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

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Bosch Group

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귀하의 모국어로 된 안내서가 배송되지 않았다면 Bosch Rexroth 대리점에 알려주시기 바랍니다.

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1 Introduction

1.1 Introduction to the 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 (project specific)
5	Installation	
6	Commissioning	Actual applications (for operators and repairers)
7	Parameter Settings	
8	Fault Indication	
9	Technical Data	
10	Accessories	
11	Additional Information	
12	Communication Protocols	
13	Disposal and Environmental Protection	General information
14	Service and Support	Service information
-	Index	Index information

Fig. 1-1: Chapters and contents

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1.2 Introduction to the Drive System

1.2.1 Delivery and Storage

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 Consists of

Standard model

- Frequency Converter Fv, protection class of IP20 (Control cabinet mounting)
- Fv firmware
- Integrated brake unit
- Operating panel
- Instruction manual

Optional accessories

- Operating panel for control cabinet mounting
- Optional PROFIBUS adapter
- RS232/485 adapter
- Engineering software
- Optional EMC filter (EN 61800-3 Environment 2)
- dV/dt filter
- Main choke
- Brake resistor

Transport of the Components

Ambient and operating conditions-Transport

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

Fig.1-2: Transport conditions

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Storage of the Components

⚠ CAUTION **Damage to the components caused by long storage periods!**

Some components contain electrolytic capacitors which may deteriorate during storage.

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

- Fv with mains voltage U_{LN}

Ambient and operating conditions-Storage

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

Fig.1-3: Storage conditions

1.2.2 Definition

Bosch Rexroth Fv drive system is composed of individual parts (components) for application in different circumstances.

- FVCA: Frequency Converter Fv
- FVCC: Fv operating panel
- FSWA: Engineering software
- FELB：Brake unit
- FELR: Brake resistor
- FVAA: ModBus/PROFIBUS adapter
- FVAM: Mounting plate for control cabinet
- FRKB: Adapter interface cable
- FRKS: Operating panel cable

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Introduction

1.2.3 Type Coding

Type Coding of Fv Series Converters

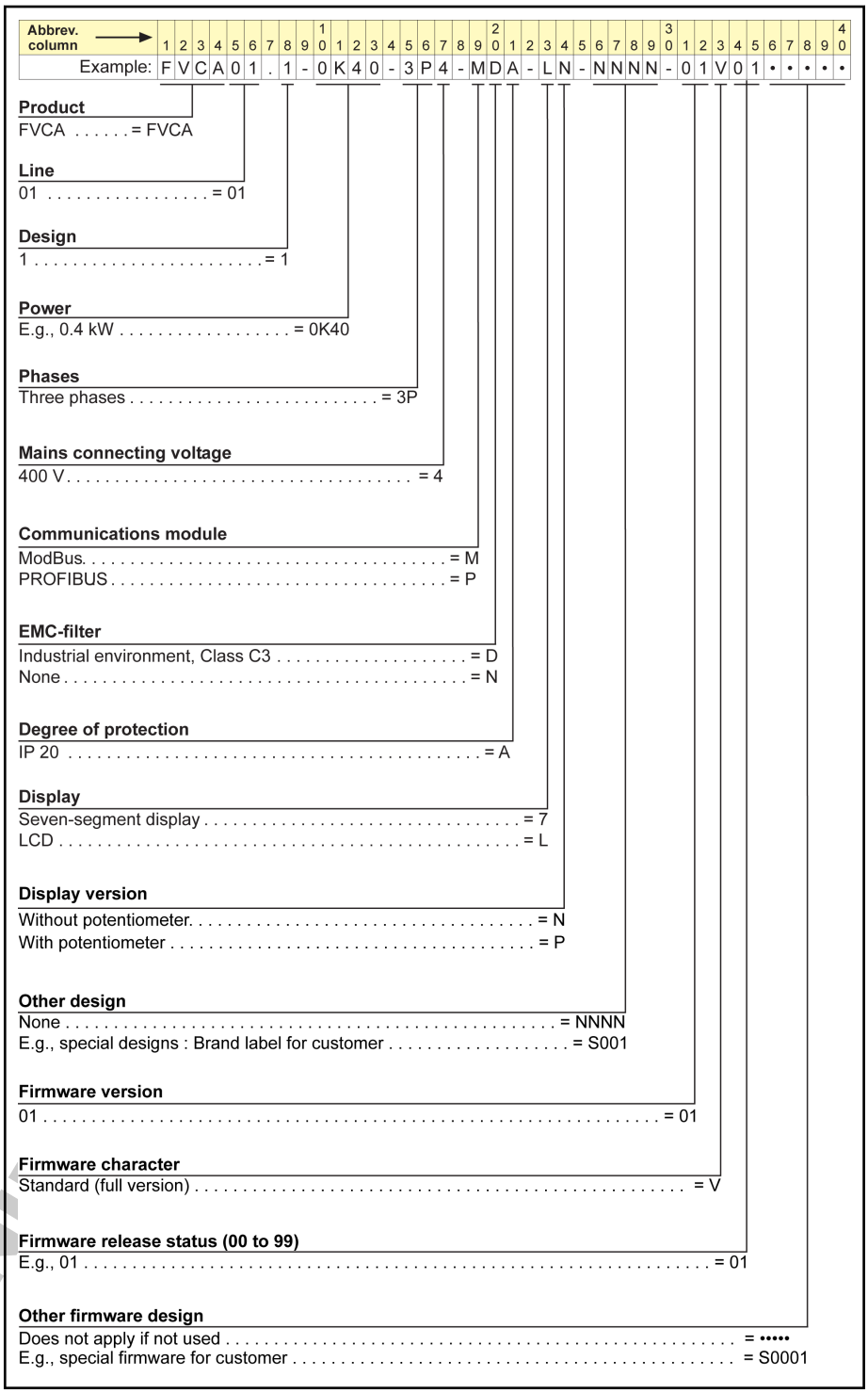

Fig. 1-4: Type Coding of Fv Series Converters

Type Coding of Fv Function Modules

Operating Panel Type Coding

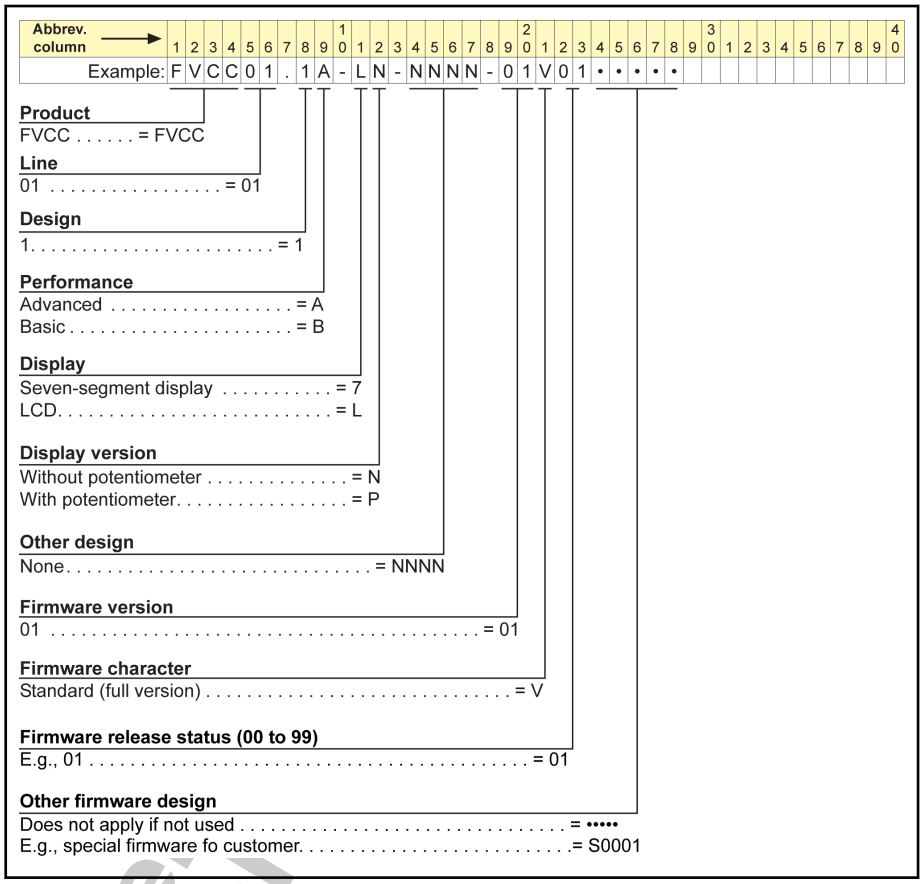

Fig. 1-5: Operating panel type coding

Engineering Software Type Coding

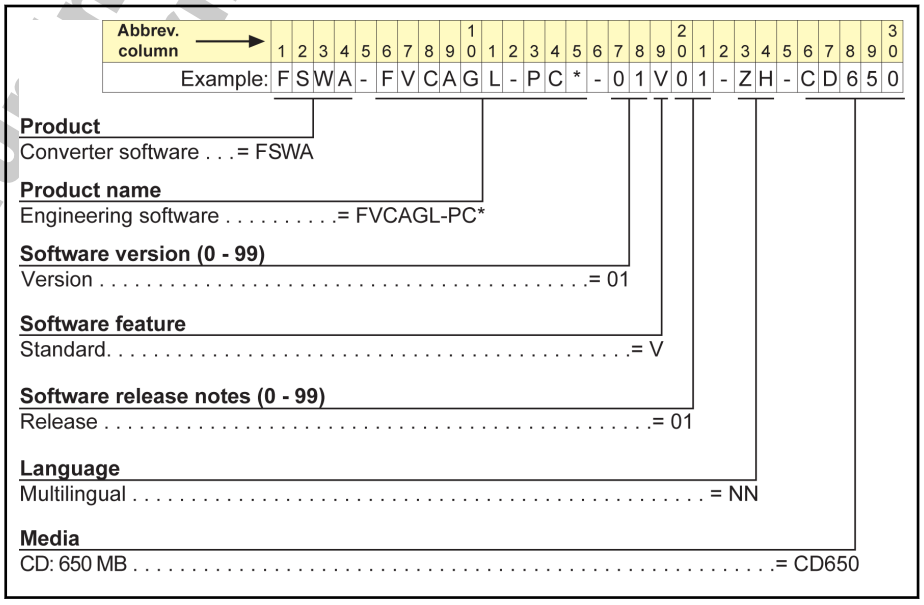

Fig. 1-6: Engineering software type coding

Nur für interne

Introduction

Type Coding of Fv Accessories

Interface Adapter Type Coding

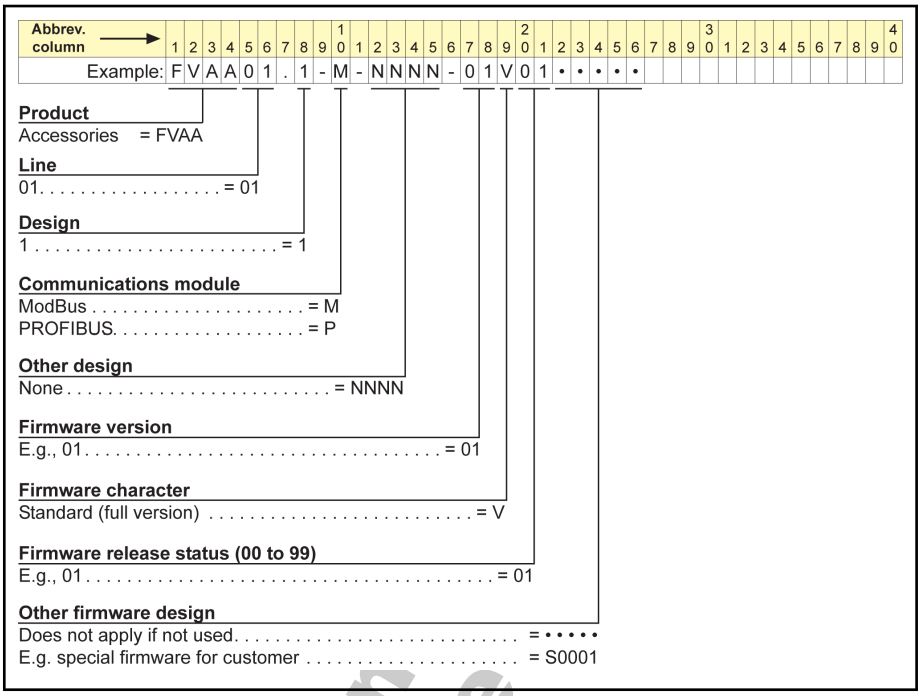

Fig. 1-7: Interface adapter type coding

Interface Adapter Cable Type Coding

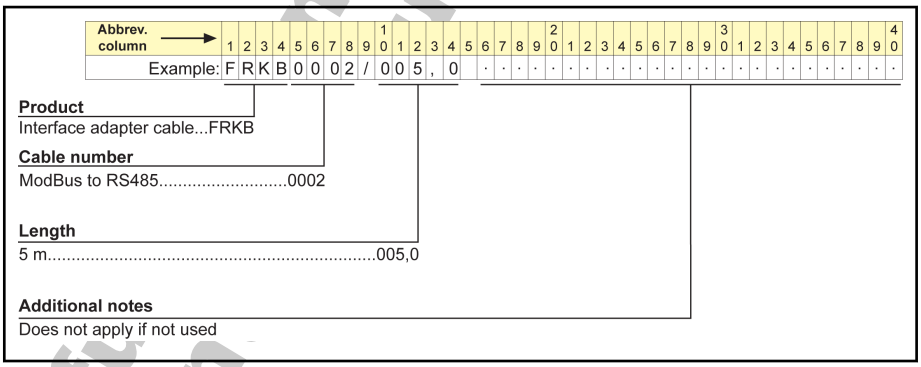

Fig. 1-8: Interface adapter cable type coding

Operating Panel Cable Type Coding

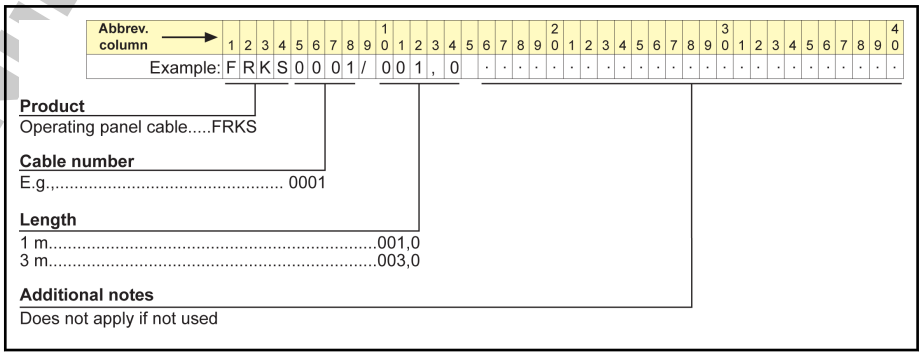

Fig. 1-9: Operating panel cable type coding

Not for resale

Brake Resistor Type Coding

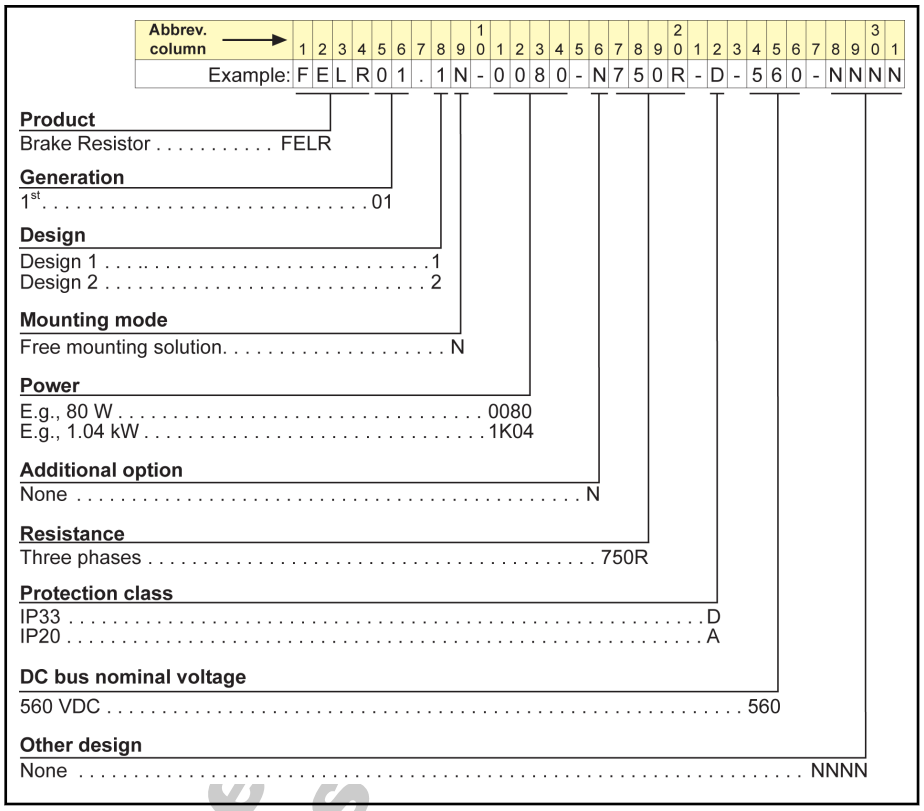

Fig. 1-10: Brake resistor type coding

Brake Unit Type Coding

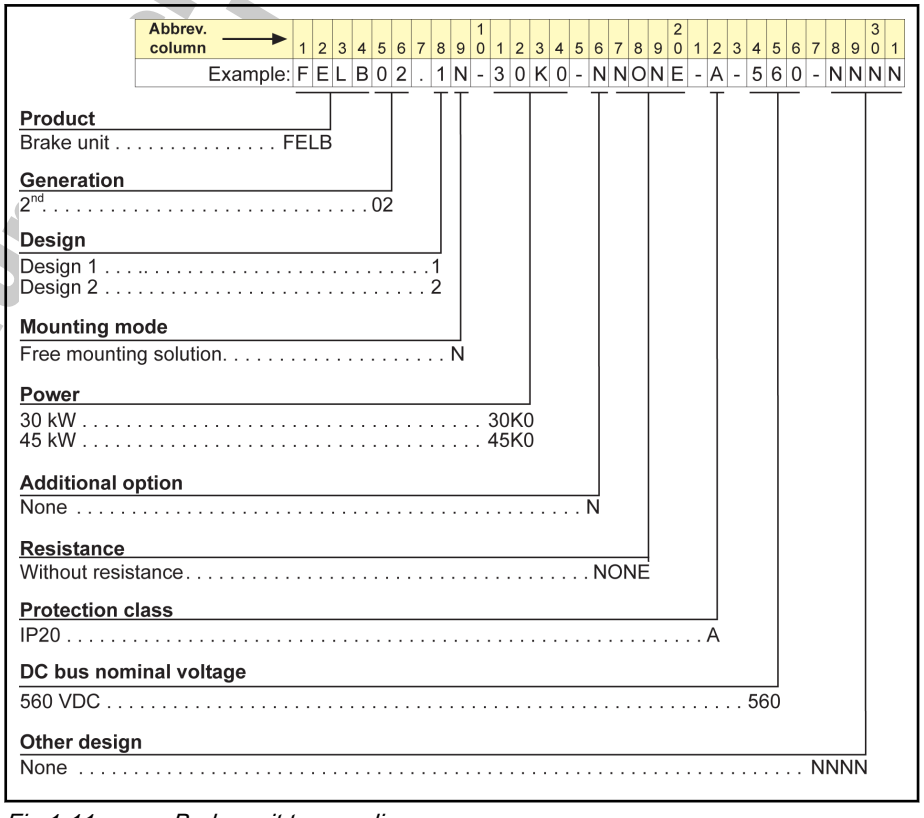

Fig. 1-11: Brake unit type coding

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1.3 Fv Description

1.3.1 Certification

CE Certification

Declaration of conformity

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

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

CE Label

Fig.1-12: CE label

High-Voltage Test

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

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

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

UL Certification

Fv products are in process of UL certification.

1.3.2 Properties of the Basic Device Fv

- Allowed ambient temperature: -10 − 40 ℃;
- Protection class: IP20 (Control cabinet mounting)
- Power range: 0.4 to 15 kW
- Power supply voltage: 3 AC 380 to 480 V (-15 % / +10 %)
- High start-up torque and precise motor speed control
- Overload capacity:
  - 150 % of rated current for 60s
  - 180 % of rated current for 10s
- Output frequency: 0 to 400 Hz

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- Pulse width modulation (PWM) for converters with: 1 to 15 kHz, adjustable in 0.1 kHz steps
- Integrated brake unit (brake resistor connected externally)
- Control mode: FOC, SVC, V/F

1.3.3 Interfaces

- 10 digital inputs
- 1 encoder input for speed feedback
- 3 analog inputs
- 2 open collector outputs
- 1 pulse output
- 2 relay outputs AC 250 V / DC 30 V, 3 A
- 2 analog outputs
- 1 optional ModBus / PROFIBUS communication port

1.3.4 Cooling types

- Air cooling
- Forced, temperature-controlled air cooling

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2 Safety Instructions for Electric Drives and Controls

2.1 General Information

2.1.1 Brief Introduction

Using the Safety Instructions and Passing them on to Others

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

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Safety Instructions for Electric Drives and Controls

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

- Read these instructions before the initial start-up of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times.
- Bosch Rexroth AG is not liable for damages resulting from failure to observe the warnings provided in this documentation.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this device.
- Only assign trained and qualified persons to work with electrical installations.
- Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.
- Only use spare parts and accessories approved by the manufacturer.
- Follow all safety regulations and requirements for the specific application as 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 Project Planning Manual.If this is not the case, they are excluded.
- Safety-relevant are all such applications which can cause danger to persons and material damage.
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.
- The machine and installation manufacturer must make sure that the delivered components are suited for each individual application. Check the information given in this document with regard to the use of the components.
- 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.

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

2.1.2 Explanation of Warning Symbols and Degrees of Hazard Seriousness

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

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

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

2.2 Hazards by Improper Use

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

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

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

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

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

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

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Safety Instructions for Electric Drives and Controls

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.

⚠ 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. 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.

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With electrical drive and filter components, observe the following:

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

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

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

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

- To all connections and terminals with voltages between 0 and 50 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

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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.

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.

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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

⚠ 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.

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Safety Instructions for Electric Drives and Controls

2.8 Protection During Handling and Mounting

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

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

- Observe the general construction and safety regulations on handling and assembly.
- Use suitable devices for assembly and transport.
- Avoid jamming and bruising by appropriate measures.
- Always use suitable tools. Use 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).
- not stand under hanging loads.
- Immediately clean up any spilled liquids because of the danger of skidding.

2.9 Protection Against Pressurized Systems

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

⚠ CAUTION **Risk of injury by improper handling of pressurized lines!**

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

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

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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 may only be used in the manner that is defined as appropriate. If they are used in an inappropriate manner, then situations can develop that may lead to property damage or injury to personnel.

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

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

Drive controllers shall not be used in following conditions:

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

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4 Frequency Converter Mounting

4.1 Mounting

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

- The frequency converter must be vertically installed.
- Frequency Converter Fv has no side ventilation hole, which enables parallel mounting of Fv with zero distance.
- 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 chapter 9 "Technical Data" on page 143).
- A baffle plate is recommended between the frequency converters to prevent the rising hot air being drawn into the upper converter.

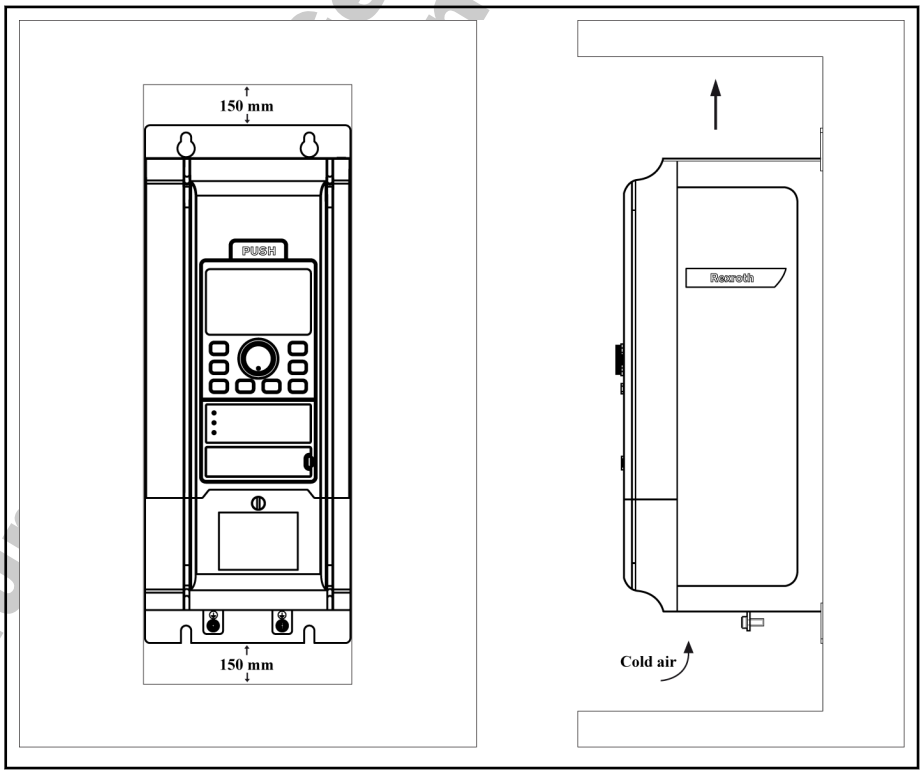


Fig.4-1: Converter mounting

⚠ CAUTION **Risks of damage to the components!**

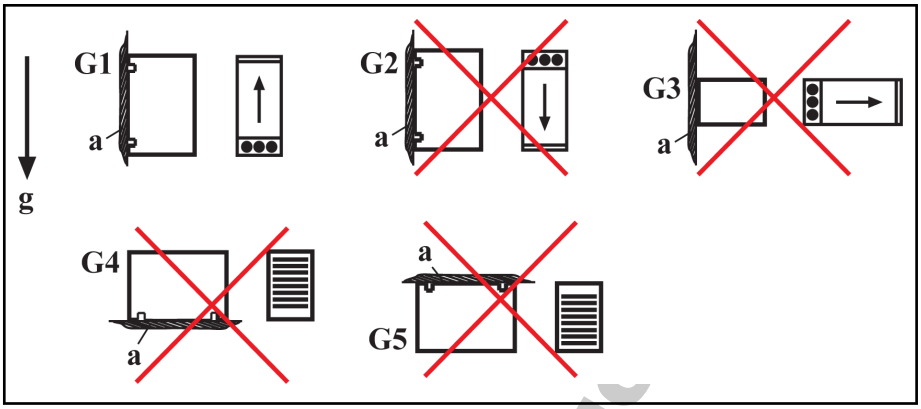
Only operate the components in their allowed mounting positions.

Allowed Mounting Position of the components:

Only the mounting position G1 is allowed for Fv components.

Nur für Lehrzwecke

Frequency Converter Mounting



a	Mounting surface
g	Direction of gravitational force
G1	Normal mounting positions. The natural convention supports the forced cooling air current. This avoids the generation of pockets of heat in the component.
G2	180° to normal mounting position
G3	Turned by 90° from vertical to horizontal mounting position
G4	Bottom mounting; mounting surface on bottom of control cabinet
G5	Top mounting; mounting surface at top of control cabinet

Fig.4-2: Converter mounting mode

Efficiency:

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

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4.2 Fv Dimensions and Outline

4.2.1 Fv Dimensions

Housing	Fv model	Dimensions [mm]									Screw size
		B	b	T	t	H	h	h1	d	L1	
A	FVCA01.1-0K40-3P4-MNA-LP-NNNN-01V01••••• FVCA01.1-0K75-3P4-MNA-LP-NNNN-01V01••••• FVCA01.1-1K50-3P4-MNA-LP-NNNN-01V01••••• FVCA01.1-2K20-3P4-MNA-LP-NNNN-01V01•••••	125	75	122	1.5	275	300	315	5.5	5.5	M5
B	FVCA01.1-4K00-3P4-MNA-LP-NNNN-01V01••••• FVCA01.1-5K50-3P4-MNA-LP-NNNN-01V01••••• FVCA01.1-7K50-3P4-MNA-LP-NNNN-01V01•••••	150	100	157	1.5	330	365	380	6.5	6.5	M6
C	FVCA01.1-11K0-3P4-MNA-LP-NNNN-01V01••••• FVCA01.1-15K0-3P4-MNA-LP-NNNN-01V01•••••	175	100	204	2	398	432	448	6.5	6.5	M6

Fig.4-3: Fv dimensions

4.2.2 Fv Outline

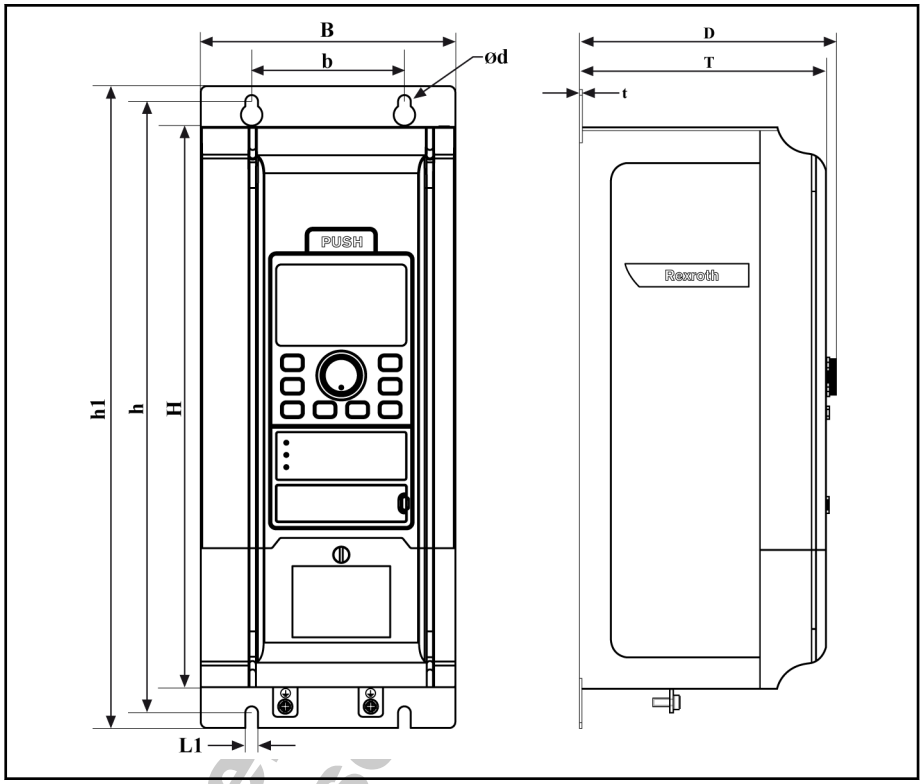

Fig.4-4: Fv outline

Please refer to fig. 4-3 "Fv dimensions" on page 30 to select four screws for converter mounting.

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5 Installation

5.1 Converter Disassembly and Assembly Instruction

5.1.1 Removal and Mounting of Operating Panel

Removal of Operating Panel

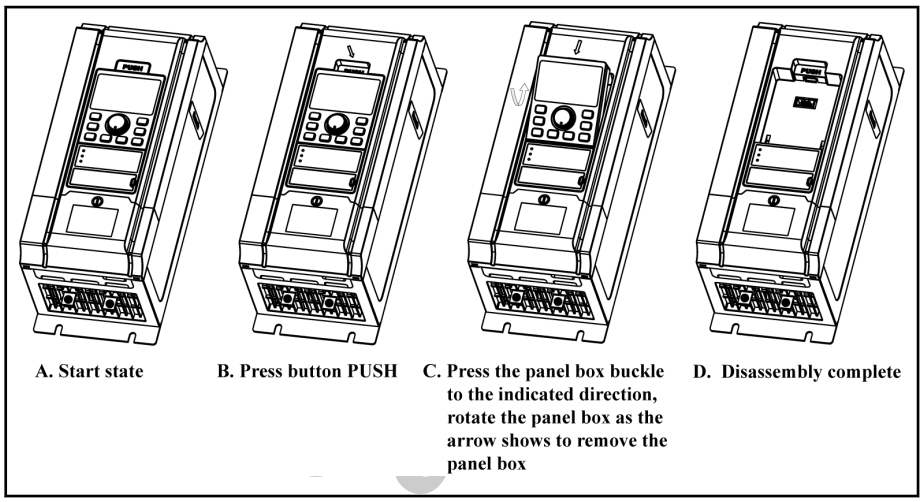

Fig.5-1: Removal of operating panel

Mounting of Operating Panel

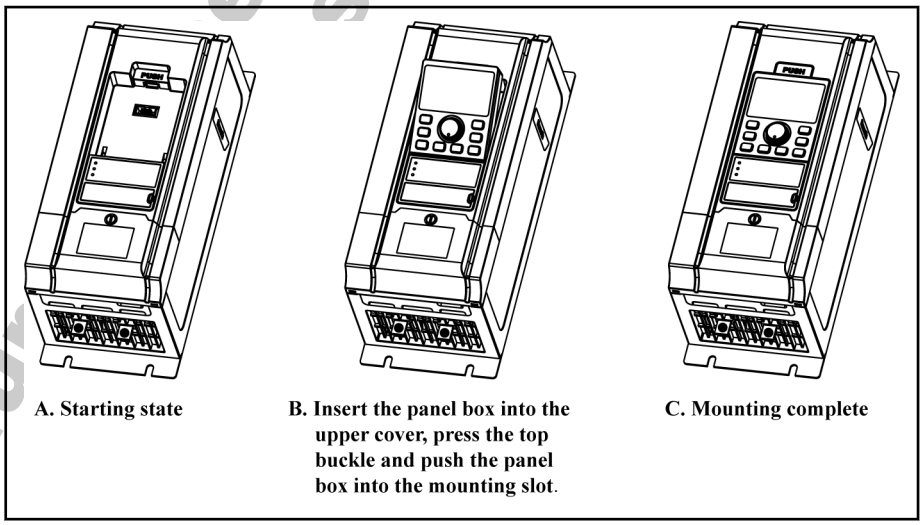

Fig.5-2: Mounting of operating panel

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Installation

5.1.2 Removal and Mounting of Adapter

Removal of Adapter

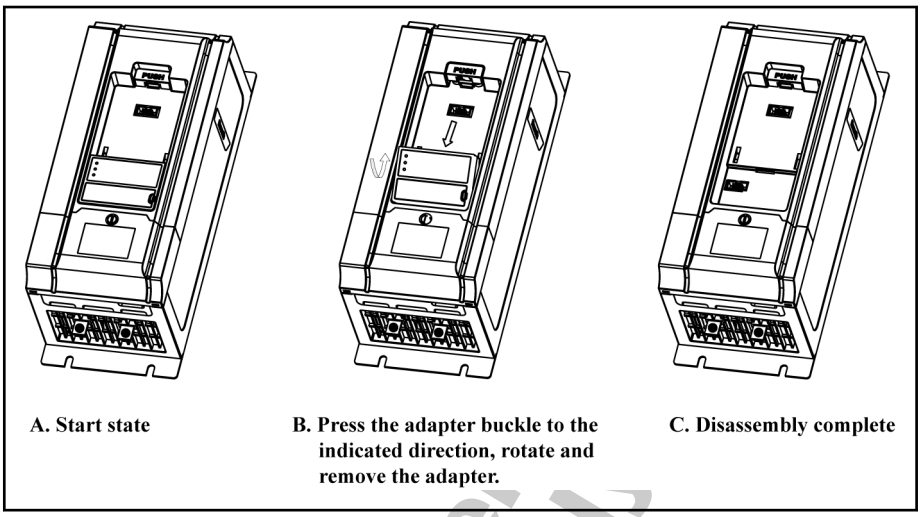

Fig.5-3: Removal of adapter

Mounting of Adapter

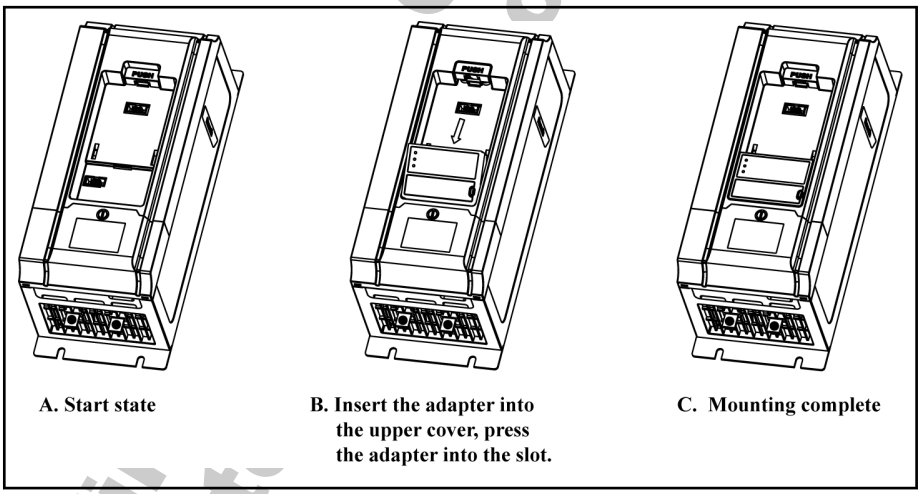

Fig.5-4: Mounting of adapter

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5.2 Drive System Wiring

5.2.1 Block Diagram

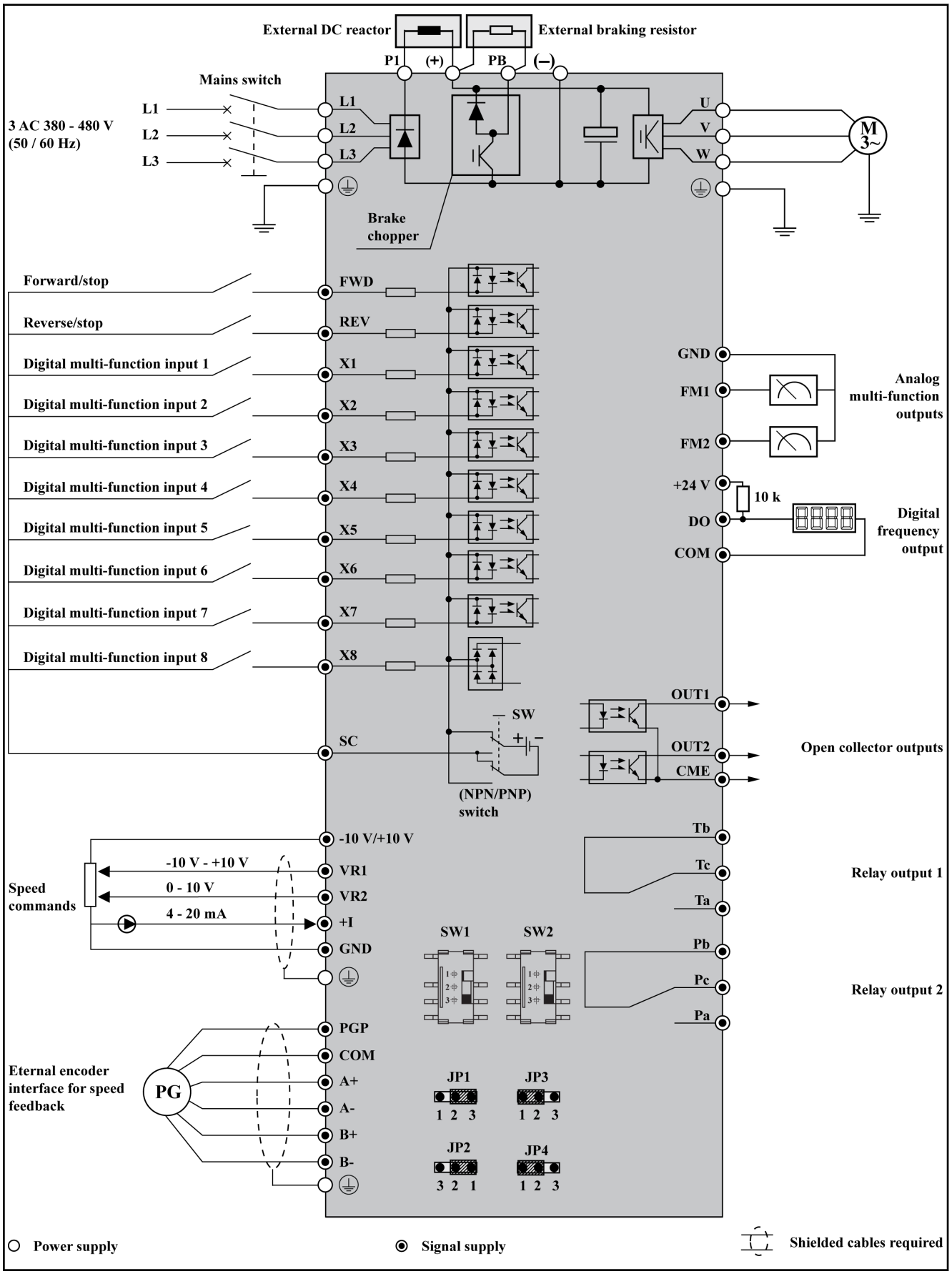

Fig.5-5: Block diagram

Installation

5.2.2 Main Circuit Wiring

Main circuit wiring cautions

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

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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 cable control cabinet.

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

Main Circuit Wiring Diagram

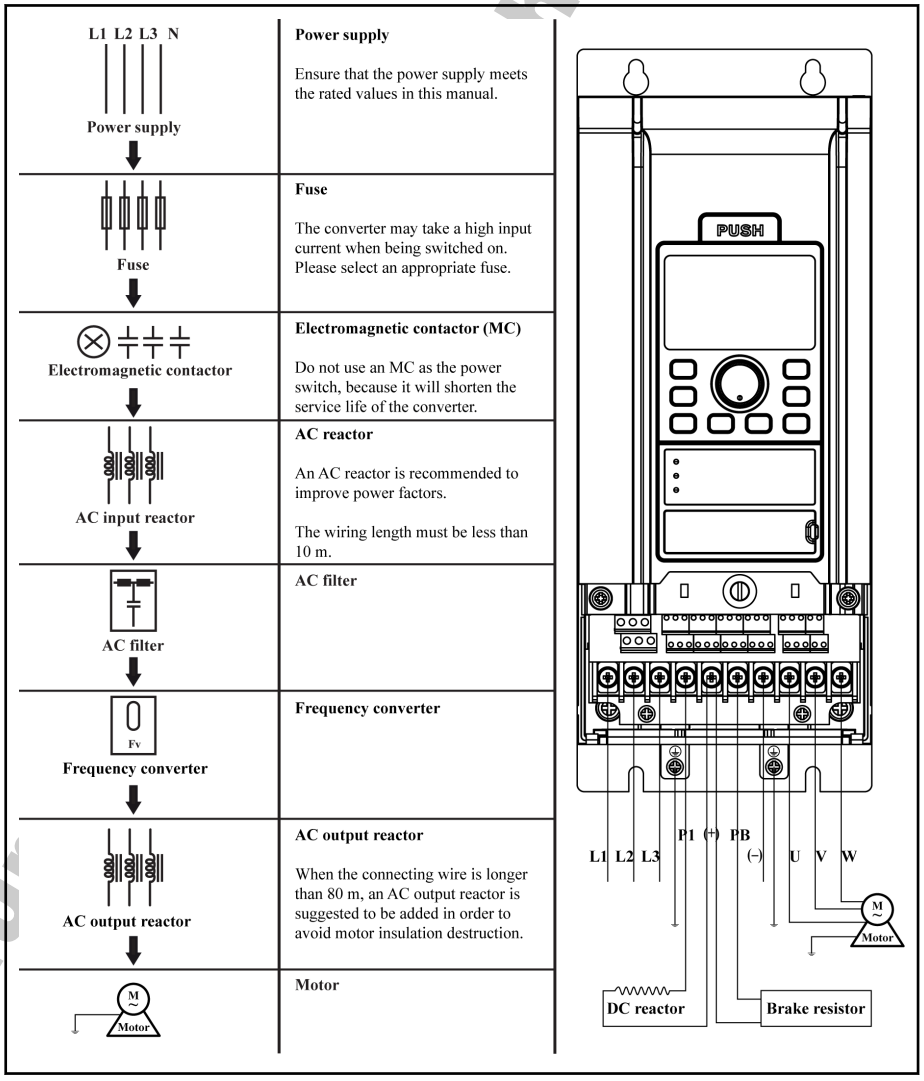

Fig.5-6: Main circuit wiring diagram

☞ To select an appropriate fuse, please refer to chapter 5.2.4 "Cable and Fuse Dimensions" on page 39.

Nur für

Installation

Main Circuit Wiring Steps

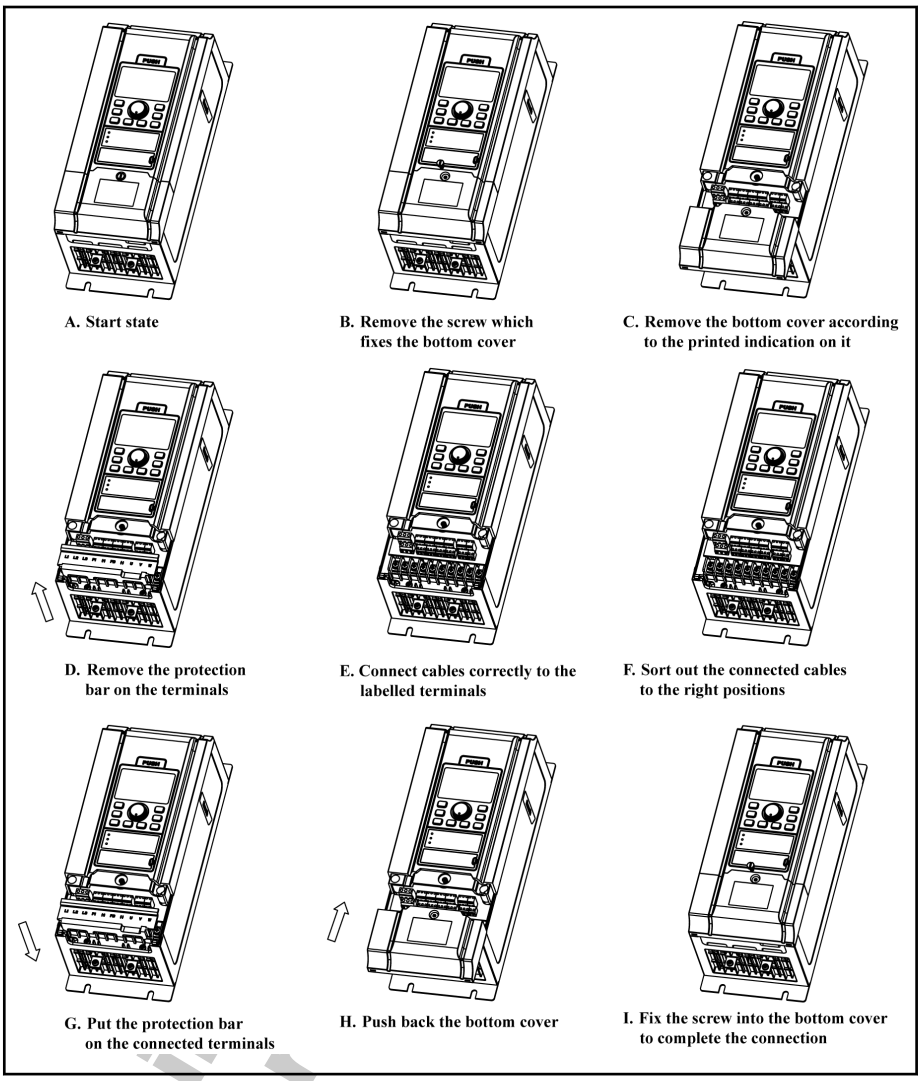

Fig.5-7: Main circuit wiring steps

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5.2.3 Control Circuit Wiring

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

5.2.4 Cable and Fuse Dimensions

The power cable dimensions and the fuse dimensions are based on the VDE 0298 (part 4) and the standard for the European countries EN 60204-1.

The dimension for flexible wiring is according to VDE 0298 (part 4) and for fix wiring according to VDE 0298 (part 4) or IEC 60364-5 (operating temperature at the conductor 90 °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. Determines the power size of the frequency converter;
2. Determines country of use (e.g. “international without USA/Canada”);
3. Determines installation type (e.g. B1 or B2);
4. In table row “Nominal current fuse”, read corresponding fuse.

