# Rexroth Frequency Converter Fe

**R912001311** Edition 08

**Instruction Manual** 



Title Rexroth Frequency Converter Fe

Type of Documentation Instruction Manual

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> 귀하의 모국어로 된 안내서가 배송되지 않았다면 Bosch Rexroth 대리점에 알 려주시기 바랍니다.

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## 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.

#### **Chapters and Contents**

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

Fig.1-1: Chapters and contents

#### 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 via email to:

service.svc@boschrexroth.de

## 1.2 Definition

**Bosch Rexroth AG** 

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

• Fe: Rexroth Frequency Converter Fe

FECC: Fe operating panelFSWA: Engineering software

• FEAA: Interface adapter

FRKB: Interface adapter cableFRKS: Operating panel cable

FELR: Brake resistorFELB: Brake chopperFENF: EMC filter

## 1.3 Type Coding

## 1.3.1 Type Coding of Fe

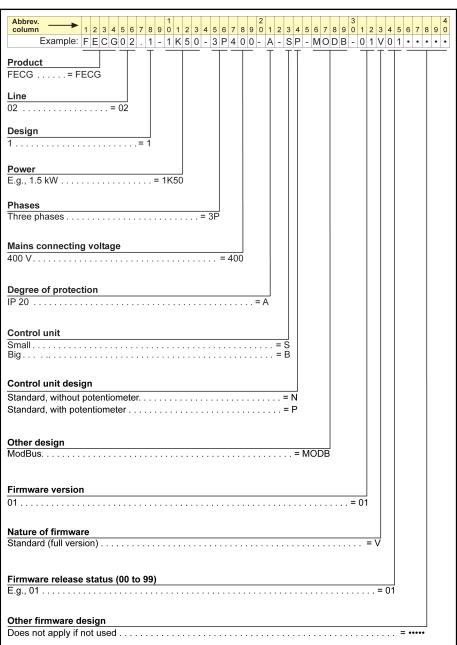


Fig. 1-2: Type coding of Fe

## 1.3.2 Type Coding of Fe Function Modules

#### **Operating Panel Type Coding**

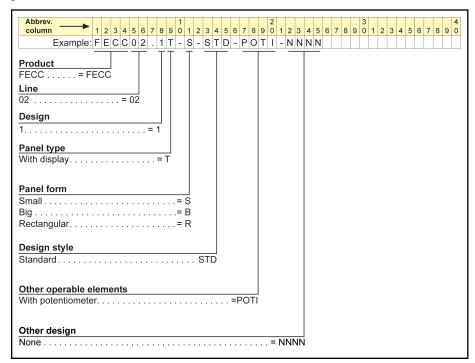


Fig.1-3: Operating panel type coding

#### **Engineering Software Type Coding**

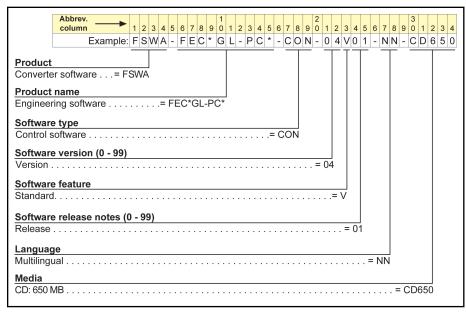


Fig.1-4: Engineering software type coding

## 1.3.3 Type Coding of Fe Accessories

#### Interface Adapter Type Coding

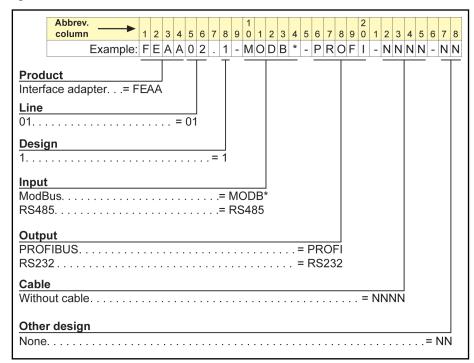


Fig.1-5: Interface adapter type coding

#### Interface Adapter Cable Type coding

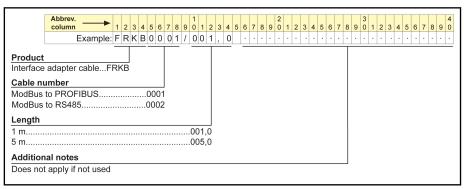


Fig. 1-6: Interface adapter cable type coding

#### **Operating Panel Cable Type Coding**

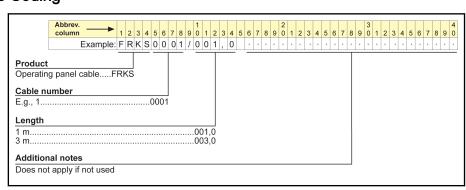


Fig.1-7: Operating panel cable type coding

#### **Brake Resistor Type Coding**

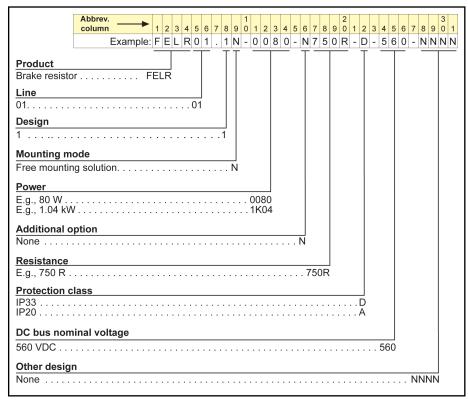


Fig.1-8: Brake resistor type coding

#### **Brake Chopper Type Coding**

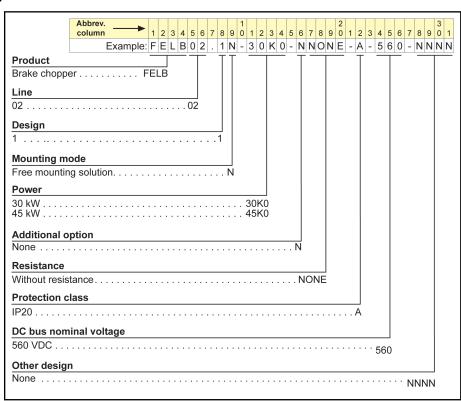


Fig.1-9: Brake chopper type coding

#### **EMC Filter Type Coding**

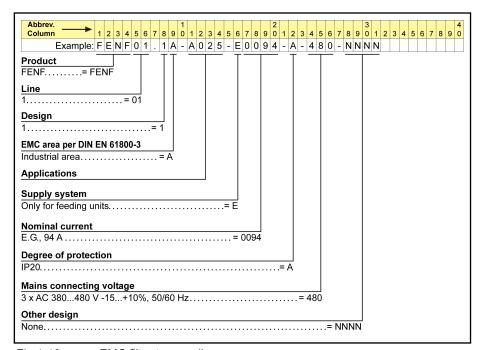


Fig.1-10: EMC filter type coding

## 1.4 Introduction to the Drive System

## 1.4.1 Delivery and Storage

**Bosch Rexroth AG** 

#### **Brief Introduction**

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.



This is also applicable if the packaging is undamaged.

#### The Scope of Supply

#### Standard model

- Frequency Converter Fe, protection class of IP20 (Control cabinet mounting)
- Internal brake chopper (0.75 to 15 kW)
- Operating panel
- Safety notes

#### Optional accessories

- Instruction manual
- Operating panel for control cabinet mounting
- Operating panel with potentiometer (11 to 160 kW)
- PROFIBUS adapter
- RS232/485 adapter
- Engineering software
- EMC filter (EN 61800-3 Environment 2)
- Motor filter (dV/dt filter)
- Mains choke
- Brake resistor
- Brake chopper (18.5 to 160 kW)

#### **Transport of the Components**

#### Ambient and operating conditions - Transport

Description	Symbol	Unit	Value
Temperature range	T <sub>a_store</sub>	°C	-2570
Relative humidity	_	%	595
Absolute humidity	_	g/m³	160
Climate category (IEC 721)	_	_	2K3
Moisture condensation	_	-	not allowed
Icing	_	_	not allowed

Fig.1-11: Transport conditions

#### Storage of the Components

# Damage to the components caused by long storage periods!

Frequency converters contain electrolytic capacitors which may deteriorate during storage.

When storing frequency converters for a long period of time, operate them once a year for at least 1 hour with power on:

- Fe with mains voltage U<sub>LN</sub>
- FELB with DC bus voltage U<sub>DC</sub>

#### Ambient and operating conditions - Storage

Description	Symbol	Unit	Value
Temperature range	T <sub>a_store</sub>	°C	-2555
Relative humidity	-	%	595
Absolute humidity	-	g/m³	129
Climate category (IEC 721)	-	-	2K3
Moisture condensation	-	-	not allowed
Icing	-	-	not allowed

Fig. 1-12: Storage conditions

#### Fe Description 1.5

**Bosch Rexroth AG** 

#### 1.5.1 Certification

#### **CE Certification**

**Declaration of conformity** 

For Fe, there are declarations of conformity which confirm that the frequency converters comply with the applicable EN standards and EC Directives. If required, you may ask our sales representative for the declarations of conformi-

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

Fig. 1-13: Declaration of conformity and standard

**CE** label



Fig.1-14: CE label

High-voltage test

According to standard EN 61800-5-1, all Fe components are tested with high voltage.

Rexroth Frequency Converter Fe

Introduction

#### **UL Certification**

The frequency converters are listed by UL "Underwriters Laboratories Inc.®". You can find the evidence of certification on the Internet under <a href="http://www.ul.com">http://www.ul.com</a> under "Certifications" by entering the file number or the "Company Name: Rexroth".

**UL** listing



Fig. 1-15: UL listing

UL standard UL 508C

Company name BOSCH REXROTH (Xi'an) ELECTRIC DRIVES and CONTROLS Co., Ltd.

Category name Power Conversion Equipment

File number E328841

UL ratings For using the components in the scope of UL, take the UL ratings of the indi-

vidual component into account.

Make sure that the indicated short circuit rating SCCR is not exceeded

(5000 Arms), e.g. by appropriate fuses in the power supply lines.

**UL wiring material** In the scope of UL, use copper 60 °C and above only.

For 45 to 160 kW frequency converters, use copper 75 °C and above only.

## 1.5.2 Properties of the Basic Device Fe

**Bosch Rexroth AG** 

- Allowed ambient temperature: -10 to 40 °C
- Protection class: IP20 (control cabinet mounting)
- Power range: 0.75 to 160 kW
- Power supply voltage: 3 AC 380 to 480 V (-15 % / +10 %)
- High start-up torque and precise motor speed control
- 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
- Output frequency: 0 to 650 Hz
- Pulse width modulation (PWM) for frequency converters with:

Power [kW]	PWM setting range [kHz], adjustable in 1 kHz steps
0.75 to 7.5	1 to 15
11 to 45	1 to 8
55 to 160	1 to 6

Fig.1-16: Fe PWM setting range

- Internal brake chopper
  - (0.75 to 15 kW only, brake resistor connected externally)
- Control mode: V/F

#### 1.5.3 Functions

- Programmable skip frequencies: See Parameters [E00] to [E03]
- Upper and lower frequency commands, and highest frequency: See Parameters [b03], [b21] and [b22]
- DC braking for starting and stopping: See Parameters [H04] to [H07]
- PI control: See Parameters [E24] to [E30]
- Energy saving: See Parameters [H23] to [H28]
- ModBus and PROFIBUS communication: See Parameters [H08] to [H21]
- Fault reset: See Parameters [E42] to [E44]
- Drooping control: See Parameter [H37]
- Forward and reverse rotation dead zone setting: See Parameter [b18]
- Constant voltage control: See Parameter [b14]
- Jogging control: See Parameters [b35] to [b38]
- Speed capturing: See Parameter [b46] to [b50]
- Automatic adjustment of PWM frequency according to temperature: See Parameter [H01]
- Current no-trip control: See Parameters [H30] to [H33]
- Dynamic braking point set with function code: See Parameter [H36]

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#### Introduction

- Zero speed control: See Parameters [b42] and [b43]
- Restart after power failure: See Parameter [H02]
- Multi-speed and logic control: See Parameters [P00] to [P37]
- S-curve acceleration/ deceleration: See Parameter [b15]
- 3-wire/2-wire terminal function: See Parameter [E38]
- Automatic energy-saving of cooling fan: See Parameter [H22]

#### 1.5.4 Interfaces

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

## 1.5.5 Cooling Types

- Air cooling
- Forced, temperature-controlled air cooling

## 2 Safety Instructions for Electric Drives and Controls

## 2.1 General Information

### 2.1.1 Using the Safety Instructions and Passing them on to Others

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 or check <a href="https://www.boschrexroth.com/">www.boschrexroth.com/</a> various/utilities/mediadirectory/ for available downloads of safety instructions and instruction manuals. If the device is resold, rented and/or passed on to others in any other form, then these safety instructions (official language version of the user) must be delivered with the device.

#### **A** 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 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 practiced 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 Instruction 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 and check the information given in this document with regard to the use of the components.
  - 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.

#### 2.1.2 Explanation of Safety 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.

Safety symbols	Degree of hazard seriousness	
▲ DANGER	Death or severe bodily harm will occur.	
<b>▲</b> WARNING	Death or severe bodily harm may occur.	
<b>▲</b> CAUTION	Minor or moderate injury or property damage may occur.	

Fig.2-1: Safety symbols and degree of hazard

#### 2.2 Hazards by Improper Use

<b>▲</b> DANGER	High electric voltage and high working current! Risk of death or severe bodily injury by electric shock!
<b>▲</b> DANGER	Dangerous movements! Danger to life, severe bodily harm or material damage by unintentional motor movements!

# High electric voltage because of incorrect connection! Risk of death or bodily injury by electric shock! MARNING Health hazard to persons with heart pace-

## **A** CAUTION

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

makers, metal implants and hearing aids in

proximity to electrical equipment!

## **A** CAUTION

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

## 2.3 Instructions with Regard to Specific Dangers

**Protection Against Contact with Electrical Parts** 



This section only concerns devices and drive components with voltages of more than 50 V. Contact with parts conducting voltages above 50 V can cause personal danger and electric shock. When operating electrical equipment, it is unavoidable that some parts of the devices conduct dangerous voltage.

#### **A** 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 V, the device must be disconnected from the mains voltage or power supply unit.
- With electrical drive and filter components, observe the following:
  - Wait for 30 minutes after switching off power to allow capacitors to discharge before beginning to work.

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- 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.

With electrical drive and filter components, observe the following:

#### **DANGER**

High housing voltage and large leakage currentl

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<sup>2</sup> 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.

#### Protection Against Electric Shock by Protective Low Voltage 2.4 (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 Volt, 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. Don't 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.

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# 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 the 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

#### **A** 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 °C, 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.

#### **A** CAUTION

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

- 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 specific 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.

Rexroth Frequency Converter Fe

Important Directions for Use

## 3 Important Directions for Use

## 3.1 Appropriate Use

Bosch Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

The products have been designed for use in the industrial environment and only in the appropriate way. If they are not used in the inappropriate way, situations resulting in property damage and personal injury may occur.



Bosch Rexroth as manufacturer is not 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 Bosch 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 frequency converters outside of the operating conditions described in this manual and outside of the indicated technical data and specifications is defined as "inappropriate use".

Frequency converters 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 frequency converters shall not be used in applications which have not been expressly authorized by Bosch Rexroth. Please carefully follow the specifications outlined in the general Safety Instructions!

Fe Mounting

## **Fe Mounting**

## **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.

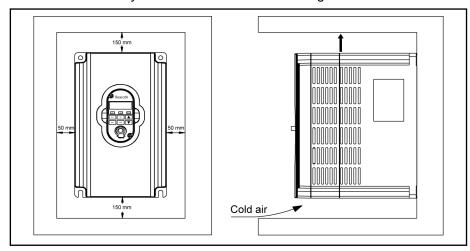


Fig.4-1: Fe mounting

B

The frequency converter must be vertically installed.

If one frequency converter is arranged above the other, make sure that the upper limit of air temperature into the inlet is not exceeded (See fig. 9-1 "General technical data" on page 157). If exceeded, a baffle plate is recommended between the frequency converters, to prevent the rising hot air being drawn into the upper frequency converter.

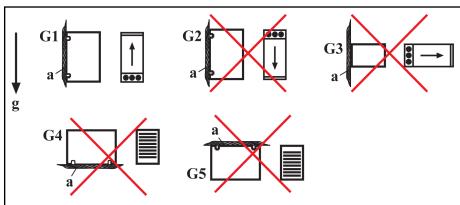
> A CAUTION Risk of damage to the components!

Only operate the components in their allowed mounting positions.

#### Fe Mounting

# Allowed mounting position of the components

Only the mounting position G1 is allowed for Frequency Converter Fe.



а	Mounting surface
g	Direction of gravitational force
G1	Normal mounting positions. The natural convection 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 on top of control cabinet.
Fig.4-2:	Allowed mounting position

# 4.2 Fe Dimensions and Figure

## 4.2.1 Fe Dimensions

Fe model	Dimensions [mm]					Weight	Screw		
i e modei		н	Т	b	h	Ø	t	[kg]	size
FECG02. 1-0K75-3P400-A-SP-MODB-01V01								3.0	
FECG02. 1-1K50-3P400-A-SP-MODB-01V01								3.0	
FECG02. 1-2K20-3P400-A-SP-MODB-01V01	125	220	176	109	204	6	10	3.2	M5
FECG02. 1-4K00-3P400-A-SP-MODB-01V01	125	220	170	109	204	0	10	3.2	IVIO
FECx02. 1-5K50-3P400-A-SP-MODB-01V01								3.5	
FECx02. 1-7K50-3P400-A-SP-MODB-01V01	1							3.5	
FECx02. 1-11K0-3P400-A-BN-MODB-01V01	220	392	218	180	372	0.5	2.5	10.7	
FECx02. 1-15K0-3P400-A-BN-MODB-01V01	_ 220	392 21	210	100	3/2	9.5	2.5	10.9	
FECx02. 1-18K5-3P400-A-BN-MODB-01V01	275	463	218	200	443	9.5	2.5	16.2	
FECx02. 1-22K0-3P400-A-BN-MODB-01V01	7 2/3	403	210	200	443	9.5	2.5	16.9	
FECx02. 1-30K0-3P400-A-BN-MODB-01V01	290	574	236	200	550	11	2.5	21.5	M8
FECx02. 1-37K0-3P400-A-BN-MODB-01V01	_ 290	374	230	200	330	11	2.5	22	IVIO
FECx02. 1-45K0-3P400-A-BN-MODB-01V01	364	602	260	360	576	11	4.5	33.2	
FECx02. 1-55K0-3P400-A-BN-MODB-01V01	304	002	200	300	370	11	4.5	33.8	
FECx02. 1-75K0-3P400-A-BN-MODB-01V01	455	682	290	375	650	11	4.5	50.9	
FECx02. 1-90K0-3P400-A-BN-MODB-01V01	455	002	290	3/3	030	11	4.5	52.5	
FECx02. 1-110K-3P400-A-BN-MODB-01V01								96.5	
FECx02. 1-132K-3P400-A-BN-MODB-01V01	570	850	360	450	825	11	4.5	100	M10
FECx02. 1-160K-3P400-A-BN-MODB-01V01								102	

Fig.4-3: Fe dimensions



- x is a substitute for G or P series.
- The above table is also applicable to C001 models.
- Fix the mounting screws with the following typical tightening torque:

M5: 4 Nm / 35 lb-in

– M8: 12 Nm / 110 lb-in

# 4.2.2 Fe Figure

Applicable to 0.75 to 7.5 kW:

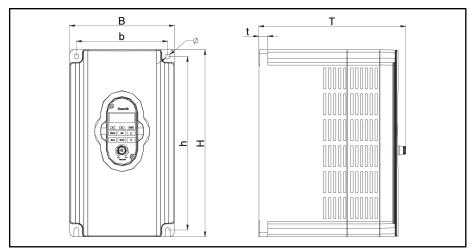


Fig.4-4: Figure (0.75 to 7.5 kW)

## Applicable to 11 to 37 kW:

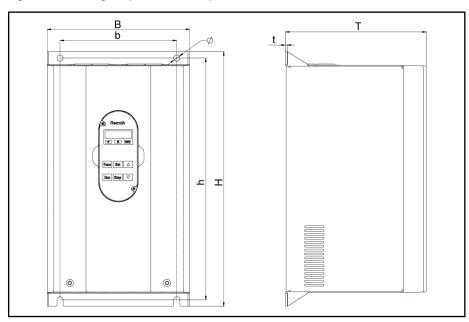


Fig.4-5: Figure (11 to 37 kW)

## Applicable to 45 to 90 kW:

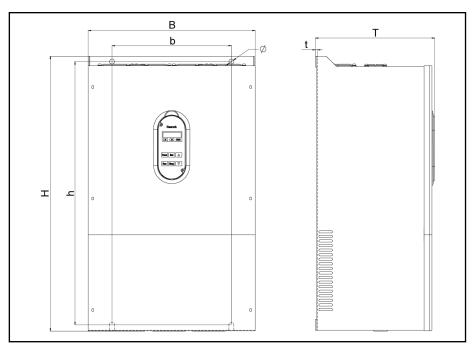


Fig.4-6: Figure (45 to 90 kW)

## Applicable to 110 to 160 kW:

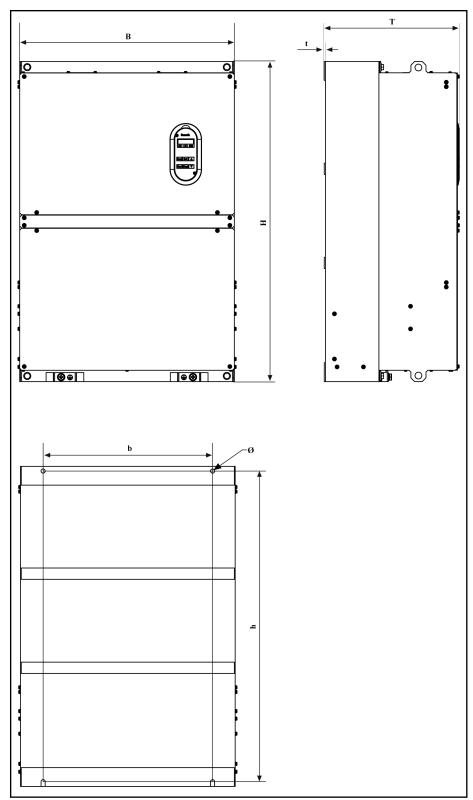


Fig.4-7: Figure (110 to 160 kW)

# 5 Installation

# 5.1 Fe Opening Instruction

Applicable to 0.75 to 7.5 kW:

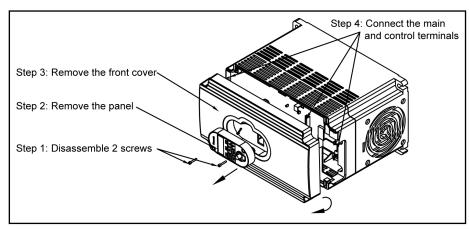


Fig.5-1: Opening instruction (0.75 to 7.5 kW)



Please follow the steps strictly to avoid destroy of the front cover buckle.

### Applicable to 11 to 15 kW:

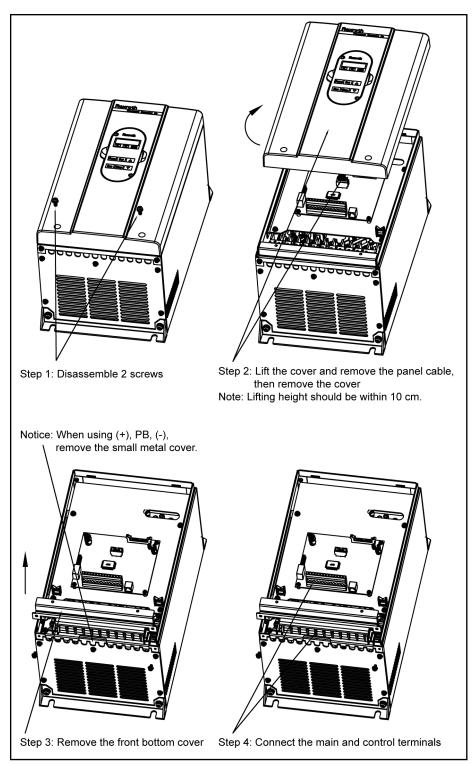


Fig.5-2: Opening instruction (11 to 15 kW)

Applicable to 18.5 to 37 kW:

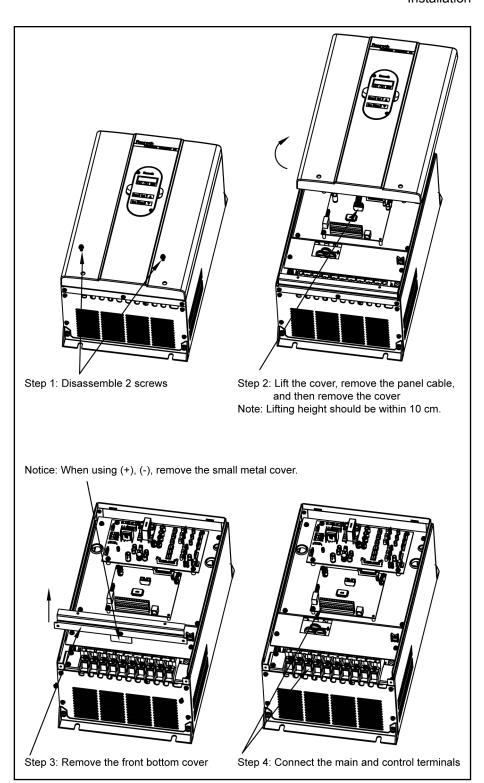


Fig.5-3: Opening instruction (18.5 to 37 kW)

### Applicable to 45 to 55 kW:

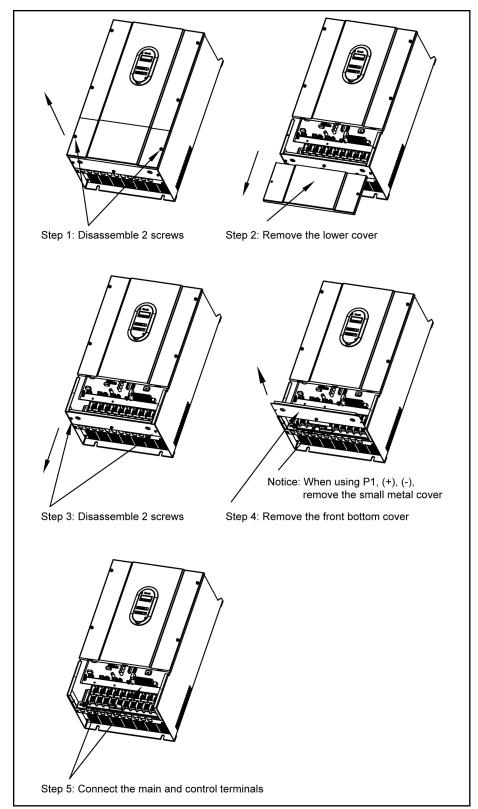


Fig.5-4: Opening instruction (45 to 55 kW)

### Applicable to 75 to 90 kW:

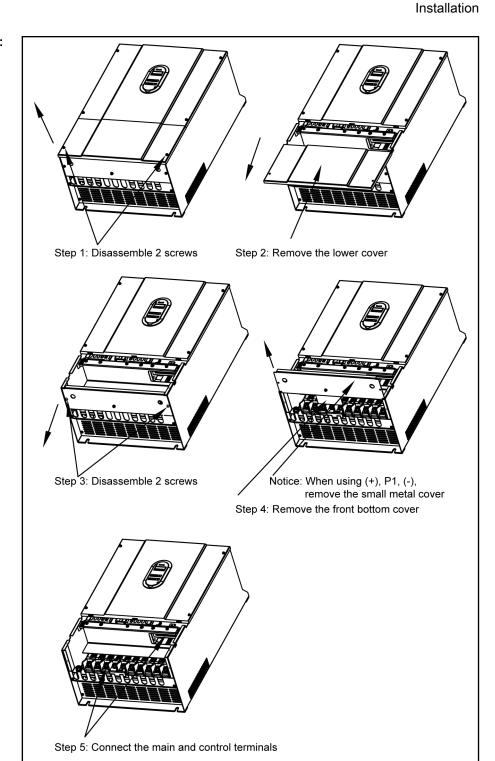


Fig.5-5: Opening instruction (75 to 90 kW)

## Applicable to 110 kW:

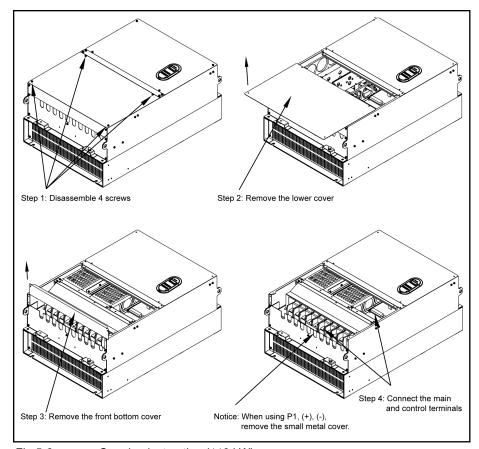


Fig.5-6: Opening instruction (110 kW)

## Applicable to 132 to 160 kW:

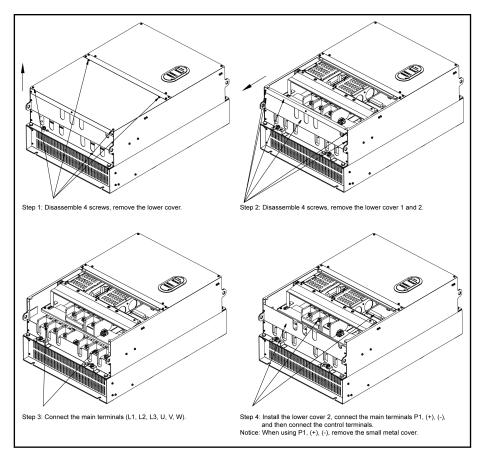


Fig.5-7: Opening instruction (132 to 160 kW)

#### 5.2 **Drive System Wiring**

#### 5.2.1 **Block Diagram**

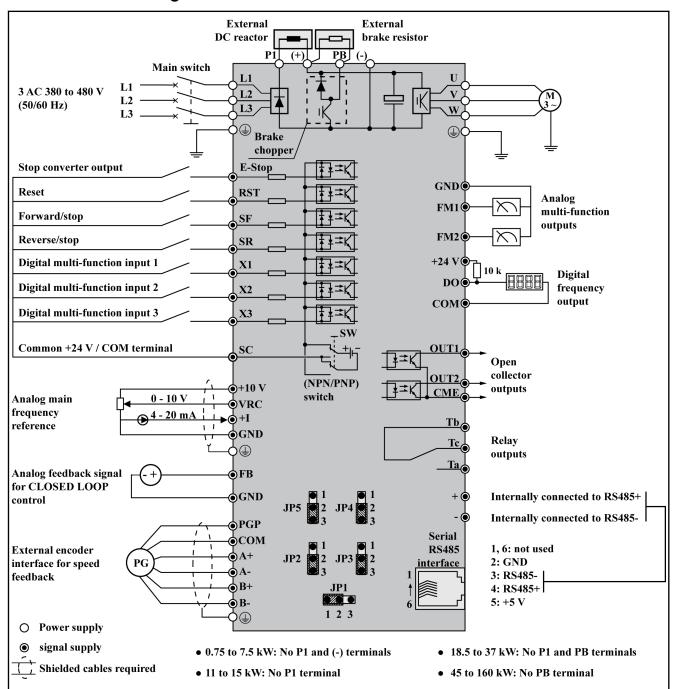


Fig.5-8: Block diagram

B

Fe up to 15 kW has internal brake chopper.

