setting	H35	Software over voltage protection point	790 - 820 V	●	810
Braking voltage setting	H36	Deceleration braking activation voltage threshold	600 - 785 V	●	770
Dropping control	H37	Dropping control	0.00 - 10.00 Hz	●	0.00
Motor parameters	H38	Motor poles	2 - 14 (put in an even number)	●	4
	H39	Rated motor power	0.4 - 999.9 kW	●	Depending on model
	H40	Rated motor current	0.1 - 999.9 A	●	Depending on model
	H41	No-load current	0.1 - 999.9 A	●	Depending on model
	H42	Stator resistance	0.00 - 50.00 %	●	Depending on model
	H43	Leakage inductance	0.00 - 50.00 %	●	Depending on model
	H44	Rotor resistance	0.00 - 50.00 %	●	Depending on model
	H45	Mutual inductance	0.00 - 2000.0 %	●	Depending on model
	H46	Rated slip frequency	0.00 - 20.00 Hz	●	0.00
	H47	Auto-tuning of parameters	0: No auto-tuning of parameters 1: Auto-tuning when the motor is static 2: Auto-tuning when the motor is running. After auto-tuning, [H47] is automatically set to be 0. **WARNING:** Motor load has to be removed before using auto-tuning function [H47]=2!	●	0
Total working hours	H48	Total working hours	0 - 65535 hours	☆	0
Password input	H49	Password input	Enabling factory function codes		0

Note: ☆ indicates that direct modification is not allowed.

11.2 Notes on Function Groups

Notes on Basic Function Group (group b)

b00	Running command source (Option 1 and 3 have frequency command source)		Factory default	0
	Setting range	0	**Run/Stop** control with operating panel	
		1	**Up/Down** control with operating panel	
		2	External via control terminals (including multi-speed), while **Stop** key is activated	
		3	Internal PLC control	
		4	External via control terminals (X3 is used to switch between internal/external sources of frequency command), while **Stop** key is activated	
		5	External computer controls **Run/Stop**, while **Stop** key is activated	
		6	External computer controls **Run/Stop**, while **Stop** key is deactivated	

[b00]=0: Run/Stop control (related settings: [b02], [b16] and [b17])

- **Run/Stop** are used to control starting/stopping; [b02] sets the frequency command source; [b16] and [b17] set acceleration and deceleration time.
- When [b02] = 0-9 or 11 or 12, the input state of SF/SR decides the direction of rotation:

  SF closed: Forward rotation; SR closed: Reverse rotation

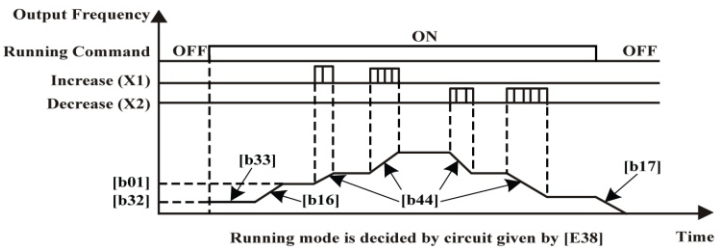
  If SF and SR are closed or disconnected simultaneously, the motor will not run even **Run** key is pressed.

  If SF and SR are closed or disconnected simultaneously, the converter will stop even **Stop** is not pressed.

  When [b02] = 10, the direction of rotation is decided by the polarity of the frequency giving voltage instead of SF/SR control.

[b00]＝1: External via control terminals, Up/Down control (related setting: [E38])

- **Run** key is deactivated, and **Stop** is activated.
- Running mode is decided by the circuit given by [E38].
- While the running command remains valid, closing X1 will lead to frequency increasing, and
  closing X2 will lead to frequency decreasing.
- While the digital operator panel is under running monitoring status, ▲ can be used to increase the frequency, and ▼can be used to decrease the frequency.
- The changing rate of the output frequency given by **Up/Down** is decided by function code [b44].
- A general example is shown as the below chart. When the running command is valid the frequency converter starts running at the startup frequency (set by [b32], startup frequency), and holds at the startup frequency (holding time is set by [b33],). The converter accelerates (acceleration time is set by [b16]) to the set frequency [b01] and then responds to the commands of **Up/Down**.
  In the startup phase, if the startup frequency is higher than the set frequency, the converter will decelerate (deceleration time is set by [b17]) to the set frequency.



- If X1 or X2 has already been defined by another function, [b00] can not be set to 1.

[b00]=2: External via control terminals (including multi-speed), while Stop key is activated (related settings: [E38] and group P parameters)

- **Run** key is deactivated, and **Stop** is activated.
- The running mode and source running commands are decided by the circuit given by [E38].
- Speeds 0-7 are selected with binary combinations of the input status of terminals X1, X2 and X3; the holding time of the speed is decided by the holding time of the combination of terminals X1, X2 and X3; the running direction is decided by the circuit given by [E38]; and the frequency acceleration/deceleration time is set by group P parameters.
- If X1, X2 or X3 have already been defined by another function, [b00] can not be set to 2. The default input of the occupied X terminal is 0.

[b00]=3: Internal PLC control (related settings: group b parameters)

- Press **Run** key or close SF to start running, and press **Stop** key or close SR to stop running.
- For a speed not involved in the programmed running, its holding time is set to be OFF; for a speed involved in the programmed running, the function code for the holding time is set to be the corresponding time, and group P parameters, including frequency, direction and acceleration/deceleration time, should be set.

[b00]=4: External via control terminals (X3 is used to switch between internal/external sources of frequency command, while Stop key is activated) (related setting: [b02])

- **Run** key is deactivated, and **Stop** is activated.
- The running mode is decided by the circuit given by [E38].
- When X3 is effective, frequency is set by external signals. If [b02]=0-2, [b02] is considered as 5. Other values of [b02] shall be normally considered.
- When X3 is disconnected, the operating panel potentiometer is used to set the frequency.

[b00]=5: External computer controls Run/Stop, while Stop key is activated (related settings: [H08], [H09], [H10] and [H11])

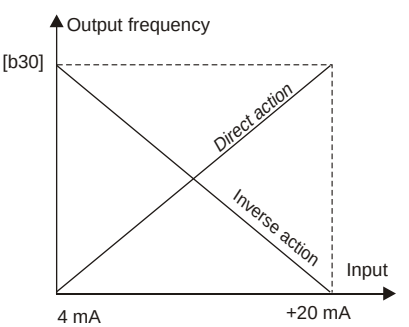
[B00]=6: External computer controls Run/Stop, while Stop key is deactivated (related settings: [H08], [H09], [H10]and [H11])

An external computer controls starting, stopping and direction, and **Stop** is deactivated.

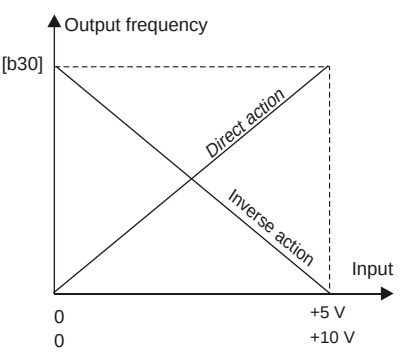
b01	Frequency command given by the digital operating panel		Factory default	0.00
	Setting range	0.00 - HF	Minimum unit	0.01 Hz

- Frequency given by the digital panel is the frequency command source, when [b02]＝0.
- When [b00]=0, the initial frequency is given, and the function code may also be used to directly set the frequency.
- When [b00]=3, frequency given by the digital panel is the frequency command source of speed 0.

b02	Frequency command source		Factory default	1
	Setting range	0	Given by the digital operating panel .
		1	By the operating panel’s potentiometer 0 - 5 V
		2	Inverse action of the digital operating panel’s potentiometer 5 - 0 V
		3	Direct action of external terminal 0 - 5 V (input 0 - 5 V between VRC / GND)
		4	Inverse action of external terminal 5 - 0 V (input 0 - 5 V between VRC / GND)
		5	Direct action of external terminal 0 - 10 V (input 0 - 10 V between VRC / GND)
		6	Inverse action of external terminal 10 - 0 V (input 0 - 10 V between VRC / GND)
		7	Direct action of external terminal 4 - 20 mA (input 4 - 20 mA between +I / GND)
		8	Inverse action of external terminal 20 - 4 mA (input 4 - 20 mA between +I / GND)
		9	External terminals (0 - 5 V) + (4 - 20 mA)
		10	VRC terminal input -10 V - +10 V: -10 - 0 reverse; 0 - 1 0 V forward **Run / Stop** signals given by [E38]
		11	Pulse frequency setting
		12	External computer frequency setting

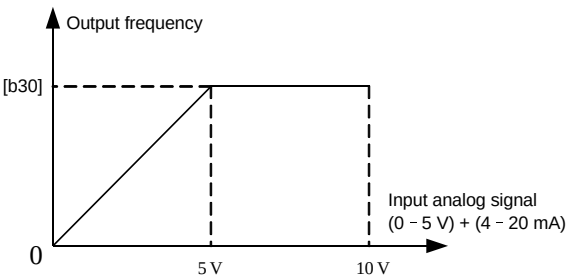


Input current 4 - 20 mA

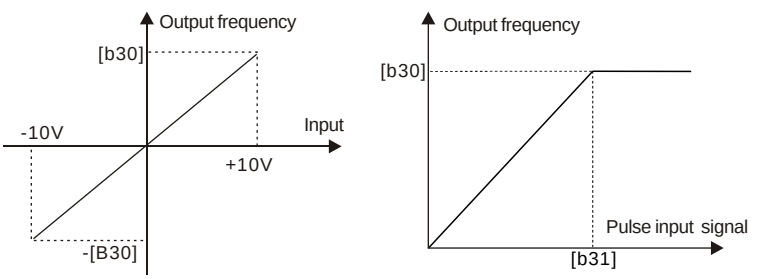


Panel potentiometer control 0 - 5 VDC
Analog voltage control 0 - 10 VDC

- When [b02]=9, the frequency is given by the combination of VRC terminal (0 - 5 V) and +I terminal (4 - 20 mA). 4 mA analog current is equivalent to 0 V, and similarly, 20 mA is equivalent to 5 V, as shown in the diagram below.



- When [b02]=10，VRC terminal inputs -10 V to +10 V analog signals, and the direction is decided by the input voltage signal. Negative signal indicates reverse rotation, and positive signal indicates forward rotation. When [b02]=5, 6 or 10, set switch JP5 to position 2-3.



- [b02]=11 pulse frequency setting. Pulse signals are input via terminal A-, set switch JP2 to position 1-2.

  When [b02]=11, [E25]=4/5 invalid.If [b02]=11, then [E25]=4 and [E25]=5 are invalid.

  Furthermore the maximum input pulse frequency [E31] has to be set.

  Special note: The set value of [E31] must be linked to the frequency corresponding to maximum curve setting [b30].

- When [b02]=12, frequency is given by the external computer. Please correctly set function codes [H08], [H09], [H10] and [H11].

b03	Highest frequency - HF		Factory default	50.00
	Setting range	50.00 - 650.00 Hz	Minimum value	0.01 Hz

- Sets the highest output frequency of the converter.

b04	Base frequency - BF		Factory default	50.00
	Setting range	20.00 - HF	Minimum value	0.01 Hz

- The rated motor frequency is written on the nameplate of the motor.

b05	Base voltage - BV		Factory default	380.0
400V models	Setting range	240.0 V - 480.0 V	Minimum value	0.1 V

- The rated motor voltage is written on the nameplate of the motor.

b06	V/F curve mode		Factory default	H-03
	Setting range	OFF: user-defined V/F curve		
		H-00 - H-15: constant torque characteristic		
		P-00 - P-15: square descending torque characteristic		

- OFF: For the mode with user-defined V/F curve, hidden function codes [b07] - [b13] are displayed.

b07	Lowest output frequency - LLF		Factory default	0.00
	Setting range	0.00 - [b09]	Minimum value	0.01 Hz

- The lowest allowable motor frequency is used to set the lowest frequency of the user-defined V/F curve.

b08	Lowest output voltage - LLV		Factory default	1
	Setting range	0 - 120 %BV	Minimum value	1 %

- The lowest allowable motor voltage is a percentage of the base voltage (BV) and used to set the lowest voltage of the user-defined V/F curve.

b09	Middle frequency 1 - MF1		Factory default	0.00
	Setting range	LLF - BF	Minimum value	0.01 Hz

- Middle frequency 1 of the user-defined V/F curve.

b10	Middle voltage 1 - MV1		Factory default	1
	Setting range	0 - 120 %BV	Minimum value	1 %

- The voltage which corresponds to Mf1 of the user-defined V/F curve is a percentage of the base voltage (BV).

b11	Middle frequency 2 - MF2		Factory default	50.00
	Setting range	BF - HF	Minimum value	0.01 Hz

- Middle frequency 2 of the user-defined V/F curve.

b12	Middle voltage 2 - MV2		Factory default	100
	Setting range	0 - 120 %BV	Minimum value	1 %

- The voltage which corresponds to MF2 of the user-defined V/F curve is a percentage of the base voltage (BV).

b13	Highest voltage - HV		Factory default	100
	Setting range	0 - 120 %BV	Minimum value	1 %

- The voltage which corresponds to HF of the user-defined V/F curve is a percentage of the base voltage (BV).

b14	Constant voltage control		Factory default	OFF
	Setting range	OFF/ON		

- When the constant voltage control is enabled (set to be on), the converter can automatically control the voltage of output V/F characteristics within the set value, even if the power supply voltage changes.
- However, the output voltage of the converter must not be higher than the input voltage, even if constant voltage control is ON.
- No constant voltage control is available when the set value is OFF, and the output voltage will be in direct proportion to the input voltage.

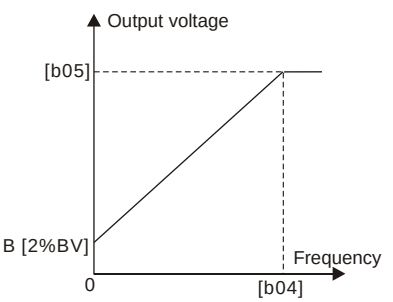
★ Following are notes on frequently used V/F curves.

(a) General automation applications

H-0 - H-15 constant torque characteristic

Example: Constant torque characteristic settings

Function code	Value [50Hz]
b03	70.00 Hz
b04	50.00 Hz
b05	380.0 V
b06	H-02

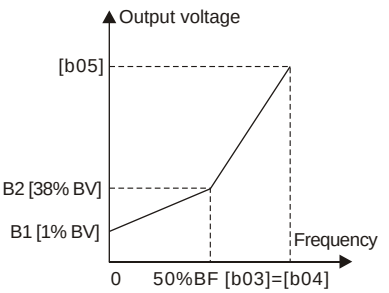


(b) Fan and pumps

P-00 - P-15 square decreasing torque

Example: Parameters setting for fans and pumps

Function code	Values [50 Hz]	Values [60 Hz]
b03	50.00 Hz	60.00 Hz
b04	50.00 Hz	60.00 Hz
b05	380.0 V	380.0 V
b06	P-08	P-08

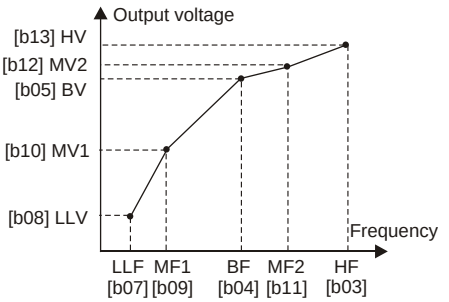


Voltage of H curve and P curve

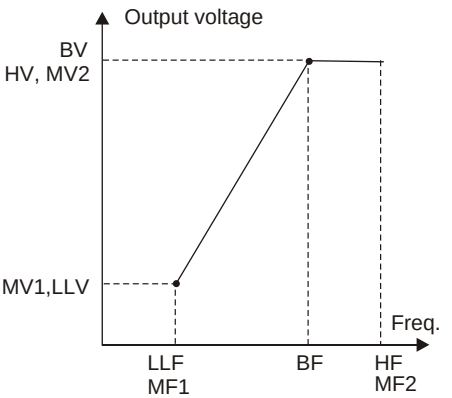
H curve constant torque setting		P curve square descending torque setting		
Display	B [x%BV]	Display	B1 [x%BV]	B2 [x%BV]
H-00	0	P-00	0	25
H-01	1	P-01	0	27
H-02	2	P-02	0	28
H-03	3	P-03	0	29
H-04	4	P-04	0	30
H-05	5	P-05	1	32
H-06	6	P-06	1	34
H-07	7	P-07	1	36
H-08	8	P-08	1	38
H-09	9	P-09	1	40
H-10	10	P-10	2	42
H-11	11	P-11	2	44
H-12	12	P-12	2	46
H-13	13	P-13	2	48
H-14	14	P-14	2	49
H-15	15	P-15	2	50

(c) User-defined V/F curve

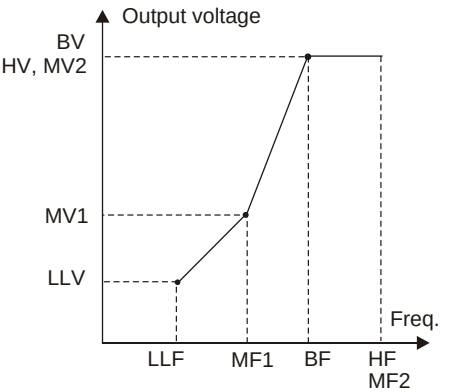
When [b06]=OFF, the following curve can be defined with [b03] - [b05] and [b07] - [b13].



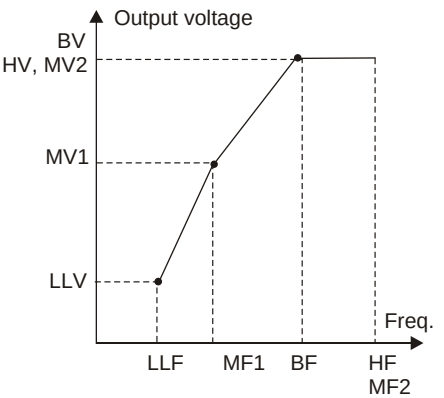
★ The following user-defined V/F curves are common based on the requirements of loaded motors.



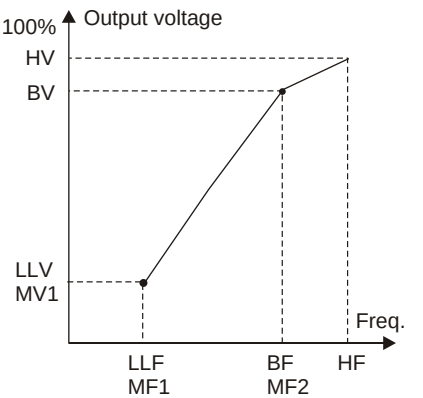
Constant torque type



Fan and pump energy saving type



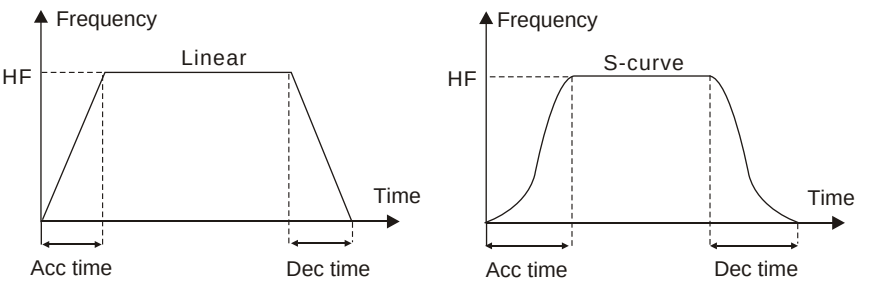
High starting torque type



Higher than the rated frequency Variable frequency motor with increased voltage

b15	Acceleration/deceleration curve		Factory default	0
	Setting range	0	Linear acceleration/deceleration	
		1	S curve acceleration/deceleration	
b16	Acceleration time		Factory default	10.00
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
b17	Deceleration time		Factory default	10.00
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s

[b15]: Acceleration/deceleration curve mode



- [b15] also determines the jogging acceleration/deceleration curve mode.

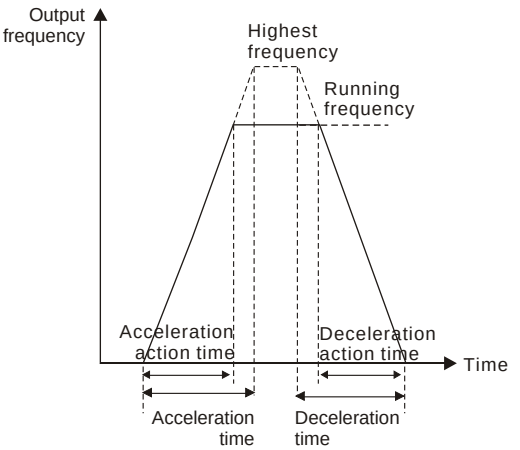
[b16]: Acceleration time

- If internal PLC control is disabled ([b00]≠3), [b16] sets the time for frequency increasing from 0.00 Hz to HF.
- If internal PLC control is enabled ([b00]=3) and speed 0 is activated, [b16] sets the time for frequency increasing from 0.00 Hz to the frequency given by [b01].

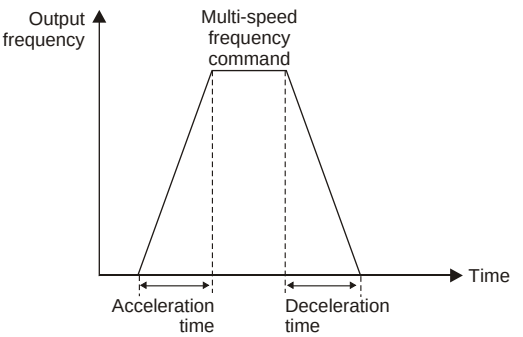
[B17]: Deceleration time

- If internal PLC control is disabled ([b00]≠3), [b17] sets the time for frequency decreasing from HF to 0.00 Hz.
- If internal PLC control is enabled ([b00]=3) and speed 0 is activated, [b17] sets the time for frequency decreasing from the frequency given by [b01] to 0.00 Hz.

(1) Internal PLC control is disabled ([b00]≠3)

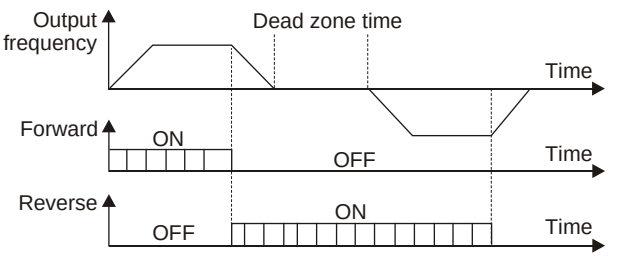


(2) Internal PLC control is enabled ([b00] = 3)



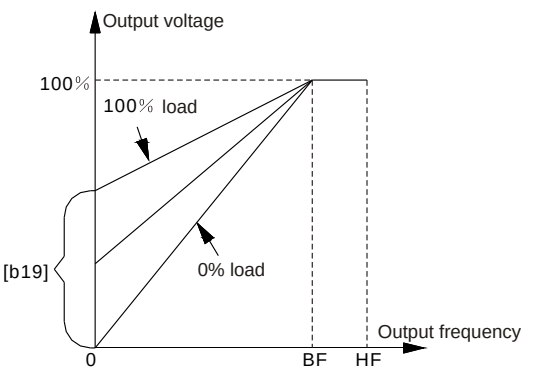
b18	Forward and reverse rotation dead zone time		Factory default	1.0
	Setting range	0.0 - 10.0s	Minimum unit	0.1s

- The time given by [b18] is the duration from slowing down to stop to starting to accelerate in the reverse direction. The function should be set based on load inertia and deceleration time.
- If forward and reverse rotation signals are input simultaneously, the motor will decelerate to stop. When the forward and reverse rotation dead zone time is 0.0s, only forward rotation is allowed.



b19	Automatic torque increase	Factory default	OFF
	Setting range	OFF	
		1 - 10 %	

- "OFF" is to prohibit automatic torque increasing, and other values is the percentage to the voltage increasing at 0 output frequency and rated current. It is used to improve the torque characteristics of the motor running at a low frequency. The function can automatically adjust the output voltage of the converter, based on the load current, to increase torque at low frequency and avoid over excitation when the motor has no load.
- In operation, the converter automatically determines the percentage of voltage increasing based on output frequency and load current.
- During commissioning, [b19] should be gradually increased. An excessively large value may lead to excessive motor current or activation of "no-trip function".



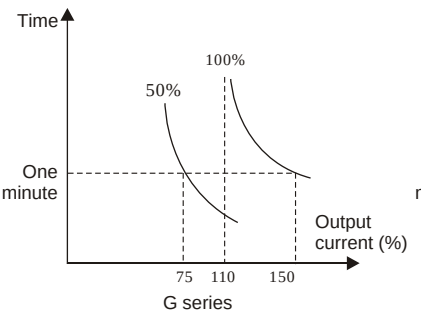
b20	Electronic thermal relay	Factory default	100
	Setting range	50 - 110 %	
		OFF	

- Electronic thermal relay setting value (%) = $\frac{\text{rated motor current}}{\text{rated converter current}} \times 100\%$
- If only one motor is connected to one converter, no overload relay is necessary, and the function should be set based on the characteristics of the motor.
- If multiple motors are driven or the rated current of the motor is lower than the setting value of electronic overheat protection, the protection for motors is not sufficient. Provide a thermal relay for each motor in this case.

- Inverse time lag characteristics of overload protection are shown in the diagram.

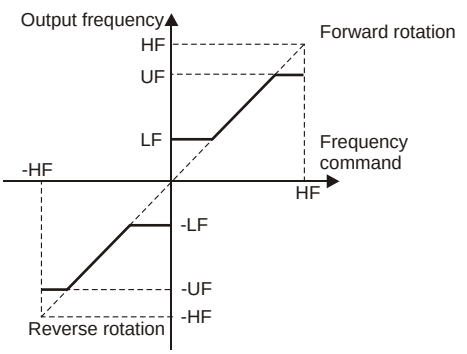
  G series: 200 % of rated current for 1 second; 150 % of rated current for 60 seconds.

  P series: 120 % of rated current for 60 seconds; 105 % of rated current for 60 minutes.



b21	Upper frequency - UF		Factory default	50.00
	Setting range	LF - HF	Minimum unit	0.01 Hz
b22	Lower frequency - LF		Factory default	0. 50
	Setting range	0.00 - UF	Minimum unit	0.01 Hz

- Upper frequency (UF) is the highest allowable frequency when the converter works stably.
- Lower frequency (LF) is the lowest allowable frequency when the converter works stably.

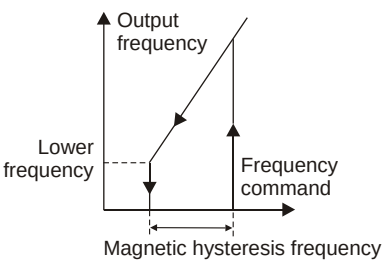


b23	LF mode		Factory default	0
	Setting range	0	Stop	
		1	Run	
b24	Hysteresis frequency width		Factory default	1.00
	Setting range	0.10 - HF	Minimum unit	0.01 Hz

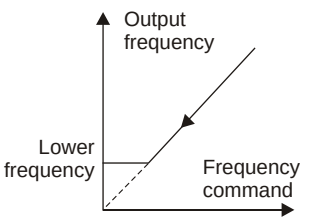
When the frequency command is lower than the set value of LF, the converter has two work modes:

- If [b23]=0, the output frequency directly lowers down to 0.00 Hz; it is necessary to set hysteresis frequency width, to avoid possible frequent starting and stopping of the converter at frequencies around the LF.
- If [b23] = 1, the converter works under the LF.

