rexroth
A Bosch Company

VFC x610 Series

Brake Chopper

Operating Instructions
R912007234

Edition 05

Record of Revision

Edition	Release Date	Notes
DOK-RCON04-VFC*BRAKE**-IT01-EN-P	2016.09	First Release
DOK-RCON04-VFC*BRAKE**-IT02-EN-P	2019.11	Second Release
DOK-RCON04-VFC*BRAKE**-IT03-EN-P	2020.08	Third Release
DOK-RCON04-VFC*BRAKE**-IT04-EN-P	2021.08	Fourth Release
DOK-RCON04-VFC*BRAKE**-IT05-EN-P	2021.12	Fifth Release

Version Matching Table

Firmware	Operating Instructions
01V02	Edition 01
01V06	Edition 02 and above

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1 Safety Instructions for Electric Drives and Controls

1.1 Definitions of Terms

Documentation

A documentation comprises the entire documentation used to inform the user of the product about the use and safety-relevant features for configuring, integrating, mounting, installing, commissioning, operating, maintaining, repairing and decommissioning the product. The following terms are also used for this kind of documentation: Operating Instructions, Instruction Manual, Commissioning Manual, Application Description, Assembly Instructions, Project Planning Manual, Safety Notes, Product Insert, etc.

Component

A component is a combination of elements with a specified function, which are part of a piece of equipment, device or system. Components of the electric drive and control system are, for example, supply units, drive controllers, mains choke, mains filter, motors, cables, etc.

Control System

A control system comprises several interconnected control components placed on the market as a single functional unit.

Device

A device is a finished product with a defined function, intended for users and placed on the market as an individual piece of merchandise.

Electrical Equipment

Electrical equipment encompasses all devices used to generate, convert, transmit, distribute or apply electrical energy, such as electric motors, transformers, switching devices, cables, lines, power-consuming devices, circuit board assemblies, plug-in units, control cabinets, etc.

Electric Drive System

An electric drive system comprises all components from mains supply to motor shaft; this includes, for example, electric motor(s), motor encoder(s), supply units and drive controllers, as well as auxiliary and additional components, such as mains filter, mains choke and the corresponding lines and cables.

Installation

An installation consists of several devices or systems interconnected for a defined purpose and on a defined site which, however, are not intended to be placed on the market as a single functional unit.

Machine

A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements,

as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

Manufacturer

The manufacturer is an individual or legal entity bearing responsibility for the design and manufacture of a product which is placed on the market in the individual's or legal entity's name. The manufacturer can use finished products, finished parts or finished elements, or contract out work to subcontractors. However, the manufacturer must always have overall control and possess the required authority to take responsibility for the product.

Product

Examples of a product: Device, component, part, system, software, firmware, among other things.

Qualified Persons

In terms of this application documentation, qualified persons are those persons who are familiar with the installation, mounting, commissioning and operation of the components of the electric drive and control system, as well as with the hazards this implies, and who possess the qualifications their work requires. To comply with these qualifications, it is necessary, among other things,

1) to be trained, instructed or authorized to switch electric circuits and devices safely on and off, to ground them and to mark them

2) to be trained or instructed to maintain and use adequate safety equipment

3) to attend a course of instruction in first aid

User

A user is a person installing, commissioning or using a product which has been placed on the market.

1.2 Explanation of signal words and the Safety alert symbol

The Safety Instructions in the available application documentation contain specific signal words (DANGER, WARNING, CAUTION or NOTICE) and, where required, a safety alert symbol (in accordance with ANSI Z535.6-2011).

The signal word is meant to draw the reader's attention to the safety instruction and identifies the hazard severity.

The safety alert symbol (a triangle with an exclamation point), which precedes the signal words DANGER, WARNING and CAUTION, is used to alert the reader to personal injury hazards.

⚠ DANGER

In case of non-compliance with this safety instruction, death or serious injury **will** occur.

⚠ WARNING

In case of non-compliance with this safety instruction, death or serious injury **could** occur.

⚠ CAUTION

In case of non-compliance with this safety instruction, minor or moderate injury could occur.

NOTICE

In case of non-compliance with this safety instruction, property damage could occur.

1.3 General Information

1.3.1 Using the Safety Instructions and Passing Them on to Others

Do not attempt to install and operate the components of the electric drive and control system without first reading all documentation provided with the product. Read and understand these safety instructions and all user documentation prior to working with these components. If you do not have the user documentation for the components, contact your responsible Bosch Rexroth sales partner. Ask for these documents to be sent immediately to the person or persons responsible for the safe operation of the components.

If the component is resold, rented and/or passed on to others in any other form, these safety instructions must be delivered with the component in the official language of the user's country.

Improper use of these components, failure to follow the safety instructions in this document or tampering with the product, including disabling of safety devices, could result in property damage, injury, electric shock or even death.

1.3.2 Requirements for Safe Use

Read the following instructions before initial commissioning of the components of the electric drive and control system in order to eliminate the risk of injury and/or property damage. You must follow these safety instructions.

- Bosch Rexroth is not liable for damages resulting from failure to observe the safety instructions.
- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.
- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.
- Only qualified persons may work with components of the electric drive and control system or within its proximity.
- Only use accessories and spare parts approved by Bosch Rexroth.
- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.
- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".
- The ambient and operating conditions given in the available application documentation must be observed.
- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technology". If this is not the case, they are excluded. Functional safety is a safety concept in

which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.

- The information given in the application documentation with regard to the use of the delivered components contains only examples of applications and suggestions.

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,

  – make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only allowed if the national EMC regulations for the application are met.
- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective application documentation.

  The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.
- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user must take into account

- European countries: In accordance with European EN standards
- United States of America (USA):
  – National Electrical Code (NEC)
  – National Electrical Manufacturers Association (NEMA), as well as local engineering regulations
  – Regulations of the National Fire Protection Association (NFPA)
- Canada: Canadian Standards Association (CSA)
- Other countries:
  – International Organization for Standardization (ISO)
  – International Electrotechnical Commission (IEC)

1.3.3 Hazards by Improper Use

- High electrical voltage and high working current! Danger to life or serious injury by electric shock!

- High electrical voltage by incorrect connection! Danger to life or injury by electric shock!
- Dangerous movements! Danger to life, serious injury or property damage by unintended motor movements!
- Health hazard for persons with heart pacemakers, metal implants and hearing aids in proximity to electric drive systems!
- Risk of burns by hot housing surfaces!
- Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!
- Risk of injury by improper handling of pressurized lines!

1.4 Instructions with Regard to Specific Dangers

1.4.1 Protection against Contact with Electrical Parts and Housings

This section concerns components of the electric drive and control system with voltages of **higher than 50 V**.

Contact with parts conducting voltages above 50 V can cause personal danger and electric shock. When operating components of the electric drive and control system, it is unavoidable that some parts of these components conduct dangerous voltage.

High electrical voltage! Danger to life, risk of injury by electric shock or serious injury!

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.
- Follow the general installation and safety regulations when working on power installations.
- Before switching on, the equipment grounding conductor must have been permanently connected to all electric components in accordance with the connection diagram.
- Even for brief measurements or tests, operation is only allowed if the equipment grounding conductor has been permanently connected to the points of the components provided for this purpose.
- Before accessing electrical parts with voltage potentials higher than 50 V, you must disconnect electric components from the mains or from the power supply unit. Secure the electric component from reconnection.
- With electric components, observe the following aspects:

  Always wait **30 minutes** after switching off power to allow live capacitors to discharge before accessing an electric component. Measure the electrical voltage of live parts before beginning to work to make sure that the equipment is safe to touch.
- Install the covers and guards provided for this purpose before switching on.
- Never touch electrical connection points of the components while power is turned on.
- Do not remove or plug in connectors when the component has been powered.
- Under specific conditions, electric drive systems can be operated at mains protected by residual-current-operated circuit-breakers sensitive to universal current (RCDs/RCMs).
- Secure built-in devices from penetrating foreign objects and water, as well as from direct contact, by providing an external housing, for example a control cabinet.

High housing voltage and high leakage current! Danger to life, risk of injury by electric shock!

- Before switching on and before commissioning, ground or connect the components of the electric drive and control system to the equipment grounding conductor at the grounding points.
- Connect the equipment grounding conductor of the components of the electric drive and control system permanently to the main power supply at all times. The leakage current is greater than 3.5 mA.

1.4.2 Protective Extra-Low Voltage as Protection Against Electric Shock

Protective extra-low voltage is used to allow connecting devices with basic insulation to extra-low voltage circuits.

On components of an electric drive and control system provided by Bosch Rexroth, all connections and terminals with voltages between 5 and 50 volts are PELV ("Protective Extra-Low Voltage") systems. It is allowed to connect devices equipped with basic insulation (such as programming devices, PCs, notebooks, display units) to these connections.

Danger to life, risk of injury by electric shock! High electrical voltage by incorrect connection!

If extra-low voltage circuits of devices containing voltages and circuits of more than 50 volts (e.g., the mains connection) are connected to Bosch Rexroth products, the connected extra-low voltage circuits must comply with the requirements for PELV ("Protective Extra-Low Voltage").

1.4.3 Protection against Dangerous Movements

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

- Improper or wrong wiring or cable connection
- Operator errors
- Wrong input of parameters before commissioning
- Malfunction of sensors and encoders
- Defective components
- Software or firmware errors

These errors can occur immediately after equipment is switched on or even after an unspecified time of trouble-free operation.

The monitoring functions in the components of the electric drive and control system will normally be sufficient to avoid malfunction in the connected drives. Regarding personal safety, especially the danger of injury and/or property damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case

that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

Dangerous movements! Danger to life, risk of injury, serious injury or property damage!

A **risk assessment** must be prepared for the installation or machine, with its specific conditions, in which the components of the electric drive and control system are installed.

As a result of the risk assessment, the user must provide for monitoring functions and higher-level measures on the installation side for personal safety. The safety regulations applicable to the installation or machine must be taken into consideration. Unintended machine movements or other malfunctions are possible if safety devices are disabled, bypassed or not activated.

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
  - Safety fences
  - Safety guards
  - Protective coverings
  - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equipment works. Do not operate the machine if the emergency stopping switch is not working.
- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches / OFF buttons or use a safe starting lockout.
- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.
- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") 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 components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control

and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

1.4.4 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

Magnetic and electromagnetic fields generated by current-carrying conductors or permanent magnets of electric motors represent a serious danger to persons with heart pacemakers, metal implants and hearing aids.

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

- Persons with heart pacemakers and metal implants are not allowed to enter the following areas:
  - Areas in which components of the electric drive and control systems are mounted, commissioned and operated.
  - Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- If it is necessary for somebody with a heart pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of implanted heart pacemakers differs so greatly 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.

1.4.5 Protection against contact with hot parts

Hot surfaces of components of the electric drive and control system. Risk of burns!

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.
- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can

be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

1.4.6 Protection during handling and mounting

Risk of injury by improper handling! Injury by crushing, shearing, cutting, hitting!