## 5.2.2 Main Circuit Wiring

### Main circuit wiring cautions

- Connect power supply only to the mains 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 or 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 supply 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 circuit 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 (R-C 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 frequency, the voltage drop may lead to a reduced torque output from 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 to the capacitor or the suppressor. Immediately remove any such device which has been installed.
- 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 [USA] and any additional local codes.
- After connecting the power supply terminals, the motor and the control terminals, mount the cover before switching on the power. Take account of the following instructions:
  - 1. Ensure that the power supply can provide appropriate voltage and current. Ensure that the rated current range is within that of the frequency converter and power supply.

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Installation

- 2. It is recommended to use 4-core cables to connect the motor. Cables are connected to motor terminals PE-U-V-W.
- 3. If shielded cables are used, the shield layer should be securely connected to the metal surface of the control cabinet.



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

Rexroth Frequency Converter Fe

Installation

## Main circuit wiring diagram

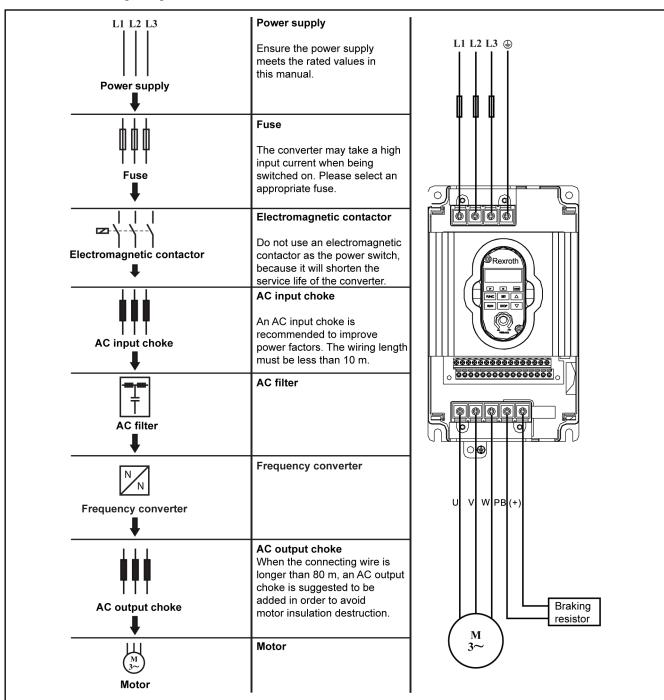


Fig.5-9: Main circuit wiring diagram



Please see chapter 5.2.4 "Cable and Fuse Dimensions" on page 51 for appropriate fuses.

## 5.2.3 Control Circuit Wiring

- Terminal GND is the common terminal for analog signals, and COM 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).
- 0.3 mm<sup>2</sup> to 1.0 mm<sup>2</sup> 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.

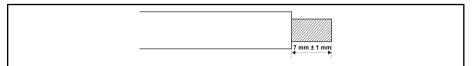


Fig.5-10: Cable stripping length

- 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 diameter 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.

## 5.2.4 Cable and Fuse Dimensions

#### Introduction

The power cable dimension 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 fixed wiring according to VDE 0298 (part 4) or IEC 60364-5 (operating temperature at the conductor is 90 °C).

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.

## Recommendation on cable dimensioning:

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

		Input Sid	e			
International without USA/Canada						
Туре	Nominal current	Installation mode B1	Installation mode B2	Installation mode E		
	of fuse in [A]	Cable size in [mm²]	Cable size in [mm²]	Cable size in [mm²]		
0K75	10	1.5	1	1		
1K50	10	1.5	1	1		
2K20	16	1.5	1	1		
4K00	20	1.5	1.5	1.5		
5K50	25	2.5	2.5	2.5		
7K50	25	4	4	2.5		
11K0	35	6	6	6		
15K0	50	10	16	10		
18K5	63	10	16	10		
22K0	80	16	16	10		
30K0	100	25	25	16		
37K0	125	25	25	25		
45K0	160	50	50	35		
55K0	200	50	70 / 2x35	50		
75K0	250	95 / 2x50	120 / 2x50	70 / 2x35		
90K0	315	120 / 2x50	150 / 2x70	95 / 2x50		
110K	350	150 / 2x70	240 / 2x95	120 / 2x70		
132K	350	240 / 2x95	2x120	150 / 2x70		
160K	450	2x120	-	240		

Fig.5-11: Recommended cable dimensions\_input side\_international without USA/Canada



- 1. Input Side and Output Side: The dimensioning is based on the supply voltage of AC 3x 380 V.
- 2. For screw torque information, please refer to the table below.

	Input Side							
	US	A/Canada						
Туре			Screw torque for power cable	Inj	put PE			
	Nominal current of fuse in [A]		terminals in [Nm / lb-in] (screw size)	Cable size in [mm²]	Torque in [Nm / lb-in] (screw size)			
0K75	6	AWG14	1.8 (M4)	10	1.8 (M4)			
1K50	10	AWG14	1.8 (M4)	10	1.8 (M4)			
2K20	16	AWG14	1.8 (M4)	10	1.8 (M4)			
4K0	25	AWG12	1.8 (M4)	10	1.8 (M4)			
5K50	40	AWG10	1.8 (M4)	10	1.8 (M4)			
7K50	40	AWG10	1.8 (M4)	10	1.8 (M4)			
11K0	70	AWG8	2 to 2.8 (M5)	10	2 to 2.8 (M5)			
15K0	80	AWG6	2 to 2.8 (M5)	10	2 to 2.8 (M5)			
18K5	80	AWG6	4 to 5 (M6)	10	4 to 5 (M6)			
22K0	80	AWG6*	4 to 5 (M6)	10	4 to 5 (M6)			
30K0	100	2xAWG6	4 to 5 (M6)	16	4 to 5 (M6)			
37K0	125	2xAWG6	4 to 5 (M6)	25	4 to 5 (M6)			
45K0	150	AWG1	6 to 9 (M8)	35	6 to 9 (M8)			
55K0	175	AWG1/0	6 to 9 (M8)	50	6 to 9 (M8)			
75K0	225	AWG3/0 / 2xAWG1	15 to 20 (M10)	70 / 2x35	15 to 20 (M10)			
90K0	300	250 kcmil / 2xAWG1/0	15 to 20 (M10)	95 / 2x50	15 to 20 (M10)			
110K	300	2xAWG3/0	15 to 20 (M10)	120 / 2x70	15 to 20 (M10)			
132K	2x250	2xAWG3/0	20 (M12)	150 / 2x70	15 to 20 (M10)			
160K	2x300	2xAWG4/0	20 (M12)	240	15 to 20 (M10)			

Fig.5-12: Recommended cable dimensions\_input side\_USA/Canada

R.

For 22 kW frequency convertes, the AWG 6 cable is copper 75  $^{\circ}\text{C}$  and above only.

	Output Side							
	International without USA/Canada	USA/Canada						
Туре		Cable size in [AWG]	Screw torque for power cable	Output PE				
	Cable size in [mm²]		terminals in [Nm / lb-in] (screw size)	Cable size in [mm²]	Torque in [Nm / lb-in] (screw size)			
0K75	1 <sup>(1)</sup>	AWG14	1.8 (M4)	10	1.8 (M4)			
1K50	1 <sup>(1)</sup>	AWG14	1.8 (M4)	10	1.8 (M4)			
2K20	1 <sup>(1)</sup>	AWG14	1.8 (M4)	10	1.8 (M4)			
4K00	1 <sup>(1)</sup>	AWG12	1.8 (M4)	10	1.8 (M4)			
5K50	1 <sup>(1)</sup>	AWG10	1.8 (M4)	10	1.8 (M4)			
7K50	2,5 <sup>(1)</sup>	AWG10	1.8 (M4)	10	1.8 (M4)			
11K0	6 <sup>(1)</sup>	AWG8	2 to 2.8 (M5)	10	2 to 2.8 (M5)			
15K0	6 <sup>(1)</sup>	AWG6	2 to 2.8 (M5)	10	2 to 2.8 (M5)			
18K5	10 <sup>(1)</sup>	AWG6	4 to 5 (M6)	10	4 to 5 (M6)			
22K0	10 <sup>(1)</sup>	AWG6	4 to 5 (M6)	10	4 to 5 (M6)			
30K0	16 <sup>(1)</sup>	2xAWG6	4 to 5 (M6)	16	4 to 5 (M6)			
37K0	25 <sup>(1)</sup>	2xAWG6	4 to 5 (M6)	25	4 to 5 (M6)			
45K0	35 <sup>(2)</sup>	AWG1	6 to 9 (M8)	35	6 to 9 (M8)			
55K0	35 <sup>(2)</sup>	AWG1/0	6 to 9 (M8)	50	6 to 9 (M8)			
75K0	70 / 2x 35 <sup>(2)</sup>	AWG3/0 / 2xAWG1	15 to 20 (M10)	70 / 2x35	15 to 20 (M10)			
90K0	95 / 2x 35 <sup>(2)</sup>	250 kcmil / 2xAWG1/0	15 to 20 (M10)	95 / 2x50	15 to 20 (M10)			
110K	120 / 2x50 <sup>(2)</sup>	2xAWG3/0	15 to 20 (M10)	120 / 2x70	15 to 20 (M10)			
132K	150 / 2x70 <sup>(1)</sup>	2xAWG3/0	20 (M12)	150 / 2x70	15 to 20 (M10)			
160K	240 <sup>(1)</sup>	2xAWG4/0	20 (M12)	240	15 to 20 (M10)			

Fig.5-13: Recommended cable dimensions\_output side



- (1) Installation Mode E
- (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.

## B

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 on design of the fuses:

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

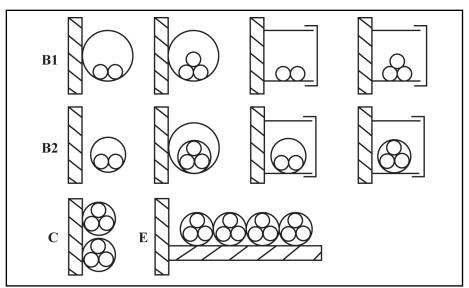
## B

#### Characteristic

To prevent errors (e.g. ground fault at connections L+, L-), fuses of characteristic  $\mathbf{gL}$  (general-purpose fuse link for cables and lines) and  $\mathbf{gG}$  (general-purpose fuse link for general installations) can be used to protect the lines in the frequency converter system.

To **protect the semiconductors** in the input of supply units and frequency 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

Cables or lines on walls

E Cables or lines on open cable trays

Fig.5-14: Cable installation modes

С

## Wire range for field wiring terminals:

Туре	Type Housing Terminal Type		Wire Range [AWG]
0K75 to 7K50	A	Input Terminal Block (DW2): fig. 5-17 "Main circuit terminals_0.75 to 7.5 kW_Top" on page 57	10 to 18
		Output Terminal Block (DW1): fig. 5-18 "Main circuit terminals_0.75 to 7.5 kW_Bottom" on page 57	10 to 18
		Terminal Block (CPU Board) Type: fig. 5-25 "Control circuit terminals" on page 61	12 to 30
11K0 to 15K0	В	Main Terminal Block Type: fig. 5-19 "Main circuit terminals_11 to 15 kW" on page 57	6 to 12
1110 10 1310		Terminal Block (CPU Board) Type: fig. 5-25 "Control circuit terminals" on page 61	12 to 30
18K5 to 22K0	С	Main Terminal Block Type: fig. 5-20 "Main circuit terminals_18.5 to 37 kW" on page 57	6 to 12
1000 to 2200		Terminal Block (CPU Board) Type: fig. 5-25 "Control circuit terminals" on page 61	12 to 30
30K0 to 37K0	D T	Main Terminal Block Type: fig. 5-20 "Main circuit terminals_18.5 to 37 kW" on page 57	(2) 6
3000 10 37 00		Terminal Block (CPU Board) Type: fig. 5-25 "Control circuit terminals" on page 61	12 to 30
45K0 to 55K0	E	Main Terminal Block Type: fig. 5-21 "Main circuit terminals_45 to 90 kW" on page 57	2/0-6, STR
4300 10 3300		Terminal Block (CPU Board) Type: fig. 5-25 "Control circuit terminals" on page 61	12 to 30
75K0 to 90K0	F	Main Terminal Block Type: fig. 5-21 "Main circuit terminals_45 to 90 kW" on page 57	4/0-4, STR
7300 10 9000	KU to 90KU F	Terminal Block (CPU Board) Type: fig. 5-25 "Control circuit terminals" on page 61	12 to 30
110K	0К G	Main Terminal Block Type: fig. 5-22 "Main circuit terminals_110 kW" on page 57	350 kcmil-4, STR
HOIX		Terminal Block (CPU Board) Type: fig. 5-25 "Control circuit terminals" on page 61	12 to 30
132K to 160K		Main Terminal Block Type: fig. 5-23 "Main circuit terminals_132 to 160 kW" on page 58	(2) 2 - (2) 750 kcmil, STR
1321\ (0 1001\		Terminal Block (CPU Board) Type: fig. 5-25 "Control circuit terminals" on page 61	12 to 30

Fig.5-15: Wire range for field wiring terminals

# 5.3 Wiring Terminals Description

## 5.3.1 Main Circuit Terminals

## Main circuit terminals description

Terminal	Description
L1, L2, L3	Mains power supply inputs
U, V, W	Frequency converter outputs (to be connected to the motor)
РВ	Reserved terminal for external braking resistor (applicable to 0.75 kW to 15 kW frequency converters)
P1, (+)	DC positive bus outputs
(-)	DC negative bus output
<b>(1)</b>	Grounding

Fig.5-16: Main circuit terminals description

## Main circuit terminals figure

Applicable to 0.75 to 7.5 kW:

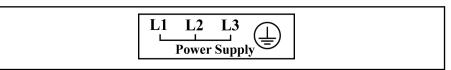


Fig.5-17: Main circuit terminals\_0.75 to 7.5 kW\_Top

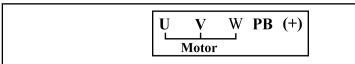


Fig.5-18: Main circuit terminals\_0.75 to 7.5 kW\_Bottom

Applicable to 11 to 15 kW:

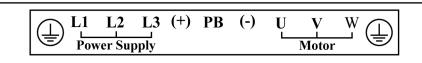


Fig.5-19: Main circuit terminals\_11 to 15 kW

Applicable to 18.5 to 37 kW:

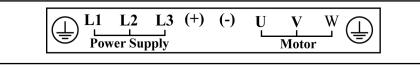


Fig.5-20: Main circuit terminals\_18.5 to 37 kW

Applicable to 45 to 90 kW:

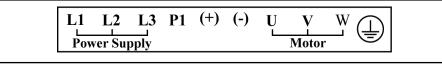


Fig.5-21: Main circuit terminals\_45 to 90 kW

Applicable to 110 kW:

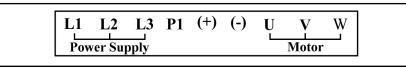


Fig.5-22: Main circuit terminals\_110 kW

#### Applicable to 132 to 160 kW:

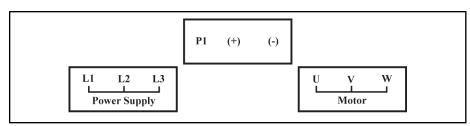


Fig.5-23: Main circuit terminals\_132 to 160 kW



- 1. For 11 kW to 160 kW frequency converters, the main circuit terminals are on the bottom of the frequency converter.
- 2. For 45 kW to 160 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.
- 3. There are two grounding connections, one for the input side, the other for the output side.

# 5.3.2 Control Circuit Terminals

## Control circuit terminals description

Туре	Terminals	Signal Function	Description	Signal Requirement		
	SF	Forward/stop	See parameters [b00] and [E38]			
	SR	Reverse/stop	See parameters [b00] and [E38]			
	RST	Error reset	"Connected" for reset	Opto-electronic coupler isolated in-		
Digital inputs	E-Stop	External abnormality input	[E32]=0: "Connected", coasting to stop [E32]=1, "Disconnected", coasting to stop	put, 24 VDC for external power supply  NPN/PNP modes, see fig. 5-29  "NPN/PNP Jumper SW" on page		
	X1, X2, X3	Multi-function inputs	See parameters [b00], [b34], [b35], [b45], [E39], [H07] and [H23]	63 for details.		
	SC	Shared connection for digital signals	Shared connection for SF\SR\RST\E-Stop\X1-X3			
	FB	Feedback input signal	Feedback signal, analog voltage input	Input voltage range Standard models: 0 to 5 V C001 models: 0 to 10 V Input resistance: $100 \text{ k}\Omega$ Resolution: $1:1000$		
	+10 V	Power supply terminal for speed commands	Power supply for speed commands	10 V (max. current 10 mA)		
Analog inputs	VRC	Frequency commands	Analog voltage frequency command	JP5, position 2-3 Input voltage range: 0 to 10 V; Input resistance: $100 \text{ k}\Omega$ ; Resolution: $1:2000$ JP5, position 1-2 Input voltage range: 0 to 5 V; Input resistance: $50 \text{ k}\Omega$ ; Resolution: $1:2000$		
	+1		Analog current frequency feedback signal	Input current range: 4 to 20 mA; Input resistance: 165 Ω; Resolution: 1:1000		
	GND	Analog common terminal	Isolated from COM			

Туре	Terminals	Signal Function	Description	Signal Requirement
	OUT1	Open collector output 1 Open collector	Programmable digital output with multiple functions. See parameters [E16], [E17] for details.	Open collector outputs isolated via
	OUT2	output 2	[2.1].o. cottano.	opto-electronic couplers:
		l l	For internal 24 V power supply: to be short circuited to the COM terminal;	Max. output voltage: +24 VDC Max. output current: 50 mA
puts	CME	for OUT1 and OUT2	For external power supply: to be short circuited to the "earth" of the power supply.	
Digital outputs			Programmable to be pulse output with	Open collector outputs isolated via opto-electronic couplers:
Dig	DO-COM	Pulse output	multiple functions. See parameters [E09] for details.	Output frequency: depends on [E10], max. 50.0 kHz;
				Max. output voltage: 24 VDC
	Та	Relay Ry output	Ta-Tb: N.O; Tb-Tc: N.C (Tb is the	Contact transmitter capacity:
	Тс	reday rey output	common terminal)	250 VAC, 3A or lower
	Tb	Relay output common terminal	Programmable relay output with multiple functions. See parameter [E18].	30 VDC, 3A or lower
	+24 V	Anode 24 VDC	COM (Cathode)	
outputs	FM1-GND	Analog multi- function output 1	Programmable analog output with	Output voltage/ current settable via JP3, JP4 for FM1, FM2:
Analog outputs	FM2-GND	Analog multi- function output 2	multiple functions. See parameters [E04]-[E08] for details.	Voltage signal range: 0/2 to 10 V Current signal range: 0/4 to 20 mA
lal	PGP-COM	Supply voltage non- break function	Power supply for the encoder	Max. output current: 100 mA
Encoder signal	A+	Encoder signal A	JP2, position 2-3: select encoder differential inputs from A+, A-, B+ and B-;	Encoder voltage range for
oder	A-	Encoder signar /		differential input:
Enc	B+	Encoder signal B	JP2, position 1-2: select open collector	+8 to 24 V
	B-	- Lilcodel Signal D	inputs from A-, B	Max. input frequency: 200 kHz
nication	485+	Positive terminal for differential signal RS485	Standard 485 communication port. Use twisted pair or shielded cables. RJ45 port and 2 PIN crimp terminals are op-	
Communication	485-	Negative terminal for differential signal RS485	tional. Both connections are connected internally with the same 485 port (parallel mode).	

Fig.5-24: Control circuit terminals description

Rexroth Frequency Converter Fe

Installation

## Control circuit terminals figure

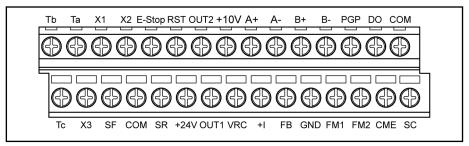


Fig.5-25: Control circuit terminals

B

Applicable to 0.75 kW to 160 kW CPU board.

## **Communication Port**

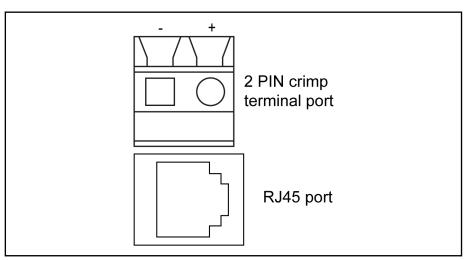


Fig.5-26: RS485 communication port



- Crimp terminal wiring range: 22 12 AWG
- Crimp terminal wire type: 75 °C copper only
- Crimp terminal torque: 5 kgf-cm (4.3 in-ibf)

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

**Bosch Rexroth AG** 

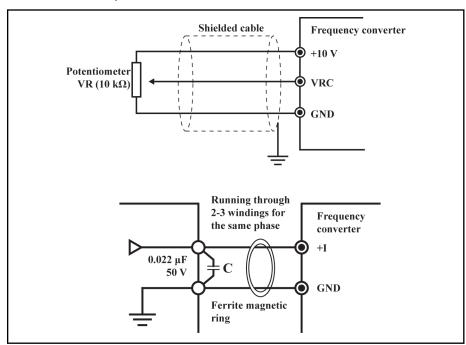


Fig.5-27: Analog input terminal



- 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. 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 above.

## 5.3.3 Jumper Wiring

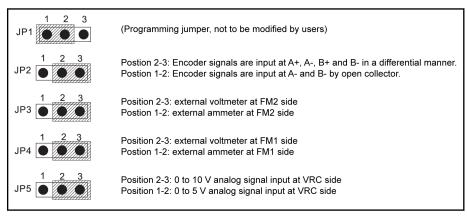


Fig.5-28: Jumper description

RES

Shown above are factory defaults.

Rexroth Frequency Converter Fe

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## 5.3.4 NPN/ PNP Mode Selection

## **Jumper SW**

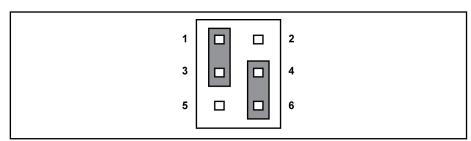


Fig.5-29: NPN/PNP Jumper SW

B

The factory default setting of the jumper is NPN (postion 3).

### Jumper SW determines:

- 1. The internal 24 V power supply or an external 24 V power supply.
- 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).

## NPN/PNP modes and signal inputs

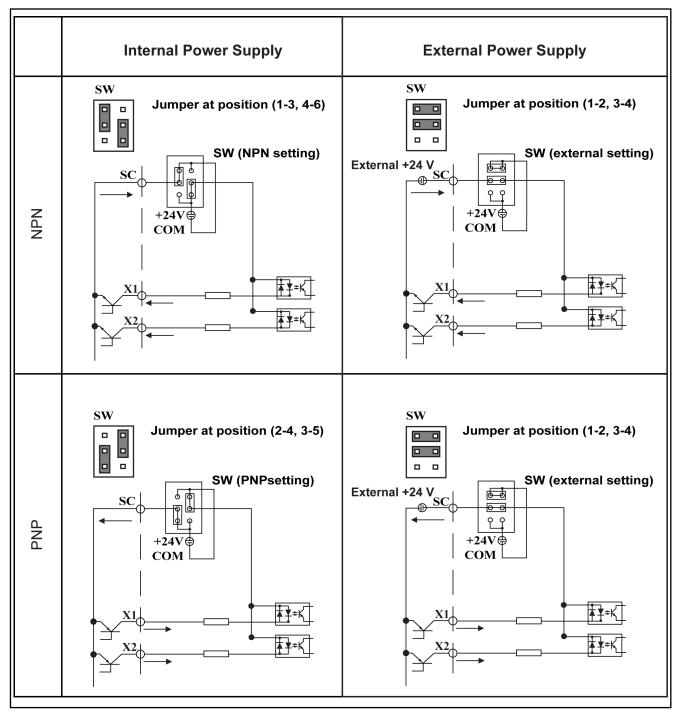


Fig.5-30: NPN/PNP modes and signal inputs

# 6 Commissioning

## 6.1 Operating Panel

## 6.1.1 Overview

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

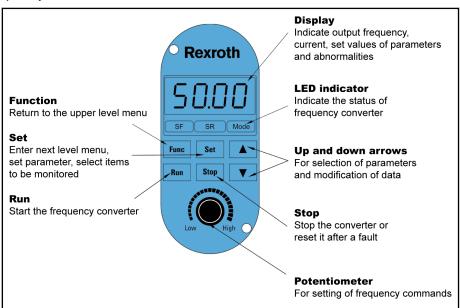


Fig.6-1: Fe operating panel



For frequency converters of 0.75 to 7.5 kW, the potentiometer is configured as standard, while for frequency converters of 11 to 160 kW, no potentiometer is configured as standard.

#### LED indication description

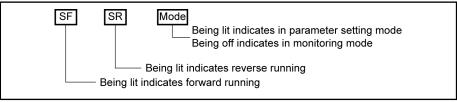


Fig.6-2: LED indication description

#### Digital indication description

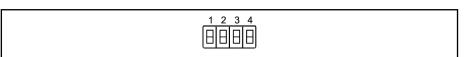


Fig.6-3: Digital indication description



- 1. The LEDs display has 4 digits, it is sometimes used to show 5 significant digits.
- 2. 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.
- 3. 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.