(1) [b23]=0

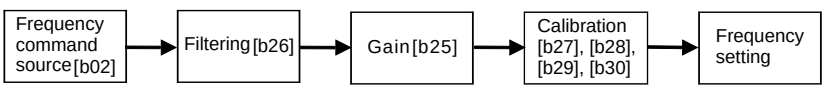


(2) [b23]=1

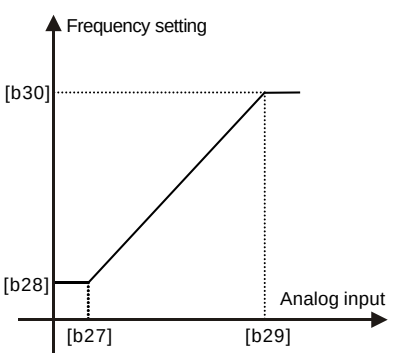


b25	Gain of given channel		Factory default	1.00
	Setting range	0.00 - 9.99	Minimum unit	0.01
b26	Analog input channel filtering time constant		Factory default	0.5
	Setting range	0.0 - 10.0s	Minimum unit	0.1s
b27	Minimum curve setting		Factory default	0.0
	Setting range	0.0 - 100.0 %		
b28	Frequency corresponding to minimum curve setting		Factory default	0.00
	Setting range	0.00 - 650.00 Hz	Minimum unit	0.01 Hz
b29	Maximum curve setting		Factory default	100.0
	Setting range	0.0 - 100.0 %	Minimum unit	
b30	Frequency corresponding to maximum curve setting		Factory default	50.00
	Setting range	0.00 - 650.00 Hz	Minimum unit	0.01 Hz

When VRC, +I, pulse frequency or operating panel potentiometer input is selected to give open loop frequency, the relationship between commanded value and set frequencies is illustrated below:



- If analogue signals (0 - 5 V, 0 - 10 V, 4 - 20 mA, or operating panel potentiometer 0 - 5 V) and pulse frequency are used to set the frequency command value, the output frequency may be freely set by changing [b25], [b27], [b28], [b29] and [b30].
- [b26] defines the first order lag time constant, for first order lag filtering of analog input. The larger the time constant, more interference signals will be suppressed, but the lower the response will be. [b26] is also the filtering time constant of FB channel.
- For command value of frequency after filtering and gain processing, their relationship with the frequency setting is determined by the curve defined with [b27], [b28], [b29] and [b30]. See the diagram below for details.



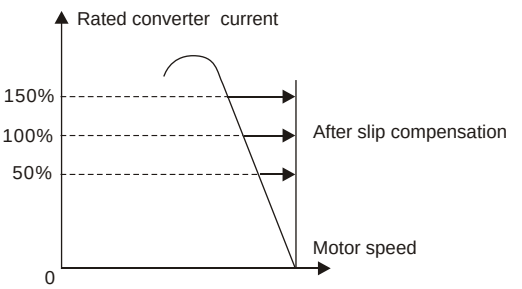
b31	Slip frequency compensation		Factory default	0.00
	Setting range	0.00 - 5.00 Hz	Minimum unit	0.01 Hz

- When the frequency converter is used to drive an asynchronous motor, the load and slip will be increased. The parameter is used to set the compensation frequency to reduce slip, allowing the motor to run under the rated current with a speed closer to the synchronous speed. The slip frequency compensation can be determined based on the loads.

Note: Too large slip frequency compensation will cause the motor speed to exceed the synchronous speed. In this case:

Upper frequency = output frequency + K × (slip compensation [b31])

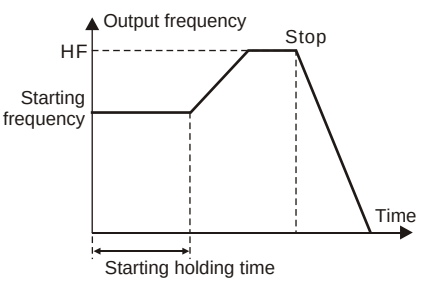
K depends on the load current and is less than or equal 1.



Note: If slip frequency compensation is used, turn off drooping control of [H37] by setting [H37]=0.00.

b32	Starting frequency		Factory default	0.50
	Setting range	0.00 - 60.00 Hz	Minimum unit	0.01 Hz
b33	Starting holding time		Factory default	0.0
	Setting range	0.0 - 10.0s	Minimum unit	0.1s

- [b32] starting frequency can be used to optimally adjust the starting torque in combination with torque compensation; however, a too large value may lead to a current trip.
- [b33] refers to the duration of running at the starting frequency. If the running frequency is lower than the starting frequency, the motor will run at the starting frequency. After the starting holding time ends, the running frequency will be reached according to the deceleration time, to address the starting of systems with different inertia loads.



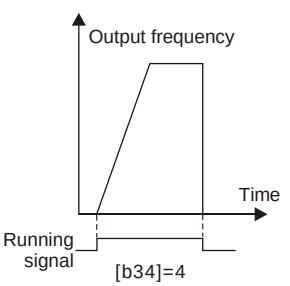
b34	Stopping mode selection	Factory default	0
	Setting range	0	OFF
		1	X1
		2	X2
		3	X3
		4	ON

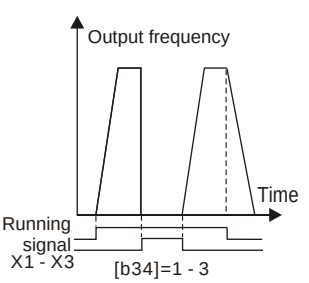
- The motor may be stopped in two modes: deceleration to stop and coasting to stop.

  [B34]=0: Deceleration to stop is selected while coasting to stop is turned off.

  [B34]=1-3: Coasting to stop is achieved by closing external terminals X1, X2 or X3, while deceleration to stop applies for other stopping commands.

  [B34]=4: Coasting to stop is selected.
- If the parameter [b34] is set to be 1-3 and if the selected terminal is closed, coasting to stop will be immediately activated and F.r.on is immediately displayed. If the external terminal is disconnected, the output will increase from 0.00 Hz to the set frequency. If a stop signal is given and the selected terminal is disconnected, the motor decelerates to stop.
- If X1, X2 or X3 has already been defined by another function, [b34] will not show related value to avoid repeated definition for the same terminal.

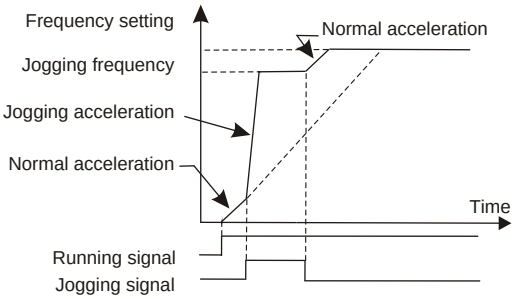




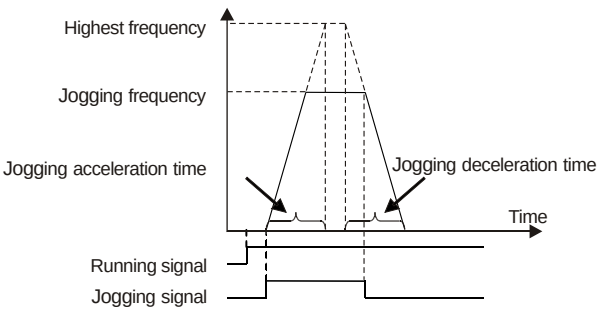
b35	Jogging mode selection		Factory default	0
	Setting range	0	OFF	
		1	X1	
		2	X2	
		3	X3	
b36	Jogging frequency		Factory default	0.00
	Setting range	0.00 - HF	Minimum unit	0.01 Hz
b37	Jogging acceleration time		Factory default	0.1
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
b38	Jogging deceleration time		Factory default	0.1
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s

- [b35]=0: Jogging is disabled.
- [b35]=1-3: For selection of terminals X1 - X3 as the input terminal for jogging. The terminal is closed to be enabled. Jogging commands will only be executed when both jogging signal and running signal are valid.
- No jogging is allowed during programmable program running.
- Jogging acceleration time [b37] is the time for increasing from 0.00 Hz to HF, and jogging deceleration time [b38] is time for decreasing from HF to 0.00 Hz.
- After the jogging command is removed, if the jogging frequency is higher than the set frequency, the set frequency will be reached according to the jogging deceleration time.
- After the jogging command is removed, if the jogging frequency is lower than the set frequency, the set frequency will be reached according to the normal acceleration time.

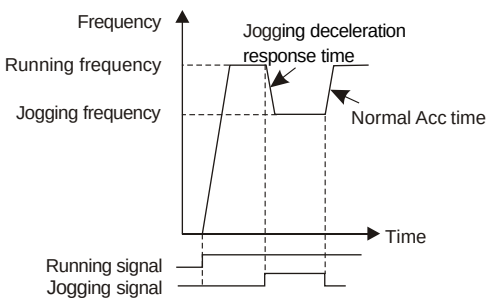
Three common jogging modes are illustrated below:



Use "jogging" to have faster frequency increasing



Jogging at running frequency of 0.00 Hz



Jogging frequency lower than running frequency

b39	Data protection options and initialization	Factory default	0
	Setting range	0	All parameters are readable and rewritable.
		1	All parameters are read-only except [b01] and [b39]
		2	Initialization to factory defaults at 50 Hz
		3	Initialization to factory defaults at 60 Hz
		4	Clear all fault records

- Note: Hold ▲ key for 2 seconds to change [b39] from 1 to 2, 3 or 4.
- When [b39]=3 and initialization to factory default at 60 Hz is activated, related parameters are listed below.

Function Code	Function	Parameter range and eescription		Factory default at 60 Hz
b03	Highest frequency - HF	50.00 - 650.00 Hz	●	60.00
b04	Base frequency - BF	20.00-HF	●	60.00
b11	Middle frequency 2 - MF2	BF-HF	●	60.00
b21	Upper frequency - UF	LF-HF	●	60.00
b30	Frequency corresponding to maximum curve setting	0.00 - 650.00 Hz		60.00
E11	Frequency level detection FDT1	0.00 - 650.00 Hz		60.00
E13	Frequency level detection FDT2	0.00 - 650.00 Hz		30.00
P33	Speed 7 frequency setting	0.00 - HF		60.00

b40	Converter input power supply voltage setting		Factory default	380.0
	Setting range	380.0 V - 480.0 V	Minimum unit	0.1 V

- Parameter [b40] has to be set according to the power supply voltage.

b41	Frequency setting saving in case of power down		Factory default	1
	Setting range	0	Not saved when power is off or the converter is stopped	
		1	Not saved when power is off; saved when the converter is stopped	
		2	Saved when power is off; not saved when the converter is stopped	
		3	Saved when power is off or the converter is stopped	

- If [b00]=0-2 and [b02]=0 and if [b41]=1 or 2 or 3 the current frequency will be saved in [b01] before the system power is switched off or the converter is stopped, and will be restored from [b01] automatically when the system power is switched on again.

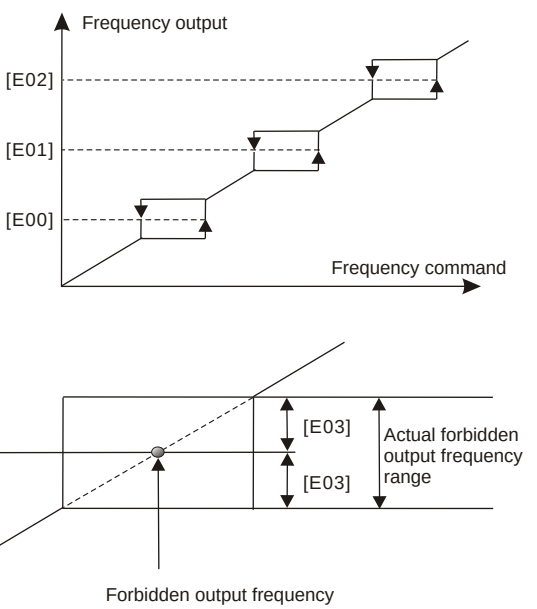
b42	Zero speed control selection	Factory default	0
	Setting range	0	No output
		1	Output DC voltage as per [b43] as holding torque
		2	Output DC voltage as per V/F curve
b43	Voltage command for zero speed control	Factory default	5.0
	Setting range	0.0 - 20.0 %BV	
b44	Changing rate of **Up/Down**	Factory default	0.01
	Setting range	0.01 - 99.99 Hz / s	

- The changing rate of the output frequency can be adjusted by the external control terminals or the button **Up/Down** on the panel.

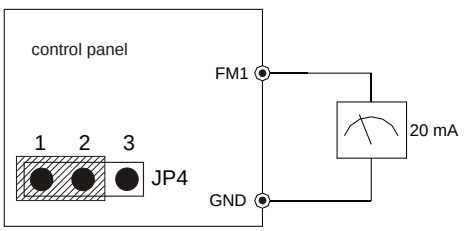
Notes on Extended Function Group (group E)

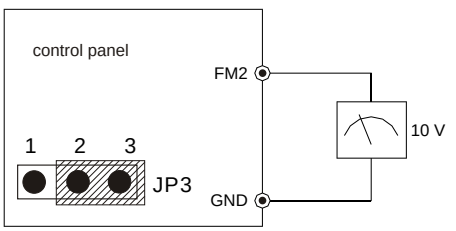
E00	Skip frequency 1		Factory default	0.00
	Setting range	0.00 - HF	Minimum unit	0.01 Hz
E01	Skip frequency2		Factory default	0.00
	Setting range	0.00 - HF	Minimum unit	0.01 Hz
E02	Skip frequency3		Factory default	0.00
	Setting range	0.00 - HF	Minimum unit	0.01 Hz
E03	Skip frequency range		Factory default	0.00
	Setting range	0.00 - 10.00 Hz	Minimum unit	0.01 Hz

- The function is used to avoid mechanical vibration (noise) and resonance of loads.
- Three skip frequencies may be set within the range of 0.00 Hz - HF.
- If no skip frequency is used, set the skip frequency parameters to be 0.00 Hz.
- The function is invalid during acceleration and deceleration (the function is only available for steady state output).
- The function is available for the frequency giving channels selected by [b02].



E04	FM1 selection	Factory default	0
	Setting range	0	Output frequency
		1	Output voltage
		2	Output current
		3	PI feedback signal
E05	FM1 gain setting	Factory default	1.00
	Setting range	0.50 - 1.20	
E06	FM2 selection	Factory default	1
	Setting range	0	Output frequency
		1	Output voltage
		2	Output current
		3	PI feedback signal
E07	FM2 gain setting	Factory setting	1.00
	Setting range	0.5 - 1.20	





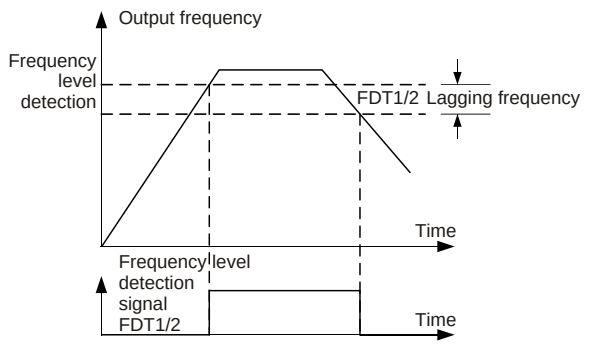
- A DC ammeter (0 to 20 mA) or a DC voltmeter (0 to 10 V) may be connected between FM1/FM2 and GND terminal to monitor the frequency, output voltage or output current of the converter.
- When Jp3 is in position 2-3, the output of FM2 is 0 to 10 V; connect a voltmeter or frequency meter with a full range of 10 V and a resistance of larger than 10 kΩ.
- When JP4 is in position 1-2, the output of FM1 is 0 to 20mA; connect an ammeter or frequency meter with a full range of 20 mA.
- [E04]=0: Frequency is output; when the highest frequency is reached, the FM1 terminal outputs 20 mA or 10 V;
  [E04]=1: Voltage is output; when the AC 500 V is reached, the FM1 terminal outputs 20 mA or 10 V;
  [E04]=2: Current is output; when the output is 2 times the rated current, the FM1 terminal outputs 20 mA or 10 V;
  [E04]=3: PI feedback signal.
- [E05] is used to adjust the gain of FM1.
- The output and gain of FM2 are selected by [E06] and [E07] respectively.

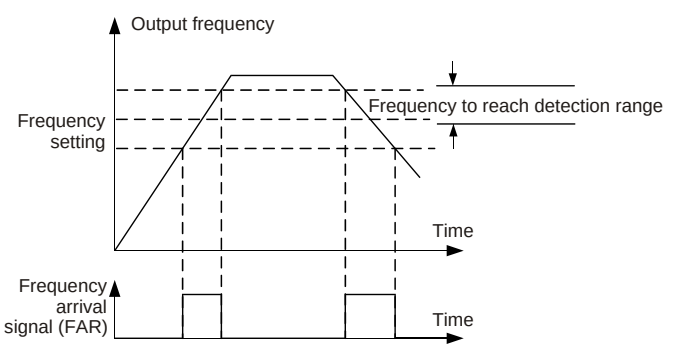
E08	FM channel mode	Factory default	0
	Setting range	0	FM1 outputs 0 - 20 mA or 0 - 10 V FM2 outputs 0 - 20 mA or 0 - 10 V
		1	FM1 outputs 4 - 20 mA or 2 - 10 V FM2 outputs 4 - 20 mA or 2 - 10 V
		2	FM1 outputs 0 - 20 mA or 0 - 10 V FM2 outputs 4 - 20 mA or 2 - 10 V
		3	FM1 outputs 4 - 20 mA or 2 - 10 V FM2 outputs 0 - 20 mA or 0 - 10 V
E09	Pulse output selection	Factory default	2
	Setting range	0	Output frequency
		1	Output voltage
		2	Output current

- DO pulse frequency output range: 0 - [E10].
  [E09] =0 Frequency is outputted; when the highest frequency is reached, the DO terminal outputs [E10] kHz.
  [E09] =1 Voltage is outputted; when 500 V is reached, the DO terminal outputs [E10] kHz.
  [E09] =2 Current is outputted; when rated current is reached, the DO terminal outputs ([E10]/2) kHz.

E10	Maximum output pulse frequency		Factory default	10.00
	Setting range	0.1 - 50.0 kHz	Minimum unit	0.01 kHz
E11	Frequency level detection FDT1		Factory default	50.00
	Setting range	0.00 - 650.00 Hz	Minimum unit	0.01 Hz
E12	FDT1 lagging frequency		Factory default	1.00
	Setting range	0.00 - 650.00 Hz	Minimum unit	0.01 Hz
E13	Frequency level detection FDT2		Factory default	25.00
	Setting range	0.00 - 650.00 Hz	Minimum unit	0.01 Hz
E14	FDT2 lagging frequency		Factory default	1.00
	Setting range	0.00 - 650.00 Hz	Minimum unit	0.01 Hz
E15	Frequency to reach detection range		Factory default	2.00
	Setting range	0.00 - 650.00 Hz	Minimum unit	0.01 Hz

- After the output frequency exceeds the frequency set by [E11], the digital output "frequency level detection signal 1 (FDT1)" becomes active until the output frequency is lower than set in [E11] minus [E12].
- After the output frequency exceeds the frequency set by [E13], the digital output "frequency level detection signal 2 (FDT2)" becomes active until the output frequency is lower than set in [E13] minus [E14].

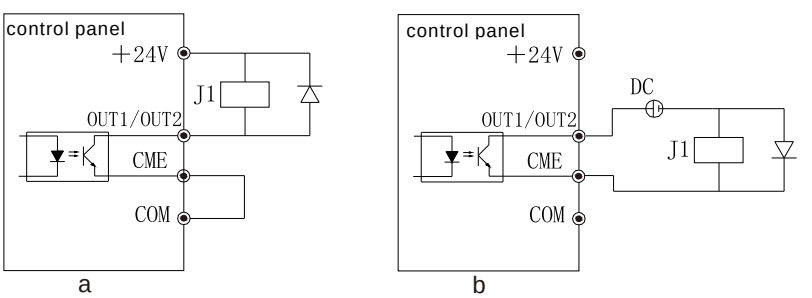




When the output frequency is within the set frequency ±[E15], the digital output "frequency arrival signal (FAR)" is active.

E16	Open collector output OUT1	Setting range	0	Running	Factory default	6
			1	Frequency level detection signal 1 (FDT1)		
			2	Frequency level detection signal 2 (FDT2)		
			3	Frequency arrival signal (FAR)		
			4	Reserved		
			5	Under voltage		
			6	Over load		
			7	Reserved		
			8	Zero speed(lower than starting frequency)		
E17	Open collector output OUT2	Setting range	9	E-Stop	Factory default	0
			10	Lower voltage		
			11	No trip action		
			12	Fault		
			13	Programable program running		
			14	Programable program run		
			15	Run for one stage		
			16	Over current stall		
			17	Over voltage stall		
E18	Relay Ry output selection		18	In forward rotation command indication	Factory default	12
			19	In reverse rotation command indication		
			20	Zero speed (incl. stop)		
			21	Being braked		
			22	Accelerating		
			23	Decelerating		
			24	Fan action		
			25	Reserved		

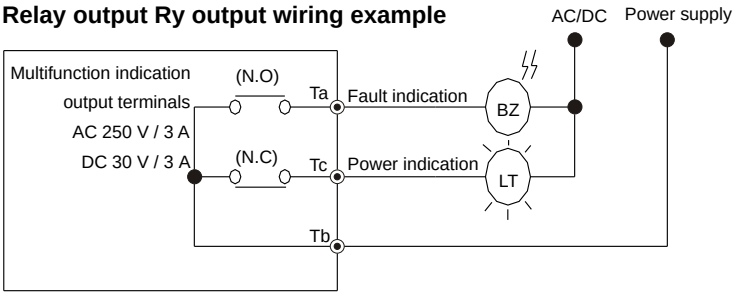
Open collector output terminal wiring examples



Note 1: Open collector output terminals OUT1 and OUT2 may use the internal +24 V power supply of the converter, and the wiring is illustrated in diagram a.

Note 2: Open collector output terminals OUT1 and OUT2 may also use the external power supply, and the wiring is illustrated in diagram b.

Relay output Ry output wiring example



Detailed notes on [E16], [E17] and [E18] settings:

0: Running

When the converter has output frequency, OUT or Ry activates.

1: Frequency level detection signal 1 (FDT1)

When the output frequency of the converter exceeds [E11], OUT or Ry activates until the output frequency is lower than [E11] minus [E12].

2: Frequency level detection signal 2 (FDT2)

When the output frequency of the converter exceeds [E13], OUT or Ry activates until the output frequency is lower than [E13] minus [E14].

3: Frequency arrival signal (FAR)

When the output frequency is within the set frequency 15], OUT or Ry activates.

4: Reserved.

5: Under voltage

When the converter detects that the input voltage is too low (P.OFF), OUT or Ry activates.

6: Overload

When the converter detects an overload, OUT or Ry activates.

7: Reserved.

8: Zero speed (lower than starting frequency)

When the output frequency of the converter is lower than the set frequency of starting [b32], OUT or Ry activates.

9: E-Stop

When an external abnormal command is sent to E-Stop and [E32]=0 and [E34]=1, OUT or Ry activates.

10: Low voltage

When the converter detects that the DC bus voltage is lower than 90 % of the rated voltage, OUT or Ry activates.

11: No trip action

When the converter has no trip control action, OUT or Ry activates.

12: Fault

When the converter detects fault, OUT or Ry activates.

13: Programmable program running

When the Internal PLC control is being automatically run ([b00]=3), OUT or Ry activates.

14: Programmable program run

When the Internal PLC control has been automatically run ([b00]=3) for all stages, OUT or Ry activates.

15: Run for one stage

When the Internal PLC control is being automatically run ([b00]=3) for all stages, OUT or Ry activates for 0.5 second for every stage.

16: Over current stall

When the converter is in the state of stall over current protection or acceleration stall over current protection, OUT or Ry activates, the related parameters are [E19] and [E20].

17: Over voltage stall

When the converter is in the state of stall over voltage protection, OUT or Ry activates, the related parameter is [H34].

18: In forward rotation command indication

When the converter is rotating forward, OUT or Ry activates.

19: In reverse rotation command indication

When the converter is rotating reverse, OUT or Ry activates.

20: Zero speed (incl. stop)

When the output frequency of the converter is lower than the set frequency of starting [b32] or when the frequency converter is stopped, OUT or Ry activates.

21: Being braked

When the converter is in the state of DC braking, OUT or Ry activates.

22: Accelerating

When the output frequency of the converter is increasing, OUT or Ry activates.

23: Decelerating

When the output frequency of the converter is decreasing, OUT or Ry activates.

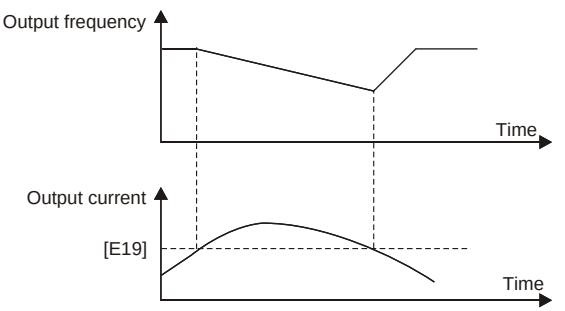
24: Fan action

When the cooling fan of the converter is working, OUT or Ry activates.

25: Reserved.

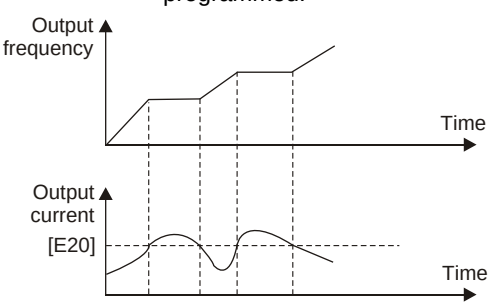
E19	Stall over current protection level during running		Factory default	OFF
	Setting range	50 % - 200 % of rated current		
		OFF		

- The stallover current protection level during running may be set between 50 % and 200 % of rated converter current. If the setting is OFF, the stall over current protection is turned off.
- The diagram below shows that during running at the set frequency, the output frequency is automatically decreased once the current exceeds [E19], to reduce the output current below the stall over current level.



E20	Stall over current protection level during acceleration		Factory default	OFF
	Setting range	50 % - 200 % of rated current		
		OFF		

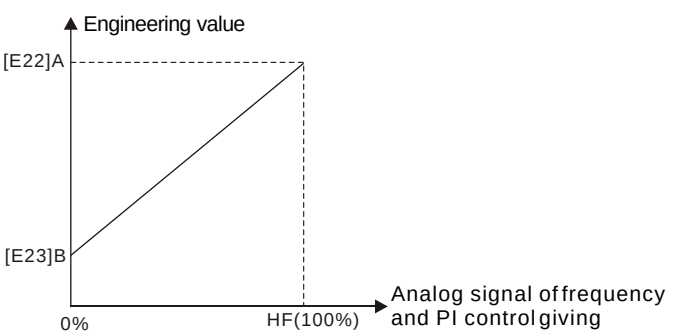
- The stall over current protection level [E20] during acceleration may be set between 50 % and 200 % of rated converter current. If the setting is OFF, the stall over current protection during acceleration is turned off.
- As shown in the diagram below, the frequency increase will be stopped when the output current is larger than the stall over current protection level [E20] during the acceleration, the acceleration will be resumed once the current is lower than [E20], to avoid over current due to stall. This function will lead to a longer acceleration time than programmed.



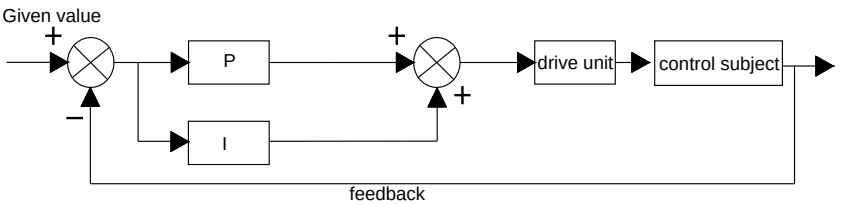
Note: The stall over current protection function may only be used when the no trip control function is turned off ([H33]=OFF). If no trip control is used ([H33]=ON), set [E19]=OFF and [E20]=OFF.