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Installation

kW	Input Side			
	International without USA/Canada			
	Nominal current of Fuse in [A]	Installation mode B1 Cable size in [mm²]	Installation mode B2 Cable size in [mm²]	Installation mode E Cable size in [mm²]
0.4	6	1.5	0.75	0.75
0.75	10	1.5	1	1
1.5	10	1.5	1	1
2.2	16	1.5	1	1
4.0	20	1.5	1.5	1.5
5.5	25	2.5	2.5	2.5
7.5	25	4	4	2.5
11	35	6	6	6
15	50	10	10	10

Fig.5-8: Recommended cable dimensions_input side_international without USA/Canada

- Input Side and Output Side: The dimensioning is based on the supply voltage of 3x 380 VAC;
- For screw torque information, please refer to the table on next page.

kW	Input Side				
	USA/Canada				
	Nominal current of fuse in [A]	Cable size in [AWG]	Screw torque for power cable terminals in [Nm / lb-in] (screw size)	Input PE	
				Cable size in [mm²/AWG]	Torque in [Nm / lb-in] (screw size)
0.4	6	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
0.75	6	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
1.5	10	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
2.2	16	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
4.0	25	AWG12	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
5.5	40	AWG10	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
7.5	40	AWG10	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
11	70	AWG8	2.7 / 24 (M5)	10 / 7	2.7 / 24 (M5)
15	80	AWG6	2.7 / 24 (M5)	10 / 7	2.7 / 24 (M5)

Fig.5-9: Recommended cable dimensions_input side_USA/Canada

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kW	Output Side				
	International without USA/Canada	USA/Canada			
	Cable size in mm^2	Cable size in AWG	Screw torque for power cable terminals in Nm / lb-in (screw size)	Output PE	
				Cable size in mm^2/AWG	Torque in Nm / lb-in (screw size)
0.4	0.75(1)	AWG14	1.7 / 15 (M4)	10 / 7	1.7 / 15 (M4)
0.75	1(1)	AWG14	1.7 / 15 (M4)	10 / 7	1.7 / 15 (M4)
1.5	1(1)	AWG14	1.7 / 15 (M4)	10 / 7	1.7 / 15 (M4)
2.2	1(1)	AWG14	1.7 / 15 (M4)	10 / 7	1.7 / 15 (M4)
4	1(1)	AWG14	1.7 / 15 (M4)	10 / 7	1.7 / 15 (M4)
5.5	1(1)	AWG12	1.7 / 15 (M4)	10 / 7	1.7 / 15 (M4)
7.5	2.5(1)	AWG10	1.7 / 15 (M4)	10 / 7	1.7 / 15 (M4)
11	6(1)	AWG8	2.7 / 24 (M5)	10 / 7	2.7 / 24 (M5)
15	6(1)	AWG8	2.7 / 24 (M5)	10 / 7	2.7 / 24 (M5)

Fig.5-10: Recommended cable dimensions_output side

☞ (1) Installation Mode E

Dimensioning variables of the table values

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

     Internal wiring: Routing inside of control cabinet or inside of devices;

     Field wiring: Routing of cross sections of terminal connectors wired by the user (in the field).
2. **Recommendation for design of the fuses:**
   - **International except for USA/Canada:** Class gL-gG; 500 V, 690 V; design NH, D (DIAZED) or D0 (NEOZED).

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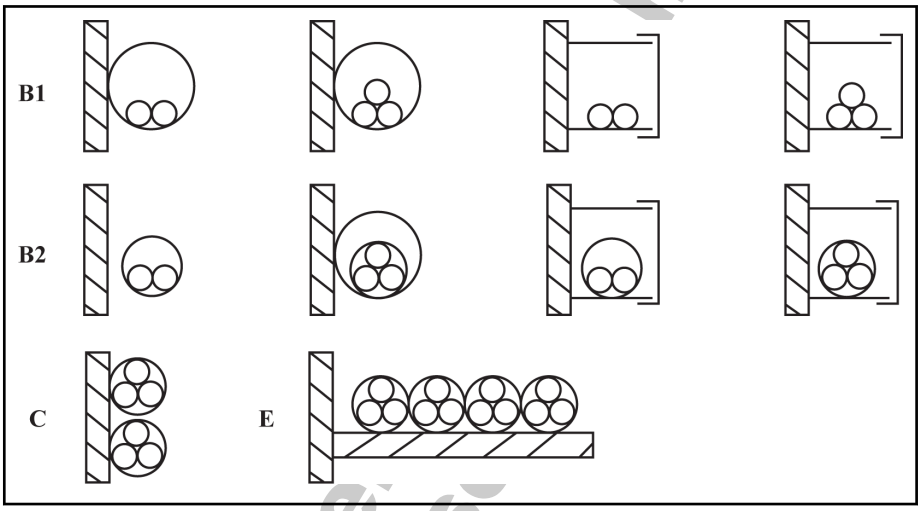
Characteristics

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

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

- USA/Canada: Class J; 600 V



B1	Conductors in installation pipes and in installation channels that can be opened
B2	Cables or lines in installation pipes and in installation channels that can be opened
C	Cables or lines on walls
E	Cables or lines on open cable trays

Fig.5-11: Cable installation types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)

Wire range for field wiring terminals

Frame size	Housing	Terminal type	Wire range [AWG]
0.4 − 2.2 kW 4.0 − 7.5 kW	A B	Main terminal block HP-T4052-2-10P	10 − 20
		Terminal block (CPU board) MKKDSN 1, 5	16 – 26
		Terminal block (CPU board) MKKDS 1	16 – 26
11 − 15 kW	C	Main terminal block HP-T5325-1-10P	4 – 10
		Terminal block (CPU board) MKKDSN 1, 5	16 – 26
		Terminal block (CPU board) MKKDS 1	16 – 26

Fig.5-12: Wire range for field wiring terminals

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5.3 Wiring Terminals Description

5.3.1 Main Circuit Terminals

Main circuit terminals description

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

Main circuit terminals illustration

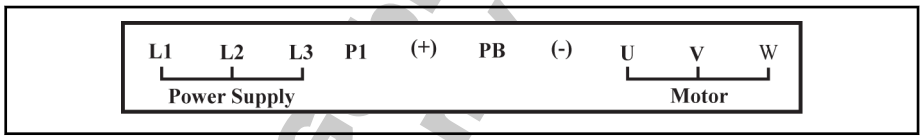

Fig.5-13: Main circuit terminals illustration

Fig.5-14: Grounding terminal

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Installation

5.3.2 Control Circuit Terminals

Control circuit terminals description

Type	Terminal	Signal function	Description	Signal requirement
Digital input signals	FWD	FWD/Stop	See parameters [b1.02]、[E0.00]	24 VDC 8 mA inputs via opto-electric couplers
	REV	REV/Stop	See parameters [b1.02]、[E0.00]	
	X1 − X8	Multiple speed commands	Activated with “closed”	
	SC	Shared connection for digital signals	Isolated from GND	
Analog input signals	±10 V	Supply voltage for external frequency setpoint value specified	Power supply for speed commands	±10 V (Max. current 10 mA)
	VR1	Analog frequency commands	Analog voltage frequency input 1	Input voltage range：-10 − 10 V ; Input resistance：100 kΩ ; Resolution：1/2000
	VR2		Analog voltage frequency input 2	Input voltage range：0 − 10 V ; Input resistance：100 kΩ ; Resolution：1/2000
	+I		Analog current frequency input	Input current range：4 − 20 mA ; Input resistance：165 Ω ; Resolution：1/1000
	GND	Frame potential (0 V)	Isolated from COM	
Digital output signals	OUT1-CME	Open collector output 1	Can be programmed as multiple function digital outputs, see parameters [E1.00], [E1.01].	Open collector outputs: Max. output voltage: +24 VDC; Max. current: 50 mA
	OUT2-CME	Open collector output 2		
	DO-COM	Digital frequency output	Can be programmed as multiple function pulse outputs, see [E1.16].	Open collector outputs via opto-couplers: Max. output frequency 50 kHz (set by [E1.17]); Max. output voltage: 24 VDC
	Ta	Relay changeover 1 contacts	In case of error protection: Ta − Tb closed; Tb − Tc open (Tb is the shared terminal.)	Rated capacity of contact transmitter: 250 VAC 3 A ; 30 VDC 3 A
	Tc			
	Tb	Relay 1 shared contact		
	Pa	Relay changeover 2 contacts	Programmable multi-function relay outputs, see parameters [E1.02] Pa − Pb always open ; Pb − Pc always closed (Pb is the common terminal)	Rated capacity of contact transmitter: 250 VAC 3 A; 30 VDC 3 A
	Pc			
	Pb	Relay 2 shared contact		
	+24 V	Shared +24 VDC connection for digital output signals	---	

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Type	Terminal	Signal function	Description	Signal requirement
Analog output signals	FM1-GND	Analog multi-function output 1	Programmable analog output with multiple functions. See parameters [E1.10] − [E1.15]	Output voltage / current can be set via JP3 for FM1and JP4 for FM2: Output voltage: 0 / 2 – 10 V Output current: 0 / 4 – 20 mA
	FM2-GND	Analog multi-function output 2		
Encoder signals	PGP1-COM	Supply voltage +24 V	Voltage supply 1 for the encoder	Max. output current:100 mA
	PGP2-COM	Supply voltage +8 V − +20 V	Voltage supply 2 for the encoder	Max. output current:100 mA
	A+	Encoder signal A	---	Encoder supply voltage range of differential inputs: +8 V − 24 V ; Max. input frequency: 200 kHz
	A-			
	B+	Encoder signal B		
	B-			

Fig.5-15: Control circuit terminals description

Control circuit terminals illustration

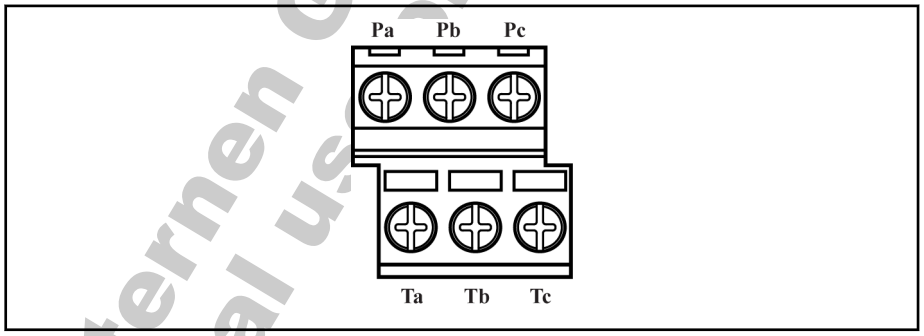

Fig.5-16: Control circuit terminals_1

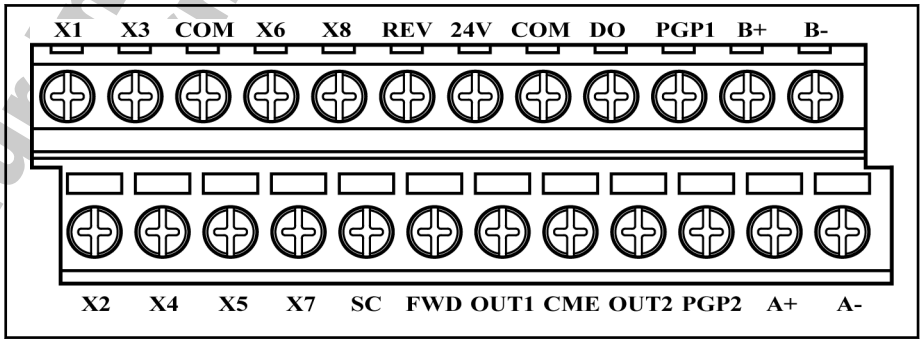

Fig.5-17: Control circuit terminals_2

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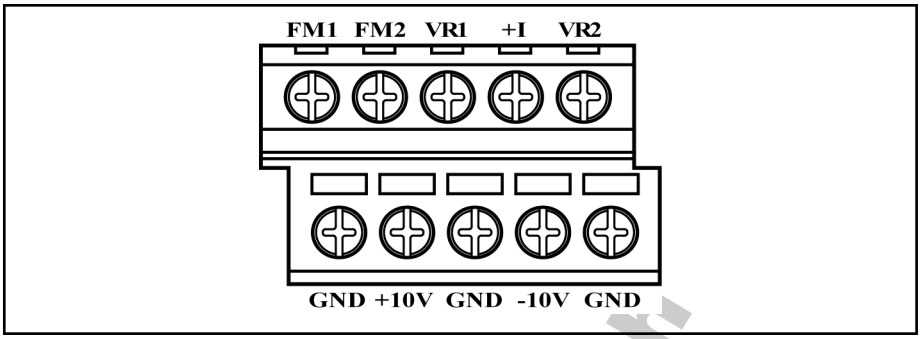

Fig.5-18: Control circuit terminals_3

Analog input terminals (+10 V, VRC, GND, +I)

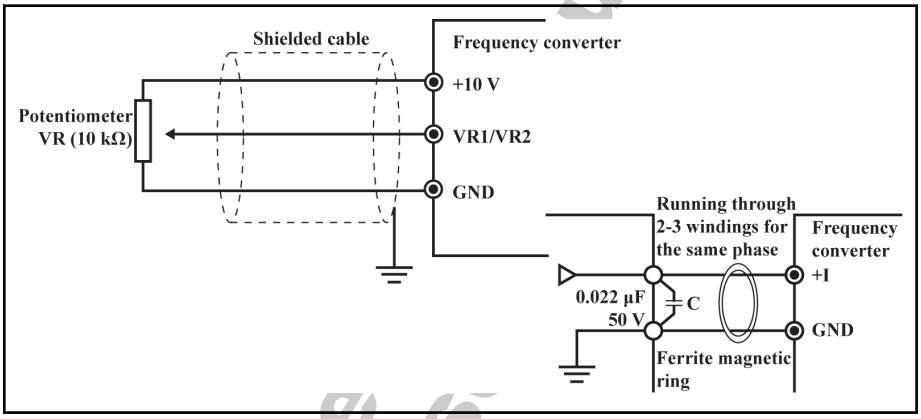

Fig.5-19: Analog input terminals (+10 V, VRC, GND, +I)

1. For connection of low level analog signals, which are easily affected by external interference, the wiring length should be as short as possible (less than 20 m), shielded cables must be used.
2. Use twin contacts to handle low level signals if contacts are used in the circuit. In addition, do not ground the GND terminal.
3. Incorrect operation may occur due to interference on the analog signal. In such cases, connect a capacitor and ferrite core at the side of output of the analog signal, as shown below.

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5.3.3 Switch Wiring

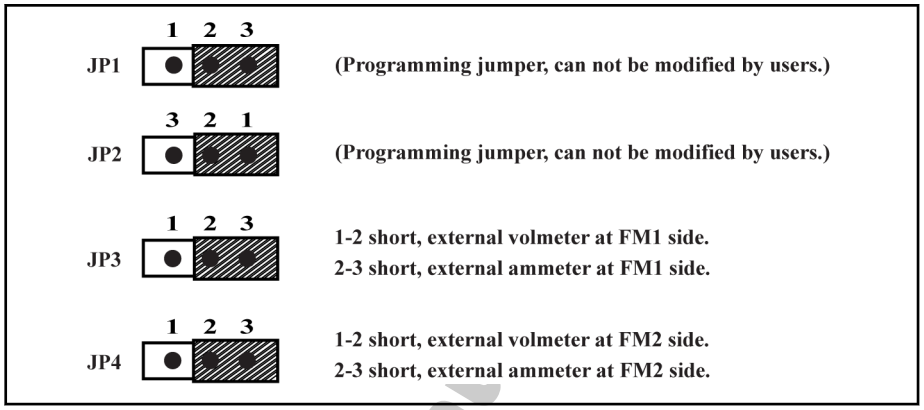

Fig.5-20: Switch description

Shown are factory defaults.

5.3.4 NPN/ PNP Switch SW1

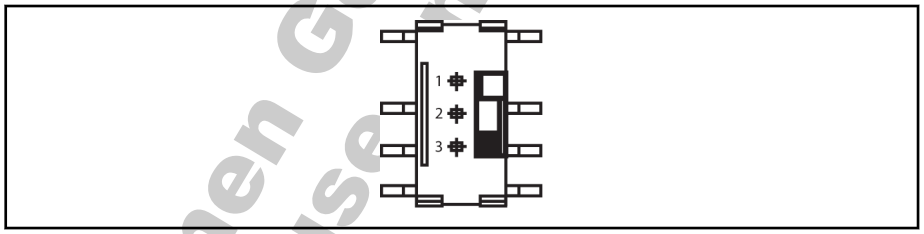

Fig.5-21: NPN/ PNP Switch SW1

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

A three position switch determines:

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

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5.3.5 NPN and PNP Modes

The SMD switch SW can swich between 0 V (NPN / passive input) and +24 V (PNP / active input) inputs , respecitve external +24 V power supply is also available, which improves the flexibility of singal input mode.

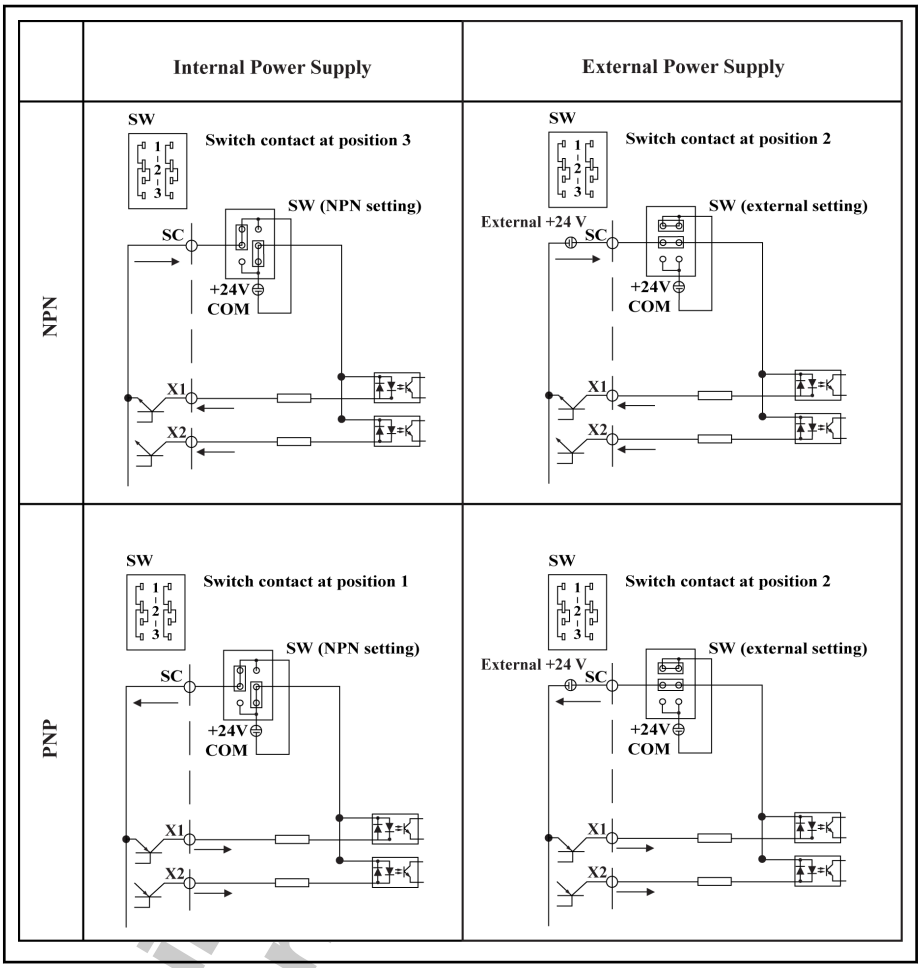

Fig.5-22: NPN and PNP modes

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5.3.6 Encoder Signal Selection Switch SW2

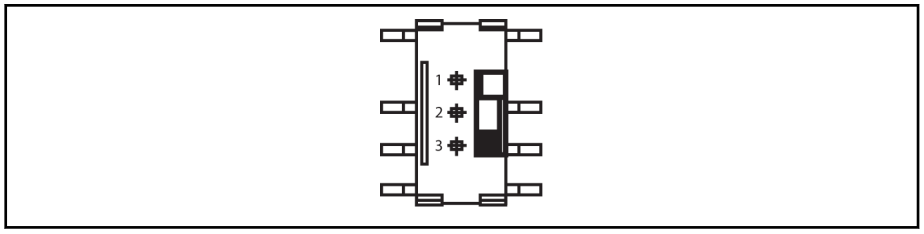

Fig.5-23: Encoder Switch SW2

☞ The factory default for the three position switch is differential inputs A+, A-, B+ and B- (Switch contact at position 3).

Encoder input signals are set by three positions of SW2:

Position 1 : Encoder provided by PGP1 , encoder signals are provided via open collector inputs A- and B-;

Position 2 : Encoder provided by PGP2 , encoder signals are provided via open collector inputs A- and B-;

Position 3 : Encoder signals are provided via differential inputs A+, A-, B+ and B-.

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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 operation state of the frequency converter. The keys allow the user to program the frequency converter.

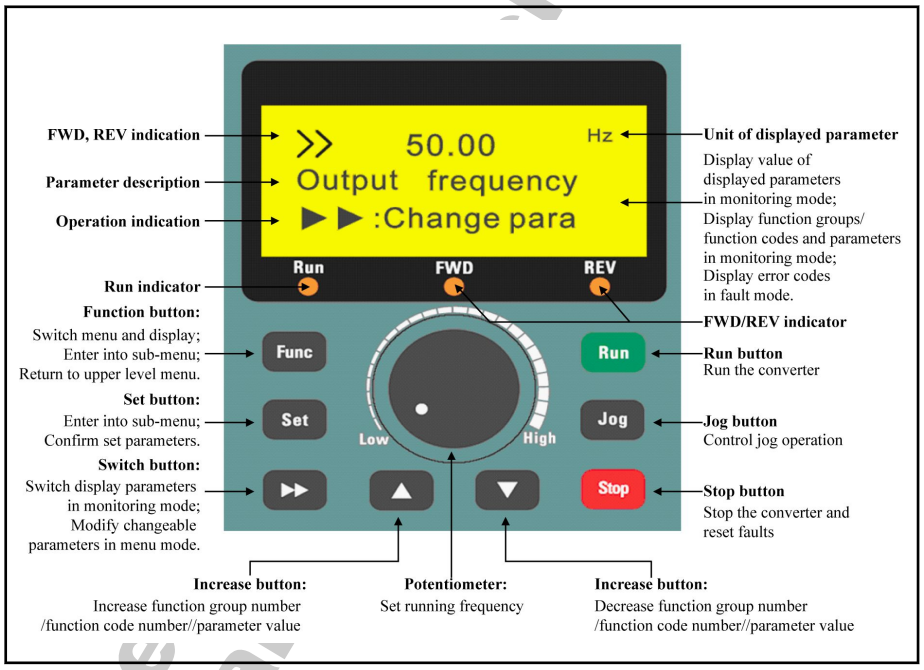

Fig.6-1: Operating panel

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Commissioning

6.1.2 3-Level Menu Structure

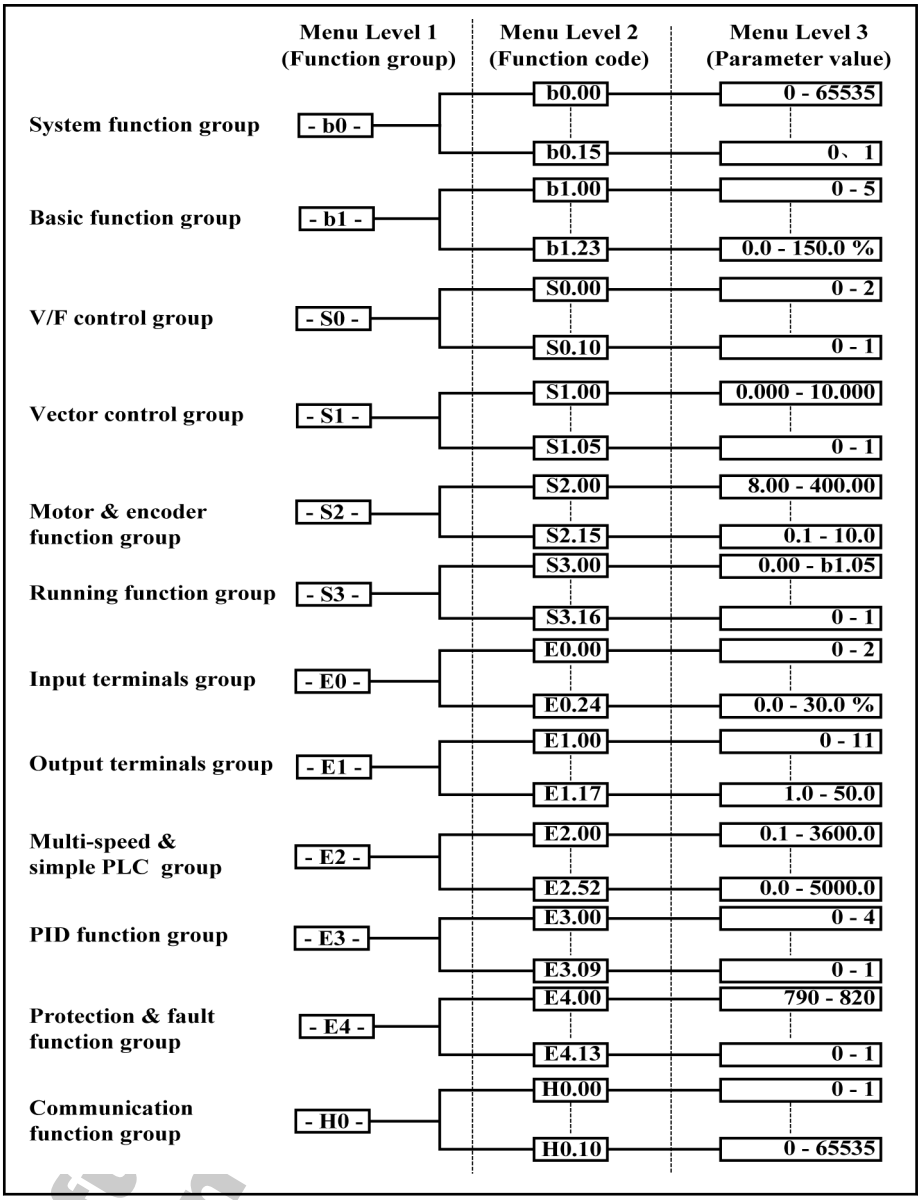

Fig.6-2: 3-level menu structure

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

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6.1.3 Operation Mode Description

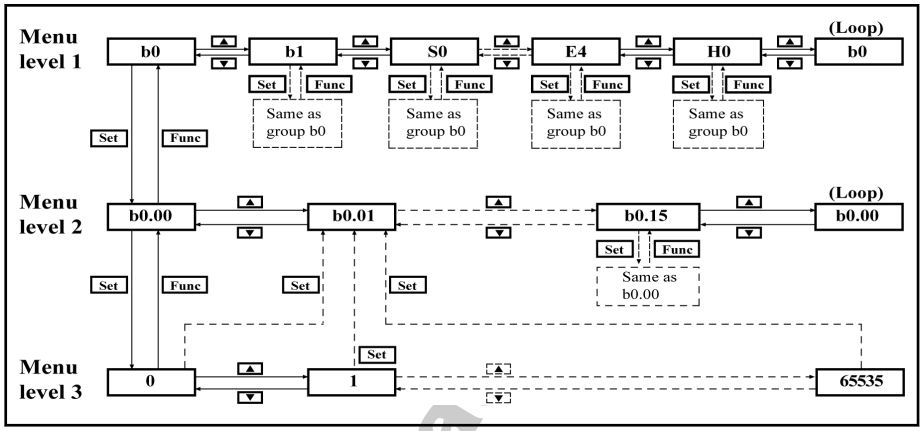

Fig.6-3: Operation mode description

6.1.4 Example of Operating Panel Operation

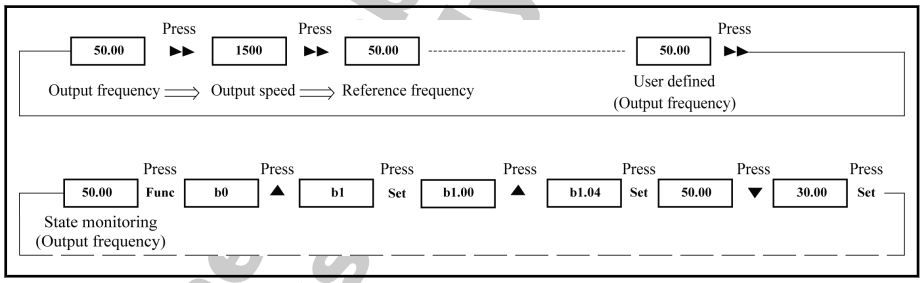

Fig.6-4: Example of operating panel operation

6.2 Commission Process

6.2.1 Check and Preparation before Commissioning

1. Check if the wiring is correct. Particularly, ensure that the output terminals U, V and W of the converter are not connected to the power supply and that the ground terminal is well grounded.
2. Ensure that there are no short circuits between terminals, live terminals or short circuit to ground.
3. Ensure that terminal connections, connectors and screws are secure.
4. Ensure the motor is not connected to other loads.
5. Check that all inputs are off before powering on, to ensure that the converter will be started as expected and no unexpected action occurs.
6. Make the following checks after powering on:
   - Set frequency flashes on the display (without fault indication);
   - The displayed parameters match with the field application.

6.2.2 Notes on Commissioning

1. The converter has no internal contactor, and will be energized once the main power supply is connected. When the **Run** key is pressed down (or the control through terminals is selected), the converter will give output.
2. By factory default, the converter initially displays output frequency after being energized. You may change it to another parameter as instructed

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in chapter 7.4.1 "Category b: Basic Parameters" on page 85. The factory defaults are based on standard applications with standard motors.

3. The frequency command of the converter is set to be 0.00 Hz upon delivery, meaning that the motor will remain static. To start the motor, the converter settings must be changed with the operating panel.

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

6.2.3 Fv Basic Parameter Fast Setting

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

Function code	Name	Setting range	Minimum unit	Factory default	Symbol
b0.04	Converter input supply voltage	380 − 480 V	1	380	◆
b1.09	Acceleration time 1	0.1 − 3600.0s	0.1s	10.0s	◇
b1.10	Deceleration time 1	0.1 − 3600.0s	0.1s	10.0s	◇
S2.00	Rated motor frequency	8.00 − 400.00 Hz	0.01 Hz	50.00 Hz	◆
S2.01	Rated motor rotation speed	1 − 30000 rpm	1 rpm	1440 rpm	◆
S2.02	Rated motor power	0.4 − 1000.0 kW	0.1 kW	Depends on model	◆
S2.03	Rated motor voltage	0 − 480 V	1 V	Depends on model	◆
S2.04	Rated motor current	0.1 − 1000.0 A	0.1 A	Depends on model	◆

Fig.6-5: Basic parameter fast setting

6.2.4 Example: Commissioning of Converter with Potentiometer

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

Sequence	Operation	Description
1	Rotate the potentiometer counterclockwise to the greatest extent.	The initial frequency value is 0.00
2	Press **Run** 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: If any abnormality occurs and stop the motor immediatelyby shutting off the power. Restart commissioning only after the fault causes have been removed.
5	Rotate the potentiometer clockwise (rightwards)	The motor accelerates

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Sequence	Operation	Description
6	Rotate the potentiometer counterclockwise (leftwards)	The motor decelerates
7	Press **Stop** key	Enter the command for stopping. The motor stops.

Fig.6-6: Commissioning of converter with potentiometer

☞ The default control mode of the frequency converter is operating panel control.

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. Set [b0.02]=1 will start initialization to restore factory defaults.

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	3Φ / 380 V / 50 Hz SVPWM wave
Operating frequency	0 − 50 Hz
Acc./Dec. time	Linear , Acc. For 10s/Dec. for 10s
Protection mode in case of motor overload	Rated current of Motor*100 %
Operating panel options	Control **Run**、**Stop** with▲▼or via external analog voltage

Fig.6-7: Factory defaults

6.4 Solutions for Simple Fault during Commissioning

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

6.5 Notes on Frequent Start and Stop

1. Do not use the electromagnetic contactor KM connected prior to terminals L1, L2 and L3 to start or stop the frequency converter to avoid early aging and damage of the filter capacitor. External terminals **FWD**, **REV** and X1 - X8 may be used to start and stop the frequency converter.
2. The current limiting resistor for capacitor recharging may be damaged due to frequent start and stop with the electromagnetic contactor KM connected prior terminals L1, L2 and L3.

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7 Parameter Settings

7.1 Main Functions

7.1.1 Control Command

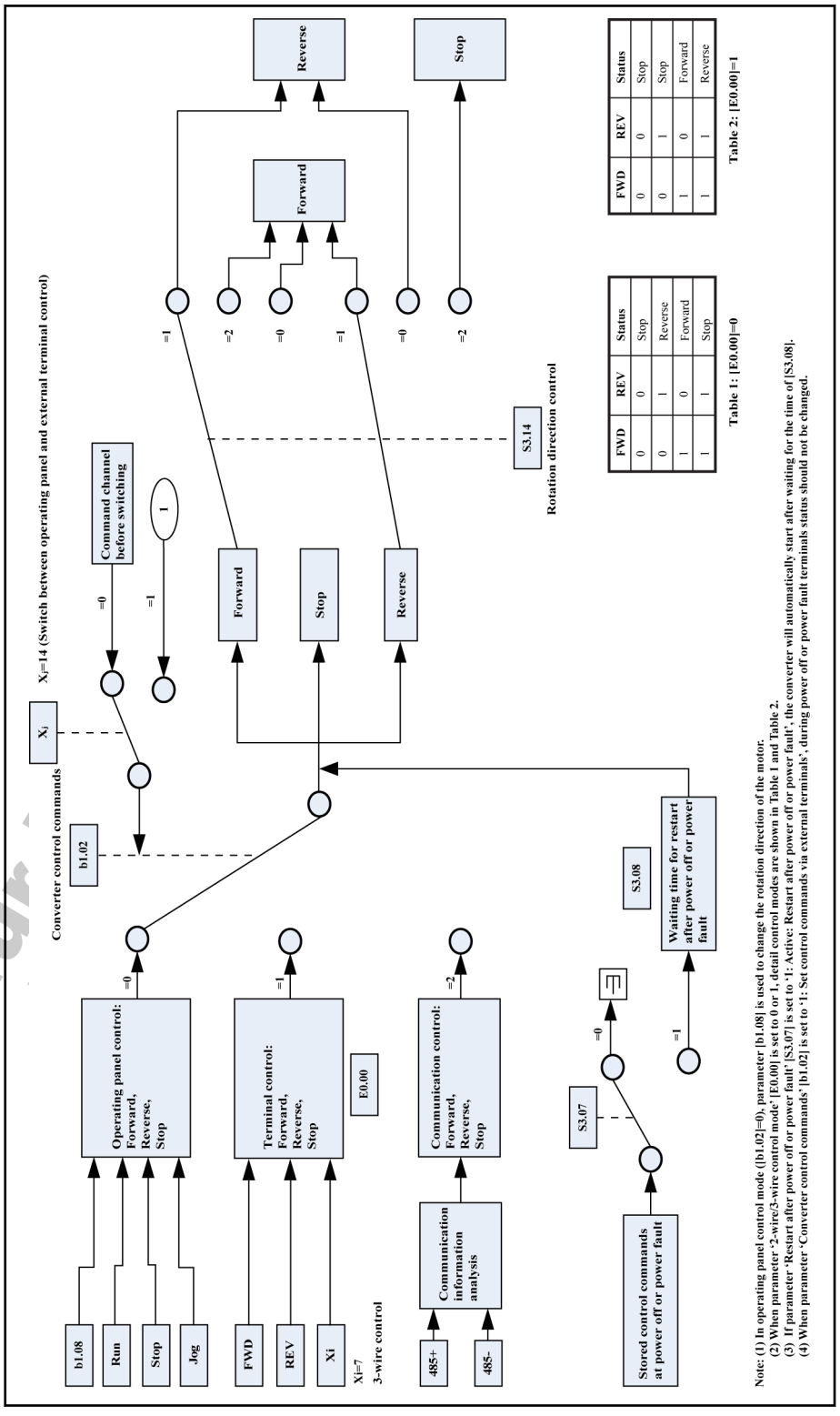

Fig.7-1: Control command

Nur für

Parameter Settings

7.1.2 Frequency Setting

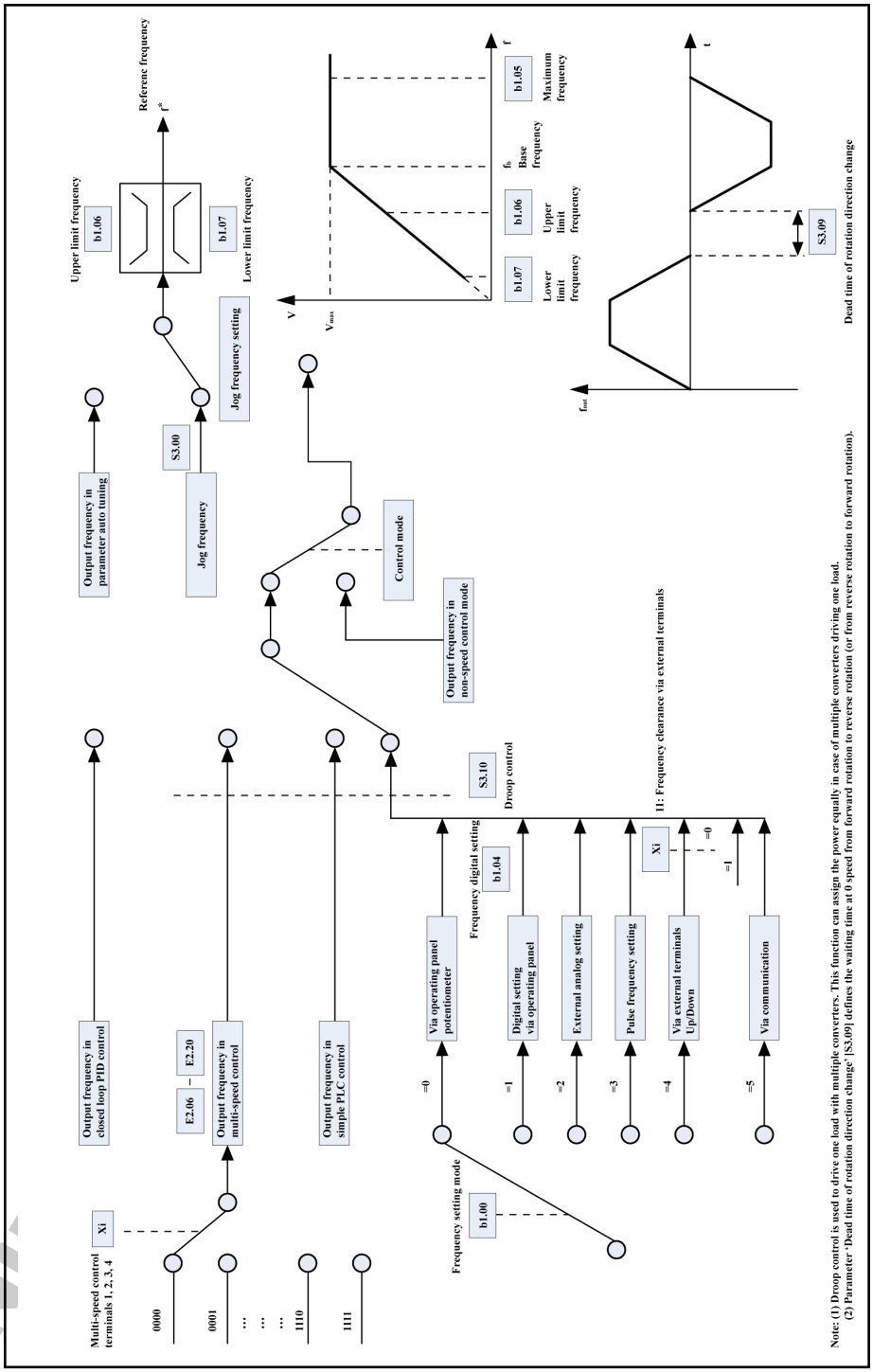

Fig.7-2: Frequency setting

7.1.3 Start Control

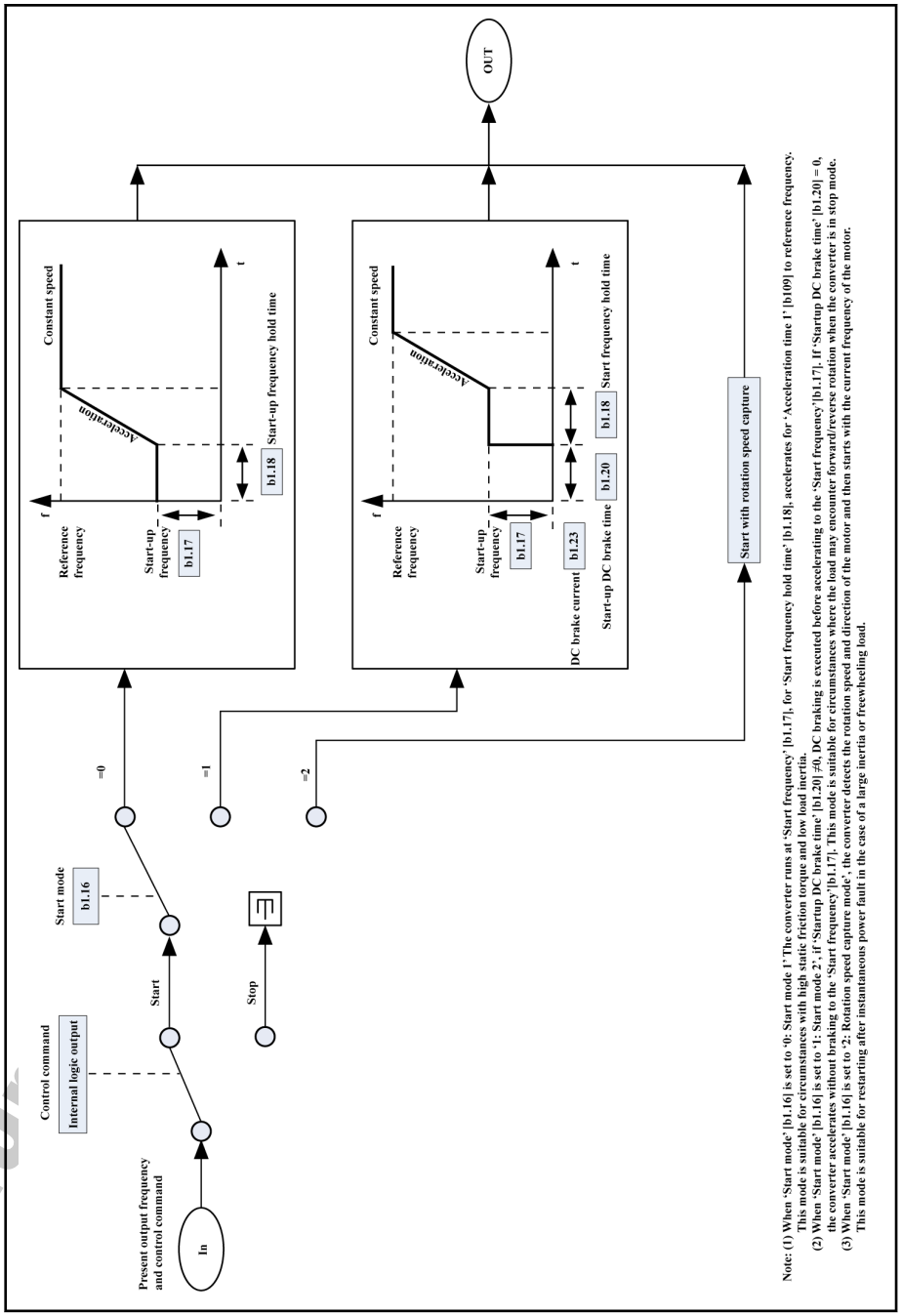

Fig.7-3: Start control

Nur für

Parameter Settings

7.1.4 Stop Control

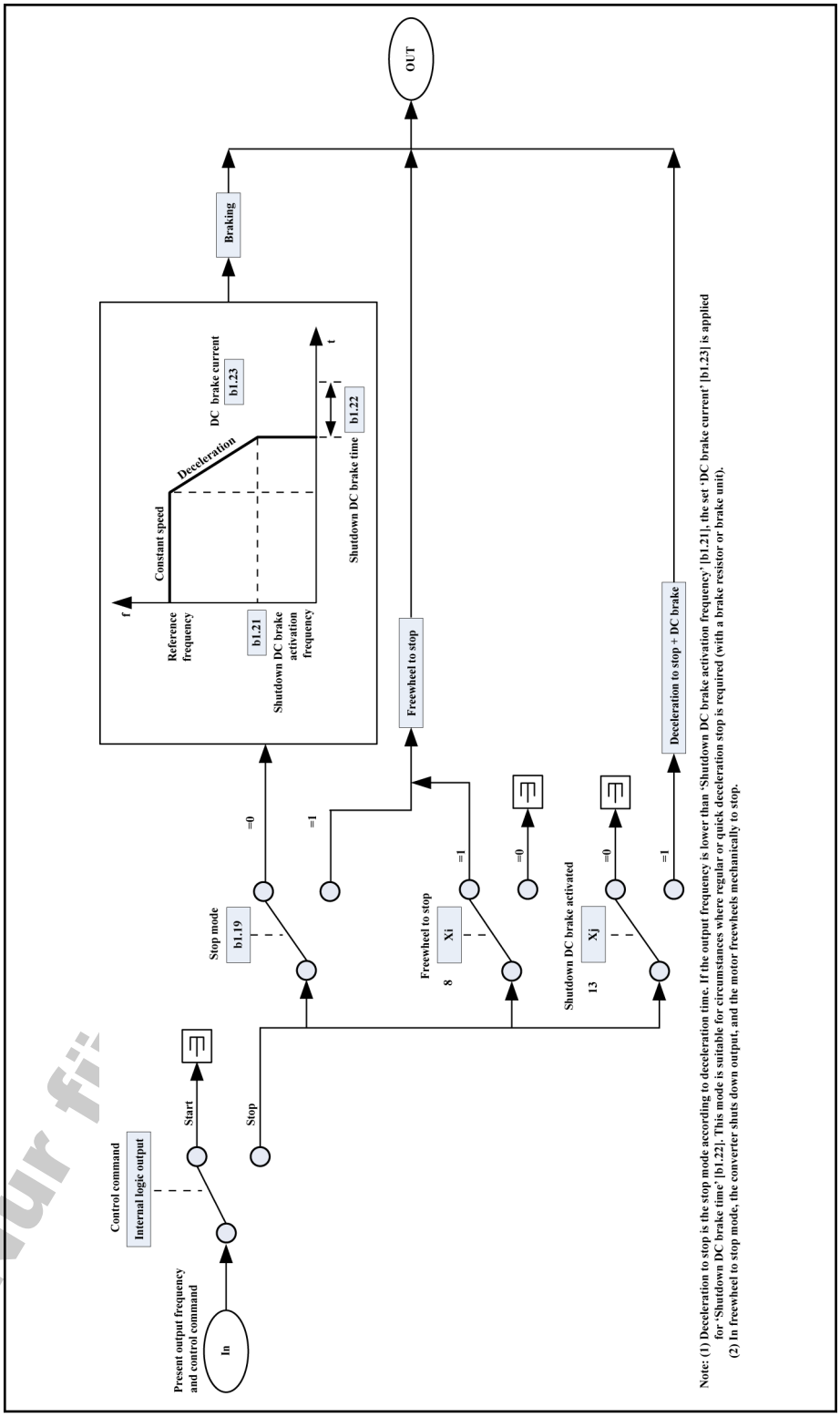

Fig.7-4: Stop control

7.1.5 Linear/S-curve Acceleration/Deceleration

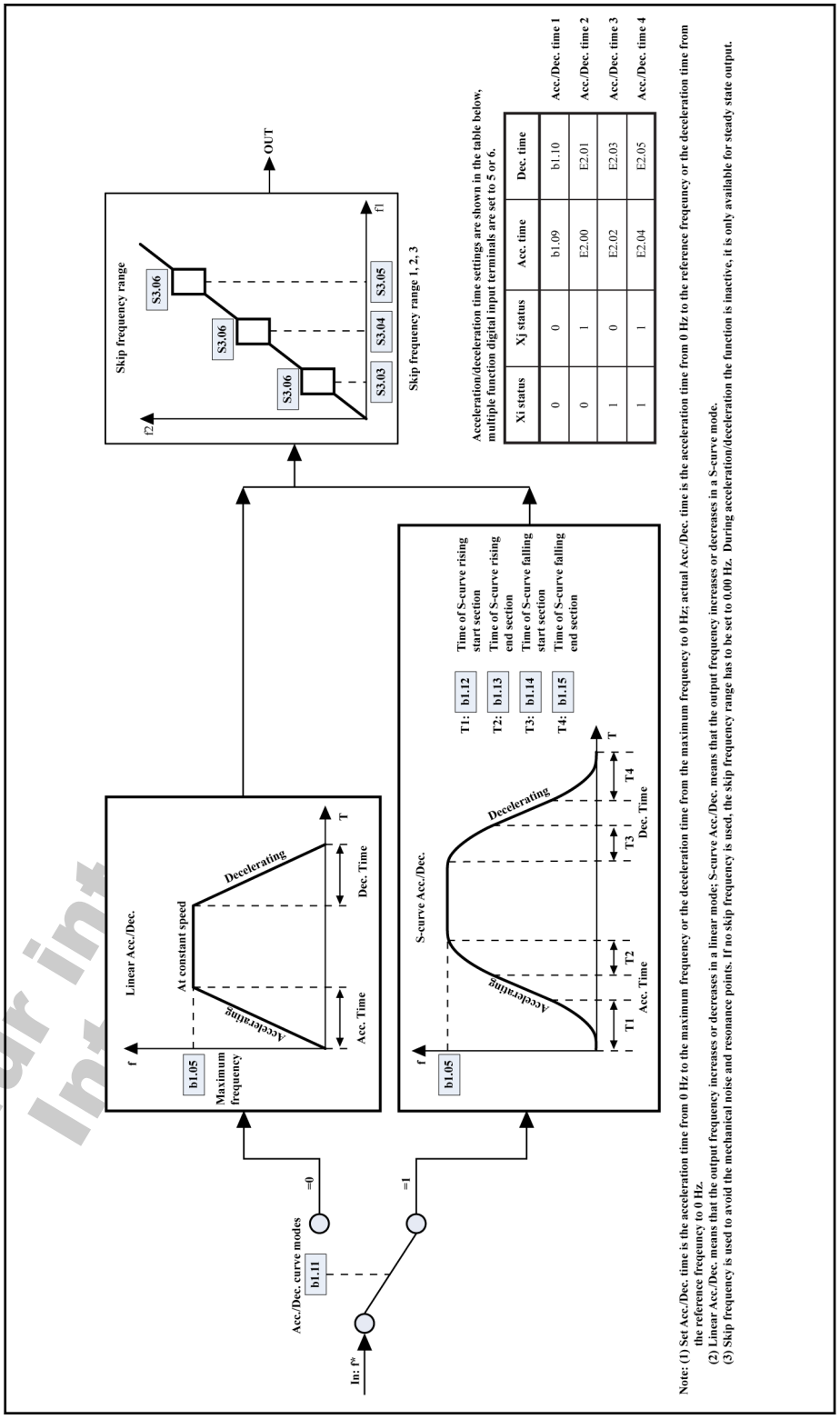

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Fig.7-5: Linear/S-curve acceleration/deceleration