## 6.1.2 3-Level Menu Structure

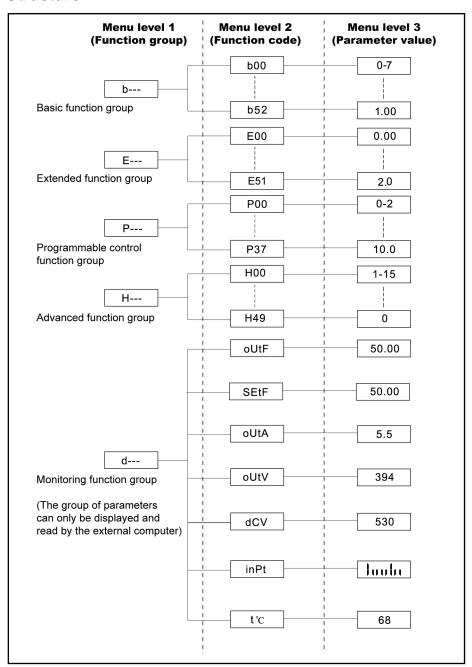


Fig.6-4: 3-Level menu structure

REP.

The digital operating panel can be used to toggle between menu options, set parameters, and reset the frequency converter after fault with the **Func**, **Set**,  $\blacktriangle$  and  $\blacktriangledown$  buttons.

# 6.1.3 Operation Mode Description

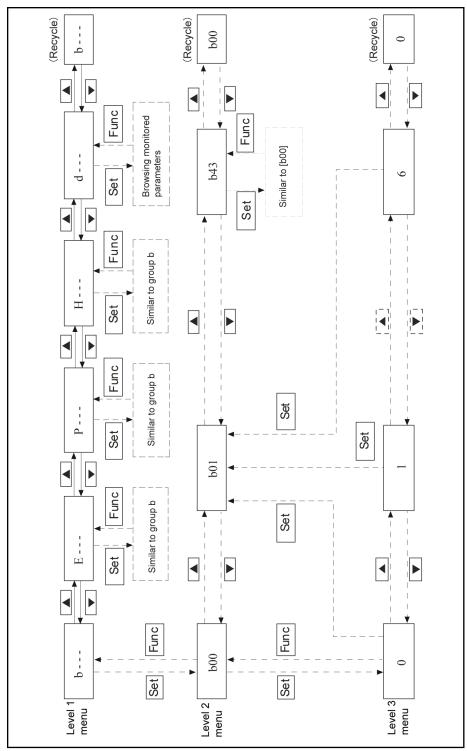


Fig.6-5: Operation mode description of operating panel

Rexroth Frequency Converter Fe

Commissioning



- 1. The default monitored parameters of menu level 3 group d will be displayed automatically on the panel, if power is on or no key is pressed over 2 minutes.
- 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 frequency converter is not running.

#### Shortcuts:

- 1. Press **Func** under level 1 menu to display the default monitoring parameters (depending on parameter [E21] of the displayed items while running) of group d level 3.
- 2. In case of fault, press **Func** to toggle between the fault display and level 1 menu (it is possible to operate menus after entering the level 1 menu).
- 3. Press Func in group d level 2 menu to enter group b level 1.

## 6.1.4 Example of Operating Panel Operation

View output current under the frequency monitoring mode

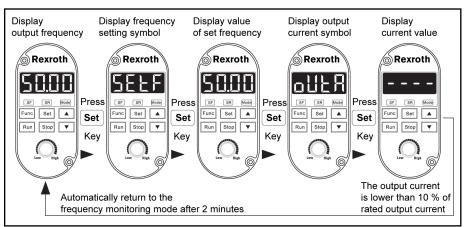


Fig.6-6: View output current

Set the frequency by the digital operating panel as 50 Hz ([b01]=50.00 Hz) under output frequency monitoring mode

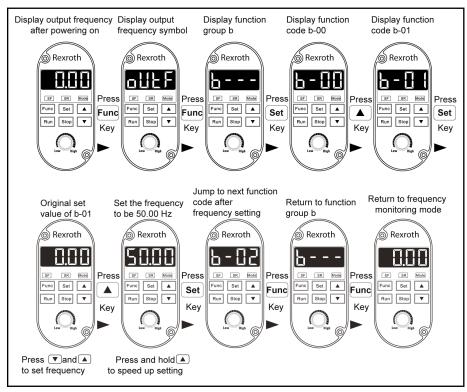


Fig.6-7: Set frequency to 50.00 Hz

B

- 1. To set frequency with the digital operating panel, [b02]=0.
- 2. Frequency setting can be done during stop or running of the frequency converter.

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

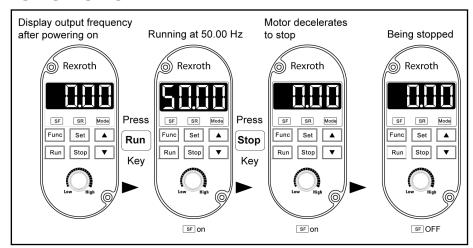


Fig.6-8: Run/ Stop operation example



By factory default, SF-COM is closed. After pressing down **Run** key and rotating the potentiometer knob clockwise to the maximum position, the displayed output will be 50.00 Hz.

#### Operation and resetting in case of fault

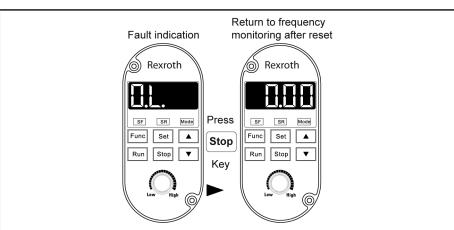


Fig.6-9: Operation and resetting in case of fault



- 1. A fault code (chapter 8 "Fault Indication" on page 153) will be displayed in case of fault. When several faults occurred, the corresponding fault code will be displayed alternatively.
- 2. Press **Stop** to reset after fault, and the fault code will not be displayed any longer. **Stop** key is deactivated if fault causes are not removed.
- 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.
- 4. In case of fault, the user can directly enter level 1 menu using **Func** key, to work with most of the function codes.

## 6.2 Commission Process

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### 6.2.1 Check and Preparation before Commissioning

- Check if the wiring is correct. Particularly, ensure that the output terminals U, V and W of the frequency converter are not connected to the power supply and that the ground terminal is well connected.
- 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 that the motor is not connected to any load.
- Check that all switches are off before powering on, to ensure that the frequency converter will not be started and no unexpected action occurs.
- 6. Make the following checks after powering on:
  - 0.00 flashes on the display (without fault indication).
  - The cooling fan in the frequency converter works normally (factory default [H22]=0).

### 6.2.2 Notes on Commissioning

- The frequency converter has no internal contactor, and will be energized<sup>®</sup> once the mains power supply is connected. When the Run key is pressed down (or the control through terminals is selected), the frequency converter will give output<sup>®</sup>.
- By factory default, the frequency converter initially displays output frequency after being energized. You may change it to another parameter as instructed in chapter 7 "Parameter Settings" on page 77. The factory defaults are based on standard applications with standard motors.
- 3. The frequency command of the frequency 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<sup>⑤</sup>.



- 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 this period.
- ②: The starting and stopping of the frequency converter is controlled by the panel as a factory default, and terminal SF and COM are shorted.
- ③: The frequency is 0.00 Hz by factory default. This is to avoid unexpected motor running during the initial setting. For the motor to run, enter a frequency value by pressing ▲ under the monitoring mode or by setting [b01].

#### Basic control

Basically you can follow the steps below to operate the frequency converter. The frequency is set by the digital operating panel, and the user only needs to change few parameters.

- 1. After powering on the frequency converter, [b39]=0, all the parameters are readable/writable.
- 2. Write the required output frequency into function code [b01] and set [b02]=0.

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- 3. Check and make sure that parameters like base frequency [b04] and base voltage [b05] are consistent with data on motor nameplate.
- 4. Press **Run** on the digital operating panel of the frequency converter, then the motor will be run according to the set frequency.

If necessary, the user can directly adjust the motor speed (i. e. the frequency) via ▲▼ key, under the operation monitoring mode.

## 6.2.3 Fe Basic Parameter Fast Setting

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

Function code	Name	Setting range		Factory default
b03	Highest frequency – HF	50.00 to 650.00 Hz	•	50.00 Hz
b04	Base frequency – BF	20.00 to HF	•	50.00 Hz
b05	Base voltage – BV	400V class: 240 to 480 V	•	380.0 V
b16	Acceleration time	0.1 to 6500.0s		Depending on model
b17	Deceleration time	0.1 to 6500.0s		Depending on model
b21	Upper frequency – UF	LF to HF	•	50.00 Hz
b22	Lower frequency – LF	0.00 to UF	•	0.50 Hz
b40	Frequency converter input power supply voltage	400 V model: 380.0 to 480.0 V	•	380.0 V
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 to 14	•	4
H39	Rated motor power	0.4 to 999.9 kW	•	Depending on model
H40	Rated motor current	0.1 to 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

Fig.6-10: Fe basic parameter fast setting

### Commissioning

# 6.2.4 Commissioning of Fe with Potentiometer

By factory default, Fe can use the front mounted potentiometer to set the frequency output according to 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 key.	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 <b>Stop</b> key.	Enter the command for stopping. The motor stops.

Fig.6-11: Commissioning of Fe with potentiometer

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# 6.3 Restore Parameters to Factory Defaults

If the frequency converter fails to run the motor due to incorrect parameters, a simple solution is to initialize the parameters to factory defaults. Setting [b39]=2 will start initialization to restore factory defaults at 50 Hz.

Please be sure that the parameters after factory defaults restore match with the motor and the field application. Adjust the parameters after factory defaults restore if necessary.

Output voltage/frequency	power supply output 3Φ / 380 V / 50 Hz SVPWM wave
Voltage/frequency ratio	Constant torque [b06]=H-03 (Depending on model)
Operating frequency	0 to 50 Hz
Acc./Dec. time	Linear, Acc. for 6s/Dec. for 6s (Depending on model)
Protection mode in case of motor overload	Rated current of Motor*100 %
Operating panel options	Run, Stop buttons control running and stop; panel potentiometer sets output frequency

Fig.6-12: Restore to factory default

## 6.4 Solutions for Simple Faults during Commissioning

Simple faults	Solutions
Over current (O.C.) occurs during acceleration	Increase the acceleration time
Over voltage (O.E.) occurs during deceleration	Increase the deceleration time
Over current (O.C.) occurs immediately after pressing the <b>Run</b> key	Incorrect wiring. Check if U, V, W outputs of the main circuit are shorted or grounded
The motor runs in the direction opposite to expected	Change the sequence of any two phases of U, V and W
The motor vibrates and runs in uncertain directions after each starting	One phase of U, V and W is disconnected (output phase loss)

Fig.6-13: Solutions for simple faults

Rexroth Frequency Converter Fe

# 7 Parameter Settings

# 7.1 Description of Attribute Symbols in Parameter Tables

Parameter attribute	Description
	Parameter setting can be modified when the frequency converter is in run mode.
•	Parameter setting cannot be modified when the frequency converter is in run mode.
*	Parameter setting cannot be modified directly.

Fig.7-1: Parameter attributes and descriptions

# 7.2 Parameters Functions

# 7.2.1 Category b: Basic Parameters

Туре	Function code	Name	Setting range	Factory default <sup>©</sup>	Attribute
Control command source	b00	Set the source of control commands (options 1 and 3 have frequency command source)	O: Run/Stop control with digital operating panel 1: External via control terminals, Up/Down control 2: External via control terminals (including multispeed), while Stop key is activated 3: Logic 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 7: External via control terminals (X1, X2 and X3 are	0	•
	b01	Set frequency via digital operating panel	used to switch between sources of frequency command, while <b>Stop</b> key is activated)  0.00 – HF	0.00 Hz	
Frequency command source	b02	Set the source of frequency commands	0: Set via the digital operating panel 1: Direct action of the digital operating panel's potentiometer Kv*(0 – 5 V) 2: Inverse action of the digital operating panel's potentiometer Kv*(5 – 0 V) 3: Direct action of external terminal Kv*(0 – 5 V) 4: Inverse action of external terminal Kv*(5 – 0 V) 5: Direct action of external terminal Kv*(0 – 10 V) 6: Inverse action of external terminal Kv*(10 – 0 V) 7: Direct action of external terminal Ki*(4 – 20 mA) 8: Inverse action of external terminal Ki*(20 – 4 mA) 9: External terminal Kv*(0 – 5 V) + Ki*(4 – 20 mA) or External terminal Kv*(0 – 10 V) + Ki*(4 – 20 mA) 10: VRC terminal Kv*(-10 – +10 V) 11: Kp*(Pulse frequency setting) + Kv*(VRC - 5 V) or Kp*(Pulse frequency setting) + Kv*(VRC - 2.5 V) 12: External computer frequency setting	1	•

Туре	Function code	Name	Setting range	Factory default <sup>®</sup>	Attribute
	b03	Highest frequency – HF	50.00 – 650.00 Hz	50.00 Hz	•
	b04	Base frequency – BF	20.00 – HF	50.00 Hz	•
	b05	Base voltage – BV	400 V class: 240.0 – 480.0 V	380.0 V	•
	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	Depending on model	•
V/F curve setting	b07	Lowest output frequency – LLF	0.00 – [b09]	0.00 Hz	•
> "	b08	Lowest output voltage - LLV	0 % – 120 %BV	1 %	•
	b09	Middle frequency 1 – MF1	LLF – BF	0.00 Hz	•
	b10	Middle voltage 1 – MV1	0 % – 120 %BV	1 %	•
	b11	Middle frequency 2 – MF2	BF – HF	50.00 Hz	•
	b12	Middle voltage 2 – MV2	0 % – 120 %BV	100 %	•
	b13	Highest voltage HV	0 % – 120 %BV	100 %	•
Constant voltage control	b14	Constant voltage control	OFF/on	OFF	•
on ion 'pe	b15	Acceleration/deceleration curve	0: linear; 1: S curve	0	
Acceleration /deceleration time and type	b16	Acceleration time	0.1 – 6500.0s	Depending on model	
Ac /de tim	b17	Deceleration time	0.1 – 6500.0s	Depending on model	
Forward and reverse rotation dead zone time	b18	Forward and reverse rotation dead zone time	0.0 – 10.0s	1.0s	•
Torque increasing	b19	Automatic torque increasing	OFF/1 % – 10 % <sup>©</sup>	OFF	•
Electronic thermal relay	b20	Electronic thermal relay	50 % – 110 %/OFF <sup>®</sup>	100 %	•
ut ncy s	b21	Upper frequency (UF)	LF – HF	50.00 Hz	•
Output frequency limits	b22	Lower frequency (LF)	0.00 – UF	0.50 Hz	•
LF mode	b23	LF mode	0: Stop; 1: Run	0	•
LF	b24	Hysteresis frequency width	0.10 – HF	1.00 Hz	•

Туре	Function code	Name	Setting range	Factory default <sup>®</sup>	Attribute
	b25	Voltage gain of given channel Kv	0.00 – 9.99	1.00	
iency	b26	Analog input channel filtering time constant	0.0 – 10.0s	0.5s	
frequ	b27	Minimum curve setting	0.0 % – 100 %	0.0 %	
Analog frequency setting adjustment	b28	Frequency corresponding to minimum curve setting	0.00 – 650.00 Hz	0.00 Hz	
- 6	b29	Maximum curve setting	0.0 % – 100 %	100.0 %	
	b30	Frequency corresponding to maximum curve setting	0.00 – 650.00 Hz	50.00 Hz	
Slip frequency compensation	Slip frequency compensation  Slip frequency		0.00 Hz	•	
ting	b32	Starting frequency	0.00 – 60.00 Hz	0.50 Hz	
Starting	b33	Starting holding time	0.0 – 10.0s	0.0s	
Stopping mode	b34	Stopping mode selection	0: OFF; 1: X1; 2: X2; 3: X3; 4: on	0	•
	b35	Jogging mode selection	0: OFF; 1: X1; 2: X2; 3: X3	0	•
Jogging control	b36	Jogging frequency	0.00 – HF	0.00 Hz	
) Bop	b37	Jogging acceleration time	0.1 – 6500.0s	0.1s	
	b38	Jogging deceleration time	0.1 – 6500.0s	0.1s	
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: Initialization to factory defaults at 60 Hz 4: Clear all fault records	0	•
Frequency converter input power supply voltage setting	b40	Frequency converter input power supply voltage setting	400 V model: 380.0 – 480.0 V	380.0 V	•

Type	Function code	Name	Setting range	Factory default <sup>®</sup>	Attribute
Frequency setting saving in case of power down	b41	Frequency setting saving in case of power down	O: Not saved when power is off or the frequency converter is stopped  1: Not saved when power is off; saved when the frequency converter is stopped  2: Saved when power is off; not saved when the frequency converter is stopped  3: Saved when power is off or the frequency converter is stopped	0	•
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 Hz/s	
Switching between local and remote control	b45	Switching between local and remote control	0: OFF; 1: X1; 2: X2; 3: X3	0	•
oturing	b46	Starting mode of speed capturing	0: Starting of speed capturing disabled 1: Speed capturing in forward rotation only 2: Speed capturing in reverse rotation only 3: Speed capturing in forward and reverse rotation	0	•
sed cap	b47	Deceleration time for speed capturing	1.0 – 5.0s	1.5s	•
Starting of speed capturing	b48	Current level for speed capturing	10 % – 100 % of rated frequency converter current	50 %	•
Start	b49	Current regulator proportion factor	0.000 – 1.000	0.060	•
	b50	Integration time constant for current regulator	0.001 – 10.000	0.200	•

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Туре	Function code	Name	Setting range	Factory default <sup>0</sup>	Attribute
g frequency adjustment	b51	Current gain (Ki) of given channel	0.00 – 9.99	1.00	
Analog fre gain adju	b52	Pulse frequency gain (Kp) of given channel	0.00 – 9.99	1.00	

Fig.7-2: Category b: basic parameters



- ①: Values that correspond to the factory default upon initialization at 50 Hz.
- ②: "OFF" at the beginning indicates that it represents "OFF" when the external computer reads "0".
- ③: "OFF" at the end indicates that it represents "OFF" when the external computer reads "111".
- 4: Press and hold ▲ key for 2 seconds to change [b39] from 1 to 2, 3 or 4.

# 7.2.2 Category E: Extended Parameters

Туре	Function code	Name	Setting range	Factory default	Attribute
cy	E00	Skip frequency 1	0.00 – HF	0.00 Hz	
dner	E01	Skip frequency 2	0.00 – HF	0.00 Hz	
Skip frequency	E02	Skip frequency 3	0.00 – HF	0.00 Hz	
Skij	E03	Skip frequency range	0.00 – 10.00 Hz	0.00 Hz	
			0: Output frequency		
			1: Output voltage		
	E04	FM1 selection	2: Output current	0	
6			3: PI feedback signal		
//2 lecti			4: Set frequency		
FM1 and FM2 analog output selection	E05	FM1 gain setting	0.50 – 1.20	1.00	
1 an outpu			0: Output frequency		
FM og o		FM2 selection	1: Output voltage		
anal	E06		2: Output current	1	
			3: PI feedback signal		
			4: Set frequency		
	E07	FM2 gain setting	0.50 – 1.20	1.00	
			0: FM1 outputs 0 – 20 mA or 0 – 10 V,		
o o			FM2 outputs 0 – 20 mA or 0 – 10V		
FM channel mode			1: FM1 outputs 4 – 20 mA or 2 – 10 V,		
l el n	F00	EM sharpel made	FM2 outputs 4 – 20 mA or 2 – 10 V		
Janr	E08	FM channel mode	2: FM1 outputs 0 – 20 mA or 0 – 10 V,	0	
່ຽ   Σ			FM2 outputs 4 – 20 mA or 2 – 10 V		
正			3: FM1 outputs 4 – 20 mA or 2 – 10 V,		
			FM2 outputs 0 – 20 mA or 0 – 10 V		
			0: Output frequency		
	E00	Rules output coloctics	1: Output voltage		
DO pulse output	E09	Pulse output selection	2: Output current	2	
_ <u> </u>			3: Set frequency		
	E10	Maximum output pulse frequency	0.1 – 50.0 kHz	10.0 kHz	$\prod$

Туре	Function code	Name	Setting range	Factory default	Attribute
Ħ	E11	Frequency level detection FDT1	0.00 – 650.00 Hz	50.00 Hz	
OUT open collector output	E12	FDT1 lagging frequency	0.00 – 650.00 Hz	1.00 Hz	
	E13	Frequency level detection FDT2	0.00 – 650.00 Hz	25.00 Hz	
olle	E14	FDT2 lagging frequency	0.00 – 650.00 Hz	1.00 Hz	
) uəc	E15	Frequency arrival detection range	0.00 – 650.00 Hz	2.00 Hz	
A T	E16	Open collector output OUT1	0: Running	6	$\Box$
0	E17	Open collector output OUT2	1: Frequency level detection signal 1 (FDT1)	0	П
Relay output selection	E18	Relay Ry output selection	2: Frequency level detection signal 2 (FDT2) 3: Frequency arrival signal (FAR) 4: Reserved 5: Under voltage 6: Overload (O.L.) 7: Reserved 8: Zero speed (lower than starting frequency) 9: E – Stop 10: Low 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	12	
		20: Zero speed (incl. stop) 21: Being braked 22: Accelerating 23: Decelerating 24: Fan action 25: Reserved			
all urrent ction	E19	Stall over current protection level during running	50 % – 200 % of rated current/ OFF	OFF	
Stall over current protection	E20	Stall over current protection level during acceleration	50 % – 200 % of rated current/ OFF	OFF	

Type	Function code	Name	Setting range	Factory default	Attribute
			0: Display output frequency 1: Display set frequency		
Running monitoring display	E21	Running monitoring display	<ul><li>2: Display output current</li><li>3: Display output voltage</li><li>4: Display DC bus voltage</li><li>5: Display input signal</li></ul>	0	
			6: Display radiator temperature		
Display factor	E22	Display factor A	-99.9 – 6000.0 <sup>©</sup>	1.0	
Disp	E23	Display factor B	-99.9 – 6000.0 <sup>©</sup>	0.0	
	E24	PI adjustment selection	0: No PI;1: Direct action; 2: Inverse action	0	•
Pl regulator selection	E25	PI adjustment feedback channel selection	0: Control terminal FB direct action voltage input 0 – 5 V for standard models voltage input 0 – 10 V for C001 models 1: Control terminal FB inverse action voltage input 5 – 0 V for standard models voltage input 10 – 0 V for C001 models 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	10.0 times	
	E27	Integration time constant	0.1 – 60.0s	1.0s	
	E28	Sampling period	0.1 – 60.0s	0.1s	•
	E29	PI adjustment upper factor	0 – 100/OFF	OFF	•
	E30	PI adjustment lower factor	0 – 100	0	•
Maximum input pulse	E31	Maximum input pulse	1.0 – 200.0 kHz	20.0 kHz	•
opping of olem	E32	E-Stop command input modes in the case of external problem	O: Stopping due to connected E-Stop/SC  1: Stopping due to disconnected E-Stop/SC	0	•
Handling of stopping in the case of external problem	E33	E-Stop modes in the case of external problem	0: Coasting to stop 1: Deceleration to stop	0	•
Handli in t exter	E34	E-Stop alarm modes in the case of external problem	0: No alarm output 1: Alarm output	1	

Туре	Function code	Name	Setting range	Factory default	Attribute
Low voltage and under voltage protection	E35	Low voltage protection mode	0: Coasting to stop 1: Deceleration to stop 2: Resume with previous speed	2	•
Low and und	E36	Under voltage protection alarm	0: No alarm output 1: Alarm output	0	
Starting upon powering on	E37	Frequency 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	•
Input phase loss protection enabling	E40	Input phase loss protection enabling	Input phase loss protection disabled     Input phase loss protection enabled	1	
Output phase loss protection enabling	E41	Output phase loss protection enabling	O: Output phase loss protection disabled  1: Output phase loss protection enabled	1	

Туре	Function code	Name	Setting range	Factory default	Attribute
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 overload 8: 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	10.0s	•
	E44	Number of fault retries 0 – 3		0	•
	E45	Current fault record	0: No fault record	0	*
	E46	Last fault record	1: O.C1, over current at constant speed	0	*
	E47	Last 2 fault records	2: O.C2, over current during acceleration	0	*
Fault records	E48	Last 3 fault records	3: O.C3, over current during deceleration 4: O.E1, over voltage at constant speed 5: O.E2, over voltage during acceleration 6: O.E3, over voltage during deceleration 7: O.L., motor overload 8: O.H., frequency converter overheat 9: d.r., drive protection 10: CPU-, EMI 11: IPH.L., input phase loss 12: oPH.L., output phase loss 13: ESt., stopping by external abnormality command 14: O.T., motor overheat 15: CPUE, EMI	0	*
at	E49	Sensor type	0: PTC; 1: NTC	0	•
Motor over heat protection	E50	Motor over heat input channels	0: Ineffective; 1: VRC channel; 2: FB channel	0	
ove pro	E51	Motor over heat reference	0.0 – 10.0 V	2.0 V	•

Fig.7-3: Category E: extended parameters



①②: "0" read by the external computer corresponds to "-99.9", and "60999" corresponds to "6000.0".