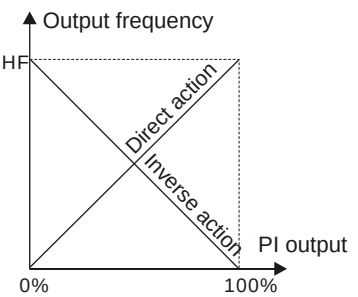
E21	Running monitoring display		Factory default	0
	Setting range	0	Display output frequency	
		1	Display set frequency	
		2	Display output current	
		3	Display output voltage	
		4	Display DC bus voltage	
		5	Display input signal	
		6	Display radiator temperature	
E22	Display factor A	Factory default	1.0	
	Setting range	-99.9 - 6000.0		
E23	Display factor B	Factory default	0.0	
	Setting range	-99.9 - 6000.0		

- The first use of display factor A and display factor B is to convert the output frequency of converter to a physical quantity and display it on the digital operating panel.
- In group d of the digital operating panel, “oUtF”=output frequency *A+B, “SEtF”= set frequency *A+B
- If [E22] and [E23] are as default, “oUtF” and “SEtF” display the actual output frequency and set frequency.
- The second use of display factor A and display factor B is to calibrate the given and the feedback quantity value, when the motor is controlled with the PI closed loop function.
- Display factor A [E22] = Maximum analog given or feedback value (e.g.: 5 V) corresponding to the physical engineering application.
- Display factor B [E23] = Minimum analog given or feedback value (e.g.: 0 V) corresponding to the physical engineering application.



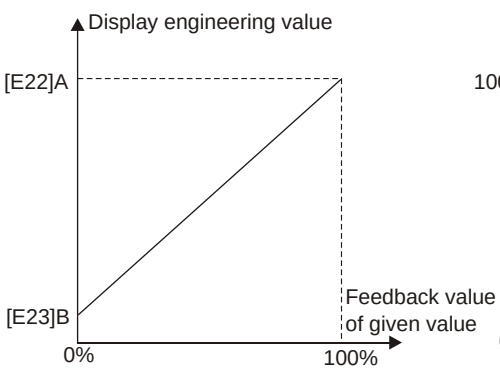
- The PI adjustment function of the converter detects the sensor feedback of the control subject and compares it with the given value. If deviation exists, use the PI adjustment to reduce the deviation up to 0. This function is suitable for control of flow, pressure, temperature, speed of rotation, etc.

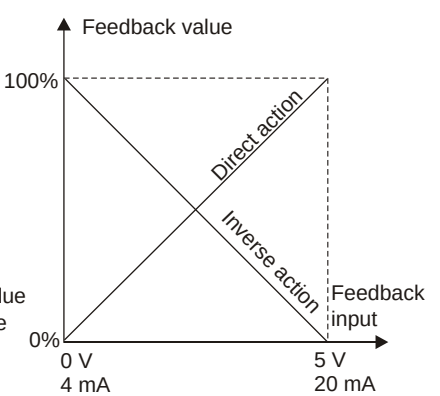




E24	PI adjustment selection		Factory default	0
	Setting range	0	No PI	
		1	Direct action	
		2	Inverse action	

- Direct action or inverse action may be selected for PI adjustment output, therefore PI adjustment output can increase or decrease motor speed.

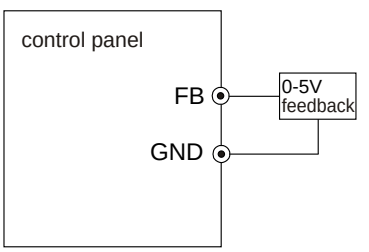




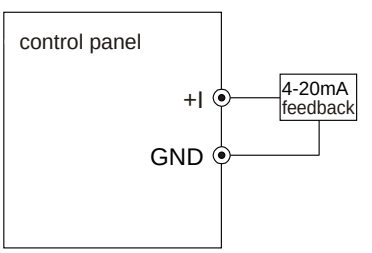
E25	PI adjustment feedback channel selection		Factory default	0
	Setting range	0	Control terminal FB direct action (voltage input 0 - 5 V)	
		1	Control terminal FB Inverse action (voltage input 5 - 0 V)	
		2	Control terminal +I direct action (current input 4 - 20 mA)	
		3	Control terminal +I inverse action (current input 20 - 4 mA)	
		4	Single phase pulse feedback	
		5	Orthogonal pulse feedback	
E26	Proportional gain		Factory default	10.00
	Setting range		0.01 - 99.99 times	
E27	Integration time constant		Factory default	1.0
	Setting range		0.1 - 60.0s	
E28	Sampling period		Factory default	0.1
	Setting range		0.1 - 60.0s	

Note: If [E25]=4 or if [E25]=5, the upper limit of input pulse frequency range is 200 kHz.

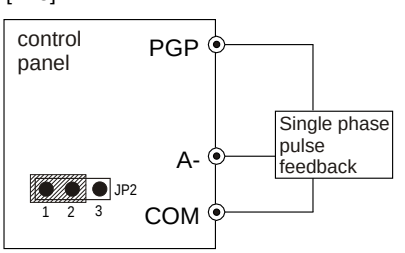
[E25]=0, 1



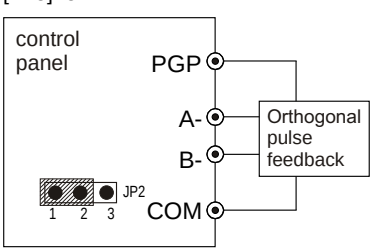
[E25]=2, 3



[E25]=4

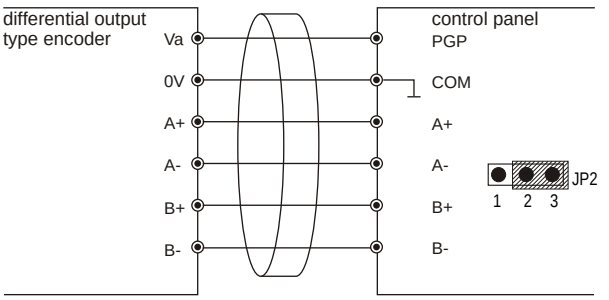


[E25]=5



Note: Orthogonal pulse encoder has two modes. The diagrams above correspond to the open collector output type (JP2 in position 1-2). The diagram below shows the encoder PG as differential output type (JP2 in position 2-3). In this case make the wiring as shown below.

[E25]=5



- Setting range of proportional gain [E26]: 0.01 - 99.99 times
  A larger proportional gain means faster response; however, a too large proportional gain may cause oscillation. A smaller proportional gain means slower response.
- Setting range of integration time constant [E27]: 0.1 - 60.0s
  A larger integration time constant means slower response, and the reaction to external disturbance is slowed, with better stability. A smaller integration time constant means faster response; however, a too small integration time constant may cause oscillation.
- Proportional adjustment is based on deviation. Generally, PI adjustment is used to eliminate steady state deviation in a closed loop system. For PI adjustment, if the integration time constant is too large, the response will be slow for fast changing deviation. P adjustment alone may be used for load systems with integrating elements.
- Simple method of PI parameter adjustment:
  [E26] (P) Increase the value if no oscillation occurs.
  [E27] (I) Decrease the value if no oscillation occurs.
  [E28] is the sampling period of closed loop adjustment, with a range of 0.1 to 60.0s, and depends on the time constant (inertia) of control subjects.

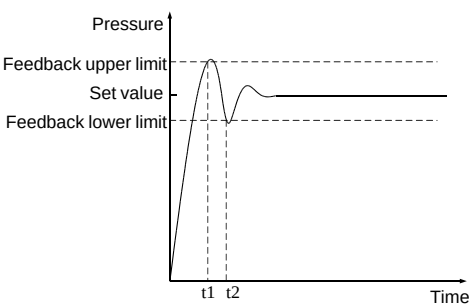
E29	PI adjustment upper factor	Factory default	OFF
	Setting range	1 - 100/OFF	
E30	PI adjustment lower factor	Factory default	0
	Setting range	1 - 100	

- [E29] is used to set the PI adjustment upper factor of closed loop system;

  [E30] is used to set the PI adjustment lower factor of closed loop system.
- During PI adjustment, as shown in the diagram, when the feedback quantity is larger than the feedback upper limit (time t1), PI is deactivated and the output frequency is decreased to the lower frequency ([b23]=1) or 0.00 Hz ([b23]=0) according to the deceleration time; when the feedback quantity is smaller than the feedback lower limit (time t2), PI is reactivated.

  Feedback upper limit = [E22]×[E29]/100)

  Feedback lower limit = [E22]×([E30]/100)



PI adjustment upper and lower limit frequency

E31	Maximum input pulse frequency		Factory default	20.0
	Setting range	1.0 kHz - 200.0 kHz	Minimum unit	0.1 kHz

- When [b02]=11, the function code gives the external input pulse frequency (≤200.0 kHz) corresponding to [b30].
- When [b02]≠11, and [E24]≠0, [E25]=4 or 5 (under PI control), the function code gives the feedback pulse frequency corresponding to the maximum set engineering quantity.

E32	E-Stop command input modes in the case of external problem		Factory default	0
	Setting range	0	Stopping due to connected E-Stop/SC	
		1	Stopping due to disconnected E-Stop/SC	
E33	Stop modes in the case of external abnormality		Factory default	0
	Setting range	0	Coasting to stop	
		1	Deceleration to stop	
E34	Stop alarm modes in the case of external abnormality		Factory default	1
	Setting range	0	No alarm output	
		1	Alarm output	

- [E33]=0: Coasting to stop. Alarm output is allowed.
  [E34]=0: No alarm output. While E-Stop input is activated, it can be used in combination with “brake” and other mechanical drive devices. “E.-St” indication will disappear after a short time.
  [E34]=1: Alarm output confirms stopping with external abnormal command. “E.-St” indication remains, until fault retry or fault reset with Stop key, before the converter is put into service again. OUT/Ry may output alarm signal by selecting [E16], [E17] or [E18]=9.
- [E33]=1: Deceleration to stop. Alarm output is not allowed.
  “E.-St” will not be displayed. The alarm output is not allowed and invalid even if [E34]=1.

IMPORTANT: Without additional measures the “E-Stop” command does not provide an “Emergency Stop”. There is neither an electrical isolation between motor and frequency converter nor a “service switch” or a “repair switch”. An “Emergency Stop” requires an electrical isolation, e.g. by means of a central mains contactor!

E35	Low voltage protection mode	Factory default	2
	Setting range	0	Coasting to stop
		1	Deceleration to stop
		2	Resume with previous speed
E36	Under voltage protection alarm	Factory default	0
	Setting range	0	No alarm output
		1	Alarm output

- Low voltage protection is a countermeasure against a fault where the power supply voltage is 10 % lower than the rated voltage, in this case the motor will act according to [E35].
- Under voltage protection means that when the power supply voltage is 20 % lower than the rated voltage, the converter immediately blocks output to make the motor coast to stop and displays P.oFF.
- If [E36]=1, the alarm state remains until the power supply voltage increases to 90 % of the rated voltage.
- OUT1, OUT2 or Ry may output alarm signal by selecting [E16], [E17] or [E18]=5.

E37	Converter automatically starts after powering on	Factory default	0
	Setting range	0	Forbidden
		1	Allowed

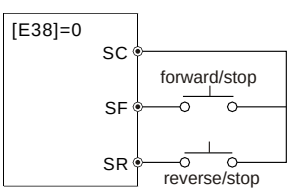
- When the running control of digital operating panel is used ([b00]=0 or 3), and no stop signal exists, in the case of [E37]=1, the converter will automatically start without Run key being pressed down after powering on; in the case of [E37]=0, the converter only starts after Run key is pressed down.
- When another source of running commands is selected, in the case of [E37]＝1, the converter will automatically start after powering on, if a running command (e.g. connected SF/SC) exists; in the case of [E37]=0, the converter will remain static, even if a running command exists. To start the converter, cancel and reissue the running command (e.g. disconnecting and reconnecting SF/SC).

E38	SF and SR terminal function	Factory default	0
	Setting range	0	Forward/reverse mode
		1	Run/stop, forward/reverse mode
		2	Key control holding mode.

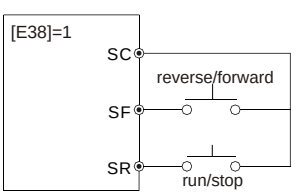
- [E38] terminal function is only activated when [b00]=1 or 2 or 4.

In the following the function of [E38] is explained, assuming the NPN/PNP switch in position 3 (internal NPN)

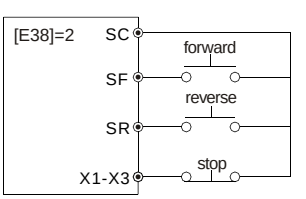
- [E38]=0: Forward/reverse mode
  SF/SC connected: Forward rotation
  SR/SC connected: Reverse rotation
  SF/SC and SR/SC connected or disconnected simultaneously: Stop



- [E38]=1: Run/Stop, forward/reverse mode
  SF/SC connected: Run
  SF/SC disconnected: Stop
  SR/SC connected: Reverse rotation
  SR/SC disconnected: Forward rotation



- [E38]=2: Key control holding mode
  [E39] is used to select X1, X2 or X3 as the stopping terminal.
  SF/SC connected: Forward rotation
  SR/SC connected: Reverse rotation
  X1-X3/SC disconnected: Stop



If the reverse key is pressed when the converter is rotating forward, the motor will decelerate to zero to stop before reversing its rotation to the set frequency.

E39	Self-holding function			Factory default	0
	Setting range	0	OFF		
		1	X1 is a self-holding stop terminal		
		2	X2 is a self-holding stop terminal		
		3	X3 is a self-holding stop terminal		

- If [E38]=2, terminal X selected with [E39] and SF and SR key input have self-holding function.
- [E39]=0: Self-holding not activated.

E40	Input phase loss protection enabling			Factory default	1
	Setting range	0	Input phase loss protection disabled		
		1	Input phase loss protection enabled		

- If [E40]=0, the protection is disabled; if [E40]=1, the protection will act as the converter stops output and the motor coasts to stop.
- Important note: The function is invalid for Frequency Converter Fe up to 7.5 kW.

E41	Output phase loss protection enabling			Factory default	1
	Setting range	0	Output phase loss protection disabled		
		1	Output phase loss protection enabled		

- If [E41]=0, the protection is disabled; if [E41]=1, the protection will act as the converter stops output and the motor coasts to stop.

E42	Fault retry options			Factory default	0
	Setting range	0	Fault retry disabled		
		1	Retry from over current at constant speed		
		2	Retry from over current during acceleration		
		3	Retry from over current during deceleration		
		4	Retry from over voltage at constant speed		
		5	Retry from over voltage during acceleration		
		6	Retry from over voltage during deceleration		
		7	Retry from overload		
		8	Retry from overheat		
		9	Retry from drive protection		
		10	Retry from EMI		
		11	Retry from input phase loss		
		12	Retry from output phase loss		
		13	Retry from stop after response to internal abnormality command		
		14	Retry from any fault		

E43	Waiting time for fault retry		Factory default	10.0
	Setting range	2.0 - 60.0s	Minimum unit	0.1s
E44	Number of fault retries		Factory default	0
	Setting range	0 - 3	Minimum unit	1
E45	Current fault record	0: No fault record 1: O.C.-1, over current at constant speed 2: O.C.-2, over current during acceleration 3: O.C.-3, over current during deceleration 4: O.E.-1, over voltage at constant speed 5: O.E.-2, over voltage during acceleration 6: O.E.-3, over voltage during deceleration 7: O.L., Overload; 8: O.H., overheat 9: d.r., drive protection; 10: CPU-, EMI 11: IPH.L., input phase loss 12: oPH.L., output phase loss 13: E.-St., stopping by external abnormality command	Factory default	0
E46	Last fault record		Factory default	0
E47	Last 2 fault records		Factory default	0
E48	Last 3 fault records		Factory default	0

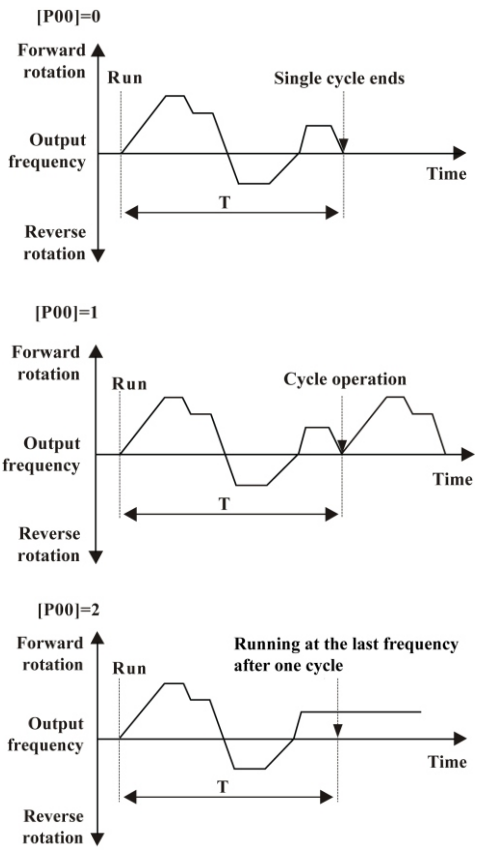
- [E43] is the waiting time for the converter to automatically resume running after a fault, while [E42] has been activated ([E42]≠0).
- [E44] is the allowed number of attempts to resume running after powering on of converter.

Notes on Programmable Control Function Group (group P)

This function group will be used in the case of internal PLC control running and multi-speed running with external terminals.

P00	PLC working mode		Factory default	0
	Setting range	0	Stop after one cycle	
		1	Cycle operation	
		2	Running at the last frequency after one cycle	

- [P00] setting is only activated when [b00]=3, that means when internal PLC control has been activated.



P03	Speed 1 frequency setting		Factory default	5.00
	Setting range	0.00 Hz - HF	Minimum unit	0.01 Hz
P08	Speed 2 frequency setting		Factory default	10.00
	Setting range	0.00 Hz - HF	Minimum unit	0.01 Hz
P13	Speed 3 frequency setting		Factory default	20.00
	Setting range	0.00 Hz - HF	Minimum unit	0.01 Hz
P18	Speed 4 frequency setting		Factory default	30.00
	Setting range	0.00 Hz - HF	Minimum unit	0.01 Hz
P23	Speed 5 frequency setting		Factory default	40.00
	Setting range	0.00 Hz - HF	Minimum unit	0.01 Hz
P28	Speed 6 frequency setting		Factory default	50.00
	Setting range	0.00 Hz - HF	Minimum unit	0.01 Hz
P33	Speed 7 frequency setting		Factory default	50.00
	Setting range	0.00 Hz - HF	Minimum unit	0.01 Hz

- These are settings of the running frequency for speeds 1 to 7.
- The frequency command for speed 0 depends on two different multi-speed modes:
  If [b00]=2 (multi-speed external terminal control), the source for speed 0 is given by [b02].
  If [b00]=3 (internal PLC control), speed 0 is directly given by [b01].
- The acceleration and the deceleration time of speed 0 are still determined by [b16] and [b17].

P01	Speed 0 running direction		Factory default	SF
	Setting range	SF: Forward, SR: Reverse		
P04	Speed 1 running direction		Factory default	SF
	Setting range	SF: Forward, SR: Reverse		
P09	Speed 2 running direction		Factory default	SF
	Setting range	SF: Forward, SR: Reverse		
P14	Speed 3 running direction		Factory default	SF
	Setting range	SF: Forward, SR: Reverse		

P19	Speed 4 running direction		Factory default	SF
	Setting range	SF: Forward, SR: Reverse		
P24	Speed 5 running direction		Factory default	SF
	Setting range	SF: Forward, SR: Reverse		
P29	Speed 6 running direction		Factory default	SF
	Setting range	SF: Forward, SR: Reverse		
P34	Speed 7 running direction		Factory default	SF
	Setting range	SF: Forward, SR: Reverse		

- Speeds 0-7 running direction is activated when [b00]=3 (internal PLC control).

P02	Speed 0 holding time	Factory default	OFF
	Setting range	OFF/1-65000s	1s
P05	Speed 1 holding time	Factory default	OFF
	Setting range	OFF/1-65000s	1s
P10	Speed 2 holding time	Factory default	OFF
	Setting range	OFF/1-65000s	1s
P15	Speed 3 holding time	Factory default	OFF
	Setting range	OFF/1-65000s	1s
P20	Speed 4 holding time	Factory default	OFF
	Setting range	OFF/1-65000s	1s
P25	Speed 5 holding time	Factory default	OFF
	Setting range	OFF/1-65000s	1s
P30	Speed 6 holding time	Factory default	OFF
	Setting range	OFF/1-65000s	1s
P35	Speed 7 holding time	Factory default	OFF
	Setting range	OFF/1-65000s	1s

- Speeds 0-7 holding time is activated when [b00]=3 (internal PLC control).
- Speeds 0-7 holding time is the time for running after reaching the set speed. OFF indicates the motor will not run at the corresponding speed.

P06	Speed 1 acceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P11	Speed 2 acceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P16	Speed 3 acceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P21	Speed 4 acceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P26	Speed 5 acceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P31	Speed 6 acceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P36	Speed 7 acceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s

- Speed 1-7 acceleration time:

  If [b00]=2, (multi-speed external terminal control), it is the time from 0.00 Hz to HF.

  If [b00]=3, (internal PLC control), it is the time from the former speed to the current speed.

P07	Speed 1 deceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P12	Speed 2 deceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P17	Speed 3 deceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P22	Speed 4 deceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P27	Speed 5 deceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P32	Speed 6 deceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P37	Speed 7 deceleration time		Factory default	10.0
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s

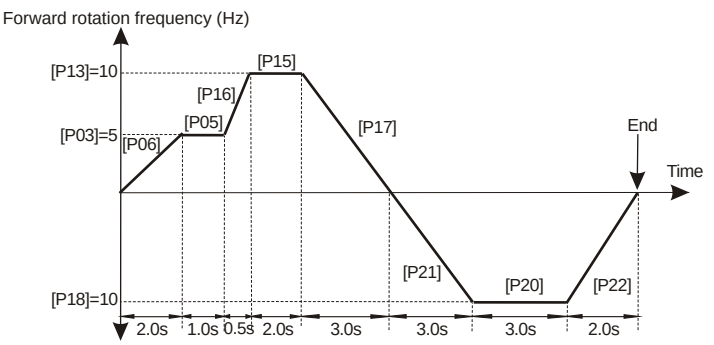
- Speed 1-7 deceleration time:
  If [b00]=2 (multi-speed external terminal control), it is the time from HF to 0.00 Hz.
  If [b00]=3, (internal PLC control), it is the time from the former speed to the current speed.

Example of internal PLC control ([b00]=3):

The converter is required to run according to the curve shown in the diagram, [P00]=0 should be set. The speeds include speed 1, 3 and 4. The running parameters are given in the table below. For speeds without internal PLC control, the holding time is set to be OFF, i.e.

[P02]=[P10]=[P25]=[P30]=[P35]=OFF.

The deceleration time of each speed phase is decided by [b17].



Note: The diagram does not show the effect of the forward and reverse rotation dead zone time. Please refer to the following table for speeds 1, 3 and 4 with internal PLC control:

Function code	Parameter set value	Unit
P03	5.00	Hz
P04	SF: Forward	--
P05	1.0	s
P06	2.0	s
P13	10.00	Hz
P14	SF: Forward	--
P15	2.0	s
P16	0.5	s
P17	3.0	s
P18	10.00	Hz
P19	SR: Reverse	--
P20	3.0	s
P21	3.0	s
P22	2.0	s

Example of Multi-speed under external terminal control ([b00]＝2)

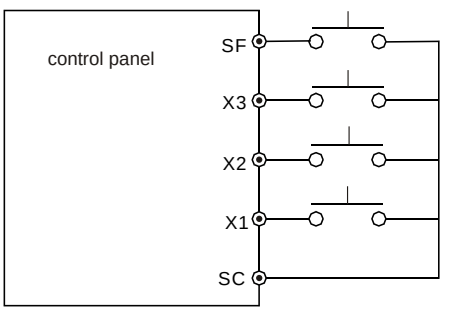
X3, X2 and X1 binary combination speed table (X closed indicates 1)

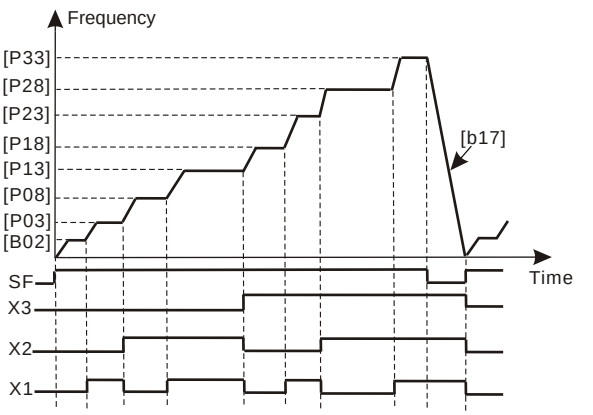
Speed	0	1	2	3	4	5	6	7
Frequency setting	[b02]	[P03]	[P08]	[P13]	[P18]	[P23]	[P28]	[P33]
X3-SC	0	0	0	0	1	1	1	1
X2-SC	0	0	1	1	0	0	1	1
X1-SC	0	1	0	1	0	1	0	1

The following examples are explained according to the NPN/ PNP switch in position 3 (internal NPN)

- Example 1: 8-speed forward rotation cycle operation.

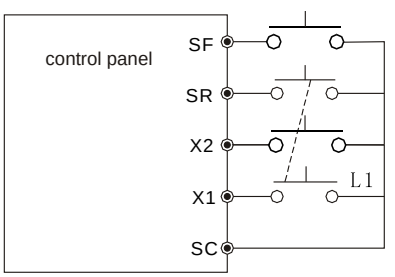
[E38]=0

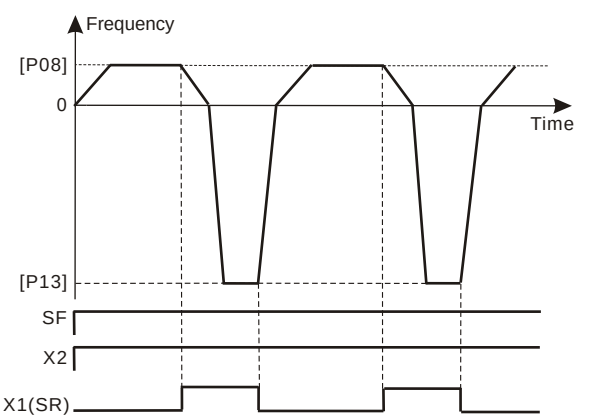




- Example 2: 2-speed forward/reverse rotation cyclic operation.

[E38]=1





Notes on Advanced Function Group (group H)

H00	PWM frequency		Factory default	Depending on model
	Setting range	1 - 15 kHz (range depends on frequency converter rated power)	Minimum unit	1 kHz

- The function is used to set the PWM frequency output.

Note: the setting range depends on frequency converter rated power. See the table below.

[H00]: Setting range and factory default

Frequency converter power range	PWM frequency setting range	Factory default
0.75 - 7.5 kW	1 - 15 kHz	6 kHz
11 - 22 kW	1 - 8 kHz	6 kHz
30 - 45 kW	1 - 6 kHz	3 kHz
55 - 110 kW	1 - 4 kHz	2 kHz

Note: 1) adjustable in 1 kHz steps

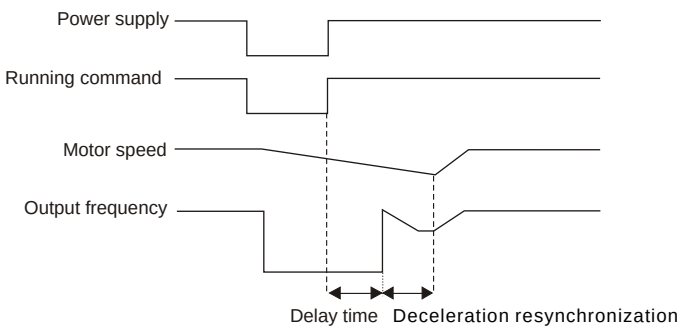
2) The PWM frequency at output frequency below 4 kHz is always limited to 4 kHz to protect the converter.