- Observe the relevant statutory regulations of accident prevention.
- Use suitable equipment for mounting and transport.
- Avoid jamming and crushing by appropriate measures.
- Always use suitable tools. Use special tools if specified.
- Use lifting equipment and tools in the correct manner.
- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids from the floor due to the risk of falling!

2 Important Directions for Use

2.1 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 can only be used in the appropriate way. Otherwise, situations resulting in property damage and personal injury may occur.

Bosch Rexroth as manufacturer is not liable for any damages resulting from inappropriate use. In such cases, the guarantee and the rights 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.

2.2 Inappropriate Use

Using the brake choppers outside of the operating conditions described in this documentation and outside of the indicated technical data and specifications is defined as "**inappropriate use**".

Brake choppers shall not be used under 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 brake choppers shall not be used in applications which have not been expressly authorized by Rexroth. Please carefully follow the specifications outlined in the general Safety Instructions!

3 Delivery and Storage

3.1 Product Identification

3.1.1 Packing Nameplate

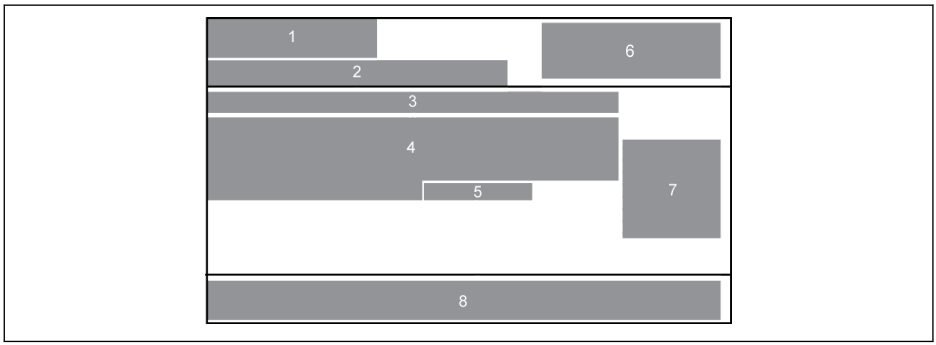
Check if the model information on the packing nameplate is the same as you ordered **immediately** after receipt. If the model is wrong, please contact Bosch Rexroth distributor.

1 Product series
2 Short text / Type code
3 Volume
4 Net weight
5 Material number
6 Product version index
7 Mass weight
8 Production week: e.g., 14W20 means week 20 in 2014
9 Product QR code
10 Serial number
11 Manufacturer
12 QR code (Internal use)
13 Certification

Fig. 3-1: Packing nameplate

3.1.2 Product Nameplate

Check if the model information on product nameplate is the same as you ordered **immediately** after unpacking. If the model is wrong, please contact Bosch Rexroth distributor.



1 Brand logo
2 Product series
3 Short text / Type code
4 Technical data
5 Production week: e.g., 14W20 means week 20 in 2014
6 Certification
7 Product QR code
8 Manufacturer

Fig. 3-2: Product nameplate

3.2 Visual Inspection

Check the product for transport damages, e.g. deformation or loose parts, immediately after 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.

3.3 Scope of Supply

If any of the following standard supply items is missing, please contact Bosch Rexroth distributor.

- Brake chopper
- Operating Instructions

3.4 Transport of the Components

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

Tab. 3-1: Transport conditions

3.5 Storage of the Components

⚠ CAUTION

Damage to the components caused by long storage periods!

When storing these components for a long period of time, remember to operate them once a year.

Description	Symbol	Unit	Value
Temperature range	T_{a_store}	°C	-20...60
Relative humidity	–	%	5...95
Absolute humidity	–	g/m^3	1...29
Climate category (IEC 721)	–	–	1K3
Moisture condensation	–	–	not allowed
Icing	–	–	not allowed

Tab. 3-2: Storage conditions

4 Brake Chopper Overview

4.1 Work Principle

During the process of frequency converter stops, some regenerative energy will be produced by external motor and be feed back to the converter. Brake chopper is used to control and deliver this energy to the connected braking resistor, the resistor then dissipate the energy and transfer it into heat. This can limit the DC-bus voltage of frequency converter into a rational range to improve the braking performance and finally stop motor quickly. Before the brake chopper is normally running, the start voltage for braking should be properly set according to the selected frequency converter and its load condition, while the stop voltage for braking can be set by parameter H6.03.

When brake chopper is normally running, its control circuit detects the DC-bus voltage in real time. If the bus voltage reaches the pre-set start voltage which can be set by parameter H6.01, brake chopper will start braking during which the electrical energy returned from the motor is consumed by the external braking resistor, and stop braking until the bus voltage reduces to the stop voltage. The brake chopper duty cycle can be adjusted by parameter H6.02. The higher the duty cycle is, the better the braking performance will be. Brake chopper duty cycle should be properly set according to the actual load condition. For example, if the braking resistor overheats, the duty cycle should be appropriately reduced with the premise that the braking performance is satisfied.

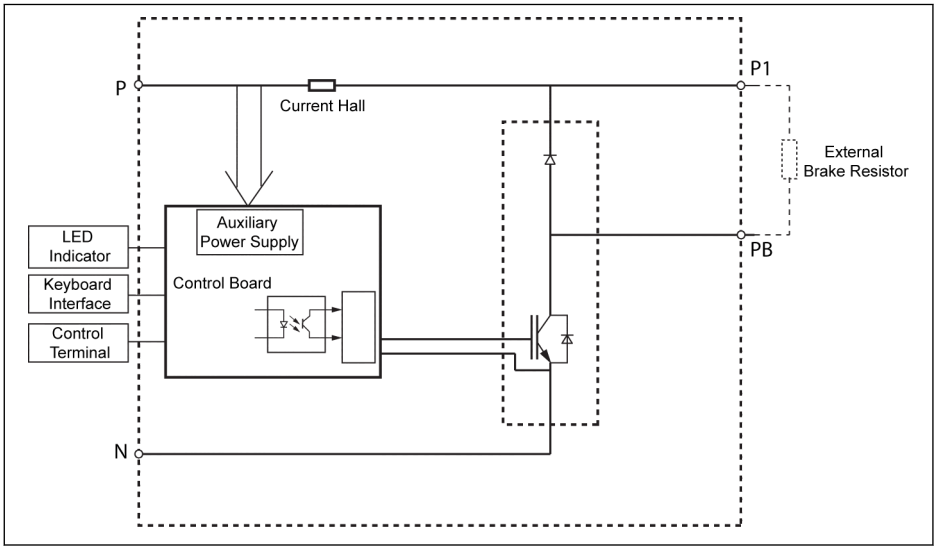


Fig. 4-1: Work principle

4.2 Product Features

4.2.1 Conditions

Rated ambient temperature	-10...40 °C
Derating / ambient temperature	1.5 % / 1 °C (40...50 °C)
Rated storage temperature	-20...60 °C
Rated altitude	≤ 1,000 m
Derating / altitude	1 % / 100 m (1,000...4,000 m)
Relative humidity	≤ 90 % RH (No condensation)
Degrees of protection	IP 20
Degrees of pollution	2 (EN 50178)
Vibration	10 Hz ≤ f ≤ 57 Hz amplitude: 0.075 mm 57 Hz < f ≤ 150 Hz acceleration: 1 g
Mounting mode	Wall mounting
Cooling type	Natural cooling Enforced air cooling
Certification	CE

4.3 Technical Data

4.3.1 Electric Data

Voltage class		3P 380...480 VAC (-15 % / +10 %); 50 / 60 Hz (±5 %)	
Brake chopper model		FEAE07.1-VA1-NNNN	FEAE07.1-VA2-NNNN
Input and output specifications	Output current	0.0...80.0 A	0.0...125.0 A
	Brake chopper start voltage	600...785 V	
	Maximum hysteresis	0...100 V	
	Synchronous signal	Linkage input, Linkage output, up to 3 brake choppers in parallel	
Power supply	DC-bus voltage range	600...810 VDC	
Protection	Heat sink overheat	Active when the temperature exceeds the setting point.	
	Error output	RELAY junction 0.6 A 125 VAC / 2 A 30 VDC (Ta, Tb are normally open contact)	
	Other protections	Overvoltage protection / Overheat protection / Overcurrent protection / Short circuit protection	
Terminal	Digital input terminal	5 digital input terminals	
	Digital output terminal	Digital output terminals OUT+, OUT-, one relay output	
Continuous braking time under the maximum output current		0.0...10.0 s (ED = 10 %)	
Indication functions		Power indication / Error indication / Master-slave indication / Brake indication	

Tab. 4-1: Technical specifications

4.3.2 Requirement of Cable Length

- The cable length between brake chopper and frequency converter is less than or equal to 5 m
- The cable length between brake chopper and brake resistor is less than or equal to 5 m

4.4 Applicable Model of Frequency Converter

Model of brake chopper	Model of frequency converter
FEAE07.1-VA1-NNNN	VFC 5610 30...55 kW
FEAE07.1-VA2-NNNN	VFC 5610 75, 90 kW

Tab. 4-2: Applicable model of frequency converter

4.5 Brake Chopper and Brake Resistor

4.5.1 Braking Ratio

Brake resistors with different power ratings are available to dissipate braking energy when the frequency converter is in generator mode. The following table lists the details of brake chopper and brake resistor corresponding to each brake power in the condition that a certain braking ratio is given.

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

ED Braking ratio
Tb Braking time
Tc Engineering cycle time in application

Fig. 4-2: Braking ratio

In different applications, ED has different typical value. User can select the brake chopper and brake resistor based on the ED value.

4.5.2 Recommended Brake Chopper and Brake Resistor

When braking voltage is 750 V, ED = 10 % and braking torque is 100%, the recommended brake chopper and brake resistor are listed as below.