# 7.2.3 Category P: Programmable Control Parameters

Туре	Function code	Name	Setting range	Factory default	Attribute
			0: Stop after one cycle		
Logic control	P00	Logic control working mode	1: Cycle operation	0	•
working mode	100	Logic control working mode	2: Running at the last frequency		
			after one cycle		
Speed 0 setting	P01	Speed 0 running direction	SF: Forward; SR: Reverse	SF	
	P02	Speed 0 holding time	OFF/1 – 65000s	OFF	•
	P03	Speed 1 frequency setting	0.00 – HF	5.00 Hz	
	P04	Speed 1 running direction	SF: Forward; SR: Reverse	SF	
Speed 1 setting	P05	Speed 1 holding time	OFF/1 – 65000s	OFF	•
	P06	Speed 1 acceleration time	0.1 - 6500.0s	10.0s	
	P07	Speed 1 deceleration time	0.1 - 6500.0s	10.0s	
	P08	Speed 2 frequency setting	0.00 – HF	10.00 Hz	
	P09	Speed 2 running direction	SF: Forward; SR: Reverse	SF	
Speed 2 setting	P10	Speed 2 holding time	OFF/1 – 65000s	OFF	•
	P11	Speed 2 acceleration time	0.1 – 6500.0s	10.0s	
	P12	Speed 2 deceleration time	0.1 – 6500.0s	10.0s	
	P13	Speed 3 frequency setting	0.00 – HF	20.00 Hz	
	P14	Speed 3 running direction	SF: Forward; SR: Reverse	SF	
Speed 3 setting	P15	Speed 3 holding time	OFF/1 – 65000s	OFF	•
	P16	Speed 3 acceleration time	0.1 – 6500.0s	10.0s	
	P17	Speed 3 deceleration time	0.1 – 6500.0s	10.0s	
	P18	Speed 4 frequency setting	0.00 – HF	30.00 Hz	
	P19	Speed 4 running direction	SF: Forward; SR: Reverse	SF	
Speed 4 setting	P20	Speed 4 holding time	OFF/1 – 65000s	OFF	•
	P21	Speed 4 acceleration time	0.1 - 6500.0s	10.0s	
	P22	Speed 4 deceleration time	0.1 – 6500.0s	10.0s	
	P23	Speed 5 frequency setting	0.00 – HF	40.00 Hz	
	P24	Speed 5 running direction	SF: Forward; SR: Reverse	SF	
Speed 5 setting	P25	Speed 5 holding time	OFF/1 – 65000s	OFF	•
	P26	Speed 5 acceleration time	0.1 – 6500.0s	10.0s	
	P27	Speed 5 deceleration time	0.1 – 6500.0s	10.0s	

Туре	Function code	Name	Setting range	Factory default	Attribute
	P28	Speed 6 frequency setting	0.00 – HF	50.00 Hz	
	P29	Speed 6 running direction	SF: Forward; SR: Reverse	SF	
Speed 6 setting	P30	Speed 6 holding time	OFF/1 – 65000s	OFF	•
	P31	Speed 6 acceleration time	0.1 - 6500.0s	10.0s	
	P32	Speed 6 deceleration time	0.1 – 6500.0s	10.0s	
	P33	Speed 7 frequency setting	0.00 – HF	50.00 Hz	
	P34	Speed 7 running direction	SF: Forward; SR: Reverse	SF	
Speed 7 setting	P35	Speed 7 holding time	OFF/1 – 65000s	OFF	•
	P36	Speed 7 acceleration time	0.1 - 6500.0s	10.0s	
	P37	Speed 7 deceleration time	0.1 – 6500.0s	10.0s	

Fig.7-4: Category P: programmable control parameters

#### Category H: Advanced Parameters 7.2.4

Type	Function code	Name	Setting range	Factory default	Attribute
PWM frequency	H00	PWM frequency	1 – 15 kHz	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			
D	H04	DC braking time	OFF/0.1 – 10.0s	OFF	•
akin	H05	DC braking initial frequency	0.00 – 60.00 Hz	3.00 Hz	•
DC braking	H06	DC braking voltage	1 % – 15 % of rated voltage	10 %	•
	H07	DC braking holding options	0: OFF; 1: X1; 2: X2; 3: X3; 4: ON	0	
	H08	Communication protocol selection	0: ModBus; 1: PROFIBUS	0	
_	H09	Local address	ModBus: 1 – 247 PROFIBUS: 1 – 126	1	
Communication parameters	H10	Baud rate selection	0: 1200 bps 1: 2400 bps 2: 4800 bps 3: 9600 bps 4: 19200 bps 5: 38400 bps	3	
Con	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	

Туре	Function code	Name	Setting range	Factory default	Attribute
	H12	Communication disruption action	0: Stop; 1: Keep running	0	
<u>د</u>	H13	Communication disruption detection time	0.0 (ineffective), 0.1 – 60.0s	0.0s	
Communication parameters	H14	PZD3 setting	0: Output frequency	0	
arar	H15	PZD4 setting	1: Set frequency	1	
d uo	H16	PZD5 setting	2: Output current	2	
icati	H17	PZD6 setting	3: Output voltage	3	
l mur	H18	PZD7 setting	4: Bus voltage	4	
Com	H19	PZD8 setting	5: Digital input signal	5	
	H20	PZD9 setting	6: Module temperature	6	
	H21	PZD10 setting	7: PI control feedback value	7	
Fan	H22	Fan control	0: Auto control 1: No control	0	
Energy saving	H23	Energy saving mode	0: Disabled 1: X1 2: X2 3: X3 4: Automatic energy saving	0	•
ly sa	H24	Energy saving initial frequency	0.00 – 650.00 Hz	10.00 Hz	•
.uerg	H25	Energy saving percentage	0.0 % – 50.0 %	0.0 %	•
Ш	H26	Energy saving voltage adjustment time	0.5 – 100.0s	2.0s	•
	H27	Voltage resumption time	0.5 – 100.0s	1.0s	•
	H28	Reserved			
Braking ratio setting	H29	Braking ratio	0 – 100 %	100 %	•
_	H30	Automatic current limitation level	G series: 20 % – 250 %/OFF; P series: 20 % – 170 %/OFF	150 %	•
ontro	H31	Current regulator proportion factor	0.000 – 1.000	0.060	•
No-trip control	H32	Current regulator integrating time constant	0.001 – 10.000	0.200	•
	H33	Automatic current limitation at constant speed	on/OFF	on	•

Туре	Function code	Name	Setting range	Factory default	Attribute
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 V	•
Braking voltage setting	H36	Braking activation voltage threshold	600 – 780 V	660 V	•
Drooping control	H37	Drooping control	0.00 – 10.00 Hz	0.00 Hz	•
	H38	Motor poles	2 – 14 (input 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	•
Motor parameters	H42	Stator resistance	0.00 % – 50.00 %	Depending on model	•
N para	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 Hz	•
	H47	Auto-tuning of parameters	0 – 2	0	•
Total working hours	H48	Total working hours	0 – 65535	0	*
Password input	H49	Password input	Enabling manufacturer's function codes	0	

Fig.7-5: Category H: advanced parameters

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**Parameter Settings** 

## 7.3 Notes on Function Groups

## 7.3.1 Category b: Basic Parameters

<b>L00</b>	Control command source
b00	(option 1 and 3 have frequency command source)
	0: Run/Stop control with digital operating panel
	1: Up/Down control with external terminals
	2: External via control terminals (including multi-speed), while <b>Stop</b> key is activated
	3: Logic control
	4: External via control terminals
Setting range	(X3 is used to switch between internal/external sources of frequency command), while <b>Stop</b> key is activated
	5: External computer controls <b>Run/Stop</b> , <b>Stop</b> key is activated
	6: External computer controls <b>Run/Stop</b> , <b>Stop</b> key is deactivated
	7: External via control terminals
	(X1, X2 and X3 are used to switch between sources of frequency command, while <b>Stop</b> key is activated)
Factory default	0

# [b00]=0: Run/Stop control with digital operating panel (related settings: [b02], [b16] and [b17])

- Run/Stop is 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, SR are closed or disconnected simultaneously, the motor will not run even Run key is pressed.
- If SF, SR are closed or disconnected simultaneously, the frequency converter will stop even Stop key 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: Up/Down control with external terminals (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 output frequency increasing, and closing X2 will lead to output frequency decreasing.
- While the digital operating panel is under running monitoring status, "▲" can be used to increase the frequency, and "▼" can be used to decrease the frequency.
- X1, X2 have already been defined by other functions, [b00] can not be set to 1.

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#### Parameter Settings

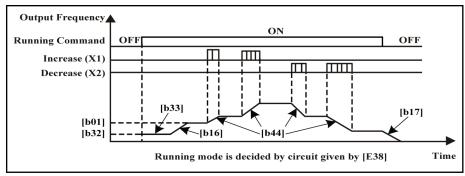


Fig.7-6: External via control terminals, Up/Down control

[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 other functions, [b00] can not be set to 2. The default input of the occupied X terminal is 0.

#### [b00]=3: Logic control (related settings: group P 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])

 An external computer controls starting, stopping and direction, and Stop key is activated.

[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** key is deactivated.

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[b00]=7: Via the various combinations of external terminals X1, X2 and X3, the switches among "internal sources of frequency command", "external sources of frequency command" and "frequency setting locking" can be realized. The running command and direction are decided by the circuit given by [E38]. The relation between various combinations of external terminals X1, X2 and X3 and switches of frequency sources are shown in the table below:

	X1	X2	Х3
External sources of frequency command <sup>®</sup>	1	0	1
	1	1	1
	1	1	0
Internal sources of	1	0	0
frequency command <sup>®</sup>	0	1	1
	0	1	0
	0	0	1
Frequency setting locking®	0	0	0

Fig.7-7: External via control terminals, swithches among frequency sources



- Manual mode, i.e. setting the frequency via external VRC.
- <sup>®</sup> Auto mode, i.e. setting the frequency via external computer RTU.
- When external terminals X1, X2 and X3 are combinbed this way, the "internal sources of frequency command" and "external sources of frequency command" are both deactivated.
- "Frequency setting locking" can be unlocked when you set the external terminals X1, X2 and X3 in any combinations as indicated in the "internal sources of frequency command" and "external sources of frequency command" mode.
  - When external terminals X1, X2 and X3 are combined as indicated in "external sources of frequency command" mode to unlock the "frequency setting locking", the converter firstly works in "Auto mode", i. e. "internal sources of frequency command", and then works in "external sources of frequency command" mode when it reaches "setting the frequency via external computer RTU".
  - When external terminals X1, X2 and X3 are combined as indicated in "internal sources of frequency command" mode to unlock the "frequency setting locking", the "setting the frequency via external computer RTU" will be the default frequency of the frequency converter.

b01	Frequency command given by the digital operating panel
Setting range	0.00 – HF
Minimum unit	0.01 Hz
Factory default	0.00 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
	0: Given by the digital operating panel
	1: Direct action of the digital operating panel's potentiometer Kv*(0 – 5 V)
	2: Inverse action of the digital operating panel's potentiometer $Kv^*(5 - 0 V)$
	3: Direct action of external terminal Kv*(0 – 5 V)
	4: Inverse action of external terminal Kv*(5 – 0 V)
	5: Direct action of external terminal Kv*(0 – 10 V)
	6: Inverse action of external terminal Kv*(10 – 0 V)
Setting range	7: Direct action of external terminal Ki*(4 – 20 mA)
lange	8: Inverse action of external terminal Ki*(20 – 4 mA)
	9: External terminal Kv*(0 – 5 V) ) + Ki*(4 – 20 mA) or
	External terminal Kv*(0 – 10 V) ) + Ki*(4 – 20 mA)
	10: VRC terminal Kv*(-10 – +10 V)
	11: Kp*(Pulse frequency setting) + Kv*(VRC - 5 V) or
	Kp*(Pulse frequency setting) + Kv*(VRC - 2.5 V)
	12: External computer frequency setting
Factory default	1

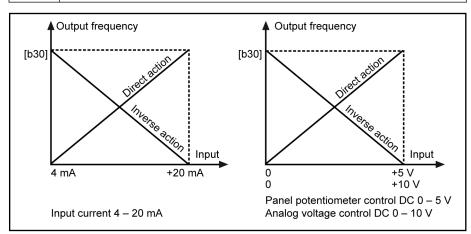


Fig.7-8: Frequency command source setting

- When [b02]=9, the frequency is given by the combination of VRC terminal and +I terminal. Analog voltage gain factor is Kv (see parameter [b25]) and analog current gain factor is Ki (see parameter [b51]).
  - If VRC terminal is 0 to 5 V: Kv\*(0 5 V) + Ki\*(4 20 mA)
     Analog current 4 mA is equivalent to 0 V, and similarly, 20 mA is equivalent to 5 V, as shown in the figure below.
  - If VRC terminal is 0 to 10 V: Kv\*(0 10 V) + Ki\*(4 20 mA)
     Analog current 4 mA is equivalent to 0 V, and similarly, 20 mA is equivalent to 10 V, as shown in the figure below.

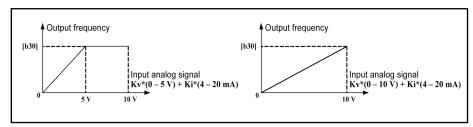


Fig.7-9: Combination input of VRC terminal and +I terminal

- When [b02]=10, VRC terminal inputs -10 to +10 V analog signals, and the direction is decided by the input voltage signal.
  - Negative signal indicates reverse rotation;
  - Positive signal indicates forward rotation;

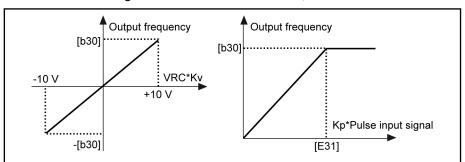


Fig.7-10: VRC terminal and pulse input

- When [b02]=11, the frequency is given by the combination of Pulse frequency setting and VRC terminals. Pulse frequency gain factor is Kp (see parameter [b52])and analog voltage gain factor is Kv (see parameter [b25]).
  - If VRC terminal=0 10 V, the set frequency is: Kp\*(Pulse frequency setting) + Kv\*(VRC 5 V)
  - If VRC terminal=0 5 V, the set frequency is: Kp\*(Pulse frequency setting) + Kv\*(VRC 2.5 V)

Pulse signals are input via A- terminal, set switch JP2 to position 1 - 2.

- When [b02]=12, frequency is given by the external computer. Please correctly set function codes [H08], [H09], [H10] and [H11].
- Set switch JP5 to position 2 3 when [b02]=5, 6,10
   [b02]=9, 11 and the input is 0 to 10 V

b03	Highest frequency – HF
Setting range	50.00 – 650.00 Hz
Minimum Unit	0.01 Hz
Factory default	50.00 Hz

• Set the highest output frequency of the frequency converter.

b04	Base frequency – BF
Setting range	20.00 – HF
Minimum Unit	0.01 Hz
Factory default	50.00 Hz

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

b05 (400 V models)	Base voltage – BV
Setting range	240.0 – 480.0 V
Minimum Unit	0.1 V
Factory default	380.0 V

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

b06	V/F curve mode	
	OFF: user-defined V/F curve	
Setting range	H-00 – H-15: Constant torque characteristic	
	P-00 – P-15: Square descending torque characteristic	
Factory default	Depending on model	

- OFF: For the mode with user-defined V/F curve, hidden function codes [b07] [b13] are displayed.
- 0.75 37 kW factory default: H-03.
- 45 160 kW factory default: H-01.

b07	Lowest output frequency – LLF	
Setting range	0.00 – [b09]	
Minimum Unit	0.01 Hz	
Factory default	0.00 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	
Setting range	0 % – 120 %BV	
Minimum Unit	1 %	
Factory default	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. Rexroth Frequency Converter Fe

**Parameter Settings** 

b09	Middle frequency 1 – MF1
Setting range	LLF – BF
Minimum Unit	0.01 Hz
Factory default	0.00 Hz

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

b10	Middle voltage 1 – MV1
Setting range	0 % – 120 %BV
Minimum Unit	1 %
Factory default	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	
Setting range	BF – HF	
Minimum Unit	0.01 Hz	
Factory default	50.00 Hz	

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

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

• 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
Setting range	0 % – 120 %BV
Minimum Unit	1 %
Factory default	100 %

 The voltage which corresponds to HF of the user-defined V/F curve is 0 % – 120 % of the base voltage (BV).

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

#### (a) General applications

H-0 - H-15 Constant torque characteristic

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

Fig.7-11: Parameter setting for constant torque

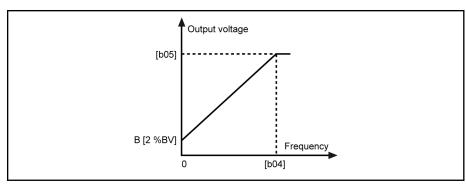


Fig.7-12: Constant torque characteristic

### (b) Fans and pumps

P-00 – P-15 square descending torque

Function code	Value [50 Hz]	Value [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

Fig.7-13: Parameter setting for fans and pumps

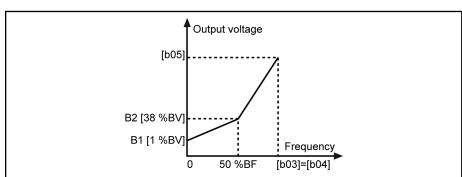


Fig.7-14: Square descending torque

H curve constant torque setting		P curve square descending torque setting		
Display	B [%BV]	Display	B1 [%BV]	B2 [%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 curve constant torque setting		P curve square descending torque setting		
Display	B [%BV]	Display	B1 [%BV]	B2 [%BV]
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-05	2	50

Fig.7-15: Voltages of H curve and P curve

(c) User-defined V/F curve

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

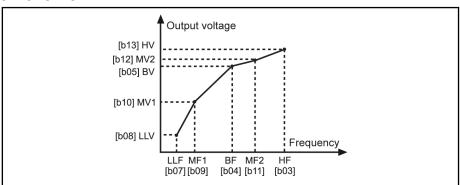


Fig.7-16: User-defined V/F curve

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

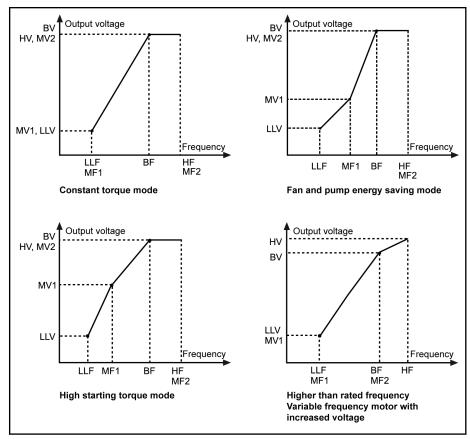


Fig.7-17: Frequently used user-defined V/F curve

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

- When the constant voltage control is enabled (set to be ON), the frequency 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 frequency 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, then the output voltage will be in direct proportion to the input voltage.

b15	Acceleration/deceleration curve
0 "	0: Linear acceleration/deceleration
Setting range	1: S-curve acceleration/deceleration
Factory default	0
b16	Acceleration time
Setting range	0.1 – 6500.0s
Minimum unit	0.1s
Factory default	Depending on model

b17	Deceleration time
Setting range	0.1 – 6500.0s
Minimum unit	0.1s
Factory default	Depending on model

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

#### [b15]: Acceleration/deceleration curve mode

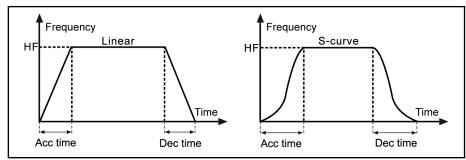


Fig.7-18: Acceleration/deceleration curve mode

#### [b16]: Acceleration time

- If logic control is disabled ([b00]±3), [b16] sets the time for frequency increasing from 0.00 Hz to HF.
- If logic 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 logic control is disabled ([b00]±3), [b17] sets the time for frequency decreasing from HF to 0.00 Hz.

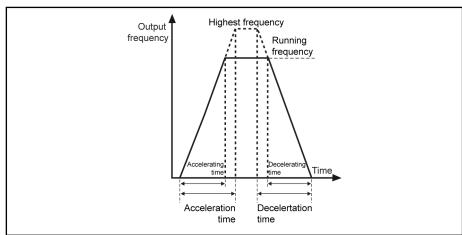


Fig.7-19: Logic control disabled ([b00] +3)

 If logic 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.

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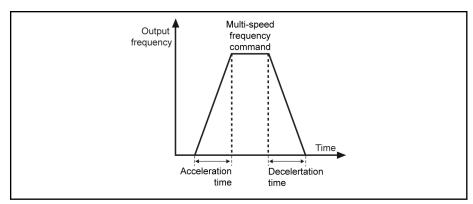


Fig.7-20: Logic control enabled ([b00]=3)

Model [kW]	Acceleration time factory default [b16]	Deceleration time factory default [b17]
0.75 – 22	6.0s	6.0s
30 – 45	20.0s	20.0s
55 – 160	30.0s	30.0s

Fig.7-21: Acceleration/deceleration time factory default

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

- 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.

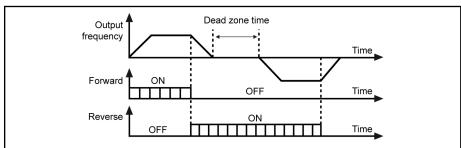


Fig.7-22: Forward/reverse rotation dead zone time

b19	Automatic torque increasing
Setting range	OFF / 1 % – 10 %
Factory default	OFF

 "OFF" is to prohibit automatic torque increasing, and other value is the maximum voltage increase (percentage of base voltage). 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 fre-

- quency 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 frequency 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".

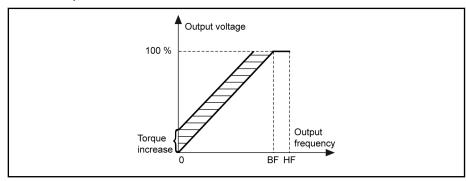


Fig.7-23: Automatic torque increase

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

- Electronic thermal relay setting value (%) = (rated motor current/ rated frequency converter current) ×100 %.
- If only one motor is connected to one frequency 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 as below.
  - G series: 150 % of rated current for 60 seconds; 200 % of rated current for 1 second.
  - P series: 120 % of rated current for 60 seconds; 105 % of rated current for 60 minutes.

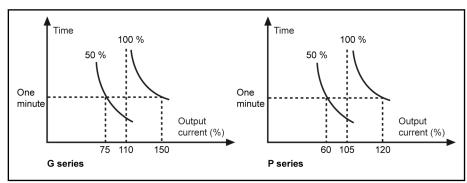


Fig.7-24: Overload protection inverse time lag characteristics

b21	Upper frequency (UF)
Setting range	LF – HF
Minimum Unit	0.01 Hz
Factory default	50.00 Hz
b22	Lower frequency (LF)
Setting range	0.00 – UF
Minimum Unit	0.01 Hz
Factory default	0.50 Hz

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

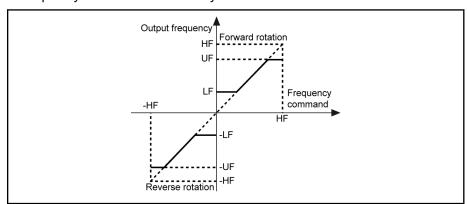


Fig.7-25: Upper frequency and lower frequency

b23	LF mode
Setting range	0: Stop; 1: Run
Factory default	0
b24	Hysteresis frequency width
Setting range	0.10 – HF
Minimum Unit	0.01 Hz
Factory default	1.00 Hz

When the frequency command is lower than the set value of LF, the frequency 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 frequency converter at frequencies around the LF.

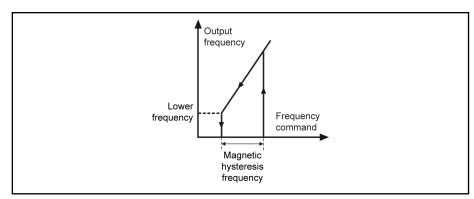


Fig.7-26: [b23]=0

• If [b23]=1, the frequency converter works at LF.

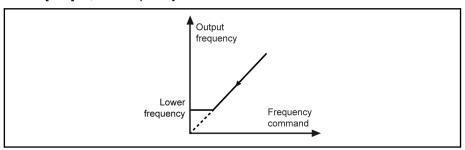


Fig.7-27: [b23]=1

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

b30	Frequency corresponding to maximum curve setting
Setting range	0.00 – 650.00 Hz
Minimum unit	0.01 Hz
Factory default	50.00 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 frequency is illustrated below:

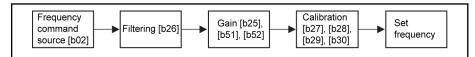


Fig.7-28: Relationship between given and set values

- If analog 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], [b51], [b52] and [b27], [b28], [b29], [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:

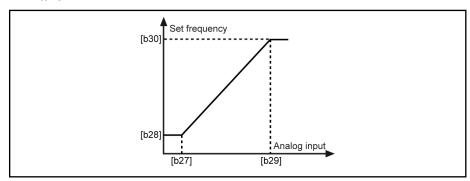


Fig.7-29: Relationship curve between given frequency signal and set frequency

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

# **A** CAUTION

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 equals to 1.

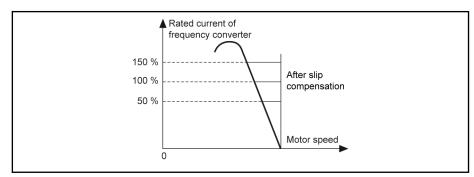


Fig.7-30: Slip frequency compensation

图

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

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

- [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 adapt the starting of systems with different inertia loads.

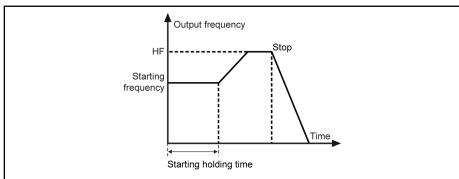


Fig.7-31: Start frequency and holding time

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

- 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.

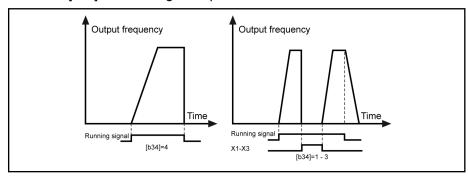


Fig.7-32: Motor stopping mode

- 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 have already been defined by another function, [b34] will not show related value to avoid repeated definition for the same terminal.

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

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**Parameter Settings** 

Minimum unit	0.1s
Factory default	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 the 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 as below:

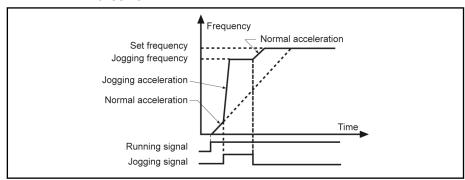


Fig.7-33: Use "jogging" to faster frequency increasing

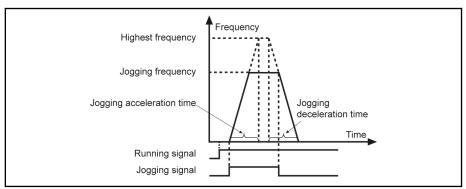


Fig.7-34: Jogging at 0.00 Hz

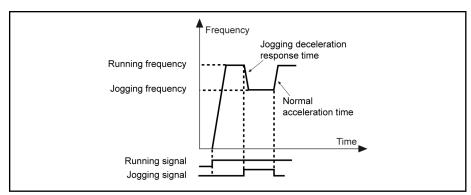


Fig.7-35: Jogging frequency lower than running frequency

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

- 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 as below.

Function code	Name	Setting range	Factory default at 60 Hz	Attribute
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 (400 V models)	Frequency converter input power supply voltage setting
Setting range	380.0 – 480.0 V
Minimum unit	0.1 V
Factory default	380.0 V

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

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

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

b42	Zero speed control selection	
	0: No output	
Setting range	1: Output DC voltage as per [b43] as holding torque	
	2: Output DC voltage as per V/F curve	
Factory default	0	
b43	Voltage command for zero speed control	
Setting range	0.0 % – 20.0 %BV	
Factory default	5.0 %	
b44	Changing rate of Up/Down	
Setting range	0.01 – 99.99 Hz/s	
Factory default	1.00 Hz/s	

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

b45	Local and remote switch
	0: OFF
Catting range	1: X1
Setting range	2: X2
	3: X3
Factory default	0

- [b45]=0: Local control.
- [b45]=1 3: Select terminal X1 X3 to switch the signal input terminals for the local and remote control, "closed" is for the remote control, and "open" is for the local control.
- "Switching the terminal status" function is disabled during running.

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- Local control: The running command and frequency command are set by [b00] [b02].
- Remote control: The running command and frequency command are set by external computer, with the Stop key deactivated.

b46	Starting mode of speed capturing
	0: Starting of speed capturing disabled
Setting range	1: Speed capturing in forward rotation only
Setting range	2: Speed capturing in reverse rotation only
	3: Speed capturing in forward and reverse rotation
Factory default	0
b47	Deceleration time for speed capturing
Setting range	1.0 – 5.0s
Factory default	1.5s
b48	Current level for speed capturing
Setting range	10 % – 100 % of rated current
Factory default	50 %
b49	Current regulator proportion factor
Setting range	0.000 – 1.000
Factory default	0.060
b50	Integration time constant for current regulator
Setting range	0.001 – 10.000
Factory default	0.200

- The speed capturing can help the freely running motor started smoothly by evaluating the motor speed.
- When the speed capturing is enabled, if the motor rotating direction is already known, please firstly set [b46]=1 or 2 to shorten the starting time for speed capturing, which also can avoid the opposite running of the motor; If the motor rotating direction can't be specified, please set [b46]=3.
- The deceleration time for speed capturing specifies the speed for frequency dropping during speed capturing, if the rotating inertia is stronger, please prolong the decelerating time as needed.
- Please set the current lelve for speed capturing properly accoring to the load status, for example: set as no-load current for no-load running, and set as rated current for running in rated load. Setting the value too low may cause the zero speed starting due to the failure of speed capturing; setting it too high may lower the capturing accuracy.

b51	Current gain of given channel Ki
Setting range	0.00 – 9.99
Minimum unit	0.01
Factory default	1.00

b52	Pulse frequency gain of given channel Kp
Setting range	0.00 – 9.99
Minimum unit	0.01
Factory default	1.00

# 7.3.2 Category E: Extended Parameters

E00	Skip frequency 1
Setting range	0.00 – HF
Minimum unit	0.01 Hz
Factory default	0.00 Hz
E01	Skip frequency 2
Setting range	0.00 – HF
Minimum unit	0.01 Hz
Factory default	0.00 Hz
E02	Skip frequency 3
Setting range	0.00 – HF
Minimum unit	0.01 Hz
Factory default	0.00 Hz
E03	Skip frequency range
Setting range	0.00 – 10.00 Hz
Minimum unit	0.01 Hz
Factory default	0.00 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.

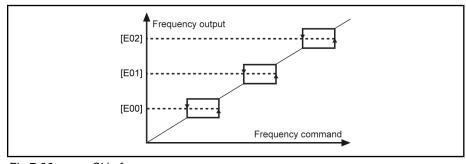


Fig.7-36: Skip frequency

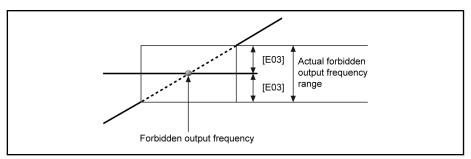


Fig.7-37: Skip frequency range

E04	FM1 selection
Setting range	0: Output frequency; 1: Output voltage; 2: Output current;
	3: PI feedback signal; 4: Set frequency
Factory default	0
E05	FM1 gain setting
Setting range	0.5 – 1.20
Factory default	1.00
E06	FM2 selection
Sotting range	0: Output frequency; 1: Output voltage; 2: Output current;
Setting range	3: PI feedback signal; 4: Set frequency
Factory default	1
E07	
E07	FM2 gain setting
Setting range	0.5 – 1.20
	<u> </u>
Setting range	0.5 – 1.20
Setting range Factory default	0.5 – 1.20 1.00
Setting range Factory default E08	0.5 – 1.20  1.00  FM channel mode  0: FM1 outputs 0 – 20 mA or 0 – 10 V; FM2 outputs 0 – 20 mA or 0
Setting range Factory default	0.5 – 1.20  1.00  FM channel mode  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
Setting range Factory default E08	0.5 – 1.20  1.00  FM channel mode  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

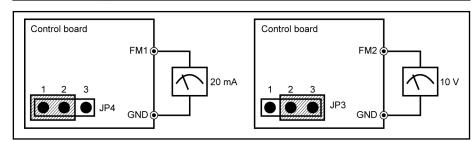


Fig.7-38: FM1 & FM2

- 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 frequency converter.
- When JP4 is at position 2 3, the output of FM1 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 k $\Omega$ .
- When JP4 is at position 1 2, the output of FM1 is 0 to 20 mA; connect an ammeter or frequency meter with a full range of 20 mA.
- [E04]=0: Frequency is outputted; when the highest frequency is reached, the FM1 terminal outputs 20 mA or 10 V;

[E04]=1: Voltage is outputted; when the AC 500 V is reached, the FM1 terminal outputs 20 mA or 10 V;

[E04]=2: Current is outputted; when the output is 2 times the rated current, the FM1 terminal outputs 20 mA or 10 V;

[E04]=3: PI feedback signal.