Parameter Settings

7.1.6 Simple PLC Control

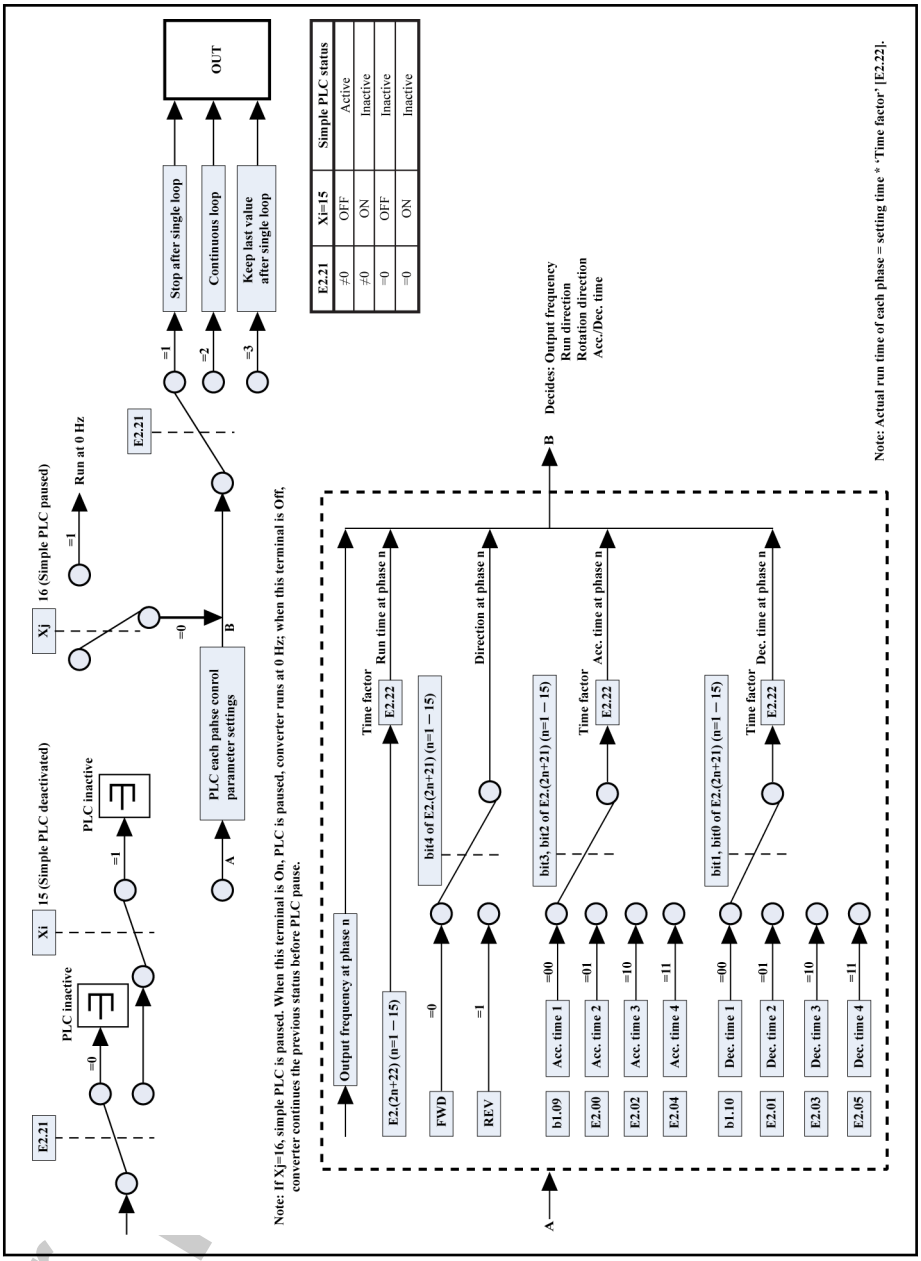

Fig.7-6: Simple PLC control

7.1.7 PID Control

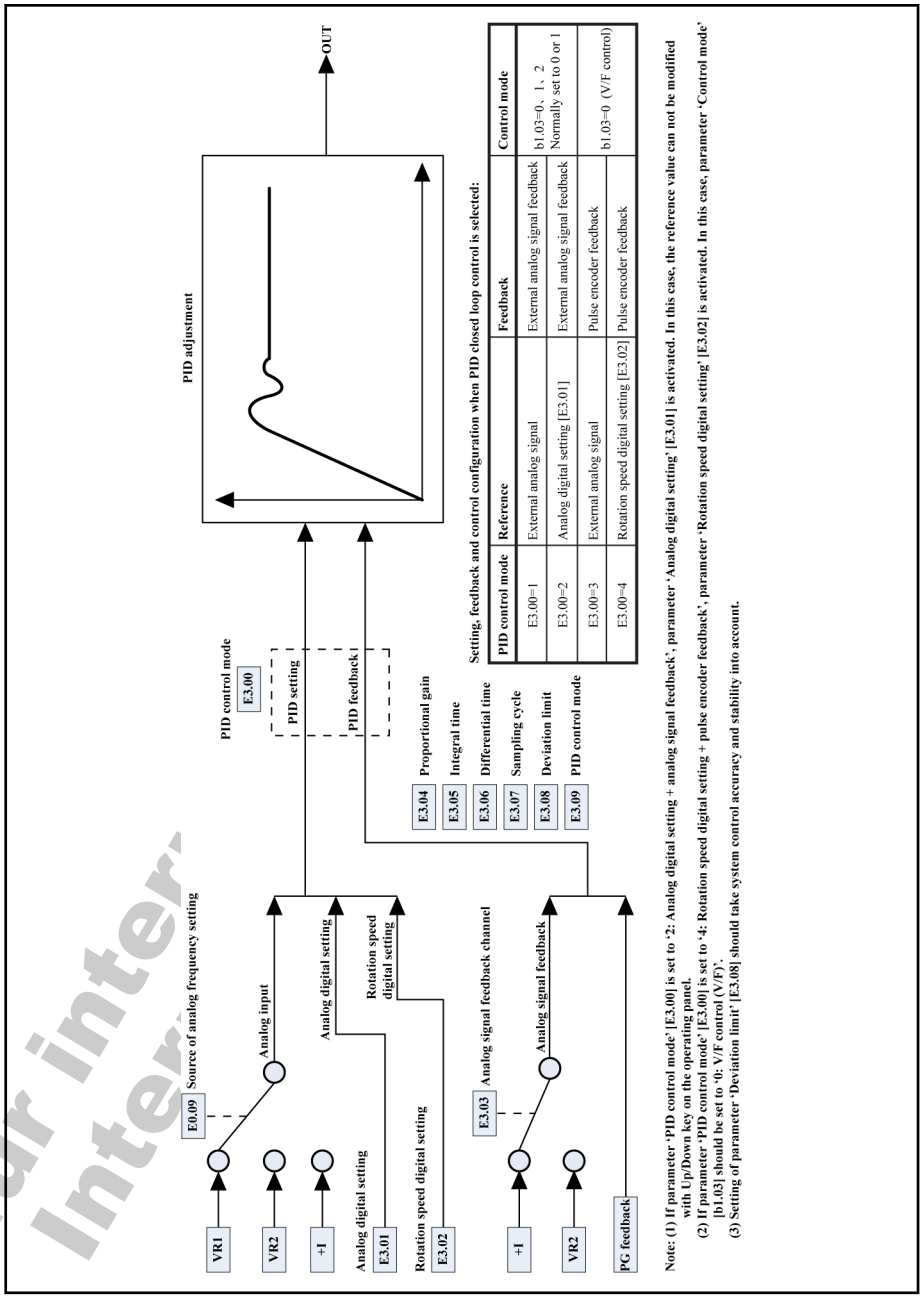

Fig.7-7: PID control

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Parameter Settings

7.1.8 Frequency Setting via Analog Inputs and Pulse Inputs

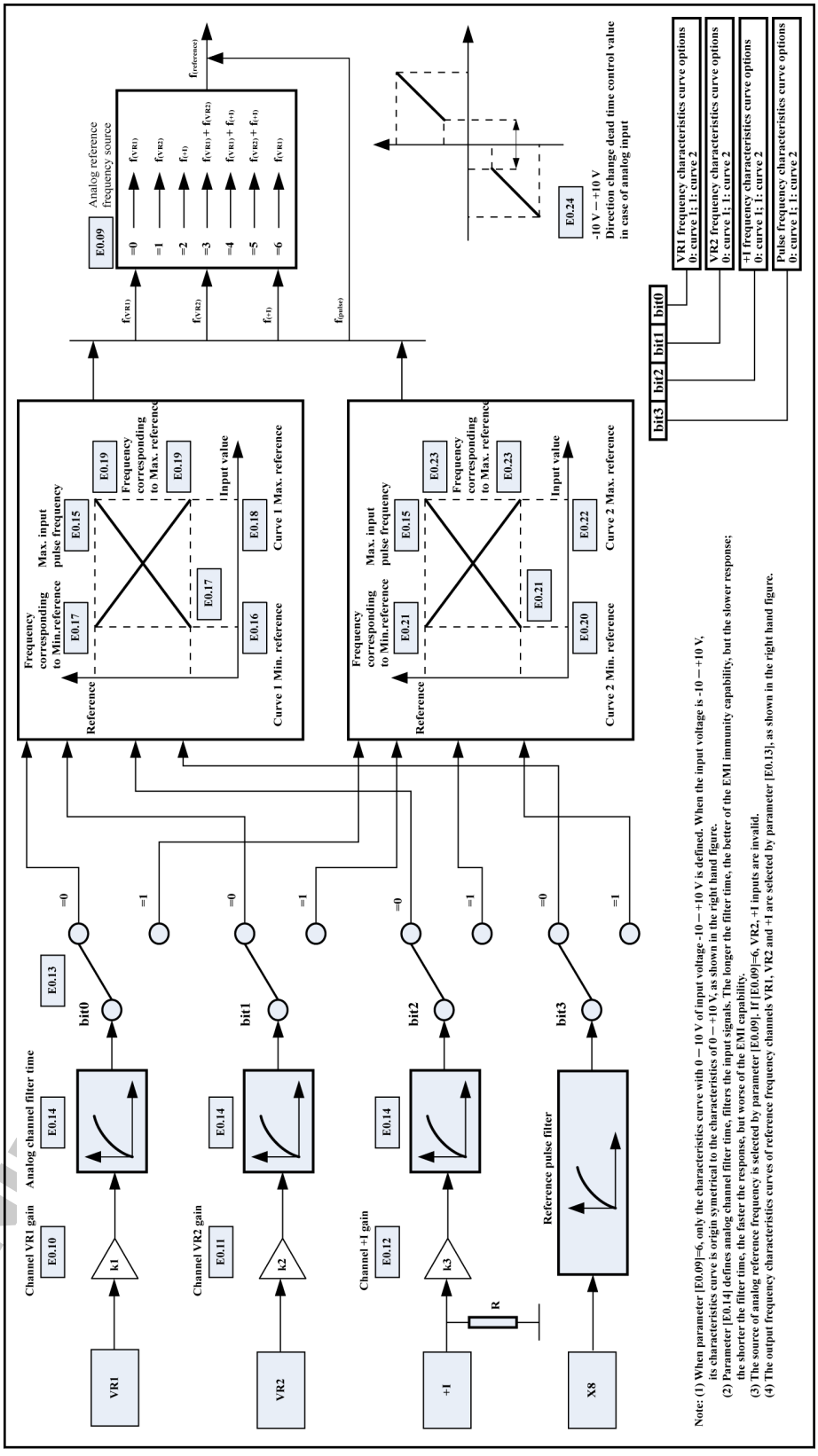

Fig.7-8: Frequency setting via analog inputs and pulse inputs

7.1.9 Multiple Function Digital Input Terminals

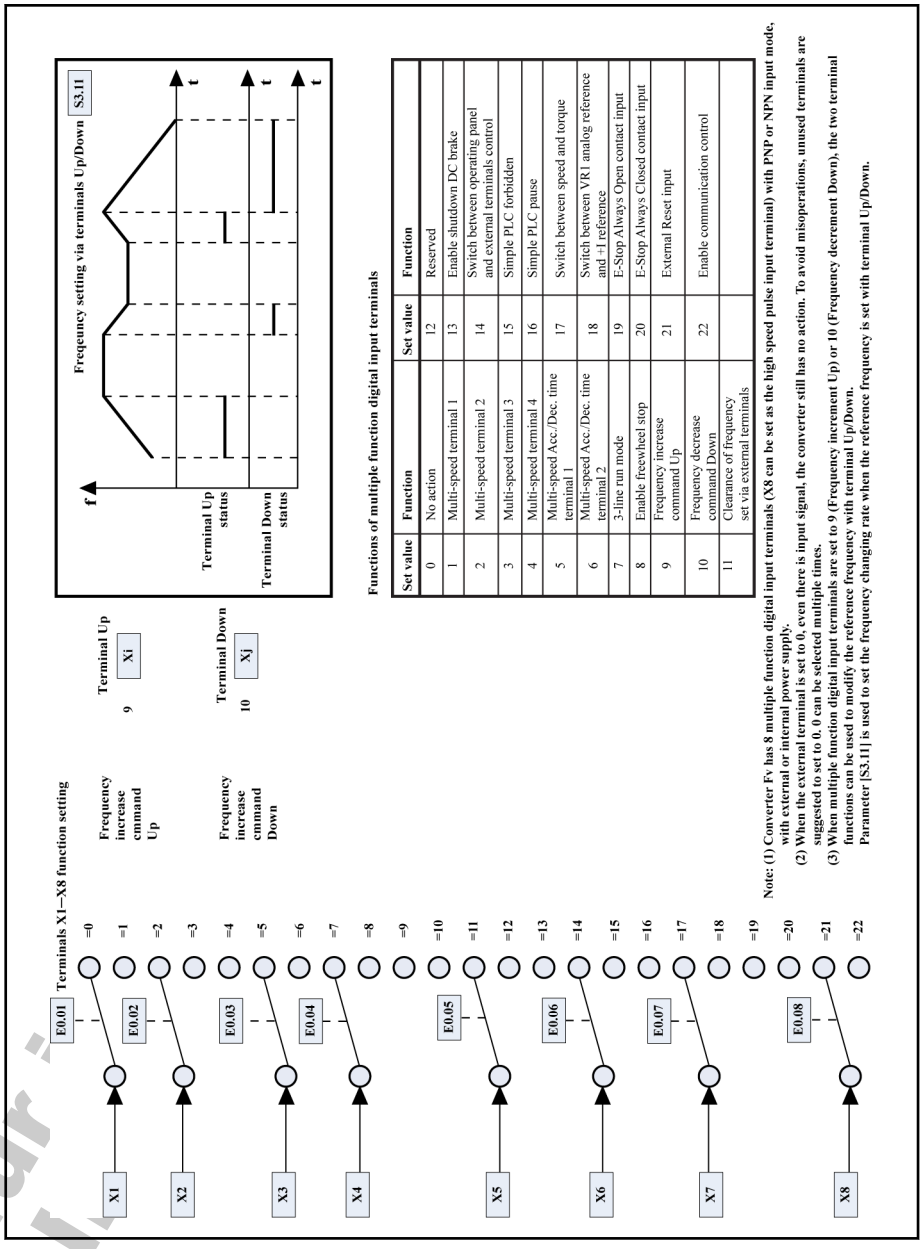

Fig.7-9: Multiple function digital input terminals

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7.1.10 Analog Output Terminals

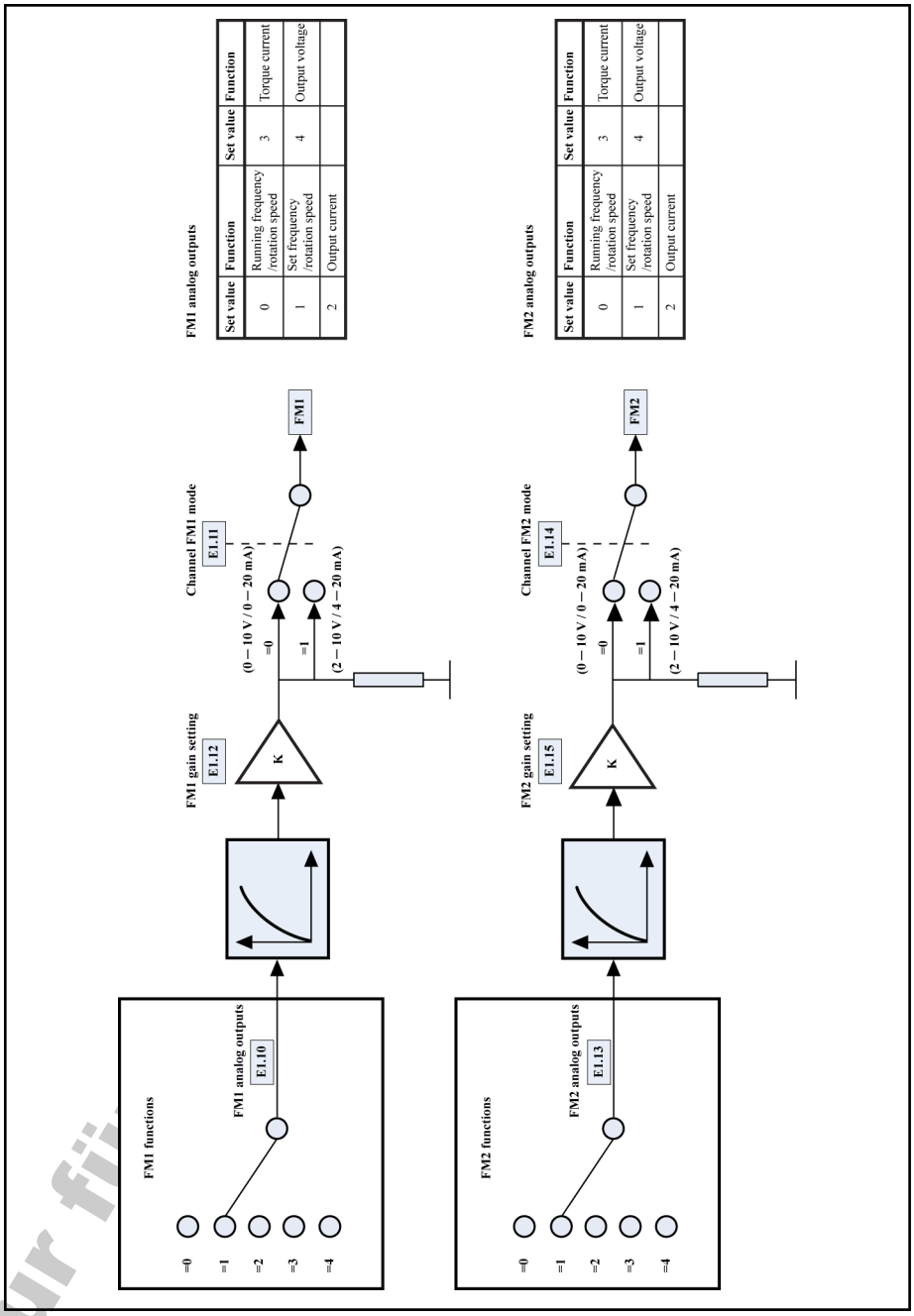

Fig.7-10: Analog output terminals

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7.1.11 Digital Output Terminals

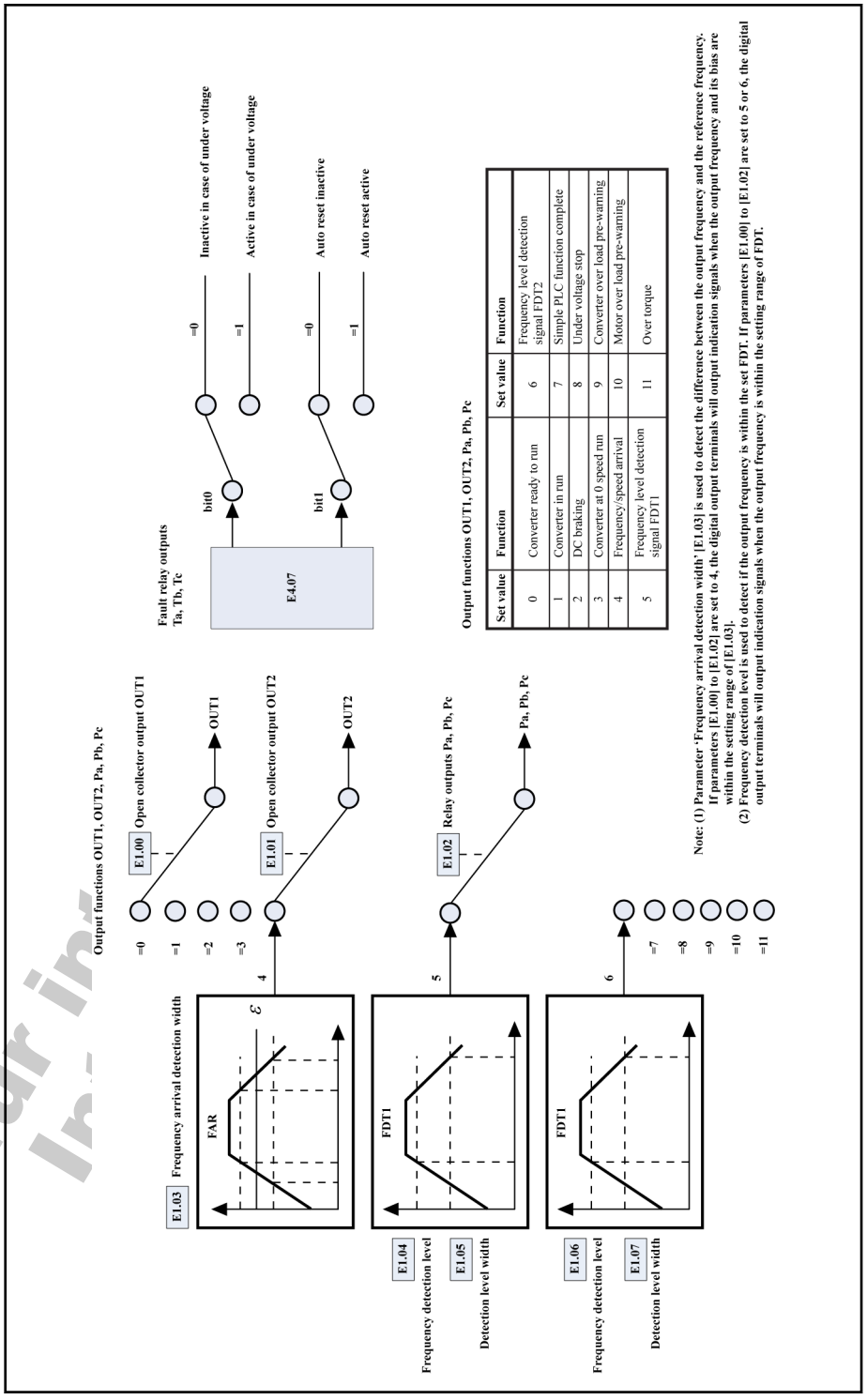

Fig.7-11: Digital output terminals

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7.2 Description of Attribute Symbols in Parameter Tables

The meaning of attribute symbols in the parameter tables are explained in fig. 7-12 "Parameter attributes and descriptions" on page 68.

Parameter attribute	Description
◇	Parameter setting can be modified when the frequency converter is in run or stop mode.
◆	Parameter setting cannot be modified when the frequency converter is in run mode.
◎	Parameter setting is a calculated value which cannot be modified.

Fig.7-12: Parameter attributes and descriptions

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7.3 Parameters Functions

7.3.1 Category b: Basic Parameters

Group b0: System Parameters

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
System parameters	b0.00	User password	0 − 65535	1	0	◇
	b0.01	LCD language	0: Chinese; 1: English	1	0	◇
	b0.02	Restore factory default	0: No action 1: Restore parameter to factory default Note: The value is automatically set to 0 after restoring factory default.	1	0	◆
	b0.03	Parameter copy	0: No action 1: Copy from converter to operating panel 2: Copy from operating panel to converter Note: The value is automatically set to 0 after parameter copy.	1	0	◆
	b0.04	Mains voltage	380 − 480 V	1 V	380 V	◆
	b0.05	PWM frequency	1.0 − 15.0 kHz	0.1 kHz	Depends on model	◇
	b0.06	Automatic adjustment of PWM frequency	0: Off 1: On	1	1	◆
	b0.07	LCD backlight mode	0: Energy saving; 1: Always on	1	0	◇
	b0.08	LCD display in run mode	0: Output frequency 1: Output rotation speed 2: Set output frequency 3: Set rotation speed 4: Output voltage 5: Output current 6: Output power 7: DC bus voltage 8: Torque current 9: Excitation current 10: User-defined reference value 11: User-defined output value 12: Reference torque 13: Reserved	1	0	◇
	b0.09	LCD display in stop mode	1	2	◇	
	b0.10	Scale factor of output frequency	0.1 % − 1000.0 %	0.1 %	100.0 %	◇
	b0.11	Parameter filter setting	0: b Parameters 1: b, S Parameters 2: b, S, E Parameters 3: b, S, E, H Parameters	1	0	◇
	b0.12	Heat sink temperature	Read-only	1 ℃	Measured value	◎
	b0.13	Total running time	0 − 65535 hours	1 hour	0 hour	◎
	b0.14	Firmware version	Read-only	—	—	◎
	b0.15	Reserved	0, 1	1	0	◆

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Group b1: Basic Parameters

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Basic parame-ters	b1.00	Frequency setting mode	0: Set by operating panel potentiometer 1: Set by operating panel 2: Set by external analog terminals 3: Set by pulse frequency 4: Set by external **Up/Down** terminals 5: Set via communication	1	0	◆
	b1.01	Saving options of digital set frequency	0: Not saved when powered off or stopped 1: Not saved when powered off; saved when stopped 2: Saved when powered off; not saved when stopped 3: Saved when powered off or stopped	1	0	◆
	b1.02	Converter control commands	0: Set control commands via operating pan-el 1: Set control commands via external termi-nals 2: Set control commands via communication	1	0	◆
	b1.03	Control mode	0: V/F control (V/F) 1: Senseless vector control (SVC) 2: Field oriented vector control (FOC)	1	0	◆
	b1.04	Digital set frequency	b1.07 − b1.06	0.01 Hz	50.00 Hz	◇
	b1.05	Maximum frequency	50.00 − 400.00 Hz	0.01 Hz	50.00 Hz	◆
	b1.06	Upper limit frequency	b1.07 − b1.05	0.01 Hz	50.00 Hz	◇
	b1.07	Lower limit frequency	0.00 − b1.06	0.01 Hz	0.00 Hz	◇
	b1.08	Operating panel controlled direction	0: Forward rotation 1: Reverse rotation	1	0	◇
Acc. Dec. time and modes	b1.09	Acceleration time 1	0.1 − 3600.0s	0.1s	10.0 s	◇
	b1.10	Deceleration time 1	0.1 − 3600.0s	0.1s	10.0 s	◇
	b1.11	Acceleration/deceleration mode	0: Linear mode 1: S-curve mode	1	0	◆
	b1.12	Time of S-curve rising section 1	0.0 % − 40.0 % (of ‘Acceleration time 1’ [b1.09])	0.1 %	20.0 %	◆
	b1.13	Time of S-curve rising section 3	0.0 % − 40.0 % (of ‘Acceleration time 1’ [b1.09])	0.1 %	20.0 %	◆
	b1.14	Time of S-curve falling section 4	0.0 % − 40.0 % (of ‘Deceleration time 1’ [b1.10])	0.1 %	20.0 %	◆
	b1.15	Time of S-curve falling section 6	0.0 % − 40.0 % (of ‘Deceleration time 1’ [b1.10])	0.1 %	20.0 %	◆

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Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Start or stop parame-ters	b1.16	Start mode	0: Start mode 1 1: Start mode 2 2: Rotation speed capture mode	1	0	◆
	b1.17	Start frequency	0.00 − 15.00 Hz	0.01 Hz	0.50 Hz	◆
	b1.18	Start frequency hold time	0.0 − 10.0s	0.1s	0.0s	◆
	b1.19	Stop mode	0: Decelerate to stop 1: Freewheel to stop	1	0	◆
DC brake	b1.20	Startup DC brake time	0.0 − 20.0s (0.0 deactivates DC braking)	0.1s	0.0s	◆
	b1.21	Shutdown DC brake activation frequency	0.00 − 10.00 Hz	0.01 Hz	0.00 Hz	◆
	b1.22	Shutdown DC brake time	0.0 − 20.0s (0.0 deactivates DC braking)	0.1s	0.0s	◆
	b1.23	DC brake current	0.0 % − 150.0 % (of rated converter current)	0.1 %	0.0 %	◆

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Parameter Settings

7.3.2 Category S: Standard Parameters

Group S0: V/F Control

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
V/F control	S0.00	V/F mode	0: Linear mode 1: Square mode 2: User-defined multipoint mode	1	0	◆
	S0.01	V/F frequency 1	0.00 ~ S0.03	0.01 Hz	0.00 Hz	◆
	S0.02	V/F voltage 1	0.0 % ~ 120.0 % (of 'Rated motor voltage' [S2.03])	0.1 %	0.0 %	◆
	S0.03	V/F frequency 2	S0.01 ~ S0.05	0.01 Hz	0.00 Hz	◆
	S0.04	V/F voltage 2	0.0 % ~ 120.0 % (of 'Rated motor voltage' [S2.03])	0.1 %	0.0 %	◆
	S0.05	V/F frequency 3	S0.03 ~ b1.05	0.01 Hz	0.00 Hz	◆
	S0.06	V/F voltage 3	0.0 % ~ 120.0 % (of 'Rated motor voltage' [S2.03])	0.1 %	0.0 %	◆
	S0.07	Slip compensation	0.00 ~ 10.00 Hz	0.01 Hz	0.00 Hz	◆
	S0.08	Torque increase	0.0: Automatic increase 0.1 % ~ 20.0 % (of rated converter voltage): Manual increase	0.1 %	0.1 %	◆
	S0.09	Automatic voltage stabilization	0: Not active 1: Always active 2: Not active during deceleration and braking	1	0	◆
	S0.10	Reserved	0, 1	1	0	◆

Group S1: Vector Control

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Vector control	S1.00	Speed feedback proportional gain	0.000 ~ 10.000	0.001	1.000	◆
	S1.01	Speed feedback integral time	0.000 ~ 10.000s (0.000 means inactive)	0.001s	1.000s	◆
	S1.02	Torque limit	0.0 % ~ 200.0 % (of rated motor torque)	0.1 %	150.0 %	◆
	S1.03	Slip compensation gain	0.0 % ~ 250.0 %	0.1 %	100.0 %	◆
	S1.04	Torque control selection	0: Terminal control; 1: Always active	1	0	◆
	S1.05	Torque control reference	0: Terminal +I; 1: Terminal VR1	1	0	◆

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Group S2: Motor and encoder Parameters

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Motor name-plate parame-ters	S2.00	Rated motor frequency	8.00 − 400.00 Hz	0.01 Hz	50.00 Hz	◆
	S2.01	Rated motor rotation speed	1 − 30000 rpm	1 rpm	1440 rpm	◆
	S2.02	Rated motor power	0.4 − 1000.0 kW	0.1 kW	Depends on model	◆
	S2.03	Rated motor voltage	0 − 480V	1 V	Depends on model	◆
	S2.04	Rated motor current	0.1 − 1000.0 A	0.1 A	Depends on model	◆
Motor parame-ters and adjust-ment	S2.05	Stator resistance factor	0.00 % − 50.00 %	0.01 %	Depends on model	◆
	S2.06	Rotator resistance factor	0.00 % − 50.00 %	0.01 %	Depends on model	◆
	S2.07	Leakage inductance factor	0.00 % − 50.00 %	0.01 %	Depends on model	◆
	S2.08	Mutual inductance factor	0.0 % − 2000.0 %	0.1 %	Depends on model	◆
	S2.09	No-load current	0.0 − 1000.0 A	0.1 A	Depends on model	◆
	S2.10	Parameter auto-tuning	0: No action 1: Auto tuning with running motor 2: Auto tuning with static motor Warning: Motor load has to be removed before using auto-tuning function. Note: The value is automatically set to 0 after auto-tuning.	1	0	◆
	S2.11	Reserved	0, 1	1	0	◆
Encoder parame-ters	S2.12	Pulses per revolution of pulse encoder	1 − 20000	1	1024	◆
	S2.13	Pulse encoder direction reverse	0: No reverse 1: Reverse	1	0	◆
	S2.14	Pulse encoder fault detection extent	0.0 (No break protection), 0.1 − 1000.0 rpm	0.1 rpm	0.0 rpm	◆
	S2.15	Pulse encoder fault detection time	0.1 − 10.0s	0.1s	1.0s	◆

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Parameter Settings

Group S3: Run Parameters

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Jog	S3.00	Jog frequency	0.00 − b1.05	0.01 Hz	5.00 Hz	◆
	S3.01	Jog acceleration time	0.1 − 3600.0s	0.1s	5.0s	◇
	S3.02	Jog deceleration time	0.1 − 3600.0s	0.1s	5.0s	◇
Skip frequency	S3.03	Skip frequency 1	b1.07 − b1.06	0.01 Hz	0.00 Hz	◆
	S3.04	Skip frequency 2	b1.07 − b1.06	0.01 Hz	0.00 Hz	◆
	S3.05	Skip frequency 3	b1.07 − b1.06	0.01 Hz	0.00 Hz	◆
	S3.06	Skip frequency range	0.00 − 30.00 Hz	0.01 Hz	0.00 Hz	◆
Restart after power off or power fault	S3.07	Restart after power off or power fault	0: Deactivated 1: Activated	1	0	◆
	S3.08	Waiting time to restart after power off or power fault	0.1 − 10.0s	0.1s	1.0s	◆
S3.09		Direction change dead time	0.0 − 3600.0s	0.1s	4.0s	◆
S3.10		Droop control	0.00 − 10.00 Hz	0.01 Hz	0.00 Hz	◆
S3.11		Setting velocity via **Up/Down**	0.10 − 100.00 Hz/s	0.01 Hz/s	1.00 Hz/s	◇
S3.12		Brake unit threshold	600 − 785 V	1 V	770 V	◆
S3.13		Brake hysteresis voltage	5 − 20 V	1 V	10 V	◆
S3.14		Motor standard rotation direction	0: Standard motor direction 1: Reverse standard motor direction 2: Deactivate reverse motor rotation	1	0	◆
S3.15		Stop key validity	0: Valid only for operating panel control 1: Valid for all control means	1	1	◆
S3.16		Fan control	0: Temperature controlled 1: Always on	1	0	◇

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7.3.3 Category E - Extended Parameters

Group E0: Input Terminals

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Multi-function digital input terminals	E0.00	2-wire/3-wire control mode	0: Forward/Stop, Reverse/Stop 1: Forward/Reverse, Run/Stop 2: 3-wire control	1	0	◆
	E0.01	Terminal X1	0: Inactive (allows multiple selection) 1: Multi-speed control 1 2: Multi-speed control 2 3: Multi-speed control 3 4: Multi-speed control 4 5: Acceleration/deceleration time 1 6: Acceleration/deceleration time 2 7: 3-wire control 8: Freewheel to stop 9: Frequency increment **Up** 10: Frequency decrement **Down** 11: Set frequency to 0 12: (Reserved) 13: Activate DC brake 14: Switch between operating panel and external terminal control 15: Simple PLC deactivated 16: Simple PLC paused 17: Switch between speed and torque control 18: Switch between VR1 analog and +I analog reference 19: External fault N.O contact input 20: External fault N.C contact input 21: External Reset input 22: Activate communication control	1	0	◆
	E0.02	Terminal X2		1	0	◆
	E0.03	Terminal X3		1	0	◆
	E0.04	Terminal X4		1	0	◆
	E0.05	Terminal X5		1	0	◆
	E0.06	Terminal X6		1	0	◆
	E0.07	Terminal X7		1	0	◆
	E0.08	Terminal X8		1	0	◆

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Parameter Settings

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Analog input terminal	E0.09	Source of analog frequency setting	0: k1*VR1 1: k2*VR2 2: k3* (+I) 3: k1*VR1 + k2*VR2 4: k1*VR1 + k3* (+I) 5: k2*VR2 + k3* (+I) 6: k1*VR1 (only valid for -10 − +10 V forward/reverse control	1	0	◆
	E0.10	VR1 channel amplification factor k1	0.00 − 10.00	0.01	1.00	◆
	E0.11	VR2 channel amplification factor k2	0.00 − 10.00	0.01	1.00	◆
	E0.12	+I channel amplification factor k3	0.00 − 10.00	0.01	1.00	◆
	E0.13	Reference frequency curve	0 − 15 bit3: Pulse reference frequency characteristic curve 0: Curve 1 1: Curve 2 bit2: +I reference frequency characteristic curve 0: Curve 1 1: Curve 2 bit1: VR2 reference frequency characteristic curve 0: Curve 1 1: Curve 2 bit0: VR1 reference frequency characteristic curve 0: Curve 1 1: Curve 2	1	0	◆
	E0.14	Analog channel filter time	0.000 − 2.000s	0.001s	0.100s	◆
	E0.15	Maximum input pulse frequency	1.0 − 50.0 kHz	0.1 kHz	20.0 kHz	◆
	E0.16	Curve 1 minimum reference	0.0 % − E0.18	0.1 %	0.0 %	◆
	E0.17	Frequency corresponding to curve 1minimum reference	0.00 − b1.06	0.01 Hz	0.00 Hz	◆
	E0.18	Curve 1 maximum reference	E0.16 − 100.0 %	0.1 %	100.0 %	◆
	E0.19	Frequency corresponding to curve 1 maximum reference	0.00 − b1.06	0.01 Hz	50.00 Hz	◆
	E0.20	Curve 2 minimum reference	0.0 % − E0.22	0.1 %	0.0 %	◆
	E0.21	Frequency corresponding to curve 2 minimum reference	0.00 − b1.06	0.01 Hz	0.00 Hz	◆
	E0.22	Curve 2 maximum reference	E0.20 − 100.0 %	0.1 %	100.0 %	◆
	E0.23	Frequency corresponding to curve 2 maximum reference	0.00 − b1.06	0.01 Hz	50.00 Hz	◆
	E0.24	-10 − +10 V analog setting of dead area	0.0 % − 30.0 %	0.1 %	0.0 %	◆

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Group E1: Output Terminals

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Multi-function digital output terminals	E1.00	Open collector output OUT1	0: Converter is ready to run 1: Converter is running 2: DC brake active 3: Converter runs at zero speed 4. Frequency/speed arrival signal 5. Frequency level detection signal (FDT1) 6. Frequency level detection signal (FDT2) 7: Simple PLC phase completed 8: Under voltage / converter stop warning 9: Converter over load pre-warning 10: Motor over load pre-warning 11: Over torque	1	1	◆
	E1.01	Open collector output OUT2		1	1	◆
	E1.02	Relay outputs Pa, Pb and Pc		1	1	◆
	E1.03	Frequency arrival detection width	0.0 % − 20.0 % (of maximum frequency b1.05)	0.1 %	5.0 %	◇
	E1.04	Frequency detection level FDT1	0.0 % − 100.0 % (of maximum frequency b1.05)	0.1 %	90.0 %	◇
	E1.05	Frequency detection level FDT1 width	0.0 % − 100.0 % (of maximum frequency b1.05)	0.1 %	5.0 %	◇
	E1.06	Frequency detection level FDT2	0.0 % − 100.0% (of maximum frequency b1.05)	0.1 %	50.0 %	◇
	E1.07	Frequency detection level FDT2 width	0.0 % − 100.0 % (of maximum frequency b1.05)	0.1 %	5.0 %	◇
	E1.08	Converter over load pre-warning level setting	20.0 % − 100.0 % (of rated converter current)	0.1 %	100.0 %	◇
	E1.09	Motor over load pre-warning level setting	100.0 % − 250.0 % (of rated motor current)	0.1 %	100.0 %	◇
Analog output terminals	E1.10	FM1 analog outputs	0: Output frequency / rotation speed 1: Set frequency / rotation speed 2: Output current 3: Torque current 4: Output voltage	1	0	◇
	E1.11	FM1 channel mode	0 : 0 − 10 V or 0 − 20 mA 1 : 2 − 10 V or 4 − 20 mA	1	0	◇
	E1.12	FM1 gain setting	0.00 − 10.00	0.01	1.00	◇
	E1.13	FM2 analog outputs	0: Output frequency / rotation speed 1: Set frequency / rotation speed 2: Output current 3: Torque current 4: Output voltage	1	1	◇
	E1.14	FM2 channel mode	0 : 0 − 10 V or 0 − 20 mA 1 : 2 − 10 V or 4 − 20 mA	1	0	◇
	E1.15	FM2 gain setting	0.00 − 10.00	0.01	1.00	◇

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Parameter Settings

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
DO pulse outputs	E1.16	Pulse outputs	0: Output frequency 1: Output voltage 2: Output current	1	0	◇
	E1.17	Maximum output pulse frequency	1.0 − 50.0 kHz	0.1 kHz	10.0 kHz	◇

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Group E2: Multi-Speed and Simple PLC

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Acceleration deceleration time 2, 3 and 4	E2.00	Acceleration time 2	0.1 ~ 3600.0 s	0.1s	10.0 s	◇
	E2.01	Deceleration time 2	0.1 ~ 3600.0 s	0.1s	10.0 s	◇
	E2.02	Acceleration time 3	0.1 ~ 3600.0 s	0.1s	10.0 s	◇
	E2.03	Deceleration time 3	0.1 ~ 3600.0 s	0.1s	10.0 s	◇
	E2.04	Acceleration time 4	0.1 ~ 3600.0 s	0.1s	10.0 s	◇
	E2.05	Deceleration time 4	0.1 ~ 3600.0 s	0.1s	10.0 s	◇
Multi-speed frequency	E2.06	Multi-speed frequency 1	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.07	Multi-speed frequency 2	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.08	Multi-speed frequency 3	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.09	Multi-speed frequency 4	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.10	Multi-speed frequency 5	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.11	Multi-speed frequency 6	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.12	Multi-speed frequency 7	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.13	Multi-speed frequency 8	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.14	Multi-speed frequency 9	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.15	Multi-speed frequency 10	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.16	Multi-speed frequency 11	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.17	Multi-speed frequency 12	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.18	Multi-speed frequency 13	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.19	Multi-speed frequency 14	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇
	E2.20	Multi-speed frequency 15	b1.07 ~ b1.06	0.01 Hz	0.00 Hz	◇

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Parameter Settings

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
PLC control	E2.21	PLC control mode	0: Inactive 1: Mode 1 2: Mode 2 3: Mode 3	1	0	◆
	E2.22	PLC time factor	1 − 60	1	1	◆
	E2.23	Stage 1 action selection	0 − 31	1	0	◆
	E2.24	Stage 1 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.25	Stage 2 action selection	0 − 31	1	0	◆
	E2.26	Stage 2 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.27	Stage 3 action selection	0 − 31	1	0	◆
	E2.28	Stage 3 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.29	Stage 4 action selection	0 − 31	1	0	◆
	E2.30	Stage 4 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.31	Stage 5 action selection	0 − 31	1	0	◆
	E2.32	Stage 5 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.33	Stage 6 action selection	0 − 31	1	0	◆
	E2.34	Stage 6 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.35	Stage 7 action selection	0 − 31	1	0	◆
	E2.36	Stage 7 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.37	Stage 8 action selection	0 − 31	1	0	◆
	E2.38	Stage 8 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.39	Stage 9 action selection	0 − 31	1	0	◆
	E2.40	Stage 9 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.41	Stage 10 action selection	0 − 31	1	0	◆
	E2.42	Stage 10 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.43	Stage 11 action selection	0 − 31	1	0	◆
	E2.44	Stage 11 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.45	Stage 12 action selection	0 − 31	1	0	◆
	E2.46	Stage 12 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.47	Stage 13 action selection	0 − 31	1	0	◆
	E2.48	Stage 13 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.49	Stage 14 action selection	0 − 31	1	0	◆
	E2.50	Stage 14 running time	0.0 − 5000.0s	0.1s	0.0s	◆
	E2.51	Stage 15 action selection	0 − 31	1	0	◆
	E2.52	Stage 15 running time	0.0 − 5000.0s	0.1s	0.0s	◆

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Group E3: PID Control

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
PID control	E3.00	PID control mode	0: PID control inactive 1: Analog input + analog feedback 2: Analog digital setting + analog feedback 3: Analog input + pulse encoder feedback 4: Rotation speed digital setting + pulse encoder feedback	1	0	◆
	E3.01	Analog digital setting	0.00 − 10.00 V	0.01 V	0.00 V	◇
	E3.02	Rotation speed digital setting	0 − 30000 rpm	1 rpm	0 rpm	◇
	E3.03	Analog feedback channel	0 : +I 1 : VR2	1	0	◆
	E3.04	P: Proportional gain	0.0 − 10.000	0.001	1.500	◇
	E3.05	Ti: Integral time	0.00 − 100.00s (0.00 represents no integral)	0.01s	0.00s	◇
	E3.06	Td: Derivative time	0.00 − 100.00s (0.00 represents no derivative)	0.01s	0.00s	◇
	E3.07	T: Sampling period	0.01 − 100.00s	0.01s	0.50s	◇
	E3.08	Deviation limit	0.0 % − 20.0 % (of closed loop reference)	0.1 %	2.0 %	◇
	E3.09	PID control mode	0: Stop integral adjustment, when output frequency reaches upper/lower limit frequency 1: Continue integral adjustment, when output frequency reaches upper/lower limit frequency	1	0	◇

Nur für internen Gebrauch
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Parameter Settings

Group E4: Protection and Fault Parameters

Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Protection parameters	E4.00	Software over voltage protection threshold	790 − 820 V	1 V	810 V	◆
	E4.01	Stall over voltage function	0: Deactivated 1: Activated	1	0	◆
	E4.02	Stall over voltage protection level	120.0 % − 150.0 % (of rated converter peak voltage)	0.1 %	130.0 %	◆
	E4.03	Stall over current protection level	20.0 % − 200.0 % (of rated converter output current)	0.1 %	150.0 %	◆
	E4.04	Motor over load protection	0: Inactive 1: Heat protection active at low-speed 2: Heat protection inactive at low-speed	1	1	◇
	E4.05	Motor over load protection factor	50.0 % − 110.0 %	0.1 %	100.0 %	◇
	E4.06	Phase loss protection	0: Both input and output phase loss protection active 1: Only input phase loss protection active 2: Only output phase loss protection active 3: Both input and output phase loss protection inactive	1	0	◇
	E4.07	Fault relay setting	0 − 3 bit0: 0: Inactive for under voltage 1: Active for under voltage bit1: 0: Inactive for auto reset 1: Active for auto reset	1	0	◇
E4.08		Number of fault reset attempts	0 − 3 (0: Inactive for auto reset)	1	0	◆
E4.09		Interval between reset attempts	2 − 60s	1s	10s	◆

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Type	Function code	Name	Setting range	Minimum unit	Factory default	Attribute
Fault record	E4.10	Last fault	0: No fault record 1: Over current at constant speed (O.C.-1) 2: Over current during acceleration (O.C.-2) 3: Over current during deceleration (O.C.-3) 4: Over voltage at constant speed (O.C.-1) 5: Over voltage during acceleration (O.C.-2) 6: Over voltage during deceleration (O.C.-3) 7: Converter over load (O.L.-1) 8: Motor over load (O.L.-2) 9: CPU read/write fault (R.E.) 10: Operating panel read/write fault (KEY-) 11: External device fault (E.-St) 12: Communication fault (R.S.) 13: Circuit disconnection (C.F.) 14: Pulse encoder speed detection fault (PULS) 15: Reserved 16: EMI fault (CPU-) 17: Short circuit (S.C.) 18: Reserved 19: L1, L2, L3 input phase loss (IPH.L) 20: U, V, W output phase loss (OPH.L) 21: Converter overheat (O.H.) 22: Parameter setting fault (PRSE) 23: Parameter auto-tuning fault (TUNE)	1	0	◎
	E4.11	2nd last fault		1	0	◎
	E4.12	3rd last fault		1	0	◎
	E4.13	Delete fault record	0: Inactive 1: Delete fault record Note: The value is automatically set to 0 after the operation.	1	0	◆

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Parameter Settings

7.3.4 Category H: Advanced Rights

Group H0: Communication Parameters

Type	Function code	Name	Setting range		Minimum unit	Factory default	Attribute
Communication parameters	H0.00	Communication protocol	0: ModBus 1: PROFIBUS		1	0	◆
	H0.01	Baud rate	0: 1200 bps 1: 2400 bps 2: 4800 bps 3: 9600 bps 4: 19200 bps 5: 38400 bps		1	3	◆
	H0.02	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)		1	0	◆
	H0.03	Local address	H0.00=0	1 − 247 (0 represents broadcast address)	1	1	◆
			H0.00=1	1 − 126			
	H0.04	PZD4, PZD3 setting	0 − 238		1	0	◆
	H0.05	PZD6, PZD5 setting	0 − 238		1	0	◆
	H0.06	PZD8, PZD7 setting	0 − 238		1	0	◆
	H0.07	PZD10, PZD9 setting	0 − 238		1	0	◆
	H0.08	Communication disconnection detection time	0.0 (invalid), 0.1 − 60.0s		0.1s	0.0	◆
	H0.09	Communication disconnection action	0: Stop 1: Keep running		1	0	◆
	H0.10	Reserved	0 − 65535		1	0	◆

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7.4 Notes on Function Groups

7.4.1 Category b: Basic Parameters

Group b0: System Parameters

b0.00	User password		Factory default	0
	Setting range	0 − 65535	Minimum unit	1

User password protects converter parameters from being modified by unauthorized people. Set password: Set a number between 1 to 65535 to activate the user password function.