H01	Automatic adjustment of PWM frequency	Factory default	ON
	Setting range	OFF/ON	

- When the function is enabled, the frequency converter can automatically adjust PWM frequency based on machine temperature.

H02	Delay for restarting after transient stopping	Factory default		OFF
	Setting range	OFF		
		0.1 - 20.0s	Minimum unit	0.1s

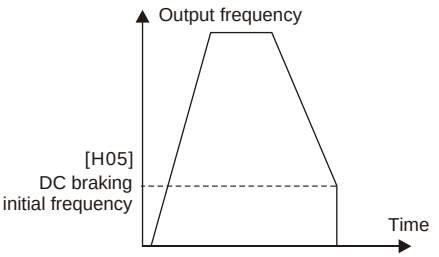
- Restarting after a transient stopping allows the motor to restart smoothly by estimating the rotating speed of the motor.
- If there is a run command signal when powering on after a transient stop, the motor may be instantaneously stopped before restarting.
- The delay time may be between 0.1 to 20.0 seconds.
- The function is disabled, if the parameter is set to be OFF.
- [E35] should be set to 2 (for running at the current speed) to enable restarting after transient stopping due to low voltage protection mode.

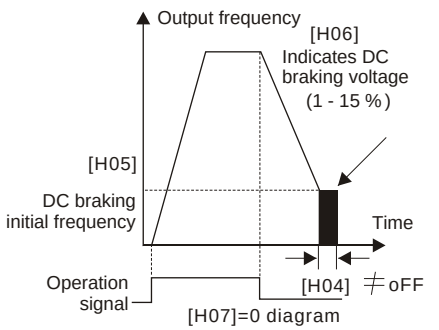


H03	Reserved			
H04	DC braking time		Factory default	OFF
	Setting range	OFF		
		0.1 - 10.0s	Minimum unit	0.1s
H05	DC braking initial frequency		Factory default	3.00
	Setting range	0.00 - 60.00 Hz	Minimum unit	0.01 Hz
H06	DC braking voltage		Factory default	10
	Setting range	1 - 15 % of rated voltage		
H07	DC braking holding options		Factory default	0
	Setting range		0	OFF
			1	X1
			2	X2
			3	X3
			4	ON

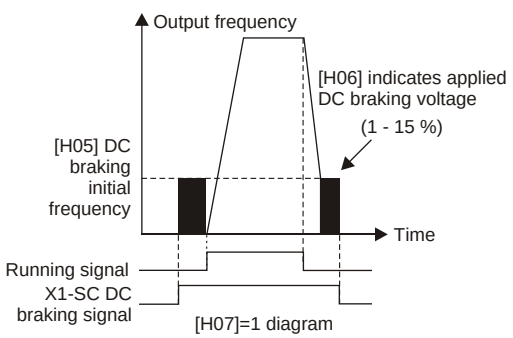
- DC braking allows the frequency converter to achieve fast and stable stopping, it is defined by [H04]-[H07].
- If [H04]=OFF, DC braking is disabled during deceleration to stop, then [H05], [H06] and [H07] settings has no meaning.
- If [H07]=0, no DC braking voltage will be applied after the motor is stopped, dc.on is displayed during DC braking.

- If [H07]=1-3, DC braking voltage will be applied when X1-X3 are closed under stopping state, dc.on is displayed during DC braking. If any of X1-X3 is occupied by other functions, no related indication will be shown.
- If [H07]=4, DC braking voltage remains under stopping state, but dc.on is not displayed. If a run signal is applied during DC braking, DC braking will be interrupted and running will start.

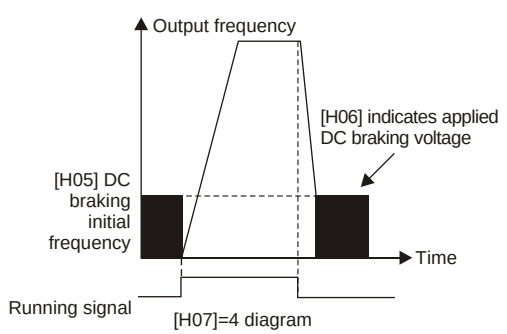




[H07]=0 diagram



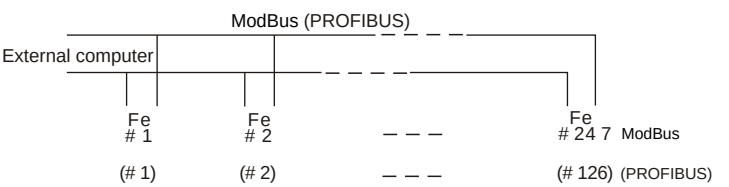
[H07]=1 diagram



[H07]=4 diagram

H08	Communication protocol selection	Factory default	0
	Setting range	0	ModBus
		1	PROFIBUS
H09	Local address	Factory setting	1
	Setting range	ModBus: 1 - 247 PROFIBUS: 1 - 126	
H10	Baud rate selection	Factory default	3
	Setting range	0	1200 bps
		1	2400 bps
		2	4800 bps
		3	9600 bps
		4	19200 bps
		5	38400 bps

- If [H08]=0, [H09] defines the local address for ModBus serial communication, and one external computer may be connected to a maximum of 247 frequency converters. If [H08]=1, [H09] defines the local address for PROFIBUS communication, and one external computer or control device may be connected to a maximum of 126 frequency converters.



- H10] defines the baud rate of communication.
  Important: The baud rate [H10] must be identical to the rate of the external computer.
  In case of PROFIBUS communication, the baud rate of the converter must be identical to the PROFIBUS communication interface.

H11	Data format	Factory default	0
	Setting range	0	N, 8, 2 (1 start bit, 8 data bits, 2 stop bits, without check)
		1	E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even)
		2	O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd)
H12	Communication disruption action	Factory default	0
	Setting range	0	Stop
		1	Keep running
H13	Communication disruption detection time	Factory default	0.0
	Setting range	0: (ineffective); 0.1 - 60.0s	

- [If the frequency converter does not receive valid massages from the external control system within the in [H13] defined time, the converter assumes a communication disruption and reacts according to parameter [H12].

H14	PZD3 Settings	Setting range	0	Output frequency	Factory default	0
H15	PZD4 Settings		1	Frequency setting		1
H16	PZD5 Settings		2	Output current		2
H17	PZD6 Settings		3	Output voltage		3
H18	PZD7 Settings		4	Bus voltage		4
H19	PZD8 Settings		5	Switch value input signal		5
H20	PZD9 Settings		6	Module temperature		6
H21	PZD10 Settings		7	PI control feedback value		7

- The parameters [H14] to [H21] can be used to set the register values for converter state feedback.

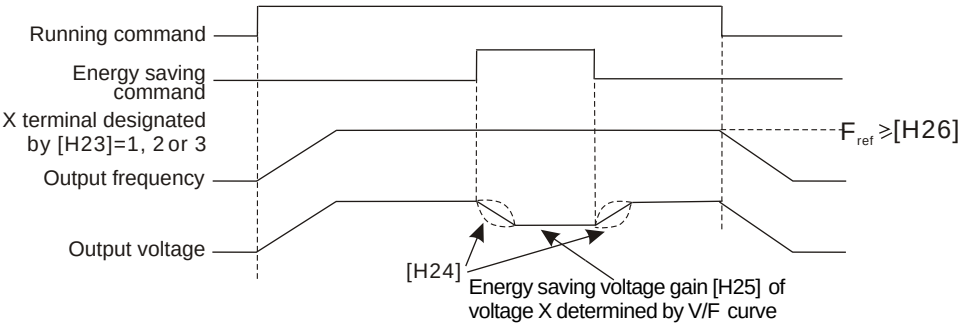
H22	Fan control	Factory default	0
	Setting range	0	Auto control
		1	No control

- [H22]=0: The fan keeps rotating while the converter is working.

  The fan automatically starts internal temperature detection 3 minutes after the converter stopped and then decides whether to continue or to stop based on the module temperature.
- [H22]=1: No control. The fan starts when the converter is powered on.

H23	Energy saving mode		Factory default	0
	Setting range		0	Disabled
			1	X1
			2	X2
			3	X3
			4	Automatic energy saving
H24	Voltage resumption time		Factory default	2.0
	Setting range	0.0 - 5.0s	Minimum unit	0.1s
H25	Voltage gain for energy saving under external terminal control		Factory default	80
	Setting range	50 - 100 %		
H26	Energy saving initial frequency		Factory default	0.00
	Setting range	0.00 - 650.00 Hz		
H27	Automatic energy saving control gain		Factory default	0.5
	Setting range	0.0 - 10.0		
H28	Automatic energy saving time constant		Factory default	1.00
	Setting range	0.0 - 10.00		
H29	Automatic energy saving rated percentage slip		Factory default	5.0
	Setting range	0.1 - 50.0 %		

- Energy saving control is beneficial especially in circumstances where light loads are encountered.



- [H23]=1, 2 or 3: X1, X2 or X3 as the input terminal for energy saving command
  If the energy saving command is activated and if the output frequency is larger than the starting frequency for energy saving set by [H26], the output voltage of the converter will decrease from the previous V/F curve value to the previous V/F curve value multiplied with the energy saving gain [H25]. The output voltage decreasing time and resumption time are set by [H24].
- [H23]=4: Automatic energy saving
  In contrast to the energy saving with external terminals, the automatic energy saving method will search the motor voltage with the highest degree of energy saving (for frequencies bigger than set by parameter [H26]).
  For automatic energy saving parameter [H27] defines the voltage range for every adjustment; [H28] defines the time interval between two voltage adjustments and can be changed based on the motor capacity and the application to achieve fast and stable control for energy saving.
  [H29] is the maximum allowable decrease of speed due to voltage decrease for automatic energy saving.
  When the motor load increases, the voltage of the motor resumes from the energy saving mode to the V/F curve value according to [H24].

H30	Automatic current limitation level	Factory default	150
	Setting range	G series: 20 - 250 % / OFF; P series: 20 - 170 % / OFF	

- [H30] defines the threshold current of the automatic current limitation. The set value is a percentage of the rated converter current.
- The automatic current limitation function is used to limit the load current up to the in parameter [H30] set value. This way a tripping of the frequency converter can be avoided. The function is useful for loads with large inertia or in case of big load changes.
- If [H30]=OFF, the function is disabled.

H31	Current regulator proportion factor	Factory default	0.060
	Setting range	0.001 - 1.000	

- The higher the set value of [H31] the faster the current suppression will be; but if [H31] is set too high this may result in operation of anti-trip control.

H32	Current regulator integrating time constant	Factory default	0.200
	Setting range	0.001 - 10.00	

- Larger [H32] means less accuracy of current suppression (compared with current threshold). And vice versa, however, a too small value may lead to incorrect operation of anti-trip control.

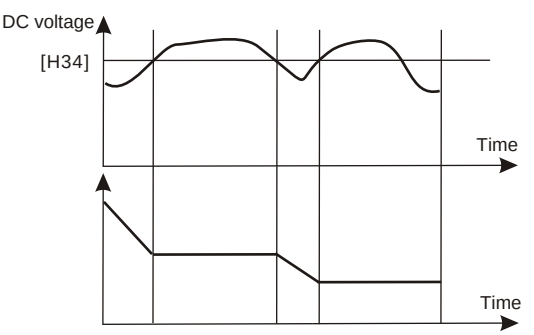
H33	Automatic current limitation at constant speed	Factory default	ON
	Setting range	OFF/ON	

- [H33]=ON; automatic current limitation is enabled at constant speed.
- [H33]=OFF; automatic current limitation is disabled at constant speed.
- Parameter [H33] does not affect the automatic current limitation during acceleration and deceleration.

H34	Stall over voltage selection		Factory default	OFF
	Setting range	400 V model: 710 - 800 V/OFF	Minimum unit	1 V

- Stall over voltage protection detects the DC bus voltage during the deceleration of the frequency converter and compares the voltage with the stall over voltage point set by [H34].

  If the voltage exceeds the stall over voltage point, the output frequency of the frequency converter stops to decrease and deceleration will only be resumed after the detected DC bus voltage is lower than the stall over voltage point, as shown in the diagram.



Note: if [H34]=OFF, stall overvoltage protection is disabled.

H35	Software over voltage protection point		Factory default	810
	Setting range	790 - 820 V		

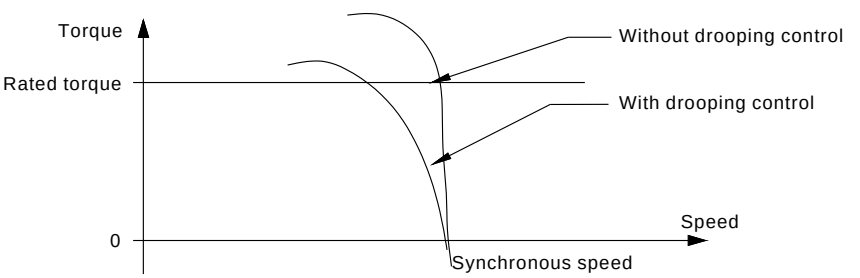
- When the DC bus voltage of the main circuit of the frequency converter raises to the over voltage point or software over voltage protection point, over voltage fault will be reported and the frequency converter will immediately stop output and running.

H36	Deceleration braking activation voltage threshold		Factory default	770
	Setting range	600 - 785 V		

- During deceleration of the frequency converter, the frequency converter will activate dynamic braking if the DC bus voltage exceeds the deceleration braking activation voltage threshold.
- The function is valid for models with built-in braking transistors (15 kW and below).

H37	Drooping control		Factory default	0.00
	Setting range	0.00 - 10.00 Hz	Minimum unit	0.01 Hz

- The function is suitable for circumstances where multiple frequency converters are used to drive the same load.
- The function allows uniform distribution of power among multiple frequency converters which drive the same load. When a frequency converter takes on a heavy load, the converter will automatically reduce the output frequency to relieve part of the load according to the parameter value. The parameter may be adjusted from small to large values during commissioning. The relation between load and output frequency is shown in the diagram below:



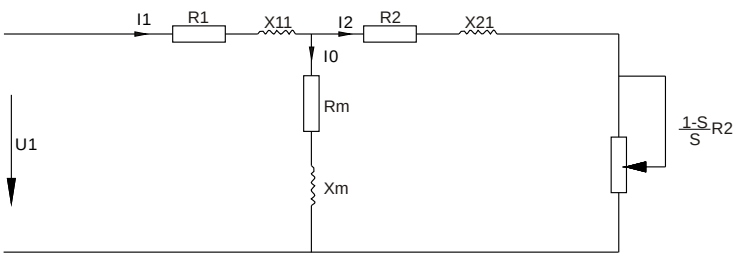
Note: If drooping control is used, turn off slip frequency compensation by setting [H31]=0.00 Hz.

H38	Motor poles		Factory default	4
	Setting range	2 - 14 (It is only allowed to input even numbers like 2, 4, 6…14.)		
H39	Rated power of the motor		Factory default	Dependent on model
	Setting range	0.4 - 999.9 kW	Minimum unit	0.1 kW
H40	Rated stator current		Factory default	Dependent on model
	Setting range	0.1 - 999.9 kA	Minimum unit	0.1 A

- Set the parameters of the controlled motor according to its nameplate to ensure that the rated motor and the rated converter power match.
- Generally, the motor power is allowed to be one power level higher or up to two power levels lower than that of the frequency converter. For example, a motor from 30 kW up to 55 kW is allowed to be used with a 45 kW frequency converter. Otherwise the control performance cannot be ensured.

H41	No-load current		Factory default	Depending on model
	Setting range	0.1 - 999.9 A	Minimum unit	0.1 A
H42	Stator resistance		Factory default	Depending on model
	Setting range	0.00 - 50.00 %		
H43	Leakage inductance		Factory default	Depending on model
	Setting range	0.00 - 50.00 %		
H44	Rotor resistance		Factory default	Depending on model
	Setting range	0.00 - 50.00 %		
H45	Mutual inductance		Factory default	Depending on model
	Setting range	0.0 - 2000.0 %	Minimum unit	0.1

Details of above motor parameters are shown in the diagram below:



- R1, X11, R2, X21, Xm and I0 in the diagram represent stator resistance, stator leakage inductance, rotor resistance, rotor leakage inductance, mutual inductance and no-load current.
- [H43] is the sum of the stator and the rotor leakage inductance. [H42]-[H45] are all percentages to the motor parameters and the formula is as follows:

  Resistance (of stator or rotor) $R\%=\frac{R}{V/(\sqrt{3}\cdot I)}\times 100\%$

  V: Rated voltage / I: Rated motor current

  Inductance (leak or mutual) $X\%=\frac{R}{V/(\sqrt{3}\cdot I)}\times 100\%$

  V: Rated voltage / I: Rated motor current

- Set [H41] directly and set the values obtained from above formula in [H42]-[H45] if all motor parameters are known.
- If auto-tuning of motor parameters is used, values in [H41]-[H45] will be automatically set after the auto-tuning.

H46	Rated slip frequency		Factory default	0.00
	Setting range	0.00 - 20.00 Hz	Minimum unit	0.01 Hz

- The rated slip frequency of the motor can be calculated with the help of the rated motor speed on the nameplate.

$$\text{Rated slip frequency} = \text{rated frequency([b04])} \times \frac{\text{(synchronous speed - rated speed)}}{\text{synchronous speed}}$$

$$\text{synchronous speed} = \frac{\text{rated frequency} \times 120}{\text{motor poles ([H38])}}$$

H47	Auto-tuning parameters		Factory default	0
	Setting range	0: No auto-tuning of parameters 1: Auto-tuning when the motor is static 2: Auto-tuning when the motor is running. After auto-tuning, [H47] is automatically set to be 0.		

- Before auto-tuning, you must correctly input the nameplate parameters of the connected motor ([H38]-[H40])
- The function automatically detects and sets motor parameters.
  [H47]=0, No auto-tuning of parameters;
  [H47]=1, Auto-tuning when the motor is static;
  [H47]=2, Auto-tuning when the motor is running.

Motor load has to be removed before using auto-tuning function [H47]=2!

Dangerous movements! Danger to life, risk of injury, severe bodily harm or material damage!

DANGER

Ensure safety because the motor shaft will rotate.

- After auto-tuning, [H47] is automatically set to be 0.
- Auto-tuning steps:
  (1) Set the base frequency ([b04]) and the base voltage ([b05]) according to the motor characteristics.
  (2) Set the nameplate parameters of the connected motor ([H38]-[H40]).
  (3) Set the acceleration time ([b16]) and the deceleration time ([b17]).Before setting [H47]=2, disengage the motor shaft from the load and check carefully to ensure safety!
  (4) Set [H47] to 1 or 2, press the Set key and press Run to start the auto-tuning;
  (5) The auto-tuning is complete when the display of the operating panel is flashing.

Notes:

- When [H47] is set to be 2, increase the acceleration/deceleration time appropriately, if over current or over voltage occurs during auto-tuning.
- When [H47] is set to be 2 to conduct auto-tuning when the motor is running, disengage the motor shaft from the load. Do not conduct auto-tuning when the motor is running with a load!
- Ensure the motor is stopped before starting auto-tuning, or else auto-tuning will not work properly.
- In circumstances in which auto-tuning is not used, properly input the parameters on the motor nameplate ([H38]-[H40]). If accurate motor parameters are known, properly input [H38]-[H45].
- “d. Frr” will be displayed If auto-tuning fails .

H48	Total working hours		Factory default	0
	Setting range	0 - 65535 hours	Minimum unit	1 hour
H49	Password input		Factory default	0

- [H49] allows access to manufacturer function codes ([H50]-[H63]).

Notes on Monitoring Function Group (group d)

Function	Abbreviation	Description
Monitored items	outF	displays converter output frequency (Hz), motor speed and linear speed
	SEtF	displays converter set frequency (Hz), motor speed or PI target value
	outA	displays converter output current
	outV	displays output command voltage if PI control is disabled; displays feedback quantity if PI control is enabled
	dCV	displays DC bus voltage
	inPt	displays input signals 
	t℃	displays the temperature of power module and heat sink (℃)

Notes:

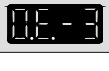
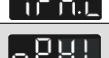
- [b00], [b34], [b35], [E39], [H07] and [H23] are related to external terminals.
- Consider if any of the external terminals X1, X2 and X3 have already been used by a function, they cannot be used by another function.
- To select a terminal which has already been used, the previous function has to be disabled before the definition of a new function.

12 Fault Indication

Faults may cause the converter to stop.

12.1 Fault Types

The frequency converter can record the reasons of the last 4 faults and can display them after resetting from faults.

Fault Code	Description	Cause	Solution
	Over current at constant speed	Excessively reduced acceleration/deceleration time	Increase acceleration/deceleration time
		Load short circuit or sudden changes in load	Check the load
		Low grid voltage	Check power supply
		A special motor or a motor larger than the maximum allowable capacity	Use a converter with suitable power
	Over current during acceleration	Too short acceleration time	Increase acceleration time
		Improper V/F curve	Enable automatic torque increasing or manualLY adjust V/F curve settings
		The converter power is too low	Select a converter with higher power
	Over current during deceleration	Too short deceleration time	Increase deceleration time
		Large load inertia torque or potential load	Add a appropriate dynamic braking unit
		The converter power is too low	Select a converter with higher power
	Over voltage at constant speed	Too high input voltage of power supply	Keep the input voltage of power supply within the specified range
		Excessively reduced acceleration/deceleration time	Increase acceleration/deceleration time
		Abnormality in load	Check the load
	Over voltage during acceleration	Abnormality in input voltage of power supply	Check power supply
		Abnormality in load	Check the load
	Over voltage during deceleration	Too large moment of inertia of load	Increase the deceleration time to suit the load inertia, or purchase a dynamic braking unit
	Motor overload	Too large load, too short acceleration/deceleration time or cycle	Adjust the load, acceleration/deceleration time or cycle; or increase the converter capacity
		Improper V/F characteristic curve settings	Adjust V/F curve settings
		Improper setting of electronic thermal relay	Set proper setting of electronic thermal relay
	Converter overheat	Fan failure	Check if fan works normally
		Too high ambient temperature	Lower the ambient temperature
		Ventilation outlet obstructed	Clear dust and foreign matters at ventilation outlet
	Drive protection	Damaged power component	Seek technical support
		Incorrect operation of drive circuit protection	Remove interference and seek technical support
	EMI	CPU incorrect operation due to external interference	Remove nearby interference or other EMI
	Phase loss at input side	Phase loss of the converter's 3-phase input power supply	Check 3-phase input power supply or seek technical support
	Phase loss at output side	Open wire or phase loss of converter's 3-phase output power supply (severe asymmetry of the 3 phase's loads)	Check converter's 3-phase wiring (or symmetry of loads)

Fault Code	Description	Cause	Solution
	Motor fails to start	Abnormal power supply voltage	Check power supply
		External wiring between control SF or SR is disconnected	Check external wiring between control SF or SR
		Improper parameter setting	Check parameter setting
	Motor can not run at different speeds	The highest frequency is too low	Check the highest frequency
		Improper frequency setting mode	Confirm frequency setting
	Motor stalls during acceleration	Too short acceleration time	Increase acceleration time
		Too large inertia of motor and load	Adjust acceleration time
	Abnormal heating of motor	Improper V/F curve	Adjust V/F curve settings
		Continuous running at low speed	Use a special motor if it is necessary to run at low speed for a long time
		Too large load	Check load

12.2 List of Fault Protection Actions

What	Fault Code on Display	Description
Main circuit under voltage	P.oFF	This function code will be displayed when the main circuit voltage is less than 80 % of the rated value.
Main circuit over current	O.C.-1 O.C.-2 O.C.-3	This function code will be displayed when the output current exceeds the maximum allowed current. The output will then be shut off and the frequency converter will stop.
Main circuit over voltage	O.E.-1 O.E.-2 O.E.-3	This function code will be displayed when the main circuit DC voltage exceeds 800 V through deceleration of the motor. The output will then be shut off and the frequency converter will stop.
Motor overload	O.L.	This function code will be displayed when the set load exceeds the specified characteristic of the output. The frequency converter will then stop according to the anti-time curve. The characteristic of the output can be set according to the motor type.
Converter over heating	O.H.	This function code will be displayed when the heat sink temperature is about 85°C. The frequency converter will then stop.
Drive protection	d.r.	This function code will be displayed when there is a bridge fault in the main circuit. The frequency converter will then stop.
EMI	CPU-	This function code will be displayed when the CPU or the output protection circuit is under EMI. If there are strong magnetic field disturbing factors, the frequency converter will stop.
Phase loss protection	IPH.L oPH.L	The converter immediately stops output and running in case of input/output phase loss protection of the converter.
Under voltage trip		This happens in operation when the power supply is lower than the set value due to power off or declining voltage. The output will then be shut off and the frequency converter will stop.
Over current limit (stall current)		During acceleration or running, once over current occurs, the frequency converter will regulate its output frequency to decrease the current under current stall level.
Over voltage limit (stall voltage)		If the output frequency declines rapidly, the regenerated energy from motor will increase the DC voltage. The frequency converter will then auto-regulate frequency to avoid DC voltage of the main circuit exceeding the specified value.
Stopping upon abnormality	E.-St	This function code will be displayed when the input terminal E-Stop/SC is connected and [E32]=0, [E33]=0 and [E34]=1. The frequency converter will then stop.

13 Technical Data

13.1 Fe General Technical Data

Input	Power supply voltage	3 AC 380 to 480 V (-15 % / +10 %) (TN-Net)	
	Supply frequency	50 to 60 Hz (±5 %)	
	Rated motor output	0.75 to 110 kW	
	Short circuit current rating (UL) (SCCR) (480 V Maximum)	5000 A_{rms}	
Output	Rated voltage	Corresponding to input voltage	
	Output frequency	0 to 650 Hz	
	Overload capability	G series: 200 % of rated current for 1s; 150 % of rated current for 60s P series: 120 % of rated current for 60s; 105 % of rated current for 60min	
Functions	Control mode	V/F	
	Modulation type	Magnetic flux PWM modulation	
	Speed regulation range	1:100	
	Start-up torque	Maximum start-up torque 150 % at 5 Hz (torque and slip compensation activated)	
	Frequency resolution	Digital	0.01 Hz
		Analog	Maximum frequency x 0.1 %
	V/F characteristic curve	Freely definable	
	Ramps	Linear, S-curve	
	Direct-current brake	Start frequency	0 to 60 Hz
		Braking time	0.1 to 10s
	Integrated controller	Integrated PLC, operating panel	
	Status messages via multi-function output signal	In/above/below frequency range, operation, etc.	
	Automatic energy saving function	Load-dependent adaptation of V/F characteristic curve	
	Automatic PWM frequency adaptation	Load-dependent adaptation of PWM frequency	
	Fast current restriction	Fast current restriction during running to prevent trip due to frequent over current	
	Automatic voltage regulation (AVR)	Excessively high supply voltage is automatically reduced to rated motor voltage	
Customization functions	Running command channel	Given by operating panel, control terminal and serial port	
	Frequency setting	Set by digital operating panel, analog voltage, analog current and serial port, which can be switched at any time	
	Auxiliary frequency setting	Flexible frequency trimming and frequency synthesis	
	Analog output terminal	Analog signal output, 0 or 4 to 20 mA / 0 or 2 to 10 V, to output physical quantities, such as output frequency	
Operating panel	LED display	Displaying of various parameters, including set frequency, output frequency, output voltage, output current, etc.	
Protection	Input phase loss protection (models = 11 kW), output phase loss protection, output short circuit protection, grounding protection, over current protection, over voltage protection, under voltage protection, overheat protection, overload protection		
Optional parts	Braking resistor, remote controller, remote communication cable, bus adapter		
Environment	Location	Indoor use, without corrosive gas or liquid or dust	
	Power reduction/Max. installation height	Up to 1000 m above sea level: none; 1000…4000 m above sea level: 1 % / 100 m	
	Ambient temperature	-10 °C to 40 °C (without condensation and frost); Derating between 40 °C and 50 °C	
	Relative humidity	< 90 % RH (without condensation)	
	Allowed pollution degree	2 (EN 50178)	
	Shocking	< 5.9 m/s (0.6 g)	
	Degrees of protection	IP20	

Derating of electrical data

Derating and ambient temperature

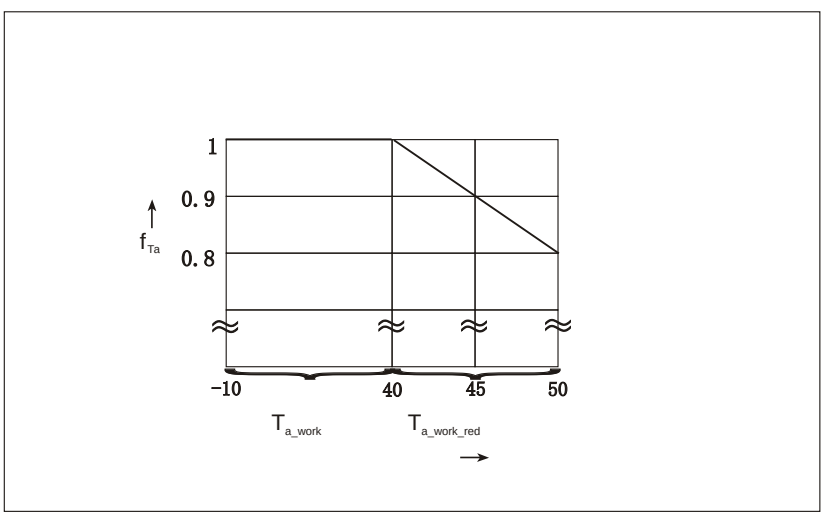
Where installation conditions differ, the following performance data are reduced in accordance with the diagram:

Frequency converter:

- continuous power output
- continuous current output

Use outside of the indicated installation conditions is not allowed, even if the performance data are additionally reduced.