[E04]=4: Frequency is set; when the highest frequency is reached, the FM1 terminal outputs 20 mA or 10 V;

- [E05] is used to adjust the gain of FM1.
- When JP3 is set to be 2 3, FM2 outputs 0 10 V; When JP3 is set to be 1 – 2, FM2 outputs 0 – 20 mA. The output and gain of FM2 are selected by [E06] and [E07] respectively.

E09	Pulse output selection	
Setting range	0: Output frequency; 1: Output voltage;	
	2: Output current; 3: Set frequency	
Factory default	2	
E10	Maximum output pulse frequency	
Setting range	0.1 – 50.0 kHz	
Minimum unit	0.01 kHz	
Factory default	10.00 kHz	

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.
- [E09]=3: Frequency is set; when the highest frequency HF is reached, the DO terminal outputs [E10] kHz.

E11	Frequency level detection FDT1
Setting range	0.00 – 650.00 Hz
Minimum unit	0.01 Hz
Factory default	50.00 Hz
E12	FDT1 lagging frequency

Catting range	0.00 650.00 H=
Setting range	0.00 – 650.00 Hz
Minimum unit	0.01 Hz
Factory default	1.00 Hz
E13	Frequency level detection FDT2
Setting range	0.00 – 650.00 Hz
Minimum unit	0.01 Hz
Factory default	25.00 Hz
E14	FDT2 lagging frequency
Setting range	0.00 – 650.00 Hz
Minimum unit	0.01 Hz
Factory default	1.00 Hz
E15	Frequency arrival detection range
Setting range	0.00 – 650.00 Hz
Minimum unit	0.01 Hz
Factory default	2.00 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]-[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]-[E14]).

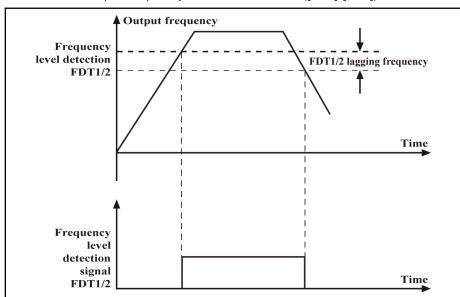


Fig.7-39: Frequency level detection (FDT)

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

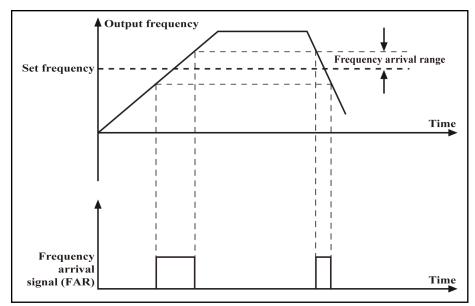


Fig.7-40: Frequency arrival signal

			T		
	<u> </u>		0: Running		
E16	Open collector output OUT2 Open collector output OUT1 Setting range		1: Frequency level detection signal 1 (FDT1)		
			2: Frequency level detection signal 2 (FDT2)		
			3: Frequency arrival signal (FAR)		6
	ectc		4: Reserved		
	8		5: Under voltage		
	ben		6: Overload (O.L.)		
	0		7: Reserved		
	LT2		8: Zero speed (lower than starting frequency)		
	0 #		9: E-Stop		
	L <del>t</del>		10: Low voltage		
E17	o o	e G	11: No trip action	in H	0
		Setting range	12: Fault	Factory default	
	8	fing	13: Programmable program running	ory	
	led C	Set	14: Programmable program run	-act	
			15: Run for one stage	_	
	Relay Ry output selection		16: Over current stall		
			17: Over voltage stall		
			18: In forward rotation command indication		
			19: In reverse rotation command indication		
E18			20: Zero speed (incl. stop)		12
		21: Being braked			
		22: Accelerating			
			23: Decelerating		
	<u> </u>		24: Fan action		
			25: Reserved		

# Open collector output terminal wiring examples

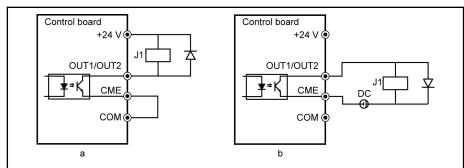


Fig.7-41: Open collector output terminal wiring



- 1. Open collector output terminals OUT1 and OUT2 may use the internal +24 V power supply of the frequency converter, and the wiring is illustrated in figure a.
- 2. Open collector output terminals OUT1 and OUT2 may also use the external power supply, and the wiring is illustrated in figure b.

#### Relay Ry output wiring example

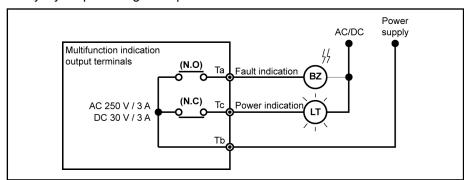


Fig.7-42: Relay Ry output wiring

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

0: Running

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

• 1: Frequency level detection signal 1 (FDT1)

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

• 2: Frequency level detection signal 2 (FDT2)

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

• 3: Frequency arrival signal (FAR)

When the output frequency is within the set frequency  $\pm$ [E15], OUT or Ry activates.

- 4: Reserved.
- 5: Under voltage

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

6: Overload (O.L.)

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

- 7: Reserved.
- 8: Zero speed (lower than starting frequency)

When the output frequency of the frequency 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 (bus voltage lower than 90 % of rated voltage)

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

12: Fault

When the frequency converter detects fault, OUT or Ry activates.

13: Programmable program running

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

• 14: Programmable program run

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

• 15: Run for one stage ([b00]=3)

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

18: In forward rotation

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

• 19: In reverse rotation

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

• 20: Zero speed (incl. stop)

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

22: Accelerating

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

23: Decelerating

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

24: Fan action

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

• 25: Reserved.

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

- The stall over current protection level during running may be set between 50 % and 200 % of rated frequency 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.

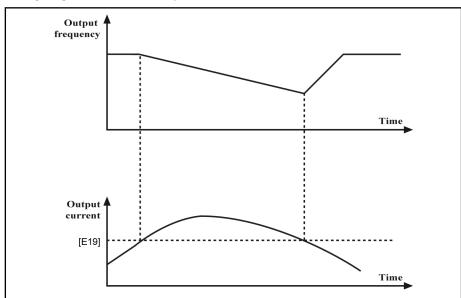


Fig.7-43: Stall over current protection in run mode

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

- The stall over current protection level [E20] during acceleration may be set between 50 % and 200 % of rated frequency 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

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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.

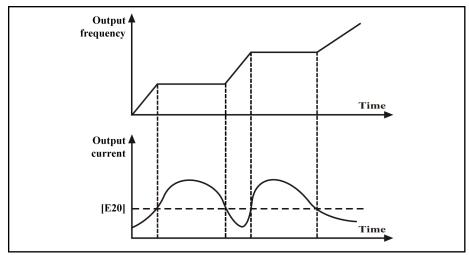


Fig.7-44: Stall over current protection in acceleration mode

B

The stall over current protection function may only be used when the no trip control function is turned off ([H30]=OFF). If [H30] ±OFF, set [E19]=OFF and [E20]=OFF.

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

- The first use of display factor A and display factor B is to convert the output frequency of the frequency converter to an application engineering value 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 application engineering value, when the motor is controlled with the PI closed loop function.
- Display factor A [E22]=Maximum analog given or feedback value (e.g., 10 V) corresponding to the application engineering value.
- Display factor B [E23]=Minimum analog given or feedback value (e.g., 0
   V) corresponding to the application engineering value.

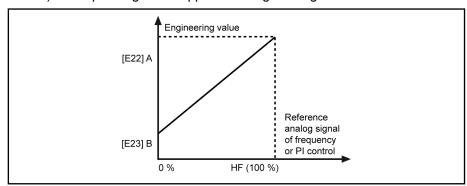


Fig.7-45: Display factor

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

The PI adjustment function of the frequency 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.

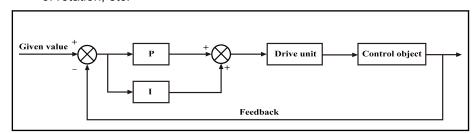


Fig.7-46: PI adjustment

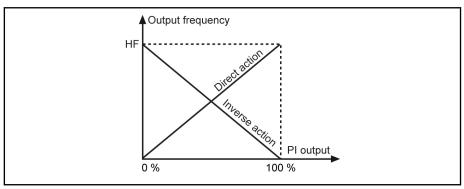


Fig.7-47: PI adjustment curve

 PI adjustment selection [E24]=0: No PI

[E24]=1: Direct action [E24]=2: Inverse action

E25	PI adjustment feedback channel selection
	0: Control terminal FB direct action
	(voltage input 0 – 10 V for C001 models; 0 – 5 V for standard models)
	1: Control terminal FB inverse action
Setting range	(voltage input 10 – 0 V for C001 models; 5 – 0 V for standard models)
	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
Factory default	0
E26	Proportional gain
Setting range	0.01 – 99.99 times
Factory default	10.00 times
E27	Integral time constant
Setting range	0.1 – 60.0s
Factory default	1.0s
E28	Sample period
Setting range	0.1 – 60.0s
Factory default	0.1s

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- If [E25]=4 or 5, the upper limit of input pulse frequency range is 200 kHz.
- Direct action or inverse action may be selected for PI adjustment output, therefore PI adjustment output can increase or decrease motor speed.

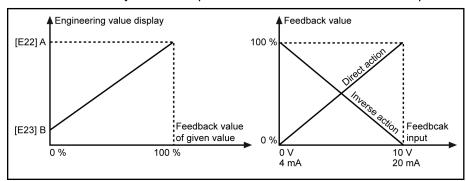


Fig.7-48: PI mode selection

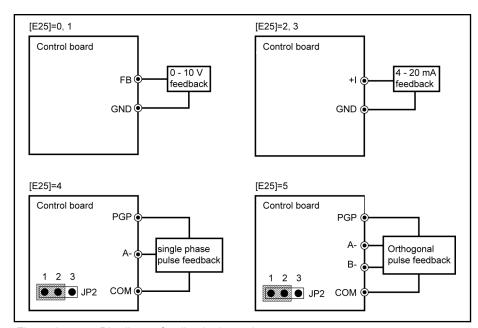


Fig.7-49: PI adjuster feedback channels



- FB feedback is 0 − 5 V (for standard models), 0 − 10 V (for C001 models).
- Orthogonal pulse encoder has two modes. The diagrams above correspond to the open collector output type (JP2 at position 1 – 2). The diagram below shows the encoder PG as differential output type (JP2 at position 2 – 3). In this case make the wiring as shown below.

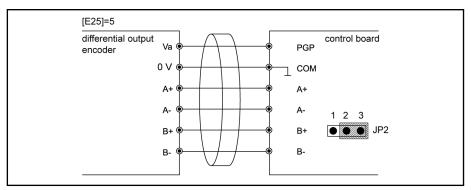


Fig. 7-50: Differential output encoder wiring

- 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

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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
Setting range	0 – 100/OFF
Factory default	OFF
E30	PI adjustment lower factor
Setting range	0 – 100
Factory default	0

- [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 value 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 value is smaller than the feedback lower limit (time t2), PI is reactivated.

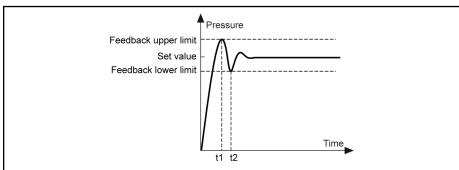


Fig.7-51: PI adjustment upper and lower limit

B

- Feedback upper limit=[E22]×([E29]/100)
- Feedback lower limit=[E22]×([E30]/100)

E31	Maximum input pulse frequency
Setting range	1.0 – 200.0 kHz
Minimum Unit	0.1 kHz
Factory default	20.0 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 value.

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

- [E33]=0: Coasting to stop/Freewheel 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 frequency 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.

## **A** CAUTION

The "Emergency Stop" function can't be realized by the "E-Stop" command when no additional measures are taken.

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

 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 frequency converter immediately blocks output to make the motor coast to stop and display 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	Frequency converter automatically starts after powering on
Setting range	0: Forbidden; 1: Allowed
Factory default	0

- 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 frequency converter will automatically start after powering on without pressing the Run key; in the case of [E37]=0, the frequency converter only starts after Run key is pressed down.
- When another source of running commands is selected, in the case of [E37]=1, the frequency converter will automatically start after powering on, if a running command (e.g. connected SF) exists; in the case of [E37]=0, the frequency converter will remain static, even if a running command exists. To start the frequency converter, cancel and reissue the running command (e.g. disconnecting and reconnecting SF).

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

[E38] terminal function is only activated when [b00]=1, 2, 4 or 7. [E38] function is explained below, assuming the NPN/ PNP jumper is in position 3 (internal NPN).

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

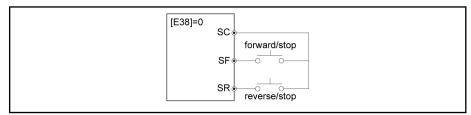


Fig.7-52: E38=0

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

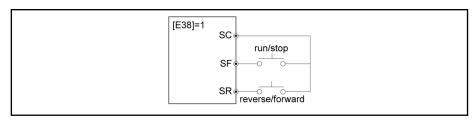


Fig.7-53: E38=1

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

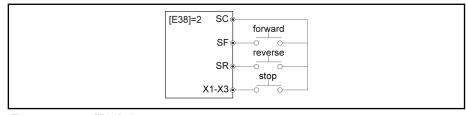


Fig.7-54: [E38]=2

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

E39	Self-holding function
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
Factory default	0

- If [E38]=2, terminal X selected with [E39] and SF and SR key input have self-holding function.
- [E39]=0: Self-holding function is deactivated.

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

• If [E40]=0, the protection is disabled; if [E40]=1, the protection will act as the frequency converter stops output and the motor coasts to stop.

The function is invalid for Frequency Converter Fe up to 7.5 kW.

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

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

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
Setting range	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 external abnormality command
	14: Retry from any fault
Factory default	0
E43	Waiting time for fault retry
Setting range	2.0 – 60.0s
Minimum unit	0.1s
Factory default	10.0s
E44	Number of fault retries
Setting range	0 – 3
Minimum unit	1
Factory default	0

E45	Current fault record	0: No fault record		0
E46	Last fault record	1: O.C1, over current at constant speed		0
E47	Last 2 <sup>nd</sup> fault records	2: O.C2, over current during acceleration		0
		3. O.C3, over current during deceleration		
		4: O.E1, over voltage at constant speed		
		5: O.E2, over voltage during acceleration		
	Last 3 <sup>rd</sup> fault records	6: O.E3, over voltage during deceleration	≒	
		7: O.L., motor overload	Factory default	
		8: O.H., frequency converter overheat 9: d.r., drive protection		
E48		10: CPU-, EMI	ш	0
		11: IPH.L., input phase loss		
		12: oPH.L., output phase loss		
		13: ESt., stopping by external abnormality command		
		14: O.T., motor over heat		
		15: CPUE, EMI		

- [E43] is the waiting time for the frequency 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 frequency converter.

E49	Sensor type
Setting range	0: PTC; 1: NTC
Factory default	0
E50	Motor over heat input channels
Setting range	0: Deactivated; 1: VRC channel; 2: FB channel
Factory default	0
E51	Motor over heat reference
Setting range	0.0 – 10.0 V
Minimum unit	0.1 V
Factory default	2.0 V

To activate this function, PTC/NTC temperature sensors need be mounted in the motor with the output terminals connected to the respective frequency converter control terminals. The wiring diagram of temperature detection is shown as below:

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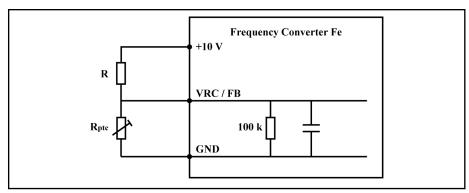


Fig.7-55: PTC temperature detect wiring

- The input of PTC/NTC shares the same channel with VRC or FB, so the setting of [E50] and the setting of [b02] or of [E25] are mutually exclusive:
  - [E50]=1 and [b02]=3\4\5\6\9\10\11 are mutually exclusive.
  - [E50]=2 and [E25]=0\1 are mutually exclusive.
- When the temperature arrives at the set value of [E51] (motor over heat reference), the motor will stop automatically with fault information "O.T." displayed on the operating panel.
- PTC/NTC temperature detection shares the same filter time constant [b26] with the analog input channel.
- The corresponding input voltage options of channel VCR include +10 V (JP5 at position 2 – 3); the corresponding input voltage of channel FB is +10 V (for C001 models) or +5 V (for standard models).
- To activate this function, the corresponding motor over heat reference based on temperature sensor type needs to be calculated. If [E49]=0, [E50]=1, external terminals VRC, +10 V and GND are used. The calculation formula is shown as below:

[E51]=10 \* (Rptc // 100 k) / [R + (Rptc // 100 k)]



When FB is selected as the motor overheat protection channel, the calculation formula of [E51] is same as above. If FB is set as 0 to 5 V, please select appropriate R value so that the overheat reference is lower than 5 V.

If a standard PTC resistor is used, the corresponding resistance of motor protection reference is 1330  $\Omega$ . If a general resistor is used, the corresponding motor protection reference is shown in the table below:

Motor overheat protection reference [E51] [V]	Resistance divider R [kΩ]
1.16	10.0
2.01	5.1
2.18	4.7
2.85	3.3

Fig.7-56: Motor protection reference for general resistor

# 7.3.3 Category P: Programmable Control Parameters

This function group will be used in the case of logic control running and multispeed running with external terminals. Here are two examples:

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

• [P00] setting is only activated when [b00]=3, that means when logic control has been activated.

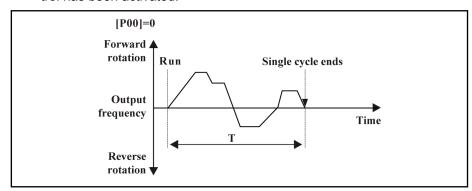


Fig.7-57: [P00]=0

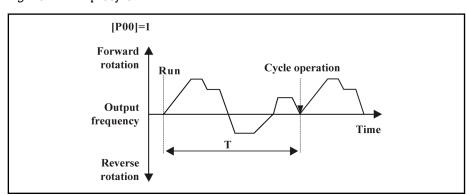


Fig.7-58: [P00]=1

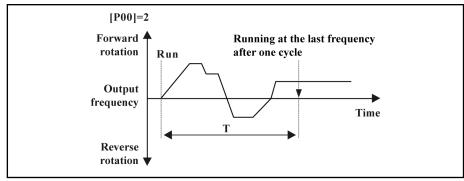


Fig.7-59: [P00]=2

P03	Speed 1 frequenc	y setting	Factory default	5.00 Hz
	Setting range	0.00 Hz – HF	Minimum Unit	0.01 Hz
P08	Speed 2 frequency	y setting	Factory default	10.00 Hz
	Setting range	0.00 Hz – HF	Minimum Unit	0.01 Hz
P13	Speed 3 frequency	y setting	Factory default	20.00 Hz
	Setting range	0.00 Hz – HF	Minimum Unit	0.01 Hz
P18	Speed 4 frequency setting		Factory default	30.00 Hz
	Setting range	0.00 Hz – HF	Minimum Unit	0.01 Hz
P23	Speed 5 frequency	y setting	Factory default	40.00 Hz
	Setting range	0.00 Hz – HF	Minimum Unit	0.01 Hz
P28	Speed 6 frequency	y setting	Factory default	50.00 Hz
	Setting range	0.00 Hz – HF	Minimum Unit	0.01 Hz
P33	Speed 7 frequency setting		Factory default	50.00 Hz
	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 multispeed modes:
  - If [b00]=2 (multi-speed external terminal control), the source for speed 0 is given by [b02].
  - If [b00]=3 (logic control), speed 0 is directly given by [b01].
- The acceleration and the deceleration time of speed 0 are still determined by [b16]/[b17].

P01	Speed 0 running direction		Factory default	SF
	Setting range	SF: Forward; SR: Reverse		
P04	Speed 1 running dire	ection	Factory default	SF
	Setting range	SF: Forward; SR: Reverse		
P09	Speed 2 running dire	ection	Factory default	SF
	Setting range	SF: Forward; SR: Reverse		
P14	Speed 3 running dire	ection	Factory default	SF
	Setting range	SF: Forward; SR: Reverse		
P19	Speed 4 running dire	ection	Factory default	SF
	Setting range	SF: Forward; SR: Reverse		
P24	Speed 5 running dire	ection	Factory default	SF
	Setting range	SF: Forward; SR: Reverse		
P29	Speed 6 running dire	ection	Factory default	SF
	Setting range	SF: Forward; SR: Reverse		
P34	Speed 7 running dire	ection	Factory default	SF
	Setting range	SF: Forward; SR: Reverse		

• Speeds 0 – 7 running direction is activated when [b00]=3 (logic control).

SF: ForwardSR: Reverse

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

- Speeds 0 7 holding time is activated when [b00]=3 (logic 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 accelerat	ion time	Factory default	10.0s
	Setting range	0.1 – 6500.0s	Minimum unit	0.1s
P11	Speed 2 accelerate	ion time	Factory default	10.0s
	Setting range	0.1 – 6500.0s	Minimum unit	0.1s
P16	Speed 3 accelerat	ion time	Factory default	10.0s
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P21	Speed 4 accelerat	ion time	Factory default	10.0s
	Setting range	0.1 - 6500.0s	Minimum unit	0.1s
P26	Speed 5 accelerat	ion time	Factory default	10.0s
	Setting range	0.1 – 6500.0s	Minimum unit	0.1s
P31	Speed 6 accelerat	ion time	Factory default	10.0s
	Setting range	0.1 – 6500.0s	Minimum unit	0.1s
P36	Speed 7 accelerat	ion time	Factory default	10.0s
	Setting range	0.1 – 6500.0s	Minimum unit	0.1s

• Speeds 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 (logic control), it is the time from the former speed to the current speed.

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

- Speeds 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 (logic control), it is the time from the former speed to the current speed.

## Example of logic control ([b00]=3)

The frequency 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 logic control, the holding time is set to be OFF, i.e. [P02]=[P10]=[P25]=[P30]=[P35]=OFF.

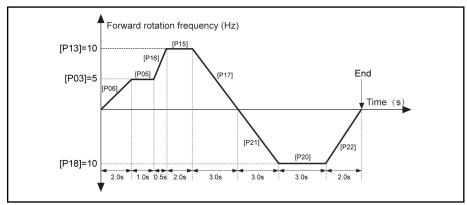


Fig.7-60: Logic control example

B

The above figure does not show the effect of the forward and reverse rotation dead zone time.

Function code	Parameter setting	Unit
P03	5.00	Hz
P04	SF: Forward	-
P05	1.0	S
P06	2.0	S
P07	X	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

Fig.7-61: Logic running table for speeds 1, 3 and 4

# Example of multi-speed external terminal control ([b00]=2)

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

Speed	Running frequency	Х3	X2	X1
0	[b02]	0	0	0
1	[P03]	0	0	1
2	[P08]	0	1	0
3	[P13]	0	1	1
4	[P18]	1	0	0
5	[P23]	1	0	1
6	[P28]	1	1	0
7	[P33]	1	1	1

Fig.7-62: Binary combination speed table

The following examples are explained according to the NPN/ PNP jumper at position 3 (internal NPN).

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

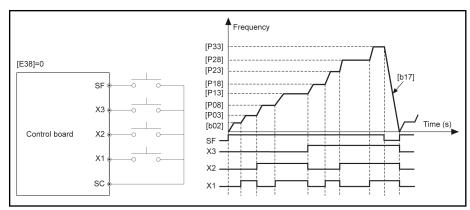


Fig.7-63: 8-speed forward rotation cycle operation

# **Example 2:** 2-speed forward/reverse rotation cycle operation

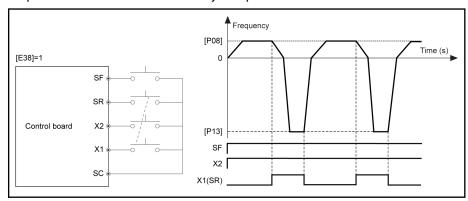


Fig.7-64: 2-speed forward/reverse rotation cycle operation

# 7.3.4 Category H: Advanced Parameters

H00	PWM frequency
Setting range	1 – 15 kHz
Minimum unit	1 kHz
Factory default	Depending on model

 The function is used to set the PWM frequency output. The setting range depends on frequency converter rated power. See the table below.

Power [kW]	PWM frequency factory default [kHz]	PWM frequency setting range [kHz]
0.75 – 7.5	8	1 – 15
11 – 45	6	1 – 8
55 – 160	2	1 – 6

Fig.7-65: PWM frequency factory default and setting range



- 1. Adjustable in 1 kHz steps.
- 2. The PWM frequency at output frequency below 4 Hz is always limited to 4 kHz to protect the frequency converter.
- 3. To increase the PWM frequency, please refer to chapter 9.2.3 "Derating and Output Current" on page 160.

H01	Automatic adjustment of PWM frequency
Setting range	OFF; on
Factory default	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
Setting range	OFF; 0.1 – 20.0s
Minimum unit	0.1s
Factory default	OFF

- 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 lagging 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.

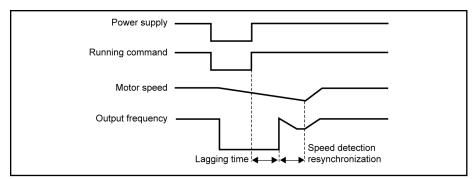


Fig.7-66: Lagging time for restart after transient stop

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

- 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 have 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, the DC braking will be interrupted and running will start.

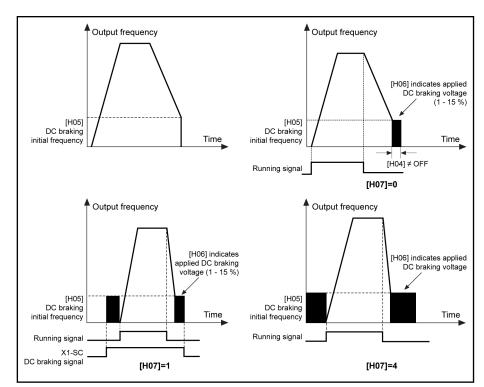


Fig.7-67: DC braking holding options

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

• 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.

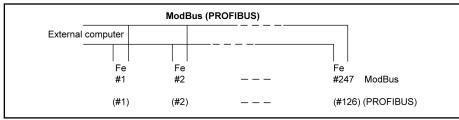


Fig.7-68: Communication protocol selection

- [H10] defines the baud rate of communication.
  - [H10]=0 (1200), 1 (2400), 2 (4800), 3 (9600), 4 (19200), 5 (38400).
  - 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 frequency converter must be identical to the PROFIBUS communication interface.

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

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

H14 H15 H16 H17 H18 H19 H20	PZD3 setting PZD4 setting PZD5 setting PZD6 setting PZD7 setting PZD8 setting PZD9 setting PZD9 setting PZD10 setting	Setting Range	0: Output frequency 1: Set frequency 2: Output current 3: Output voltage 4: Bus voltage 5: Digital input signal 6: Module temperature 7: PI control feedback value	Factory default	0 1 2 3 4 5 6
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• The parameters [H14] to [H21] can be used to set the register values for frequency converter state feedback.

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

- [H22]=0: The fan keeps rotating while the frequency converter is working. The fan automatically starts internal temperature detection 3 minutes after the frequency 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 frequency converter is powered on.