- Delete password: Enter the correct user password and set [b0.00]=0 to deactivate the password.
- Modify password: Enter the correct user password and set a new number between 1 to 65535 to modify the user password.
- After a user password has been set, users may only read but not modify nor copy parameters if an incorrect password is entered.

☞
1. After a user password has been set, users may only read but not modify nor copy parameters if an incorrect password is entered.
2. Please contact the manufacturer if you forgot the set password.

b0.01	LCD language		Factory default	0
	Setting range	0 − 1	Minimum unit	1

LCD / Menu language is available in

- 0: Chinese
- 1: English

b0.02	Restore factory default		Factory default	0
	Setting range	0 − 1	Minimum unit	1

- 0: No action
- 1: Restore factory default

☞
1. All parameters (except [S2.00] − [S2.09] and [E4.10] − [E4.12]) will be restored to factory default.
2. [b0.02] is automatically set to 0 after the parameters have been set to factory default.

b0.03	Parameter copy		Factory default	0
	Setting range	0 − 2	Minimum unit	1

- 0: No action
- 1: Copy parameters from converter to operating panel
  - Parameter settings of the frequency converter (except [E4.10] − [E4.12]) will be uploaded to the operating panel.
- 2: Copy parameters from operating panel to converter

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– Parameter settings of the frequency converter (except [E4.10] − [E4.12]) will be downloaded to the converter.

☞ 1. [b0.03] is automatically set to 0 after parameters have been copied.
2. All operations are invalid in parameter copy process.

b0.04	Mains voltage		Factory default	380 V
	Setting range	380 − 480 V	Minimum unit	1 V

b0.05	PWM frequency		Factory default	Depends on model
	Setting range	1.0 − 15.0 kHz	Minimum unit	0.1 kHz

Used to set the PWM frequency.

- A higher PWM frequency may reduce the motor noise, line to ground current leakage and interferences caused by the frequency converter but the frequency converter power loss and temperature will be increased.
- A lower PWM frequency may increase the higher harmonic component of output current, motor power loss and motor temperature.

☞ For the temperature, voltage and current derating figures related to PWM frequency, refer to chapter 9 "Technical Data" on page 143.

b0.06	Automatic adjustment of PWM frequency		Factory default	0
	Setting range	0: Off; 1: On	Minimum unit	1

The converter can automatically adjust the PWM frequency based on converter temperature.

b0.07	LCD backlight mode		Factory default	0
	Setting range	0: Energy saving 1: Always on	Minimum unit	1

- 0: Energy saving
  – The LCD backlight will be inactive automatically if no key has been pressed for 80 seconds. If the LCD backlight is inactive, the first key press will activate the backlight, press again to execute the command.
- 1: Always on
  – The LCD backlight will be always active.

☞ It is recommended to set the LCD backlight mode to 1 (always on), if [b1.02]=1 or 2.

b0.08	LCD display value in run mode		Factory default	0
	Setting range	0 − 13	Minimum unit	1
b0.09	LCD display value in stop mode		Factory default	2
	Setting range	0 − 13	Minimum unit	1

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- 0: Output frequency
- 1: Output rotation speed
- 2: Set output frequency
- 3: Set rotation speed
- 4: Output voltage
- 5: Output current
- 6: Output power
- 7: DC bus voltage
- 8: Torque current
- 9: Excitation current
- 10: User-defined reference value
- 11: User-defined output value
- 12: Reference torque
- 13: Reserved

☞ Switch between the 14 monitoring values with the ►► key.

b0.10	Scale factor of output frequency		Factory default	100 %
	Setting range	0.1 % − 1000.0 %	Minimum unit	0.1 %

- Valid only for ‘LCD display value in run mode’ [b0.08] and ‘LCD display value in stop mode’ [b0.09] = 10 or 11.
- ‘LCD display value in run mode’ [b0.08] and ‘LCD display value in stop mode’ [b0.09] equals ‘output frequency’ multiplied by ‘Scale factor of output frequency’ [b0.10].

b0.11	Parameter filter setting		Factory default	0
	Setting range	0 − 3	Minimum unit	1

- Only parameters of the selected groups are visible.

b0.11	**Parameter groups to be read and set**
0	b
1	b, S
2	b, S, E
3	b, S, E, H

Fig.7-13: Parameter filter range

b0.12	Heat sink temperature		Factory default	Detected value
	Setting range	25 − 100 °C	Minimum unit	1 °C

- Displays the heat sink temperature (in °C).
  - '−−' is displayed when the temperature is lower than 25 °C.
  - Overheat protection activates at 85 °C.

b0.13	Total running time		Factory default	0 hour
	Setting range	0 − 65535 hours	Minimum unit	1 hour

- Displays the total running time of the frequency converter.

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Parameter Settings

☞ It will not be set to 0 using ‘Restore factory default’ [b0.02].

b0.14	Firmware version		Factory default	
	Setting range	Read-only	Minimum unit	

b0.15	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1

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Group b1: Basic Parameters

b1.00	Frequency setting mode		Factory default	0
	Setting range	0: Set by operating panel potentiometer 1: Set by operating panel 2: Set by external analog 3: Set by pulse frequency 4: Set by external **Up/Down** terminals 5: Set via communication	Minimum unit	1

- 0: Set by operating panel potentiometer
  - Set the frequency by adjusting the operating panel's potentiometer.
- 1: Set by operating panel
  - Use the value of parameter [b1.04] as the set frequency.
  - Use▲ and ▼ keys to change the output frequency value when the frequency converter is in run mode.

☞
  - In run mode
    - In the case of power fault or undervoltage, if 'Digital set frequency saving' [b1.01] = 2 or 3, the current running frequency will be saved in parameter [b1.04].
  - In stop mode
    - If 'Digital set frequency saving' [b1.01] = 1 or 3, the current running frequency will be saved in parameter [b1.04].

- 2: Set by external analog terminals
  - Set the frequency by external analog signals using the independent channels VR1, VR2 and +I.

☞
1. VR1 for 0 – 10 V or -10 – +10 V
   - Unipolar analog signal

     Input of negative level signals will be processed as absolute values without motor direction information.
   - Bipolar analog signal

     Input of bipolar level signals will be processed as values with motor direction information.
2. VR2 for 0 – 10 V
3. +I is for 0 – 20 mA (with channel input resistance of 165 Ω).
4. Please also set parameters [E0.09] – [E0.24].

- 3: Set by pulse frequency
  - Set output frequency by external pulse frequency signals using terminal X8 (signal range is 9 – 30 V, maximum pulse frequency of 50 kHz).

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☞ Please also set ‘Highest input pulse frequency’ [E0.15]. ‘X8 terminal function’ [E0.08] is automatically set to 0 (invalid).

- 4: Set by external terminals **Up/Down**

  Set output frequency by external control terminals

  – Step 1
    – Define any 3 external control terminals in parameters [E0.01] – [E0.08] and set one to 9 ‘Frequency incremental Up command’, one to 10 ‘Frequency decrement Down command’, and one to 11 ‘Zeroing of external terminal frequency setting’.
  – Step 2
    – Set ‘Frequency changing rate’ [S3.11] for the frequency change rate of the terminals **Up/Down**.

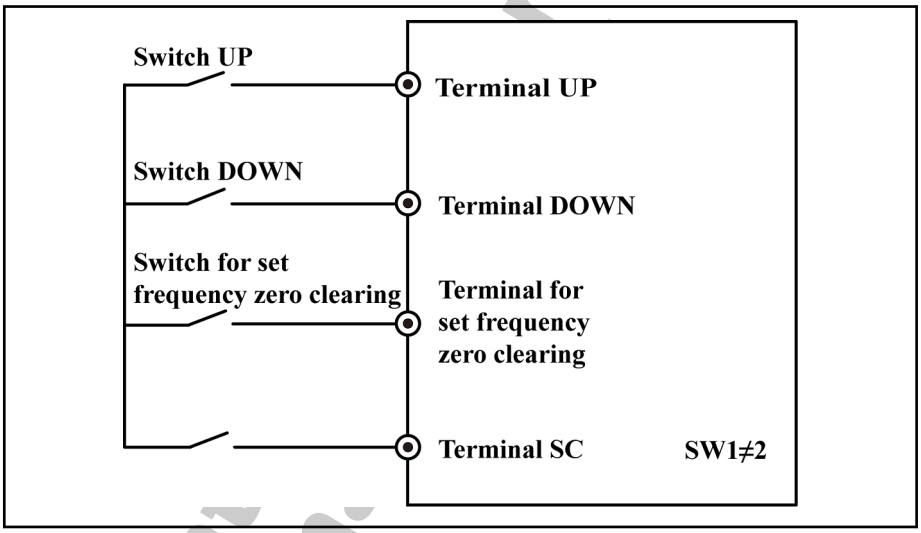

Fig.7-14: Frequency setting via external terminals Up/Down

Clear frequency	Open				Closed
Up terminal	Open		Closed		Open/ Closed
Down terminal	Open	Closed	Open	Closed	
Converter frequency reaction	Hold	Decrease	Increase	Hold	Zero

Fig.7-15: Relationship between terminal status and converter set frequency

☞
- At power on [b1.04] is used as start up frequency.
  – If [b1.01] = 0 or 2 the current set frequency will not be saved in [b1.04] using **Stop** command or power off.
  – If [b1.01] = 1 or 3 the current set frequency will be saved to [b1.04] using **Stop** command or power off.

- 5: Set via communication
  – Set output frequency by communication with the external computer or PLC.

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b1.01	Saving options of digital set frequency		Factory default	0
	Setting range	0 – 3	Minimum unit	1

- 0: Not saved in [b1.04] when powered off or stopped
- 1: Not saved in [b1.04] when powered off; saved when stopped
- 2: Saved in [b1.04] when powered off; not saved when stopped
- 3: Saved in [b1.04] when powered off or stopped

b1.02	Converter control commands		Factory default	0
	Setting range	0, 1, 2	Minimum unit	1

- 0: Set control commands via operating panel
  - Use operating panel keys (**Run**, **Stop** and **Jog**) to control the frequency converter.
- 1: Set control commands via external terminals
  - Use external terminals (X0 – X7) to control run, stop, forward or reverse. See also parameters in group E0.
- 2: Set control commands via communication
  - See the instructions for communication in chapter 12 "Communication Protocols" on page 179.

☞ If [b1.02]=1 or 2, the **Stop** key on the operating panel can be enabled with [S3.15].

b1.03	Control mode		Factory default	0
	Setting range	0, 1, 2	Minimum unit	1

- 0: V/F control (V/F)
  - Select this mode if it is impossible to conduct auto-tuning or obtain accurate motor parameters.
    - V/F control without pulse encoder: is used to drive multiple motors with one frequency converter.
    - V/F control with pulse encoder: is used when high accuracy of speed control is required. See parameters [S2.12] – [S2.15] for related settings.

☞ In V/F control mode, set control parameters in group S0.

- 1: Sensorless vector control (SVC)
  - For high performance applications where no pulse encoder is necessary and high low-frequency torque and high accuracy of speed control are required.
- 2: Field oriented vector control (FOC)
  - For high accuracy applications with speed and torque control. A pulse encoder is necessary. See parameters [S2.12] – [S2.15] for related settings.

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1. Accurate motor parameters are required for vector control. Motor parameters can be obtained by auto-tuning function, please refer to parameters [S2.00] − [S2.10] for related settings. If auto-tuning is impossible and the accurate motor parameters are known, first set parameters [S2.00] − [S2.04] with values found on the motor nameplate. Then set parameters [S2.05] − [S2.09].
2. In vector control mode, please set the parameters of rotation speed controller to obtain good static and dynamic control. See parameters [S1.00] and [S1.01] for related information.
3. In vector control mode, one frequency converter can only drive one motor.
4. In V/F control mode, please refer to parameters in group S for related settings.

b1.04	Digital set frequency		Factory default	50.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz

If “Frequency setting mode”[b1.00] = 1, value of [b1.04] is the set frequency.

b1.05	Maximum frequency		Factory default	50.00 Hz
	Setting range	50.00 − 400.00 Hz	Minimum unit	0.01 Hz
b1.06	Upper limit frequency		Factory default	50.00 Hz
	Setting range	b1.07 − b1.05	Minimum unit	0.01 Hz
b1.07	Lower limit frequency		Factory default	0.00 Hz
	Setting range	0.00 Hz − b1.06	Minimum unit	0.01 Hz

- The “Upper limit frequency”[b1.06] and “Lower limit frequency” [b1.07] represent the maximum and minimum allowed output frequency.

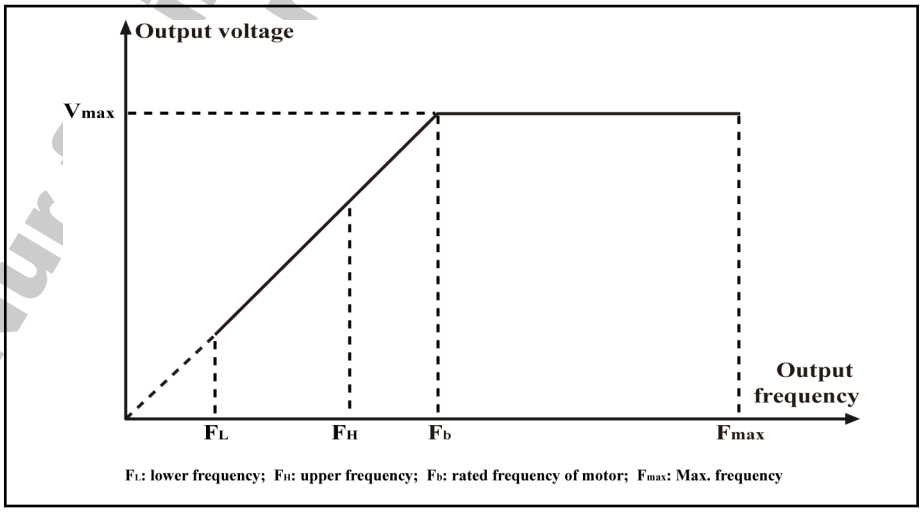

Fig.7-16: Maximum frequency_upper limit frequency_lower limit frequency

b1.08	Operating panel controlled direction		Factory default	0
	Setting range	0, 1	Minimum unit	1

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This parameter is used to change the rotation direction of motor when running commands are set by the operating panel.

- 0: Forward rotation
- 1: Reverse rotation

b1.09	Acceleration time 1		Factory default	10.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s
b1.10	Deceleration time 1		Factory default	10.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s

- The acceleration time is the duration, in which the converter changes the output frequency from 0 Hz to 'Maximum frequency' [b1.05]. Shown as T1 in figure fig. 7-17 "Acceleration time1 & Deceleration time 1" on page 93.
- The deceleration time is the duration, in which the converter changes the output frequency from 'Maximum frequency' [b1.05] to 0 Hz. Shown as T2 in figure fig. 7-17 "Acceleration time1 & Deceleration time 1" on page 93.

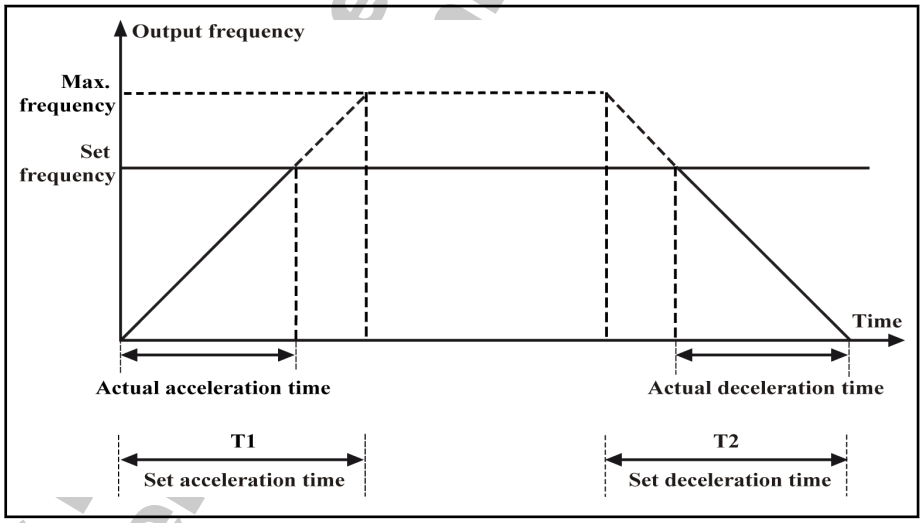

Fig.7-17: Acceleration time1 & Deceleration time 1

- 4 groups of acceleration/deceleration time are available, which can be selected via external terminals. See parameters [E0.01] − [E0.08] and [E2.00] − [E2.05] for related settings.

b1.11	Acceleration/deceleration mode		Factory default	0
	Setting range	0, 1	Minimum unit	1

This parameter sets the acceleration/deceleration mode of the converter to linear or S-Curve in start, stop, forward or reverse, acceleration or deceleration processes.

- 0: Linear mode
  - The output frequency is increased or decreased linear as shown in Figure fig. 7-18 "Linear acceleration/deceleration mode" on page 94.

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Parameter Settings

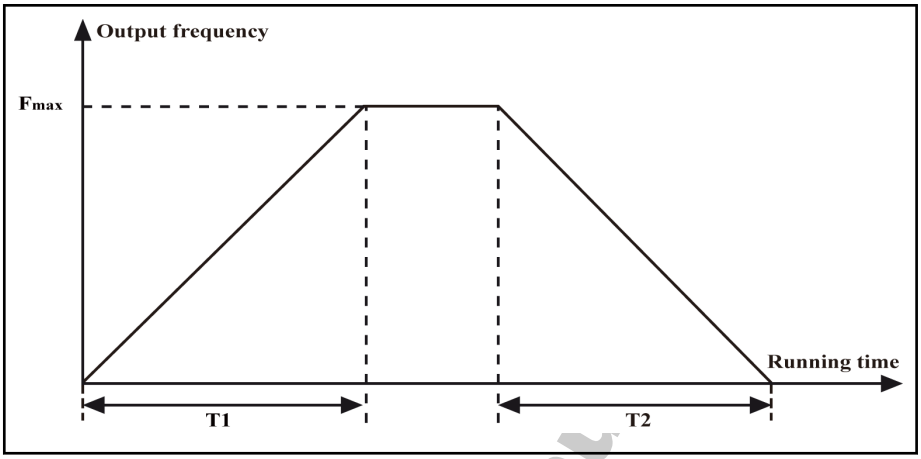

Fig.7-18: Linear acceleration/deceleration mode

- 1: S-curve mode
  - The output frequency is increased or decreased in an S-curve as shown in Figure fig. 7-19 "S-curve acceleration/deceleration mode" on page 94. The S-curve mode is used to achieve smooth start or stop.

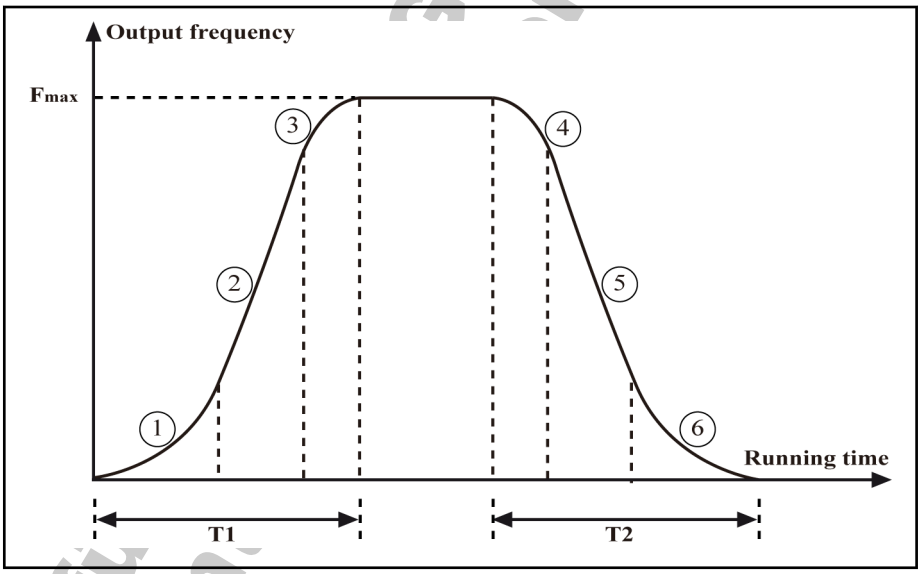

Fig.7-19: S-curve acceleration/deceleration mode

b1.12	Time of S-curve rising section 1		Factory default	20.0 %
	Setting range	0.0 % – 40.0 % (of 'Acceleration time 1' [b1.09])	Minimum unit	0.1 %
b1.13	Time of S-curve rising section 3		Factory default	20.0 %
	Setting range	0.0 % – 40.0 % (of 'Acceleration time 1' [b1.09])	Minimum unit	0.1 %
b1.14	Time of S-curve falling section 4		Factory default	20.0 %
	Setting range	0.0 % – 40.0 % (of 'Deceleration time 1' [b1.10])	Minimum unit	0.1 %

b1.15	Time of S-curve falling section 6		Factory default	20.0 %
	Setting range	0.0 % − 40.0 % (of ‘Deceleration time 1’ [b1.10])	Minimum unit	0.1 %

b1.16	Start mode		Factory default	0
	Setting range	0: Start mode 1 1: Start mode 2 2: Rotation speed capture mode	Minimum unit	1
b1.17	Start frequency		Factory default	0.5 Hz
	Setting range	0.00 − 15.00 Hz	Minimum unit	0.01 Hz
b1.18	Start frequency hold time		Factory default	0.0s
	Setting range	0.0 − 10.0 s	Minimum unit	0.1s

- 0: Start mode 1
  - The converter runs at ‘Start frequency’ [b1.17], for ‘Start frequency hold time’ [b1.18], accelerates for ‘Acceleration time 1’ [b109] to set frequency.
  - This mode is suitable for circumstances with high static friction torque and low load inertia.
- 1: Start mode 2
  - If ‘Startup DC brake time’ [b1.20] ≠0, DC brake is executed before accelerating to ‘Start frequency’[b1.17]. If ‘Startup DC brake time’ [b1.20] = 0, the converter accelerates without braking to ‘Start frequency’[b1.17].
  - This mode is suitable for circumstances where the load may encounter forward/reverse rotation when the converter is in stop mode.
- 2: Rotation speed capture mode
  - The converter detects the rotation speed and direction of the motor and then starts with the current frequency of the motor.
  - This mode is suitable for restarting after instantaneous power fault in the case of a large inertia or freewheeling load.

☞
- At startup, if the ‘Start frequency’ [b1.17] is lower than the set frequency, the converter first accelerates to ‘Start frequency’ [b1.17], after ‘Start frequency hold time’ [b1.18], the converter decelerates to the set frequency.
- For rotation speed capture mode, a pulse encoder is necessary.

b1.19	Stop mode		Factory default	0
	Setting range	0: Decelerate to stop 1: Freewheel to stop	Minimum unit	1

- 0: Decelerate to stop
  - The converter decelerates to stop according the deceleration time.

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1. In case of too fast deceleration a fault may happen, extend the deceleration time or calculate if additional brake units / resistors are required.
2. If the output frequency is lower than ' Shutdown DC brake activation frequency' [b1.21], the set 'DC brake current' [b1.23] is applied, for 'Shutdown DC brake time' [b1.22]. This mode is suitable for circumstances where regular or quick deceleration stop is required (with a brake resistor or brake unit).

- 1: Freewheel to stop
  - Once the stop command is activated, the converter shuts down output, and the motor freewheels mechanically to stop.

b1.20	Startup DC brake time		Factory default	0.0s
	Setting range	0.0 − 20.0s	Minimum unit	0.1s

- If 'Start mode'[b1.16] is '1: Start mode 2', apply 'DC brake current' [b1.23] for 'Startup DC brake time' [b1.20].
- If 'Startup DC brake time' [b1.20] is 0, the converter starts directly without DC brake. The larger the DC brake current, the larger the braking force is. Take the withstanding capability of the motor into account.

b1.21	Shutdown DC brake activation frequency		Factory default	0.00 Hz
	Setting range	0.00 − 10.00 Hz	Minimum unit	0.01 Hz

b1.22	Shutdown DC brake time		Factory default	0.0s
	Setting range	0.0 − 20.0s	Minimum unit	0.1s

- Used to set the time for applying the DC brake current during the stop process. If set to 0.0s no DC brake is done, and the converter stops according to 'Stop mode' [b1.19] is '0: Decelerate to stop'. When digital input terminal Xi=13, parameter [b1.22] is deactivated.

b1.23	DC brake current		Factory default	0.0 %
	Setting range	0.0 % − 150.0 % (of 'Rated converter current')	Minimum unit	0.1 %

- When the frequency converter starts in the DC brake mode or shutdown DC brake is active, [b1.23] is used to control the braking current and is set in a percentage of the rated converter current.

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7.4.2 Category S: Standard Parameters

Group S0: V/F Control

Parameters of group S0 are only valid when 'Control mode' [b1.03] is ‘0: V/F control’.

S0.00	V/F mode		Factory default	0
	Setting range	0: Linear mode 1: Square mode 2: User-defined multipoint mode	Minimum unit	1

- 0: Linear mode
  - Suitable for constant torque load
    (shown as 0 in chapter "Group S0: V/F Control" on page 97).
- 1: Square mode
  - Suitable for variable torque loads
    (shown as 1 in chapter "Group S0: V/F Control" on page 97).

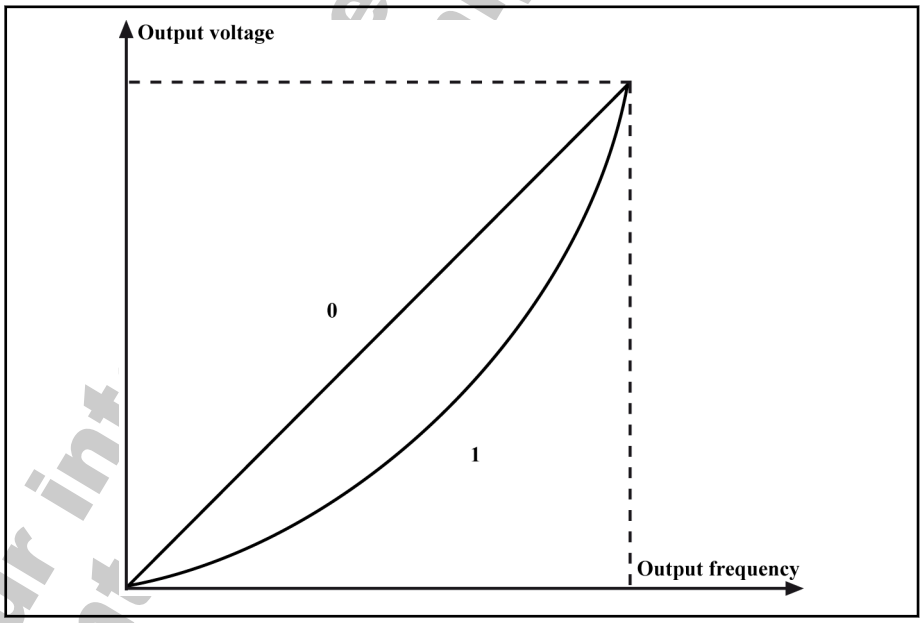

Fig.7-20: Linear and square V/F curves

- 2: User-defined multipoint mode
  - Used to set a user defined V/F curve with parameters [S0.01] to [S0.06]. Suitable for special applications (shown in chapter "Group S0: V/F Control" on page 97).

Nur für int... Gebrauch

Parameter Settings

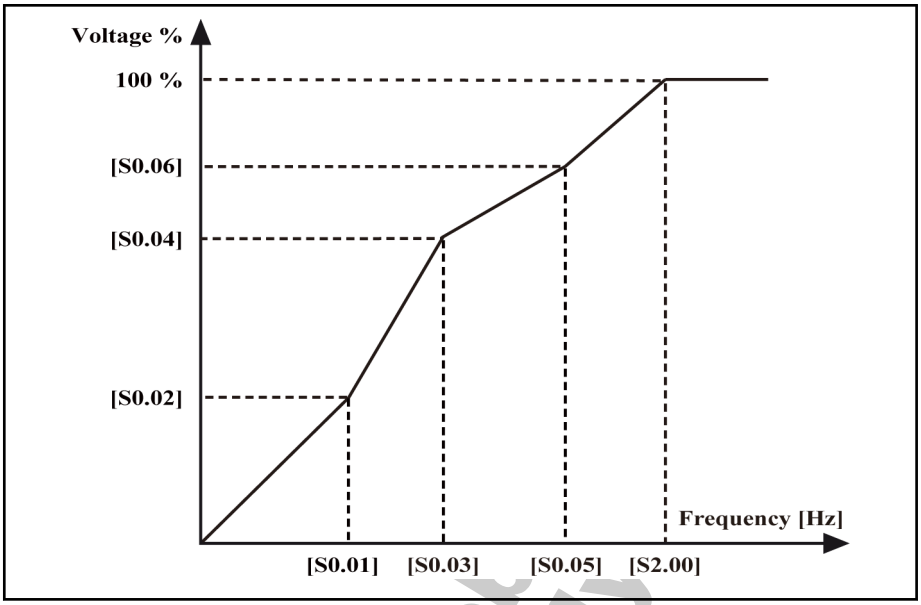

Fig.7-21: User defined V/F curve

S0.01	V/F frequency 1		Factory default	0.00 Hz
	Setting range	0.00 − S0.03	Minimum unit	0.01 Hz
S0.02	V/F voltage 1		Factory default	0.0 %
	Setting range	0.0 % − 120.0 % (of 'Rated motor voltage' [S2.03])	Minimum unit	0.1 %
S0.03	V/F frequency 2		Factory default	0.00 Hz
	Setting range	S0.01 − S0.05	Minimum unit	0.01Hz
S0.04	V/F voltage 2		Factory default	0.0 %
	Setting range	0.00 % − 120.0 % (of 'Rated motor voltage' [S2.03])	Minimum unit	0.1 %
S0.05	V/F frequency 3		Factory default	0.00 Hz
	Setting range	S0.03 − b1.05	Minimum unit	0.01Hz
S0.06	V/F voltage 3		Factory default	0.0 %
	Setting range	0.00 % − 120.0 % (of 'Rated motor voltage' [S2.03])	Minimum unit	0.1 %

☞ Excessive low-frequency voltages may cause the motor to overheat or result in motor damage. The converter may stall due to over current or may activate over current protection.

S0.07	Slip compensation		Factory default	0.00 Hz
	Setting range	0.00 − 10.00 Hz	Minimum unit	0.01 Hz

- Compensates the speed difference of the motor and the output of the converter caused by the load in case of V/F control.
- Improves the mechanical behavior of the motor. Should be set according to the rated motor slip frequency shown on motor plate.

Nur für internen Gebrauch
Internal use only

S0.08	Torque increase		Factory default	0.1 %
	Setting range	0.0: Automatic increase 0.1 % − 20.0 % (of rated converter voltage): Manual increase	Minimum unit	0.1 %

- 0.0: Automatic increase
  - Determines automatically the percentage of output voltage increase based on output frequency and load current.

The linear and square V/F curve automatic torque increase is shown in chapter "Group S0: V/F Control" on page 97 and chapter "Group S0: V/F Control" on page 97.

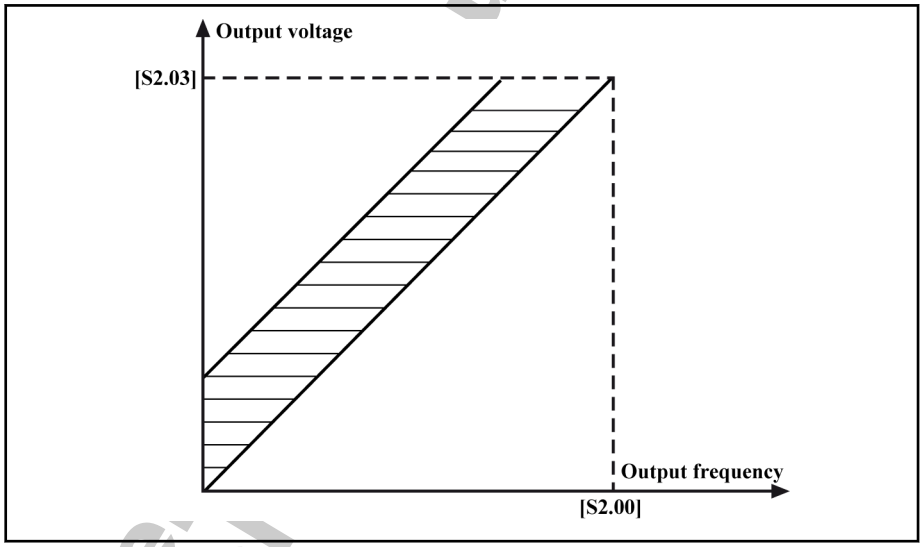

Fig.7-22: Linear V/F curve automatic torque increase

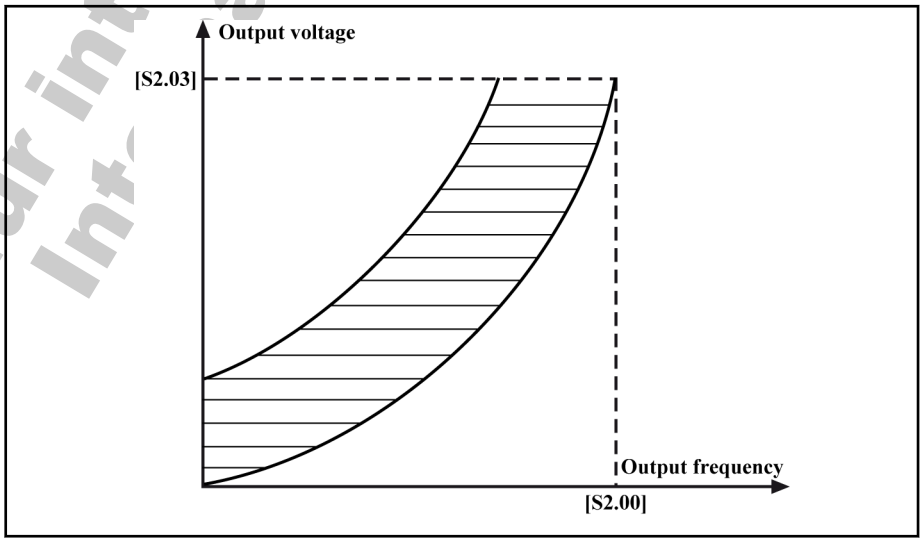

Fig.7-23: Square V/F curve automatic torque increase

- 0.1 % − 20.0 %: Manual increase
  - Used to increase the converter's output voltage and compensate the stator voltage decrease, to generate sufficient torque and improve the low-frequency characteristics of V/F control.

Nur für interne Zwecke

Large increase may cause high current leading to motor over heat and may result in motor damage. Linear and square V/F curve manual torque increase is shown in chapter "Group S0: V/F Control" on page 97 and chapter "Group S0: V/F Control" on page 97.

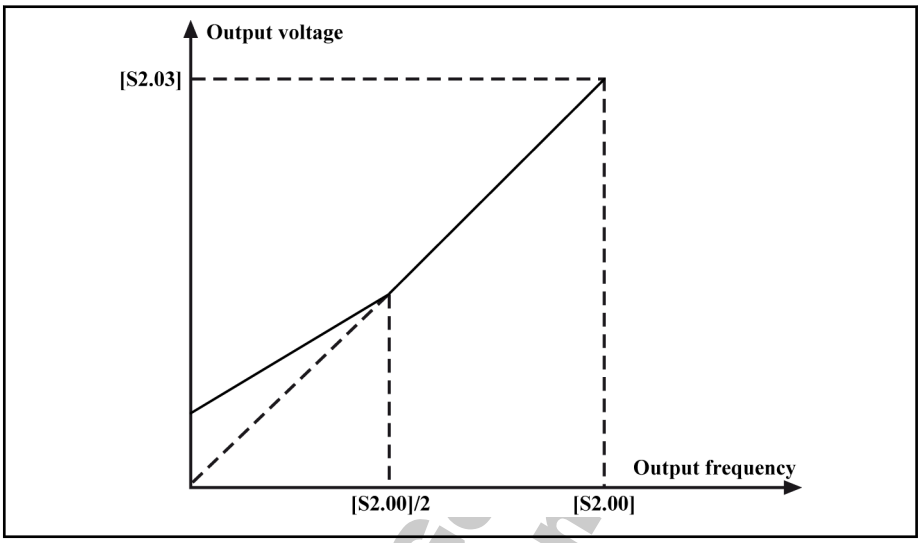

Fig.7-24: Lineare V/F curve manual torque increase

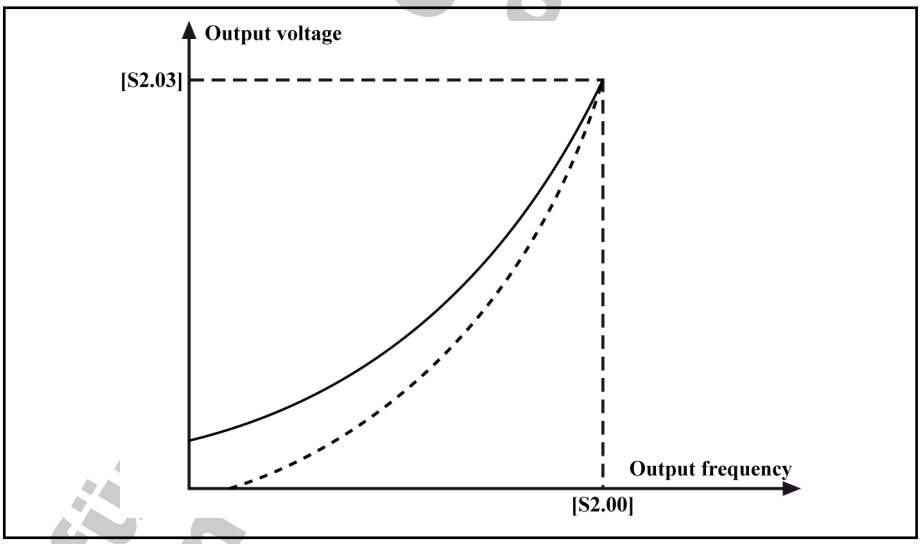

Fig.7-25: Square V/F curve manual torque increase

S0.09	Automatic voltage stabilization		Factory default	0
	Setting range	0: Not active 1: Always active 2: Not active during deceleration and braking	Minimum unit	1

Used to keep the output voltage constant within the output capability, when the supply voltage is different than the rated voltage of the converter.

- 0: Not active
- 1: Always active
  - Select if brake resistor is in place or no quick deceleration is necessary.
- 2: Not active during deceleration and braking

– Select if quick deceleration is necessary and no brake resistor is in place to reduce significantly the possibility of over voltage warnings.

S0.10	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1

Nur für internen Gebrauch
Internal use only

Parameter Settings

Group S1: Vector control

S1.00	Speed feedback proportional gain		Factory default	1.000
	Setting range	0.000 − 10.000	Minimum unit	0.001
S1.01	Speed feedback integral time		Factory default	1.000s
	Setting range	0.000 − 10.000s (0.000 means inactive)	Minimum unit	0.001s

Used to adjust the speed dynamic response characteristics of vector control.

- Larger proportional gain leads to faster response.
- Too large proportional gain may cause oscillation.
- Smaller proportional gain leads to slower response.
- Larger integral time leads to slower dynamic response of the system and the control on external disturbance is slowed.
- Smaller integral time leads to faster dynamic response of the system.
- Excessively small integral time may cause oscillation.

If the factory defaults can not meet the application requirements, the parameters can be adjusted in the following manner:

- The proportional gain should be increased without causing oscillation.
- The integral time should be decreased to allow the system to have quick response and smaller overshoot.

☞ Improperly set parameters may lead to excessive speed overshoot or overvoltage faults during fall back from the overshoot.

S1.02	Torque limit		Factory default	150.0 %
	Setting range	0.0 % − 200.0 % (of rated motor torque)	Minimum unit	0.1 %

Used to to limit the maximum torque current of the converter during startup or braking.

☞ If a large brake torque is required, apply the torque limit funcion together with brake.

S1.03	Slip compensation gain		Factory default	100.0 %
	Setting range	0.0 % − 250.0 %	Minimum unit	0.1 %

Used to maintain constant motor speeds with load changes.

☞ Increase this value when the motor is heavily loaded and has a low speed, and vice versa.

S1.04	Torque control selection		Factory default	0
	Setting range	0: Terminal control 1: Always active	Minimum unit	1

- 0: Terminal control

Nur für interne Anwendung
Internal use only

- The multi-function input terminals can be used to switch between torque control and speed control. See parameter group E0 for related setting.
  - Speed control
    - Speed commands are used to control motor actions and the speed controller is active.
    - Output frequency changes according to set frequency and the output torque changes with the load torque.
    - The output torque is limited by ‘Torque limit’ [S1.02]. If the load torque is larger than ‘Torque limit’ [S1.02], the output frequency will be different from set frequency because of torque limitation.
  - Torque control
    - Speed controller is inactive and the output torque changes according to the set torque.
    - Output frequency changes with the load speed.
    - The output speed is limited by ‘Upper frequency’ [b1.06]. If the load speed is larger than ‘Upper frequency’ [b1.06], the output torque will be different from the set torque because of speed limitation.

- 1: Always active
  - Torque control is always active.

☞ Torque control is only active for ‘Control mode’ [b1.03] is ‘2: Field oriented vector control (FOC)’.

S1.05	Torque control reference		Factory default	0
	Setting range	0, 1	Minimum unit	1

Used to select the source of reference torque in torque control mode.

- 0: Terminal +I
  - The reference torque is set with the analog terminal +I.
  - The maximum value of +I input current corresponds to 200 % of the rated torque.
  - +I can only generate positive torque.
- 1: Terminal VR1
  - The reference torque is set with the analog terminal VR1.
  - The maximum value of VR1 input voltage corresponds to 200 % of the rated torque.
  - VR1 can generate positive and negative torque. In this case, the torque direction is determined by the polarity of the input voltage regardless of settings of ‘Operating panel controlled direction’ [b1.08] and ‘Motor standard rotation direction’ [S3.14].

Nur für internen Gebrauch
Internal use only

Parameter Settings

Group S2: Motor and Encoder Parameters

S2.00	Rated motor frequency		Factory default	50.00 Hz
	Setting range	8.00 − 400.00 Hz	Minimum unit	0.01 Hz
S2.01	Rated motor rotation speed		Factory default	1440 rpm
	Setting range	1 − 30000 rpm	Minimum unit	1 rpm
S2.02	Rated motor power		Factory default	Depends on model
	Setting range	0.4 − 1000.0 kW	Minimum unit	0.1 kW
S2.03	Rated motor voltage		Factory default	Depends on model
	Setting range	0 − 480 V	Minimum unit	1 V
S2.04	Rated motor current		Factory default	Depends on model
	Setting range	0.1 − 1000.0 A	Minimum unit	0.1 A

Set parameters [S2.00] − [S2.04] according to the nameplate of the motor. The rated motor power should be the same or one class lower than the rated power of the converter. Otherwise the performance could be affected.

S2.05	Stator resistance factor		Factory default	Depends on model
	Setting range	0.00 % − 50.00 %	Minimum unit	0.01 %
S2.06	Rotator resistance factor		Factory default	Depends on model
	Setting range	0.00 % − 50.00 %	Minimum unit	0.01 %
S2.07	Leakage inductance factor		Factory default	Depends on model
	Setting range	0.00 % − 50.00 %	Minimum unit	0.01 %
S2.08	Mutual inductance factor		Factory default	Depends on model
	Setting range	0.0 % − 2000.0 %	Minimum unit	0.1 %
S2.09	No-load current		Factory default	Depends on model
	Setting range	0.0 − 1000.0 A	Minimum unit	0.1 A
S2.10	Parameter auto-tuning		Factory default	0
	Setting range	0, 1, 2	Minimum unit	1

The motor parameters ([S2.00] − [S2.04]) must be set before using ‘Parameter auto-tuning’[S2.10]. The necessary information can be found on the nameplate of the motor.