Brake power (kW)	Brake chopper type code	Number of brake choppers
0.4...22	Internal	-
30	FEAE07.1-VA1-NNNN	1
37		1
45		1
55		1
75	FEAE07.1-VA2-NNNN	1
90		1
110	FEAE07.1-VA1-NNNN	2

Brake power (kW)	Brake chopper type code	Number of brake choppers
132	FEAE07.1- VA2-NNNN	2
160		2
185		3
200		3
220		3
250		3
280		4
315		4

Tab. 4-3: Recommended brake chopper

Brake power (kW)	Recommended brake resistence (750 V)			Minimum brake resistence	
	Resistence (Ω)	Power (kW)	Number of paralleled brake resistors	Resistence (Ω)	Power (kW)
0.4	FCAR01.1W0080-N750R0-B-05-NNNN	750 Ω / 80 W	1	≥403	≥0.05
0.75	FCAR01.1W0080-N750R0-B-05-NNNN	750 Ω / 80 W	1	≥228	≥0.1
1.5	FCAR01.1W0260-N400R0-B-05-NNNN	400 Ω / 260 W	1	≥131	≥0.2
2.2	FCAR01.1W0260-N250R0-B-05-NNNN	250 Ω / 260 W	1	≥94	≥0.3
3.0	FCAR01.1W0390-N150R0-B-05-NNNN	150 Ω / 390 W	1	≥71	≥0.4
4.0	FCAR01.1W0390-N150R0-B-05-NNNN	150 Ω / 390 W	1	≥54	≥0.5
5.5	FCAR01.1W0780-N075R0-A-05-NNNN	75 Ω / 780 W	1	≥39	≥0.7
7.5	FCAR01.1W0780-N075R0-A-05-NNNN	75 Ω / 780 W	1	≥27	≥0.9
11	FCAR01.1W1K56-N040R0-A-05-NNNN	40 Ω / 1,560 W	1	≥21	≥1.4
15	FCAR01.1W1K56-N040R0-A-05-NNNN	40 Ω / 1,560 W	1	≥17	≥1.8
18.5	FCAR01.1W04K8-N032R0-A-05-NNNN	32 Ω / 4,800 W	1	≥15	≥2.3

Brake power (kW)	Recommended brake resistence (750 V)			Minimum brake resistence	
	Resistence (Ω)	Power (kW)	Number of paralleled brake resistors	Resistence (Ω)	Power (kW)
22	FCAR01.1W04K8-N025R0-A-05-NNNN	25 Ω / 4,800 W	1	≥11	≥3
30	FCAR01.1W4K00-N016R0-A-05-NNNN	16 Ω / 4,000 W	1	≥8	≥4
37	FCAR01.1W4K00-N016R0-A-05-NNNN	16 Ω / 4,000 W	1	≥8	≥5
45	FCAR01.1W6K50-N010R0-A-05-NNNN	10 Ω / 6,500 W	1	≥8	≥6
55	FCAR01.1W6K50-N010R0-A-05-NNNN	10 Ω / 6,500 W	1	≥8	≥7
75	FCAR01.1W10K0-N006R0-A-05-NNNN	6 Ω / 10,000 W	1	≥5	≥9
90	FCAR01.1W10K0-N006R0-A-05-NNNN	6 Ω / 10,000 W	1	≥5	≥10
110	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω / 12,000 W	2	≥8	≥15
132	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω / 12,000 W	2	≥5	≥17
160	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω / 12,000 W	2	≥5	≥21
185	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω / 12,000 W	3	≥5	≥24
200	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω /12,000 W	3	≥5	≥26
220	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω /12,000 W	3	≥5	≥29
250	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω / 12,000 W	3	≥5	≥32
280	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω / 12,000 W	4	≥5	≥35
315	FCAR01.1W12K0-N008R0-A-05-NNNN	8 Ω / 12,000 W	4	≥5	≥38

Tab. 4-4: Recommended brake resistor

- The recommended resistance of the brake resistor is 100 % braking torque, selected according to necessity. If the actually needed torque is not 100 %, the resistance of the brake resistor in the table should be adjusted in inverse proportion, i.e. how much the braking torque increases based on 100 %, the resistance of the brake resistor should decrease by the same amount, vice versa.
- When selecting brake resistor R_b, make sure the current I_c which flows through the resistor is less than the current output ability of the brake chopper. The current I_c through the brake resistor can be calculated by formula $I_c = U_d / R_b$, in which U_d is the braking operating voltage of brake chopper.
- The actual power of brake resistor can be calculated by formula $P_R = k \times P_{max} \times ED\ \%$, in which 'k' is the derating coefficient and P_{max} is the maximum power of brake resistor, $P_{max} = U_d^2 / R_b$. According to the actual working condition, the braking ratio ED % can be selected to reduce the power of brake resistor reasonably for intermittent braking load. The selection of the braking torque should be in general smaller than 150 % of the rated motor torque, or consult the technical support for more information.
- For the case of brake power > 90 kW or ED > 10 %, the master / slave control mode is recommended (see chapter 9.2.2 "Master / Slave Control Mode" on page 52 and chapter 9.2.3 "The Application of Multiple Brake Choppers In Parallel Connection" on page 53), or consult the technical support.

5 Brake Chopper Mounting

5.1 Installation Conditions

The brake chopper must be vertically installed.

If one brake chopper is arranged above another, make sure the upper limit of air temperature (50 °C) into the inlet is not exceeded. An air guide is recommended between the brake choppers to prevent the rising hot air being drawn into the upper brake chopper if the upper limit of air temperature is exceeded.

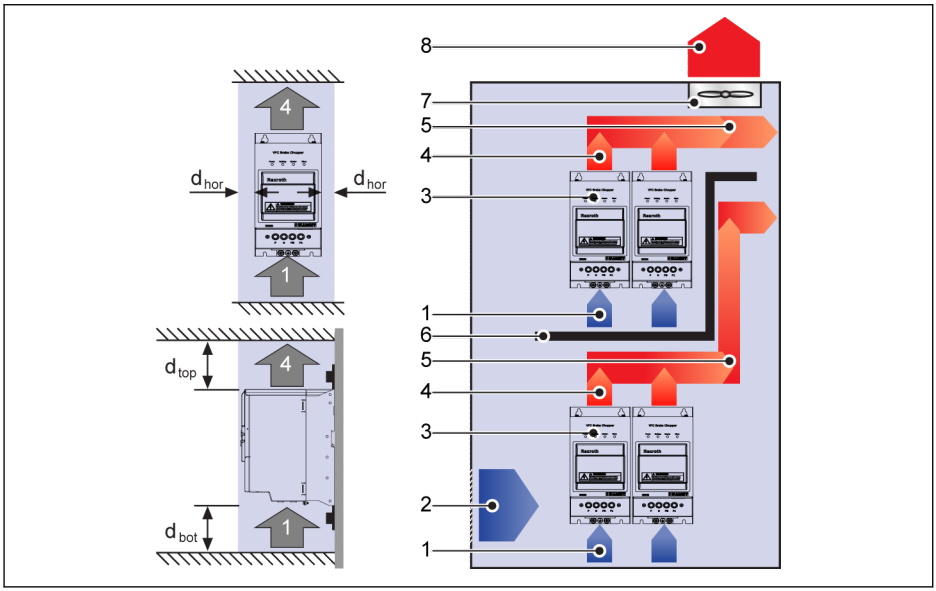


Fig. 5-1: Mounting distance and arrangement

d_{hor}: Distance horizontal = 0 mm

d_{top}: Minimum top distance = 125 mm

d_{bot}: Minimum bottom distance = 125 mm

1: Air inlet at brake chopper

2: Air inlet at control cabinet

3: Brake chopper

4: Air outlet at brake chopper

5: Heated air conveying direction

6: Air guide in control cabinet

7: Fan in control cabinet

8: Discharge of heated air

5.2 Figures and Dimensions

5.2.1 Figures

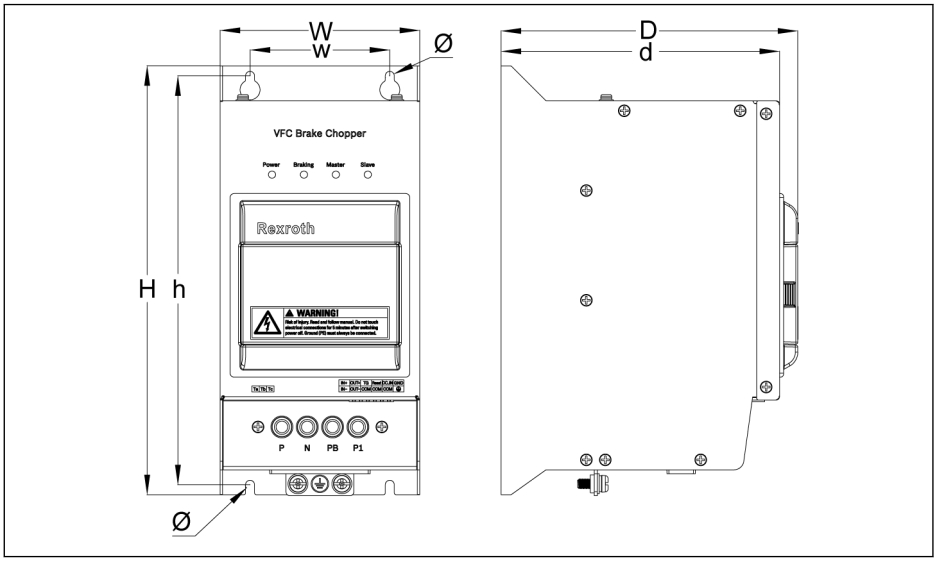


Fig. 5-2: Brake chopper dimensions figure

5.2.2 Dimensions

Model	W	H	D	w	h	d	Ø	Screw size	Net weight [kg]
FEAE07.1-VA1-NNNN	100	215	149	70	205	140	4.5	M4	2.24
FEAE07.1-VA2-NNNN									2.34

Tab. 5-1: Brake chopper dimensions (unit: mm)