As the ambient temperature increases, the capacity utilization of the devices is reduced according to the figure below.



Ambient temperature in ℃

f_{Ta} load factor

$T_{a\ work}$ ambient temperature range for operation with nominal data

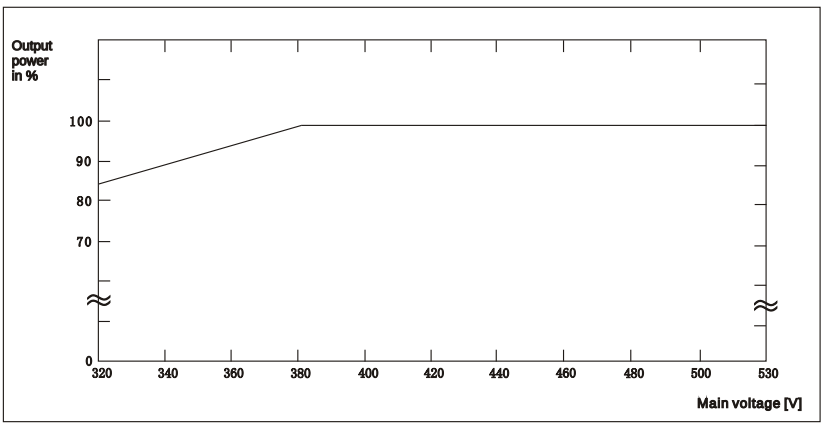
$T_{a\ work\ red}$ ambient temperature range for operation with reduced nominal data

Derating and mains voltage

Reduced overcurrent based on mains voltage

The Fe frequency converters are thermally dimensioned for the rated currents. This rated current is available with the specified rated voltage. With deviating voltages in the permissible range, please note the following:

- Umains＜Urated: With mains voltages below the rated voltage, no higher currents may be withdrawn to ensure that the dissipated power remains current.
- Umains＞Urated: With mains voltages greater than the rated voltage, a reduction of the permissible output permanent currents takes place to compensate for the increased switching losses.



Derating vs. U mains

At mains voltage < 380 V: 1 % power derating every 4 V

Derating of the output current depending on the pulse frequency

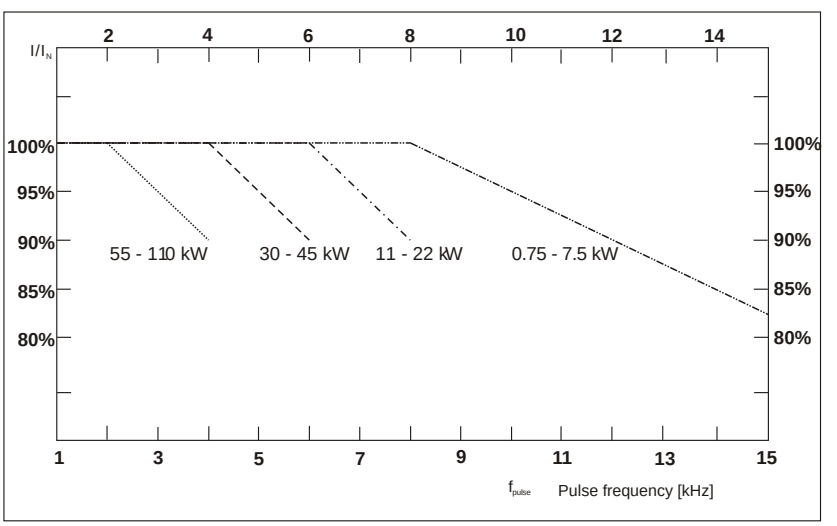
This illustration shows the current reduction based on the pulse frequency for the different frequency converters. In case of higher pulse frequency, the current is reduced insofar that the power dissipation in power section remains more or less constant.

For converters with 0.75 to 7.5 kW, the current reduction starts at 8 kHz;

with 11 to 22 kW at 6 kHz;

with 30 to 45 kW at 4 kHz;

with 55 to 110 kW at 2 kHz.

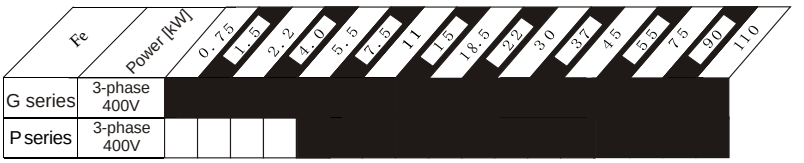


I: Permissible overcurrent

I_N: Rated current

Derating output current vs. fs

13.2 Electrical Parameters



400 V Series

Model	Unit	FECG02 • 1-0K75-3P400-A-SP-MODB-01V01	FECG02 • 1-1K50-3P400-A-SP-MODB-01V01	FECG02 • 1-2K20-3P400-A-SP-MODB-01V01	FECG02 • 1-4K00-3P400-A-SP-MODB-01V01	FECx02 • 1-5K50-3P400-A-SP-MODB-01V01	FECx02 • 1-7K50-3P400-A-SP-MODB-01V01	FECx02 • 1-11K0-3P400-A-BN-MODB-01V01
Power	kW	0.75	1.5	2.2	4	5.5	7.5	11
Rated input current	A	3.4	6	8	13	17	21	30
Capacity	kVA	1.9	3	4	7.6	9.9	13	18
Rated output current	A	2.5	4	5.5	10	13	17	24
Weight	kg	3.0	3.0	3.2	3.2	3.5	3.5	10.7
Model	Unit	FECx02 • 1-15K0-3P400-A-BN-MODB-01V01	FECx02 • 1-18K5-3P400-A-BN-MODB-01V01	FECx02 • 1-22K0-3P400-A-BN-MODB-01V01	FECx02 • 1-30K0-3P400-A-BN-MODB-01V01	FECx02 • 1-37K0-3P400-A-BN-MODB-01V01	FECx02 • 1-45K0-3P400-A-BN-MODB-01V01	FECx02 • 1-55K0-3P400-A-BN-MODB-01V01
Power	kW	15	18.5	22	30	37	45	55
Rated input current	A	42	43	51	68	83	101	117
Capacity	kVA	25	29	34	46	55	68	85
Rated output current	A	33	39	44	60	75	95	110
Weight	kg	10.9	16.2	16.9	21.5	22.0	33.2	33.8
Model	Unit	FECx02 • 1-75K0-3P400-A-BN-MODB-01V01	FECx02 • 1-90K0-3P400-A-BN-MODB-01V01	FECx02 • 1-110K-3P400-A-BN-MODB-01V01				
Power	kW	75	90	110				
Rated input current	A	157	187	226				
Capacity	kVA	116	140	170				
Rated output current	A	152	183	223				
Weight	kg	50.9	52.5	96.5				

Note 1: x is a substitute for G or P series.

Note 2: The data is based on the supply voltage of 3 × 380 VAC.

13.3 Electromagnetic Compatibility (EMC)

13.3.1 EMC Requirements

13.3.1.1 General information

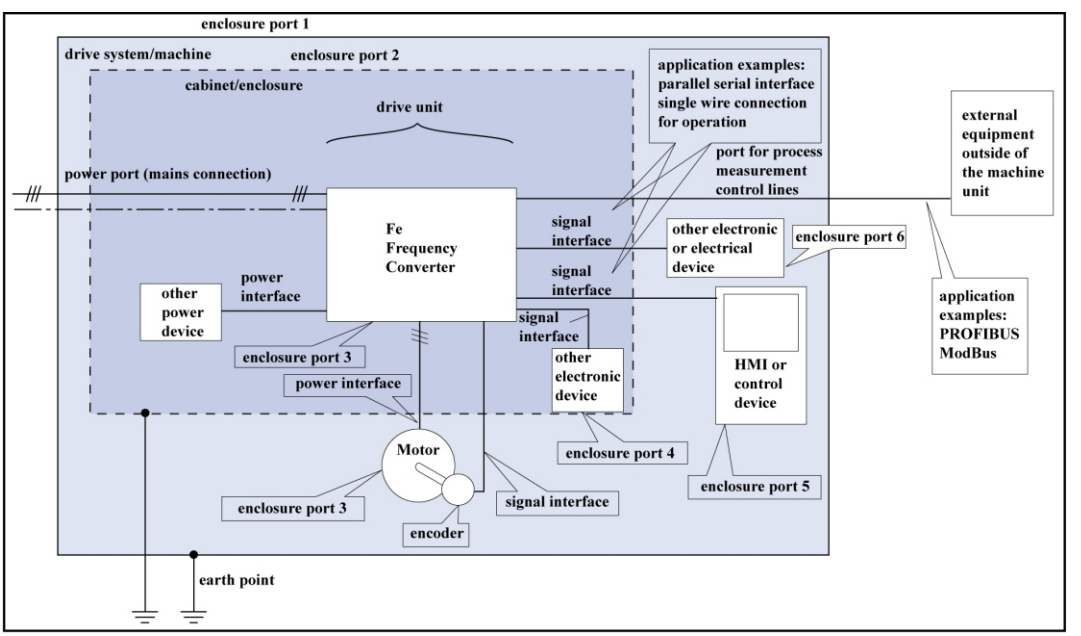
The electromagnetic compatibility (EMC) or electromagnetic interference (EMI) includes the following requirements:

- Sufficient noise immunity of an electric installation or an electric device against external electric, magnetic or electromagnetic interference via lines or through air.
- Sufficiently low noise emission of electric, magnetic or electromagnetic noise of an electric installation or an electric device to other surrounding devices via lines or through air.

13.3.1.2 Noise immunity in the drive system

Basic structure for noise immunity

The figure below illustrates the interference for definition of noise immunity requirements in the drive system.



Minimum noise immunity values

No.	Place of effect	Phe-nomenon	Standard	Conditions	Coupling	Test values according to standard EN61800-3	Perform-ance level
	Enclosure port	ESD	IEC 61000-4-2		CD, AD	4 kV CD; 8 kV AD, if CD not possible	B
		RF field	IEC 61000-4-3		Via antenna on EUT	10 V / m	A
	Power port	Burst	IEC 61000-4-4		mains connection I<100 A: CDN; I>= 100 A: clamp	2 kV / 2.5 kHz (CN or CDN); 4 kV / 2.5 kHz (clamp)	B
		Surge	IEC 61000-4-5	only mains connection; I<63 A, light load test		line-line 1 kV line-earth 2 kV	B
			IEC 61000-4-6	length>3 m	clamp	10 V, 0.15 - 80 MHz	A
	Power interface	Burst	IEC 61000-4-4	length>3 m	clamp	2 kV / 5 kHz	B
	Signal interface	Burst	IEC 61000-4-4	length>3 m	clamp	1 kV / 5 kHz	B
			IEC 61000-4-6	length>3 m	clamp or CDN	10 V, 0.15 - 80 MHz	A
	Ports of process; measurement control lines	Burst	IEC 61000-4-4	length>3 m	clamp	2 kV / 5 kHz	B
			IEC 61000-4-6	length>3 m	clamp or CDN	10 V, 0.15 - 80 MHz	A

Note:

CD: contact discharge

AD: air discharge

CDN: coupling and decoupling network

CN: coupling network

Evaluation criterion

Evaluation criterion	Explanation (abbreviated form from EN 1800-3)
A	deviations within allowed range
B	automatic recovery after interference
C	Switched off without automatic recovery. Device remains undamaged.

13.3.1.3 Noise emission of the drive system

Causes of noise emission

Controlled variable-speed drives contain converters containing snappy semiconductors. The advantage of modifying the speed with high precision is achieved by means of pulse width modulation of the converter voltage. This can generate sinusoidal currents with variable amplitude and frequency in the motor.

The steep voltage rise, the high clock rate and the resulting harmonics cause unwanted by physically unavoidable emission of interference voltage and interference fields (wide band interference). The interference mainly is asymmetric interference against ground.

The propagation of this interference strongly depends on:

- configuration of the connected drives
- number of the connected drives
- conditions of mounting
- site of installation
- radiation conditions
- wiring and installation

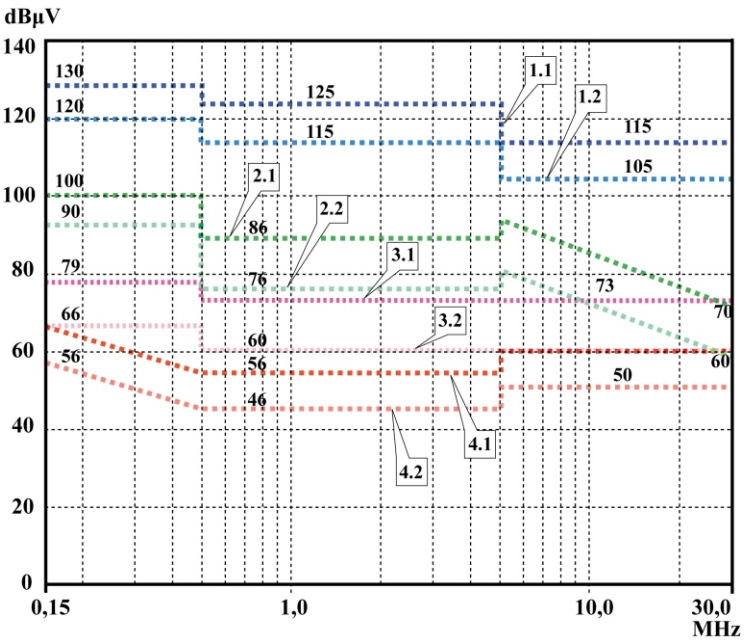
If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

Limit values for line-based disturbances

According to IEC EN 61800-3 or CISPR 11 (corresponds to EN 55011), the limit values in the table below are distinguished. For this documentation both standards are combined in the limit value classes A2.1 to B1.

IEC / EN61800-3	CISPR 11	Explanation	In this documentation	Curves of limit value characteristic
IEC / EN 61800-3 Category C4 2nd environment	None	One of the following 3 requirements must have been fulfilled: Mains connection current ＞400 A, IT mains or required dynamic drive behavior not reached by means of EMC filter. Adjust limit values to use and operation on site. User has to carry out and provide evidence of EMC planning.	None	-
Category C3 2nd environment	Class A; group 2 I＞100 A	limit value in industrial areas to be complied with for applications operated at supply mains with no minal currents＞100 A	A2.1	1.1 1.2
Category C3 2nd environment	Class A; group 2 I＜100 A	limit value in industrial areas to be complied with for applications operated at supply mains with no minal currents＜100 A	A2.2	2.1 2.2
Category C2 1st environment; restricted distribution	Class A; group 1	Limit value in residential area or at facilities at low-voltage mains supplying buildings in residential areas. To be comply with for applications with restricted distribution.	A1	3.1 3.2
Category C1 1st environment; unrestricted distribution	Class B; group 1	limit value in residential areas to be complied with for applications with unrestricted distribution	B1	4.1 4.2

Limit values for line-based disturbances (IEC 61800-3); limit characteristic through frequency range



1.1 Category C3: 2nd environment, QSP, I>100 A (class A, group 2, I >100 A)
1.2 Category C3: 2nd environment, AV, I>100 A (class A, group 2, I >100 A)
2.1 Category C3: 2nd environment, QSP, I<100 A (class A, group 2, I <100 A)
2.2 Category C3: 2nd environment, AV, I<100 A (class A, group 2, I <100 A)
3.1 Category C2: 1st environment, restricted distribution, QSP (1st environment, even if source of interference in 2nd environment) (class A, group 1)
3.2 Category C2: 1st environment, restricted distribution, AV (1st environment, even if source of interference in 2nd environment) (class A, group 1)
4.1 Category C1: 1st environment, unrestricted distribution, QSP (1st environment , even if source of interference in 2nd environment) (class B, group 1)
4.2 Category C1: 1st environment, unrestricted distribution, AV (1st environment, even if source of interference in 2nd environment) (class B, group 1)

Notes (1) Limit value for 1st environment is also relevant, if source of interference of 2nd environment affects 1st environment.
(2) Designations “class” and “group” according to IEC CISPR 11.

QSP: measuring method quasi peak measurement;
AV: measuring method arithmetic averaging

Second Environment, Industrial Area	Facilities not directly connected to a low-voltage mains to supply buildings in residential areas. If the limit values in an industrial area separated from public supply by a transformer station only have to be complied with at the property boundary or in the neighboring low-voltage mains, the filter might not be necessary. In the vicinity such as measuring sensors, measuring lines or measuring devices, it is normally required to use the interference suppression filter. Increasing the noise immunity of a sensitive device can often be the economically better solution compared to measures of interference suppression at the drive system of installation.
First Environment	Environment containing residential areas and facilities directly connected, without interstage transformer, to a low-voltage mains supplying buildings in residential areas. Medium-sized manufacturing plants and industrial establishments can be connected to the public low-voltage mains together with residential buildings. In this case there is a high risk for radio and television reception if there are not any measures for radio interference suppression taken. Therefore, the indicated measures are generally recommended.
Nominal Current of Supply Mains	The nominal current of the supply mains (＞100 A or ＜100 A) is specified by the local power supply company at the connection point of the mains. For industrial companies, for example, such connection points are the interconnecting stations from the power supply company.
Unrestricted Distribution	Channel of distribution for which placing on the market is independent of the EMC expert knowledge of the customer or user of electric drives.
Restricted Distribution	Channel of distribution for which the placing on the market is restricted to traders, customers or users who individually or together have technical expert knowledge of EMC for the use of electric drives. Since it is impossible to obtain the lower limit values for residential areas with all applications by means of usual measures (like in the case of large and electrically not closed installations, longer motor cables or a large number of drives), the following note included in EN 61800-3 has to be observed

★ Components of the drive system Rexroth Fe are products of category C3 (with restricted distribution) according to IEC 61800-3. They are not provided for use in a public low-voltage mains supplying residential areas. If they are used in such a mains, high-frequency interference is to be expected. This can require additional measures of radio interference suppression.

See the following chapters for the limit classes (as per categories C1, C2, C3, C4 according to EN 61800-3) which can be reached for the Frequency Converter Fe.

13.3.2 Ensuring the EMC requirements

Standards and laws

On the European level there are the EU Directives. In the EU states these Directives are transformed into laws valid on a national level. The relevant directive for EMC is EU Directive 89/336/EWG which was transformed on the national level in Germany into the law EMVG (“Law concerning electromagnetic compatibility of devices”) of 1992-11-09.

EMC Properties of Components

Drive and control components by Rexroth are designed and built, in accordance with the present state-of-the-art of standardization, according to legal regulations of the EU Directive EMC 89/336/EEC and the German law.

The compliance with EMC standards was tested by means of a typical arrangement with a test setup conforming to standard with the indicated mains filters. The limit values according to product standard EN 61800-3 have been complied with.

Apart from the internal test at the factory, a conformity test was carried out for individual drive systems in an accredited laboratory of a CE-responsible authority.

Applicability for End Product

Measurements of the drive system with an arrangement typical for the system are not in all cases applicable to the status in a machine or installation. Noise immunity and noise emission strongly depend on:

- ★ configuration of the connected drives
- ★ number of the connected drives
- ★ conditions of mounting
- ★ site of installation
- ★ radiation conditions
- ★ wiring and installation

In addition, the required measures depend on the requirements of electric safety technology and economic efficiency in the application.

In order to prevent interference as far as possible, notes on mounting and installation are contained in the application manuals of the components and in this documentation.

Cases to Distinguish for Declaration of EMC Conformity

For validity of the harmonized standards, we distinguish the following cases:

- Case 1: Delivery of the drive system.

  According to the regulations, the product standard EN 61800-3 is complied with for Rexroth drive systems. The drive system is listed in the declaration of EMC conformity. This fulfills the legal requirements according to EMC directive.

- Case 2: Acceptance test of a machine or installation with the installed drive systems.

  The product standard for the respective type of machine/installation, if existing, applies to the acceptance test of the machine or installation. In the last years, some new product standards were created at present.

These new product standards contain references to the product standard EN 61800-3 for drives or specify higher-level requirements demanding increased filter and installation efforts. When the machine manufacturer wants to put the machine/installation into circulation, the product standard relevant to his machine/installation has to be complied with for his end product “machine/installation”. The authorities and test laboratories responsible for EMC normally refer to this product standard.

This documentation specifies the EMC properties which can be achieved, in a machine or installation, with a drive system consisting of the standard components.

It is also specifies the conditions under which the indicated EMC properties can be achieved.

13.3.3 EMC measures for design and installation

13.3.3.1 Rules for design of installations with drive controllers in compliance with EMC

The following rules are the basics for designing and installing drives in compliance with EMC

Mains Filter

Correctly use a mains filter recommended by Rexroth for radio interference suppression in the supply feeder of the drive system.

Control Cabinet Grounding

Connect all metal parts of the cabinet with one another over the largest possible surface area to establish a good electrical connection. This, too applies to the mounting of the mains filter. If required, use serrated washers which cut through the paint surface. Connect the cabinet door to the control cabinet using the shortest possible grounding straps.

Line Routing

Avoid coupling routes between lines with high potential of noise and noise-free lines; therefore, signal, mains and motor lines and power cables have to be routed separately from another. Minimum distance: 10 cm. Provide separating sheets between power and signal lines. Ground separating sheets several times.

The lines with high potential of noise include:

- Lines at the mains connection (incl. synchronization connection)
- Lines at the motor connection
- Lines at the DC bus connection

Generally, interference injections are reduced by routing cables close to grounded sheet steel plates. For this reason, cables and wires should not be routed freely in the cabinet, but close to the cabinet housing or mounting panels. Separate the incoming and outgoing cables of the radio interference suppression filter.

Interference Suppression Elements

Provide the following components in the control cabinet with interference suppression combinations:

- Contractors
- Relays
- Solenoid values
- Electromechanical operating hours counters

Connect these combinations directly at each coil.

Twisted Wires

Twist unshielded wires belonging to the same circuit (feeder and return cable) or keep the surface between feeder and return cable as small as possible. Wires that are not used have to be grounded at both ends.

Lines of Measuring Systems

Lines of measuring systems must be shielded. Connect the shield to ground at both ends and over the largest possible surface area. The shield may not be interrupted, e.g. using intermediate terminals.

Digital Signal Lines

Ground the shields of digital signal lines at both ends (transformer **and** receiver) over the largest possible surface area and with low impedance. This avoids low frequency interference current (in the mains frequency range) on the shield.

Analog Signal Lines

Ground the shields of digital signal lines at one end (transformer **or** receiver) over the largest possible surface area and with low impedance. This avoids low frequency interference current (in the mains frequency range) on the shield.

Connection of Mains Choke

Keep connection lines of the mains choke at the drive controller as short as possible and twist them.

Installation of Motor Power Cable

- Use shield motor power cable or run motor power cables in a shielded duct;
- Use the shortest possible motor power cable;
- Ground shield of motor power cable at both ends over the largest possible surface area to establish a good electrical connection;
- Run motor lines in shielded form inside the control cabinet;
- Do not use any steel-shielded lines;
- The shield of the motor power cable must not be interrupted by mounted components, such as output chokes, sine filter or motor filters.

13.3.3.2 EMC-optimal installation in facility and control cabinet

General information

For EMC-optimal installation, a special separation of the interference-free area (mains connection) and the interference-susceptible area (drive components) is recommended, as shown in the figures below.

★ For EMC-optimal installation in the control cabinet, use a separate control cabinet panel for the drive components.

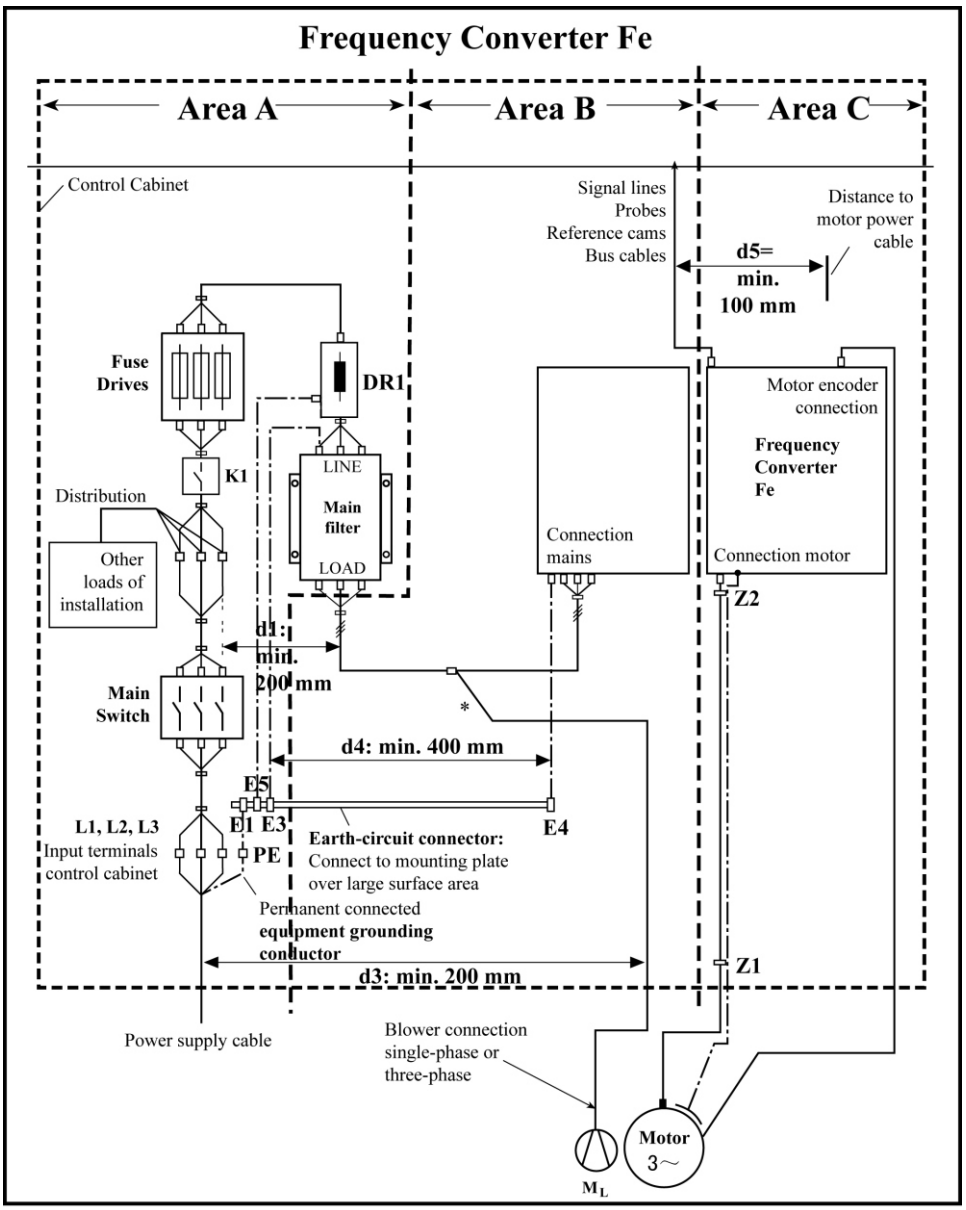
Division into areas (zones)

Exemplary arrangements in the control cabinet: See section **Control Cabinet Mounting According to Interference Areas Exemplary Arrangements**

We distinguish three areas:

1. Interference-free area of control cabinet **(area A):**
   This includes:
   - Supply feeder, input terminals, fuse, main switch, mains side of mains filter for drives and corresponding connecting lines;
   - Control voltage or auxiliary voltage connection with power supply unit, fuse and other parts unless connection is run via the mains filter of the AC drives;
   - All components that are not electrically connected with the drive system.
2. Interference-susceptible area **(area B):**
   - Mains connections between drive system and mains filter for drives, mains contactor;
   - Interface lines of drive controller
3. Strongly interference-susceptible area **(area C):**
   - Motor power cables including single cores
     Never run lines of one of these areas in parallel with lines of another area so that there is not any unwanted interference injection from one area to the other and that the filter is jumped with regard to high frequency. Use the shortest possible connecting lines.
     Recommendation for complex systems: Install drive components in one cabinet and the control units in a second, separate cabinet.
     Badly grounded control cabinet doors act as antennas. Therefore, connect the control cabinet doors to the cabinet on top, in the middle and on the bottom via short equipment grounding conductors with a cross section of at least 6 mm^2 or, even better, via grounding straps with the same cross section. Make sure connection points have good contract.