- [S2.10]=0: No action
- [S2.10]=1: Auto tuning with running motor
  - ‘Auto tuning with running motor’ can ensure the dynamic control performance of the converter. Before using ‘Auto tuning with running motor’, any load must be removed from the motor. Parameters [S2.05] − [S2.09] will be updated during auto tuning.
- [S2.10]=2: Auto tuning with static motor
  - Parameters [S2.05] − [S2.07] will be updated during auto tuning.

Nur für internen Gebrauch
Internal use only

1. ‘Parameter auto-tuning’ [S2.10] is ‘1: Auto tuning with running motor’ and over current or over voltage occurs, increase the parameters ‘Acceleration time 1’ [b1.09] and ‘Deceleration time 1’ [b1.10].
2. Ensure the motor is stopped before starting auto-tuning; otherwise auto-tuning may end in abnormal results.
3. In some cases, it is not possible to use auto-tuning. In such cases, accurate motor parameter values must be entered, to parameters [S2.00] − [S2.09]. However, the motor’s nameplate parameters of the motor must be entered first.

S2.11	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
S2.12	Pulses per revolution of pulse encoder		Factory default	1024
	Setting range	1 − 20000	Minimum unit	1
S2.13	Pulse encoder direction reverse		Factory default	0
	Setting range	0, 1	Minimum unit	1
S2.14	Pulse encoder fault detection extent		Factory default	0.0
	Setting range	0.1 − 1000.0 rpm	Minimum unit	0.1 rpm
S2.15	Pulse encoder fault detection time		Factory default	1.0
	Setting range	0.0 , 0.1 − 10.0s	Minimum unit	0.1s

Set parameters [S2.12] − [S2.15] in the case of vector control with speed sensor or pulse encoder feedback V/F control.

- Parameter [S2.12] is used to set the number of pulses per revolution of the pulse encoder.
- Parameter [S2.13] is used to change the phase sequence, if the encoder phases are reversely connected.
- If the set frequency is larger than ‘Pulse encoder fault detection extent’ [S2.14] and the actual speed is smaller than ‘Pulse encoder fault detection extent’ [S2.14] and lasts for ‘ Pulse encoder fault detection time’ [S2.15], the converter will apply fault protection to the pulse encoder.

Nur für internen Gebrauch
Internal use only

Parameter Settings

Group S3: Run Parameters

S3.00	Jog frequency		Factory Default	5.00 Hz
	Setting range	0.00 − b1.05	Minimum unit	0.01 Hz
S3.01	Jog acceleration time		Factory Default	5.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s
S3.02	Jog deceleration time		Factory Default	5.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s

- Parameter [S3.00] is used to set jog frequency.
- Parameters [S3.01] and [S3.02] are used to define the jog acceleration and deceleration time, as shown in fig. 7-26 "Jog frequency setting" on page 106.

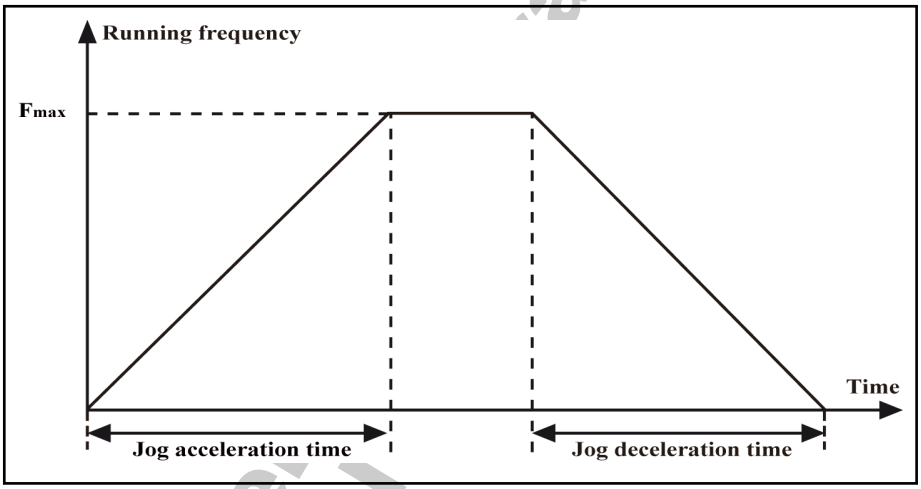

Fig.7-26: Jog frequency setting

- The converter allows jog when power is on. Jog can be set via operating panel or external computer.

☞ Jog is inactive in torque control mode.

S3.03	Skip frequency 1		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
S3.04	Skip frequency 2		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
S3.05	Skip frequency 3		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
S3.06	Skip frequency range		Factory Default	0.00 Hz
	Setting range	0 − 30.00 Hz	Minimum unit	0.01 Hz

- Three skip frequencies may be set to avoid mechanical resonance points
  - If the output frequency falls within the skip frequency range, the output frequency will be automatically set to the upper or lower limit of the skip frequency range.

Nur für interne Zwecke

  - If no skip frequency is used, the skip frequency range has to be set to 0.00 Hz.
- During acceleration/deceleration the function is inactive (only available for steady state output).
- Do not make the three skip frequency ranges overlap or nest in each other.

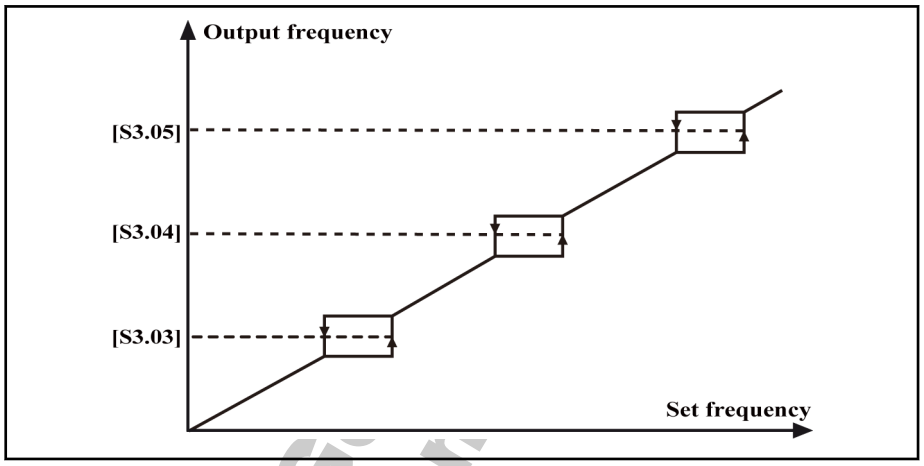

Fig.7-27: Skip frequencies and ranges

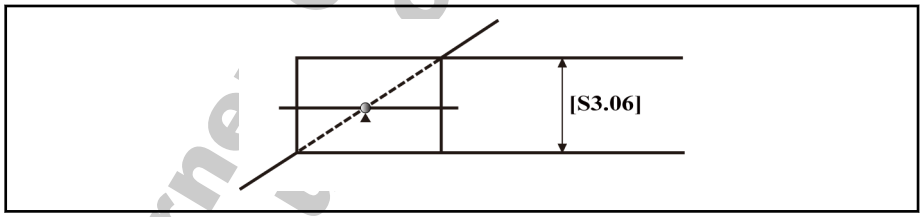

Fig.7-28: Frequency output fobidden point

S3.07	Restart after power off or power fault		Factory Default	0
	Setting range	0, 1	Minimum unit	1
S3.08	Waiting time to restart after power off or power fault		Factory Default	1.0s
	Setting range	0.1 − 10.0s	Minimum unit	0.1s

This function allows automatic running of the converter if power on after power off or power fault.

- 0: Inactive: No restart after power off or power fault.
- 1: Active: Restart after power off or power fault.
  - For a running converter, when ‘Converter control commands’ [b1.02] is ‘0: Set control commands via operating panel’ and no stop signal input:
    - If parameter [S3.07]=1, the converter will automatically start.
    - If parameter [S3.07]=0, the converter only starts after the Run key is pressed down.
  - For a running converter, when ‘Converter control commands’ [b1.02] is ‘1: Set control commands via external terminals’ or ‘2: Set control commands via communication’ and there is running command input:
    - If parameter [S3.07]=1, the converter will automatically start after waiting for the time of [S3.08].

Nur für interne Gebrauch

– If parameter [S3.07]=0, the converter only starts after reissuing the running command.

– When ‘Converter control commands’ [b1.02] is ‘1: Set control commands via external terminals’, do not change the state of external terminals during power off or power fault.

⚠ WARNING **Ensure running safety!**

S3.09	Direction change dead time		Factory Default	4.0s
	Setting range	0.0 − 3600.0s	Minimum unit	0.1s

Waiting time when the converter switches from forward rotation to reverse rotation, and vice versa, while the rotation speed is zero.

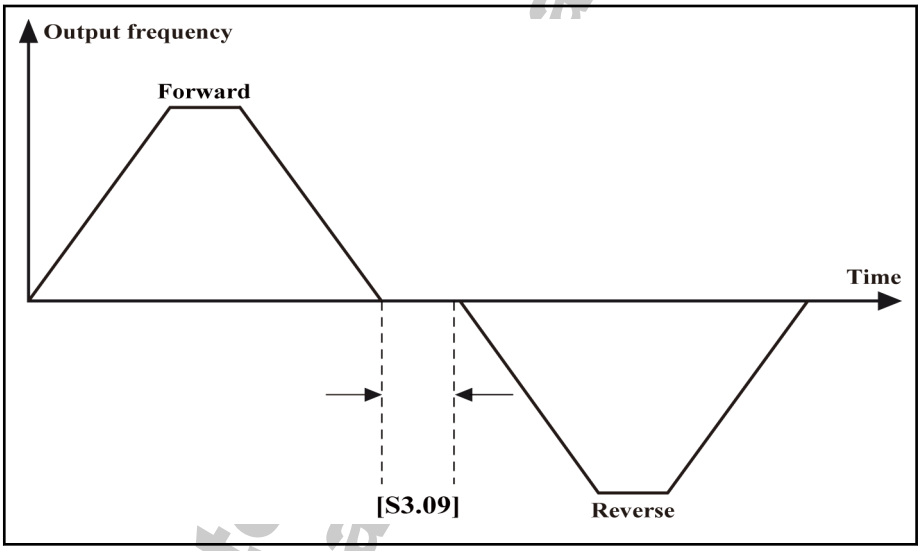

Fig.7-29: Direction change dead time

S3.10	Droop control		Factory Default	0.00 Hz
	Setting range	0.00 − 10.00 Hz	Minimum unit	0.01 Hz

Used to change the decrease value of the output frequency.

This function is suitable for circumstances where multiple converters are used to drive the same load And allows even of output power distribution.

- When a converter is subject a too high load, the converter will automatically reduce its output frequency to reduce the load according to the parameter setting.

  Change the value gradually in case of adjustment. The relationship between the load and output frequency is illustrated in fig. 7-30 "Droop control" on page 109.

Nur für interne Zwecke

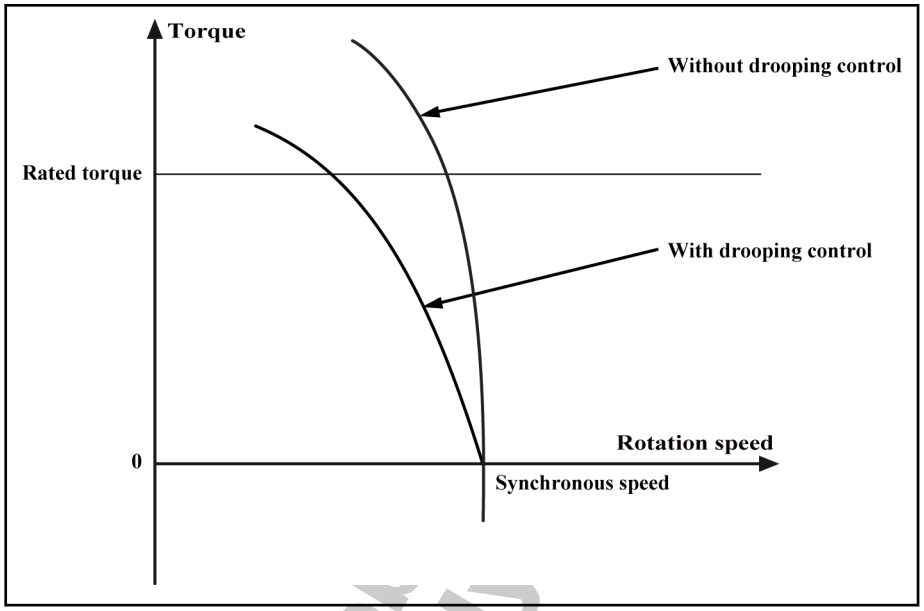

Fig.7-30: Droop control

S3.11	Setting velocity via **Up/Down**		Factory Default	1.00 Hz / s
	Setting range	0.10 − 100.00 Hz / s	Minimum unit	0.01 Hz / s

Used to set the frequency changing rate when the frequency is set with the external Up/Down terminals or the ▲/▼ keys of the operating panel.

S3.12	Brake unit threshold		Factory Default	770 V
	Setting range	600 − 785 V	Minimum unit	1 V
S3.13	Brake hysteresis voltage		Factory Default	10 V
	Setting range	5 − 20 V	Minimum unit	1 V

- Only for models with a built-in brake unit.
- A suitable brake voltage set via ‘Brake unit threshold’ [S3.12] executes a fast brake to stop.
- In deceleration or breakdown braking process, the brake function is deactivated when DC voltate is larger than ‘Brake unit threshold’ [S3.12] and smaller than (‘Brake unit threshold’ [S3.12] - ‘Brake hysteresis voltage’ [S3.13]).

S3.14	Motor standard rotation direction		Factory Default	0
	Setting range	0, 1, 2	Minimum unit	

Used to change the standard rotation direction of the motor, same like adjusting any two wires (U, V and W) of the motor.

- 0: Standard motor direction
- 1: Reverse standard motor direction
- 2: Deactivate reverse motor rotation

S3.15	**Stop** key validity		Factory Default	1
	Setting range	0, 1	Minimum unit	1

- 0: Valid only for operating panel control

Nur für internen Gebrauch
Internal use only

  - **Stop** key is only valid when ‘Converter control commands’ [b1.02] is set to ‘0: Set control commands via operating panel’.
- 1: Valid for all control means
  - **Stop** key is valid for all settings of ‘Converter control commands’ [b1.02].

- **Stop** key as a fault reset key is valid for all settings of ‘Converter control commands’ [b1.02].
- If the converter is controlled by external commands and stopped with the **Stop** key, in order to restart the converter, the external commands have to be disabled first.

S3.16	Fan control		Factory Default	0
	Setting range	0, 1	Minimum unit	1

- 0: Temperature controlled
  - Automatically controls the start and stop of the cooling fan according to the detected temperature of the heat sink. The fan is always active if converter is running.
- 1: Always on

Nur für internen Gebrauch
Internal use only

7.4.3 Category E: Extended Parameters

Group E0: Input Terminals

E0.00	2-wire / 3-wire control mode		Factory Default	0
	Setting range	0, 1, 2	Minimum unit	1

- 0: Forward/Stop, Reverse/Stop

FWD	REV	Status
0	0	Stop
0	1	Reverse
1	0	Forward
1	1	Stop

Fig.7-31: 2-wire control mode 1

- 1: Forward/Reverse, Run/Stop

FWD	REV	Status
0	0	Stop
0	1	Stop
1	0	Forward
1	1	Reverse

Fig.7-32: 2-wire control mode 2

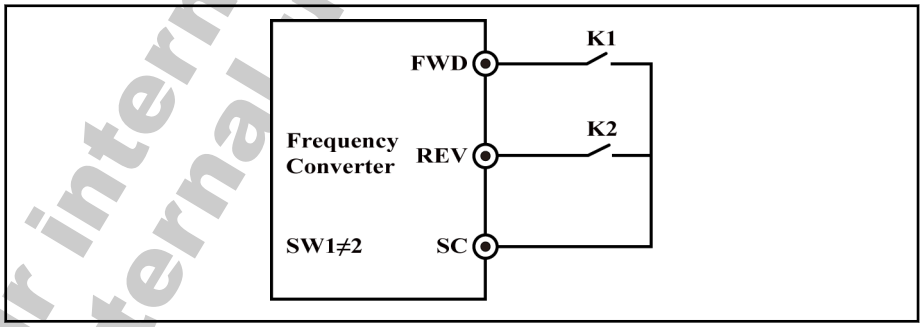

Fig.7-33: 2-wire control mode

- 2: 3-wire control

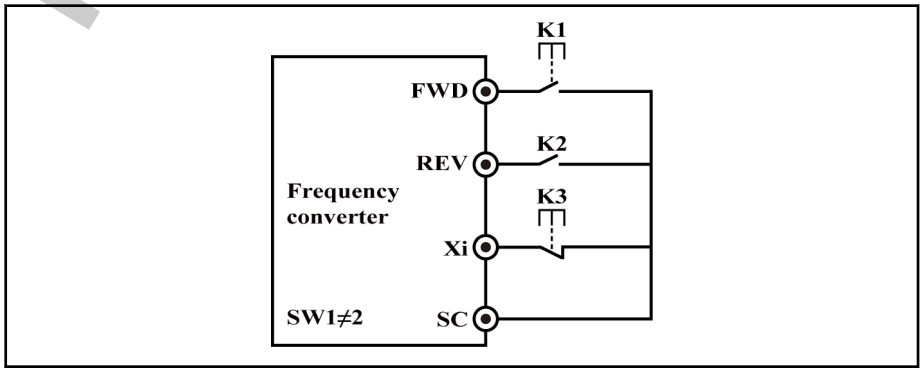

Fig.7-34: 3-wire control mode

Nur für internen Gebrauch
Internal use only

- If Xi (i=1 − 8) terminal is set to 7, “3-wire control” is selected.
- K2 is for direction selection: 0: forward; 1: reverse.
- K1 is the N.O switch, and K3 is the N.C switch. K1 and K3 are activated with pulse edges.

E0.01	Terminal X1		Factory Default	0
	Setting range	0 − 22	Minimum unit	1
E0.02	Terminal X2		Factory Default	0
	Setting range	0 − 22	Minimum unit	1
E0.03	Terminal X3		Factory Default	0
	Setting range	0 − 22	Minimum unit	1
E0.04	Terminal X4		Factory Default	0
	Setting range	0 − 22	Minimum unit	1
E0.05	Terminal X5		Factory Default	0
	Setting range	0 − 22	Minimum unit	1
E0.06	Terminal X6		Factory Default	0
	Setting range	0 − 22	Minimum unit	1
E0.07	Terminal X7		Factory Default	0
	Setting range	0 − 22	Minimum unit	1
E0.08	Terminal X8		Factory Default	0
	Setting range	0 − 22	Minimum unit	1

8 multifunction digital input terminals (X8 can be used as a high-speed pulse input terminal) are available with PNP and NPN input modes and with either internal or external power supply.

- 0: Inactive
  - The converter is inactive even if there is input signal. Unused terminals are suggested to be set to 0 (no active) to avoid malfunction. Multiple selection is possible.
- 1: Multi-speed control terminal 1
- 2: Multi-speed control terminal 2
- 3: Multi-speed control terminal 3
- 4: Multi-speed control terminal 4

16 multi-speeds are available with the combinations of the four terminals.

For example, if external terminals X1, X2, X3 and X4 are set as multi-speed terminals: [E0.01]=1, [E0.02]=2, [E0.03]=3 and [E0.04]=4, multi-speed control can be set with external switches. Run, Stop and direction can be set with FWD and REV, as shown in fig. 7-35 "Multi-speed control wiring" on page 113.

Nur für internen Gebrauch
Internal use only

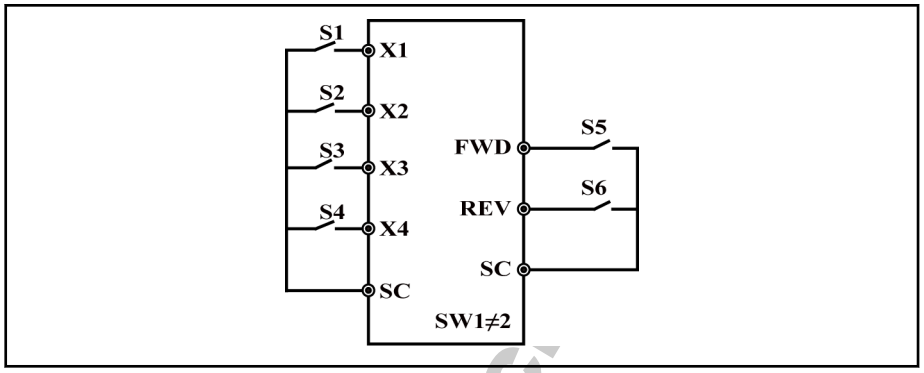

Fig.7-35: Multi-speed control wiring

Multi-speed frequencies can be set with the combination of switches S1, S2, S3 and S4, as shown in fig. 7-37 "Multi-speed control terminals" on page 113. The control process is shown in fig. 7-36 "Multi-speed control process" on page 113.

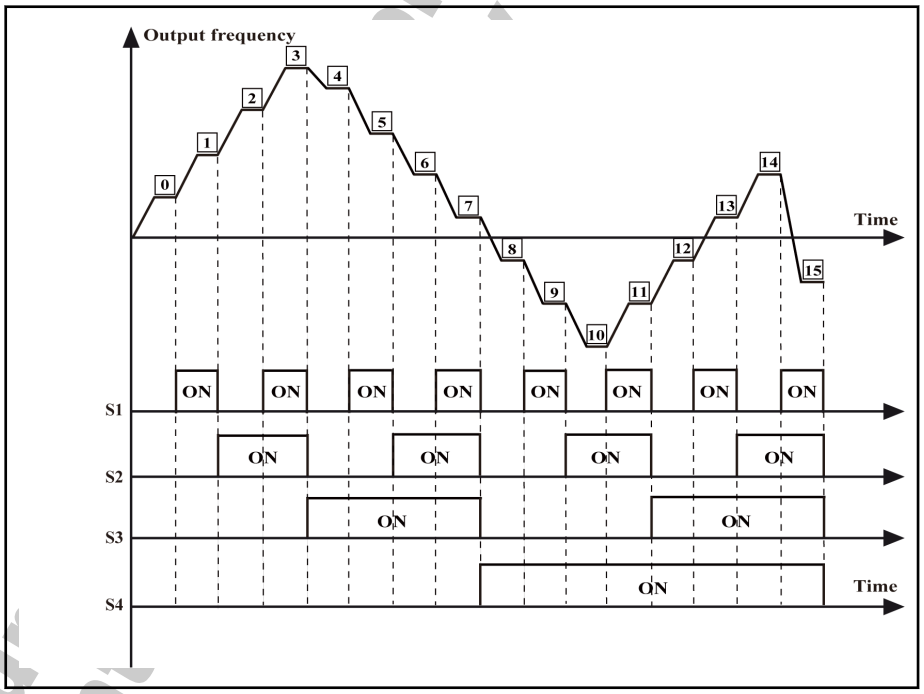

Fig.7-36: Multi-speed control process

Combination of terminal input signals				Selected frequency	Corresponding parameter
S4	S3	S2	S1		
OFF	OFF	OFF	OFF	Multi-speed frequency 0	[b1.00]
OFF	OFF	OFF	**ON**	Multi-speed frequency 1	[E2.06]
OFF	OFF	**ON**	OFF	Multi-speed frequency 2	[E2.07]
OFF	OFF	**ON**	**ON**	Multi-speed frequency 3	[E2.08]
OFF	**ON**	OFF	OFF	Multi-speed frequency 4	[E2.09]
OFF	**ON**	OFF	**ON**	Multi-speed frequency 5	[E2.10]
OFF	**ON**	**ON**	OFF	Multi-speed frequency 6	[E2.11]

Nur für

OFF	**ON**	**ON**	**ON**	Multi-speed frequency 7	[E2.12]
ON	OFF	OFF	OFF	Multi-speed frequency 8	[E2.13]
ON	OFF	OFF	**ON**	Multi-speed frequency 9	[E2.14]
ON	OFF	**ON**	OFF	Multi-speed frequency 10	[E2.15]
ON	OFF	**ON**	**ON**	Multi-speed frequency 11	[E2.16]
ON	**ON**	OFF	OFF	Multi-speed frequency 12	[E2.17]
ON	**ON**	OFF	**ON**	Multi-speed frequency 13	[E2.18]
ON	**ON**	**ON**	OFF	Multi-speed frequency 14	[E2.19]
ON	**ON**	**ON**	**ON**	Multi-speed frequency 15	[E2.20]

Fig.7-37: Multi-speed control terminals

- 5: Acceleration/deceleration time control terminal 1
- 6: Acceleration/deceleration time control terminal 2

Four options of acceleration/deceleration time are available with the combinations of the two terminals, as shown in fig. 7-38 "Multi-speed acceleration/deceleration time" on page 114.

Combination of terminal input signals		Selected acceleration /deceleration time	Corresponding parameter
Acc./Dec. time 2	**Acc./Dec. time 1**		
OFF	OFF	Acceleration time 1	[b1.09]
		Deceleration time 1	[b1.10]
OFF	**ON**	Acceleration time 2	[E2.00]
		Deceleration time 2	[E2.01]
ON	OFF	Acceleration time 3	[E2.02]
		Deceleration time 3	[E2.03]
ON	**ON**	Acceleration time 4	[E2.04]
		Deceleration time 4	[E2.05]

Fig.7-38: Multi-speed acceleration/deceleration time

- 7: 3-wire control
  - Used to control the converter in 3-wire control mode. See parameter [E0.00].
- 8: Freewheel to stop activated
  - Used for large inertia loads without requirement to stop time.
  - The converter blocks output and the motor's stopping is not controlled by the converter.
- 9: Frequency increment Up command
- 10: Frequency decrement Down command
  - These two terminals are used to change the set frequency with terminals Up/Down. See parameters [b1.00] and [S3.11].
- 11: Zeroing of external terminal frequency setting
  - Used to clear the frequency set with terminals Up/Down and change the set frequency to 0.

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- 12: Reserved
- 13: Shutdown DC brake activated
  - When the output frequency reaches the shutdown DC brake activation frequency, the converter decelerate to stop, this terminal is active and the converter directly switches to the shutdown DC brake status. See parameters [b1.21] and [b1.23]. Parameter [b1.22] is inactive in this case.
- 14: Switch between control with operating panel and with external terminal
  - Used to switch between control with operating panel and with external terminal, when [b1.02]=0 or [b1.02]=1.
- 15: Simple PLC deactivated
  - Used to control the operation of simple PLC.

[E2.21]	Xi=15	Simple PLC status
≠0	OFF	Running (factory default)
≠0	ON	Inactive
=0	OFF	Inactive
=0	ON	Inactive

Fig.7-39: Simple PLC control status

- 16: Simple PLC paused
  - When the terminal is of ON, the PLC control is paused and the converter runs at zero speed; when the terminal is of OFF, the converter resumes the status before the PLC pause.
- 17: Switch between speed control and torque control
  - Used to switch between speed control and torque control in vector control with feedback. The related parameter is [S1.04].
    - When parameter [S1.04]= 0, the terminal is disconnected to activate speed control; and when the terminal is connected to activate torque control.
    - When parameter [S1.04] =1, torque control is always on regardless of the terminal.
- 18: Switch between VR1 analog reference and +I analog reference
  - The switching rule is shown in table fig. 7-40 "Switch between VR1 analog reference and +I analog reference" on page 115.

Parameter setting	Terminal is OFF	Terminal is ON
[b1.00]=2 , [E0.09]=0 (k1*VR1)	Reference channel is k1*VR1	Reference channel is k3*(+I)
[b1.00]=2 , [E0.09]=1 (k2*VR2)	Inactive	Inactive
[b1.00]=2 , [E0.09]=2 (k3* (+I))	Terminal is k3* (+I)	Reference channel is k1*VR1
[b1.00]=2 , [E0.09]=3 (k1*VR1 + k2*VR2)	Reference channel is k1*VR1 + k2*VR2	Reference channel is k3* (+I) + k2*VR2

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Parameter Settings

Parameter setting	Terminal is OFF	Terminal is ON
[b1.00]=2 , [E0.09]=4 (k1*VR1 + k3* (+I))	Inactive	Inactive
[b1.00]=2 , [E0.09]=5 (k2*VR2 + k3* (+I))	Reference channel is k2*VR2 + k3* (+I)	Reference channel is k2*VR2 + k1*VR1
[b1.00]=2 , [E0.09]=6 (k1*VR1)	Inactive	Inactive

Fig.7-40: Switch between VR1 analog reference and +I analog reference

- 19: External fault N.O contact input
- 20: External fault N.C contact input
  - When an external fault signal is sent to the converter, the concreter responses with 'E.-St' alarm and stops. This is to facilitate the monitoring and interlinking of the external devices.
- 21: External reset input
  - Same like reset with operating panel.
  - Allows remote fault reset.
- 22: Communication control activated
  - Used to switch between control with operating panel and with communication, when [b1.02]=0.
  - Used to switch between control with external terminals and with communication, when [b1.02]=1.

E0.09	Source of analog setting reference frequency		Factory Default	0
	Setting range	0: k1*VR1 1: k2*VR2 2: k3* (+I) 3: k1*VR1 + k2*VR2 4: k1*VR1 + k3* (+I) 5: k2*VR2 + k3* (+I) 6: k1*VR1 (only active for -10 − +10 V forward/reverse control)	Minimum unit	1
E0.10	VR1 channel amplification factor k1		Factory Default	1.00
	Setting range	0.00 − 10.00	Minimum unit	0.01
E0.11	VR2 channel amplification factor k2		Factory Default	1.00
	Setting range	0.00 − 10.00	Minimum unit	0.01
E0.12	+I channel amplification factor k3		Factory Default	1.00
	Setting range	0.00 − 10.00	Minimum unit	0.01
E0.13	Reference frequency curve selection		Factory Default	0
	Setting range	0 − 15	Minimum unit	1
E0.14	Analog channel filter time		Factory Default	0.100s
	Setting range	0.000 − 2.000s	Minimum unit	0.001s

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E0.15	Maximum input pulse frequency		Factory Default	20.0 kHz
	Setting range	1.0 − 50.0 kHz	Minimum unit	0.1 kHz
E0.16	Curve 1 minimum reference		Factory Default	0.0 %
	Setting range	0.0 % − [E0.18]	Minimum unit	0.1 %
E0.17	Frequency corresponding to curve 1 minimum reference		Factory Default	0.00 Hz
	Setting range	0.00 − [b1.06]	Minimum unit	0.01 Hz
E0.18	Curve 1 maximum reference		Factory Default	100.0 %
	Setting range	[E0.16] − 100.0%	Minimum unit	0.1 %
E0.19	Frequency corresponding to curve 1 maximum reference		Factory Default	50.00 Hz
	Setting range	0.00 − [b1.06]	Minimum unit	0.01 Hz
E0.20	Curve 2 minimum reference		Factory Default	0.0 %
	Setting range	0.0 % − [E0.22]	Minimum unit	0.1 %
E0.21	Frequency corresponding to curve 2 minimum reference		Factory Default	0.00 Hz
	Setting range	0.00 − [b1.06]	Minimum unit	0.01 Hz
E0.22	Curve 2 maximum reference		Factory Default	100.0 %
	Setting range	[E0.20] − 100.0 %	Minimum unit	0.1 %
E0.23	Frequency corresponding to curve 2 maximum reference		Factory Default	50.00 Hz
	Setting range	0.00 − [b1.06]	Minimum unit	0.01 Hz
E0.24	Analog reference forward/reverse dead zone control value at -10 − +10 V		Factory Default	0.0 %
	Setting range	0.0 − 30.0 %	Minimum unit	0.1 %

- When VR1, VR2, +I, or pulse frequency (PULSE) input is used as reference frequency channel, the relationship between reference channel and reference frequency is shown in fig. 7-41 "Reference frequency channel and reference frequency" on page 117.

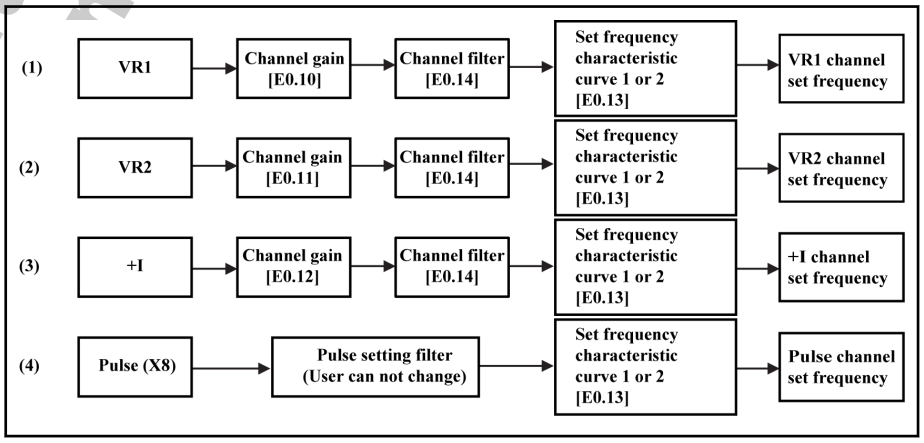

Fig.7-41: Reference frequency channel and reference frequency

- For reference frequency signals of after gain and filter processing, their relationship with the set frequencies is determined by curve 1 or curve

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2. Curve 1 is defined with [E0.16] − [E0.19], and curve 2 is defined with [E0.20] − [E0.23]. Either of them can independently realize positive and negative actions, as shown in fig. 7-42 "Output frequency characteristics curves" on page 118.

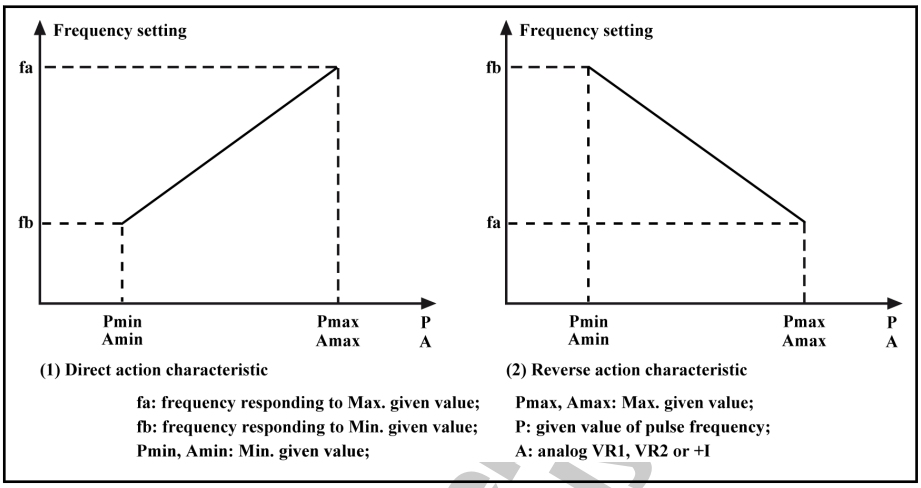

Fig.7-42: Output frequency characteristics curves

- Analog input A being 100 % corresponds to 10 V or 20 mA, and pulse frequency P being 100 % corresponds to the maximum input pulse frequency defined with [E0.15].
- Parameter [E0.13] is used to select output frequency characteristic curves for VR1, VR2, +I and PULSE frequency reference channels, as shown in fig. 7-43 "Reference frequency curve selection" on page 118.

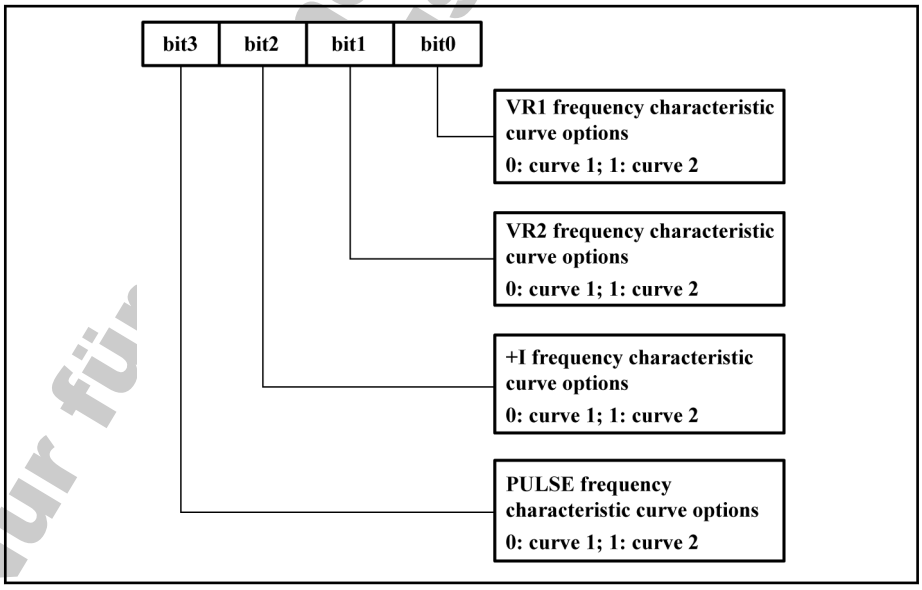

Fig.7-43: Reference frequency curve selection

- Parameter [E0.14] is used to define the analog channel filter time constant for processing of input signals. Longer filter time means stronger anti-interference capability and slower response; shorter filtering time means weaker anti-interference capability and faster response.
- Parameter [E0.09] is used to select the source of analog reference frequency. VR2 and +I inputs are active if [E0.09]=6.
- If [E0.09]=6 and the voltage range of VR1 analog input is -10 V to 0 V to +10 V, direction information exists. In this case, the direction control with

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operating panel or terminal commands is automatically deactivated, and is not subject to the rotation direction parameter [S3.14], and the dead zone is determined with [E0.24].

- If [E0.09]=6, parameter [E0.24] can be used to define the forward and reverse rotation dead zone of the motor, i.e. the range for treating input signals as zero, as shown in fig. 7-44 "Reference frequency and analog input voltage when [E0.09]=6" on page 119.

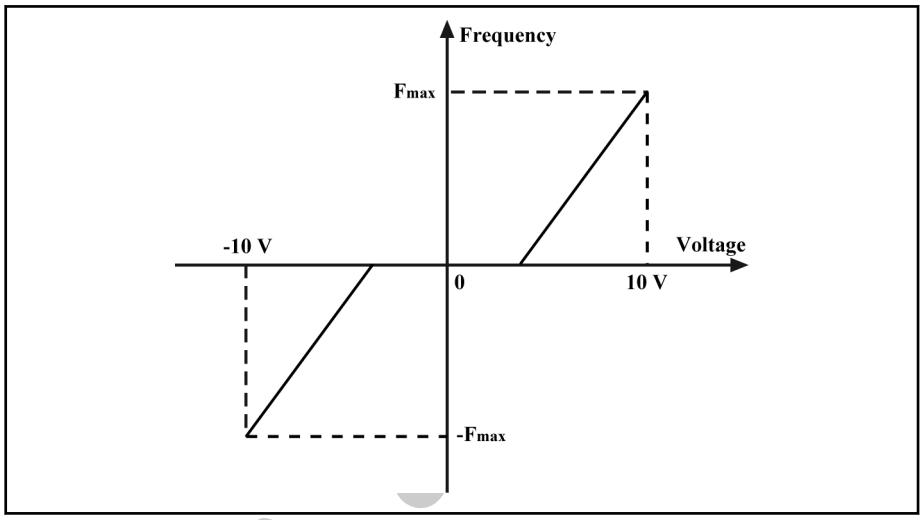

Fig.7-44: Reference frequency and analog input voltage when [E0.09]=6

- For example, if [E0.24]=10.0 % when [E0.09]=6, analog input signals within the range of -1 − +1 V will be treated as zero, 1 − 10 V corresponds to 0 Hz – maximum frequency, -1 − -10 V corresponds to 0 Hz – minus maximum frequency. The dead zone range is -1 − +1 V in this case.

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Parameter Settings

Group E1: Output Terminals

E1.00	Open collector output OUT1		Factory Default	1
	Setting range	0 − 11	Minimum unit	1
E1.01	Open collector output OUT2		Factory Default	1
	Setting range	0 − 11	Minimum unit	1
E1.02	Relay outputs Pa, Pb and Pc		Factory Default	1
	Setting range	0 − 11	Minimum unit	1

Open collector outputs OUT1 and OUT2 and the relay outputs are described as below:

- 0: Converter is ready to run
  - Terminal output indicating signal when the converter is free of fault and ready to run after the main circuit and the control circuit power supplies have been established.
- 1: Converter is running
  - Terminal output indicating signal when the converter is running and has frequency output.
- 2: DC brake indication
  - Terminal output indicating signal when the converter is in DC braking process.
- 3: Converter runs at zero speed
  - Terminal output indicating signal when the converter runs at 0 Hz.
- 4: Frequency/speed arrival signal
  - See related parameter ‘Frequency arrival detection width’ [E1.03].
- 5: Frequency level detection signal (FDT1)
  - See related parameters [E1.04] − [E1.05].
- 6: Frequency level detection signal (FDT2)
  - See related parameters [E1.06] − [E1.07].
- 7: Simple PLC phase completion indication
  - Terminal pulse output indicating signal when each phase is complete in simple PLC control.
- 8: Under voltage stop
  - Terminal output indicating signal when the converter is at under voltage.
- 9: Converter over load pre-warning
  - Terminal output indicating signal when the output current exceeds the set value of parameter ‘Converter over load pre-warning level setting’ [E1.08].
- 10: Motor over load pre-warning
  - Terminal output indicating signal when the output current exceeds the set value of parameter ‘Motor over load pre-warning level setting’ [E1.09].
- 11: Over torque
  - Terminal output indicating signal when the motor torque exceeds the set value of parameter ‘Torque limit’ [S1.02] in vector control.

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E1.03	Frequency arrival detection width		Factory Default	5.0 %
	Setting range	0.0 % − 20.0 % (of 'maximum frequency' [b1.05])	Minimum unit	0.1 %

Used to detect the difference between the output frequency and the set frequency.

If parameters [E1.00] − [E1.02] are set to ‘4: Frequency/speed arrival signal’, the difference between the output frequency and the set frequency is within the setting range, and the output indicating signals are shown in fig. 7-45 "Frequency arrival signal" on page 121.

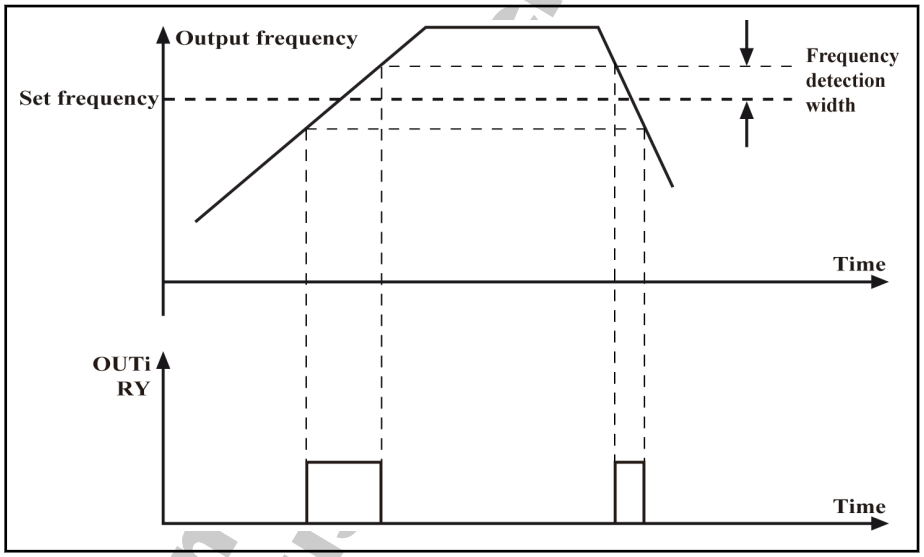

Fig.7-45: Frequency arrival signal

E1.04	Frequency detection level FDT1		Factory Default	90.0 %
	Setting range	0.0 % − 100.0 % (of 'maximum frequency' [b1.05])	Minimum unit	0.1 %
E1.05	Frequency detection level FDT1 width		Factory Default	5.0 %
	Setting range	0.0 % − 100.0 % (of 'maximum frequency' [b1.05])	Minimum unit	0.1 %
E1.06	Frequency detection level FDT2		Factory Default	50.0 %
	Setting range	0.0 % − 100.0 % (of 'maximum frequency' [b1.05])	Minimum unit	0.1 %
E1.07	Frequency detection level FDT2 width		Factory Default	5.0 %
	Setting range	0.0 % − 100.0 % (of 'maximum frequency' [b1.05])	Minimum unit	0.1 %

Used to detect if the output frequency is within the setting range of FDT.

- If parameters [E1.00] − [E1.02] are set to ‘5: Frequency level detection signal (FDT1)’ or ‘6: Frequency level detection signal (FDT2)’, and the converter output frequency is within the corresponding FDT range, the output indicating signals will be output via the output terminals.

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Parameter Settings

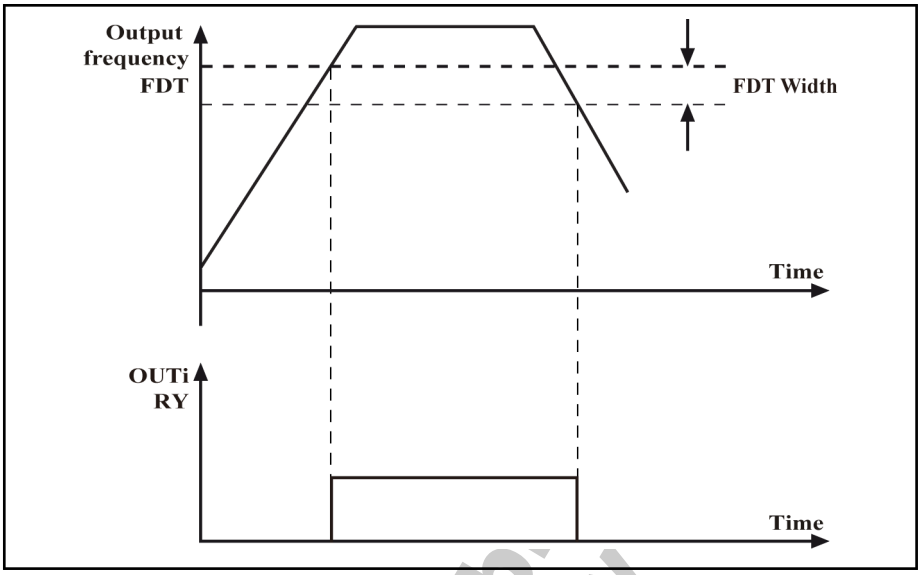

Fig.7-46: Frequency level detection signal

E1.08	Converter over load pre-warning level setting		Factory Default	100.0 %
	Setting range	20.0 % − 100.0 % (of rated converter current)	Minimum unit	0.1 %

If parameters [E1.00] − [E1.02] are set to '9: Converter over load pre-warning', and the converter output current exceeds the value '[E1.08] * converter rated current', output indicating signals will be output via output terminals.If parameters [E1.00] − [E1.02] are set to '9: Converter over load pre-warning', and the converter output current exceeds the value '[E1.08] * converter rated current', output indicating signals will be output via output terminals.

E1.09	Motor over load pre-warning level setting		Factory Default	100.0 %
	Setting range	100.0 % − 250.0 % (of rated motor current)	Minimum unit	0.1 %

If parameters [E1.00] − [E1.02] are set to '10: Motor over load pre-warning', and the converter output current exceeds the value '[E1.09] * motor rated current', output indicating signals will be output via output terminals.

E1.10	FM1 analog outputs		Factory Default	0
	Setting range	0: Output frequency/rotation speed 1: Set frequency/rotation speed 2: Output current 3: Torque current 4: Output voltage	Minimum unit	1
E1.11	FM1 channel mode		Factory Default	0
	Setting range	0 : 0 − 10 V or 0 − 20 mA 1 : 2 − 10 V or 4 − 20 mA	Minimum unit	1
E1.12	FM1 gain setting		Factory Default	1.00
	Setting range	0.00 − 10.00	Minimum unit	0.01

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The analog output terminals can be set with parameter ‘FM1 channel mode’ [E1.11] to select output signals 0 − 10 V, 0 − 20 mA or 2 − 10 V, or 4 − 20 mA.