6 Brake Chopper Wiring

6.1 System Wiring

6.1.1 Electrical Interface

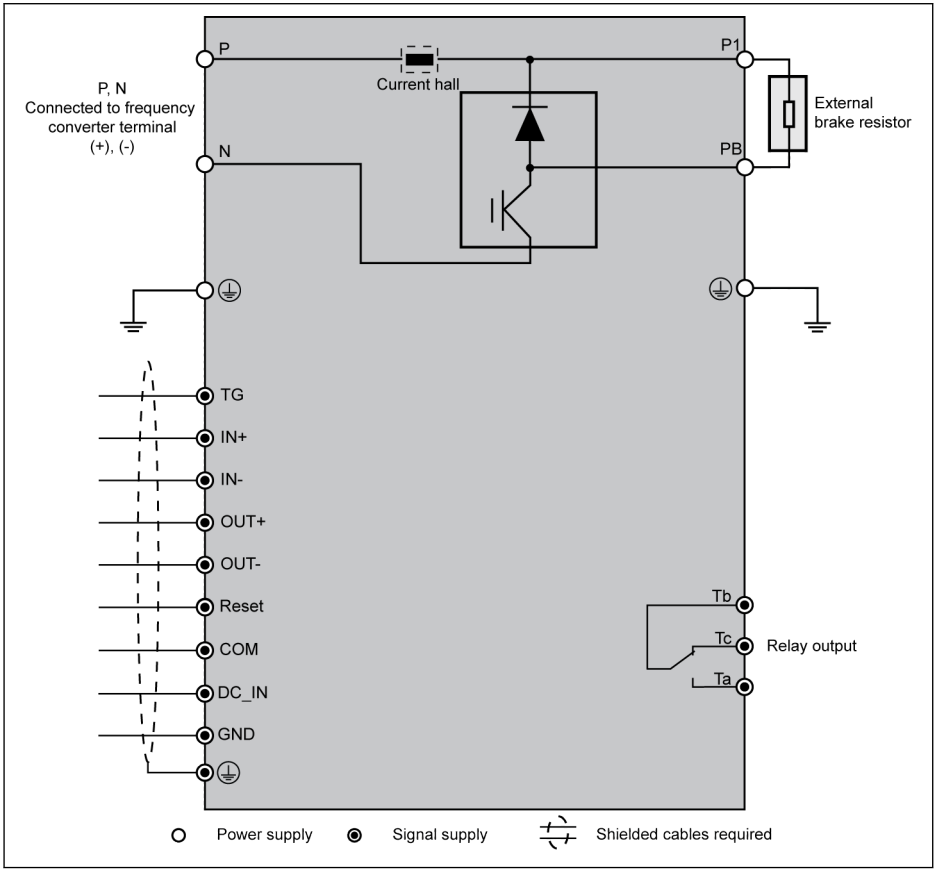


Fig. 6-1: Electrical interface of brake chopper

6.1.2 Typical Connection Mode 1

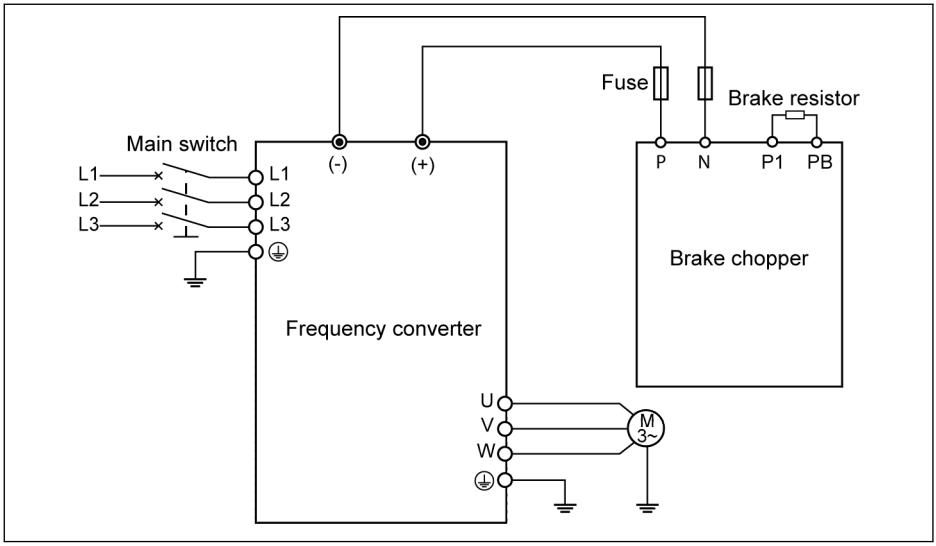


Fig. 6-2: Typical connection mode 1

6.1.3 Typical Connection Mode 2

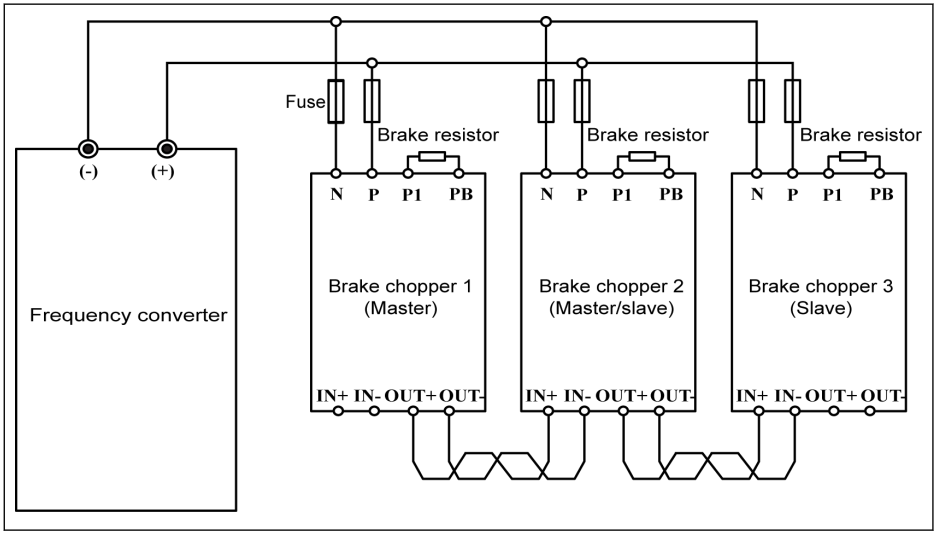


Fig. 6-3: Typical connection mode 2

- Make sure that terminals (+), (-) of frequency converter are connected to the corresponding terminals P, N of brake chopper respectively. Incorrect connection may damage the brake chopper.
- Please connect to frequency converter directly or install a terminal block.
- The master / slave control mode of the brake chopper supports the following two connections, which currently supports up to three brake choppers in parallel.
  - Two devices: master + slave
  - Three devices: master + slave + slave

6.2 Cable Specifications

6.2.1 Power Cables

Brake chopper model	Fuse (gG)	Power cables installation mode			PE cable	Torque / Screw
		B1	B2	E		
		[mm²]	[mm²]	[mm²]	[mm²]	[N·m / lb·in] (Mx)
FEAE07.1-VA1-NNNN	63	10.0	10.0	10.0	10.0	1.76 / 15.6 (M4)
FEAE07.1-VA2-NNNN	80	10.0	10.0	10.0	10.0	1.76 / 15.6 (M4)

Tab. 6-1: Fuse and cable dimensions for international without USA / Canada

Brake chopper model	Fuse (Class J)	Power cables	PE cable	Torque / Screw
		[AWG]	[AWG]	[N·m / lb·in] (Mx)
FEAE07.1-VA1-NNNN	60	8	8	1.76 / 15.6 (M4)
FEAE07.1-VA2-NNNN	80	6	6	1.76 / 15.6 (M4)

Tab. 6-2: Fuse and cable dimensions for USA / Canada

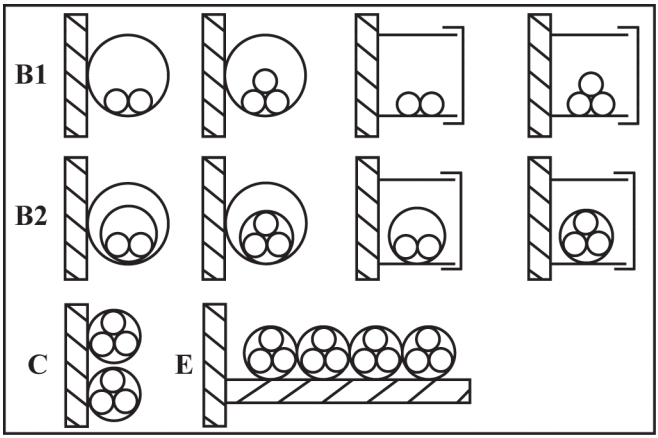
- The recommended values of the fuse listed in the tables above are based on the **Max. output current**, please select the proper fuse according to the actual application.
- For cable specification for international without USA / Canada, use copper wires of 90 °C or above according to IEC60364-5-52.
- For cable specification for USA / Canada, use copper wires of 75 ℃ or above according to UL 61800-5-1.

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 of devices.

Field wiring: Routing of cross sections of terminal connectors wired by the user (in the field).



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. 6-4: Cable installation types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)

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).

Characteristics

In the case of error (e.g. ground error 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 system.

To **protect the brake chopper**, you can use fuses of characteristic **gR**.

   - USA / Canada: Class J; 600 V

6.2.2 Control Cables

The requirements of control cables are as follows:

Cable	Unit	Min.	Max.
Type	Shielded cable		
Wire-end ferrule w/plastic collar			
Cross-section	mm^2	1	1
	AWG	17	17
Ferrule length	mm	12	12
Stripped length	mm	15	15
Wire-end ferrule w/o plastic collar			
Cross-section	mm^2	1	1.5
	AWG	17	16
Ferrule length	mm	10	10
Stripped length	mm	10	10

Tab. 6-3: Cable requirements

Please follow the steps below for wiring of control terminals.
Step 1: Switch off the brake chopper before performing wiring.
Step 2: Deactivate the control signals in the wiring process.
Step 3: Switch on the brake chopper.
Step 4: Set respective parameters.
Step 5: Activate respective control signals.

6.3 Terminals

6.3.1 Power Terminals

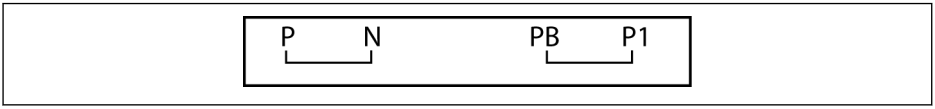


Fig. 6-5: Power terminals

Terminal	Description
P	Mains supply input terminals
N	
PB	Output terminals
P1	

Tab. 6-4: Power terminals description

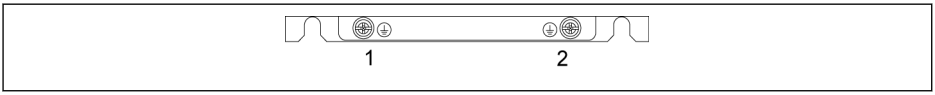


Fig. 6-6: Grounding and PE terminals

1: Power circuit terminal

2: Control circuit terminal

6.3.2 Control Terminals

Control terminals figure

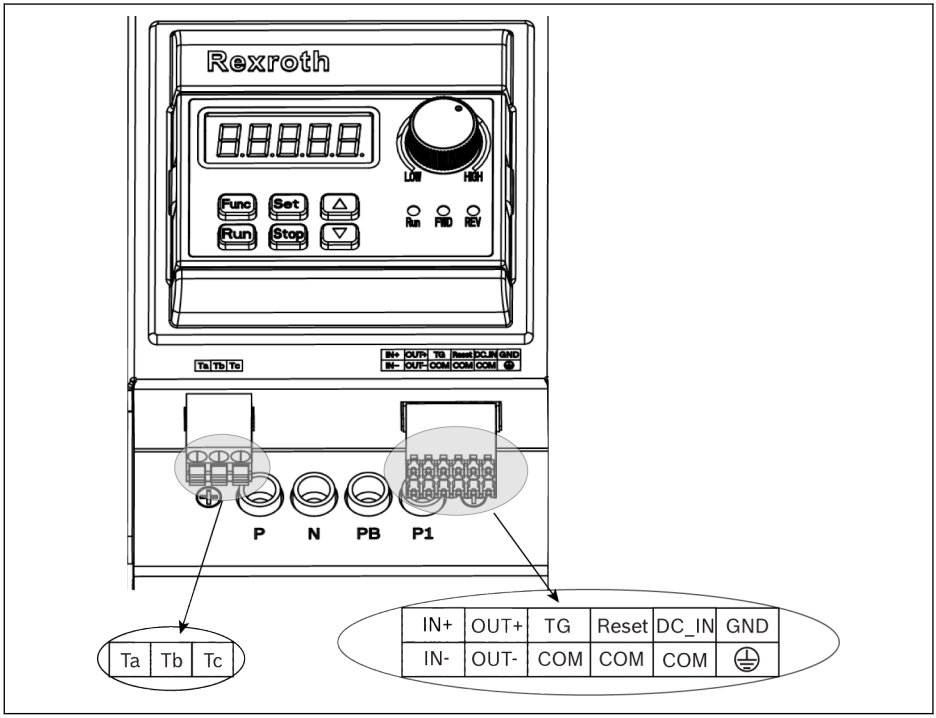


Fig. 6-7: Control circuit terminals

⚠ CAUTION

Please make sure that the power supply of the brake chopper has been switched off before plugging or unplugging the connector, otherwise the brake chopper might get damaged!