Control Cabinet Mounting According to Interference Areas Exemplary Arrangements



DR1	Mains choke (optional)
E1…E5	Equipment grounding conductor or the components
K1	External mains contactor
M_L	Motor blower
Z1, Z2	Shield connection points for cables

Design and installation in area A interference-free area of control cabinet

Arrangement of the Components in the Control Cabinet

Comply with a distance of at least 200 mm (distance d1 in the figure):

- Between components and electrical elements (switches, pushbuttons, fuses, terminal connectors) in the interference-free area A and the components in the two other areas B and C

Comply with a distance of at least 400 mm (distance d4 in the figure):

- Between magnetic components (such as transformers, mains chokes and DC bus chokes that are directly connected to the power connections of the drive system) and the interference-free components and lines between mains and filter including the mains filter in area A

If these distances are not kept, the magnetic leakage fields are injected to the interference-free components and lines connected to the mains and the limit values at the mains connection are exceeded in spite of the installed filter.

Cable Routing of the Interference-free Lines to the Mains Connection

Comply with a distance of at least 200 mm (distance d1 and d3 in the figure):

- Between supply feeder or lines between filter and exit point from the control cabinet in area A and the lines in area B and C

If this is impossible, there are two alternatives:

1. Install lines in shielded form and connect the shield at several points (at least at the begging and at the end of the line) to the mounting plate or the control cabinet housing over a large surface area.
2. Separate lines from the other interference-susceptible lines in areas B and C by means of a grounded distance plate vertically attached to the mounting plate.

Install the shortest possible lines within the control cabinet and install them directly on the grounded metal surface of the mounting plate or of the control cabinet housing.

Mains supply lines from areas B and C must not be connected to the mains without a filter.

★ In case you do not observe the information on cable routing given in this section, the effect of the mains filter is totally or partly neutralized. This will cause the noise level of the interference emission to be higher within the range of 150 kHz to 40 kHz and the limit values at the connection points of the machine or installation will thereby be exceeded.

Routing and Connecting a Neutral Conductor (N)

If a neutral conductor is used together with a three-phase connection, it must not be installed unfiltered in zones B and C, in order to keep interference off the mains.

Motor Blower at Mains Filter

Single-phase or three-phase supply lines of motor blowers, that are usually routed in parallel with motor power cables or interference-susceptible lines, must be filtered:

- In drive system with **only infeeding supply units**, via the available three phase filter of the drive system

When switching power off, make sure the blower is not switched off.

Loads at Mains Filter of Drive System

★ Only operate allowed loads at the mains filter of the drive system!

Shielding Mains Supply Lines in Control Cabinet

If there is a high degree of interference injection to the mains supply line within the control cabinet, although you have observed the above instructions (to be found out by EMC measurement according to standard), proceed as follows:

- Only use shielded lines in area A
- Connect shields to the mounting plate at the beginning and the end of the line by means of clips

The same procedure may be required for long cables of more than 2 m between the point of power supply connection of the control cabinet and the filter within the control cabinet.

Mains Filters for AC Drives

Ideally, mount the mains filter on the parting line between area A and B. make sure the ground connection between filter housing and housing of the drive controllers has good electrically conductive properties.

If **single-phase** loads are connected on the load side of the filter, their current may be a maximum of 10 % of the three-phase operating current. A highly imbalanced load of the filter would deteriorate its interference suppression capacity.

If the mains voltage is more than 480 V, connect the filter to the output side of the transformer and not to the supply side of the transformer.

Grounding

In the case of bad ground connections in the installation, the distance between the lines to the grounding points E1, E2 in area A and the other grounding points of the drive system should be at least d4=400 mm, in order to minimize interference injection from ground and ground cables to the power input lines.

See also **13.3.3.2 Division into Areas (Zones)**.

Point of Connection for Environment Grounding Conductor at Machine, Installation, Control Cabinet

The equipment grounding conductor of the power cable of the machine, installation or control cabinet has to be permanently connected at point PE and have a cross section of at least 10 mm^2 or to be complemented by a second equipment grounding conductor via separate terminal connectors (according to EN50178/ 1997, section **5.3.2.1**). If the cross section of the outer conductor is bigger, the cross section of the equipment grounding conductor must be accordingly bigger.

Design and installation in area B - interference - susceptible area of control cabinet

Arranging Components and Lines	Modules, components and lines in area B should be placed at a distance of at least d1=200 mm from modules and lines in area A. Alternative: Shield modules, components and lines in area B by distance plates mounted vertically on the mounting plate from modules and lines in area A or use shield lines. Only connect power supply units for auxiliary or control voltage connections in the drive system to the mains via a mains filter. See **13.3.3.2 Division Into Areas (Zones)** Install the shortest possible lines between drive controller and filter.
Control Voltage or Auxiliary Voltage Connection	Only in exceptional cases should you connect power supply unit and fusing for the control voltage connection to phase and neutral conductor. In this case, mount and install these components in area A far away from area B and C of the drive system. Run the connection between control voltage connection of the drive system and power supply unit used through area B over the shortest distance.
Line Routing	Run the lines along grounded metal surfaces, in order to minimize radiation of interference fields to area A (transmitting antenna effect).

Design and installation in area C - strongly interference - susceptible area of control cabinet

Area C mainly concerns the motor power cables, especially at the connection point at the drive controller.

Influence of the Motor Power Cable

The longer the motor cable, the greater its leakage capacitors. To comply with a certain EMC limit value, the allowed leakage capacitance of the mains filter is limited.

★ Run the shortest possible motor power cables.

Routing the Motor Power Cables and Motor Encoder Cables

Route the motor power cables and motor encoder cables along grounded metal surfaces, both inside the control cabinet and outside of it, in order to minimize radiation of interference fields. If possible, route the motor power cables and motor encoder cables in metal-grounded cable ducts.

Rout the motor power cables and motor encoder cables

- with a distance of at least **d5=100** mm to interference-free lines, as well as to signal cables and signal lines

  (alternative separated by a grounded distance plate)
- in separate cable ducts, if possible

Routing the Motor Power Cables and Mains Connection Lines

For converters (drive controllers with individual mains connection), route motor power cables and (unfiltered) mains connection lines **in parallel for a maximum distance of 300 mm**. After that distance, route motor power cables and power supply cables in opposite directions and preferably in separate **cable ducts.**

Ideally, the outlet of the motor power cables at the control cabinet should be provided in a distance of at least **d3=200 mm** from the (filtered) power supply cable.

13.3.3.3 Ground connections

Housing and Mounting Plate

By means of appropriate ground connections, it is possible to avoid the emission of interference, because interference is discharged to ground on the shortest possible way.

Ground connections of the metal housings of EMC-critical components (such as filters, devices of the drive system, connection points of the cable shields, devices with microprocessor and switching power supply units) have to be well contacted over a large surface area. This also applies to all screw connections between mounting plate and control cabinet wall and to the mounting of a ground bus to the mounting plate.

The best solution is to use a zinc-coated mounting plate. Compared to a lacquered plate, the connections in this area have a good long-time stability.

Connection Elements

For lacquered mounting plates, always use screw connections with tooth lock washers and zinc-coated, tinned screws as connection elements. At the connection points, remove the lacquer so that there is safe electrical contact over a large surface area. You achieve contact over a large surface area by means of bare connection surfaces or several connection screws. For screw connections, you can establish the contact to lacquered surfaces by using tooth lock washers.

Metal Surfaces

Always use connection elements (screws, nuts, plain washers) with good electroconductive surface.

Bare zinc-coated or tinned metal surfaces have **good electroconductive properties.**

Anodized, yellow chromatized, black gunmetal finish or lacquered metal surfaces have **bad electroconductive properties.**

Ground Wires and Shield Connections

For connecting ground wires and shield connections, it is not the cross section but the size of contact surface that is important, as the high-frequency interference currents mainly flow on the surface of the conductor.

Always connect cable shields, especially shields of the motor power cables, to ground potential over a large surface area.

13.3.3.4 Installing signal lines and signal cables

Line Routing

For measures to prevent interference, see the Project Planning Manuals of respective device. In addition, we recommend the following measures:

- Route signal and control lines separately from the power cables with a minimum distance of d5=100 mm (see **13.3.3.2 Division Into Areas (Zones)**) or with a grounded separating sheet. The optimum way is to route them in separate cable ducts. If possible, lead signal lines into the control cabinet at one point only.
- If signal lines are crossing power cables, route them in an angle of 90° in order to avoid interference injection.
- Ground spare cables, that are not used and have been connected, at least at both ends so that they do not have any antenna effect.
- Avoid unnecessary line lengths.
- Run cables as close as possible to grounded metal surfaces (reference potential). The ideal solution are closed, grounded cable ducts or metal pipes which, however, is only obligatory for high requirements (sensitive instrument leads).
- Avoid suspended lines or lines routed along synthetic carries, because they are functioning like reception antennas (noise immunity) and like transmitting antennas (emission of interference). Exceptional cases are flexible cable tracks over short distances of a maximum of 5 m.

Shielding

Connect the cable shield immediately at the devices in the shortest and most direct possible way and over the largest possible surface area.

Connect the shield of analog signal lines at one end over a large surface area, normally in the control cabinet at the analog device. Make sure the connection to ground/housing is short and over a large surface area.

Connect the shield of digital signal lines at both ends over a large surface area and in short form. In the case of potential differences between beginning and end of the line, run an additional bonding conductor in parallel. This prevents compensating current from flowing via the shield. The guide value for the cross section is 10 mm^2.

You absolutely have to equip separate connections with connectors with grounded metal housing.

In the case of non-shielded lines belongs to the same circuit, twist feeder and return cable.

13.3.3.5 General measures of radio interference suppression for relays, contactors, switches, chokes and inductive loads

If, in conjunction with electronic devices and components, inductive loads, such as chokes, contactors, relays are switched by contacts or semiconductors, appropriate interference suppression has to be provided for them:

- By arranging free-wheeling diodes in the case of d.c. operation
- In the case of a.c. operation, by arranging usual RC interference suppression elements depending on the contactor type, immediately at the inductance

Only the interference suppression element arranged immediately at the inductance does serve this purpose. Otherwise, the emitted noise level is too high which can affect the function of the electronic system and of the drive.

If possible, mechanical switches and contacts should only be realized as snap contacts. Contact pressure and contact material must be suited for the corresponding switching currents.

Slow-action contacts should be replaced by snap switches or by solid-state switches, because slow-action contacts strongly bounce and are in an undefined switching status for a long time which emits electromagnetic waves in the case of inductive loads. These waves are an especially critical aspect in the case of manometric or temperature switches.

13.4 Selection Matrix for the EMC Accessories

For this topic, please contact us via the following email address:
dccx.drivesupport@boschrexroth.com.cn
Please send your enquiry in English.

14 Accessories

14.1 EMC Filter

EMC filters are used to reduce radio interference and mains pollution.

14.1.1 Technical Data

For this topic, please contact us via the following email address:
dccx.drivesupport@boschrexroth.com.cn
Please send your enquiry in English.

14.2 Mains Chokes

Mains chokes are used to reduce harmonics in the mains current.

14.2.1 Technical Data

For this topic, please contact us via the following email address:
dccx.drivesupport@boschrexroth.com.cn
Please send your enquiry in English.

14.3 Braking Unit

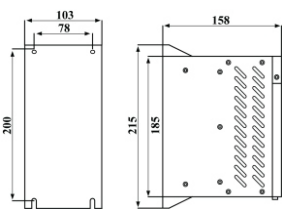
14.3.1 General precautions

The FELB braking unit is used to dissipate the energy produced by the motor during a braking process, resulting in an increased braking capability and faster deceleration of the load without overvoltage trips. In order to avoid personal injury or machine damage please read the manual carefully before installation or operation of the FELB brake unit.

14.3.2 Technical specifications

The applicable voltage class		AC power supply 380 V - 15 %...480 V+10 %; 50/60 Hz±5 %	
Braking unit model FELB		FELB02.1N-30K0-NN0NE-A-560-NNNN	FELB02.1N-45K0-NN0NE-A-560-NNNN
Input and output Specifications	Peak current (A)	50	75
	Rated current (A)	15	25
	Braking Start-up Voltage	DC 630 / DC 660 / DC 690 / DC 730 / DC 760 V ±16 V	
	Maximum hysteresis	About 16 V	
	Synchronous signal	Coupled input, coupled output, up to 3 braking units at most can be set to operate in parallel	
Power supply	DC BUS voltage range	DC 460 - 800 V	
Pro-tection	Overheat of heat sink	It is active when the temperature exceeds +85 ℃.	
	Failure output	RELAY junction 0.6 A 125 VAC / 2 A 30 VDC (T1, T2)	
Indication functions	Power ON	When voltage (more than 100 V) on the PCB AC main lead terminal flows in, the red POWER indicator light on	
	Braking ON	When braking unit works, the green BRAKING indicator light on	

14.3.3 Braking unit dimensions, weight and installation environment



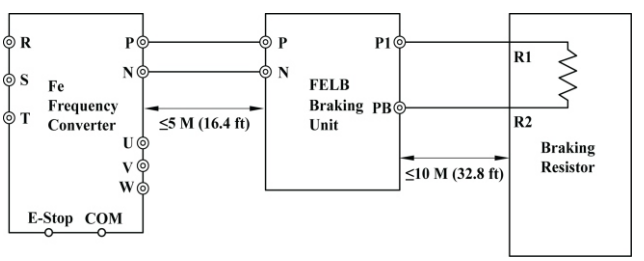
FELB Weight:

Type	Weight
FELB02.1N-30K0	2.5 kg
FELB02.1N-45K0	2.5 kg

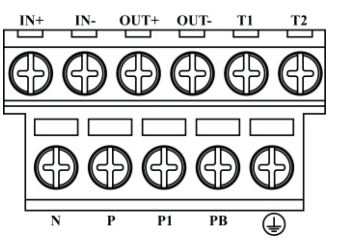
- Environment requirement:
  Keep it away from corrosive gases, liquids and dust.
  Humidity should be within 20 %RH 90 %RH.
  Temperature should be -10 ℃ - +40 ℃.
  Rigid mounting, without excessive vibration.
- Installation Space: Reserve enough air space around the braking unit to ensure proper ventilation. Recommend minimum mounting distances to other devices top/bottom 150 mm, left/right 50 mm of the braking unit.

14.3.4 Instructions for safety wiring

- When the frequency converter is connected with a DC reactor, for the wiring of the braking unit input terminal +(P), please refer to the manual of the frequency converter.
- Do not connect braking unit input terminal -(N) to the neutral point of the power supply.
- Confirm the polarities of the braking unit input terminals +(P) and -(N), otherwise the braking unit will break down immediately at the startup phase of the braking process.
- Flammable objects, gases or liquids must be avoided in the application field where the braking unit or the braking resistor is installed. They should be installed in a metal box with cooling fans and good ventilation.
- Do not change any wiring or inner setting of the braking unit while the power is on.
- To prevent personal injury, do not touch any terminal or any component on PCB in the braking unit.
- At the beginning of the wiring phase, please isolate the main circuit and control circuit wires to avoid unnecessary interference and fault operations.
- The wiring distance between the braking unit and the frequency converter should be not more than 5 M (16.4 ft). The wiring distance between braking unit and braking resistor should be not more than 10 M (32.8 ft).



(Diagram of wiring distance)



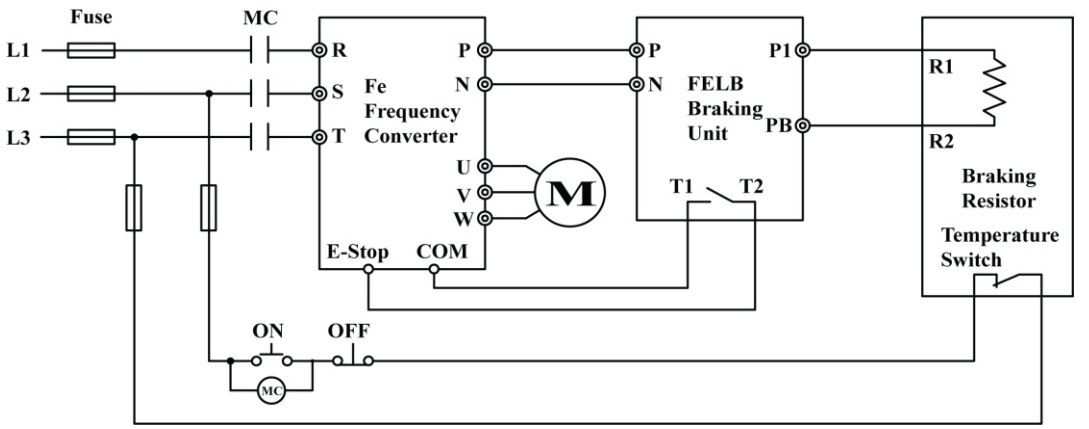
(Diagram of terminals)

Wirings on each terminal of braking units

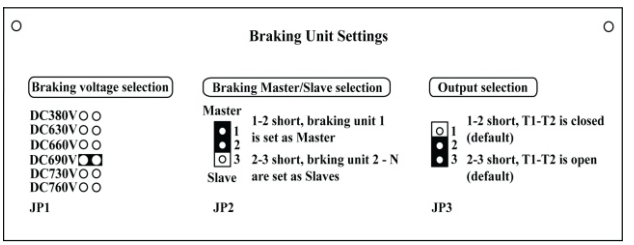
Name of terminal	Signs of terminal		Line width [mm² / AWG]	Screw specification	Torque [Nm]
Input power supply	N, P		4.0 - 6.0 / 10 - 12	M4	1.8
Braking resistor	P1, PB		4.0 -6.0 / 10 - 12	M4	1.8
Multiple units in parallel	Input	IN+, IN-	0.75 - 1.0 / 18 - 20	M4	1.8
	Output	OUT+, OUT-		M4	1.8
Failure output	T1, T2		0.75 - 1.0 / 18 - 20	M4	1.8

14.3.5 Basic wiring diagram

In order to avoid brake unit damage or break down in case of overload or fault conditions please consult the following wiring diagram. The brake unit FELB fault switch should be connected to E-Stop of the REXROTH Fe unit. The temperature switch of the braking resistor should be in series with the line contactor coil circuit.



14.3.6 The settings of the braking unit



The settings diagram of braking unit

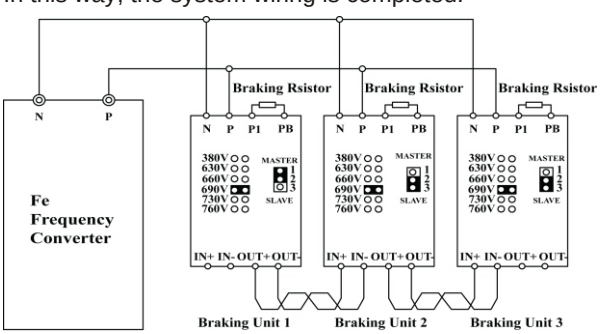
- Selections of braking voltage: the 400 V class braking unit has 5 operating voltages (630 V, 660 V, 690 V, 730 V, 760 V), and power supply of the braking unit is from +(P), -(N) of the frequency converter. This setting will influence the level of the operating voltage of the braking unit, which is an important procedure. Please switch the jumpers to the needed operating voltage position; the factory default value of JP1 is 690 V.

The table of recommended start-up braking voltage

The input voltage of the power supply to the frequency converter	380V	400V	415V	440V
Braking start-up voltage	660V	690V	730V	760V

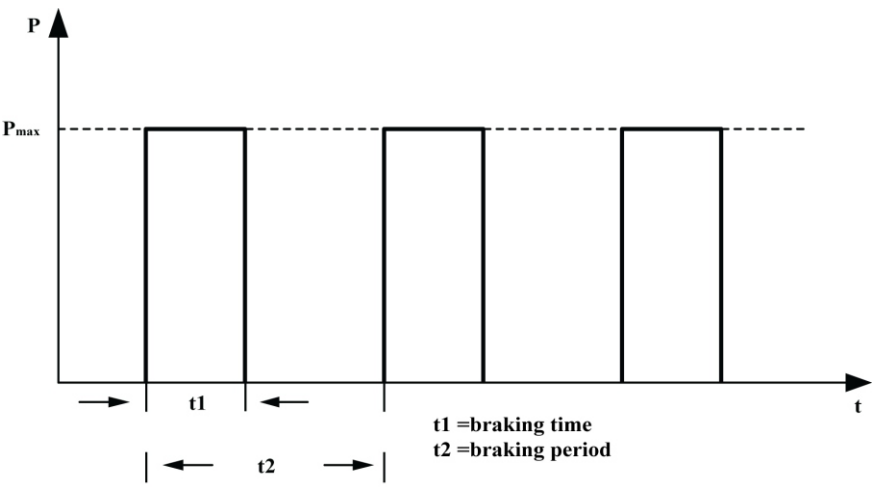
- Master/Slave settings: The braking unit set JP2 on “MASTER” as factory setting. Master braking unit will select “MASTER” and slave unit will select “SLAVE” when two or more braking units are applied in parallel.
- The selections of fault output: the temperature failure output of the braking unit is T1-T2; operating temperature is +85 ℃. T1-T2 is set normally open as factory default; if normally closed is required in practical, it can be achieved by setting JP3, and to make 1-2 short circuit.

As the chart below shows, the first braking unit is set as "MASTER"; all others have to be set as "SLAVE"s when multiple units are applied in parallel. In this way, the system wiring is completed.



14.3.7 Definition for braking usage ED%

As the indication of following diagram, braking usage ED% is the ratio of the braking time and the braking period, usually represented by percentage. When ED% is selected, the resistance and the power of braking resistor must be taken into consideration so that enough time can be ensured for the braking unit and the braking resistor to release the heat generated in the braking process.



Braking Usage ED% = t1/t2 * 100%

14.3.8 Selection of braking units and braking resistors

For the selection of the braking unit and braking resistor refer to **chapter 14.4** in this manual.

Notes:

- In the table in the manual, the recommended resistance of the braking resistor is 100 % braking torque, selected according to necessity. If the actual needed torque is not 100 %, the resistance of the braking resistor in the table should be adjusted in proportionality, i.e. how much the braking torque increases based on 100 %, the resistance of the braking resistor should decrease by the same amount, vice versa.
- When selecting braking resistor Rb, make sure the current Ic which flows through the resistor less than the current output ability of the braking unit. The current Ic through the braking resistor can be calculated by formula Ic = Ud / Rb, in which Ud is the braking operating voltage of braking unit.
- After the adjustment of the resistance of braking resistor, the power of braking resistor should be also adjusted appropriately. The power can be calculated by formula Pmax = Ud2 / Rb. According to the actual working condition, the braking rate ED% can be selected to reduce the power of braking resistor reasonably for intermittent braking load. The power of braking resistor can be calculated by formula PR = K × Pmax × ED%, in which k is the derating coefficient of braking resistor. The selection of the braking torque should be in general smaller than 150 % of the rated motor torque, or consulting the technical support for more information.

14.3.9 Fault analysis and countermeasures

When there is abnormality with the braking unit, the thermal protection of the braking unit will be active. A failure signal (via terminal T1, T2) will be sent by the braking unit to the frequency converter. The abnormality of the braking unit may result in the failure and warning of the frequency converter (depending on the setting of the frequency converter). Make sure to find the cause of failure and run it after the failure is removed.

Item	Fault conditions	Failure cause	Countermeasures
1	The POWER light of braking unit off	Wrong connection	Check out if MASTER is selected and check wire connection
2	The BRAKING light of braking unit always on	Breakdown of of braking unit IGBT	Replace braking unit
		Open circuit with braking resistor	Check out braking resistor and its wirings
3	Over voltage warning with the frequency converter	Wrong connected wires	Check out wires
		Inadequate capacity of braking resistor and braking unit	Check out design and calculate again
		Inappropriate braking unit voltage selection	Set again
4	Thermal protection device of braking unit acts resulted by overheated radiator	Over braking ratio	Check out design and calculate again
		Environmental temperature >40℃	Reduce entironmental temperature with cooling fans

14.4 Braking Resistor

Braking resistors with different power ratings are available to dissipate braking energy when the frequency converter is in generator mode.
The adjacent tables list the optimal combination of frequency converter, braking unit and braking resistor and the number of components required to operate one frequency converter with respect to a given moderating ratio OT.

$$ON\ time\ (OT)\quad \frac{Braking\ time}{Cycle\ time}\quad 100\,\%$$

Selection reference of OT = 10 %

Motor power [kW]	Converter typecode	Braking units		Braking resistors		
		Typecode	Quantity	Typecode	Type	Quantity
0.75	FECG02. 1-0K75-3P400	Internal	-	FELR01.1N-0080-N750R-D-560-NNNN	750Ω/80W	1
1.5	FECG02. 1-1K50-3P400	Internal	-	FELR01.1N-0260-N400R-D-560-NNNN	400Ω/260W	1
2.2	FECG02. 1-2K20-3P400	Internal	-	FELR01.1N-0260-N250R-D-560-NNNN	250Ω/260W	1
4.0	FECG02. 1-4K00-3P400	Internal	-	FELR01.1N-0390-N150R-D-560-NNNN	150Ω/390W	1
5.5	FECx02. 1-5K50-3P400	Internal	-	FELR01.1N-0520-N100R-D-560-NNNN	100Ω/520W	1
7.5	FECx02. 1-7K50-3P400	Internal	-	FELR01.1N-0780-N075R-D-560-NNNN	75Ω/780W	1
11	FECx02. 1-11K0-3P400	Internal	-	FELR01.1N-1K04-N050R-D-560-NNNN	50Ω/1040W	1
15	FECx02. 1-15K0-3P400	Internal	-	FELR01.1N-1K56-N040R-D-560-NNNN	40Ω/1560W	1
18.5	FECx02. 1-18K5-3P400	FELB02・1N-30K0	1	FELR01.1N-04K8-N032R-D-560-NNNN	32Ω/4.8kW	1
22	FECx02. 1-22K0-3P400	FELB02・1N-30K0	1	FELR01.1N-04K8-N27R2-D-560-NNNN	27.2Ω/4.8kW	1
30	FECx02. 1-30K0-3P400	FELB02・1N-30K0	1	FELR01.1N-06K0-N020R-D-560-NNNN	20Ω/6.0kW	1
37	FECx02. 1-37K0-3P400	FELB02・1N-45K0	1	FELR01.1N-09K6-N016R-D-560-NNNN	16Ω/9.6kW	1
45	FECx02. 1-45K0-3P400	FELB02・1N-45K0	1	FELR01.1N-09K6-N13R6-D-560-NNNN	13.6Ω/9.6kW	1
55	FECx02. 1-55K0-3P400	FELB02・1N-30K0	2	FELR01.1N-06K0-N020R-D-560-NNNN	20Ω/6.0kW	2
75	FECx02. 1-75K0-3P400	FELB02・1N-45K0	2	FELR01.1N-09K6-N13R6-D-560-NNNN	13.6Ω/9.6kW	2
90	FECx02. 1-90K0-3P400	FELB02・1N-45K0	3	FELR01.1N-06K0-N020R-D-560-NNNN	20Ω/6.0kW	3
110	FECx02. 1-110K-3P400	FELB02・1N-45K0	3	FELR01.1N-06K0-N020R-D-560-NNNN	20Ω/6.0kW	3

Note: x is a substitute for G or P series.