Either voltage signals or current signals are output via analog output terminals is determined with JP3 and JP4 on the control board:

- If JP3 is set to 1 − 2, FM1 outputs voltage signals; if JP3 is set to be 2 − 3, FM1 outputs current signals.
- If JP4 is set to 1 −2, FM2 outputs voltage signals; if JP4 is set to be 3 − 4, FM2 outputs current signals.
- Analog outputs are set with parameter ‘FM1 analog outputs’ [E1.10], as shown in fig. 7-47 "Meanings of analog outputs" on page 123.

[E1.10]	Outputs	[E1.11]=0	[E1.11]=1
0	Output frequency/ rotation speed	0 to maximum output frequency, corresponding 0 − 10 V / 0 − 20 mA	0 to maximum output frequency, corresponding 2 − 10 V / 4 − 20 mA
1	Reference frequency/ rotation speed	0 to maximum reference frequency, corresponding 0 − 10 V / 0 − 20 mA	0 to maximum reference frequency, corresponding 2 − 10 V / 4 − 20 mA
2	Output current	0 to 2 times of rated current, corresponding 0 − 10 V / 0 − 20 mA	0 to 2 times of rated current, corresponding 2 − 10 V / 4 − 20 mA
3	Torque current	0 to 200 % of rated torque current, corresponding 0 − 10 V / 0 − 20 mA	0 to 200 % of rated torque current, corresponding 2 − 10V / 4 − 20 mA
4	Output voltage	0 to 1.2 times of rated voltage, corresponding 0 − 10 V / 0 − 20 mA	0 to 1.2 times of rated voltage, corresponding 2 − 10 V / 4 − 20 mA

Fig.7-47: Meanings of analog outputs

- Parameter ‘FM1 gain setting’ [E1.12] is used to set the gain of FM1.

E1.13	FM2 analog outputs		Factory Default	1
	Setting range	0 − 4	Minimum unit	1
E1.14	FM2 channel mode		Factory Default	0
	Setting range	0, 1	Minimum unit	1
E1.15	FM2 gain setting		Factory Default	1.00
	Setting range	0 − 10.00	Minimum unit	0.01

The description is the same as that of parameters [E1.10] − [E1.12].

E1.16	Pulse outputs		Factory Default	0
	Setting range	0, 1, 2	Minimum unit	1

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Parameter Settings

E1.17	Maximum output pulse frequency		Factory Default	10.0 kHz
	Setting range	1.0 − 50.0 kHz	Minimum unit	0.1 kHz

DO pulse frequency output range: 0 − [E1.17]

- If parameter ‘Pulse outputs’ [E1.16] is set to ‘0: Output frequency’, when the output frequency reaches the maximum frequency, the corresponding set value of parameter ‘Maximum output pulse frequency’ [E1.17] is output via DO terminal.
- If parameter ‘Pulse outputs’ [E1.16] is set to ‘1: Output voltage’, when the output voltage reaches 500 V, the corresponding set value of parameter ‘Maximum output pulse frequency’ [E1.17] is output via DO terminal.
- If parameter ‘Pulse outputs’ [E1.16] is set to ‘2: Output current’, when the output current reaches the rated current, the corresponding set value of parameter ‘Maximum output pulse frequency’ [E1.17] is output via DO terminal.

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Group E2: Multi-Speed and Simple PLC Control

E2.00	Acceleration time 2		Factory Default	10.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s
E2.01	Deceleration time 2		Factory Default	10.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s
E2.02	Deceleration time 3		Factory Default	10.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s
E2.03	Acceleration time 3		Factory Default	10.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s
E2.04	Acceleration time 4		Factory Default	10.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s
E2.05	Deceleration time 4		Factory Default	10.0s
	Setting range	0.1 − 3600.0s	Minimum unit	0.1s

- Acceleration/deceleration time 2, 3, 4 are defined the same meanings as that of Parameter ‘Acceleration time 1’ [b1.09] / ‘Deceleration time 1’ [b1.10].
- Multifunction terminal Xi is used to selected different acceleration/deceleration time, see parameters [E0.01] − [E0.08].

E2.06	Multi-speed frequency 1		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.07	Multi-speed frequency 2		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.08	Multi-speed frequency 3		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.09	Multi-speed frequency 4		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.10	Multi-speed frequency 5		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.11	Multi-speed frequency 6		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.12	Multi-speed frequency 7		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.13	Multi-speed frequency 8		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.14	Multi-speed frequency 9		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.15	Multi-speed frequency 10		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz

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E2.16	Multi-speed frequency 11		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.17	Multi-speed frequency 12		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.18	Multi-speed frequency 13		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.19	Multi-speed frequency 14		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz
E2.20	Multi-speed frequency 15		Factory Default	0.00 Hz
	Setting range	b1.07 − b1.06	Minimum unit	0.01 Hz

Parameters [E2.06] − [E2.20] are used to set the speeds (frequencies) in multi-speed control and simple PLC control.

- Multi-speed control
  - 16 multiple speeds can be set via multi-speed control terminals, together with forward/reverse control terminals (FWD-COM and REV-COM) and acceleration/deceleration terminals.
    - Running time of each speed is decided by the hold time of corresponding logic combination.
    - Output frequency is decided by parameters [E2.06] − [E2.20] corresponding to each speed. For details of multi-speed running, see parameters [E0.01] − [E0.08].
- Simple PLC control
  - Automatic control according the current acceleration/deceleration time, output frequency, running time and rotation direction. One cycle of simple PLC control is shown in fig. 7-48 "Simple PLC control" on page 126.

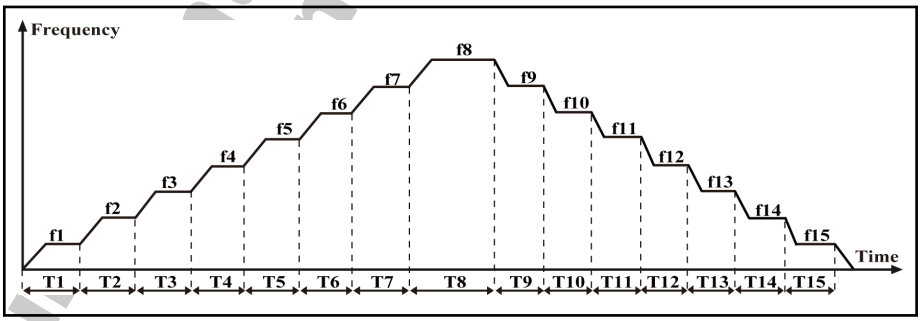

Fig.7-48: Simple PLC control

☞ f1 − f15 are set with parameters [E2.06] − [E2.20], and T1 − T15 are set with parameters [E2.22] − [E2.52].

E2.21	PLC control mode		Factory Default	0
	Setting range	0, 1, 2, 3	Minimum unit	1

- 0: Inactive
  - Simple PLC control is inactive.
- 1: Mode 1

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  - Simple PLC control stops after one cycle.
- 2: Mode 2
  - Converter runs repeatedly, will be stopped by stop commands.
- 3: Mode 3
  - Converter keeps running at the set frequency of the last phase after one cycle.

E2.22	PLC time factor		Factory Default	1
	Setting range	1 − 60	Minimum unit	1

The actual run time of each stage is ‘Set time * parameter ‘PLC time factor’ [E2.22]’.

E2.23	Stage 1 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1

- The set frequency of stage 1 is defined with parameter ‘Multi-speed frequency 1’ [E2.06].
- Used to define running direction and acceleration/deceleration time of stage 1.
  - bit4
    - 0: Forward
    - 1: Reverse
  - bit3 and bit2
    - 00: set with parameter ‘Acceleration time 1’ [b1.09]
    - 01: set with parameter ‘Acceleration time 2’ [E2.00]
    - 10: set with parameter ‘Acceleration time 3’ [E2.02]
    - 11: set with parameter ‘Acceleration time 4’ [E2.04]
  - bit1 and bit0
    - 00: set with parameter ‘Deceleration time 1’ [b1.10]
    - 01: set with parameter ‘Deceleration time 2’ [E2.01]
    - 10: set with parameter ‘Deceleration time 3’ [E2.03]
    - 11: set with parameter ‘Deceleration time 4’ [E2.05]
- The data format of this parameter is shown in .

bit4	bit3	bit2	bit1	bit0

Fig.7-49: Data format of parameter [E2.23]

E2.24	Stage 1 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s

Used to set the running time of stage 1, related parameter ‘PLC time factor’ [E2.22].

E2.25	Stage 2 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.26	Stage 2 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s

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Parameter Settings

E2.27	Stage 3 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.28	Stage 3 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.29	Stage 4 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.30	Stage 4 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.31	Stage 5 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.32	Stage 5 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.33	Stage 6 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.34	Stage 6 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.35	Stage 7 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.36	Stage 7 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.37	Stage 8 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.38	Stage 8 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.39	Stage 9 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.40	Stage 9 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.41	Stage 10 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.42	Stage 10 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.43	Stage 11 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.44	Stage 11 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s

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E2.45	Stage 12 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.46	Stage 12 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.47	Stage 13 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.48	Stage 13 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.49	Stage 14 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.50	Stage 14 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s
E2.51	Stage 15 action selection		Factory Default	0
	Setting range	0 − 31	Minimum unit	1
E2.52	Stage 15 running time		Factory Default	0.0s
	Setting range	0.0 − 5000.0s	Minimum unit	0.1s

- To set stages 2 – 15, please refer to the description for stage 1.
- If the running time of a stage is set to 0, simple PLC will skip this stage.
- If parameter ‘Motor standard rotation direction’ [S3.14] is set to ‘2: Deactivate reverse motor rotation’, simple PLC control will stop immediately when a reverse rotation command is executed.
- For simple PLC control with external terminals, please refer to parameters [E0.01]−[E0.08].

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Parameter Settings

Group E3: PID Control

PID control is a common used process control approach suitable for flow control, pressure control and temperature control.

Based on proportional, integral and derivative calculations of the difference between the reference and the feedback, a negative feedback system can be formed with the adjustment of the converter output frequency to limit the difference from the reference. The basic control principle is shown in fig. 7-50 "Process PID control" on page 130.

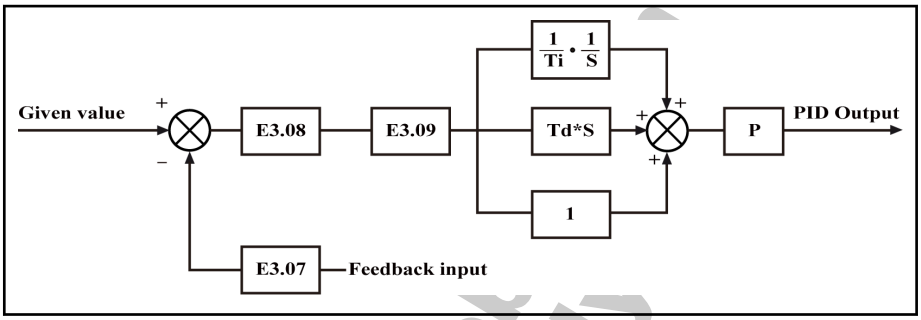

Fig.7-50: Process PID control

☞ P represents the proportion gain, Ti represents the integral time and Td represents the derivative time.

E3.00	PID control mode		Factory Default	0
	Setting range	0, 1, 2, 3, 4	Minimum unit	1

- 0: PID control inactive
- 1: Analog input + analog feedback
- 3: Analog input + pulse encoder feedback
  - In this mode, parameter ‘Control mode’ [b1.03] needs to be set as ‘0: V/F control’.
- 4: Rotation speed digital setting + pulse encoder feedback
  - In this mode, parameter ‘Control mode’ [b1.03] needs to be set as ‘0: V/F control’.

E3.01	Analog digital setting		Factory Default	0.00 V
	Setting range	0.00 − 10.00 V	Minimum unit	0.01 V

Active when parameter ‘PID control mode’ [E3.00] is set to ‘2: Analog digital setting + analog feedback’.

E3.02	Rotation speed digital setting		Factory Default	0 rpm
	Setting range	0 − 30000 rpm	Minimum unit	1 rpm

- Active when parameter ‘PID control mode’ [E3.00] is set to ‘4: Rotation speed digital setting + pulse encoder feedback’.
- In closed loop PID control, configuration of reference, feedback and control mode is shown in fig. 7-51 "Configuration in closed loop PID control" on page 131.

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PID control mode	Reference	Feedback	Converter control mode
[E3.00]=1	External analog input	External analog signal feedback	[b1.03]=0, 1, 2 0 or 1 in most cases
[E3.00]=2	Analog digital setting [E3.01]	External analog signal feedback	
[E3.00]=3	External analog input	Pulse encoder feedback	[b1.03]=0 (V/F control)
[E3.00]=4	Rotation speed digital setting [E3.02]	Pulse encoder feedback	

Fig.7-51: Configuration in closed loop PID control

E3.03	Analog feedback channel		Factory Default	0
	Setting range	0, 1	Minimum unit	1

- 0: Feedback is via terminal +I in PID control.
- 1: Feedback is via terminal VR2 in PID control.

E3.04	P: Proportional gain		Factory Default	1.500
	Setting range	0.000 − 10.000	Minimum unit	0.001
E3.05	Ti: Integral time		Factory Default	0.00s
	Setting range	0.00 − 100.00s (0.00 represents no integral)	Minimum unit	0.01s
E3.06	Td: Derivative time		Factory Default	0.00s
	Setting range	0.00 − 100.00s (0.00 represents no derivative)	Minimum unit	0.01s
E3.07	T: Sampling period		Factory Default	0.50s
	Setting range	0.01 − 100.00s	Minimum unit	0.01s

Used to set PID control parameters.

- P: Proportional gain
  - Used to eliminate deviation
    - Larger P means larger scale and faster response, but too large P leads to oscillation.
    - P cannot eliminate deviation,.
- Ti: Integral time
  - Used to eliminate deviation
    - Smaller Ti means faster response of converter to deviation changes, but too mall Ti leads to oscillation.
- Td: Derivative time
  - Used to respond fast to changes of deviation between reference and feedback exists in the system.
    - Larger Td means faster response, but too large Td leads to oscillation.

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Parameter Settings

E3.08	Deviation limit		Factory Default	2.0 %
	Setting range	0.0 % − 20.0 % (of closed loop reference)	Minimum unit	0.1 %

Used to set the limit of the deviation between reference signals and feedback signals to stop internal PID control and keep stable output.

- PID control stops when feedback deviation is within the range of ‘Deviation limit’ [E3.08].

☞ Control accuracy and stability of the system should be taken into account in setting of parameter ‘Deviation limit’ [E3.08].

E3.09	PID adjustment mode		Factory Default	0
	Setting range	0, 1	Minimum unit	1

In closed loop PID control, if the output value reaches parameter ‘Upper limit frequency’ [b1.06] or ‘Lower limit frequency’ [b1.07], the integral loop has two options:

- 0: Stop integral adjustment
  - The integral value remains unchanged.
    - When the difference between reference value and feedback value changes, the integral value will change immediately with the changing trend.
- 1: Continue integral adjustment
  - The integral value responds simultaneously to the difference change between the reference value and the feedback value.
    - When the difference between the reference values and the feedback value changes, more time is needed to compensate the impact of continuous integral adjustment for the integral value to follow the changing trend.

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Group E4: Protection Parameters

E4.00	Software over voltage protection threshold		Factory Default	810 V
	Setting range	790 − 820 V	Minimum unit	1 V
E4.01	Stall over voltage function		Factory Default	0
	Setting range	0、1	Minimum unit	1
E4.02	Stall over voltage protection level		Factory Default	130.0 %
	Setting range	120.0 % − 150.0 % (of rated converter peak voltage)	Minimum unit	0.1 %

- Parameter ‘Stall over voltage function’ [E4.01] is used to activate or de-activate stall over voltage function.
  - 0: Deactivated
  - 1: Activated
- In stall over voltage protection, converter detects the bus voltage during deceleration and compares it with ‘Stall over voltage protection level’ [E4.02].
- If bus voltage exceeds stall over voltage protection level, the converter output frequency stops decrease.
- Only if bus voltage is lower than the stall over voltage protection level, will the converter resume deceleration, as shown in fig. 7-52 "Stall over voltage protection level" on page 133:

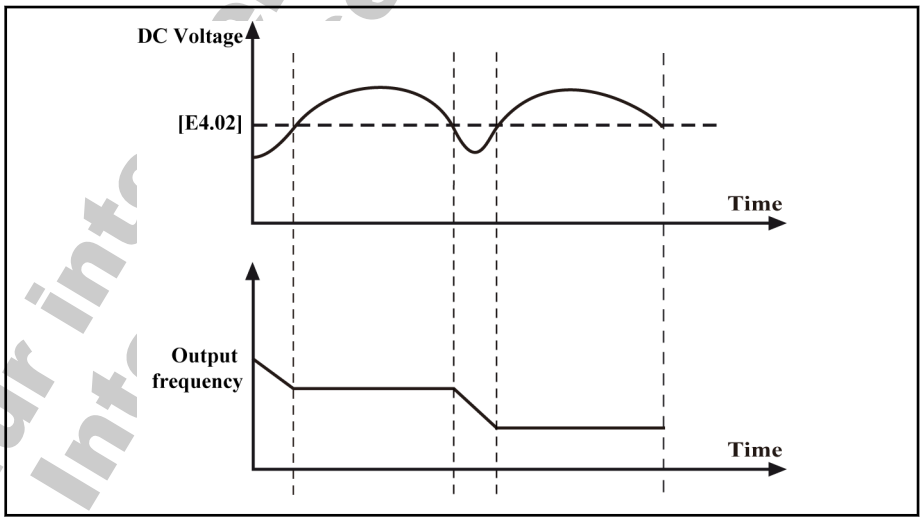

Fig.7-52: Stall over voltage protection level

E4.03	Stall over current protection level		Factory Default	150.0 %
	Setting range	20.0 % − 200.0 % (of rated converter output current)	Minimum unit	0.1 %

The function action will lead to longer acceleration time than set time.

During acceleration:

- If the converter output current exceeds ‘Stall over current protection level’, the converter output frequency will stop increase.
- Only if the converter output current is lower than ‘Stall over current protection level’ [E4.03], will the converter resume acceleration, to avoid stall over current.

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Parameter Settings

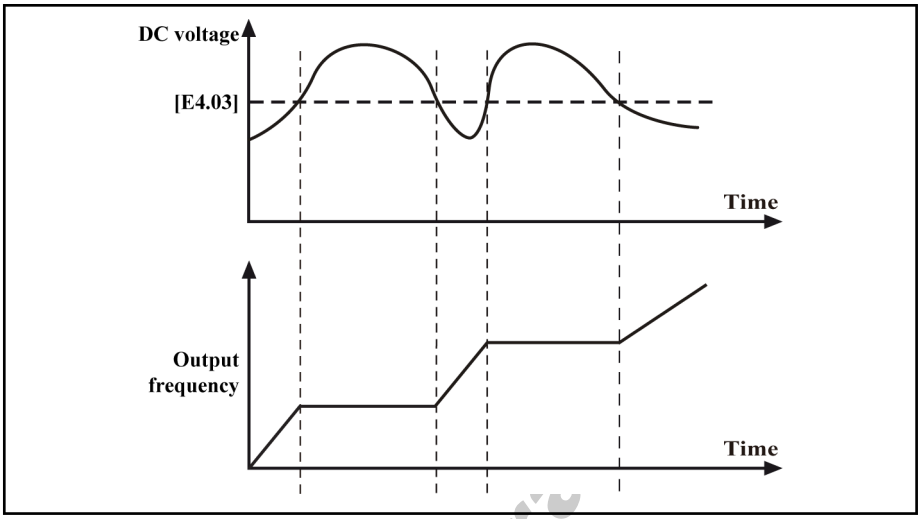

Fig.7-53: Stall over current protection level

E4.04	Motor over load protection		Factory Default	1
	Setting range	0, 1, 2	Minimum unit	1

- 0: Inactive
- 1: Heat protection active at low-speed
  - With a normal asynchronous motor, head dissipation is insufficient at low-speed running, the electronic heat protection value needs to be set properly.
- 2: Heat protection inactive at low-speed
  - With a special motor for frequency conversion, head dissipation will not be deteriorated at low-speed running, the electronic heat protection value setting is unnecessary.

E4.05	Motor over load protection factor		Factory Default	100.0 %
	Setting range	50.0 % − 110.0 %	Minimum unit	0.1 %

- If the rated converter current is different from that of the motor, motor over load protection factor needs to be set properly for effective motor protection.

  Motor over load protection factor (%) = (Rated motor current / Rated converter current) * 100 %
- The inverse time characteristic of over load protection is shown fig. 7-54 "Over load protection curve" on page 135.

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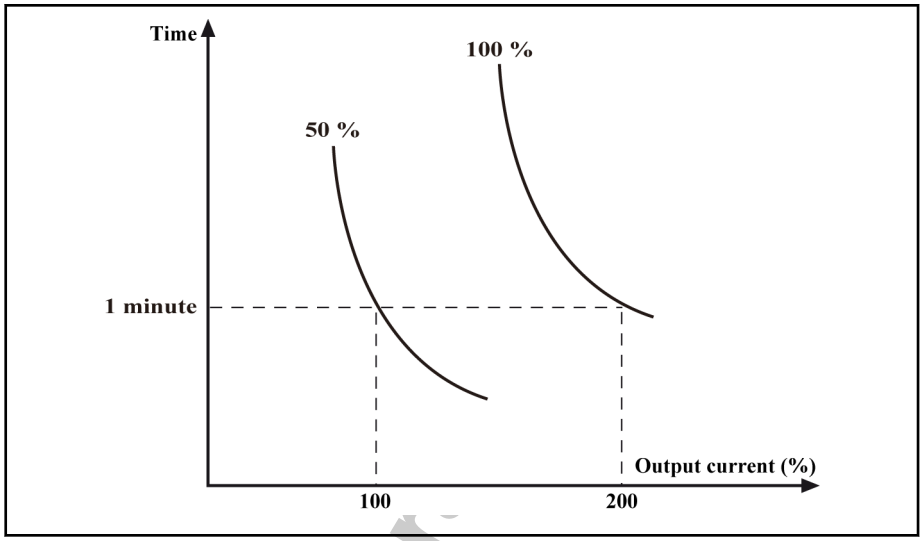

Fig.7-54: Over load protection curve

E4.06	Phase loss protection		Factory Default	0
	Setting range	0, 1, 2, 3	Minimum unit	1

- 0: Both input and output phase loss protection active
  - Converter input phase loss protection is active, and operating panel displays IPH.L.
  - Converter output phase loss protection is active, and operating panel displays OPH.L.
- 1: Only input phase loss protection active
- 2: Only output phase loss protection active
- 3: Both input and output phase loss protection inactive

E4.07	Fault relay setting		Factory Default	0
	Setting range	0 − 3	Minimum unit	1

- Fault relay Ta, Tb, Tc settinng options
  - bit0: 0: Under voltage inactive; 1: Under voltage active
  - bit1: 0: Auto reset inactive; 1: Auto reset active
- Data format of this parameter is show in fig. 7-55 "Data format of parameter [E4.07]" on page 135.

bit1	bit0

Fig.7-55: Data format of parameter [E4.07]

E4.08	Number of fault reset attempts		Factory Default	0
	Setting range	0 − 3	Minimum unit	1
E4.09	Interval between reset attempts		Factory Default	10s
	Setting range	2 − 60s	Minimum unit	1s

- Automatic fault reset function can be used to ensure continuous running without human intervention in the case of occasional faults, such as over current and over voltage during start or running.

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- If parameter ‘Number of fault reset attempts’ [E4.08] is not set to ‘0: Auto reset deactivated’, the converter is automatically reset and restarts after the interval of ‘Interval between reset attempts’ [E4.09].
  - Parameter ‘Number of fault reset attempts’ [E4.08] is used to set the allowed maximum times of attempts for automatic reset in case of fault;
  - Parameter ‘Interval between reset attempts’ [E4.09] is used to set interval time between reset attempts.
- If fault still exists after ‘Number of fault reset attempts’ [E4.08], the converter will send an alarm and stop.
- Automatic fault reset is valid to the following fault types: O.C.-1, O.C.-2, O.C.-3, O.E.-1, O.E.-2, O.E.-3, O.L.-1, O.L.-2, E.-St, CPU- and O.H.

E4.10	Last fault		Factory Default	0
	Setting range	0 − 23	Minimum unit	1
E4.11	2nd last fault		Factory Default	0
	Setting range	0 − 23	Minimum unit	1
E4.12	3rd last fault		Factory Default	0
	Setting range	0 − 23	Minimum unit	1

Used to record the recent three faults, and can be viewed after reset. For fault types, please refer to chapter 8.1 "Fault Types and Solutions" on page 139.

E4.13	Delete fault record		Factory Default	0
	Setting range	0 − 1	Minimum unit	1

- 0: No fault record
- 1: Active
  - Delete fault records stored in parameters [E4.10] − [E4.12].

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7.4.4 Category H: Advanced Parameters

Group H0: Communication Parameters

H0.00	Communication protocol		Factory Default	0
	Setting range	0 – 1	Minimum unit	1

- 0: ModBus
  - Factory default is ModBus protocol and interface. See chapter 12.2 "ModBus Protocol" on page 179.
- 1: PROFIBUS
  - An optional Rexroth PROFIBUS adapter is needed. See chapter 12.3 "PROFIBUS Protocol" on page 191.

H0.01	Baud rate		Factory Default	3
	Setting range	0 – 5	Minimum unit	

Used to select data transmission speed between external computer and converter. Available baud rate includes:

- 0: 1200 bps
- 1: 2400 bps
- 2: 4800 bps
- 3: 9600 bps
- 4: 19200 bps
- 5: 38400 bps

☞ The baud rate of converter must be the same as that of external computer; otherwise, normal communication is impossible.

H0.02	Data format		Factory Default	0
	Setting range	0, 1, 2	Minimum unit	

Used to set data format in protocols.

- 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)

☞ The data format of converter must be the same as that of external computer; otherwise, normal communication is impossible.

H0.03	Local address			Factory Default	1
	Setting range	H0.00=0	1 – 247	Minimum unit	1
		H0.00=1	1 – 126		

- In ModBus communication, the maximum number of converters in the network is 247; 0 is broadcast address.
- In PROFIBUS communication, the maximum number of converters in the network is 126.

☞ The address of a converter should be unique in the communication network.

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Parameter Settings

H0.04	PZD4, PZD3 setting		Factory Default	0
	Setting range	0 − 238	Minimum unit	1
H0.05	PZD6, PZD5 setting		Factory Default	0
	Setting range	0 − 238	Minimum unit	1
H0.06	PZD8, PZD7 setting		Factory Default	0
	Setting range	0 − 238	Minimum unit	1
H0.07	PZD10, PZD9 setting		Factory Default	0
	Setting range	0 − 238	Minimum unit	1

In PROFIBUS communication, parameters [H0.04] − [H0.07] are used to set status variables of PZD area. See chapter 12.3.4 "Periodical Data Communication" on page 195.

H0.08	Communication disconnection detection time		Factory Default	0.0s
	Setting range	0.0, 0.1 − 60.0s	Minimum unit	0.1s

- 0.0: communication disconnection detection is deactivated.
- 0.1 − 60.0s: if the interval between the current communication and next communication exceeds the communication timeout time, the system will detect timeout and act according to parameter ‘Communication disruption action’ [H0.09].

☞ Normally, this parameter is deactivated. This parameter can used to monitor the conditions of communication if continuous communication is required in a system.

H0.09	Communication disconnection action		Factory Default	0
	Setting range	0, 1	Minimum unit	

- 0: If communication is timeout, the motor freewheels to stop.
- 1: If communication is timeout, the motor keeps running at the set frequency.

H0.10	Reserved		Factory Default	0
	Setting range	0 − 65535	Minimum unit	1

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8 Fault Indication

8.1 Fault Types and Solutions

Fault No.	Fault name and code	Possible reason	Solution
1	Over current at constant speed (O.C.-1)	1. Sudden change in run mode	1. Reduce occurrence and sacle of sudden change
		2. Low mains voltage	2. Motor power has to match with converter power
		3. Motor power and converter power do not match	3. Check input power supply
		4. Too large inertia or load	4. Check motor power, converter power, load
		5. Pulse encoder fault	5. Check pulse encoder and its connection
2	Over current during acceleration (O.C.-2)	1. Too large start frequency	1. Reduce start frequency
		2. Too large load rotation inertia, too large impact load	2. Increase acceleration time, reduce sudden load change
		3. Improper motor parameter setting	3. Set motor parameters properly or auto tune motor parameters (group S2)
		4. Direct start during motor running	4. Restart after motor stop, or start with rotation speed capture (group b1)
		5. Too short acceleration time	5. Increase acceleration time
		6. Motor power and converter power do not match	6. Motor power has to match with converter power
		7. Pulse encoder fault	7. Check pulse encoder and its connection
		8. Improper V/F curve	8. Adjust V/F curve setting and torque increase
3	Over current during deceleration (O.C.-3)	1. Improper motor parameter setting	1. Improper motor parameter setting
		2. Too large load rotation inertia	2. Use suitable brake components
		3. Too short deceleration time	3. Increase deceleration time
		4. Motor power and converter power do not match	4. Motor power has to match with converter power
		5. Pulse encoder fault	5. Check pulse encoder and its connection
4	Over voltage at constant speed (O.E.-1)	1. Motor to earth short circuit	1. Check motor connection
		2. Abnormal input power supply	2. Check input power supply
		3. Too large load rotation inertia	3. Use suitable brake components
		4. Improper speed loop parameter setting in vecotor control	4. Adjust PI of speed loop (group S1)
5	5: Over voltage during acceleration (O.E.-2)	1. Motor to earth short circuit	1. Check motor connection
		2. Abnormal input power supply	2. Check input power supply
		3. Direct start during motor running	3. Restart after motor stop, or start with rotation speed capture (group b1)

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Fault Indication

Fault No.	Fault name and code	Possible reason	Solution
6	Over voltage during deceleration (O.E.-3)	1. Motor to earth short circuit	1. Check motor connection
		2. Too large load rotation inertia	2. Use suitable brake components
		3. Too short deceleration time	3. Increase deceleration time
7	Converter over load (O.L.-1)	1. Long time over load	1. Reduce over load time, reduce load
		2. Too large proportion of V/F curve	2. Adjsut V/F proportionand torque increase settings
		3. Motor power and converter power do not match	3. Motor power has to match with converter power
		4. Improper motor parameter setting	4. Set motor parameters properly or auto tune motor parameters (group S2)
		5. Direct start during motor running	5. Restart after motor stop, or start with rotation speed capture (group b1)
		6. Low mains voltage	6. Check input power supply
		7. Too short acceleration time	7. Increase acceleration time
8	Motor over load (O.L.-2)	1. Motor locked	1. Prevent motor lock
		2 Normal motor runs long time with large load at low speed	2. Use variable frequency motor or increase converter output frequency
		3. Low voltage of input power supply	3. Check input power supply
		4. Too large proportion of V/F curve	4. Adjsut V/F proportionand torque increase settings
		5. Too large sudden load change	5. Check load
		6. Improper setting of motor over load protection factor	6. Adjust setting of motor over load protection factor (group E4)
9	CPU read/ write fault (R.E.)	Fault or illeagal data in control board read/ write	Contact with technical service
10	Operating panel read/ write fault (KEY-)	Fault or illegal data in control board read/write	Contact with technical service
11	External device fault (E.-St)	External fault caused by input signals via external terminals	Check external terminals status, check respective reason to fault
12	Communication fault (R.S.)	1. Device connection problem	1. Check device communication connection
		2. Improper baud rate setting	2. Set proper baud rate
13	Circuit disconnection (C.F.)	Disconnecion of control circuit	Contact with technial service

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Fault No.	Fault name and code	Possible reason	Solution
14	Pulse encoder speed detection fault (PULS)	1. Pulse encoder fault	1. Check operations of mechanical part and electrical part of encoder, power supply and connections
		2. Pulse encoder connection problem	2. Replace encoder connection cable
		3. Improper setting of pulse encoder	3. Set parameters related to pulse encoder properly
15	Reserved		
16	EMI fault (CPU-)	CPU malfunction due to external interference	Remove environmental interference or EMI
17	Short circuit (S.C.)	1. Too large output current	1. Check if motor short circuit, motor to earth short circuit, earth short circuit, over load exist
		2. Power component fault	2. Contact with technial service for maintenance
18	Reserved		
19	R, S, T input phase loss (IPH.L)	1. Abnormal, omitted or broken connection of converter power supply	1. Follow operating procedures to check power supply connections, remove omitted or broken connections
		2. Broken fuse	2. Check fuse
		3. Imbalance in the three phases of input power supply	3. Check if the imbalance situation exceeds requirments
20	U, V, W output phase loss (OPH.L)	1. Abnormal, omitted or broken connection of converter outputs	1. Check connections of converter outputs, remove omitted or broken connections
		2. Imbalance in the three phases of outputs	2. Check motor
21	Converter over heat (O.H.)	1. Converter over heat	1. Reduce ambient temperature, improve ventilation and heat dissipation; clear dust, cotton wadding in air ducts; check fan and its power supply connection
		2. Temperature detection circuit fault	2. Contact with technial service
22	Parameter setting fault (PRSE)	Improper setting of parameters	Check set values of parameters
23	Parameter auto-tuning fault (TUNE)	1. Power of special or normal motor does not match with converter power	1. Check if the motor is special motor, check if the motor power matches with converter power
		2. Improper setting of parameters on motor nameplates	2. Set parameters according to motor nameplate
		3. No connection of converter and motor	3. Check motor cable connections

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Fig.8-1: Fault types and solutions

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9 Technical Data

9.1 Fv General Technical Data

Input	Power supply voltage	3 AC 380 to 480 V (-15 % / +10 %) (TN - Net)
	Supply frequency	50 to 60 Hz (±5 %)
Output	Rated output voltage	Corresponding to input voltage
	Output frequency	0 to 400 Hz
	Overload capacity	150 % of rated current for 60s; 180 % of rated current for 10s
Main Functions	Control mode	SVC; FOC; V/F
	Speed regulation range	Vector control without pulse encoder: 100:1 Vector control with pulse encoder: 1000:1
	Start-up torque	SVC: 150 % * rated torque at 0.5 Hz FOC: 200 % * rated torque at 0 Hz
	Frequency resolution	Analog setting: Maximum frequency * 1/2048 Digital setting: 0.01 Hz
	Frequency setting accuracy	Analog setting: 0.05 % Digital setting: 0.01 %
	Frequency control accuracy	SVC: 0.5 % * maiximum frequency FOC: 0.05 % * maximum frequency
	Multiple speed control	Via Integrated PLC or control terminals
	Status messages via multi-function output signal	Outputs of Run, frequency level detection signal, freqeuncy arrival signal, faults, etc.
	Automatic PWM frequency adaptation	Load-dependent adaptation of PWM frequency
Customerized functions	Control commands	set by operating panel, control terminals 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 terminals	Analog signal output, 0 / 4 to 20 mA or 0 / 2 to 10 V, to output physical values, such as output frequency
Operating panel	LCD display	Displaying of various parameters, including set frequency, output frequency, output voltage, output current, etc.
	LED indicator	Showing setting direction, Run status.
Protection	Input phase failure protection, output phase failure protection, grounding protection, over current protection, over voltage protection, under voltage protection, overheat protection, overload protection, etc.	
Optional parts	Braking resistor, operating panel for cabinet control, communication cable for cabinet control, fieldbus adapter	

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Environment	Power reduction/maximum installation height	Up to 1000 m above sea level: none; 1000…4000 m above sea level: 1 % / 100 m
	Ambient temperature	-10 °C to 40 °C (without condensation and frost); derating between 40 °C and 50 °C
	Relative humidity	< 90 % RH (without condensation)
	Shocking	< 5.9 m/s (0.6 g)
	Allowed pollution degree	2 (EN 50178)
Construction	Degrees of protection	IP20 (control cabinet mounting)
	Cooling type	Enforced, air cooling
Mounting mode	Hanging on the wall	

Fig.9-1: General technical data

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9.2 Derating of electrical data

9.2.1 Derating and ambient temperature

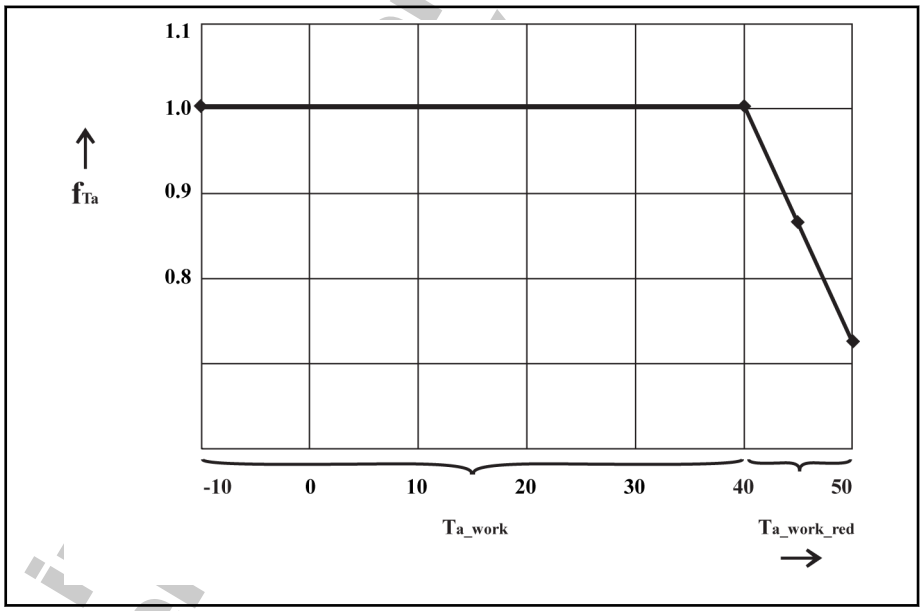
Where installation conditions differ, the following performance data are reduced in accordance with the diagram:

Frequency converter:

- continuous power output
- continuous current output

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

As the ambient temperature increases, the capacity utilization of the devices is reduced according to fig. 9-2 "Derating and ambient temperature" on page 145.



f_{Ta} load factor
T_{a_work} ambient temperature range for operation with nominal data
$T_{a\_work\_red}$ ambient temperature range for operation with reduced nominal data

Fig.9-2: Derating and ambient temperature

9.2.2 Derating and mains voltage

Reduced over current based on mains voltage

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

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

Nur für i... Gebrauch

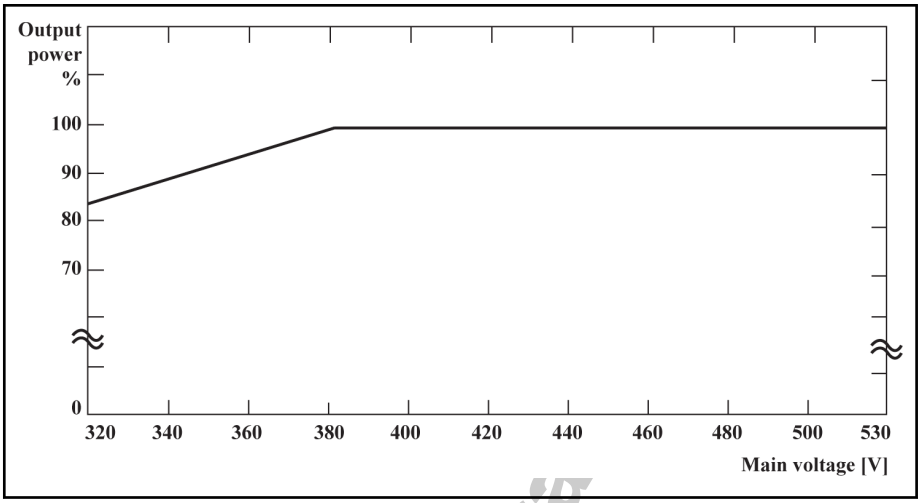


Fig.9-3: Derating and mains voltage

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

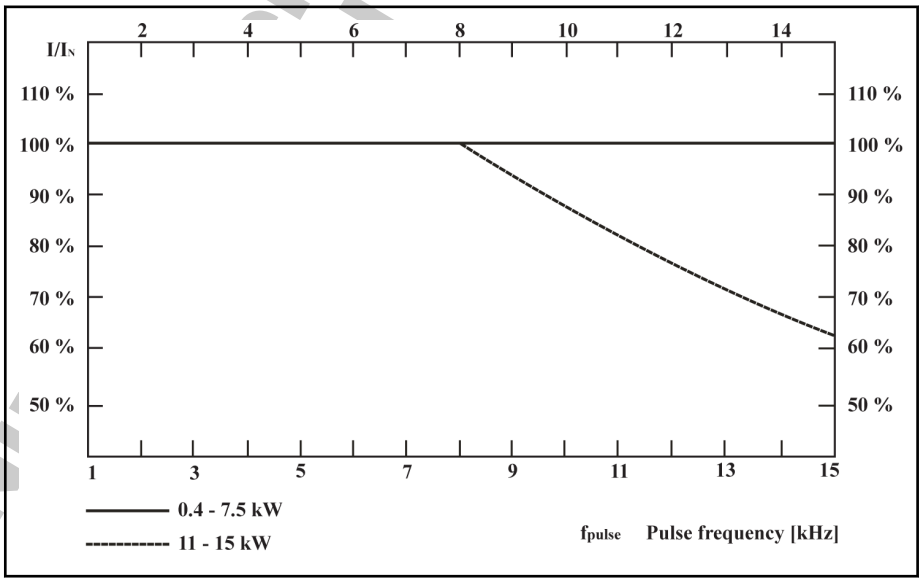
9.2.3 Derating of the output current depending on the pulse frequency

fig. 9-4 "Derating and output current" on page 146 shows the current reduction based on the pulse frequency for the different frequency converters. In case of higher pulse frequency, the current is reduced insofar that the power dissipation in power section remains more or less constant.

For converters with

with 0.4 to 7.5 kW, the current does not need derating;

with 11 to 15 kW at 8 kHz;



I permissible overcurrent
$I_{N:}$ rated current
Fig.9-4: Derating and output current

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9.3 Electrical Parameters

400 V Series

Model	FVCA01·1-0K40-3P4-MNA-LP-NNNN-01V01 •••••	FVCA01·1-0K75-3P4-MNA-LP-NNNN-01V01 •••••	FVCA01·1-1K50-3P4-MNA-LP-NNNN-01V01 •••••	FVCA01·1-2K20-3P4-MNA-LP-NNNN-01V01 •••••	FVCA01·1-4K00-3P4-MNA-LP-NNNN-01V01 •••••	FVCA01·1-5K50-3P4-MNA-LP-NNNN-01V01 •••••	FVCA01·1-7K50-3P4-MNA-LP-NNNN-01V01 •••••
Power [kW]	0.4	0.75	1.5	2.2	4.0	5.5	7.5
Rated input current [A]	3.0	3.7	5.1	7.6	16.0	16.5	24.5
Rated output current [A]	1.3	2.5	4.0	5.5	10.0	13.0	17.0
Capacity [kVA]	0.8	1.6	2.6	3.6	6.5	8.5	11.0
Weight [kg]	2.7	2.7	2.7	2.8	4.8	4.9	4.9
Model	FVCA01·1-11K-3P4-MNA-LP-NNNN-01V01 •••••	FVCA01·1-15K-3P4-MNA-LP-NNNN-01V01 •••••					
Power [kW]	11	15					
Rated input current [A]	36.0	46.0					
Rated output current [A]	24.0	33.0					
Capacity [kVA]	15.0	21.0					
Weight kg	8.8	9.0					

Fig.9-5: Fv electrical data

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Technical Data

9.4 Electromagnetic Compatibility (EMC)

9.4.1 EMC Requirements

General Information

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

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

Noise Immunity in the Drive System

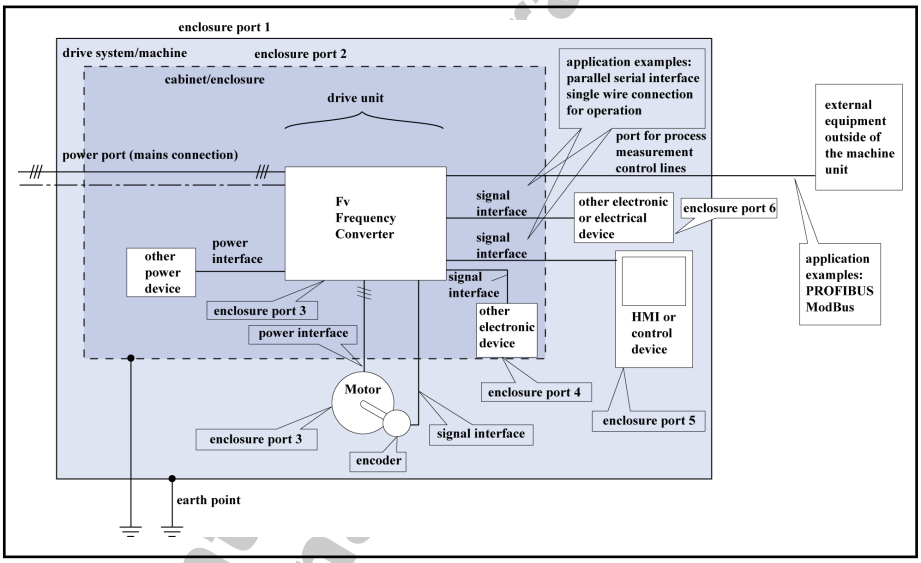

Fig.9-6: Noise immunity in the drive system

Nur für interne Zwecke

Noise immunity limit values

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

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 1800-3)
A	deviations within allowed range
B	automatic recovery after interference
C	Switched off without automatic recovery. Device remains undamaged.

Fig.9-8: Evaluation criterion

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Noise emission of the drive system

Causes of noise emission

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

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

The propagation of this interference strongly depends on:

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

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

Limit values for line-based disturbances

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

IEC / EN 61800-3	CISPR 11	Explanation	In this documentation	Curves of limit value characteristic
Category C4 2nd environment	None	One of the following 3 requirements must have been fulfilled: Mains connection current>400 A, IT mains or required dynamic drive behavior not reached by means of EMC filter. Adjust limit values to use and operation on site. User has to carry out and provide evidence of EMC planning.	None	-
Category C3 2nd environment	Class A; group 2 I>100 A	limit value in industrial areas to be complied with for applications operated at supply mains with nominal currents>100 A	A2.1	1.1 1.2
Category C3 2nd environment	Class A; group 2 I≤100 A	limit value in industrial areas to be complied with for applications operated at supply mains with nominal currents≤100 A	A2.2	2.1 2.2

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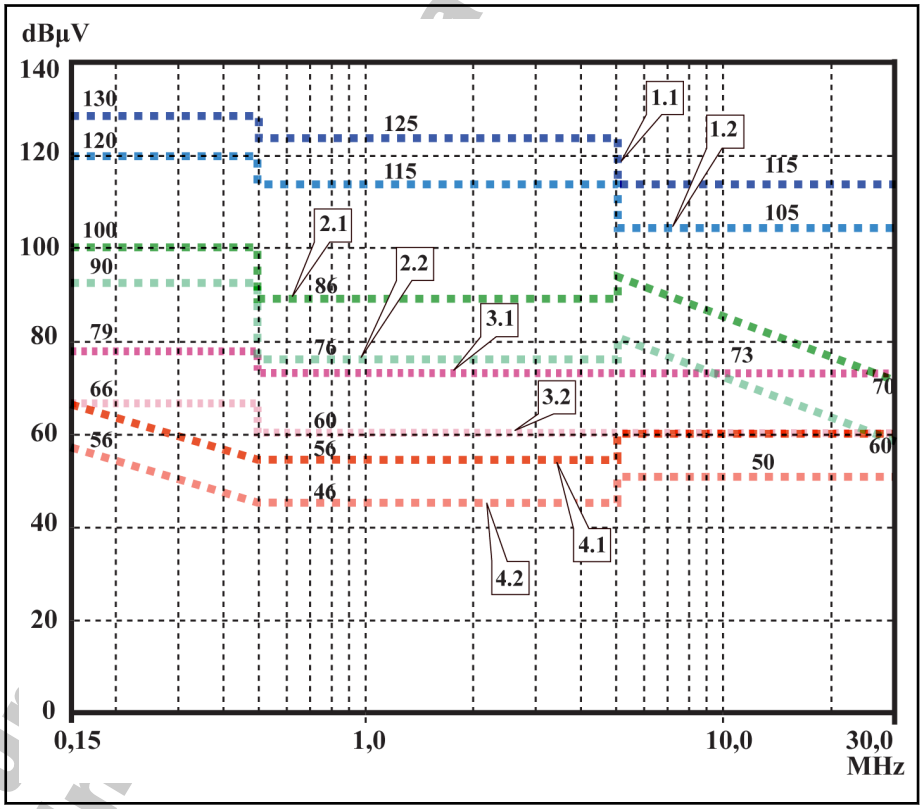
IEC / EN 61800-3	CISPR 11	Explanation	In this documentation	Curves of limit value characteristic
Category C2 1st environment; restricted distribution	Class A; group 1	Limit value in residential area or at facilities at low-voltage mains supplying buildings in residential areas. To be comply with for applications with restricted distribution.	A1	3.1 3.2
Category C1 1st environment; unrestricted distribution	Class B; group 1	limit value in residential areas to be complied with for applications with unrestricted distribution	B1	4.1 4.2

Fig.9-9: Limit values for line-based disturbances



1.1 Category C3 — 2nd environment, QSP, I>100 A (class A, group 2, I>100 A)

1.2 Category C3 — 2nd environment, AV, I>100 A (class A, group 2, I>100 A)

2.1 Category C3 — 2nd environment, QSP, I≤100 A (class A, group 2, I≤100 A)

2.2 Category C3 — 2nd environment, AV, I≤100 A (class A, group 2, I≤100 A)

3.1 Category C2 — 1st environment, restricted distribution, QSP (1st environment, even if source of interference in 2nd environment) (class A, group 1)

3.2 Category C2 — 1st environment, restricted distribution, AV (1st environment, even if source of interference in 2nd environment) (class A, group 1)

4.1 Category C1 — 1st environment, unrestricted distribution, QSP (1st environment, even if source of interference in 2nd environment) (class B, group 1)

4.2 Category C1 — 1st environment, unrestricted distribution, AV (1st environment, even if source of interference in 2nd environment) (class B, group 1)

Fig.9-10: Limit values for line-based disturbances (IEC 61800-3); limit characteristic through frequency range

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- Limit value for 1st environment is also relevant, if source of interference of 2nd environment affects 1st environment.
- Designations “class” and “group” according to IEC CISPR 11.
- QSP: measuring method quasi peak measurement.
- AV: measuring method arithmetic averaging.