H23	Energy saving mode
Setting range	0: Disabled; 1: X1; 2: X2; 3: X3; 4: Automatic energy saving
Factory default	0
H24	Energy saving initial frequency
Setting range	0.00 – 650.00 Hz
Factory default	10.00 Hz
H25	Energy saving percentage
Setting range	0.00 % – 50.00 %
Factory default	0.0 %
H26	Energy saving voltage adjustment time
Setting range	0.5 – 100.0s
Factory default	2.0s
H27	Energy saving voltage resumption time
Setting range	0.5 – 100.0s
Factory default	1.0s

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

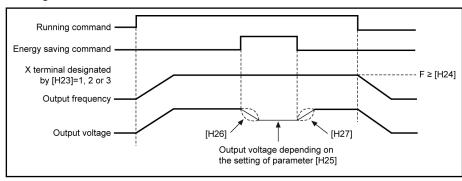


Fig.7-69: Energy saving

Reserved

H28

- [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 [H24], the output voltage of the frequency converter will decrease from the previous V/F curve value to the previous V/F curve value multiplied with (1 [H25]). The output voltage decreasing time and resumption time are set by [H26] and [H27] respectively.
- [H23]=4: Automatic energy saving. In contrast to the energy saving with
  external terminals, the automatic energy saving mode starts the energy
  saving when the frequency converter has light load. When the motor
  load increases, the voltage of the motor resumes from the energy saving mode to the V/F curve value according to [H27].

**Bosch Rexroth AG** 

H29	Braking ratio
Setting range	0 – 100 %
Factory default	100 %

- Braking ratio = (braking time/braking period) \* 100 %
- Prameter [H36] also needs to be set based on the setting of [H29] "Braking ratio".

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

- The automatic current limitation function is used to automatically limit the load current within the setting range of the set value of [H30] through the real-time control on it. In this way a tripping of the frequency converter can be avoided. The function is especially useful for loads with larger inertia or in case of big load changes.
- [H30] defines the threshold current of the automatic current limitation. The set value is a percentage of the rated frequency converter current.
- If [H30]=OFF, this function is disabled.

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

• 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 incorrect operation of anti-trip control.

H32	Current regulator integrating time constant
Setting range	0.001 – 1.000
Factory default	0.200

• 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
Setting range	OFF/on
Factory default	on

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

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

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.

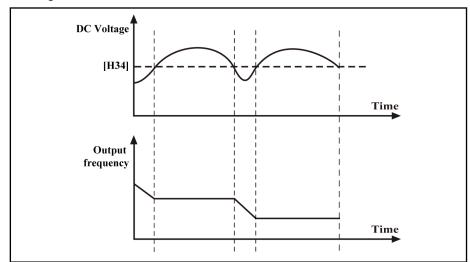


Fig.7-70: Stall over voltage level selection

B

If [H34]=OFF, stall over voltage protection is deactivated.

H35	Software over voltage protection point
Setting range	790 – 820 V
Factory default	810 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 stop running.

H36 Braking activation volt		Braking activation voltage threshold
	Setting range	600 – 780 V
	Factory default	660 V

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

H37	Drooping control	
Setting range	0.00 – 10.00 Hz	
Minimum Unit	0.01 Hz	
Factory default	0.00 Hz	

- This function is suitable for circumstances where multiple frequency converters are used to drive the same load.
- This 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 frequency 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 steadily. The relation between load and output frequency is shown in the diagram below:

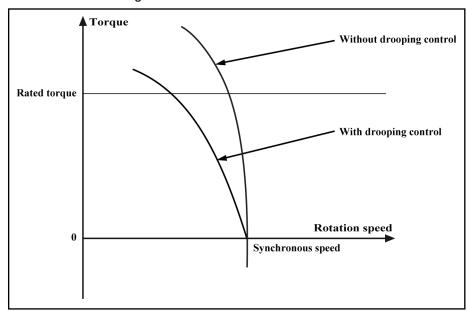


Fig.7-71: Drooping control

B

If drooping control is used, turn off slip frequency compensation by setting [b31]=0.00 Hz.

H38	Motor poles	
Setting range	2 – 14	
Factory default	4	
H39	Rated motor power	
Setting range	0.4 – 999.9 kW	
Minimum Unit	0.1 kW	
Factory default	Depending on model	
H40	Rated motor current	
Setting range	0.1 – 999.9 A	

Minimum Unit	0.1 A
Factory default	Depending on model

- Set the parameters of the controlled motor according to its nameplate to ensure that the rated motor and the rated frequency 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. Otherwise the control performance cannot be ensured.

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

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

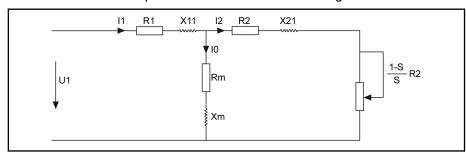


Fig.7-72: Motor parameters

- R1, X11, R2, X21, Xm and I0 in the diagram respectively represents 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] to [H45] are all percentages to the motor parameters and the formula is as follows:

 $R\% = \frac{R}{V/(\sqrt{3} \times I)} \times 100\%$ 

R: Stator resistance or rotor resistance

V: Rated voltage
I: Rated motor current
Fig.7-73: Resistance formula

$$X\% = \frac{X}{V/(\sqrt{3} \times I)} \times 100\%$$

X: Leakage inductance or mutual inductance

V: Rated voltage I: Rated motor current Fig.7-74: Inductance formula

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

H46	Rated slip frequency	
Setting range	0.00 – 20.00 Hz	
Minimum Unit	0.01 Hz	
Factory default	0.00 Hz	

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

Rated slip motor frequency = rated motor frequency [b04]) × (Synchronous motor speed - rated motor speed) ÷ synchronous motor speed

Among which: Synchronous motor speed = rated motor frequency × 120 ÷ motor poles ([H38])

H47 Auto-tuning of parameters	
Setting range	0 – 2
Factory default	0

- Before auto-tuning, you must correctly input the nameplate parameters of the connected motor ([H38]–[H40]).
- This 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.

### **A** DANGER

Danger movements! Danger to life, risk of injury, severe bodily harm or material danger! Ensure safety because the motor shaft will rotate!

• After auto-tuning, [H47] is automatically set to be 0.

**Parameter Settings** 

## Auto-tuning steps:

- 1. Set the base frequency ([b04]) and the base voltage ([b05]) according to the motor characteristics.
- 2. Correctly set ([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.



- When [H47] is set to be 2, if over current or over voltage occurs during auto-tuning, the acceleration/deceleration time needs to be appropriately increased.
- 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, otherwise 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	
Setting range	0 – 65535 hours	
Minimum Unit	1 hour	
Factory default	0 hour	
H49	Password input	
Factory default	0	

• [H49] allows access to manufacturer function codes ([H50]–[H65]).

#### Category d: Monitoring Parameters 7.3.5

Function	Abbreviation	previation Description		
	outF	displays frequency converter output frequency (Hz), motor speed and linear speed (see [E22] and [E23])		
SU	SEtF	displays frequency converter set frequency (Hz), motor speed or PI target value (see [E22] and [E23])		
Monitored items	outA	displays frequency converter output current		
forec	outV	displays output command voltage if PI control is disabled;		
Aoni	Outv	displays feedback value if PI control is enabled.		
	dCV	displays DC bus voltage		
	inPt	displays input signals <sup>①</sup>		
	t ℃	displays the temperature of power module and radiator		

Fig.7-75: Monitoring parameters

## <sup>10</sup> Input signal:

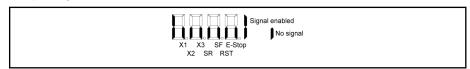


Fig.7-76: Input signal



- [b00], [b34], [b35], [b45], [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 use a terminal which has been defined with a function, the previously defined function has to be deactivated before the new function definition of this terminal.

**Fault Indication** 

# 8 Fault Indication

# 8.1 Fault Types

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

Fault code	Fault name	Possible reason	Solution
	Over current at constant	Excessively reduced acceleration/ deceleration time	Increase acceleration/ deceleration time
O.C1		Load short circuit or sudden changes in load	Check the load
	speed	Low grid voltage	Check input power supply
		A special motor or a motor larger than the maximum allowable capacity	Use a frequency converter with suitable power
		Too short acceleration time	Increase acceleration time
O.C2	Over current during accel-	Improper V/F curve	Enable automatic torque increasing or manually adjust V/F curve settings
	eration	The frequency converter power is too low	Select a frequency converter with higher power
		Too short deceleration time	Increase deceleration time
O.C3	Over current during decel- eration	Large load inertia torque or potential load	Add an appropriate dynamic brake chopper
		The frequency converter power is too low	Select a frequency 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
O.E1		Excessively reduced acceleration/ deceleration time	Increase acceleration/ deceleration time
		Abnormality in load	Check the load
O.E2	Over voltage during	Abnormality in input voltage of power supply	Check input power supply
	acceleration	Abnormality in load	Check the load
O.E3	Over voltage during deceleration	Too large moment of inertia of load	Increase the deceleration time to suit the load inertia, or purchase a dynamic brake chopper
	Motor overload	Too large load, too short acceleration/ deceleration time or cycle	Adjust the load, acceleration/ deceleration time or cycle; or increase the frequency converter capacity
O.L.		Improper V/F characteristic curve settings	Adjust V/F curve settings
		Improper setting of electronic thermal relay	Correctly set the parameters of electronic thermal relay

## Fault Indication

Fault code	Fault name	Possible reason	Solution
	frequency converter overheat	Fan failure	Check if fan works normally
O.H.		Too high ambient temperature	Lower the ambient temperature
		Ventilation outlet obstructed	Clear dust and foreign matters at ventilation outlet
d.r.	Drive protection	Damaged power component	Replace power component and seek technical support
u.i.		Incorrect operation of drive circuit protection	Remove interference and seek technical support
CPU-	EMI	CPU incorrect operation due to external interference	Remove nearby interference or other EMI
IPH.L	Phase loss at input side	Phase loss of the frequency converter's 3-phase input power supply	Check 3-phase input power supply or seek technical support
oPH.L	Phase loss at output side	Open wire or phase loss of frequency converter's 3-phase output power supply (severe asymmetry of the 3-phase's loads)	Check frequency converter's 3-phase wiring (or symmetry of loads)
		Abnormal power supply voltage	Check input power supply
	Motor fails to start	External wiring between control terminal SF or SR is disconnected	Check external wiring between control terminal SF or SR
		Improper parameter setting	Check parameter setting
	Motor cannot	The highest frequency is too low	Check the highest frequency
	run at different speeds	Improper frequency setting mode	Confirm frequency setting mode
	Motor stalls	Too short acceleration time	Increase acceleration time
	during acceleration	Too large inertia of motor and load	Adjust acceleration time
		Improper V/F curve	Adjust V/F curve settings
O.T.	Motor over heat	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 the load
CPUE	ЕМІ	CPU incorrect operation due to internal interference or damage	Remove nearby interference or other EMI

Fig.8-1: Fault types and solutions

**Fault Indication** 

# 8.2 List of Fault Protection Actions

Fault name	Description
Main circuit under voltage (P.oFF)	This fault code will be displayed when the main circuit voltage is less than 80% of the rated value.
Main circuit over current (O.C1, O.C2, O.C3)	This fault 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.E1, O.E2, O.E3)	This fault 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 fault code will be displayed when the set load exceeds the specified characteristic of the output. The frequency converter will then stop according to the inverse time lag characteristics curve. The characteristic of the output can be set according to the motor type.
frequency converter over heat (O.H.)	This fault code will be displayed when the radiator temperature is about 85°C. The frequency converter will then stop.
Drive protection (d.r.)	This fault code will be displayed when there is a bridge fault in the main circuit. The frequency converter will then stop. Some models of the frequency converter don't bear this function.
EMI (CPU-)	This fault 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 frequency converter immediately stops output and stops running in case of input/output phase loss protection of the frequency 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 (ESt)	This fault code will be displayed when the input terminal E-Stop is connected and [E33]=0 and [E34]=1. The frequency converter will then stop.
Motor overheat (O.T.)	The frequency converter stops outputs when the motor temperature increase exceeds the set protection value.
EMI (CPUE)	This fault 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.

Fig.8-2: Fault protection actions

# 9 Technical Data

# 9.1 Fe General Technical Data

Input	Power supply voltage	3 AC 380 to 480 V (-15 %/ +10 %)		
	Supply frequency	50 to 60 Hz (±5 %)		
	Short circuit current rating (UL) (SCCR) (480 V Maximum)	5000 A <sub>rms</sub>		
Output	Rated motor output power	0.75 to 160 kW		
	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		
	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)		
		Digital: 0.01 Hz		
	Frequency resolution	Analog: Maximum frequency x 0.1 % (VRC channel can reach maximum frequency x 0.05 %)		
	V/F curve	Freely definable		
ဋ	Ramps	Linear, S-curve		
Functions	DC braking	Start frequency: 0 to 60 Hz		
Fun	DO Braking	Braking time: 0.1 to 10s		
	Multi-speed control	Via integrated logic or control terminals		
	Status messages via multi-function output signal	Outputs of <b>Run</b> , frequency level detection signal, frequency arrival signal, faults, etc.		
	Automatic energy saving function	Load-dependent adaptation of V/F characteristic curve		
	Automatic voltage regulation (AVR)	Excessively high supply voltage is automatically reduced to rated motor voltage		
	Fast current restriction	Fast current restriction during running to prevent trip due to frequent over current		
	Automatic PWM frequency adaptation	Load-dependent adaptation of PWM frequency		
Customized functions	Running command channel	Set 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, frequency converter overheat protection, overload protection, motor overheat protection			
Optional parts	Braking resistor, operating panel for control cabinet, communication cable for control cabinet, bus adapter			
	Location	Indoor use, without corrosive gas, liquid or dust		
+	Power reduction / Max. installation height	Up to 1000 m above sea level: none; 10004000 m above sea level: 1 % 100 m		
men	Ambient temperature	-10 °C to 40 °C (Derating between 40 °C and 50 °C)		
Environment	Relative humidity	< 90 % RH (without condensation)		
Ë	Allowed pollution degree	2 (EN 50178)		
	Shocking	< 5 .9 m / s <sup>2</sup> (0.6 g)		
	Degrees of protection	IP20 (control cabinet mounting)		

Fig.9-1: General technical data

# 9.2 Derating of Electrical Data

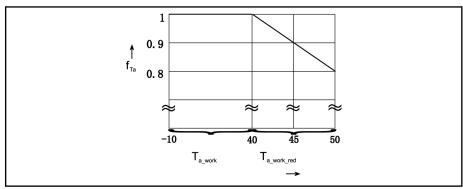
# 9.2.1 Derating and Ambient Temperature

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

- continuous power output
- continuous current output

Uses outside of the indicated installation conditions are 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.



f<sub>Ta</sub> 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

Fig.9-2: Derating and ambient temperature (°C)

## 9.2.2 Derating and Mains Voltage

## Reduced over current 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 pay attention to the following:

- U<sub>mains</sub><U<sub>rated</sub>: With mains voltages below the rated voltage, no higher currents may be withdrawn to ensure that the dissipated power remains current.
- U<sub>mains</sub>>U<sub>rated</sub>: 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.

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

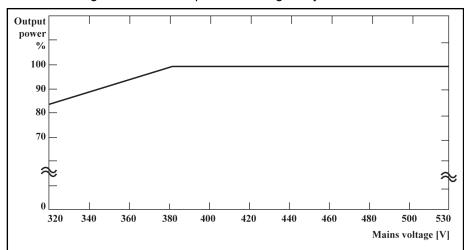
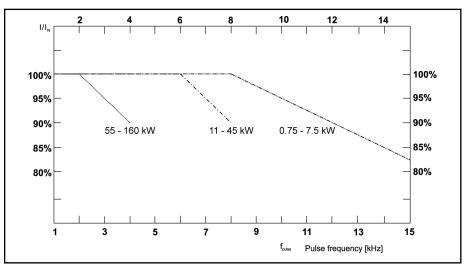


Fig.9-3: Derating and mains voltage

## 9.2.3 Derating and Output Current

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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.



permissible over current rated current

Fig.9-4: Derating and output current



- For converters of 0.75 to 7.5 kW, the current reduction starts at 8 kHz with 1 kHz as minimum unit.
- For converters of 11 to 45 kW, the current reduction starts at 6 kHz with 1 kHz as minimum unit.
- For converters of 55 to 160 kW, the current reduction starts at 2 kHz with 1 kHz as minimum unit.

# 9.3 Electrical Data (400 V Series)

Fe Model	Power [kW]	Rated input current [A]	Apparent power [kVA]	Rated output current [A]	Weight [kg]
FECG02.1-0K75-3P400-A-SP-MODB-01V01	0.75	3.4	1.5	2.5	3.0
FECG02.1-1K50-3P400-A-SP-MODB-01V01	1.5	6	2.4	4.0	3.0
FECG02.1-2K20-3P400-A-SP-MODB-01V01	2.2	8	3.2	5.5	3.2
FECG02.1-4K00-3P400-A-SP-MODB-01V01	4.0	13	6	10	3.2
FECx02.1-5K50-3P400-A-SP-MODB-01V01	5.5	17	8	13	3.5
FECx02.1-7K50-3P400-A-SP-MODB-01V01	7.5	21	10	17	3.5
FECx02.1-11K0-3P400-A-SP-MODB-01V01	11	30	15	24	10.7
FECx02.1-15K0-3P400-A-SP-MODB-01V01	15	42	21	33	10.9
FECx02.1-18K5-3P400-A-SP-MODB-01V01	18.5	43	25	39	16.2
FECx02.1-22K0-3P400-A-SP-MODB-01V01	22	51	30	44	16.9
FECx02.1-30K0-3P400-A-SP-MODB-01V01	30	68	40	60	21.5
FECx02.1-37K0-3P400-A-SP-MODB-01V01	37	83	50	75	22.0
FECx02.1-45K0-3P400-A-SP-MODB-01V01	45	101	62	95	33.2
FECx02.1-55K0-3P400-A-SP-MODB-01V01	55	117	75	110	33.8
FECx02.1-75K0-3P400-A-SP-MODB-01V01	75	157	100	152	50.9
FECx02.1-90K0-3P400-A-SP-MODB-01V01	90	187	120	183	52.5
FECx02.1-110K-3P400-A-SP-MODB-01V01	110	226	145	223	96.5
FECx02.1-132K-3P400-A-SP-MODB-01V01	132	280	175	265	100
FECx02.1-160K-3P400-A-SP-MODB-01V01	160	338	210	325	102

Fig.9-5: Fe electrical data



- 1. x is a substitute for G or P series.
- 2. The above table is also applicable to C001 models.
- 3. The data is based on the supply voltage of AC 3 × 380 V.
- 4. The exact value of frequency converter leakage current depends on design, ambient conditions, motor power and power cable length. A breaker with tripping current of 30 mA cannot ensure no-trip running. A B-type breaker is recommended to ensure normal running based on chapter 6.3.6.7 and ANNEX G of EN 61800-5-1. Fe leakage current is as below.
  - Standard models (0.75 to 160 kW): >10 mA
  - C001 models (0.75 to 7.5 kW): 3.7 to 5.2 mA
  - C001 models (11 to 160 kW): >10 mA

# 9.4 Electromagnetic Compatibility (EMC)

# 9.4.1 EMC Requirements

## **General information**

## The electromagnetic compatibility (EMC) 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.

## 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.

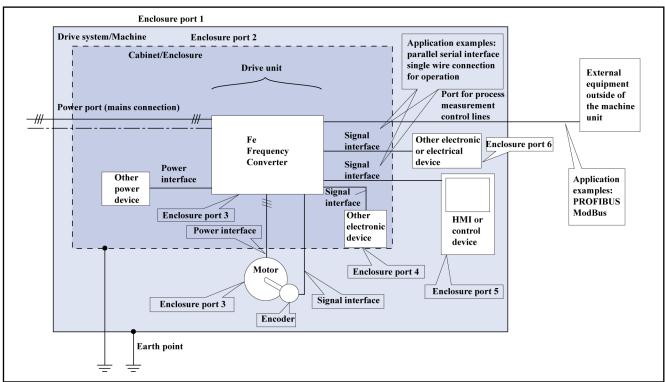


Fig.9-6: Noise immunity in the drive system

## Noise immunity limit values

Place of effect	Phenomenon	Standard	Conditions	Coupling	Test values according to standard EN 61800-3	Performance level
	ESD	IEC 61000-4-2		CD, AD	4 kV CD, 8 kV AD	В
Enclosure port	RF field	IEC 61000-4-3		Via antenna on EUT	10 V/m, 80 – 1000 MHz 3 V/m, 1400 – 2000 MHz 1 V/m, 2000 – 2700 MHz	А
	Burst	IEC 61000-4-4		mains connection I < 100 A: CDN; I ≥ 100 A: clamp or CN	2 kV / 5 kHz (CN or CDN) 4 kV / 2.5 kHz (clamp)	В
Power port	Surge	IEC 61000-4-5	only mains connection; I < 63 A, light load test		line-line 1 kV line-line 2 kV	В
	RF field	IEC 61000-4-6	length > 3 m	clamp	10 V, 0.15 – 80 MHz	А
Power interface	Burst	IEC 61000-4-4	length > 3 m	clamp	2 kV / 5 kHz	В
Cinnal interfere	Burst	IEC 61000-4-4	length > 3 m	clamp	1 kV / 5 kHz	В
Signal interface	RF field	IEC 61000-4-6	length > 3 m	clamp or CDN	10 V, 0.15 – 80 MHz	А
Ports of process;	Burst	IEC 61000-4-4	length > 3 m	clamp	2 kV / 5 kHz	В
measurement control lines	RF field	IEC 61000-4-6	length > 3 m	clamp or CDN	10 V, 0.15 – 80 MHz	А

CD contact discharge AD air discharge

CDN coupling and decoupling network

CN coupling network

Fig.9-7: Noise immunity limit values

## **Evaluation criterion**

Evaluation criterion	Explanation (abbreviated form from EN 61800-3)
Α	Deviations within allowed range
В	Automatic recovery after interference
С	Switched off without automatic recovery. Device remains undamaged.

Fig.9-8: Evaluation criterion and description

## 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 steeper voltage rises, the higher clock rate and the resulting harmonics cause unwanted but 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

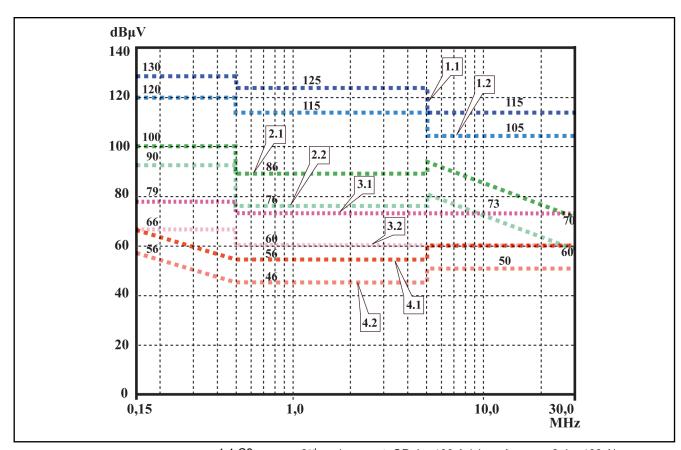
If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

#### 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 / EN 61800-3 CISPR 11		Explanation	In this documentation	Curves of limit value characteristic
Category C4  2 <sup>nd</sup> 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  2 <sup>nd</sup> environment	Class A; group 2 I >100A	Limit value in industrial areas must be complied with for applications operated at supply mains with nominal currents > 100 A.	A2.1	1.1 1.2
Category C3  2 <sup>nd</sup> environment	Class A; group 2 I ≤100A	Limit value in industrial areas must be complied with for applications operated at supply mains with nominal currents ≤ 100 A.	A2.2	2.1 2.2
Category C2  1st environment	Class A; group 1	Limit value in residential areas or at facilities with low-voltage mains supplying buildings in residential areas must be complied with.	A1	3.1 3.2
Category C1  1st environment	Class B; group 1	Limit value in residential areas must be complied with.	B1	4.1 4.2

Fig.9-9: Limit values



1.1 C3	2 <sup>nd</sup> environment, QP, I > 100 A (class A, group 2, I > 100 A)
1.2 C3	2 <sup>nd</sup> environment, AV, I > 100 A (class A, group 2, I > 100 A)
2.1 C3	2 <sup>nd</sup> environment, QP, I ≤ 100 A (class A, group 2, I ≤ 100 A)
2.2 C3	2 <sup>nd</sup> environment, AV, I ≤ 100 A (class A, group 2, I ≤ 100 A)
3.1 C2	1 <sup>st</sup> environment, QP (1 <sup>st</sup> environment, even if source of interference in 2 <sup>nd</sup> environment) (class A, group 1)
3.2 C2	1 <sup>st</sup> environment, AV (1 <sup>st</sup> environment, even if source of interference in 2 <sup>nd</sup> environment) (class A, group 1)
4.1 C1	1 <sup>st</sup> environment, QP (1 <sup>st</sup> environment, even if source of interference in 2 <sup>nd</sup> environment) (class B, group 1)
4.2 C1	1 <sup>st</sup> environment, AV (1 <sup>st</sup> environment, even if source of interference in 2 <sup>nd</sup> environment) (class B, group 1)
Fig.9-10:	Limit values for line-based disturbances (IEC 61800-3); limit characteristic through frequency range



- Limit value for 1<sup>st</sup> environment is also relevant, if source of interference of 2<sup>nd</sup> environment affects 1<sup>st</sup> environment.
- Designations for "class" and "group" are according to CISPR
   11
- QP: measuring method for quasi peak measurement.
- AV: measuring method for 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

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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 no measures for radio interference suppression are taken. Therefore, the indicated measures are generally recommended.

#### **Nominal Current of Supply Mains**

The nominal current of the supply mains (> 100 A or  $\leq$  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.

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.



According to IEC 61800-3, components of the Rexroth Fe drive system are products of category **C3** (with external filter). 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 may happen. In this case, additional measures of radio interference suppression are required.

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.

## 9.4.2 Ensuring the EMC Requirements

### Standards and Laws

On the European level there are 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 2004/108/EC which was transformed on the national level in Germany into the law EMVG ("Law concerning electromagnetic compatibility of devices") of 2008-02-26.

### **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 2004/108/EC 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 category C3 requirements according to product standard EN 61800-3 have been complied with.

#### 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
- 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, Rexroth drive systems are complied with the product standard EN 61800-3 C3. 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 recent years, some new product standards have been created, and some are also under creation. 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 also specifies the conditions under which the indicated EMC properties can be achieved.

## 9.4.3 EMC Measures for Design and Installation

## 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 also 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

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

- Contactors
- Relays
- Solenoid valves
- Electromechanical operating hours counters

These combinations must be connected at each coil directly.

**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 can't be interrupted, e.g. using intermediate terminals.

**Digital Signal Lines** 

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

**Analog Signal Lines** 

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

Connection of Mains Choke and Drive Controller

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.
- It is recommended to 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.

## 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 figure below.

**Technical Data** 



- For EMC-optimal installation in the control cabinet, use a separate control cabinet panel for the drive components.
- Converters need to be mounted in metal cabinet and connected to power supply with grounding.
- For the end application system with converters, the conformity of EMC directions needs to be confirmed.

### Division into areas (zones)

Exemplary arrangements in the control cabinet: See chapter "Control cabinet mounting according to interference areas – exemplary arrangements" on page 170

We distinguish three areas:

Interference-free area of control cabinet (area A):

This includes:

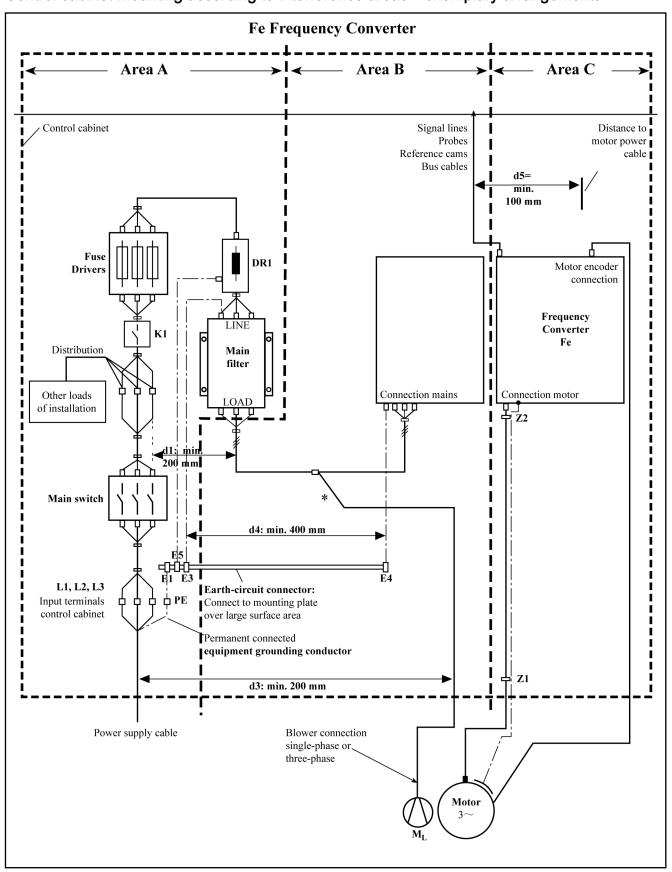
- Supply feeder, input terminals, fuse, main switch, mains side of mains filter for drives and corresponding connecting lines;
- Control voltage or auxiliary voltage connection with power supply unit, fuse and other parts unless connection is run via the mains filter of the AC drives;
- All components 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 mm² or, even better, via grounding straps with the same cross section. Make sure connection points have good contact.