The connectors are **ONLY** for wiring convenience, which **CANNOT** be used for fixing the cables. Additional measures need to be taken by users for cable fixing purpose.

Control terminals description

Digital signal terminals

Terminal	Signal function	Description	Signal requirement
IN+	Digital inputs	Control signal input terminals when brake chopper is set to slave	Inputs via opto-electric couplers: 24 VDC, 8 mA / 12 VDC, 4 mA
IN-			
OUT+	Digital outputs	Control signal output terminals when brake chopper is set to master	
OUT+			
Reset	Digital input	Short circuit with COM. Used for error reset	
TG	Digital input	Short circuit with COM. Used for overheat protection of brake resistor	
COM	Shared connection	COM as a reference point, isolation with GND	

Relay signal terminals

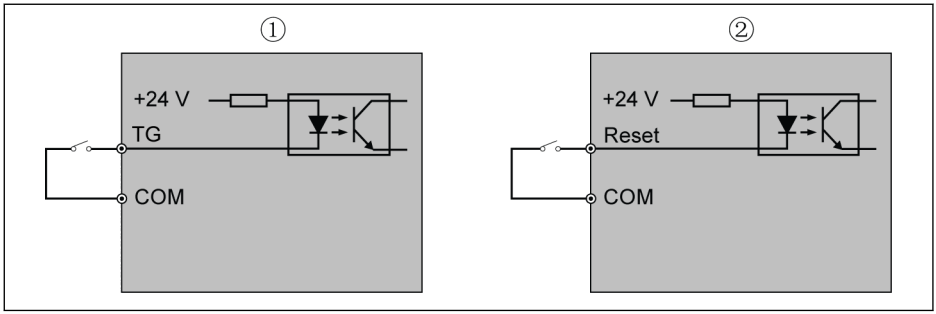
Terminal	Signal function	Description	Signal requirement
Ta	Relay changeover contacts	See parameter H6.10	Rated capacity: 250 VAC, 3 A; 30 VDC, 3 A
Tc			
Tb	Relay shared contact		

External power-supply terminals

Terminal	Signal function	Description	Signal requirement
DC_IN*	Auxiliary power supply for control board	External +24 V supply input for control and panel boards (**NOT** used for digital inputs)	Rated capacity: 24 V (-10...+15 %) 200 mA
GND	Shared connection	Isolated from COM	–

*: When the brake chopper is powered off, the DC_IN terminal is used to power on the control circuit for viewing and modifying parameters.

6.3.3 Digital Signal Internal Wiring



① Use of terminal TG
② Use of terminal Reset

Fig. 6-8: Wiring of terminals TG and Reset

Terminals Reset and TG are using the switching signals. Do not need external power supply.

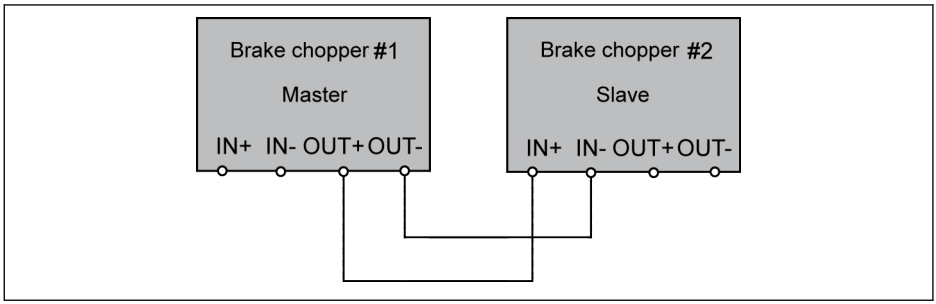


Fig. 6-9: Wiring of terminals IN and OUT

Terminals IN+, IN-, OUT+ and OUT- are ONLY used in Master / Slave control mode.

7 Electromagnetic Compatibility (EMC)

7.1 Cable Connections between Brake Chopper and Frequency Converter

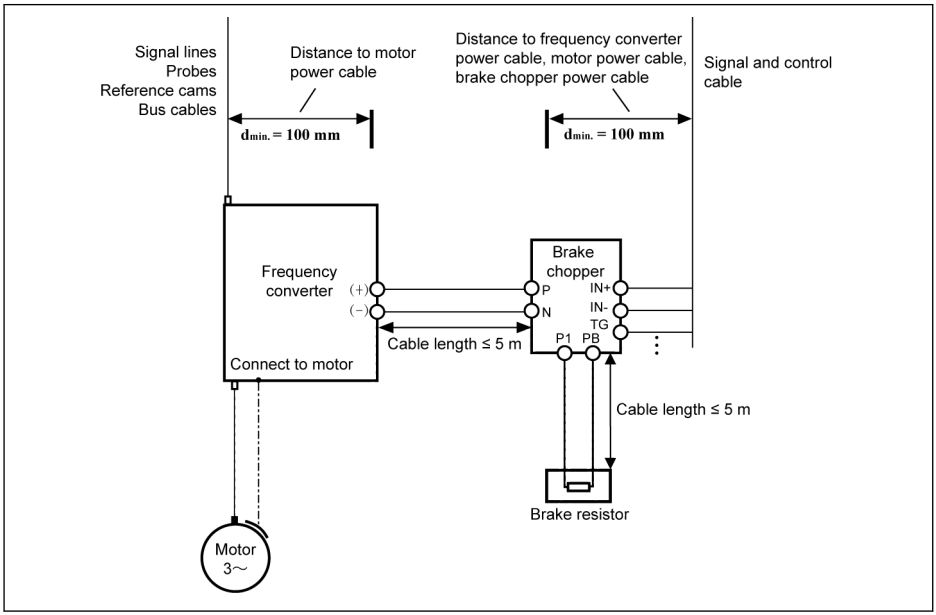


Fig. 7-1: Cable connections between brake chopper and frequency converter

7.2 Mounting and Wiring in Control Cabinet

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 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 **$d_{min.}$ = 100 mm** to inference-free lines, as well as to signal cables and signal lines (alternatively separated by a grounded distance plate)
- in separate cable ducts, if possible

Routing the Motor Power Cables and Mains Connection Lines

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

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

The required cable length between frequency converter and brake chopper (or between brake chopper and brake resistor) is less than or equal to 5 m.

7.3 Installing Signal Lines and Signal Cables

Line Routing

The following measures are recommend:

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

Shielding

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

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

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

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

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

8 Operating Panel and Dust Cover

8.1 LED Panel

8.1.1 Appearance

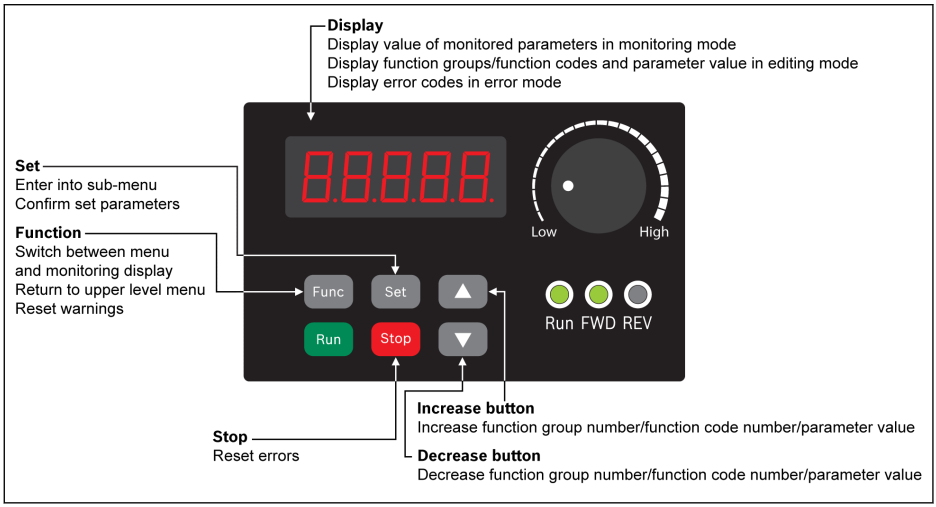


Fig. 8-1: LED panel

1. LED panel is optional accessory. The typecode of LED panel is "FPCC02.1-VANN-7P-NNNN", the firmware version of LED panel is 02V08 and above.
2. **Run** button, potentiometer and indicators (**Run**/**FWD**/**REV**) are not used in brake chopper.

8.1.2 Operating Descriptions

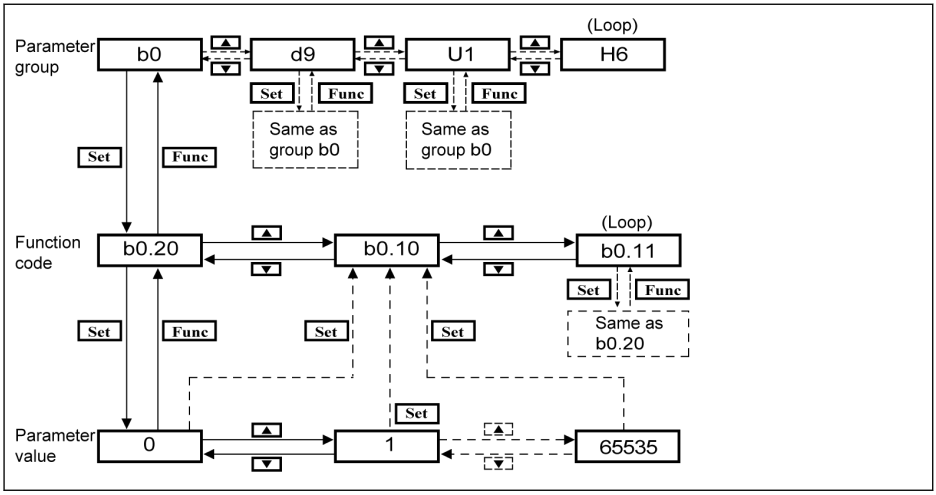


Fig. 8-2: Operating mode

8.1.3 Fast Access to Parameters with Button Combinations

Brake chopper provides fast access to parameters within a parameter group with '**<Func> + <▲>**' or '**<Func> + <▼>**' combinations.

- Press '**<Func> + <▲>**' once, the blinking bit move one bit to left.
- Press '**<Func> + <▼>**' once, the blinking bit move one bit to right.

Example:

Change the value of parameter b0.20 from '0' to '1000', perform the following steps.

- Step 1: press '**<Func> + <▲>**' or '**<Func> + <▼>** to active the fast access function, '0' is displayed.
- Step 2: press '**<Func> + <▲>**' for three times, move three bits to the left, '0000' is displayed and the left-most '0' is blinking.
- Step 3: press **<▲>** button to change left-most '0' to '1', then '1000' is displayed and '1' is blinking.
- Step 4: press **<Set>** button to save the setting. The screen will return to previous menu and parameter 'b0.10' will be displayed.