Selection reference of OT = 20 %

Motor power [kW]	Converter typecode	Braking units		Braking resistors		
		Typecode	Quantity	Typecode	Type	Quantity
0.75	FECG02. 1-0K75-3P400	Internal	-	FELR01.1N-0150-N700R-D-560-NNNN	700Ω/150W	1
1.5	FECG02. 1-1K50-3P400	Internal	-	FELR01.1N-0520-N350R-D-560-NNNN	350Ω/520W	1
2.2	FECG02. 1-2K20-3P400	Internal	-	FELR01.1N-0520-N230R-D-560-NNNN	230Ω/520W	1
4.0	FECG02. 1-4K00-3P400	Internal	-	FELR01.1N-0780-N140R-D-560-NNNN	140Ω/780W	1
5.5	FECx02. 1-5K50-3P400	Internal	-	FELR01.1N-1K04-N090R-D-560-NNNN	90Ω/1040W	1
7.5	FECx02. 1-7K50-3P400	Internal	-	FELR01.1N-1K56-N070R-D-560-NNNN	70Ω/1560W	1
11	FECx02. 1-11K0-3P400	Internal	-	FELR01.1N-02K0-N047R-D-560-NNNN	47Ω/2.0kW	1
15	FECx02. 1-15K0-3P400	Internal	-	FELR01.1N-01K5-N068R-D-560-NNNN	68Ω/1.5kW	2
18.5	FECx02. 1-18K5-3P400	FELB02・1N-30K0	1	FELR01.1N-10K0-N028R-A-560-NNNN	28Ω/10.0kW	1
22	FECx02. 1-22K0-3P400	FELB02・1N-30K0	1	FELR01.1N-10K0-N022R-A-560-NNNN	22Ω/10.0kW	1
30	FECx02. 1-30K0-3P400	FELB02・1N-45K0	1	FELR01.1N-12K5-N017R-A-560-NNNN	17Ω/12.5kW	1
37	FECx02. 1-37K0-3P400	FELB02・1N-45K0	1	FELR01.1N-10K0-N032R-A-560-NNNN	32Ω/10.0kW	2
45	FECx02. 1-45K0-3P400	FELB02・1N-45K0	2	FELR01.1N-10K0-N024R-A-560-NNNN	24Ω/10.0kW	2
55	FECx02. 1-55K0-3P400	FELB02・1N-30K0	2	FELR01.1N-12K5-N018R-A-560-NNNN	18Ω/12.5kW	2
75	FECx02. 1-75K0-3P400	FELB02・1N-45K0	3	FELR01.1N-12K5-N020R-A-560-NNNN	20Ω/12.5kW	3
90	FECx02. 1-90K0-3P400	FELB02・1N-45K0	3	FELR01.1N-12K5-N020R-A-560-NNNN	20Ω/12.5kW	3
110	FECx02. 1-110K-3P400	FELB02・1N-45K0	3	FELR01.1N-12K5-N020R-A-560-NNNN	20Ω/12.5kW	3

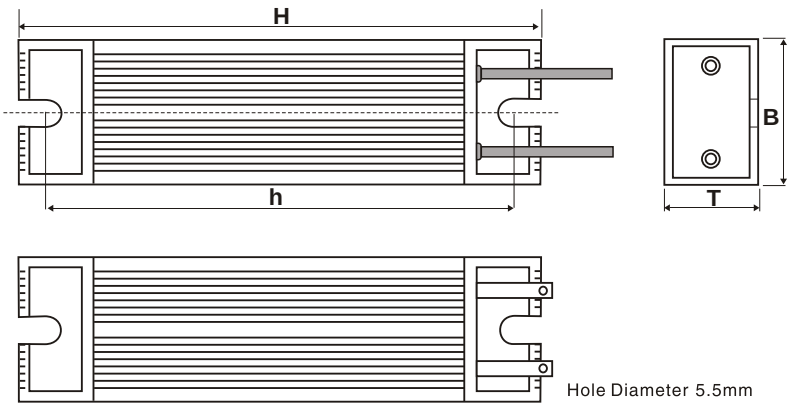
Note: x is a substitute for G or P series.

Selection reference of OT = 40 %

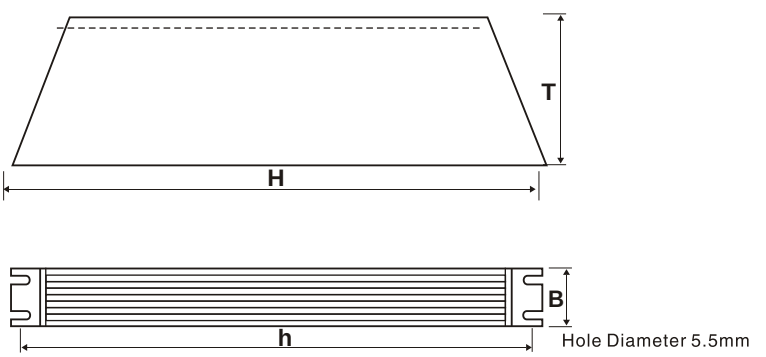
Motor power (kW)	Converter typecode	Braking units		Braking resistors		
		Typecode	Quantity	Typecode	Type	Quantity
0.75	FECG02. 1-0K75-3P400	Internal	-	FELR01.1N-0500-N550R-D-560-NNNN	550Ω/500W	1
1.5	FECG02. 1-1K50-3P400	Internal	-	FELR01.1N-0800-N275R-D-560-NNNN	275Ω/800W	1
2.2	FECG02. 1-2K20-3P400	Internal	-	FELR01.1N-01K2-N180R-D-560-NNNN	180Ω/1.2kW	1
4.0	FECG02. 1-4K00-3P400	Internal	-	FELR01.1N-02K0-N110R-D-560-NNNN	110Ω/2.0kW	1
5.5	FECx02. 1-5K50-3P400	Internal	-	FELR01.1N-01K5-N150R-D-560-NNNN	150Ω/1.5kW	2
7.5	FECx02. 1-7K50-3P400	Internal	-	FELR01.1N-04K5-N055R-A-560-NNNN	55Ω/4.5kW	1
11	FECx02. 1-11K0-3P400	Internal	-	FELR01.1N-06K0-N040R-A-560-NNNN	40Ω/6.0kW	1
15	FECx02. 1-15K0-3P400	Internal	-	FELR01.1N-08K0-N027R-A-560-NNNN	27Ω/8.0kW	1
18.5	FECx02. 1-18K5-3P400	FELB02・1N-45K0	1	FELR01.1N-10K0-N022R-A-560-NNNN	22Ω/10.0kW	1
22	FECx02. 1-22K0-3P400	FELB02・1N-45K0	1	FELR01.1N-12K5-N018R-A-560-NNNN	18Ω/12.5kW	1
30	FECx02. 1-30K0-3P400	FELB02・1N-30K0	2	FELR01.1N-10K0-N27R2-A-560-NNNN	27.2Ω/10.0kW	2
37	FECx02. 1-37K0-3P400	FELB02・1N-45K0	2	FELR01.1N-10K0-N022R-A-560-NNNN	22Ω/10.0kW	2
45	FECx02. 1-45K0-3P400	FELB02・1N-45K0	2	FELR01.1N-12K5-N018R-A-560-NNNN	18Ω/12.5kW	2
55	FECx02. 1-55K0-3P400	FELB02・1N-45K0	3	FELR01.1N-12K5-N022R-A-560-NNNN	22Ω/12.5kW	3
75	FECx02. 1-75K0-3P400	FELB02・1N-45K0	4	FELR01.1N-10K0-N022R-A-560-NNNN	22Ω/10.0kW	4
90	FECx02. 1-90K0-3P400	FELB02・1N-45K0	4	FELR01.1N-10K0-N022R-A-560-NNNN	22Ω/10.0kW	4

Note: x is a substitute for G or P series.

Drawing of braking resistor in aluminium housing



Picture A



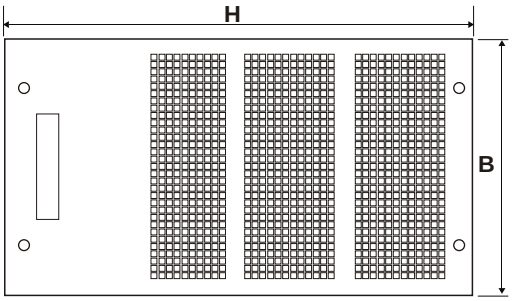
Picture B

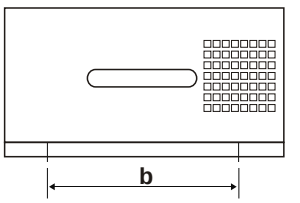
IP33

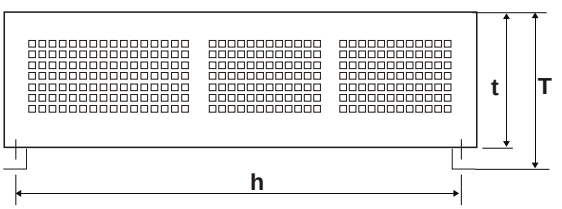
Braking resistor in aluminium housing dimensions

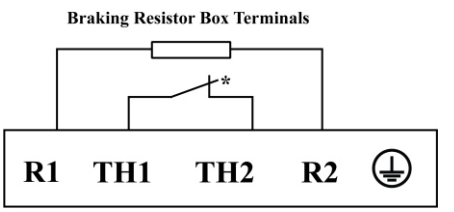
Braking resistor typecode	Impedance [Ω]	Power [W]	Picture	Dimensions[mm]				Wiring [mm²]	Terminal [mm]	Cable length [mm]	Weight [kg]	Type
				H	h	B	T					
FELR01.1N-0520-N100R-D-560-NNNN	100	520	A	335	317	60	30	2.5	-	500	1.03	Aluminium housing
FELR01.1N-0390-N150R-D-560-NNNN	150	390		265	247	60	30	2.5	-	500	0.80	Aluminium housing
FELR01.1N-0520-N230R-D-560-NNNN	230	520		335	317	60	30	2.5	-	500	1.03	Aluminium housing
FELR01.1N-0260-N250R-D-560-NNNN	250	260		215	197	60	30	2.5	-	500	0.62	Aluminium housing
FELR01.1N-0520-N350R-D-560-NNNN	350	520		335	317	60	30	2.5	-	500	1.03	Aluminium housing
FELR01.1N-0260-N400R-D-560-NNNN	400	260		215	197	60	30	2.5	-	500	0.62	Aluminium housing
FELR01.1N-0500-N550R-D-560-NNNN	550	500		335	317	60	30	2.5	-	500	1.03	Aluminium housing
FELR01.1N-0150-N700R-D-560-NNNN	700	150		215	197	40	20	2.5	-	500	0.32	Aluminium housing
FELR01.1N-0080-N750R-D-560-NNNN	750	80		140	123	40	20	2.5	-	500	0.20	Aluminium housing
FELR01.1N-1K56-N040R-D-560-NNNN	40	1560	B	485	470	50	107	2.5	M6	-	4.35	Aluminium housing
FELR01.1N-02K0-N047R-D-560-NNNN	47	2.0k		550	532	50	107	4.0	M6	-	4.90	Aluminium housing
FELR01.1N-1K04-N050R-D-560-NNNN	50	1040		400	384	50	107	2.5	M6	-	4.35	Aluminium housing
FELR01.1N-01K5-N068R-D-560-NNNN	68	1.5K		485	470	50	107	2.5	M6	-	3.60	Aluminium housing
FELR01.1N-1K56-N070R-D-560-NNNN	70	1560		485	470	50	107	2.5	M6	-	2.20	Aluminium housing
FELR01.1N-0780-N075R-D-560-NNNN	75	780		400	382	61	59	2.5	M6	-	4.35	Aluminium housing
FELR01.1N-1K04-N090R-D-560-NNNN	90	1040		400	384	50	107	2.5	M6	-	3.60	Aluminium housing
FELR01.1N-02K0-N110R-D-560-NNNN	110	2.0K		550	532	50	107	4.0	M6	-	2.20	Aluminium housing
FELR01.1N-0780-N140R-D-560-NNNN	140	780		400	382	61	59	2.5	M6	-	4.35	Aluminium housing
FELR01.1N-01K5-N150R-D-560-NNNN	150	1.5K		485	470	50	107	2.5	M6	-	4.90	Aluminium housing
FELR01.1N-01K2-N180R-D-560-NNNN	180	1.2K		450	434	50	107	2.5	M6	-	4.00	Aluminium housing
FELR01.1N-0800-N275R-D-560-NNNN	275	800		400	382	61	59	2.5	M6	-	2.20	Aluminium housing

Drawing of braking resistor box







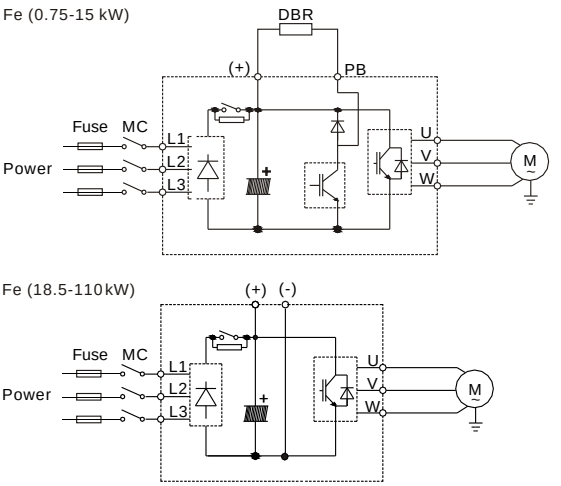


* The thermal switch is normally closed below 85 °C.

Braking resistor box dimensions

Braking resistor typecode	Impedance [Ω]	Power [kW]	Dimensions[mm]						Wiring [mm²]	Terminal [mm]	Weight [kg]	Type
			B	H	t	T	h	b				
FELR01.1N-09K6-N13R6-A-560-NNNN	13.6	9.6	410	685	145	170	642	340	6.0	M6	18.5	Resistor box
FELR01.1N-09K6-N016R-A-560-NNNN	16	9.6	410	685	145	170	642	340	6.0	M6	18.5	Resistor box
FELR01.1N-12K5-N017R-A-560-NNNN	17	12.5	410	685	145	170	642	340	6.0	M6	20.5	Resistor box
FELR01.1N-12K5-N018R-A-560-NNNN	18	12.5	410	685	145	170	642	340	6.0	M6	20.5	Resistor box
FELR01.1N-12K5-N020R-A-560-NNNN	20	12.5	410	685	145	170	642	340	6.0	M6	20.5	Resistor box
FELR01.1N-06K0-N020R-A-560-NNNN	20	6.0	340	600	145	170	580	291	4.0	M6	14.0	Resistor box
FELR01.1N-10K0-N022R-A-560-NNNN	22	10.0	410	685	145	170	642	340	6.0	M6	18.5	Resistor box
FELR01.1N-12K5-N022R-A-560-NNNN	22	12.5	410	685	145	170	642	340	6.0	M6	20.5	Resistor box
FELR01.1N-10K0-N024R-A-560-NNNN	24	10.0	410	685	145	170	642	340	6.0	M6	18.5	Resistor box
FELR01.1N-08K0-N027R-A-560-NNNN	27	8.0	410	685	145	170	642	340	6.0	M6	16.5	Resistor box
FELR01.1N-10K0-N27R2-A-560-NNNN	27.2	10.0	410	685	145	170	642	340	6.0	M6	18.5	Resistor box
FELR01.1N-04K8-N27R2-A-560-NNNN	27.2	4.8	340	600	145	170	580	291	4.0	M6	12.0	Resistor box
FELR01.1N-10K0-N028R-A-560-NNNN	28	10.0	410	685	145	170	642	340	6.0	M6	18.5	Resistor box
FELR01.1N-10K0-N032R-A-560-NNNN	32	10.0	410	685	145	170	642	340	6.0	M6	18.5	Resistor box
FELR01.1N-04K8-N032R-A-560-NNNN	32	4.8	340	600	145	170	580	291	4.0	M6	12.0	Resistor box
FELR01.1N-06K0-N040R-A-560-NNNN	40	6.0	340	600	145	170	580	291	4.0	M6	14.0	Resistor box
FELR01.1N-04K5-N055R-A-560-NNNN	55	4.5	340	600	145	170	580	291	4.0	M6	12.0	Resistor box

Connection of braking resistors



Energy regenerated when a 3-phase AC motor is decelerated (the frequency is reduced) is recovered and fed into the frequency converter. To prevent overvoltage of the frequency converter, an external braking resistor may be used. A power transistor discharges the DC bus voltage energy (braking voltage threshold at approx. 770 VDC) to the braking resistor, and the energy is lost as heat. The external braking resistor is connected as shown above:

Note 1: If a resistance lower than the recommended value (and no less than the minimum resistance) is used, contact the agent or manufacturer for calculation of resistance power.

Note 2: Safety and flammability of surrounding conditions shall be considered. Keep any item 10 cm away from the braking resistor.

Note 3: A braking resistor can not work overload for a long time. 10 times of rated load should not exceed 5 seconds.

Note 4: There could be smoking for the first use of the braking resistor as its surface uses organic silicon, which is normal and does not affect the performance of the braking resistor.

Fe Frequency Converters from 18.5 to 110 kW need an external braking unit to use the braking resistor.

For installation of the braking unit please refer to chapter **14.3 Braking Unit**.

WARNING

The braking resistor connector connection at the frequency converter (Terminals (+) and PB at converters from 0.75 - 15 kW) and the braking resistor connection at the braking unit (Terminals P1 and PB) have no shortcut protection!

Wrong wiring will cause damage to the components!

14.5 dV/dt filter (Motor filter)

dV/dt filters are used

- to reduce the rise of the output voltage of the frequency converter;
- to reduce the leakage current of the motor lines;
- to reduce the interference voltage on the motor lines.

14.5.1 Technical Data

For this topic, please contact us via the following email address:
dccx.drivesupport@boschrexroth.com.cn
Please send your enquiry in English.

14.6 Communication Interface

14.6.1 PROFIBUS adapter

The PROFIBUS adapter FEAA02.1-MODB-PROFI-NNNN-NN is used to convert the converters serial RS485 interface (ModBus) to the PROFIBUS DP standard.

Refer to the separate PROFIBUS Adapter User Manual.

14.6.2 RS232 / RS485 adapter

The RS232 / RS485 adapter FEAA01.1-RS485-RS232-NNNN-NN is used to connect the RS485 interface (ModBus) with a PC or another control unit.

14.6.3 Cable for PROFIBUS adapter

The cable FRKB0001/001,0, which is 1 m long, is used to connect the frequency converter to the PROFIBUS adapter.

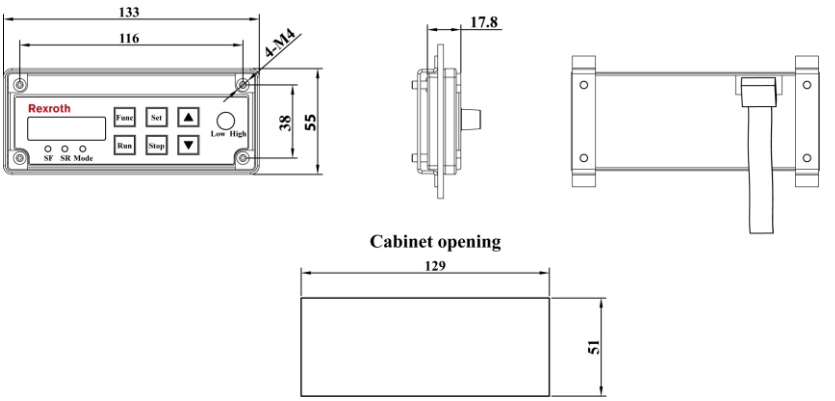
14.6.4 Cable between frequency converter and RS232 / RS485 adapter

The cable FRKB0002/005,0, which is 5 m long, is used to connect the frequency converter to the RS232 / RS485 adapter.

14.7 Remote Operating Panel

14.7.1 Remote operating panel for control cabinet mounting

The remote operating panel FECC02.1T-R-STD-POTI-NNNN is used to mount the panel at the control
cabinet. The user can conveniently operate the frequency converter from the outside of the control cabinet.



Made in China

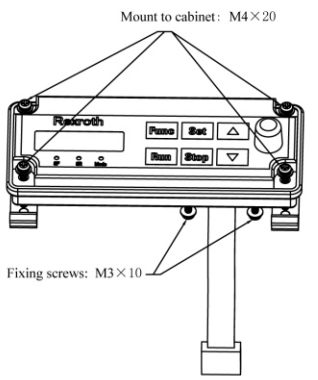
Rexroth

FECC02.1T-R-STD-POTI-NNNN

R912001498

No.	Name	MNR.
2	SCREW/3*10/Y3/A/M/A/C/N	R912000283
4	SCREW/4*20/Y3/A/M/A/C/N	R912000287
2	BOX/IRON/FECC-R/FIXING CLIPS	R912001516
1	FECC02.1T-R-STD-POTI-NNNN	R912001498

Explosion Drawing:



The cable needs to be ordered seperately.

Packing list FECC02.1T-R-STD-POTI-NNNN

No.	Name	MNR.
1	FECC02.1T-R-STD-POTI-NNNN	R912001498
2	BOX/IRON/FECC-R/FIXING CLIPS	R912001516
4	SCREW/4*20/Y3/A/M/A/C/N	R912000287
2	SCREW/3*10/Y3/A/M/A/C/N	R912000283

Date	2009-02-17	FECC02.1T-R-STD-POTI-NNNN
Name	ZhangYongqi	
MNR.	R912001498	
Drawing Number	309-1173-4201-01	

14.7.2 Control cabinet operating panel cable

The cable FRKS0001/001,0, which is 1 m long, is used to connect the operating panel for control cabinet mounting with the frequency converter.

The cable FRKS0002/003,0, which is 3 m long, can be also used for the connection of the operating panel. For connection of the FRKS0001 or FRKS0002 cable, it is necessary to remove the panel at the frequency converter and connect the cable there.

14.7.3 Operating panel with potentiometer for converters from 11 kW.

The standard panel of the frequency converter from 11 kW and bigger has no potentiometer.

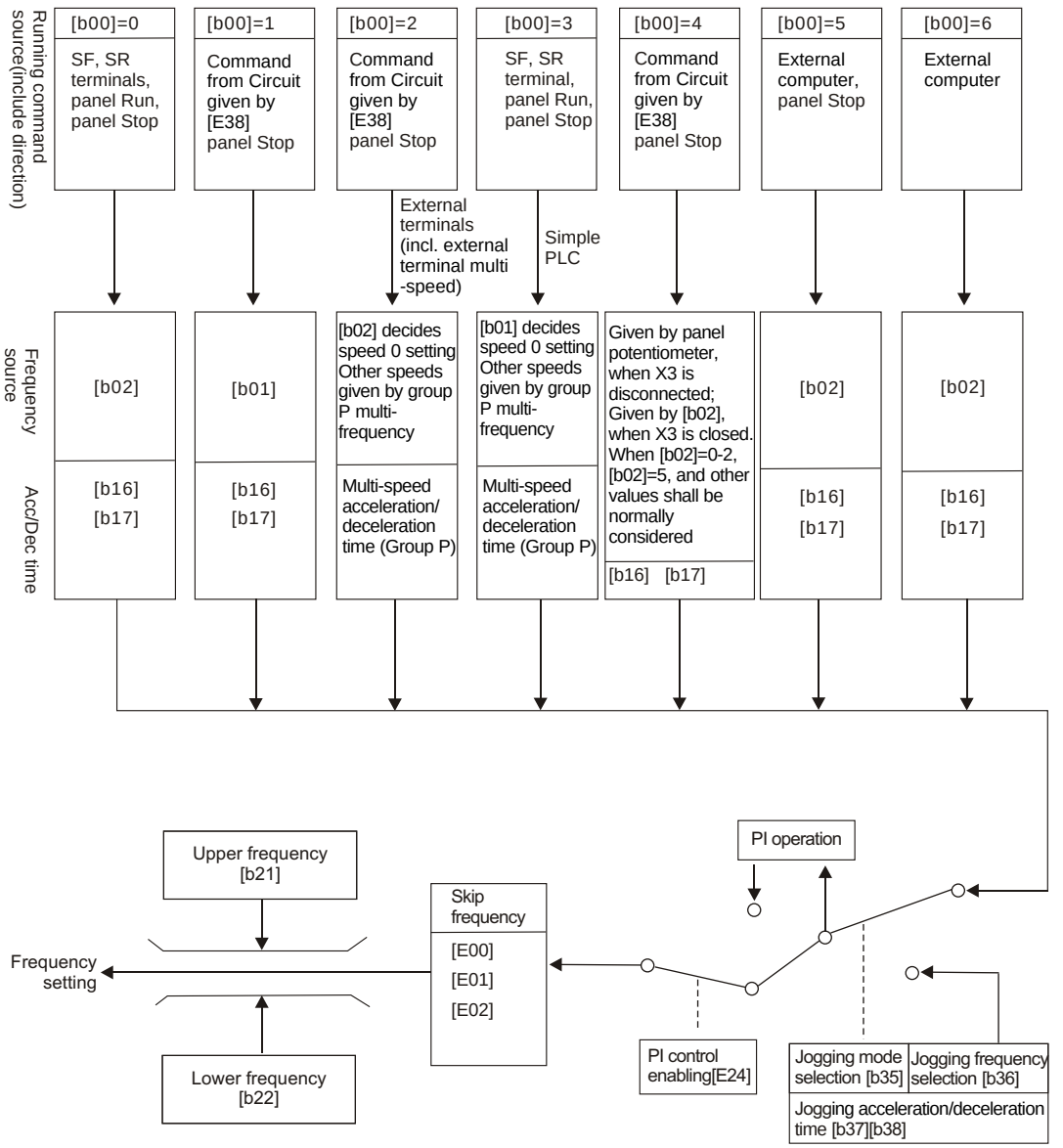
There is an optional operating panel with potentiometer for converters from 11kW and bigger available: FECC-02.1T-B-STD-POTI-NNNN.

14.8 Engineering Software

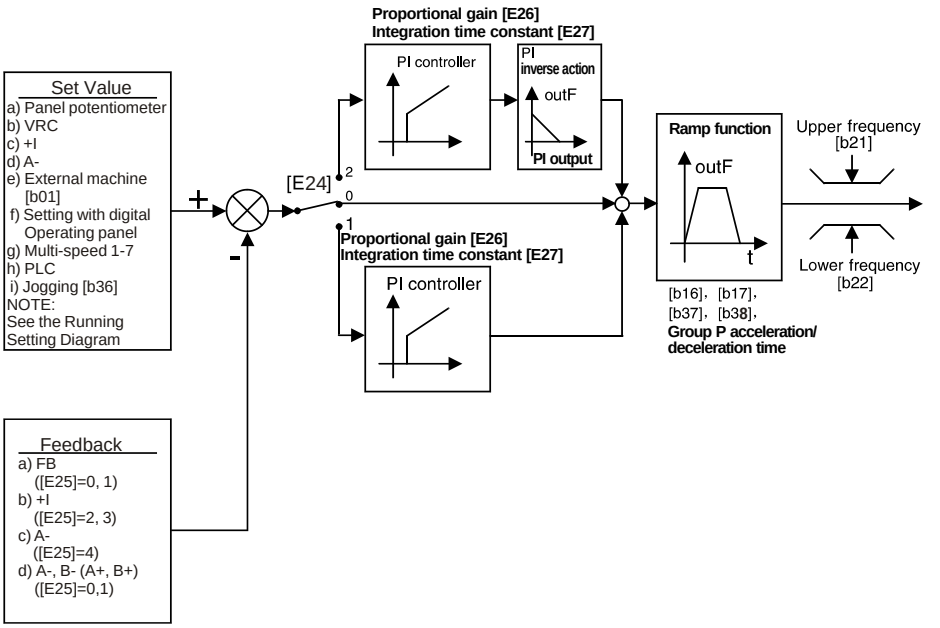
Rexroth ConverterPC4.0 is an engineering software that allows user to commission and parameterize the frequency converters. Parameters are set on the PC and transferred to the converters via serial RS485 (ModBus) interface. Together with the engineering software is the ConverterPC4.0 user manual available.