## Control cabinet mounting according to interference areas – exemplary arrangements



E1...E5 Equipment grounding conductor or the components

K1 External mains contactor

M<sub>L</sub> Motor blower

Z1, Z2 Shield connection points for cables

Fig.9-11: Control cabinet mounting according to interference areas – exemplary

arrangements

## 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 Interferencefree 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:

- Install lines in shielded form and connect the shield at several points (at least at the beginning and 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.

A filter must be connected between the mains supply lines and the mains in areas B and C.



In case the information on cable routing given in this section is not observed, 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 MHz 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 areas B and C, 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 threephase filter of the drive system.

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

#### **Technical Data**

# Loads at Mains Filter of Drive Sys-

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

#### Shielding Mains Supply Lines in **Control Cabinet**

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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 cables longer 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 power supply voltage is higher than 480 V, connect the filter to the output side of the transformer instead of the input side of the transformer.

If the mains voltage is higher than 480 V, connect the filter to the output side of the transformer instead of the input side of the power supply side.

#### Grounding

To avoid bad ground connections during 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

Please see "Division into areas (zones)" on page 169.

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<sup>2</sup> or to be complemented by a second equipment grounding conductor via separate terminal connectors (according to EN 61800-5-1: 2007, section 4.3.5.4). 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 "Division into areas (zones)" on page 169.

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.

**Technical Data** 

#### 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 Ca-

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.

Route 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 (alternatively 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.

#### **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. Contact over a large surface area can be achieved 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**.

#### **Technical Data**

# Ground Wires and Shield Connec-

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

## Installing signal lines and signal cables

**Bosch Rexroth AG** 

#### 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 "Division into areas (zones)" on page 169) 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<sup>2</sup>.

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

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

## 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.

**Technical Data** 

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.

Accessories

# 10 Accessories

# 10.1 EMC Filter

## 10.1.1 The Function of EMC Filter

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

## 10.1.2 EMC Filter Type

Fraguency Convertor Typecode	EMC Filter Typecode
Frequency Converter Typecode	EMC Filter Typecode
FECG02.1-0K75-3P400-A-SP-MODB-01V01	
FECG02.1-1K50-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0008-A-480-NNNN
FECG02.1-2K20-3P400-A-SP-MODB-01V01	
FECG02.1-4K00-3P400-A-SP-MODB-01V01	
FECx02.1-5K50-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0022-A-480-NNNN
FECx02.1-7K50-3P400-A-SP-MODB-01V01	
FECx02.1-11K0-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0030-A-480-NNNN
FECx02.1-15K0-3P400-A-SP-MODB-01V01	
FECx02.1-18K5-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0051-A-480-NNNN
FECx02.1-22K0-3P400-A-SP-MODB-01V01	
FECx02.1-30K0-3P400-A-SP-MODB-01V01	FFNF04 4A A075 F0000 A 490 NNNN
FECx02.1-37K0-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0090-A-480-NNNN
FECx02.1-45K0-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0120-A-480-NNNN
FECx02.1-55K0-3P400-A-SP-MODB-01V01	FENFUT.TA-AU75-EUT2U-A-48U-NINININ
FECx02.1-75K0-3P400-A-SP-MODB-01V01	
FECx02.1-90K0-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0250-A-480-NNNN
FECx02.1-110K-3P400-A-SP-MODB-01V01	
FECx02.1-132K-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0320-A-480-NNNN
FECx02.1-160K-3P400-A-SP-MODB-01V01	FENF01.1A-A075-E0400-A-480-NNNN

Fig. 10-1: EMC filter type

- x is a substitute for G or P series.
- The EMC filters listed above are recommended based on tests with 10 m motor cables. If longe motor cables are needed, please use appropriate EMC filters.
- The above table is also applicable to C001 models.

#### Accessories

#### 10.1.3 **Technical Data**

## Mechanical data

## **Figure**

## B

## Mounting position and distances

Only the mounting position G1 is allowed for EMC filter FENF.

Keep at least 80 mm at the top side and bottom side of EMC filter free from mounted parts.

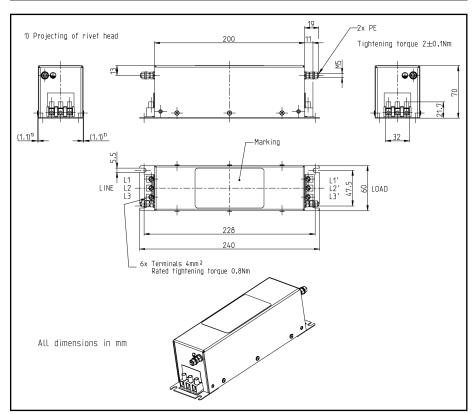


Fig.10-2: FENF01.1A-A075-E0008-A-480-NNNN

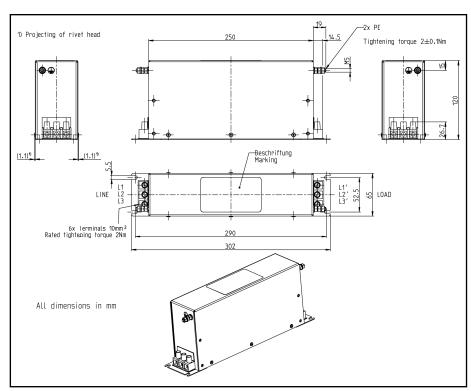


Fig. 10-3: FENF01.1A-A075-E0022-A-480-NNNN and FENF01.1A-A075-E0030-A-480-NNNN

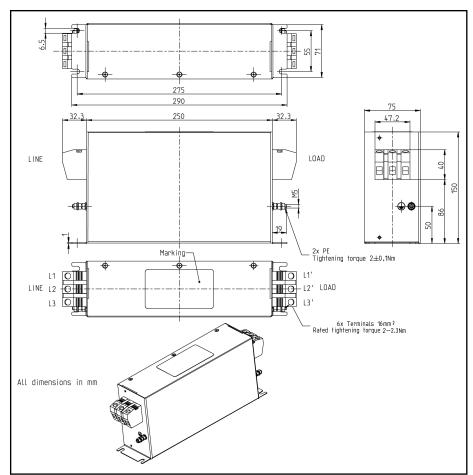


Fig. 10-4: FENF01.1A-A075-E0051-A-480-NNNN

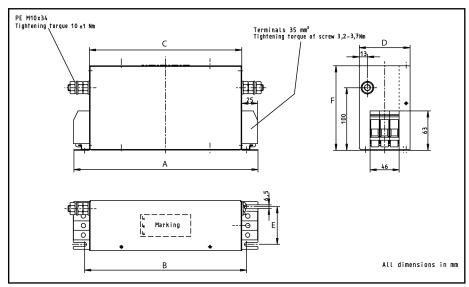


Fig. 10-5: FENF01.1A-A075-E0090-A-480-NNNN

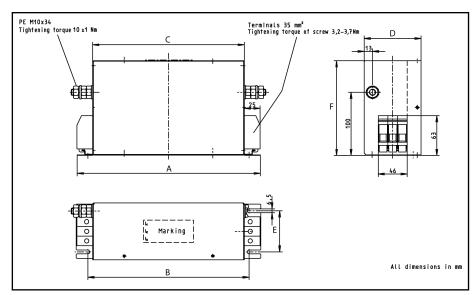


Fig. 10-6: FENF01.1A-A075-E0120-A-480-NNNN

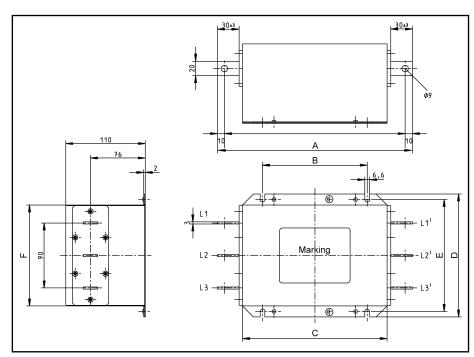


Fig. 10-7: FENF01.1A-A075-E0250-A-480-NNNN

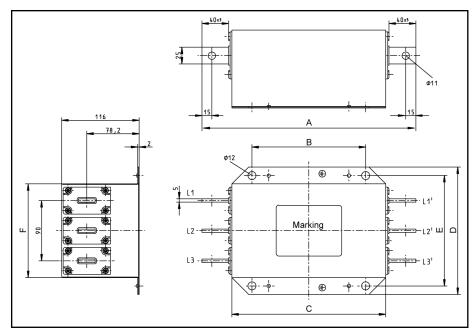


Fig. 10-8: FENF01.1A-A075-E0320-A-480-NNNN and FENF01.1A-A075-E0400-A-480-NNNN

## **Dimensions**

EMC filter	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	PE size	PE tightening torque [Nm]	Terminal wire size [mm²]	Terminal tightening torque [Nm]
FENF01.1A-A075- E0008-A-480-NNNN	240	228	200	60	47.5	70	M5	2	4	0.8
FENF01.1A-A075- E0022-A-480-NNNN	302	290	250	65	52.5	120	M5	2	10	2
FENF01.1A-A075- E0030-A-480-NNNN	302	290	230	03	32.3	120	IVIO	2	10	2
FENF01.1A-A075- E0051-A-480-NNNN	314.6	275	250	75	55	150	M5	2	16	2 – 2.3
FENF01.1A-A075- E0090-A-480-NNNN	290	255	240	80	60	135	M10	10	35	3.2 – 3.7
FENF01.1A-A075- E0120-A-480-NNNN	290	255	240	90	65	150	M10	10	35	3.2 – 3.7
FENF01.1A-A075- E0250-A-480-NNNN	250	145	200	170	155	110	Ø6.6	6 – 9	Ø9	6 – 9
FENF01.1A-A075- E0320-A-480-NNNN	290	170	230	190	165	110	Ø12	15 – 20	Ø11	15 – 20
FENF01.1A-A075- E0400-A-480-NNNN	290	170	230	190	103	110	W12	13 – 20	ווש	13 – 20

Fig. 10-9: Dimensions

## **Electrical data**

## B

## Using EMC filters in mains grounded via outer conductor

When using EMC filters in **mains grounded via outer conductor**, use an isolating transformer between mains and EMC filter.

Description	Symbol	Unit	FENF01.1A-A075- E0008-A-480-NNNN	FENF01.1A-A075- E0022-A-480-NNNN	FENF01.1A-A075- E0030-A-480-NNNN	FENF01.1A-A075- E0051-A-480-NNNN	FENF01.1A-A075- E0090-A-480-NNNN	FENF01.1A-A075- E0120-A-480-NNNN	FENF01.1A-A075- E0250-A-480-NNNN	FENF01.1A-A075- E0320-A-480-NNNN	FENF01.1A-A075- E0400-A-480-NNNN	
Degree of protection							IP20					
according to IEC60529							20					
Listing according to UL standard (UL)						ı	JL 1283	3				
Listing according to CSA standard (UL)						C2	22.2 No	. 8				
Mass (weight)	m	kg	1.4	3.0	3.3	4.4	4.2	4.9	5.0	7.2	7.5	
Mains voltage three-phase at TNS, TN-C, TT mains	$U_{LN}$	V				3	380480					
Mains voltage three-phase at Corner- grounded-Delta mains	U <sub>LN</sub>	V				No	ot allow	ed				
Mains voltage three-phase at IT mains	U <sub>LN</sub>	V		Not allowed								
Tolerance U <sub>LN</sub> ( UL )		%				+10	0 %15 %					
Input frequency (UL)	$f_{LN}$	Hz					5060					
Nominal current	I <sub>L_cont</sub>	Α	8	22	30	51	90	120	250	320	400	
Calculation of leakage current	I <sub>leak</sub>	mA	27	19	27	67	18	18	<21	<21	<21	
DC resistance typical value	$R_{typ}$		15 mΩ	8 mD	4 mΩ	2.8 mΩ	1.1 mΩ	Ωm 6.0	Ωп 011	51 μΩ	48 μΩ	
Required wire size according to IEC 60364-5-52; at I <sub>L_cont</sub>	$A_{LN}$	mm <sup>2</sup>	4	10	10	16	35	35	120 /2×70	150 /2×70	240	
Required wire size according to UL 508 A (internal wiring); at I <sub>L_cont</sub> ( UL )	A <sub>LN</sub>	AWG	10	8	6	6 (2)	1	3/0	3/0 (2)	3/0 (2)	4/0 (2)	

Fig. 10-10: Electrical data

# 10.2 Brake Components

# 10.2.1 Brake Chopper

## The function of brake chopper

A brake chopper 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 over voltage trips.

## Internal brake chopper

Frequency Converter Fe 0.75 to 15 kW have internal brake choppers. Only external braking resistors are needed to activate the braking function. The working principle of the internal brake chopper is shown as below:

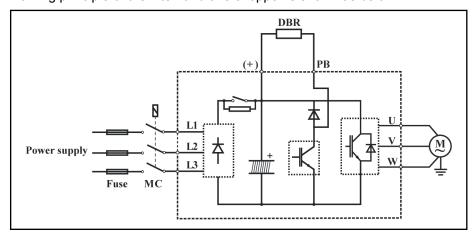


Fig. 10-11: Internal brake chopper

# External brake chopper (Fe 18.5 kW and above models)

# **Technical specifications**

Applicable voltage	class	AC power supply 380 V -	15 %480 V + 10 %; 50	/ 60 Hz ± 5 %					
Brake chopper mo	odel-FELB	FELB02.1N-30K0	FELB02.1N-30K0 FELB02.1N-45K0						
	Peak current [A]	50	50 75 300						
	Rated current [A]	15	25	85					
Input and output	Braking start-up voltage	630 / 660 / 690 / 730 / 760	) V ± 16 V						
specifications	Maximum hysteresis	About 16 V							
	Synchronous signal	Coupled input, coupled output, up to 3 brake choppers at most can be set to operate in parallel							
Power supply	DC BUS voltage range	DC 460 – 800 V							
Drotoction	Overheat of heat sink	It is active when the temperature exceeds +85 °C							
Protection	Failure output	RELAY junction 0.6 A 125 VAC / 2 A 30 VDC (T1, T2)							
Indication	Power ON	When voltage (more than in the red "POWER" indica	•	nains lead terminal flows					
functions	Braking ON	When brake chopper works, the green "BRAKING" indicator lights on							

Fig. 10-12: Technical specifications

# Dimensions and weight

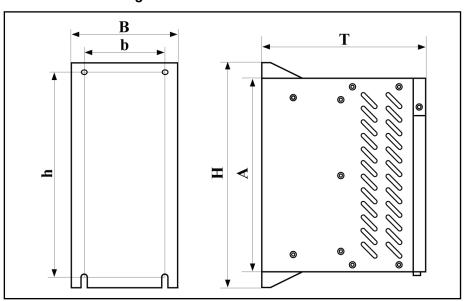


Fig. 10-13: Dimensions diagram

Brake chopper typecode			Net weight				
brake Gropper typecode		Н	Т	b	h	Α	[kg]
FELB02.1N-30K0-NNONE-A-560-NNNN	103	215	158	78	200	185	2.5
FELB02.1N-45K0-NNONE-A-560-NNNN	103	213	130	70	200	103	2.5
FELB02.1N-220K-NNONE-A-560-NNNN	254	409	203	190	270	380	11.2

Fig. 10-14: Brake chopper dimensions and weight

## Brake chopper terminals

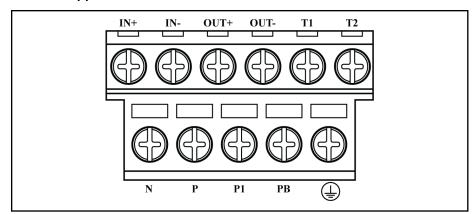


Fig. 10-15: Brake chopper terminals

### Wiring on each terminal of brake choppers

Name of terminal	Sign of terminal	Line width [AWG]	Screw specification	Torque
Input power supply	put power supply N, P 30K			
Braking resistor	P1, PB	220K: 3		
Multiple unite in line	input: IN+, IN-			18 kgf - cm
Multiple units in line	output: OUT+, OUT-	18 – 20	M4	(15.6 in - ibf)
Failure output	T1, T2			
Grounding	unding			

Fig. 10-16: Wiring on each terminal of brake choppers

### Basic wiring diagram

To avoid brake chopper damage or break down in case of overload or fault conditions, please refer to the following wiring diagram. The brake chopper 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.

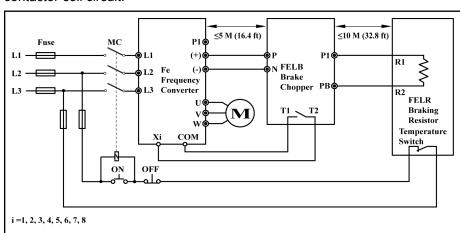


Fig. 10-17: Basic wiring diagram



- Do not connect brake chopper input terminal -(N) to the neutral point of the power supply.
- Confirm the polarities of the brake chopper input terminals +
   (P) and -(N), otherwise the brake chopper will break down
   immediately at the startup phase of the braking process.
- The wiring distance between the brake chopper and the frequency converter should be not more than 5 M (16.4 ft). The wiring distance between brake chopper and braking resistor should be not more than 10 M (32.8 ft).

### **WARNING**

The braking resistor connector connection at the frequency converter (terminals (+) and PB at converters from 0.75 – 7.5 kW) and the braking resistor connection at the brake chopper (terminals P1 and PB) have no short circuit protection! Wrong wiring will cause damage to the components!

Please ensure the reliable grounding of the brake chopper.

### The settings of the brake chopper

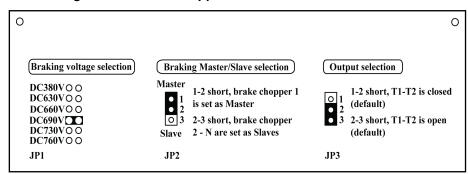


Fig. 10-18: Brake chopper settings

### Selection of braking voltage

The 400 V class brake chopper has 5 operating voltages (630 V, 660 V, 690 V, 730 V, 760 V), and power supply of the brake chopper is from +(P), -(N) of the frequency converter. This setting will influence the level of the operating voltage of the brake chopper, 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 input voltage of the power supply to the frequency converter [V]	380	400	415	440
Braking startup voltage [V]	660	690	730	760

Fig. 10-19: Recommended startup braking voltage

### Master/Slave setting

The brake chopper sets JP2 on "MASTER" as factory setting. The master brake chopper will select "MASTER" and the slave unit will select "SLAVE" when two or more brake choppers are applied in parallel.

### Fault output selection

The temperature failure output of the brake chopper is T1 - T2; operating temperature is +85 °C. T1 - T2 is set normally open as factory default; if normally closed is required, please set JP3, and short circuit 1 – 2.

As the chart below shows, when multiple units are applied in parallel, the first brake chopper should be set as "MASTER"; all others should be set as "SLAVE".

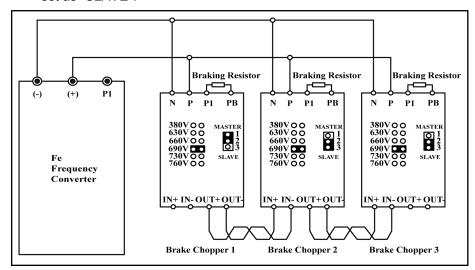


Fig. 10-20: Brake chopper wiring

### Definition for braking ratio OT %

As shown in the diagram below, braking ratio OT % is the ratio of the braking time and the braking period, usually represented by percentage. When OT % is selected, the resistance and the power of braking resistor must be taken into consideration so that enough time can be ensured for the brake chopper and the braking resistor to release the heat generated in the braking process.

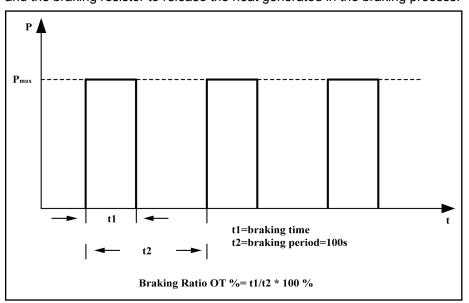


Fig. 10-21: Braking ratio

Rexroth Frequency Converter Fe

Accessories

## Fault analysis and countermeasures

When there is abnormality with the brake chopper, the thermal protection of the brake chopper will be activated. A failure signal will be sent by the brake chopper to the frequency converter. The abnormality of the brake chopper may result in the failure and warning of the frequency. 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 brake chopper off	Wrong connection	Check if "MASTER" is selected and check wire connection
		Breakdown of brake chopper IGBT	Replace brake chopper
2	The "BRAKING" light of brake chopper on	Open circuit with braking resistor	Check braking resistor and its wirings
		Wrongly connected wires	Check wires
3	"Overvoltage" warning of frequency converter	Inadequate capacity of braking resistor and brake chopper	Check design and recalculate
		Inappropriate brake chopper voltage selection	Set again
	Thermal protection device of brake chop-	High braking ratio	Check design and recalculate
4	per acts caused by overheated radiator	Environmental temperature > 40 °C	Reduce environmental temperature with cooling fans

Fig. 10-22: Fault analysis and countermeasures

### 10.2.2 Brake Resistor

### **Brief introduction**

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. 660 VDC) to the braking resistor, and the energy is lost as heat.



- 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.
- Safety and flammability of surrounding conditions shall be considered. Keep all items at least 10 cm away from the braking resistor.
- A braking resistor can not work overload for a long time. 10 times of rated load should not exceed 5 seconds.
- There could be smoking for the first use of the braking resistor since organic silicon is used on the surface which is normal and does not affect the performance of the braking resistor.

### Brake resistor selection

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

$$OT = \frac{Tb}{Tc} * 100\%$$

OT Braking ratio
Tb Braking time
Tc Cycle time
Fig. 10-23: Braking ratio

Motor		Brake chop	per	Brake	resistors	
power [kW]	Fe typecode	Typecode	Quantity	Typecode	Туре	Quantity
0.75	FECG02.1-0K75-3P400	Internal	-	FELR01.1N-0080- N750R-D-560-NNNN	750 Ω/80 W	1
1.5	FECG02.1-1K50-3P400	Internal	-	FELR01.1N-0260- N400R-D-560-NNNN	400 Ω/260 W	1
2.2	FECG02.1-2K20-3P400	Internal	-	FELR01.1N-0260- N250R-D-560-NNNN	250 Ω/260 W	1
4.0	FECG02.1-4K00-3P400	Internal	-	FELR01.1N-0390- N150R-D-560-NNNN	150 Ω/390 W	1
5.5	FECx02.1-5K50-3P400	Internal	-	FELR01.1N-0520- N100R-D-560-NNNN	100 Ω/520 W	1
7.5	FECx02.1-7K50-3P400	Internal	-	FELR01.1N-0780- N075R-D-560-NNNN	75 Ω/780 W	1
11	FECx02.1-11K0-3P400	Internal	-	FELR01.1N-1K04- N050R-D-560-NNNN	50 Ω/1040 W	1
15	FECx02.1-15K0-3P400	Internal	-	FELR01.1N-1K56- N040R-D-560-NNNN	40 Ω/1560 W	1
18.5	FECx02.1-18K5-3P400	FELB02.1N-30K0	1	FELR01.1N-0K48- N032R-A-560-NNNN	32 Ω/4.8 kW	1
22	FECx02.1-22K0-3P400	FELB02.1N-30K0	1	FELR01.1N-0K48- N27R2-A-560-NNNN	27.2 Ω/4.8 kW	1
30	FECx02.1-30K0-3P400	FELB02.1N-30K0	1	FELR01.1N-06K0- N020R-A-560-NNNN	20 Ω/6.0 kW	1
37	FECx02.1-37K0-3P400	FELB02.1N-45K0	1	FELR01.1N-09K6- N016R-A-560-NNNN	16 Ω/9.6 kW	1
45	FECx02.1-45K0-3P400	FELB02.1N-45K0	1	FELR01.1N-09K6- N13R6-A-560-NNNN	13.6 Ω/9.6 kW	1
55	FECx02.1-55K0-3P400	FELB02.1N-30K0	2	FELR01.1N-06K0- N020R-A-560-NNNN	20 Ω/6.0 kW	2
75	FECx02.1-75K0-3P400	FELB02.1N-45K0	2	FELR01.1N-09K6- N13R6-A-560-NNNN	13.6 Ω/9.6 kW	2
90	FECx02.1-90K0-3P400	FELB02.1N-45K0	3	FELR01.1N-06K0- N020R-A-560-NNNN	20 Ω/6.0 kW	3
110	FECx02.1-110K0-3P400	FELB02.1N-45K0	3	FELR01.1N-06K0- N020R-A-560-NNNN	20 Ω/6.0 kW	3
132	FECx02.1-132K-3P400	FELB02.1N-45K0	3	FELR01.1N-09K6- N13R6-A-560-NNNN	13.6 Ω/9.6 kW	3
160	FECx02.1-160K-3P400	FELB02.1N-220K	1	FELR01.1N-40K0- N03R4-A-560-NNNN	3.4 Ω/40.0 kW	1
	1	i .	·	l	1	

Fig. 10-24: Selection reference of OT=10 %



- x is a substitute for G or P series.
- The above table is also applicable to C001 models.

Motor		Brake chop	per	Brake	resistors	
power [kW]	Fe typecode	Typecode	Quantity	Typecode	Туре	Quantity
0.75	FECG02.1-0K75-3P400	Internal	-	FELR01.1N-0150- N700R-D-560-NNNN	700 Ω/150 W	1
1.5	FECG02.1-1K50-3P400	Internal	-	FELR01.1N-0520- N350R-D-560-NNNN	350 Ω/520 W	1
2.2	FECG02.1-2K20-3P400	Internal	-	FELR01.1N-0520- N230R-D-560-NNNN	230 Ω/520 W	1
4.0	FECG02.1-4K00-3P400	Internal	-	FELR01.1N-0780- N140R-D-560-NNNN	140 Ω/780 W	1
5.5	FECx02.1-5K50-3P400	Internal	-	FELR01.1N-1K04- N090R-D-560-NNNN	90 Ω/1.04 kW	1
7.5	FECx02.1-7K50-3P400	Internal	-	FELR01.1N-1K56- N070R-D-560-NNNN	70 Ω/1.56 kW	1
11	FECx02.1-11K0-3P400	Internal	-	FELR01.1N-02K0- N047R-D-560-NNNN	47 Ω/2.0 kW	1
15	FECx02.1-15K0-3P400	Internal	-	FELR01.1N-01K5- N068R-D-560-NNNN	68 Ω/1.5 kW	2
18.5	FECx02.1-18K5-3P400	FELB02.1N-30K0	1	FELR01.1N-10K0- N028R-A-560-NNNN	28 Ω/10.0 kW	1
22	FECx02.1-22K0-3P400	FELB02.1N-30K0	1	FELR01.1N-10K0- N022R-A-560-NNNN	22 Ω/10.0 kW	1
30	FECx02.1-30K0-3P400	FELB02.1N-45K0	1	FELR01.1N-12K5- N017R-A-560-NNNN	17 Ω/12.5 kW	1
37	FECx02.1-37K0-3P400	FELB02.1N-45K0	1	FELR01.1N-10K0- N032R-A-560-NNNN	32 Ω/10.0 kW	2
45	FECx02.1-45K0-3P400	FELB02.1N-30K0	2	FELR01.1N-10K0- N024R-A-560-NNNN	24 Ω/10.0 kW	2
55	FECx02.1-55K0-3P400	FELB02.1N-45K0	2	FELR01.1N-12K5- N018R-A-560-NNNN	18 Ω/12.5 kW	2
75	FECx02.1-75K0-3P400	FELB02.1N-45K0	3	FELR01.1N-12K5- N020R-A-560-NNNN	20 Ω/12.5 kW	3
90	FECx02.1-90K0-3P400	FELB02.1N-45K0	3	FELR01.1N-12K5- N020R-A-560-NNNN	20 Ω/12.5 kW	3
110	FECx02.1-110K0-3P400	FELB02.1N-45K0	3	FELR01.1N-12K5- N020R-A-560-NNNN	20 Ω/12.5 kW	3
132	FECx02.1-132K-3P400	FELB02.1N-220K	1	FELR01.1N-40K0- N03R4-A-560-NNNN	3.4 Ω/40.0 kW	1
160	FECx02.1-160K-3P400	FELB02.1N-220K	1	FELR01.1N-80K0- N03R2-A-560-NNNN	3.2 Ω/80.0 kW	1

Fig. 10-25: Selection reference of OT=20 %



- x is a substitute for G or P series.
- The above table is also applicable to C001 models.