- The parameter fast access function is only available to the parameters with a number type setting range, not available to parameters with a optional type setting range.
- Press **<Func>** button and do not release it until **<▲>** or **<▼>** button has been pressed.
- Press **<▲>** or **<▼>** button within 2 s if **<Func>** button is pressed.
- If **<Func>** button is pressed and no other buttons be pressed within 2 s, the setting will not take effect.

8.2 LCD Panel

8.2.1 LCD Panel Introduction

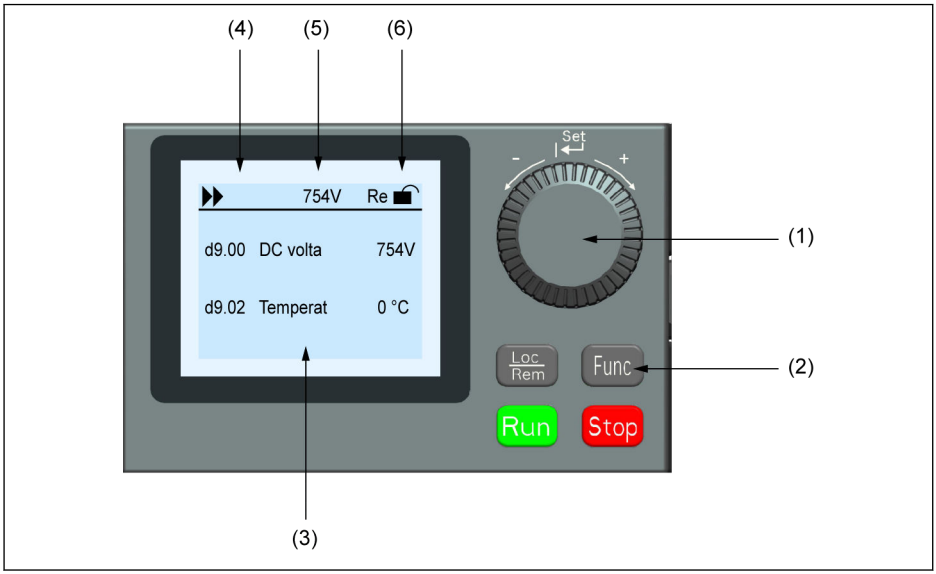


Fig. 8-3: LCD panel appearance

LCD panel is optional accessory. The typecode of LCD panel is "FPCC02.1-VANN-LP-NNNN", the firmware version of LCD panel is 01V04 and above.

(1) Rotary encoder

1. Scroll between parameter and group code
2. Set the parameter value

(2) Func button: Enter the parameter group screen and go back to previous screens.

(3) Text area: Used for displaying:

1. Parameter monitoring screen
2. Parameter group / Parameter code
3. Parameter name
4. Parameter value and unit
5. Other screens: Error / Warning display screen, welcome screen, customer information message screen

(4) Error / Warning information: Error / Warning code will be displayed in this sector. Please refer to chapter 10 "Diagnosis" on page 55.

(5) Permanent monitoring: By default, its display as "Actual output frequency" is set by parameter U2.09. Value and unit of parameter will be displayed.

(6) Panel Locked / Unlocked: Panel can be locked by the following ways:

- Setting [U2.02] to '1', or
- Pressing **Func** button with **Loc** button for longer than 3 s.

Panel can be unlocked by the following ways:

- Setting [U2.02] to '0' (only in communication mode), or
- Pressing **Func** button with **Loc** button for longer than 3 s.

☞ **Stop** button is used to reset error, **Run** button is not used in brake chopper.

8.2.2 Operating Example

Please follow the steps below to set parameter [b0.10] to '1: Restore to default settings' through LCD panel.

1. Press **Func** button.
2. Rotate **Rotary encoder** to select parameter group b0.
3. Press **Rotary encoder** and rotate it to select parameter b0.10.
4. Press **Rotary encoder** and rotate it to select parameter value '1: Restore to default settings'.
5. Press **Rotary encoder** to finish setting.

8.3 Dust Cover

Fig. 8-4: Dust Cover

☞ The dust cover is standard accessory.

8.4 LED Indicator

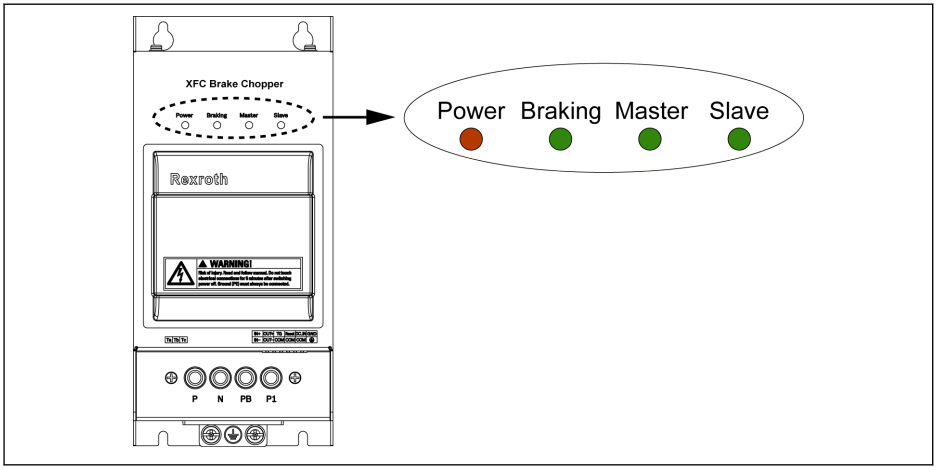


Fig. 8-5: LED indicator on front panel

LED indicator	Color	State	Description
Power	Red	Always on	Power indicator, the LED is on when brake chopper is powered on
		Flash	Error indicator, the LED flashes when the brake chopper occurs an error
Braking	Green	Always on	Braking indicator, the LED is on when brake chopper is braking
Master	Green	Always on	Master/slave mode indicator, the LED is on when brake chopper is configured as master
Slave	Green	Always on	Master/slave mode indicator, the LED is on when brake chopper is configured as slave

Tab. 8-1: The status of LED indicator

"Power" light flashes indicates the brake chopper occurs an error. In this case, user can connect LED panel (FPCC02.1-VANN-7P-NNNN) or LCD panel (FPCC02.1-VANN-LP-NNNN) to check the error code and contact with service engineer to solve the problem.

9 Parameter and Typical Application

9.1 Parameter Descriptions

9.1.1 Terminology and Abbreviation in Parameter List

- **Code:** Function / parameter code, written in bx.xx, Hx.xx, Ux.xx, dx.xx
- **Name:** Parameter name
- **Default:** Factory default
- **Min.:** Minimum setting step
- **Attri.:** Parameter attribute
  - **Run:** Parameter setting can be modified when brake chopper is in run or stop status.
  - **Stop:** Parameter setting can only be modified when brake chopper is in stop status.
  - **Read:** Parameter setting is read-only and cannot be modified.
- **[bx.xx], [Hx.xx], [Ux.xx], [dx.xx]:** Function / parameter values

9.1.2 Parameter List

Code	Name	Setting range	Default	Min.	Attri.
b0.10	Parameter initialization	0: Inactive 1: Restore to default settings 2: Clear error record	0	–	Stop
b0.11	Parameter copy	0: Inactive 1: Backup parameters to panel 2: Restore parameters from panel	0	–	Stop
b0.20	User password	0... 65,535	0	–	Run
H6.00	Brake chopper mode	0: Standalone 1: Master 2: Master / slave 3: Slave	0	–	Stop
H6.01	Brake chopper start voltage	600...785 V	750	1	Stop
H6.02	Brake chopper duty cycle	1...100 %	100%	1	Stop
H6.03	Brake chopper hysteresis voltage	0...100 V	30	1	Stop

Code	Name	Setting range	Default	Min.	Attri.
H6.10	Relay output selection	0: Brake chopper fault 1: Brake chopper working 2: Brake chopper ready	0	–	Stop
H6.11	Fan control	0: Automatic 1: Always on	0	–	Run
H6.50	Last error type	–	–	–	Read
H6.51	Second last error type	–	–	–	Read
H6.52	Third last error type	–	–	–	Read
H6.53	DC-bus voltage at last error	–	–	1	Read
H6.54	Braking current at last error	–	–	0.1	Read
H6.55	Power module temperature at last error	–	–	1	Read
H6.94	Over heat level	50-70	64	1	Read
H6.95	Product type	0 - EFC 1 -VFC	-	1	Read
H6.96	Over voltage level	790-870	810	1	Read
H6.97	DC bus calibration with fan running	950-1050	1000	1	Read
H6.98	DC bus calibration without fan running	950-1050	1000	1	Read
H6.99	Current calibration	800-1200	1000	1	Read
d9.00	DC voltage	–	–	1	Read
d9.01	Braking current	–	–	0.1	Read
d9.02	Temperature	–	–	1	Read
d9.03	Relay output	–	–	–	Read
d9.99	Firmware version	–	–	0.01	Read

9.1.3 Parameter Setting Description

b0.10: Parameter initialization

Code	Name	Setting range	Default	Min.	Attri.
b0.10	Parameter initialization	0...2	0	–	Stop

- 0: Inactive

  This parameter will be reset to '0: Inactive' automatically after parameter initialization.
- 1: Restore to default settings

  All parameters are restored to factory default settings except for:

  H6.50, H6.51, H6.52, H6.53, H6.54, H6.55 (error records).
- 2: Clear error record

  Parameter H6.50, H6.51, H6.52, H6.53, H6.54, H6.55 (error records) will be cleared.

b0.11: Parameter copy

This function is used for the same settings of multiple brake choppers via the operating panel.

With this function, users only need set parameters of one brake chopper, and then replicate its settings for all the other brake choppers.

Code	Name	Setting range	Default	Min.	Attri.
b0.11	Parameter copy	0...2	0	–	Stop

- 0: Inactive

  This parameter will be reset to '0: Inactive' automatically after parameter replication.
- 1: Backup parameters to panel (from source brake chopper to panel)

  All parameter settings are copied from the source brake chopper to the operating panel **EXCEPT** that of
  - Read-only parameters
  - H6.50, H6.51, H6.52, H6.53, H6.54, H6.55 (error records)
  - b0.10, b0.11, b0.20
- 2: Restore parameters from panel (from panel to target brake choppers)

  All parameter settings are replicated from the operating panel to the target brake choppers **EXCEPT** that of
  - Read-only parameters
  - H6.50, H6.51, H6.52, H6.53, H6.54, H6.55 (error records)
  - b0.10, b0.11, b0.20

b0.20: Password Protection

User password is used to protect parameter settings from unauthorized or unintended changes.

Code	Name	Setting range	Default	Min.	Attri.
b0.20	User password	0...65,535	0	–	Run

Possible operations with passwords are as below:

- Set user password

  The default setting of user password is '0' (inactive). Enter any integer number between 1 and 65,535.

- Change user password

  Enter the existing user password first, and then modify the value with entering another integer number between 1 and 65,535.

- Clear user password

  Enter the existing user password or super user password, then user password will be cleared.

H6.00...H6.03: Brake chopper mode

Brake chopper can run under standalone mode, or connect with multiple brake choppers in parallel.