Second Environment, Industrial Area

Facilities not directly connected to a low-voltage mains to supply buildings in residential areas.

If the limit values in an industrial area separated from public supply by a transformer station only have to be complied with at the property boundary or in the neighboring low-voltage mains, the filter might not be necessary. In the vicinity such as measuring sensors, measuring lines or measuring devices, it is normally required to use the interference suppression filter.

Increasing the noise immunity of a sensitive device can often be the economically better solution compared to measures of interference suppression at the drive system of installation.

First Environment

Environment containing residential areas and facilities directly connected, without interstage transformer, to a low-voltage mains supplying buildings in residential areas.

Medium-sized manufacturing plants and industrial establishments can be connected to the public low-voltage mains together with residential buildings. In this case there is a high risk for radio and television reception if there are not any measures for radio interference suppression taken. Therefore, the indicated measures are generally recommended.

Nominal Current of Supply Mains

The nominal current of the supply mains (> 100 A or ≤100 A) is specified by the local power supply company at the connection point of the mains. For industrial companies, for example, such connection points are the interconnecting stations from the power supply company.

Unrestricted Distribution

Channel of distribution for which placing on the market is independent of the EMC expert knowledge of the customer or user of electric drives.

Restricted Distribution

Channel of distribution for which the placing on the market is restricted to traders, customers or users who individually or together have technical expert knowledge of EMC for the use of electric drives.

Since it is impossible to obtain the lower limit values for residential areas with all applications by means of usual measures (like in the case of large and electrically not closed installations, longer motor cables or a large number of drives), the following note included in EN 61800-3 has to be observed.

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

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

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9.4.2 Ensuring the EMC requirements

Standards and laws

On the European level there are the EU Directives. In the EU states these Directives are transformed into laws valid on a national level. The relevant directive for EMC is EU Directive 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 limit values according to product standard EN 61800-3 have been complied with.

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

Applicability for End Product

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

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

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

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

Cases to Distinguish for Declaration of EMC Conformity

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

- Case 1: Delivery of the drive system.

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

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

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

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

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

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

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, too applies to the mounting of the mains filter. If required, use serrated washers which cut through the paint surface. Connect the cabinet door to the control cabinet using the shortest possible grounding straps.

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

The lines with high potential of noise include:

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

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

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

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

Connect these combinations directly at each coil.

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

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

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

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

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Installation of Motor Power Cable

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

EMC-optimal installation in facility and control cabinet

General information

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

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

Division into areas (zones)

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

We distinguish three areas:

1. Interference-free area of control cabinet **(area A):**

   This includes:

   - Supply feeder, input terminals, fuse, main switch, mains side of mains filter for drives and corresponding connecting lines;
   - Control voltage or auxiliary voltage connection with power supply unit, fuse and other parts unless connection is run via the mains filter of the AC drives;
   - All components that are not electrically connected with the drive system.

2. Interference-susceptible area **(area B):**

   - Mains connections between drive system and mains filter for drives, mains contactor;
   - Interface lines of drive controller

3. Strongly interference-susceptible area **(area C):**

   - Motor power cables including single cores

Never run lines of one of these areas in parallel with lines of another area so that there is not any unwanted interference injection from one area to the other and that the filter is jumped with regard to high frequency. Use the shortest possible connecting lines.

Recommendation for complex systems: Install drive components in one cabinet and the control units in a second, separate cabinet.

Badly grounded control cabinet doors act as antennas. Therefore, connect the control cabinet doors to the cabinet on top, in the middle and on the bottom via short equipment grounding conductors with a cross section of at least 6 mm^2 or, even better, via grounding straps with the same cross section. Make sure connection points have good contract.

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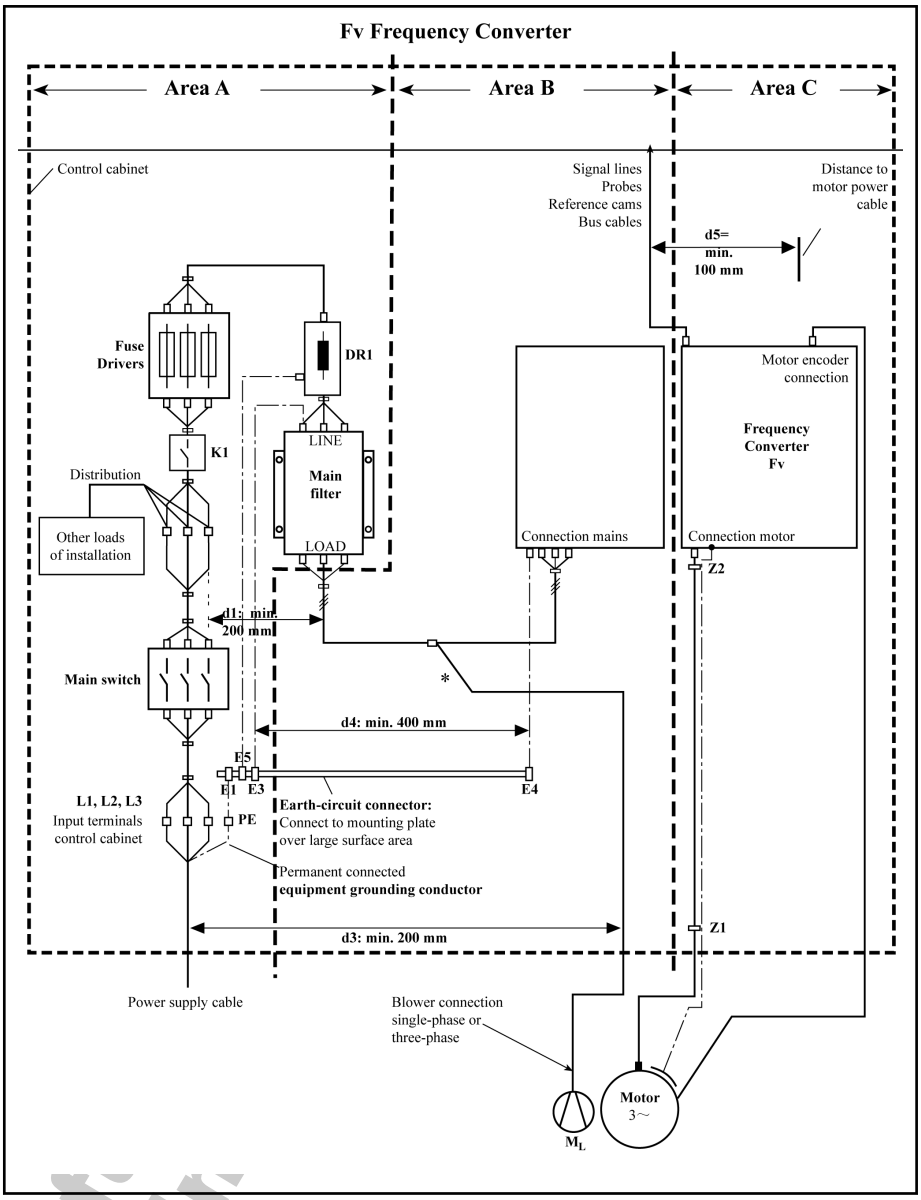
Technical Data

Control Cabinet Mounting According to Interference Areas – Exemplary Arrangements



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

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 Interference-free Lines to the Mains Connection

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

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

If this is impossible, there are two alternatives:

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

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

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

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

Routing and Connecting a Neutral Conductor (N)

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

Motor Blower at Mains Filter

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

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

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

Loads at Mains Filter of Drive System

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

  Do not operate any motor blowers, power supply units, etc. at the mains filter of the drive system.

Shielding Mains Supply Lines in Control Cabinet

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

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

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

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Mains Filters for AC Drives

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

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

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

Grounding

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

See also "Division into areas (zones)" on page 155.

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

The equipment grounding conductor of the power cable of the machine, installation or control cabinet has to be permanently connected at point PE and have a cross section of at least 10 mm^2 or to be complemented by a second equipment grounding conductor via separate terminal connectors (according to EN 61800-5-1: 2007, section 5.3.2.1). If the cross section of the outer conductor is bigger, the cross section of the equipment grounding conductor must be accordingly bigger.

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

Arranging Components and Lines

Modules, components and lines in area B should be placed at a distance of at least d1=200 mm from modules and lines in area A.

Alternative: Shield modules, components and lines in area B by distance plates mounted vertically on the mounting plate from modules and lines in area A or use shield lines.

Only connect power supply units for auxiliary or control voltage connections in the drive system to the mains via a mains filter. See "Division into areas (zones)" on page 155.

Install the shortest possible lines between drive controller and filter.

Control Voltage or Auxiliary Voltage Connection

Only in exceptional cases should you connect power supply unit and fusing for the control voltage connection to phase and neutral conductor. In this case, mount and install these components in area A far away from area B and C of the drive system.

Run the connection between control voltage connection of the drive system and power supply unit used through area B over the shortest distance.

Line Routing

Run the lines along grounded metal surfaces, in order to minimize radiation of interference fields to area A (transmitting antenna effect).

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

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

Influence of the Motor Power Cable

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

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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 inference-free lines, as well as to signal cables and signal lines

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

Routing the Motor Power Cables and Mains Connection Lines

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

Ground connections

Housing and Mounting Plate

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

Ground connections of the metal housings of EMC-critical components (such as filters, devices of the drive system, connection points of the cable shields, devices with microprocessor and switching power supply units) have to be well contacted over a large surface area. This also applies to all screw connections between mounting plate and control cabinet wall and to the mounting of a ground bus to the mounting plate. The best solution is to use a zinc-coated mounting plate. Compared to a lacquered plate, the connections in this area have a good long-time stability.

Connection Elements

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

Metal Surfaces

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

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

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

Ground Wires and Shield Connections

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

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

Installing signal lines and signal cables

Line Routing

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

- Route signal and control lines separately from the power cables with a minimum distance of d5=100 mm (see "Division into areas (zones)" on page 155) 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.

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- 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 mm2.

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

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

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

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

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

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

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

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

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9.5 Selection Matrix for the EMC Accessories

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

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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 Technical Data

For this topic, please contact us via the following email address:

dccx.drivesupport@boschrexroth.com.cn

Please send your enquiry in English.

10.2 Mains Chokes

10.2.1 The Function of Mains Chokes

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

10.2.2 Technical Data

For this topic, please contact us via the following email address:

dccx.drivesupport@boschrexroth.com.cn

Please send your enquiry in English.

10.3 Brake Components

10.3.1 Brake Unit

The Function of Brake Unit

A brake unit is used to dissipate the energy produced by the motor during a braking process, resulting in an increased brake capability and faster deceleration of the load without overvoltage trips.

Integrated Brake Unit

Frequency Converter Fv 0.4 – 15 kW have integrated brake units. External brake resistors are needed to activate the braking function.

The working principle of the braking unit is shown in fig. 10-1 "Working principle of integrated brake unit" on page 163.

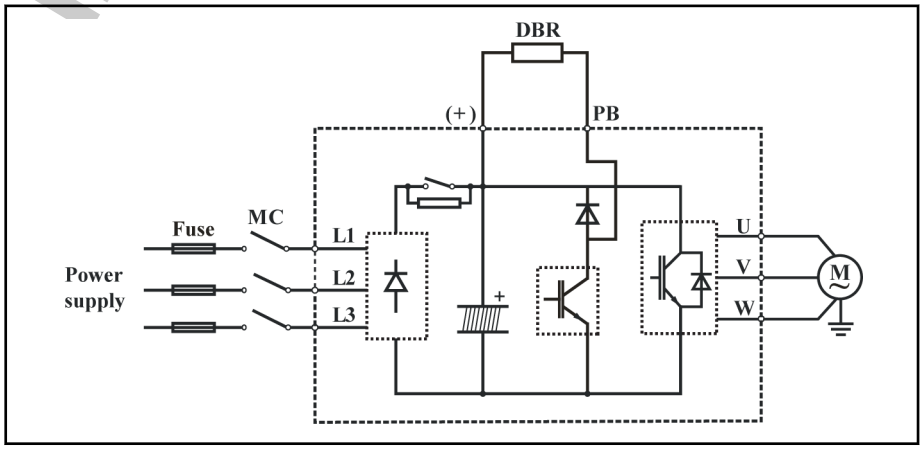

Fig. 10-1: Working principle of integrated brake unit

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Material use only

Definition for braking usage ED%

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

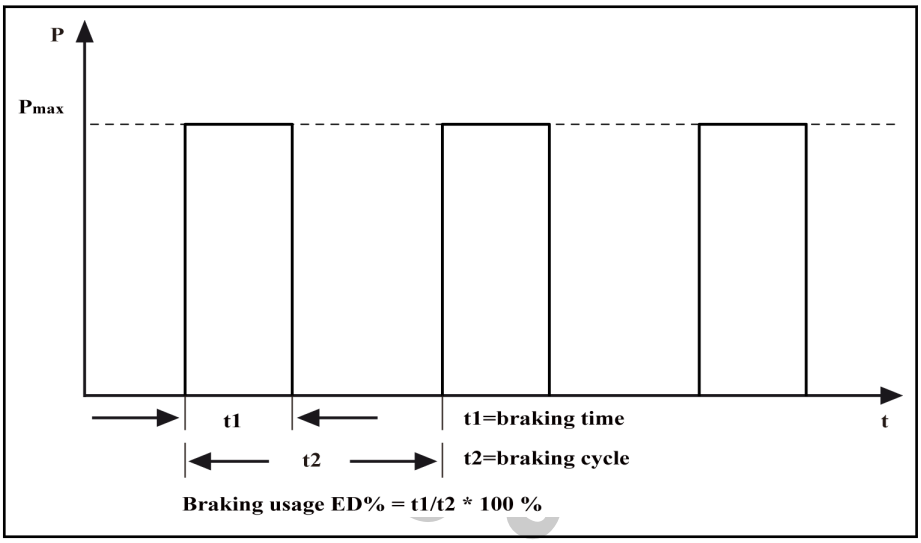

Fig.10-2: Brake usage

10.3.2 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 over voltage of the frequency converter, an external brake resistor may be used. A power transistor discharges the DC bus voltage energy (braking voltage threshold at approx. 770 VDC) to the brake 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 item 10 cm away from the brake resistor.
- A brake 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 brake resistor as its surface uses organic silicon, which is normal and does not affect the performance of the brake resistor.

Brake Resistor Selection

Brake resistors with different power ratings are available to dissipate braking energy when the frequency converter is in generator mode.

The adjacent tables list the optimal combination of frequency converter, brake unit and brake resistor and the number of components required to operate one frequency converter with respect to a given moderating ratio OT.

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

OT On time
Tb Braking time
Tc Cycle time
Fig.10-3: Moderating ratio

Selection reference of OT = 10 %:

Motor power [kW]	Converter typecode	Brake units		Brake resistors		
		Typecode	Quantity	Typecode	Type	Quantity
0.4	FVCA01.1-0K40-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0080-N750R-D-560-NNNN	750Ω/80W	1
0.75	FVCA01.1-0K75-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0080-N750R-D-560-NNNN	750Ω/80W	1
1.5	FVCA01.1-1K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0260-N400R-D-560-NNNN	400Ω/ 260W	1
2.2	FVCA01.1-2K20-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0260-N250R-D-560-NNNN	250Ω/ 260W	1
4.0	FVCA01.1-4K00-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0390-N150R-D-560-NNNN	150Ω/ 390W	1
5.5	FVCA01.1-5K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0520-N100R-D-560-NNNN	100Ω/ 520W	1
7.5	FVCA01.1-7K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0780-N075R-D-560-NNNN	75Ω/780W	1
11	FVCA01.1-11K0-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-1K04-N050R-D-560-NNNN	50Ω/ 1040W	1
15	FVCA01.1-15K0-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-1K56-N040R-D-560-NNNN	40Ω/ 1560W	1

Fig.10-4: Brake resistor selection_OT=10 %

Selection reference of OT = 20 %:

Motor power [kW]	Converter typecode	Brake units		Brake resistors		
		Typecode	Quantity	Typecode	Type	Quantity
0.4	FVCA01.1-0K40-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0150-N750R-D-560-NNNN	750Ω/ 150W	1
0.75	FVCA01.1-0K75-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0150-N700R-D-560-NNNN	700Ω/ 150W	1
1.5	FVCA01.1-1K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0520-N350R-D-560-NNNN	350Ω/ 520W	1
2.2	FVCA01.1-2K20-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0520-N230R-D-560-NNNN	230Ω/ 520W	1
4.0	FVCA01.1-4K00-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0780-N140R-D-560-NNNN	140Ω/ 780W	1

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Accessories

Motor power [kW]	Converter typecode	Brake units		Brake resistors		
		Typecode	Quantity	Typecode	Type	Quantity
5.5	FVCA01.1-5K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-1K04-N090R-D-560-NNNN	90Ω/ 1040W	1
7.5	FVCA01.1-7K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-1K56-N070R-D-560-NNNN	70Ω/ 1560W	1
11	FVCA01.1-11K0-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-02K0-N047R-D-560-NNNN	47Ω/ 2.0kW	1
15	FVCA01.1-15K0-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-01K5-N068R-D-560-NNNN	68Ω/ 1.5kW	2

Fig.10-5: Brake resistor selection_OT=20 %

Selection reference of OT = 40 %:

Motor power [kW]	Converter typecode	Brake units		Brake resistors		
		Typecode	Quantity	Typecode	Type	Quantity
0.4	FVCA01.1-0K40-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0240-N750R-D-560-NNNN	750Ω/ 240W	1
0.75	FVCA01.1-0K75-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0500-N550R-D-560-NNNN	550Ω/ 500W	1
1.5	FVCA01.1-1K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-0800-N275R-D-560-NNNN	275Ω/ 800W	1
2.2	FVCA01.1-2K20-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-01K2-N180R-D-560-NNNN	180Ω/ 1.2kW	1
4.0	FVCA01.1-4K00-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-02K0-N110R-D-560-NNNN	110Ω/ 2.0kW	1
5.5	FVCA01.1-5K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-01K5-N150R-D-560-NNNN	150Ω/ 1.5kW	2
7.5	FVCA01.1-7K50-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-04K5-N055R-A-560-NNNN	55Ω/ 4.5kW	1
11	FVCA01.1-11K0-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-06K0-N040R-A-560-NNNN	40Ω/ 6.0kW	1
15	FVCA01.1-15K0-3P4-MNA-LP-NNNN-01V01•••••	Internal	-	FELR01.1N-08K0-N027R-A-560-NNNN	27Ω/ 8.0kW	1

Fig.10-6: Brake resistor selection_OT=40 %

- In the table in the manual, the recommended resistance of the brake resistor is 100 % braking torque, selected according to necessity. If the actual needed torque is not 100 %, the resistance of the brake resistor in the table should be adjusted in proportionality, i.e. how much the brake torque increases based on 100 %, the resistance of the brake resistor should decrease by the same amount, vice versa.
- When selecting brake resistor Rb, make sure the current Ic which flows through the resistor less than the current output ability of the brake unit. The current Ic through the brake resistor can be calculated by formula Ic=Ud/Rb, in which Ud is the braking operating voltage of brake unit.

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- After the adjustment of the resistance of brake resistor, the power of brake resistor should be also adjusted appropriately. The power can be calculated by formula Pmax=Ud2 / Rb. According to the actual working condition, the braking rate ED% can be selected to reduce the power of brake resistor reasonably for intermittent braking load. The power of brake resistor can be calculated by formula PR=K * Pmax * ED%, in which k is the derating coefficient of brake resistor. The selection of the brake torque should be in general smaller than 150 % of the rated motor torque, or consulting the technical support for more information.

Brake Resistor in Aluminum Housing

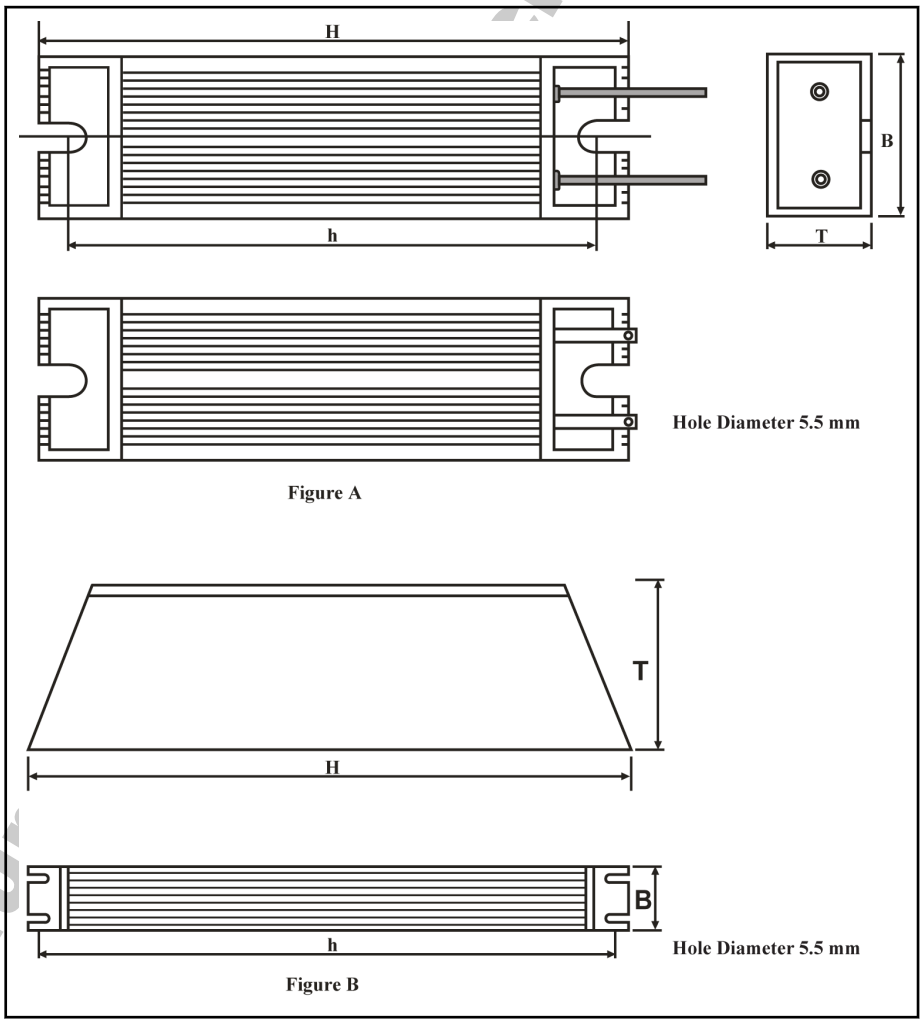

Fig.10-7: Brake resistor in aluminum housing

Nur für

Accessories

Brake resistor typecode	Impe-dance [Ω]	Power [kW]	Fig.	Dimensions [mm]				Wriing [mm²]	Terminal [mm]	Cable length [mm]	Weigth [kg]	Type
				H	h	B	T					
FELR01.1N-0520-N100R -D-560-NNNN	100	520	A	335	317	60	30	2.5	-	500	1.03	Aluminium
FELR01.1N-0390-N150R -D-560-NNNN	150	390		265	247	60	30	2.5	-	500	0.80	Aluminium
FELR01.1N-0520-N230R -D-560-NNNN	230	520		335	317	60	30	2.5	-	500	1.03	Aluminium
FELR01.1N-0260-N250R -D-560-NNNN	250	260		215	197	60	30	2.5	-	500	0.62	Aluminium
FELR01.1N-0520-N350R -D-560-NNNN	350	520		335	317	60	30	2.5	-	500	1.03	Aluminium
FELR01.1N-0260-N400R -D-560-NNNN	400	260		215	197	60	30	2.5	-	500	0.62	Aluminium
FELR01.1N-0500-N550R -D-560-NNNN	550	500		335	317	60	30	2.5	-	500	1.03	Aluminium
FELR01.1N-0150-N700R -D-560-NNNN	700	150		215	197	40	20	2.5	-	500	0.32	Aluminium
FELR01.1N-0080-N750R -D-560-NNNN	750	80		140	123	40	20	2.5	-	500	0.20	Aluminium

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Brake resistor typecode	Impe-dance [Ω]	Power [kW]	Fig.	Dimensions [mm]				Wriing [mm²]	Terminal [mm]	Cable length [mm]	Weigth [kg]	Type
				H	h	B	T					
FELR01.1N-1K56-N040R -D-560-NNNN	40	1560	B	485	470	50	107	2.5	M6	-	4.35	Aluminium
FELR01.1N-02K0-N047R -D-560-NNNN	47	2000		550	532	50	107	4.0	M6	-	4.90	Aluminium
FELR01.1N-1K04-N050R -D-560-NNNN	50	1040		400	384	50	107	2.5	M6	-	4.35	Aluminium
FELR01.1N-01K5-N068R -D-560-NNNN	68	1500		485	470	50	107	2.5	M6	-	3.60	Aluminium
FELR01.1N-1K56-N070R -D-560-NNNN	70	1560		485	470	50	107	2.5	M6	-	2.20	Aluminium
FELR01.1N-0780-N075R -D-560-NNNN	75	780		400	382	61	59	2.5	M6	-	4.35	Aluminium
FELR01.1N-1K04-N090R -D-560-NNNN	90	1040		400	384	50	107	2.5	M6	-	3.60	Aluminium
FELR01.1N-02K0-N110R -D-560-NNNN	110	2000		550	532	50	107	4.0	M6	-	2.20	Aluminium
FELR01.1N-0780-N140R -D-560-NNNN	140	780		400	382	61	59	2.5	M6	-	4.35	Aluminium
FELR01.1N-01K5-N150R -D-560-NNNN	150	1500		485	470	50	107	2.5	M6	-	4.90	Aluminium
FELR01.1N-01K2-N180R -D-560-NNNN	180	1200		450	434	50	107	2.5	M6	-	4.00	Aluminium
FELR01.1N-0800-N275R -D-560-NNNN	275	800		400	382	61	59	2.5	M6	-	2.20	Aluminium

Fig. 10-8: Aluminium brake resistor dimensions

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Accessories

Brake Resistor Box

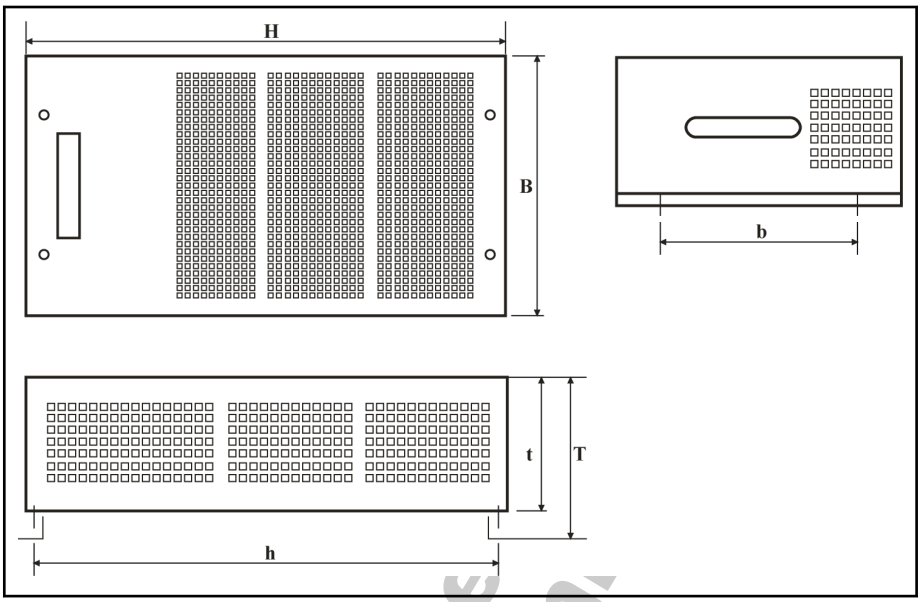

Fig.10-9: Brake resistor box

Brake resistor typecode	Impe-dance [Ω]	Power [kW]	Dimensions						Wiring [mm²]	Termi-nal [mm]	Weight [kg]	Type
			B	H	t	T	h	b				
FELR01.1N-09K6-N13R6 -A-560-NNNN	13.6	9.6	410	685	145	170	642	340	6.0	M6	18.5	Brake resistor box
FELR01.1N-09K6-N016R -A-560-NNNN	16	9.6	410	685	145	170	642	340	6.0	M6	18.5	Brake resistor box
FELR01.1N-12K5-N017R -A-560-NNNN	17	12.5	410	685	145	170	642	340	6.0	M6	20.5	Brake resistor box
FELR01.1N-12K5-N018R -A-560-NNNN	18	12.5	410	685	145	170	642	340	6.0	M6	20.5	Brake resistor box
FELR01.1N-12K5-N020R -A-560-NNNN	20	12.5	410	685	145	170	642	340	6.0	M6	20.5	Brake resistor Brake resistor box
FELR01.1N-06K0-N020R -A-560-NNNN	20	6.0	340	600	145	170	580	291	4.0	M6	14.0	Brake resistor box

Nur für interne Gebrauch
Internal use only

Brake resistor typecode	Impe-dance [Ω]	Power [kW]	Dimensions						Wiring [mm²]	Termi-nal [mm]	Weight [kg]	Type
			B	H	t	T	h	b				
FELR01.1N-10K0-N022R -A-560-NNNN	22	10.0	410	685	145	170	642	340	6.0	M6	18.5	Brake resistor box
FELR01.1N-12K5-N022R -A-560-NNNN	22	12.5	410	685	145	170	642	340	6.0	M6	20.5	Brake resistor box
FELR01.1N-10K0-N024R -A-560-NNNN	24	10.0	410	685	145	170	642	340	6.0	M6	18.5	Brake resistor box
FELR01.1N-08K0-N027R -A-560-NNNN	27	8.0	410	685	145	170	642	340	6.0	M6	16.5	Brake resistor box
FELR01.1N-10K0-N27R2 -A-560-NNNN	27.2	10.0	410	685	145	170	642	340	6.0	M6	18.5	Brake resistor box
FELR01.1N-04K8-N27R2 -A-560-NNNN	27.2	4.8	340	600	145	170	580	291	4.0	M6	12.0	Brake resistor box
FELR01.1N-10K0-N028R -A-560-NNNN	28	10.0	410	685	145	170	642	340	6.0	M6	18.5	Brake resistor box
FELR01.1N-10K0-N032R -A-560-NNNN	32	10.0	410	685	145	170	642	340	6.0	M6	18.5	Brake resistor box
FELR01.1N-04K8-N032R -A-560-NNNN	32	4.8	340	600	145	170	580	291	4.0	M6	12.0	Brake resistor box
FELR01.1N-06K0-N040R -A-560-NNNN	40	6.0	340	600	145	170	580	291	4.0	M6	14.0	Brake resistor box
FELR01.1N-04K5-N055R -A-560-NNNN	55	4.5	340	600	145	170	580	291	4.0	M6	12.0	Brake resistor box

Fig.10-10: Brake resistor box dimensions

Nur für internen Gebrauch
Internal use only

Accessories

10.4 dV/dt Filter (Motor filter)

10.4.1 The Function of dV/dt Filter

dV/dt filters are used

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

10.4.2 Technical Data

For this topic, please contact us via the following email address:

dccx.drivesupport@boschrexroth.com.cn

Please send your enquiry in English.

10.5 Communication Interface

10.5.1 PROFIBUS Adapter

The PROFIBUS adapter FVAA01.1-P-NNNN-01V01 is used to convert the converters serial RS485 interface (ModBus) to the PROFIBUS DP standard. Refer to the separate PROFIBUS Adapter User Manual.

Please refer to chapter 12 "Communication Protocols" on page 179.

10.5.2 ModBus Adapter

The ModBus adapter FVAA01.1-M-NNNN-01V01 is used to connect the RS485 interface (ModBus) with a PC or another control unit.

10.6 Accessories for Control Cabinet Mounting

10.6.1 Operating Panel for Control Cabinet Mounting

The operating panel FVCC01.1A-LP-NNNN-01V01 is used to mount at the control cabinet. The user can operate the frequency converter from the outside of the control cabinet conveniently.

Recommended opening dimensions at control cabinet

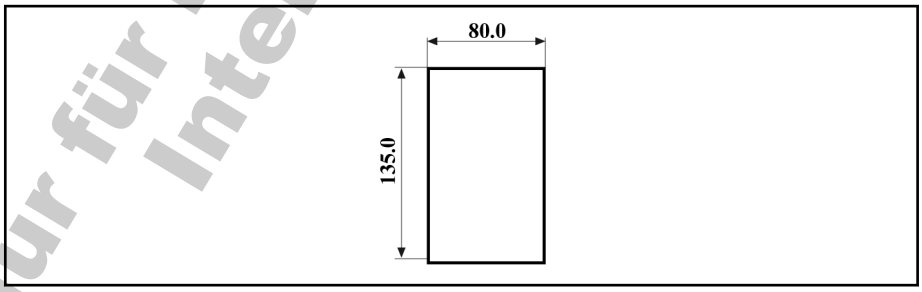

Fig.10-11: Recommended opening dimensions at control cabinet

- When the opening dimensions at the control cabinet are compliance with the recommendation, the operating panel can be mounted directly at the control cabinet with its own buckle.

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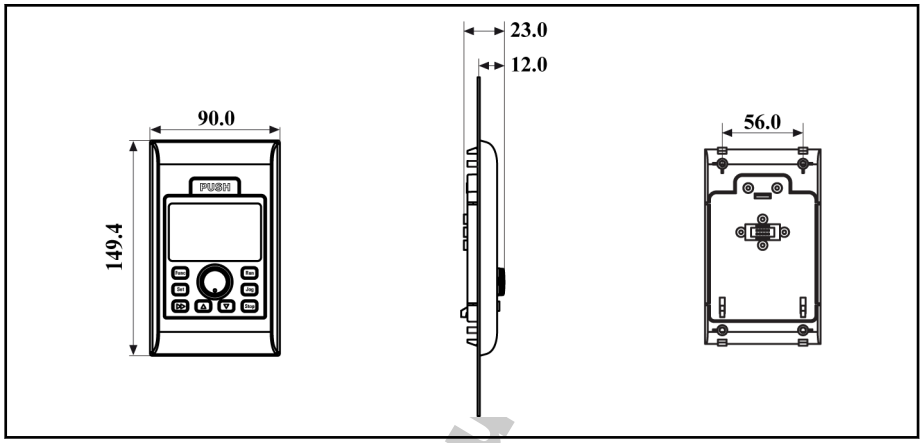

Fig.10-12: Direct mounting of operating panel at the control cabinet

- When the opening dimensions are larger than the recommendation, a mounting plate and 4 M4x10 screws are necessary for mounting. Please refer to fig. 10-13 "Panel mounting plate" on page 173 and fig. 10-14 "Mounting of operating panel at the control cabinet with mounting plate" on page 173 for detailed information.

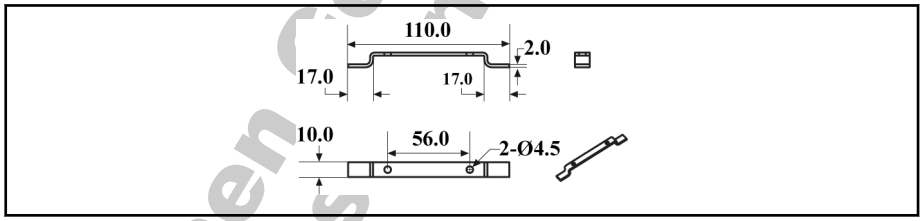

Fig.10-13: Panel mounting plate

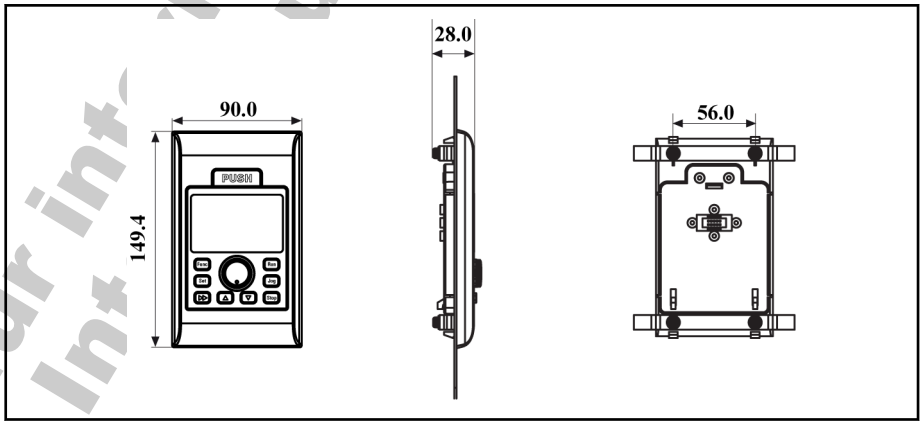

Fig.10-14: Mounting of operating panel at the control cabinet with mounting plate

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

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Int. Use Only

Accessories

10.7 Engineering Software

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

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Internal use only

11 Additional Information

11.1 Simple Applications of Process Control

11.1.1 Automatic Constant Pressure Water Control System

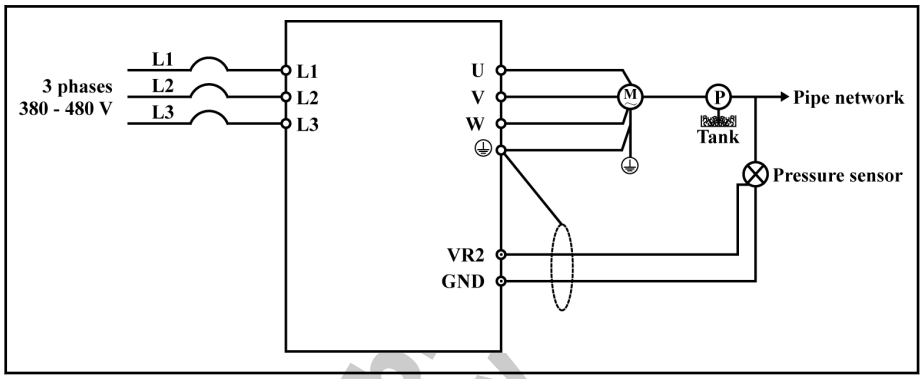


Fig.11-1: Automatic Constant Pressure Water Control System

- The set value of pressure is set by analog value digital setting [E3.01]. The pressure feedback from the terminal VR2 corresponds to a value of 0 V to 10 V.
- [E3.02], [E3.03], [E3.04], [E3.05], [E3.06], and [E3.07] are set depending on actual conditions.

11.1.2 Closed-loop Speed Control System

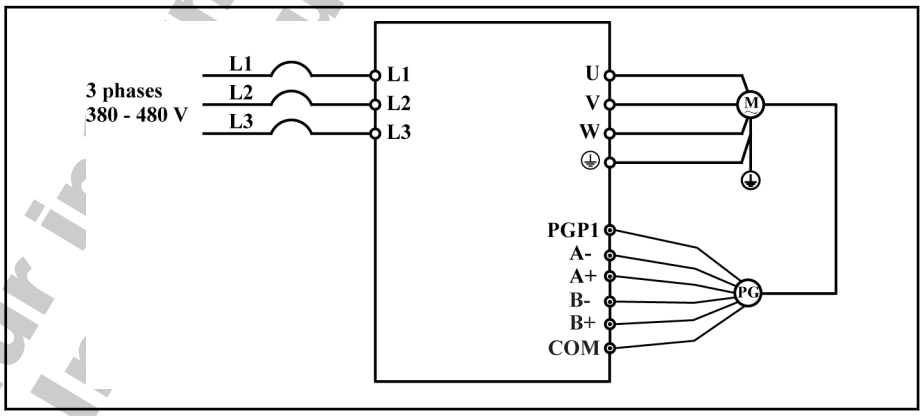


Fig.11-2: Closed-loop Speed Control System

Conditions and requirements:

PGP1 is connected to the operational power supply of pulse encoder, and the set value of speed is set by rotation speed digital setting [E3.02]. [E3.00]=4, [S3.12] is set according to the specification of the feedback encoder.

Nur für interne Schulungszwecke!

Additional Information

11.2 Discharging of Capacitors

11.2.1 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.

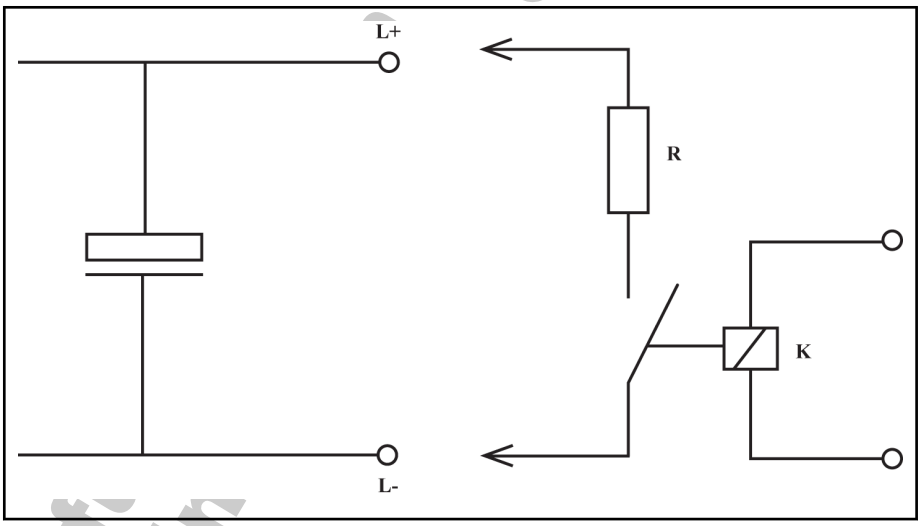
To shorten the waiting time until voltage has fallen below 50V, you can take the following measure:

- Use the discharging device described below

11.2.2 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.11-3: Operating principle of discharging device

Dimensioning

The individual components have to be sufficiently dimensioned:

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

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Installation

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

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

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

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

⚠ CAUTION **Risk of damage by intense heat!**

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

How to install the discharging device

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

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

Activation

Observe the following order for activating the discharge device:

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

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12 Communication Protocols

12.1 Brief Introduction

Fv converters provide standard RS485 communication port to realize the communication between the master station and the slave station via ModBus or PROFIBUS protocols. With the help of a PC, a PLC or an external computer a “single master/ multiple slaves” network control 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.

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 station may send information.

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

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

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

There are two types of 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 in fig. 12-1 "Typical RTU fram format" on page 179.

Slave address (1 byte)	ModBus function code (1 byte)	Data (Multiple bytes)	CRC16 check information (2 bytes)

Fig.12-1: Typical RTU fram 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.

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Similarly, if the interval between a new frame and the previous one is less than 3.5 characters, the receiving device will consider it as a part of the previous frame. Due to confusion of the frames, the CRC check will fail and lead to a communication fault.

Data format and sending sequence of one byte:

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

CRC (Cyclic redundancy check):

- CRC16, lower bytes first and higher bytes later

Slave address:

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

12.2.2 Interface

The communication interface of Fv converters is shown in fig. 12-2 "Fv communication interface" on page 180:

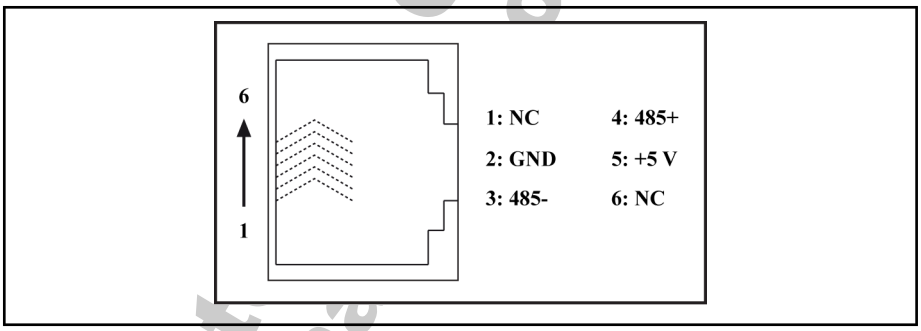

Fig. 12-2: Fv communication interface

12.2.3 Protocol Functions

Supported Functions

The main function of ModBus is to read and to write parameters. Different function codes decide different operation requests. ModBus functions managed by Fv converters and their limits are shown in fig. 12-3 "ModBus functions managed by Fv converters and their limits" on page 180.

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	-

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Function code	Description	Broadcast	Maximum value of N
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. 12-3: ModBus functions managed by Fv converters and their limits

☞ "Read" and "Write" 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. An example of exception code is shown in fig. 12-4 "Error codes_meanings_reasons" on page 181.

Error code	Meaning	Reason
1	Password locked	User password locked
2	Function code error	Function code is not 03, 06, 08, 16, 23
3	Invalid address	Undefined address
4	Invalid data	Data exceeds limit
5	Parameters can not be modified in run mode	Converter is in run mode
6	Read only	Not allowed to write in read only parameters
7	Invalid operation	Function code does not support write via external computer or multiple write
8	CRC check failure	Data error or discontinuous frame
9	EEPROM read/write error	EEPROM write does not finish

Fig. 12-4: Error codes_meanings_reasons

Function Description

- **Function 0x03**: Read N words, range: 1 – 16.

For example, it is necessary to read 2 continuous words starting from communication register 0100H of the slave converter addressed at 01H. The frame structure is described in fig. 12-5 "Function 0x03_master request" on page 181 and fig. 12-6 "Function 0x03_slave response" on page 182.

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	03H
Higher byte of start address	01H
Lower byte of start address	00H
Higher byte of data	00H
Lower byte of data	02H

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CRC lower byte	C5H
CRC higher byte	F7H
End	Transmission time for 3.5 bytes

Fig.12-5: Function 0x03_master request

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	03H
Bytes of data	04H
Higher byte of data in register 0100H	00H
Lower byte of data in register 0100H	05H
Higher byte of data in register 0101H	00H
Lower byte of data in register 0101H	00H
CRC lower byte	EAH
CRC higher byte	32H
End	Transmission time for 3.5 bytes

Fig.12-6: Function 0x03_slave response

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

Example: Write 0000H to communication register address 0006H of the slave converter with address 01H. The frame structure is described in fig. 12-7 "Function 0x06_master request" on page 182 and fig. 12-8 "Function 0x06_slave response" on page 182.