15 Additional Information

15.1 Running Settings Diagram

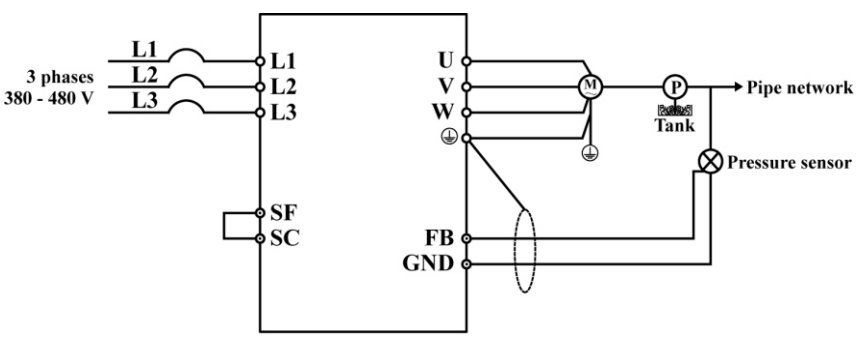


15.2 Process Control



15.2.1 Simple application of process control

(1) Automatic constant pressure water control system

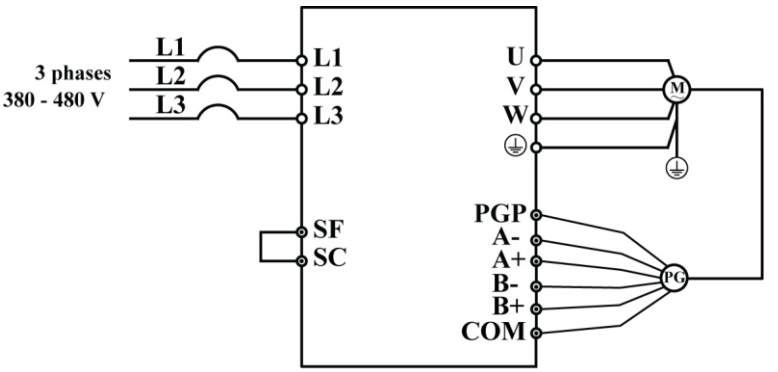


- The set value of pressure is set by using [b01] to set the frequency directly.

  The pressure feedback from the FB terminal corresponds to a value of 0 V to 5 V.

- If the pressure feedback relationship is 0V≅0.0kg/cm^2, [E22]=10.0, [E23]=0.0, [E24]=1 and [E25]=0, while [E26], [E27] and [E28] are set depending on actual conditions.

(2) Closed-loop speed control system



15.2.2 conditions and requirements

PGP is connected to the operational power supply of PG, and the set value of speed is set by 0 to 5 V signals from the panel potentiometer.

If the relationship between 0 to 5 V setting and speeds is: 0V≅0.0 rpm, and 5 V≅1500 rpm, and the pulses per cycle of the feedback encoder are 1024, the feedback pulse frequency that corresponds to 1500 rpm is:

$$\frac{\frac{1500\ \text{rpm}}{60\text{s}} \times 1024}{1000} = 25.6\ \text{kHz}$$

15.2.3 Parameter setting steps:

A. Set the display factor [E22]=1500.0, [E23]=0.0;

b. For single phase pulse input, set [E24]=1 or 2, [E25]=4 and [E31]=25.6 kHz.

c. For orthogonal pulse input, set [E24]=1 or 2, [E25]=5 and [E31]=25.6 kHz.

Notes:

If the calculated [E31] is not an integral multiple of 0.1 kHz, to improve the accuracy of steady-state control, the calculated result may be rounded to be an integral multiple of 0.1 kHz. Then [E22] can be derived and the speed corresponding to 5 V can be set. Since 200.0 kHz is the maximum pulse frequency which may be input into Fe series converter, the pulses per cycle of the feedback encoder cannot be higher than $\frac{200.0\ \text{kHz} \times 60\text{s}}{1500\ \text{rpm}} = 8000$, for the control target of 1500 rpm.

Generally, for a feedback encoder whose pulses per cycle are N, the maximum speed to be controlled is:

$$\left[\frac{200.0\ \text{kHz} \times 60\text{s}}{N}\right](\text{rpm})$$

Example:

If the relationship between 0 to 5 V and the speed is 0 V ≅0.0 rpm, and 5 V ≅1600 rpm, and the pulses per cycle of the encoder are 1000, the maximum input pulse frequency is:

$$[E31] = \frac{1000 \times \frac{1600}{60}}{1000} = 26.667\ \text{kHz}$$

To improve the control accuracy, take [E31]=26.7 kHz and

$$[E22] = \frac{26.7}{26.667} \times 1600 = 1602.0$$

Since 5 V≅1602.0 rpm, the voltage which corresponds to 1600 rpm equals

$$\frac{1600}{1602} \times 5\ \text{V} = 4.99\ \text{V}$$

15.3 Discharging of Capacitors

15.3.1 Discharging of DC bus capacitors

In the frequency converters, capacitors are used in the DC bus as energy stores. Energy stores maintain their energy even when the supply voltage has been cut off and have to be discharged before somebody gets in contact with them. Discharging devices have been integrated in the frequency converters; within the indicated discharging time, these devices discharge the voltage below the allowed 50 V.

Frequency converters have been dimensioned in such a way that after the supply voltage was cut off, the voltage value falls below 50 V within a discharging time of a maximum of 30 minutes.

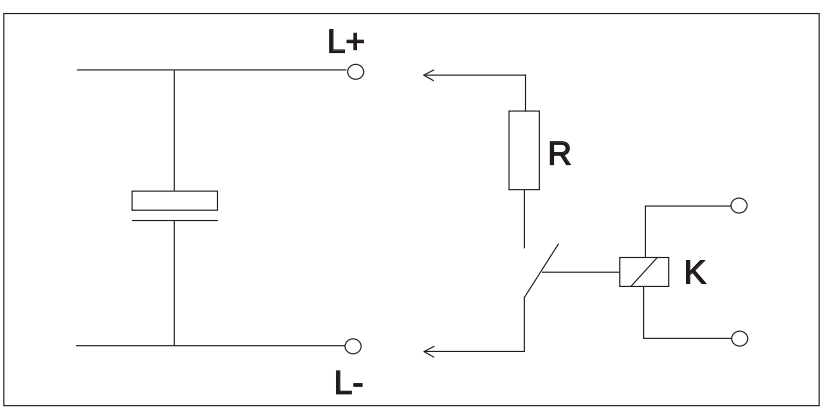
To shorten the waiting time until voltage has fallen below 50 V, you can take the following measure:

- Use the discharging device described below

15.3.2 Discharging device

Operating principle

A contactor is installed to switch a resistor to the terminals L+ and L- of the DC bus connection to discharge the capacitors. The contactor is activated via a control input which is supplied with appropriate control voltage.



R Discharging resistor
K Contactor contact

Operating Principle of Discharging Device

Dimensioning

The individual components have to be sufficiently dimensioned:

- Value of the discharging resistor: 1000 ohm and at least 1000 W;
- The discharging resistor and the contactor contact have to withstand the loads of practical operation (for example in the case of frequent use of the discharging device of the occurring continuous power).
- The contactor contact has to withstand the occurring direct voltage of a minimum of 1000 V;
- The contactor contact has to withstand the occurring discharge current according to the resistance value that is used, i.e. 1 A with 1000 ohm.

Installation

WARNING

Lethal electric shock caused by live parts with more than 50 V!

Before working on live parts: De-energize the installation and secure the power switch against unintentional or unauthorized re-energization.

Wait at least **30 minutes** after switching off the power supply voltages to allow discharging.

Check whether voltages have fallen below 50 V before touching live parts!

CAUTION

Risk of damage by intense heat!

During the discharging process, the discharging resistor generates intense heat. Therefore, place the discharging resistor as far as possible from heat-sensitive components.

How to install the discharging device

1. Preferably install discharging device **before switching on supply voltage of the first time.**

   If you install discharging device after having switched on supply voltage for the first time, wait 30 minutes to allow discharging. Check whether voltage has fallen below 50 V before touching live parts!
2. Place discharging resistor as far as possible from heat-sensitive components.

Activation

Observe the following order for activating the discharge device:

1. De-energize installation and secure power switch against unintentional for unauthorized re-energization.
2. Activate discharging device.

16 Communication Protocols

The standard RS485 port realizes the communication between the master station and the slave station via ModBus protocol. In addition to that PROFIBUS adapter is available as an external option to realize PROFIBUS network communication. With the help of a PC, a PLC or an external computer a "**single master/ multiple slave**" network can be realized (setting of frequency control command and running frequency, modification of function code parameters, monitoring of frequency converter running status and failure messages) to address the specific requirements of applications. For the PROFIBUS communication, please refer to the manual of the PROFIBUS adapter. For the ModBus communication, please refer to the following parts of this technical documentation.

16.1 ModBus Protocol

16.1.1 Overview

ModBus is a master/slave protocol. Only one device may send commands in the network at a particular time.

The master station manages information exchange by polling the slave stations. Unless being approved by the master station, no station may send information.

In case of an error during data exchange, if no response is received, the master station will query the slave stations absent from the polling.

If a slave station is not able to understand a message from the master station, it will send an exception response to the master station.

Slave stations can not communicate with each other but through the master's software, which reads data from one slave station and send them to another.

There are two types of dialogues between the master station and the slave stations:

- The master station sends a request to a slave station and waits for its response.
- The master station sends a request to all slave stations and does not wait for their response (broadcasting).

16.1.2 Transmission

The transmission is of RTU (remote terminal unit) mode with frames containing no message header or end mark. A typical RTU fame format is shown below:

Slave address	ModBus function code (1 byte)	Data	CRC16 check

Data are transmitted in binary codes.

If an interval is 3.5 characters or longer, it is taken as the end of the frame. Therefore, all information in a frame must be transmitted in a continuous data flow. If an interval of 3.5 characters or longer occurs before a complete frame is sent out, the receiving device will consider the information has ended and start processing it, and mistake following bytes for a new frame's address. Similarly, if the interval between a new frame and the previous one is less than 3.5 characters, the receiving device will consider it as a part of the previous frame. Due to confusion of the frames, the CRC check will fail and lead to a communication fault.

Data format and sending sequence of one byte:

1 start bit, 8 data bits; 1 parity check bit or no parity check bit; 1 or 2 stop bits.

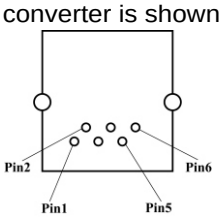
CRC (Cyclic redundancy check): CRC16, lower bytes first and higher bytes later.

Slave address:

- The address of a frequency converter may be any between 1 and 247.
- The address 0 is reserved for broadcasting. Frequency converters will act upon its request but make no acknowledgement.
- Every address must be unique in the network.

16.2 Port

The standard RS485 communication port provided by Fe series converter is shown below.



See the following table for information on the relationship between pins and signals:

Pin	Signal	Pin	Signal
1	Void	4	485+
2	GND	5	+5V
3	485-	6	Void

16.3 Protocol Functions

16.3.1 Supported functions

The main function of ModBus is to read and write parameters. Different function codes decide different operation requests.

The following table lists the ModBus functions managed by Fe series converters and their limits.

“Reading” and “writing” is considered from the prospect of the master station.

Function code	Descreption	Broadcast	Maximum value of N
3=0x03	Read N register parameters	NO	16 characters in maximum
6=0x06	Rewrite a register with information stored even after power off	YES	-
8=0x08	Loop test	NO	-
16=0x10	Rewrite N registers with information stored even after power off	YES	16 characters in maximum
23=0x17	Read from and write to N registers	NO	16 characters in maximum

If the device fails to act upon the request, it responds with an error code and exception code. The error code is the function code plus 0x80. The frame format is: Local address + (function code + 80H) + exception code + check lower byte and check higher byte. An example is given below:

Meaning	Data	RTU
Start	---	⩾3.5 t
Local address	0x01	0x01
Error code	The highest digit of the command code is 1. For example, command code 0x16 is considered as 0x96	0x96
Exception code	Code meaning 0x01: Invalid command code 0x02: Invalid data address 0x03: Illegal data frame (out of limit reading/writing characters or an incomplete frame) 0x04: Fault in command execution (function code un-rewritable due to protection/ function code to be modified out of limit/ function code can not be modified/wrong password) 0x05: CRC error	0x01
Frame check	---	CRC lower byte
		CRC higher byte
End	---	⩾3.5 t

16.3.2 Function code and communication data description

- **Function 0x03:** read N words (continuous reading 16 words in maximum) For example, it is necessary to read 2 words continuously starting from the memory address of 0004 from the slave converter addressed at 01H. The frame is described below:

RTU host command information

START	Transmission time for 3.5 bytes
ADDR	01H
CMD	03H
Higher byte of start address	00H
Lower byte of start address	04H
Higher byte of data counts	00H
Lower byte of data counts	02H
CRC lower byte	85H
CRC higher byte	CAH
END	Transmission time for 3.5 byte

Responses message from RTU slave

START	Transmission time for 3.5 bytes
ADDR	01H
CMD	03H
Number of bytes	04H
Data address 0004H higher byte	04H
Data address 0004H lower byte	00H
Data address 0005H higher byte	00H
Data address 0005H lower byte	00H
CRC lower byte	43H
CRC higher byte	07H
END	Transmission time for 3.5 bytes

- **Function 0x06:** Write a word

  Example: write 5000 (1388H) to the address 0008H of the slave converter with address 02H. The frame structure is described below:

RTU master command message

START	Transmission time for 3.5 bytes
ADDR	02H
CMD	06H
Write data address higher byte	00H
Write data address lower byte	08H
Data content higher byte	13H
Data content lower byte	88H
CRC lower byte	05H
CRC higher byte	6DH
END	Transmission time for 3.5 bytes

Responses message from RTU slave

START	Transmission time for 3.5 bytes
ADDR	02H
CMD	06H
Write data address higher byte	00H
Write data address lower byte	08H
Data content higher byte	13H
Data content lower byte	88H
CRC lower byte	05H
CRC higher byte	6DH
END	Transmission time for 3.5 bytes

- **Function 0x08:** Loop test.

  The test function code is 0000H and it is necessary to return the frame as being received. The message sent by the master to the No. 1 slave is as follows:

START	Transmission time for 3.5 bytes
Slave address:	01H
ModBus function code	08H
Test function code higher byte	00H
Test function code lower byte	00H
Test data higher byte	37H
Test data lower byte	DAH
CRC (lower byte)	77H
CRC (lower byte)	A0H
END	Transmission time for 3.5 bytes

- **Function 0x10:** Writes N words (16 in maximum)

  Example: A converter's slave address is 01H and it is necessary to modify two continuous parameter registers. The start address of the registers is 0109H and the data to be written are 003CH and 0050H. The messages are given below:

Request from the master:

Message start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	10H
Higher byte of the start address of register to be written	01H
Lower byte of the start address of register to be written	09H
Higher byte of number of registers	00H
Lower byte of number of registers	02H
Number of bytes of date to be written	04H
Higher byte of datum1	00H
Lower byte of datum1	3CH
Higher byte of datum2	00H
Lower byte of datum2	50H
CRC lower byte	FEH
CRC higher byte	65H
Message end	Transmission time for 3.5 bytes

Response from the slave :

Message start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	10H
Higher byte of the start address of register	01H
Lower byte of the start address of register	09H
Higher byte of number of registers	00H
Lower byte of number of registers	02H
CRC lower byte	90H
CRC higher byte	36H
Message end	Transmission time for 3.5 bytes

- **Function 0x17:** Read/write N words (16/16 in maximum)
  Example: A converter's slave address is 01H. It is necessary to read the contents from 2 continuous parameter registers with the start address at 0100H and write 0064H and 00C8H into 2 continuous parameter registers with the start address at 0109H. The messages are given below:

Request from the master:

Message start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	17H
Higher byte of the start address of read/write registers	01H
Lower byte of the start address of read/write registers	00H
Higher byte of number of read registers	00H
Lower byte of number of read registers	02H
Higher byte of the start address of write register	01H
Lower byte of the start address of write register	09H
Higher byte of number of registers to be written	00H
Lower byte of number of registers to be written	02H
Number of bytes of data to be written	04H
Higher byte of datum1	00H
Lower byte of datum1	64H
Higher byte of datum2	00H
Lower byte of datum2	C8H
CRC lower byte	48H
CRC higher byte	72H
Message end	Transmission time for 3.5 bytes

Response from the slave:

Message start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	17H
Byte of number of read registers	04H
Higher byte of contents in 0100H	00H
Lower byte of contents in 0100H	05H
Higher byte of contents in 0101H	00H
Lower byte of contents in 0101H	00H
CRC lower byte	E9H
CRC higher byte	26H
Message end	Transmission time for 3.5 bytes

16.4 Communication Mapping Register Address Distribution

The communication mapping registers of ModBus are in three types:

- converter parameter register group
- converter control register group
- converter state feedback register group

Converter parameter register group

Converter parameter registers correspond to the function codes one-to-one. Reading and writing of related function codes can be achieved through reading and writing of the contents in converter parameter registers via ModBus communication. The characteristics and scope of reading and writing function codes are in compliance with the user manual of the converter. The address of a converter parameter register consists of one word. The higher byte (8-bit) (0x00-0x03) represents the function code group, and the relationship is shown below; the lower byte (8-bit) represents the function code within the code group (group b: 0-43 / E: 0-48 / P: 0-37 / H: 0-63).

Function code group	b	E	P	H
Mappped address	00H	01H	02H	03H

Example:

For the parameter register with address 0x0103, the higher byte 0x01 represents group E, and the lower byte represents the fourth function code of group E, i.e. [E03].

The frequency converter may provide monitoring values, which can be used to query corresponding state feedback registers PZD3 to PZD10, with function codes [H14] to [H21].

Converter control register group (0x4000, 0x4001)

The address of register for communication control commands is 0x4000 (allows write-only). The converter is controlled through writing related data words into the address. The definition of each bit is shown below:

Control register	Address	Description	Action
Main control	0x4000	Bit 0: 0: Invalid; 1: Stopping in the mode as set by function code Bit 1: Reserved Bit 2: Reserved Bit 3: 0: Invalid; 1: Starting converter Bit 4: Reserved Bit 5: Reserved Bit 6: Reserved Bit 7: 0: Invalid; 1: Reset after fault Bit 8: 0: Forward jogging invalid; 1: Forward jogging valid (level signal) Bit 9: 0: Reverse jogging invalid;1: Reverse jogging (level signal) Bit 10: Reserved Bit 11: 0: Invalid; 1: Converter forward rotation Bit 12: 0: Invalid; 1: Converter reverse rotation Bit 13: Reserved Bit 14: Reserved Bit 15: Reserved	Write only
communication set frequency	0x4001	0 to highest frequency, unit 0.01 Hz	Write only

The address of register for communication set frequency is 0x4001 (allows write-only). If the frequency setting mode [b02] is set to be loaded by external computer, the converter's running frequency can be changed by writing the corresponding data into the address.

Converter state feedback register group

The converter state can be monitored by reading the register(allows read-only). The state is defined as follows:

Status Register	Address	Description	Action
Main status	0x5000	Bit 0: DC voltage (1: normal; 0: abnormal) Bit 1: System fault (1: fault; 0: no fault) Bit 2 and 3: Motor direction (01: reverse; 10: forward) Bit 4: Running status (1: running; 0: stopped) Bit 5: Acceleration (1: yes; 0: no) Bit 6: Deceleration (1: yes; 0: no) Bit 7: Waiting for fault retry (1: yes; 0: no) Bit 8: Coasting to stop (1: yes; 0: no) Bit 9: DC braking (1: yes; 0: no) Bit 10: Stall over current protection (1: yes; 0: no) Bit 11: Stall over voltage protection (1: yes; 0: no) Bit 12: Jogging (1: yes; 0: no) Bit 13: Restarting after transient stopping (1: yes; 0: no) Bit 14: Reserved Bit 15: Reserved	Read only
Fault word	0x5001	Bit 0: Main circuit under voltage Bit 1: Over current at constant speed Bit 2: Over current during acceleration Bit 3: Over current during deceleration Bit 4: Over voltage at constant speed Bit 5: Over voltage during acceleration Bit 6: Over voltage during deceleration Bit 7: Motor overload Bit 8: Converter overheat Bit 9: Drive protection action Bit 10: EMC CPU - Bit 11: Input phase failure Bit 12: Output phase failure Bit 13: External fault (E-Stop) Bit 14: Reserved Bit 15: Reserved	Read only
Output frequency	0x5002	Unit 0.01 Hz	
Frequency setting	0x5003	Unit 0.01 Hz	
Output current	0x5004	Unit 0.1 A	
Output voltage	0x5005	Unit 0.1 V	

Status Register	Addressing	Description	Action
Bus voltage	0x5006	Unit 0.1 V	
Switch value input signal	0x5007	Bit14-X1; bit13-X2; bit12-X3; bit11-SR; bit10-SF	
Module temperature	0x5008	Unit: 1℃	
PI control feedback value	0x5009	Signed fixed-point number Q14	
PZD1	0x7346	Status word (contents of 0x5000)	
PZD2	0x7347	Actual running frequency (contents of 0x5002)	
PZD3	0x7348	Set by [H14]	
PZD4	0x7349	Set by [H15]	
PZD5	0x734A	Set by [H16]	
PZD6	0x734B	Set by [H17]	
PZD7	0x734C	Set by [H18]	
PZD8	0x734D	Set by [H19]	
PZD9	0x734E	Set by [H20]	
PZD10	0x7350	Set by [H21]	

16.5 ModBus Communication Example

A Fe series converter's slave address is 01H. The frequency setting of the frequency converter has been set to “external computer frequency setting” and the source of running commands is “external computer control”. It is required for the motor connected to the frequency converter to run with 50 Hz (forward rotation). The operation can be achieved with function 0x10 of the ModBus protocol. The messages of the requests from the master and responses from the slave are given below:

Example 1: Start 01# converter for forward rotation at frequency of 50.00 Hz (represented by 5000 internally)

	Slave address	Function code	Start address	Number of addresses	Bytes of contents	Data contents	CRC code
Request	0x01	0x10	0x4000	0x0002	0x04	0x0808 0x1388	0x4C98
Response	0x01	0x10	0x4000	0x0002	N/A	N/A	0x5408

Example 2: Read the output voltage of 01# converter and bus voltage

	Slave address	Function code	Start address	Number of addresses	Bytes of contents	Data contents	CRC code
Request	0x01	0x03	0x5005	0x0002	N/A	N/A	0xC50A
Response	0x01	0x03	N/A	N/A	0x04	0x114D 0x175B	0x2113

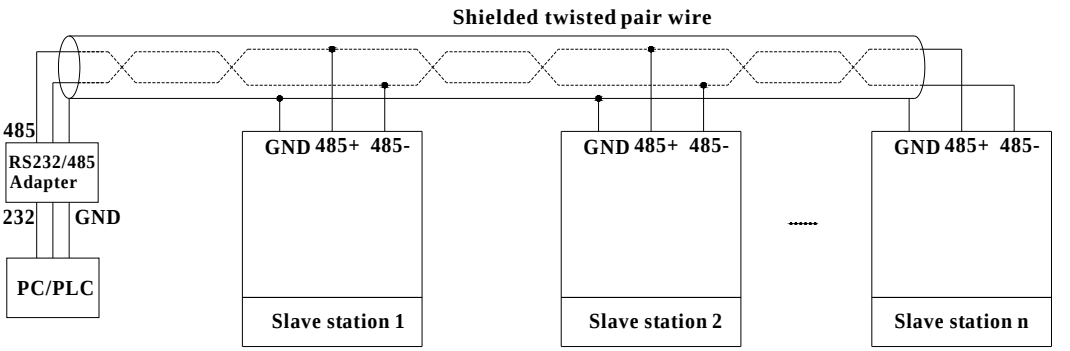
Example 3: Stop 01# converter according to the stopping mode set with the function code

	Slave address	Function code	Start address	Number of addresses	Bytes of contents	Data contents	CRC code
Request	0x01	0x06	0x4000	N/A	N/A	0x0001	0x5DCA
Response	0x01	0x06	0x4000	N/A	N/A	0x0001	0x5DCA

16.6 Communication Networking

16.6.1 Networking

The communication network is shown below, with a PC, a PLC or an external computer and various frequency converters, which are connected by shielded twisted pair cables via RS232/485 adapters. The maximum length of 232 network cable connection is 15 meters. Network terminal slaves need external resistance with a recommended value of 120 Ω .



Warning! Cables may only be connected when drive is turned off.

16.6.2 Recommendations on networking

- Use shielded twisted pair cable to connect RS485 links.
- ModBus cable should be adequately away from power cables (30 cm in minimum).
- Avoid crossing of ModBus cables and power cables and use orthogonal crossing if crossing must be used.
- The shield layer of cables should be connected to protected ground or to equipment ground if the equipment ground has already been connected to protected ground. Do not directly ground any point of the RS485 network.
- In no circumstance should ground cables constitute a loop.

17 Disposal and Environmental Protection

17.1 Disposal

Packaging Materials

The packaging materials consist of cardboard and polystyrene. These materials can be easily recycled. For ecological reasons you should not return the empty packages to us.

17.2 Environmental Protection

No Release of Hazardous Substances

Our products do not contain any hazardous substances that they can release in case of appropriate use. Normally there are not any negative effects on the environment to be expected.

Materials contained in the products

Electronic Devices

Electronic devices mainly contain:

- steel
- aluminum
- copper
- synthetic materials
- electronic components and modules

Recycling

Due to their high content of metals most of the product components can be recycled. In order to recycle the metal in the best possible way it is necessary to disassemble the products into individual modules.

The metals contained in the electric and electronic modules can also be recycled by means of specific separation processes.

The synthetic materials remaining after these processes can be thermally recycled.

18 Service and Support

Our service helpdesk at our headquarters in Lohr, Germany, will assist you with all kinds of enquiries. Out of helpdesk hours please contact our German service department directly.

	Helpdesk	Service Hotline Germany	Service Hotline Worldwide
Time [1]	Mo-Fr 7:00 am - 6:00 pm CET	Mo-Fr 6:00 pm - 7 am CET Sa-Su 0:00 am - 12:00 pm CET	Outwith Germany please contact our sales/service office in your area first. For hotline numbers refer to the sales office addresses on the Internet.
Phone	+49 (0) 9352 40 50 60	+49 (0) 171 333 88 26 or +49 (0) 172 660 04 06	
Fax	+49 (0) 9352 40 49 41	–	
e-mail	service.svc@boschrexroth.de	–	
Internet	http://www. boschrexroth. com You will also find additional notes regarding service, maintenance (e.g. delivery addresses) and training.		

1) Central European Time (CET)

Preparing Information

For quick and efficient help please have the following information ready:

- detailed description of the fault and the circumstances
- information on the type plate of the affected products, especially type codes and serial numbers
- Your phone, fax numbers and e-mail address so we can contact you in case of questions.

For technical support, please use the following email address:
dccx.drivesupport@boschrexroth.com.cn.
Please send your enquiry in English.

19 Index

A

B

C

D

E

F

G

I

L

M

N

O

P

R

S

T

U

W