Brake chopper mode is set by inputting function code directly via the panel, not via the jumper cap or pin.

Code	Name	Setting range	Default	Min.	Attri.
H6.00	Brake chopper mode	0: Standalone 1: Master 2: Master / slave 3: Slave	0	–	Stop
H6.01	Brake chopper start voltage	600...785 V	750	1	Stop
H6.02	Brake chopper duty cycle	1...100 %	100 %	1	Stop
H6.03	Brake chopper hysteresis voltage	0...100 V	30	1	Stop

To operate this function, take the following steps:

Step 1: Select brake chopper mode

Braking mode is selected according to the actual application situations, and its default mode is 'Standalone'. When multiple brake choppers run in parallel, the corresponding master or slave mode can be selected.

H6.00 is set to '0: Standalone': when bus voltage is higher than brake chopper start voltage [H6.01], brake chopper starts running. Digital input IN+ is not detected and digital output OUT+ is disabled.

H6.00 is set to '1: Master': when bus voltage is higher than braking start voltage [H6.01], brake chopper starts running. Meanwhile, as the master, brake chopper enables the digital output OUT+ in running status. Digital input IN+ is not detected.

H6.00 is set to '2: Master / slave': when bus voltage is higher than braking start voltage [H6.01], as the slave controlled by input terminal IN+ (closed-loop effective), this brake chopper starts running. It can also be the master which enables the digital output OUT+ in running status.

H6.00 is set to '3: Slave': when bus voltage is higher than braking start voltage [H6.01], as the slave controlled by input terminal IN+ (closed-loop effective), this brake chopper starts running. In this mode, digital output OUT+ is inactive.

Step 2: Set the braking start voltage

Set the braking start voltage according to the actual situations. The default value of VFC model is set to 750 V.

Brake chopper starts running at the pre-set start voltage, and shuts down with a hysteresis voltage (set by H6.03). For example, if parameter H6.01 is set to 750 V, H6.03 is set to 30 V, brake chopper will start braking at 750 V and shut down at 720 V.

Step 3: Set brake chopper duty cycle

Set parameter H6.02 'Brake chopper duty cycle' according to the actual situations. Its default value is 100 %.

Modulate the waveform of braking time (**Tb**) by pulse width modulation (PWM), then each high level time that obtained is **t1**, the PWM cycle is **t2** (fixed as **50 ms** and unmodifiable). The calculation formula of brake chopper duty cycle is:

[H6.02] = t1 / t2 x 100 %

The diagram of brake chopper duty cycle is shown as below:

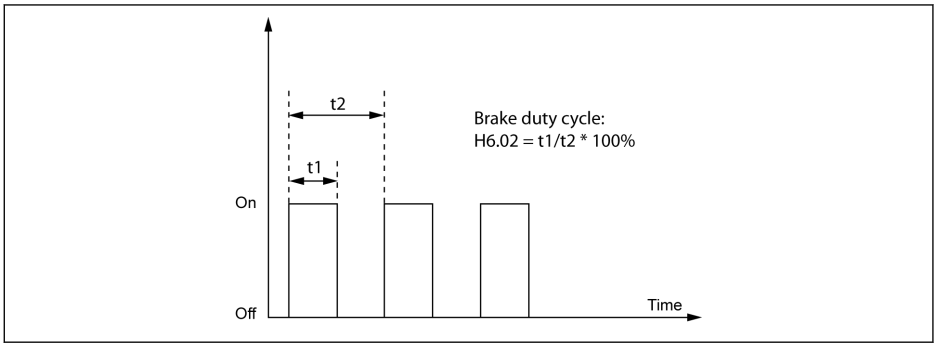


Fig. 9-1: Brake chopper duty cycle

When the brake resistor overheats, brake chopper duty cycle can be reduced appropriately. Notice that excessive low brake chopper duty cycle would affect the braking performance.

The diagram of brake chopper duty cycle (H6.02) and braking ratio (ED) are shown as below:

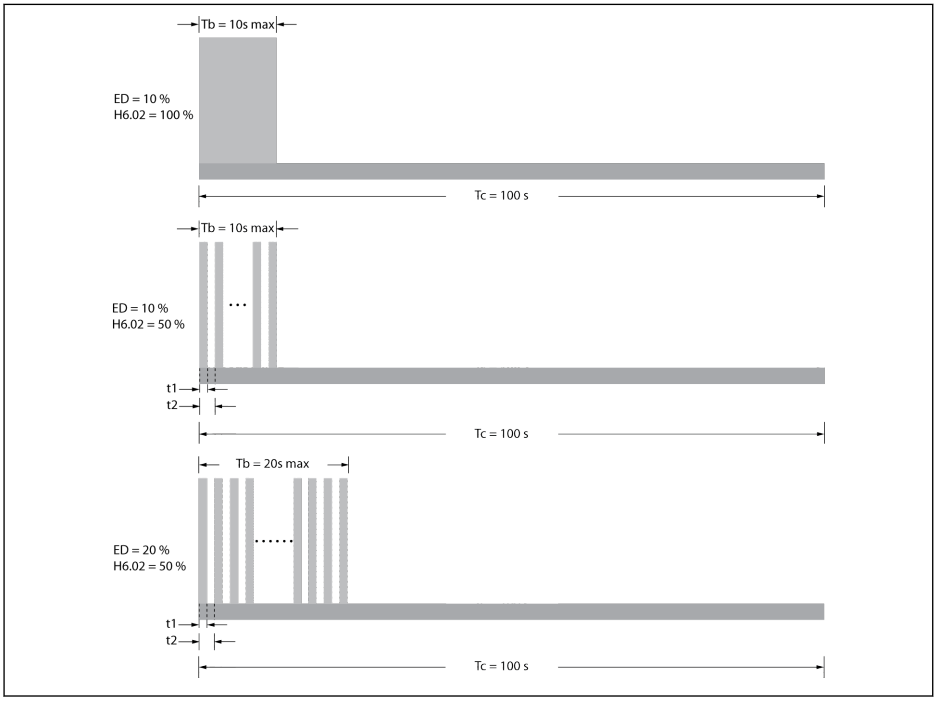


Fig. 9-2: Diagram of H6.02 and ED

For details about Tb, Tc and ED, please refer to chapter 4.5.1 "Braking Ratio" on page 19.

The diagram of the stop voltage point for brake chopper:

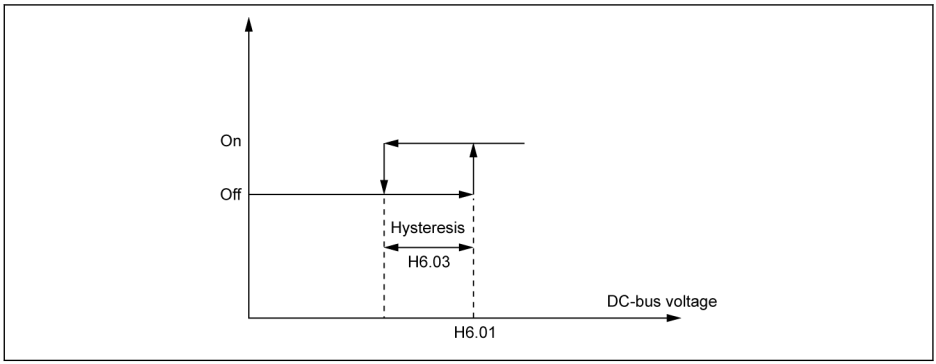


Fig. 9-3: Stop voltage point

H6.10: Relay output selection

Please read through the information on 'Wiring diagram' and 'Terminal' before the selection of 'Relay output'.

Code	Name	Setting range	Default	Min.	Attri.
H6.10	Relay output selection	0: Brake chopper fault 1: Brake chopper working 2: Brake chopper ready	0	–	Stop

- 0: Brake chopper fault

  The output is active when an error occurs, inactive when the error is reset.
- 1: Brake chopper working

  The output is active when the brake chopper is running.
- 2: Brake chopper ready

  After powering on, if no error occurs and not being in braking state, brake chopper is ready for running and the output is active.

H6.11: Fan control

This function is used to set the running mode of the fan for the heat sink.

☞ **ONLY** model 'FEAE07.1-VA2-NNNN' is equipped with fan units.

Code	Name	Setting range	Default	Min.	Attri.
H6.11	Fan control	0: Automatic 1: Always on	0	–	Run

- 0: Automatic

The fan for the heat sink is by default switched on / off automatically according to the temperature of the heat sink. In this mode, the noise level of the brake chopper can be reduced.

- 1: Always on

  The fan for the heat sink is switched on and running all the time once the brake chopper is powered on. In this mode, a better cooling performance of the brake chopper can be achieved.

H6.50...H6.55: Error parameters

Error parameters which record and indicate the error information are read-only, and can not be modified.

Code	Name	Setting range	Default	Min.	Attri.
H6.50	Last error type	–	–	–	Read
H6.51	Second last error type	–	–	–	Read
H6.52	Third last error type	–	–	–	Read
H6.53	DC-bus voltage at last error	–	–	1	Read
H6.54	Braking current at last error	–	–	0.1	Read
H6.55	Power module temperature at last error	–	–	1	Read

Setting range of H6.50...H6.52:

0: No error

1: OE-b, brake chopper overvoltage

2: OC-b, brake chopper overcurrent

3: SC, surge current or short circuit

4: OL-b, brake chopper overload

5: OH-b, brake chopper overheat

7: OH-r, brake resistor overheat

9: E.Par, parameter settings invalid

10: idE-, brake chopper internal error

d9.00...d9.99: Monitoring parameters

Code	Name	Min. unit
d9.00	DC voltage	1 V
d9.01	Braking current	0.1 A
d9.02	Temperature	1 °C
d9.03	Relay output	–
d9.99	Firmware version	0.01

9.2 Typical Application

9.2.1 Quick Start-up at Default Parameter Setting

By default, brake chopper works in **standalone** mode. Its default value of **start voltage** is **750 V** and **duty cycle** is **100 %**.

In standalone mode, when DC-bus voltage reaches to start voltage, brake chopper will start braking with 100 % of duty cycle, which is irrelevant to terminals IN and OUT of the master / slave control mode.

To meet actual requirements, start voltage and duty cycle of brake chopper can be adjusted according to actual situations.

Brake chopper is not equipped with jumper cap or contact pin. All parameters should be set via the panel.

9.2.2 Master / Slave Control Mode

System connection

Please refer to chapter 6.1.3 "Typical Connection Mode 2" on page 26.

Parameter setting

When required braking power is high and a singe brake chopper cannot meet requirements, the way to connect multiple brake choppers in parallel (currently support up to 3 choppers) for master/slave control is selected.

Before the brake chopper is powered on, terminals OUT of the master should be connected to terminals IN of the slave. For example, when three brake choppers are connected in parallel, terminals OUT of brake chopper #1 connect to terminals IN of brake chopper #2, and terminals OUT of brake chopper #2 connect to terminals IN of brake chopper #3. Ensure that the connection between master's terminals OUT and slave's terminals IN must be correct. Otherwise the slave will fail to work although the bus voltage reaches to brake chopper start voltage.