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	06H
Higher byte of write register address	00H
Lower byte of write register address	06H
Higher byte of write data	00H
Lower byte of write data	00H
CRC lower byte	69H
CRC higher byte	CBH
End	Transmission time for 3.5 bytes

Fig.12-7: Function 0x06_master request

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	06H
Higher byte of write register address	00H
Lower byte of write register address	06H
Higher byte of write data	00H

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Lower byte of write data	00H
CRC lower byte	69H
CRC higher byte	CBH
End	Transmission time for 3.5 bytes

Fig. 12-8: Function 0x06_slave response

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

To test the communication loop of 2 continuous words 1234H and 5678H with converter slave address 01H, the frame structure is described in fig. 12-9 "Function 0x08_master request" on page 183 and fig. 12-10 "Function 0x08_slave response" on page 183.

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	08H
Higher byte of test word 1	12H
Lower byte of test Word 1	34H
Higher byte of test data Word 2	56H
Lower byte of test Word 2	78H
CRC lower byte	9BH
CRC higher byte	3FH
End	Transmission time for 3.5 bytes

Fig. 12-9: Function 0x08_master request

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	08H
Higher byte of test word 1	12H
Lower byte of test word 1	34H
Higher byte of test data word 2	56H
Lower byte of test word 2	78H
CRC lower byte	9BH
CRC higher byte	3FH
End	Transmission time for 3.5 bytes

Fig. 12-10: Function 0x08_slave response

- **Function 0x10**: Write N words, range: 1 – 16.

Example: To modify 2 continuous resisters start from 0109H with words 003CH and 0050H with slave converter address 01H. The frame structure is described in fig. 12-11 "Function 0x10_master request" on page 183 and fig. 12-12 "Function 0x10_slave response" on page 184.

Start	Transmission time for 3.5 bytes
Slave address	01H

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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 in register 0109H	00H
Lower byte of data in register 0109H	3CH
Higher byte of data in register 010AH	00H
Lower byte of data in register 010AH	50H
CRC lower byte	FEH
CRC higher byte	65H
End	Transmission time for 3.5 bytes

Fig.12-11: Function 0x10_master request

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.12-12: Function 0x10_slave response

- **Function 0x17**: Read/write N words, range: 1 – 16

Example: To read data in 2 continuous registers starting from address 0100H, write 0064H and 00C8H to 2 continuous registers starting from address 0109H. The frame structure is described in fig. 12-13 "Function 0x17_master request" on page 184 and fig. 12-14 "Function 0x17_slave response" on page 185.

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

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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 in address 0109H	00H
Lower byte of data in address 0109H	64H
Higher byte of data in address 010AH	00H
Lower byte of data in address 010AH	C8H
CRC lower byte	48H
CRC higher byte	72H
End	Transmission time for 3.5 bytes

Fig. 12-13: Function 0x17_master request

Start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	17H
Bytes of read register	04H
Higher byte of read register 0100H	00H
Lower byte of read register 0100H	05H
Higher byte of read register 0101H	00H
Lower byte of read register 0101H	00H
CRC lower byte	E9H
CRC higher byte	26H
End	Transmission time for 3.5 bytes

Fig. 12-14: Function 0x17_slave response

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12.2.4 Communication Mapping Register Address Distribution

The communication mapping registers of ModBus are in four types, converter parameter registers, communication control registers, communication state feedback register and communication monitor registers.

- **Converter parameter registers**

Converter parameter registers correspond to the function codes one-to-one. Reading and writing of related function codes can be achieved through reading and writing of the contents in converter parameter registers via ModBus communication. The characteristics and scope of reading and writing function codes are in compliance with the converter function code description. The address of a converter parameter register consists of one word. The higher byte 0x00 - 0x0B represents the function code group, and the relationship is shown in fig. 12-15 "Relationship between converter parameter resigster addresses and corresponding function codes" on page 186; the lower byte represents the function code within the code group.

Function group	Mapping address	Function group	Mapping address
b0	0x00	b1	0x01
S0	0x02	S1	0x03
S2	0x04	S3	0x05
E0	0x06	E1	0x07
E2	0x08	E3	0x09
E4	0x0A	H0	0x0B

Fig.12-15: Relationship between converter parameter resigster addresses and corresponding function codes

Example: Parameter register 0x0103, the higher byte 0x01 represents group b1, the lower byte 0x03 represents the 3rd function code.

- **Communication control registers (0x4000, 0x4001)**

The address of command word register for communication control is 0x4000. This register is write-only. The converter is controlled through writing data into the address. The definition of each bit is shown in fig. 12-16 "Communication control registers (0x4000、0x4001) _bit definition" on page 186:

bit	Value	Description
15-8	-	Reserved
7	1	Inactive
	0	Active
6	1	Stop acceleration/deceleration active
	0	Inactive
5	1	Reset active
	0	Inactive
4	1	E-Stop active
	0	Inactive
3	1	Stop according to parameter setting
	0	Inactive

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2	1	Reverse
	0	Forward
1	1	Jog active
	0	Inactive
0	1	General control active
	0	Inactive

Fig.12-16: Communication control registers (0x4000、0x4001) _bit definition

The address of frequency setting register for communication control is 0x4001. This register is write-only. When 'Frequency setting mode' [b1.00] is set to '5: Set via communication', the frequency converter can be set with writing data to this address.

- **Communication state feedback register (0x5000)**

The converter state can be monitored by reading the register. This register is read-only. The definition of each bit is shown in fig. 12-17 "Communication state word register (0x5000) _bit definition" on page 187:

bit	Value	Description
15-11	-	Error code
10-8	-	Reserved
7	1	Fault
	0	No fault
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in deceleration
3	1	Accelerating
	0	Not in acceleration
2	1	Jogging
	0	Not in jog
1	1	In run
	0	In stop
0	1	Rerverse
	0	Forward

Fig.12-17: Communication state word register (0x5000) _bit definition

The meanings of error codes are described in fig. 12-18 "Error codes and meanings_ModBus" on page 188.

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No.	Error code name	No.	Error code name
0	No fault record	12	Communication fault (R.S.)
1	Over current at constant speed (O.C.-1)	13	Circuit disconnection (C.F.)
2	Over current in acceleration (O.C.-2)	14	Encoder speed detection fault (PULS)
3	Over current in deceleration (O.C.-3)	15	Reserved
4	Over voltage at constant speed (O.E.-1)	16	EMI (CPU-)
5	Over voltage in acceleration (O.E.-2)	17	Short circuit (S.C.)
6	Over voltage in deceleration (O.E.-3)	18	Reserved
7	Converter overload (O.L.-1)	19	L1, L2, L3 phase failure (IPH.L)
8	Motor overload (O.L.-2)	20	U, V, W phase failure(OPH.L)
9	CPU read/write fault (R.E.)	21	Converter over heat (O.H.)
10	Operating panel read/write fault (KEY-)	22	Parameter setting fault (PRSE)
11	External fault (E.-St)	23	Parameter auto-tuning fault (TUNE)

Fig.12-18: Error codes and meanings_ModBus

- **Communication monitor registers (0x5001 – 0x500F)**

Communication monitor registers are read-only. The relationship between the addresses of monitor registers and monitored values are shown in fig. 12-19 "Addresses of moitor registers and monitored values" on page 188.

Register address	Monitored value
0x5001	Output frequency
0x5002	Reference freqeuency
0x5003	Output current
0x5004	DC bus voltage
0x5005	Heat sink temperature
0x5006	Output voltage
0x5007	Output power
0x5008	Torque current
0x5009	Exciting current
0x500A	Output speed
0x500B	Reference speed
0x500C	User-definded reference value
0x500D	User-defined output value
0x500E	Reference torque
0x500F	Reserved

Fig.12-19: Addresses of moitor registers and monitored values

Nur für interen Gebrauch
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12.2.5 ModBus Communication Example

One 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 shown in fig. 12-20 "Example of ModBus communication" on page 189.

Example 1: Start 01# converter for forward rotation at frequency of 50.00Hz (represented by 5000 internally)							
	Slave address	Function code	Start address	Number of address	Bytes of data	Data content	CRC code
Request	0x01	0x10	0x4000	0x0002	0x04	0x0001 , 0x1388	0xFA9E
Response	0x01	0x10	0x4000	0x0002	N/A	N/A	0x0854
Example 2: Read the output voltage of 01# converter and set frequency							
	Slave address	Function code	Start address	Number of address	Bytes of data	Data content	CRC code
Request	0x01	0x03	0x5001	0x0002	N/A	N/A	0xCB84
Response	0x01	0x03	N/A	N/A	0x04	0x1388 , 0x1388	0xCB73
Example 3: Stop 01# converter according to the stop mode set with the function code							
	Slave address	Function code	Start address	Number of address	Bytes of data	Data content	CRC code
Request	0x01	0x06	0x4000	N/A	N/A	0x0008	0xCC9D
Response	0x01	0x06	0x4000	N/A	N/A	0x0008	0xCC9D

Fig.12-20: Example of ModBus communication

12.2.6 Special Notes

1. The external computer can not wirte to function codes [b0.03], [b0.08], [b0.09] and [S2.10].
2. [b0.00] and [b0.02] do not support multiple write including single write in multiple write; parameters of motor name plate and motor can not be written at the same time; Terminals X1 – X8 can not be rewritten if they are not 0.
3. If the communication protocol is changed, baud rate, data frame and local address will be restore to factory default.
4. The read response of uer password and factory password is '0000' in case of external computer reading.
5. External computer can not set, modify or cancel user password; external computer can only write 0 in case of no password or write correct password in case of with password; if a password is active, the external computer only has the access to modify the parameters after input of the correct password; After the external has the access to modify the parameters, if the previous password is input again, the modification access is disabled.
6. The access to control registers and state registers is not limited by user password.

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7. The converter can not communicate in the process of auto-tuning; the communication will be recovered when auto-tuning is complete.

12.2.7 Communication Networking

Networking

The communication network is shown in fig. 12-21 "ModBus networking" on page 190, with a PC, a PLC or an external computer and various frequency converters, which are connected by shielded twisted pair cables via RS232/485 adapters. The maximum length of 232 network cable connection is 15 meters. Network terminal slaves need external resistance with a recommended value of 120 Ω, 0.25 W.

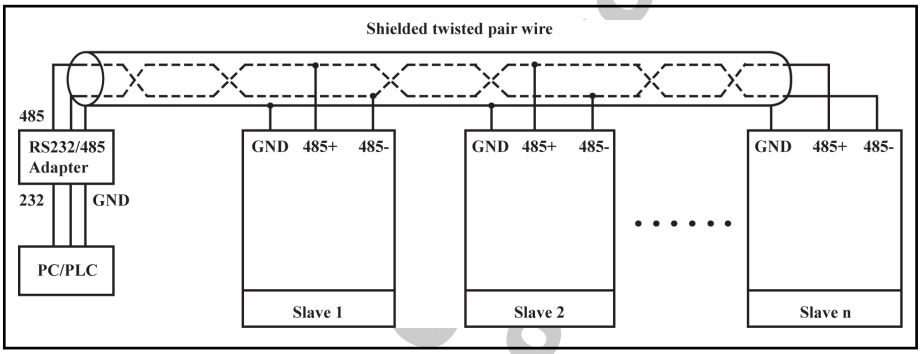

Fig.12-21: ModBus networking

⚠ 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.

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12.3 PROFIBUS Protocol

12.3.1 Protocol Description

PROFIBUS is an open serial communication standard, which enables data exchange among various automatic control devices. PROFIBUS mainly includes three types: PROFIBUS-FMS (Fieldbus Message Specifications), PROFIBUS-DP (Distributed Peripheral Equipment) and PROFIBUS-PA (Process Automation). Bosch Rexroth PROFIBUS adapter module only supports PROFIBUS-DP protocol.

PROFIBUS is widely used in various industries such as manufacturing automation and process automation, building, transportation, electronics, etc. Through PROFIBUS, automation equipments from different manufacturers can be easily connected into the same network for data exchange. The frame structure of data information in PROFIBUS network is shown in fig. 12-22 "PROFIBUS Frame format" on page 191. Contents of user data will be described in communication protocol section.

Protocol frame (header)	**User data** (control information/status information)	**Protocol frame** (end)

Fig. 12-22: PROFIBUS Frame format

Physical transmission medium for PROFIBUS is twisted-pair cable (RS-485 standard). Maximum length of bus cable is within the scope of 100 – 1200 m, depending on the set transmission rate. When no repeater is used, 32 nodes at maximum can be connected to the same PROFIBUS network; if a repeater is used, nodes connected to the network may be increased to 126. In PROFIBUS communication, the master is usually a programmable logic controller (PLC), which is able to select the nodes responsive to commands from the master. In PROFIBUS network, no communication can be achieved among nodes.

☞ PROFIBUS protocol is described in detail in standard EN 50170. For further information regarding PROFIBUS, please refer to standard EN 50170.

12.3.2 Bosch Rexroth Fieldbus Adapter

Technical Data

Technical parameters	Performance
Input voltage	+ 5 VDC, ±10%, 80 mA
Baud rate (DP interface communication)	9.6 kbps – 12 mbps
EMC requirement	IEC 1000-4

Fig. 12-23: Adaper technical parameters and performance

Functions

Bosch Rexroth fieldbus adapter is able to control Frequency Converter Fv through PROFIBUS-DP fieldbus. Main functions of the fieldbus adapter are as below:

- Sending control commands to frequency converter (such as start, stop, jog, etc.).
- Sending frequency setting signal to frequency converter.

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- Reading working status information from frequency converter (such as run, rotation direction, rotation speed, error message, etc.).
- Reading or modifying converter parameters.
- Resetting frequency converter in case of fault.

Network Structure

PROFIBUS network of Rexroth Fv series frequency converters through connection via PROFIBUS adapter is shown in fig. 12-24 "Fv converter PROFIBUS network" on page 192.

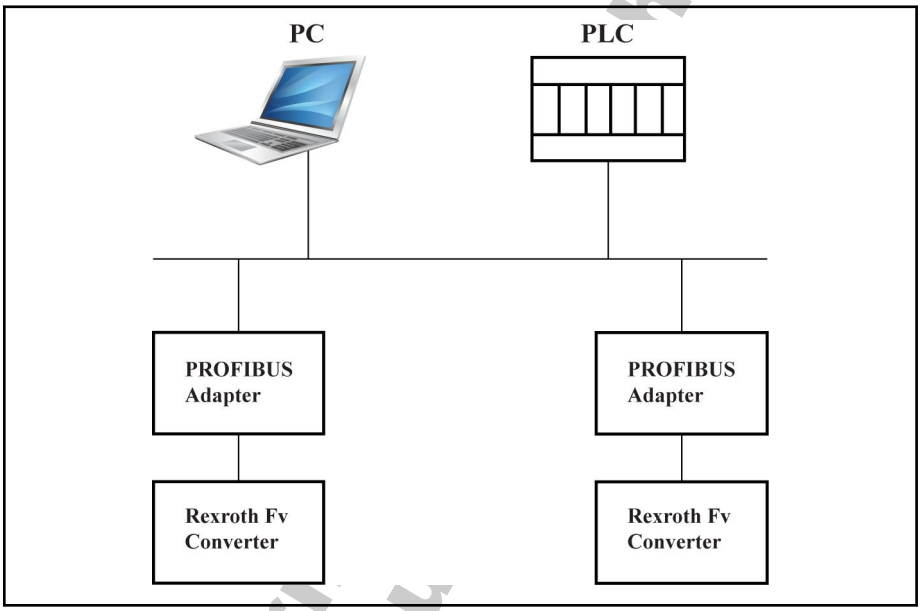

Fig. 12-24: Fv converter PROFIBUS network

12.3.3 Electrical Installations

Outline Structure

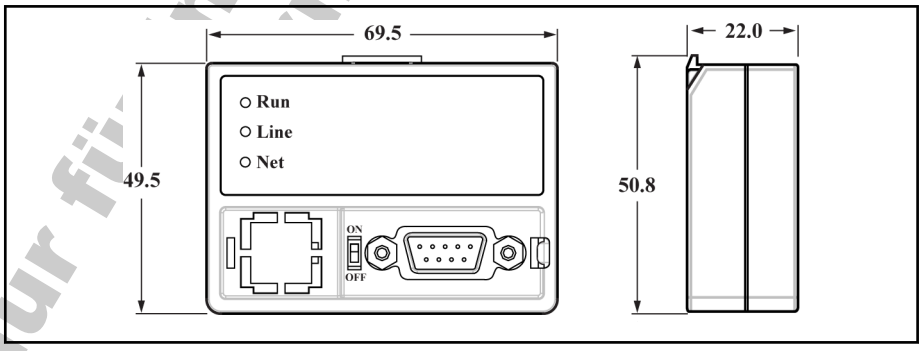

Fig. 12-25: PROFIBUS adapter dimensions

Bus Terminal Resistor

Switch S1 on PROFIBUS adapter is used to switch **On/Off** built-in bus terminal resistor of the adapter. The bus terminal resistor can prevent signal reflection of bus cable end. If the adapter is the last node or the first node of the network, S1 must be at **On** status. When PROFIBUS D-sub connector with built-in terminal resistor (for example, Siemens 6ES7972-0BA12-0XA0) is used, the built-in terminal resistor of the adapter must be disconnected.

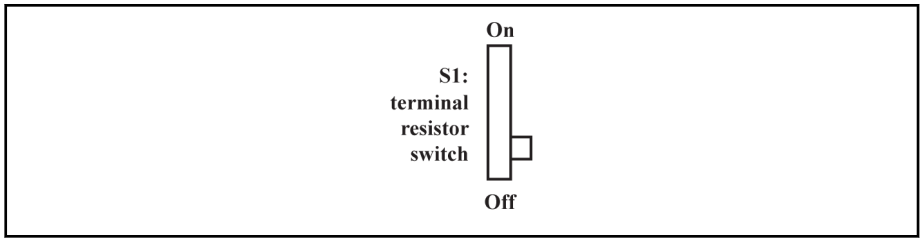

Fig. 12-26: Terminal resistor swich S1

Adapter Terminal Configuration

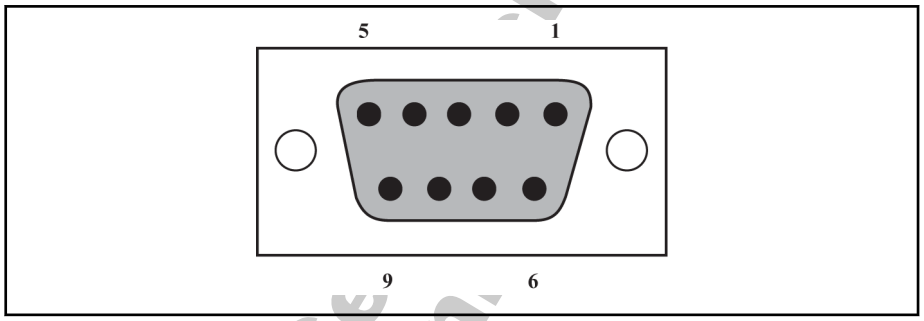

Fig. 12-27: Bus connection terminal PROFIBUS DB9

Pin No.	Terminal sign	Terminal name	Function description
1	PE	Terminal of bus cable shield	Connects with bus cable shield
2	NC	-	Reserved
3	PROFIBUS_B	PROFIBUS terminal_B	PROFIBUS data cable B
4	RTS	Request for signal sending	-
5	GND	Power-	-
6	Vcc	Power+	-
7	NC	-	Reserved
8	PROFIBUS_A	PROFIBUS terminal_A	PROFIBUS data cable A
9	NC	-	Reserved

Fig. 12-28: Definition of PROFIBUS DB9 Pins

Requirements for PROFIBUS Link

Cable used is shielded twisted pair cable. The shield is able to improve electromagnetic compatibility (EMC) ability. Unshielded twisted pair cable may be used if there is less electromagnetic interference (EMI).

Impedance of the cable should be within 100 Ω to 200 Ω. Cable capacity (among conductors) should be < 60 pF/m, and conductor cross section should be ≥0.22 (24 AWG). Two kinds of cables are used for PROFIBUS with detail definitions stated in fig. 12-29 "Type of PROFIBUS Adapter Cable" on page 193.

Cable parameters	Type A	Type B
Impedance	135 Ω – 165 Ω (f=3 MHz – 20 MHz)	100 Ω – 130 Ω (f>100 kHz)
Capacity	<30 pF/m	<60 pF/m

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Communication Protocols

Cable parameters	Type A	Type B
Resistance	≤110 Ω/km	≤110 Ω/km
Conductor cross secion	≥0.34 (22 AWG)	≥0.22 (24 AWG)

Fig.12-29: Type of PROFIBUS Adapter Cable

☞ Standard Siemens PROFIBUS cable is (MLFB) 6XV1830-0EH10 (Type A), and connector is 6ES7972-0BA12-0XA0.

Relationship between Communication Rate and Cables

Relationship between adapter's communication rate and cable length is described in fig. 12-30 "Relationship between Communication Rate and Cable Length" on page 194.

Baud rate	Maximum length for each cable in m (Type A)	Maximum length for each cable in m (Type B)
9.6 – 93.75 kbps	1000	1000
187.5 kbps	1000	600
500 kbps	400	200
1.5 Mbps	200	200
3 – 12 Mbps	100	100

Fig.12-30: Relationship between Communication Rate and Cable Length

EMC Measures

- Conductor of bus cable (signal cable) must be twisted, and shielded and installed separately with electrical power cable with a distance of at least 20 cm. Bus cable shielding layer should be grounded at one end. Terminal PE at terminal block X2 is taken as connecting terminal of the shielding layer. The terminal PE is only valid at the 1st pin of DB9 socket or when DB9 metal cover is connected with the shielding layer of bus cable.
- Conductors of communication connection cable (signal cable) for adapter and frequency converter must be twisted, and shielded and installed separately at a reasonable distance. Shielding layer for communication cable should be grounded at one end.
- Signal cable and electric power cable should be orthogonal in case of crossing.
- Signal cable should be as short as possible.
- Large area is required for the connection of shielding layer.

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12.3.4 Periodical Data Communication

PPO Data Type

PROFIBUS-DP defines data structure for periodical data communication as PPO (the Parameter Process date Object). Bosch Rexroth PROFIBUS adapter supports 5 PPO types shown in fig. 12-31 "PPO type" on page 195. PPO message is divided into two data areas in terms of transmission data contents:

Parameter area (PKW area): read or overwrite the parameter of a certain function code of slave.

Process data area (PZD area): including control word and reference frequency (data flow from master to slave), or status word, actual output frequency and other status monitoring values of slave (data flow from slave to master). For detail descriptions of PKW area and PZD area, please refer to chapter "PKW Parameter Area" on page 195 and chapter "PZD Process Data Area" on page 201.

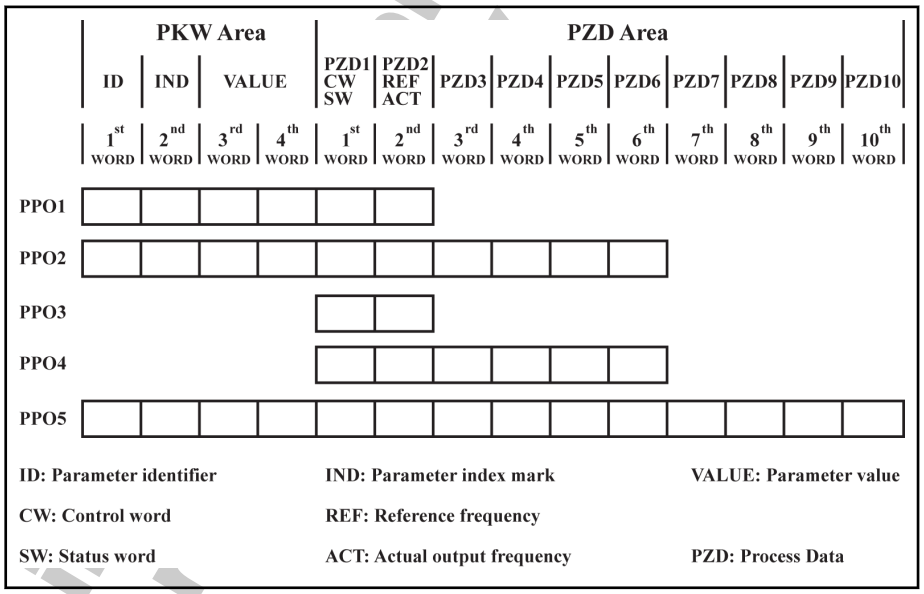

Fig. 12-31: PPO type

PKW Parameter Area

This data area is composed of ID, IND, VALUE_high and VALUE_low, as shown in fig. 12-32 "PKW area data format" on page 196. They are used to read or modify the parameter of a certain function code of frequency converter, but only one function code can be read or modified each time. When master gives request and slave makes response, bit definition for each specific word in PKW area is shown in fig. 12-33 "Request Data Frame in PKW Area_from master to slave" on page 196 and fig. 12-34 "Response Data Frame in PKW Area_from slave to master" on page 197. If frequency converter fails to execute PKW area request command, it will return error code to the master in VALUE_low. Refer to fig. 12-35 "PKW area error codes" on page 197 for details.

Nur für Interessenten

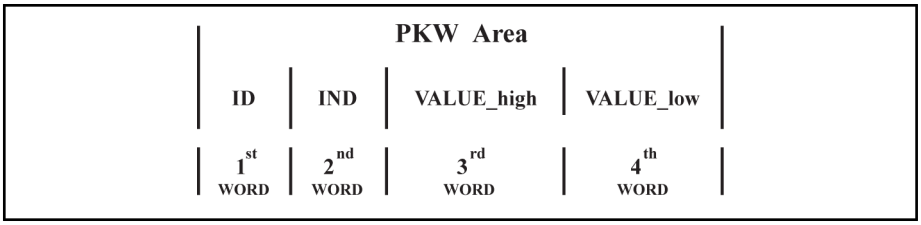

Fig.12-32: PKW area data format

- **Request data frame in PKW area**

Word	Identifier	Bit	Value	Description
1st	ID	15 – 12	0000B	No task
			0001B	Request to read function code parameter
			0010B	Request to modify function code parameter
			Others	Illegal command code
		11	0/1B	Reserved
		10 – 8	000B	Group No. for function code parameter
		7 – 0	xxH	
2nd	IND	15 – 8	xxH	Index serial number of function code within the group
		7 – 0	0	Reserved, default is 0.
3rd	VALUE_high	15 – 0	0	Reserved, default is 0.
4th	VALUE_low	15 – 0	xxxxH	1. When reading parameters, default is 0. 2. When modifying parameters, it is modified value. 3. It can be of any value in case of no operation.

Fig.12-33: Request Data Frame in PKW Area_from master to slave

☞ For addressing of parameter function group and the index serial No. within the group, please refer to chapter "Addressing of Communications Function Code Parameter Group Number and Index Number within the Group" on page 207.

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- **Response data frame in PKW area**

Word	Identifier	Bit	Value	Description
1st	ID	15 – 12	0000B	No task
			0001B	Correct in reading or modifying function code parameter
			0111B	Wrong in reading or modifying function code parameter, and error message is show in VALUE_low.
		11	0	Reserved，default is 0.
		10 – 8	000B	Group No. of function code parameter
		7 – 0	xxH	
2nd	IND	15 – 8	xxH	Index serial number of function code parameter within the group
		7 – 0	0	Reserved，default is 0.
3rd	VALUE_high	15 – 0	0	Reserved，default is 0.
4th	VALUE_low	15 – 0	xxxxH	1. When reading parameters, it returns to read parameter value. 2. when modifying parameters, it is modified value. 3. It returns 0 in case of no operation. 4. It returns error code when PKW area execution fails.

Fig.12-34: Response Data Frame in PKW Area_from slave to master

- **Error message after execution failure in PKW area**

Error code	Meaning	Reason
1	Password locked	User password is locked.
2	Invalid command codes in PKW area	Command codes (bit15 – 12 of ID) are not 0, 1 or 2.
3	Invalid parameter addresses in PKW area	Invalid function group or index number of the function group, or insufficient access/ rights
4	Invalid parameter value in PKW area	Data to wirte out of range
5	In running, can not be modified	Converter is running.
6	Read-only parameters	Parameter are read-only, can not be written.
7	Invalid operation	Function code does not support write or multiple write via external computer.

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Error code	Meaning	Reason
8	Communication data fault in PKW	Conductor interference
9	EEPROM read/write fault	EEPROM write operation is not complete.

Fig.12-35: PKW area error codes

☞ Communication line which is subject to hardware disconnection fault will also lead to execution failure in PKW area. The error code will be given in status word of PZD area.

- **Example of parameter operation in PKW area**

In real application, the PROFIBUS adapter communicates with the master through messages in PPO structure. Among the 5 PPOs stated in chapter "PPO Data Type" on page 195, PPO 1, PPO 2 and PPO5 apply both PKW area and PZD area. In following examples, PKW area data frames are taken from complete PPO message to describe its request and response data frames.

The following examples are based on Bosch Rexroth Frequency Converter Fv and PROFIBUS adapter.

Example 1

Reading value of parameter 'Skip frequency range' [S3.06]. 0×05 is the function group, 0×06 is the index serial No. of the parameter within the group, then request and response data frames in PKW area are shown in fig. 12-36 "Example 1_request and response data frames of PKW area" on page 198.

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x1005 (or 0x1805)	0x0600	0x0000	0x0000
Response data frame of PKW area	0x1005	0x0600	0x0000	0x0000

Fig.12-36: Example 1_request and response data frames of PKW area

☞ ID of request data frame could be 0×1000 or 0×1800, because the 11th digit of ID in Table 4-1 can be 0 or 1. 0 is strongly recommended. In following examples, only ID value of 0with this digit is given.

Example 2

Reading value of parameter 'Skip frequency range' [S3.06]. 0×05 is the function group, 0×06 is the index serial No. of the parameter within the group. If the index serial No. of group S3 is miswritten as 0×20 (0×20, exceeds specified limit in group S), then request and response data frames in PKW area are shown in fig. 12-37 "Example 2_request and response data frames of PKW area" on page 199

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	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x1005	0x2000	0x0000	0x0000
Response data frame of PKW area	0x7005	0x2000	0x0000	0x0003

Fig. 12-37: Example 2_request and response data frames of PKW area

Example 3

Modifying value of parameter 'Skip frequency range' [S3.06]. 0×05 is the function group, 0×03 is the index serial No. within the group, 0×0BB8 is the modified value, then request and response data frames in PKW area are shown in fig. 12-38 "Example 3_request and response data frames of PKW area" on page 199.

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x2005	0x0600	0x0000	0x0 BB 8
Response data frame of PKW area	0x1005	0x0600	0x0000	0x0 BB 8

Fig. 12-38: Example 3_request and response data frames of PKW area

Example 4

Modifying value of parameter 'Skip frequency range' [S3.06]. 0×05 is the function group, 0×06 is the index serial No. within the group, and 0×1388 (0×1388 exceeds upper limit of parameter [S3.06]) is the modified value, then request and response data frames in PKW area are shown in fig. 12-39 "Example 4_request and response data frames of PKW area" on page 199.

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x2005	0x0600	0x0000	0x1388
Response data frame of PKW area	0x7005	0x0600	0x0000	0x0004

Fig. 12-39: Example 4_request and response data frames of PKW area

Example 5

Modifying value of parameter 'Skip frequency range' [S3.06]. 0×05 is the function group, 0×06 is the index serial No. within the group, and 0×0BB8 is the modified value. But, PPO command code (bit15-12 of ID) is miswritten as 8 (illegal command code), then request and response data frames in PKW area are shown in fig. 12-40 "Example 5_request and response data frames of PKW area" on page 199.

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x8005	0x0600	0x0000	0x0BB8
Response data frame of PKW area	0x7005	0x0600	0x0000	0x0002

Fig. 12-40: Example 5_request and response data frames of PKW area

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Example 6

If the user password is available, to modify the value of parameter 'Skip frequency range' [S3.06]. 0×05 is the function group, 0×06 is the index serial No. within the group, and 0x0BB8 is the modified value, then the request and response data frames in PKW area are shown in fig. 12-41 "Example 6_after user password modified_request and response data frames of PKW area" on page 200.

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x2005	0x0600	0x0000	0x0BB8
Response data frame of PKW area	0x7005	0x0600	0x0000	0x0001

Fig.12-41: Example 6_after user password modified_request and response data frames of PKW area

Example 7

Forward run the converter at 50.00 Hz (0x1388) , then modify the value of parameter 'Skip frequency range' [S3.06]. 0×05 is the function group, 0×06 is the index serial No. within the group, and 0x0BB8 is the modified value, then the request and response data frames in PKW area are shown in fig. 12-42 "Example 7_request and response data frames of PKW area" on page 200.

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x2005	0x0600	0x0000	0x0BB8
Response data frame of PKW area	0x7005	0x0600	0x0000	0x0005

Fig.12-42: Example 7_request and response data frames of PKW area

Example 8

Modify the value of parameter 'Heat sink temperature' [b0.12]. 0x00 is the funcion group, 0x0C is the index serial No. within the group, and 0x0001 is the modified value, then the request and response data frames in PKW area are shown in fig. 12-43 "Example 8_request and response data frames of PKW area" on page 200.

	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x2000	0x0C00	0x0000	0x0001
Response data frame of PKW area	0x7000	0x0C00	0x0000	0x0006

Fig.12-43: Example 8_request and response data frames of PKW area

Example 9

Modify the value of parameter 'LCD display in run mode' [b0.08]. 0x00 is the function group, 0x08 is the index serial No. within the group, and 0x0BB8 is the modified value, then the request and response data frames in PKW area are shown in fig. 12-44 "Example 9_request and response data frames of PKW area" on page 201.

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	ID	IND	VALUE_high	VALUE_low
Request data frame of PKW area	0x2000	0x0800	0x0000	0x0001
Response data frame of PKW area	0x7000	0x0800	0x0000	0x0007

Fig.12-44: Example 9_request and response data frames of PKW area

PZD Process Data Area

When the master is sending a request message to the slave , PZD1 and PZD2 in PZD process data area are respectively corresponding to control word (CW) and reference frequency (REF) and PZD3 - PZD10 (number depending on PPO type) are written as 0. When the slave returns a response message to the master, PZD1 and PZD2 in PZD process data area are respectively corresponding to status word (SW) and actual output frequency (ACT), and PZD3-PZD10 are corresponding to status monitoring values (such as output current, output voltage, AC bus voltage, etc.) set by function code parameter [H0.04] – [H0.07].

- **Control Word (CW)**

Bit	Value	Description
15 – 8	—	Reserved
7	0	Control active
	1	Control inactive
6	0	Inactive
	1	SCI stop acceleration
5	0	Fault reset incative
	1	Fualt reset active
4	0	E-Stop inactive
	1	E-Stop active
3	0	Inactive
	1	Stop as parameter setting mode
2	0	Forward
	1	Reverse
1	0	Jog inactive
	1	Jog active
0	0	Run inactive
	1	Run active

Fig.12-45: Bit definition of control word

☞ When bit7 is 1, command is invalid.

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- **Status Word (SW)**

Bit	Value	Description
11 – 15	—	Converter error codes
10	—	Rerserved
7 – 9	000	Normal
	001	Communication hardware circuit fault (SW feedback has no meaning when there is circuit fault in communication hardware.)
	010	Communication data fault in PZD area
	011	Reference frequency exceeds limit in PZD area.
	100 – 111	Reserved
6	0	Normal
	1	Stall over current
5	0	Normal
	1	Stall over voltage
4	0	Not in deceleration
	1	Decelerating
3	0	Not in acceleration
	1	Accelerating
2	0	Not in jog
	1	Jogging
1	0	In stop
	1	In run
0	0	Forward
	1	Reverse

Fig.12-46: Bit definition of status word

☞ In case of system faults, fault records can be read in parameters [E4.10] – [E4.12].

No.	Error code name	No.	Error code name
0	No fault record	12	Communication fault (R.S.)
1	Over current at constant speed (O.C.-1)	13	Circuit disconnection (C.F.)
2	Over current in acceleration (O.C.-2)	14	Encoder speed detection fault (PULS)
3	Over current in deceleration (O.C.-3)	15	Reserved
4	Over voltage at constant speed (O.E.-1)	16	EMI (CPU-)

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No.	Error code name	No.	Error code name
5	Over voltage in acceleration (O.E.-2)	17	Short circuit (S.C.)
6	Over voltage during deceleration (O.E.-3)	18	Reserved
7	Converter overload (O.L.-1)	19	L1, L2, L3 phase failure (IPH.L)
8	Motor overload (O.L.-2)	20	U, V, W phase failure(OPH.L)
9	CPU read/write fault (R.E.)	21	Converter over heat (O.H.)
10	Operating panel read/write fault (KEY-)	22	Parameter setting fault (PRSE)
11	External fault (E.-St)	23	Parameter auto-tuning fault (TUNE)

Fig. 12-47: Error codes and meanings_PROFIBUS

☞ When system is subject to fault, please read value of function code [E45] of frequency converter.

Example 1

If the Maximum frequency of the converter is set at 100 Hz, to forward run the converter ward run at 200 Hz (0x4E20) (exceeds the maximum frequency), then the PPO request and response messages are shown in fig. 12-48 "Example 1_PPO request and response messages" on page 203.

	PZD1	PZD2
PPO request message	CW	REF
	0x0001	0x4E20
PPO response message	SW	ACT
	0x0180	0x4E20

Fig. 12-48: Example 1_PPO request and response messages

☞ In this example, the feedback status word is 0x0180, bit 7 – 9 of status word is 011 (PZD area set frequency exceeds limit).

Example 2

The converter is first forward run at 50 Hz (0x1388), the hardware circuit of communication is then disconnected, then the PPO request and response messages are shown in fig. 12-49 "Example 2_PPO request and response messages" on page 203.

	PZD1	PZD2
PPO request message	CW	REF
	0x0001	0x1388
PPO response message	SW	ACT
	0x0080	0x1388

Fig. 12-49: Example 2_PPO request and response messages

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☞ In this example, the feedback status word is 0x0080, bit 7 – 9 of status word is 001 (Communication hardware circuit fault).

Process Data PZD3 - PZD10

One of parameters [H0.04] – [H0.07] can set 2 PZDs. For example, [H0.04] sets PZD3 and PZD4, with bit0 – bit3 setting of PZD3, bit4 – bit7 setting of PZD4, then the maximum range of the funciton code is 00 – BBH or 00 – 187. The corresponding relationship between the set value (4 bits) and monitored value is shown in fig. 12-50 "Process data PZD3 – PZD 10 values and function code settings" on page 204.

00	Output current
01	Reference freqeuency
02	Output current
03	DC bus voltage
04	Heat sink temperature
05	Output voltage
06	Output power
07	Torque current
08	Exciting current
09	Output speed
0A	Reference speed
0B	User-definded reference value
0C	User-defined output value
0D	Reference torque
0E	Reserved

Fig.12-50: Process data PZD3 – PZD 10 values and function code settings

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Examples for Operation of PZD Process Data Area

Example 1

The master communicates with the slave via PPO4. From fig. 12-33 "Request Data Frame in PKW Area_from master to slave" on page 196 and fig. 12-50 "Process data PZD3 – PZD 10 values and function code settings" on page 204, we need to set status monitoring value corresponding to PZD3 - PZD6 in parameters of Frequency Converter Fv.

If we need to start frequency converter for forward rotation at 50.00 Hz (0×1388), and request PZD3 to reflect output current, PZD4 to reflect output voltage, PZD5 to reflect DC bus voltage, PZD6 to reflect radiator temperature, respective function codes are set as: [H0.04]=82; [H0.05]=67. Complete PPO request and response messages are shown in fig. 12-51 "Example 1 for PZD process data area_request and response messages of PPO" on page 205.

	PZD1	PZD2	PZD3	PZD4	PZD5	PZD6
PPO request message	CW	REF	0x0000	0x0000	0x0000	0x0000
	0x0001	0x1388				
PPO response message	SW	ACT	0x0000	0x0206	0x02DD	0x0019
	0x0002	0x1388				

Fig. 12-51: Example 1 for PZD process data area_request and response messages of PPO

☞ In this example, request and response data frame is the message of frequency converter at stable operation. Actually, at the instant start-up of the frequency converter, response data frame in PZD area is “000× 0000 0001 0000 1369 0019” (× means rotation direction is not certain at the instant of activation).

Example 2

When the converter forward runs at 50 Hz, to stop the converter as parameter settings, please refer to example 1.

	PZD1	PZD2	PZD3	PZD4	PZD5	PZD6
PPO request message	CW	REF	0x0000	0x0000	0x0000	0x0000
	0x0008	0x1388				
PPO response message	SW	ACT	0x0000	0x0000	0x0049	0x0013
	0x0000	0x0000				

Fig. 12-52: Example 2 for PZD process data area_request and response messages of PPO

Example 3

To reverse start the converter at 50 Hz, please refer to example 1 for parameter settings.

	PZD1	PZD2	PZD3	PZD4	PZD5	PZD6
PPO request message	CW	REF	0x0000	0x0000	0x0000	0x0000
	0x0005	0x1388				

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	PZD1	PZD2	PZD3	PZD4	PZD5	PZD6
PPO response message	SW	ACT	0x0000	0x0206	0x02DA	0x001A
	0x0003	0x1388				

Fig.12-53: Example 3 for PZD process data area_request and response messages of PPO

Example 4

When the converter reverse runs at 50 Hz, to stop the converter as parameter settings, please refer to example 1.

	PZD1	PZD2	PZD3	PZD4	PZD5	PZD6
PPO request message	CW	REF	0x0000	0x0000	0x0000	0x0000
	0x000C	0x1388				
PPO response message	SW	ACT	0x0000	0x0000	0x0040	0x0013
	0x0001	0x0000				

Fig.12-54: Example 3 for PZD process data area_request and response messages of PPO

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Addressing of Communications Function Code Parameter Group Number and Index Number within the Group

The communication function code address of the frequency converter is in strict correspondence with the function code. It consists of function code group No. and index of parameters within the group. Reading and writing function codes are possible through reading and writing contents of function code address of PROFIBUS communication. Reading and writing property as well as value taking range for the function code should follow the User Manual for the frequency converter.

A complete communication function code address of frequency converter consists of 19 bits, where high 11 bit is communication function code group No., and low 18 bit is index of parameters within the group. Index of parameters within the group for a certain function code refers to sexadecimal expression group No. of such function code. For example, if it is function code [E03] (programmable skip frequency range), it is numbered as 3 in Group E. So its index of parameters within the group is 0×03. As high 3 bit of 11 bit function code (bit10-8 of ID) must be 000B, in order to describe it in sexadecimal system, function code group No. stated in this manual only refers to its low 8bit (i.e., bit7-10 of ID). For example, if it is function code [E03] (programmable skip frequency range), its function code group No. is 0×01. The function code group No. mentioned above is the same as this number. Addressing the range for PROFIBUS adapter communication function code group No. and index of parameter within the group is shown in fig. 12-55 "Addressing range of funciton code group and index serial No. withing the group" on page 207.

Function code group	b0	b1	S0	S1	S2	S3
Mapping address	0x00	0x01	0x02	0x03	0x04	0x05
Index serial No. within the group	0x00 – 0x0F	0x00 – 0x17	0x00 – 0x0A	0x00 – 0x05	0x00 – 0x0F	0x00 – 0x10
Function code group	E0	E1	E2	E3	E4	H0
Mapping address	0x06	0x07	0x08	0x09	0x0A	0x0B
Index serial No. within the group	0x00 – 0x18	0x00 – 0x11	0x00 – 0x34	0x00 – 0x09	0x00 – 0x0D	0x00 – 0x0A

Fig. 12-55: Addressing range of funciton code group and index serial No. withing the group

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12.3.5 Communication Parameter Configuration

Communication Related Parameter Settings in Fv

Function code	Function name	Setting range of parameter
b1.00	Frequency setting mode	5：Set via communication
b1.02	Converter control commands	2：Set control commands via communication
H0.00	Communication protocols selection	1：PROFIBUS protocols
H0.03	Local address	1 – 126
H0.04	PZD4, PZD3 setting	0 – 238
H0.05	PZD6, PZD5 setting	0 – 238
H0.06	PZD8, PZD7 setting	0 – 238
H0.07	PZD10, PZD9 setting	0 – 238
H0.08	Communication disconnection detection time	0.0 (inactive) , 0.1 – 60.0s
H0.09	Communication disconnection action	0：Stop 1：Continue running

Fig.12-56: Converter Fv PROFIBUS-DP communication parameters

☞ If parameter [b00]=5, when the frequency converter is stopped by the **Stop** key on the operating panel, adapter is isolated from communication software of the frequency converter. If communication is to be re-established, **Stop** and **Reset** commands must be sent to the frequency converter by the adapter.

Parameter Configuration of Master

Parameter configuration for related master may refer to instructions for the master. The address configured for slave in the master should be consistent with the parameter address configured for the slave. Communication baud rate and PPO type is determined by the master.

GSD File

Users may log on the website of the company at **www.brce.cn** to download electronic database document (RXFVDP01.gsd) and bit map document (RX_FV*.bmp) pack for fieldbus adapter. For specific operation and PROFIBUS system configuration method, please refer to related system configuration documents.

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12.3.6 Faults and Analysis

LED Display Analysis

Run This light indicates if bus adapter is running normally. If bus adapter is correctly connected to the frequency converter, and related parameter configuration for the frequency converter is correct, this light is always on after power is switched on. If this light is flashing, please switch off the power supply first, and then check if bus adapter is correctly connected with the frequency converter, if frequency converter parameters are correctly configured, and if bus adapter power connection is reliable. After that, switch power on for bus adapter. If this problem still exists, please contact your dealer.

Line This light indicates the status of communication between the bus adapter and the frequency converter. It indicates normal communication if this light is always on. If this light is off, it indicates disconnection between the adapter and the frequency converter. Then, please check hardware connection between bus adapter and frequency converter. If this light is flashing, it indicates abnormal connection between the adapter and the frequency converter. Then, please check hardware connection between the bus adapter and the frequency converter.

Net This light indicates the status of communication between the bus adapter and PROFIBUS master. If this light is always flashing, it indicates normal communication. If this light is off, please check hardware wiring between the bus adapter and master, and check if the master configuration is correct.

Diagnosis Information of Master

From diagnosis of the adapter by master, 6-byte diagnosis information is obtained. Detailed meanings for each byte are as below:

- **First byte (Station_Ststus_1)**

0	Diag.Station_Non_Existent (set by master, reset by slave) 1: slave does not exist
1	Diag.Station_Non_Ready (set by slave) 1: slave is not ready for data exchange
2	Diag.Cfg_Fault (set by slave) 1: Adapter data received does not match with originally configured data
3	Diag.Ext_Diag (set by slave) 1: diagnosis entrance is at undetermined diagnosis area of the slave
4	Diag.Not-Supported (set by slave) 1: service not supported by slave
5	Diag.Invalid_Slave_Response (set by master, reset by slave) 1: invalid response of slave
6	Diag.Prm_Fault (set by master) 1: invalid parameter or parameter value
7	Diag.Master_Lock (set by master, reset by slave) 1: parameters of slave are set by other masters

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- **Second byte (Station_Status_2)**

0	Diag.Prm_Req (set by master) 1: Slave needs to be reconfigurated, parameters need to be set again.
1	Diag.Stat_Diag (set by slave) 1: Static diagnosis, slave fails (temporarily) to provide valid data.
2	Always set as 1 by slave
3	Diag.WD_On (set by slave) 1: watchdog is on
4	Diag.Freeze_Mode (set by slave) 1: freezing command received by slave
5	Diag.Sync_Mode (set by slave) 1: synchronizing command received by slave
6	Reserved
7	Diag.Deactivated (set by master, reset by slave) 1: slave inactive

- **Third byte (Station_Status_3)**

0 – 6	Reserved
7	Diag.Ext_Diag_Overflow (set by slave) 1: more diagnosis information in Ext_Diag_Date than what specified information

- **Fourth byte (Diag.Master_Add)**

Log in address of DP master which parameterizes this DP slave in this eight-bit set. If there is no such master which parameterizes this DP slave, address 255 of this DP slave will be logged in this octet.

- **Fifth and sixth bytes (Ident_Numbei)**

  The identifier of the adapter.

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13 Disposal and Environmental Protection

13.1 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.

13.2 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 remaining after these processes can be thermally recycled.

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14 Service and Support

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

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

1) Central European Time (CET)

Preparing Information

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

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

For technical support, please use the following email address:

dccx.drivesupport@boschrexroth.com.cn

Please send your enquiry in English.

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