Motor		Brake chop	per	Brake	e resistors	
power [kW]	Fe typecode	Typecode	Quantity	Typecode	Туре	Quantity
0.75	FECG02.1-0K75-3P400	Internal	-	FELR01.1N-0500- N550R-D-560-NNNN	550 Ω/500 W	1
1.5	FECG02.1-1K50-3P400	Internal	-	FELR01.1N-0800- N275R-D-560-NNNN	275 Ω/800 W	1
2.2	FECG02.1-2K20-3P400	Internal	-	FELR01.1N-01K2- N180R-D-560-NNNN	180 Ω/1.2 kW	1
4.0	FECG02.1-4K00-3P400	Internal	-	FELR01.1N-02K0- N110R-D-560-NNNN	110 Ω/2.0 kW	1
5.5	FECx02.1-5K50-3P400	Internal	-	FELR01.1N-01K5- N150R-D-560-NNNN	150 Ω/1.5 kW	2
7.5	FECx02.1-7K50-3P400	Internal	-	FELR01.1N-04K5- N055R-A-560-NNNN	55 Ω/4.5 kW	1
11	FECx02.1-11K0-3P400	Internal	-	FELR01.1N-06K0- N040R-A-560-NNNN	40 Ω/6.0 kW	1
15	FECx02.1-15K0-3P400	Internal	-	FELR01.1N-08K0- N027R-A-560-NNNN	27 Ω/8.0 kW	1
18.5	FECx02.1-18K5-3P400	FELB02.1N-45K0	1	FELR01.1N-10K0- N022R-A-560-NNNN	22 Ω/10.0 kW	1
22	FECx02.1-22K0-3P400	FELB02.1N-45K0	1	FELR01.1N-12K5- N018R-A-560-NNNN	18 Ω/12.5 kW	1
30	FECx02.1-30K0-3P400	FELB02.1N-30K0	2	FELR01.1N-10K0- N27R2-A-560-NNNN	27.2 Ω/10.0 kW	2
37	FECx02.1-37K0-3P400	FELB02.1N-45K0	2	FELR01.1N-10K0- N022R-A-560-NNNN	22 Ω/10.0 kW	2
45	FECx02.1-45K0-3P400	FELB02.1N-45K0	2	FELR01.1N-12K5- N018R-A-560-NNNN	18 Ω/12.5 kW	2
55	FECx02.1-55K0-3P400	FELB02.1N-45K0	3	FELR01.1N-12K5- N022R-A-560-NNNN	22 Ω/12.5 kW	3
75	FECx02.1-75K0-3P400	FELB02.1N-45K0	4	FELR01.1N-10K0- N022R-A-560-NNNN	22 Ω/10.0 kW	4
90	FECx02.1-90K0-3P400	FELB02.1N-45K0	4	FELR01.1N-10K0- N022R-A-560-NNNN	22 Ω/10.0 kW	4
110	FECx02.1-110K-3P400	FELB02.1N-220K	1	FELR01.1N-50K0- N03R7-A-560-NNNN	3.7 Ω/50.0 kW	1
132	FECx02.1-132K-3P400	FELB02.1N-220K	1	FELR01.1N-60K0- N03R7-A-560-NNNN	3.7 Ω/60.0 kW	1
160	FECx02.1-160K-3P400	FELB02.1N-220K	2	FELR01.1N-50K0- N05R0-A-560-NNNN	5.0 Ω/50.0 kW	2

Fig. 10-26: Selection reference of OT=40 %



- x is a substitute for G or P series.
- The above table is also applicable to C001 models.

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- The recommended resistance of the braking resistor in the table is configured assuming 100 % braking torque. If the actually needed torque is not 100 %, the resistance of the braking resistor in the table should be adjusted in inverse proportion, i.e. how much the braking torque increases based on 100%, the resistance of the braking resistor should decrease by the same amount, and vice versa.
- When selecting braking resistor R<sub>b</sub>, make sure the current I<sub>c</sub> which flows through the resistor is less than the current output ability of the brake chopper. The current I<sub>c</sub> through the braking resistor can be calculated by formula I<sub>c</sub>=U<sub>d</sub>/R<sub>b</sub>, in which U<sub>d</sub> is the braking operating voltage of the brake chopper.
- 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 P<sub>max</sub>=U<sub>d</sub><sup>2</sup>/R<sub>b</sub>. According to the actual working condition, the braking ratio OT % 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×P<sub>max</sub>× OT%, 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 please consult the technical support for more information.

# Brake resistor in aluminium housing

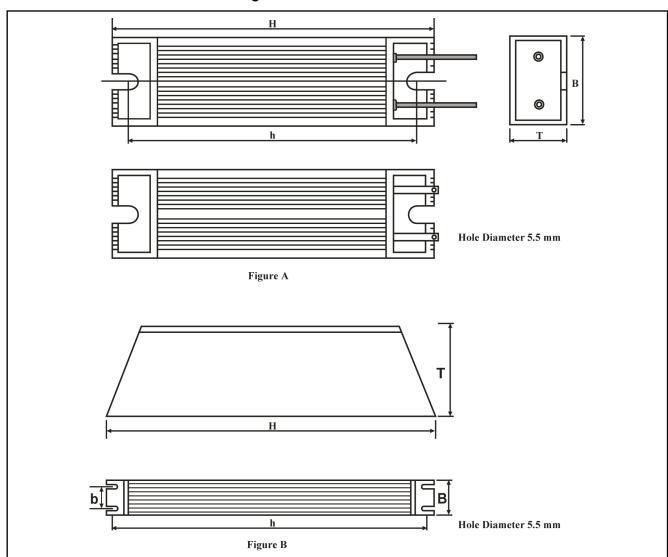


Fig. 10-27: Brake resistor in aluminium housing

	8				Dime	nsions	[mm]		_	<u> </u>	gth	<b>.</b>	
Brake resistor type- code	Impedance [Ω]	Power [W]	Figure	н	h	В	b	Т	Wiring [mm²]	Terminal [mm]	Cable length [mm]	Weight [kg]	Туре
FELR01.1N-0520- N100R -D-560- NNNN	100	520		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	A	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

	8				Dime	nsions	[mm]			_	gth		
Brake resistor type- code	Impedance [Ω]	Power [W]	Figure	н	h	В	b	Т	Wiring [mm²]	Terminal [mm]	Cable length [mm]	Weight [kg]	Туре
FELR01.1N-1K56- N040R -D-560- NNNN	40	1560		485	470	50	30	107	2.5	M6	-	4.35	Aluminium housing
FELR01.1N-02K0- N047R -D-560- NNNN	47	2000		550	534	50	30	107	4.0	M6	-	4.90	Aluminium housing
FELR01.1N-1K04- N050R -D-560- NNNN	50	1040		400	384	50	30	107	2.5	M6	-	4.35	Aluminium housing
FELR01.1N-01K5- N068R -D-560- NNNN	68	1500		485	470	50	30	107	2.5	M6	-	3.60	Aluminium housing
FELR01.1N-1K56- N070R -D-560- NNNN	70	1560		485	470	50	30	107	2.5	M6	-	2.20	Aluminium housing
FELR01.1N-0780- N075R -D-560- NNNN	75	780	В	400	382	61	40.5	59	2.5	M6	-	4.35	Aluminium housing
FELR01.1N-1K04- N090R -D-560- NNNN	90	1040		400	384	50	30	107	2.5	M6	-	3.60	Aluminium housing
FELR01.1N-02K0- N110R -D-560- NNNN	110	2000		550	534	50	30	107	4.0	M6	-	2.20	Aluminium housing
FELR01.1N-0780- N140R -D-560- NNNN	140	780		400	382	61	40.5	59	2.5	M6	-	4.35	Aluminium housing
FELR01.1N-01K5- N150R -D-560- NNNN	150	1500		485	470	50	30	107	2.5	M6	-	4.90	Aluminium housing
FELR01.1N-01K2- N180R -D-560- NNNN	180	1200		450	434	50	30	107	2.5	M6	-	4.00	Aluminium housing
FELR01.1N-0800- N275R -D-560- NNNN	275	800		400	382	61	40.5	59	2.5	M6	-	2.20	Aluminium housing

Fig. 10-28: Aluminium braking resistor dimensions

## Brake resistor box

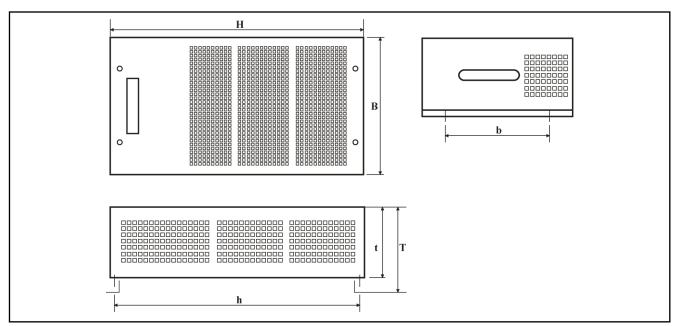


Fig. 10-29: Brake resistor box dimensions

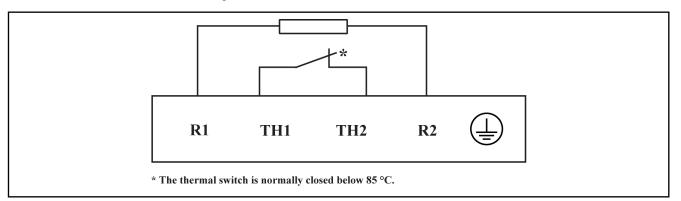


Fig. 10-30: Braking resistor box terminal

	වු	_		Di	mensi	ons [m	m]		D =	<u>a</u>	#	
Brake resistor typecode	Impedance [Ω]	Power [kW]	В	Н	t	Т	h	b	Wiring [mm²]	Terminal [mm]	Weight [kg]	Туре
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
FELR01.1N-40K0- N03R4-A-560-NNNN	3.4	40.0	700	118 5	342	500	960	615	10.0	M8	86.8	Resistor box
FELR01.1N-50K0- N03R7-A-560-NNNN	3.7	50.0	700	158 5	342	500	136 0	615	10.0	M8	100.2	Resistor box
FELR01.1N-50K0- N05R0-A-560-NNNN	5.0	50.0	500	158 5	342	500	136 0	615	10.0	M8	113.6	Resistor box

	9 <u>0</u>	<u> </u>		Dimensions [mm]					о.г.	lad _	Ħ	
Brake resistor typecode	Impedane [Ω]	Power [kW]	В	Н	t	Т	h	b	Wiring [mm²]	Terminal [mm]	Weight [kg]	Туре
FELR01.1N-60K0-	3.7	60.0	700	158	342	500	136	615	10.0	M8	86.8	Resistor
N03R7-A-560-NNNN	0.7	00.0	700	5	072	000	0	010	10.0	IVIO	00.0	box
FELR01.1N-80K0-	3.2	80.0	700	188	342	500	168	615	10.0	M8	138.5	Resistor
N03R2-A-560-NNNN	3.2	00.0	700	5	342	300	0	013	10.0	IVIO	130.3	box

Fig. 10-31: Brake resistor box dimensions

# 10.3 Communication Interface

# 10.3.1 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.

# 10.3.2 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.

# 10.3.3 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.

# 10.3.4 Cable between Frequency Converter and RS232 / RS485 Adapter

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

# 10.4 Accessories for Control Cabinet Mounting

# 10.4.1 Operating Panel for Control Cabinet Mounting

The operating panel FECC02.1T-R-STD-POTI-NNNN is mounted on the control cabinet. The user can conveniently operate and control the frequency converter from the outside of the control cabinet.

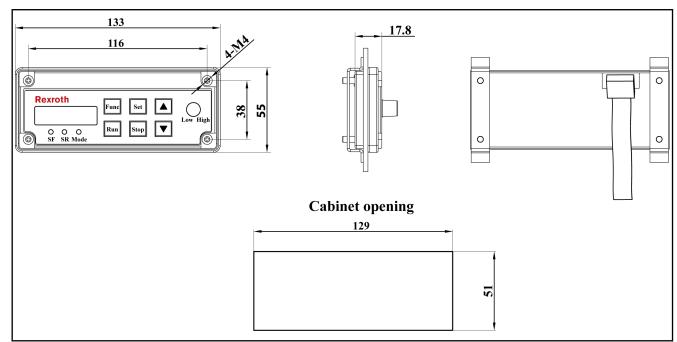
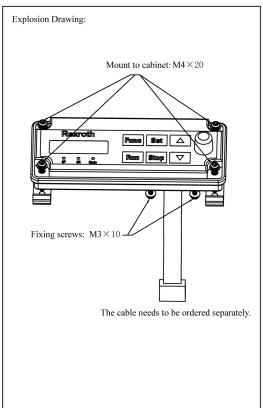
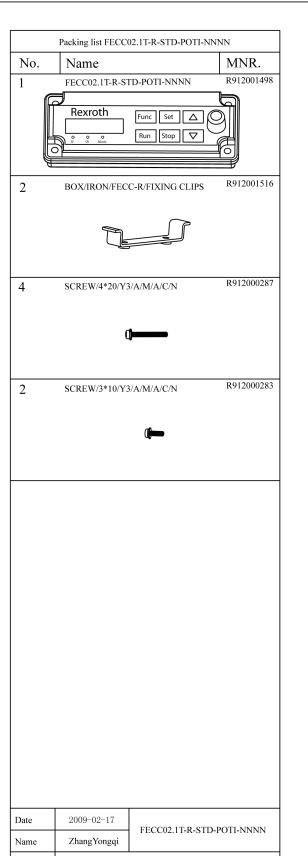


Fig. 10-32: Panel dimensions and cabinet opening







R912001498

309-1173-4201-01

MNR.
Drawing

Rexroth Frequency Converter Fe

Accessories

# 10.4.2 Operating Panel Cable for Control Cabinet Mounting

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 meters long, can also be used for the connection of the operating panel. To use the FRKS0001 or FRKS0002 cable for connection, it is necessary to remove the panel at the frequency converter and then connect the cable there.

# 10.4.3 Operating Panel with Potentiometer for Converters above 11 kW

No potentiometer is equipped for the standard panel of the frequency converter above 11 kW.

# 10.5 Engineering Software

Rexroth ConverterPC\_4.0.xx.xx is an engineering software that allows users 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 "ConverterPC\_4.0.xx.xx Instruction Manual".

# 11.1 Running Setting Diagram

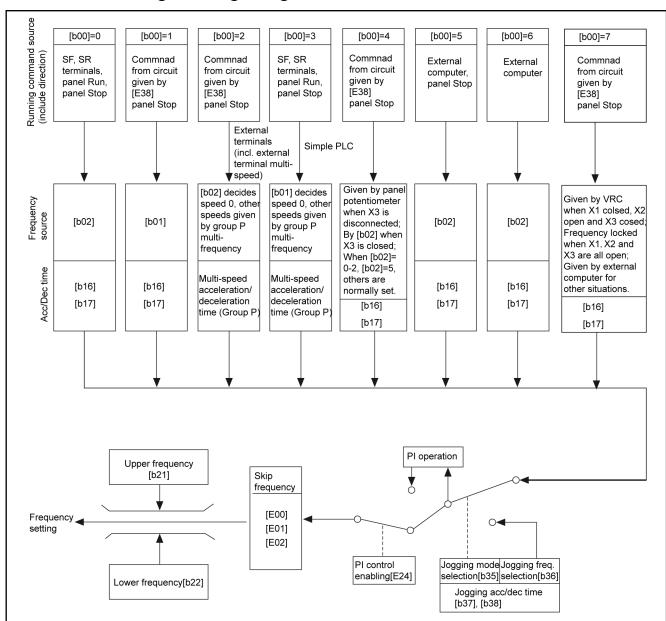


Fig. 11-1: Running setting diagram

# 11.2 Process Control

## 11.2.1 Process Control Illustration

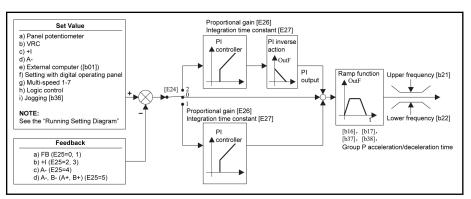


Fig. 11-2: Process control illustration

# 11.2.2 Simple Applications of Process Control

### Automatic constant pressure water control system

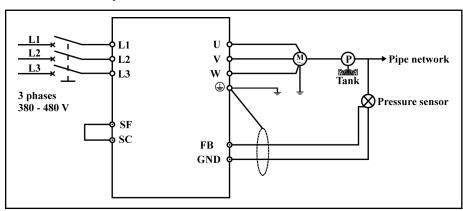


Fig. 11-3: Automatic constant pressure water control system

- 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 to 10 V for C001 models or 0 to 5 V for standard models.
- If the pressure feedback relationship is 0 V ⇔ 0.0 kg/cm², [E22]=10.0, [E23]=0.0, [E24]=1 and [E25]=0, while [E26], [E27] and [E28] are set depending on actual conditions.

## Closed-loop speed control system

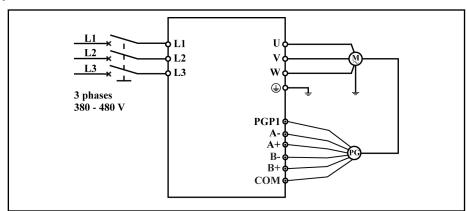


Fig. 11-4: Closed-loop speed control system

Conditions and requirements

PGP is connected to the operating power supply of PG, and the given 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 speed is: 0 V  $\Leftrightarrow$  0.0 rpm, and 5 V  $\Leftrightarrow$  1500 rpm, and the pulse per cycle of the feedback encoder is 1024, the feedback pulse frequency that corresponds to 1500 rpm is:

(1500 rpm / 60s \*1024) / 1000=25.6 kHz

- 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 90° phase shifted pulse input, set [E24]=1 or 2, [E25]=5 and [E31]=25.6 kHz.



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 (200.0 kHz \* 60s) / 1500 rpm = 8000.

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

[(200.0 kHz \* 60s) / N] (rpm)

For example:

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

[E31]=[1000 \* (1600 / 60)] / 1000=26.667 (kHz).

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

[E22]=(26.7 / 26.667) \* 1600=1602.0

Since 5 V $\Leftrightarrow$ 1602.0 rpm, the voltage corresponding to 1600 rpm equals 5 \* (1600 / 1602)=4.99 V

# 11.3 Discharging of Capacitors

# 11.3.1 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.

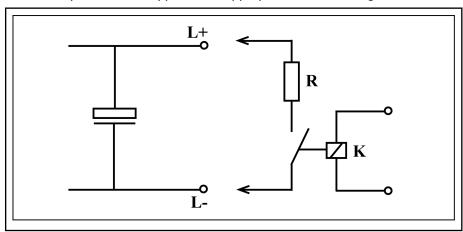
Frequency converters have been dimensioned in such a way that after the supply voltage was cut off, the voltage value falls below 50 V within a discharging time of a maximum of 30 minutes.

To shorten the waiting time until voltage has fallen below 50 V, you can use the discharging devices described below.

# 11.3.2 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

Fig. 11-5: Operating principle of discharging device

## Dimensioning

Each individual component has to be sufficiently dimensioned:

- Value of the discharging resistor: 1000 Ω 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  $\Omega$ .

### Installation

### **WARNING**

Lethal electric shock caused by live parts with voltages higher 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!

### **A** 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 for the first time.**
- 2. Place discharging resistor as far as possible from heat-sensitive components.

If you install discharging device after switching 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!

### Activation

Observe the following order to activate the discharge device:

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

Rexroth Frequency Converter Fe

# 12 Communication Protocols

## 12.1 Brief Introduction

The standard RS485 port realizes the communication between the master station and the slave station via ModBus protocol. In addition to that PROFIBUS adapter are 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. In this manual we only focus on the ModBus communication.

## 12.2 ModBus Protocol

# 12.2.1 Protocol Description

### **Brief introduction**

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 slave 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 unable to understand a message from the master station, it will send an exception response to the master station. Slave stations can't 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 dialogs 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).

### **Transmission**

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

Slave address	ModBus function code	Data	CRC16 check information
---------------	----------------------	------	-------------------------

Fig. 12-1: Typical RTU frame format

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 previ-

### Communication Protocols

ous 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 acknowledgment.
- Each address must be unique in the network.

## 12.2.2 Interface

Fe provides a 2 PIN crimp terminal port, see the front view as below:

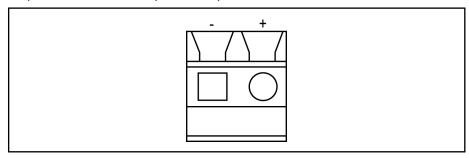


Fig. 12-2: 2 PIN crimp terminal port

The standard RJ45 communication port provided by Fe frequency converters is shown below.

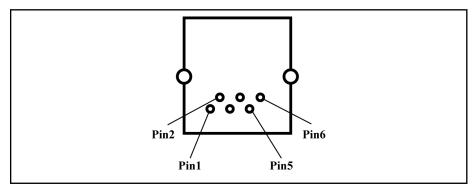


Fig. 12-3: Standard RJ45 communication port

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

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

Fig. 12-4: Relationship between pins and signals

Communication Protocols

## 12.2.3 Protocol Functions

# 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.

Function Code	Description	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

Fig. 12-5: ModBus functions managed by Fe series converters and their limits

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

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	_	≥ transmission time for 3.5 bytes
Local address	0x01	0x01
Freez codo	The highest digit of the command code is 1.	0.06
Error code	For example, command code 0x16 is considered as 0x96.	0x96
	Code meaning:	
Exception code	0x01: Invalid command code	
	0x02: Invalid data address	
	0x03: Illegal data frame (out of limit reading/writing characters or an incomplete frame)	0x01
	0x04: Fault in command execution (Function code un-rewritable due to protection/ Function code to be modified out of limit/ Function code cannot be modified/wrong password)	
	0x05: CRC error	
Cuana abaali		Lower byte
Frame check		Higher byte
End	_	≥ transmission time for 3.5 bytes

Fig. 12-6: Error code frame format

#### Communication Protocols

## Function code and communication data description

Function 0x03: Read N words (continuously reading 16 words in maxi-

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:

Start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	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 bytes

Fig.12-7: Function 0x03\_ RTU host command information

Start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	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

Fig.12-8: Function 0x03\_Response message from RTU slave

Function 0x06: Write a word (Word)

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

Start	Transmission time for 3.5 bytes
Slave address	02H
Modbus function code	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

Fig. 12-9: Function 0x06\_RTU master command message

Start	Transmission time for 3.5 bytes
Slave address	02H
Modbus function code	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

Fig. 12-10: Function 0x06\_Response message from RTU slave

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 higher byte	АОН
End	Transmission time for 3.5 bytes

Fig.12-11: Function 0x08\_Loop test

• Function 0x10: Write 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:

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	10H

Higher byte of write register start address	01H
Lower byte of write register start address	09H
Higher byte of register number	00H
Lower byte of register number	02H
Bytes of data	04H
Higher byte of data 1	00H
Lower byte of data 1	зсн
Higher byte of data 2	00Н
Lower byte of data 2	50H
CRC lower byte	FEH
CRC higher byte	65H
End	Transmission time for 3.5 bytes

Fig. 12-12: Function 0x10\_Request from the master

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

Fig. 12-13: Function 0x10\_Response from the slave

## • 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:

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	17H
Higher byte of read register start address	01H
Lower byte of read register start address	00H
Higher byte of read register number	00H
Lower byte of read register number	02H
Higher byte of write register start address	01H
Lower byte of write register start address	09H

Higher byte of write register number	00H
Lower byte of write register number	02H
Bytes of data for writing	04H
Higher byte of data 1	00H
Lower byte of data 1	64H
Higher byte of data 2	00H
Lower byte of data 2	C8H
CRC lower byte	48H
CRC higher byte	72H
End	Transmission time for 3.5 bytes

Fig. 12-14: Function 0x17\_Request from the master

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	17H
Bytes of read register	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
End	Transmission time for 3.5 bytes

Fig. 12-15: Function 0x17\_Response from the slave

# 12.2.4 Communication Mapping Register Address Distribution

The communication mapping registers of ModBus are in three types: converter parameter registers, converter control registers, converter state feedback registers.

#### Converter parameter registers

Each converter parameter register corresponds to one function code. 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 parameter settings 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: 0-52 / group E: 0-51 /group P: 0-37 / group H: 0-65).

Function group	b	Е	Р	Н
Mapping address	00H	01H	02H	03H

Fig. 12-16: Relationship between function group and mapping address

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 registers (0x4000, 0x4001)

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

Control Register	Address	Description	
		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		
Main control	0×4000	Bit 7: (0: Invalid; 1: reset after fault)	
Main control	Main control 0x4000	Bit 8: (0: Forward jogging invalid; 1: Forward jogging valid (level signal))	Write-only
		Bit 9: 0: Reverse jogging invalid; 1: Reverse jogging valid (level signal)	/rite
		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		
Communication set frequency	0x4001	0 to highest frequency, minimum unit 0.01 Hz	

Fig. 12-17: Converter control registers (0x4000, 0x4001)\_bit definition

The address of frequency setting register for communication control is 0x4001. This register is 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 registers

The converter state can be monitored by reading the register (read-only). The state of each bit is defined as below:

Status Register	Address	Description	Action
		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)	Şlu
Main status	0x5000	Bit 8: Coasting to stop (1: yes; 0: no)	Read-only
		Bit 9: DC braking (1: yes; 0: no)	Ř
		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: During speed capturing (1: yes; 0: no)	
		Bit 14: Reserved	
		Bit 15: Reserved	
		Bit 0: No fault record	
		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	<u>&gt;</u>
Fault word	0x5001	Bit 7: Motor overload	no-F
r dan word	oxecc :	Bit 8: Frequency converter overheat	Read-only
		Bit 9: Drive protection	
		Bit 10: EMI (CPU-)	
		Bit 11: Input phase loss	
		Bit 12: Output phase loss	
		Bit 13: Stopping by external abnormality command	
		Bit 14: Motor overheat	
		Bit 15: EMI (CPUE)	
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	
Bus voltage	0x5006	Unit: 0.1 V	
Digital input signal	0x5007	bit14-X1, bit13-X2, bit12-X3, bit11-SR, bit10-SF, bit9-RST, bit8-EMS	
Module temperature	0x5008	Unit: 1 °C	
PI control feedback value	0x5009	Signed fixed-point number Q14	

Status Register	Address	Description	Action
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]	

Fig. 12-18: Converter state feedback registers\_bit definition

## 12.2.5 ModBus Communication Example

An Fe 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: 9	Start 01# conve	rter for forward	rotation at frequ	ency of 50.00	Hz (represente	d by 5000 inter	nally)
	Slave address	Function code	Start ad- dress	Number of addresses	Bytes of contents	Data con- tents	CRC code
Request	0x01	0x10	0x4000	0x0002	0x04	0x0808, 0x1388	0x4C98
Response	0x01	0x10	0x4000	0x0002	N/A	N/A	0x5408
Example 2: F	Read the output	voltage of 01#	converter and b	ous voltage		•	
	Slave address	Function code	Start ad- dress	Number of addresses	Bytes of contents	Data con- tents	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# convei	ter according to	the stopping n	node set with th	ne function code	<del>)</del>	
	Slave address	Function code	Start ad- dress	Number of addresses	Bytes of contents	Data con- tents	CRC code
Request	0x01	0x06	0x4000	N/A	N/A	0x0001	0x5DCA
Response	0x01	0x06	0x4000	N/A	N/A	0x0001	0x5DCA

Fig. 12-19: ModBus communication example

## 12.2.6 Communication Networking

## **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  $\Omega$ , 0.25 W.

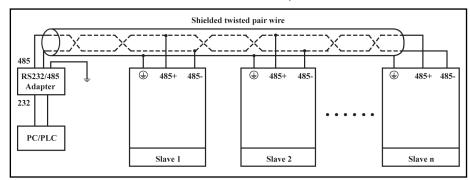


Fig. 12-20: Modbus communication networking

**A** WARNING

Cables may only be connected when drive is turned off.

## 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.

Service and Support

# 13 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 <sup>1)</sup>	Mon Fri. 7:00 am - 6:00 pm CET	Mon Fri. 6:00 pm - 7:00 am CET Sat Sun. 0:00 am - 12:00 pm CET	Outwith Germany please contact	
Phone	+49 (0) 9352 40 50 60	+49 (0) 171 333 88 26 or +49 (0) 172 660 04 06	our sales/service office in your area first.  For hotline numbers refer to the sales office addresses on the Inter-	
Fax	+49 (0) 9352 18 49 41	_	net.	
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.

Disposal and Environmental Protection

# 14 Disposal and Environmental Protection

# 14.1 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.

## 14.2 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 electronic devices:

- 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 remained after these processes can be thermally recycled.

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