Parameter setting paralleled:

The braking mode of the first-level brake chopper is set as 'Master', the second-level set as 'Master / slave', and the third-level set as 'Slave'.

For example, when three brake choppers are connected in parallel, 'H6.00' of brake chopper #1, #2, and #3 should be set to '1', '2', and '3', respectively.

Be noticed that the braking start voltage of the slave should keep consistency with that of the master. Otherwise, it may cause the overload or even breakdown of the brake chopper with relatively low braking start voltage.

Parameter setting:

Brake chopper #1: H6.00 = 1, H6.01 = 750, H6.02 = 100 %

Brake chopper #2: H6.00 = 2, H6.01 = 750, H6.02 = 100 %

Brake chopper #3: H6.00 = 3, H6.01 = 750, H6.02 = 100 %

9.2.3 The Application of Multiple Brake Choppers In Parallel Connection

Example 1

When the power of frequency converter is greater than 90 kW, multiple brake choppers in parallel connection mode can be chose. In this example, the power is 110 kW, ED = 10%.

In the conditions of brake voltage is 750 V and brake torque is 100 %, the recommended brake chopper and brake resistor are as follows:

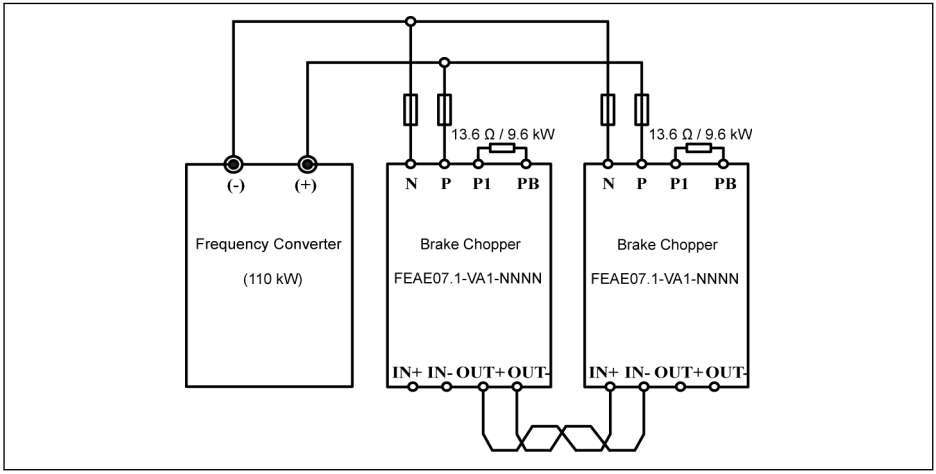


Fig. 9-4: Two sets of FEAE07.1-VA1-NNNN used in parallel_1

Example 2

When ED > 10 %, multiple brake choppers in parallel connection mode also can be chose. In this example, the power is 45 kW, ED = 20 %.

In the conditions of brake voltage is 750 V and brake torque is 100 %, the recommended brake chopper and brake resistor are as follows:

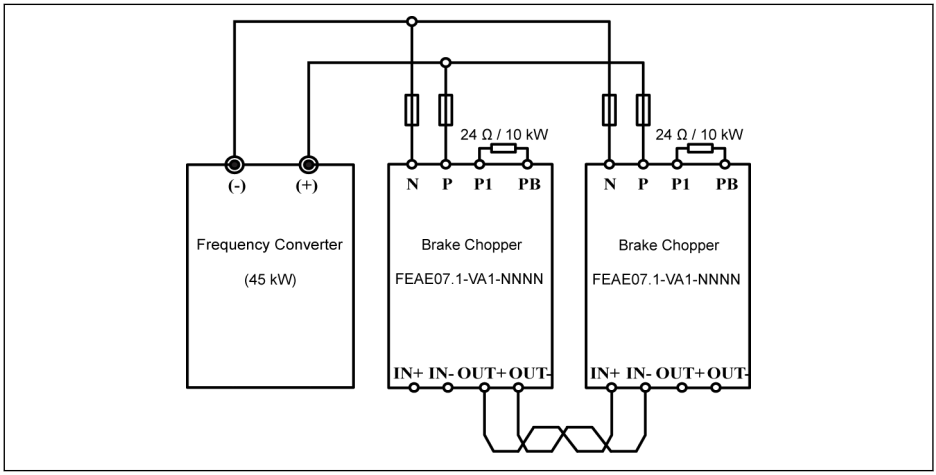


Fig. 9-5: Two sets of FEAE07.1-VA1-NNNN used in parallel_2

Brake chopper and brake resistor should be used reasonably in practical application. Ensure that the power of brake chopper is greater than the braking power while selecting brake chopper, and make the best possible use of control performance of brake chopper. When selecting brake resistor, ensure that the current of brake resistor is less than the output current of brake chopper.

10 Diagnosis

10.1 Status Code

Code	Description
'-''--''---''----''-----'	During parameter backup...

10.2 Warning Code

Code	Description
S.Err	Parameter change blocked
PrSE	Parameter setting contradiction

10.3 Error Code

10.3.1 Error 01 (OE-b): Brake Chopper Overvoltage

Possible reason	Solution
Surge voltage from power supply	Check input power supply
Excessive low resistance of brake resistor	Recalculate and choose brake resistor
Excessive high setting of brake chopper start voltage	Adjust start voltage of brake chopper
Wrong wiring of brake resistor	Check the wiring of brake resistor
Damage of brake chopper	Contact with service

10.3.2 Error 02 (OC-b): Brake Chopper Overcurrent

Possible reason	Solution
Excessive low resistance of brake resistor	Recalculate and choose brake resistor
Wrong wiring of brake resistor	Check the wiring of brake resistor
The power of brake chopper is too small	Choose brake chopper with proper power

10.3.3 Error 03 (SC): Surge Current or Short Circuit

Possible reason	Solution
Earth surge	Remove the short circuit
The power of brake chopper is too small	Choose brake chopper with proper power
Damage of brake chopper	Contact with service

10.3.4 Error 05 (OH-b): Brake Chopper Overheat

Possible reason	Solution
Brake chopper (heat sink) temperature is higher than max. setting temperature	• Reduce ambient temperature, improve ventilation and heat dissipation. • Check fan and its power supply connection • Adjust power of brake resistor
Inappropriate setting for duty cycle of brake chopper	Reduce the duty cycle accordingly
Circuit of temperature detection error	Contact with service

10.3.5 Error 07 (OH-r): Brake Resistor Overheat

Possible reason	Solution
Inappropriate type or bad heat of brake resistor	• Check power of brake resistor • Provide good heat condition
temperature sensor of brake resistor error	Check the feedback signal of the resistor's temperature sensor
Inappropriate threshold setting of temperature sensor of brake resistor	Adjust threshold of temperature sensor of brake resistor
Inappropriate setting for duty cycle of brake chopper	Reduce the duty cycle accordingly

10.3.6 Error 09 (E.Par): Invalid Parameter Setting

Possible reason	Solution
Parameter setting invalid after parameter copy	Initialize all parameters

10.3.7 Error 10 (idE-): Brake Chopper Internal Error

Possible reason	Solution
The internal program runs abnormally due to external interference	Reset the error through the terminal or operating panel. If the error still exists, contact with service

11 Maintenance

11.1 Safety Instructions

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

- Only those trained and qualified to work with or on electric equipment are permitted to operate, maintain and repair this equipment.
- Do not operate electric 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 electric parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage. Ensure that the mains voltage is not reconnected.

11.2 Daily Inspection

Please conduct daily inspection as indicated in the table below in order to prolong the life cycle of brake choppers.

Inspection category	Inspection item	Inspection criteria	Inspection result
Ambient conditions	Temperature	-10...50 ℃ (no frost or condensation)	
	Relative humidity	≤ 90 % (no condensation)	
	Dust, water and leakage	No heavy dust or sign of leakage (visual inspection)	
	Gas	No strange smell	
	Sound	No strange sound	
	Panel display	No error code	
Brake Chopper	Fan	No blockage or contamination	
Motor	Sound	No strange sound	

Tab. 11-1: Daily inspection list

11.3 Periodic Inspection

In addition to daily inspection, periodic inspection of brake choppers is also necessary. The inspection cycle should be less than 6 months. For operation details, please see table below:

Inspection category	Inspection item	Inspection criteria	Solution
Power supply	Voltage	Specified in nameplate	3P: 380...480 VAC (-15 % / +10 %)
Power cable	Power cable	No color change or damage	Replace cable
Signal line	Signal line		Replace signal line
Terminal connection	Crimp terminal and cable / line	No loose connection	Tighten crimp and terminal screw
	Crimp terminal and terminal block		
Brake chopper	Visual appearance	No deformation	Contact with service
	Fan	No color change or deformation	Replace fan
		No blockage or contamination	Eliminate blockage and clean fan
	Cooling system (radiator, inlet, outlet)	No blockage or foreign matters	Eliminate blockage and clear foreign matters
	Printed circuit board	No dust or oil contamination	Clean printed circuit board
Accessories	Connection	No loose connection	Tighten terminal screw
	Cable	No color change or damage	Replace cable

Tab. 11-2: Periodic inspection list

11.4 Removable Components Maintenance

11.4.1 Disassembly of Dust Cover

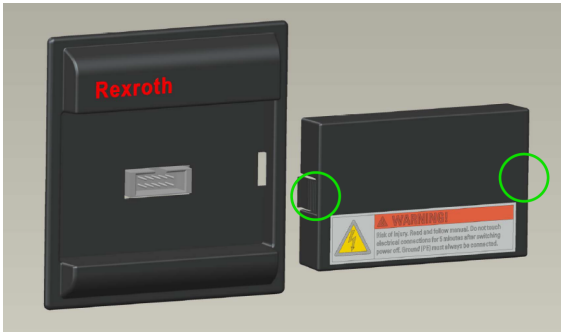


Fig. 11-1: Disassembly of dust cover

- Step 1: Press two buckles as circles indicating in the above figure
- Step 2: Hold dust cover and pull it out horizontally from the mounting plate

Remove the dust cover when use the brake chopper for the first time, install an operating panel to set the related parameters, then disassembly the operating panel and reinstall the dust cover.

11.4.2 Disassembly of Fans

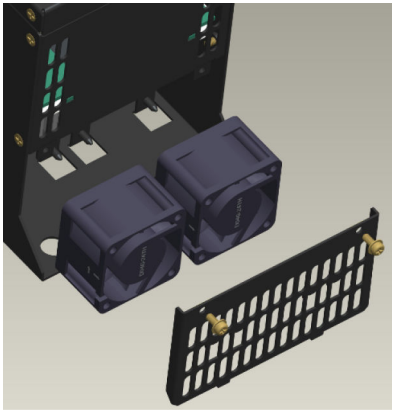


Fig. 11-2: Disassembly of fan

- Step 1: Unscrew the two screws on the fan cover
- Step 2: Take off the fan cover
- Step 3: Slowly remove the fan
- Step 4: Disconnect fan power wires

12 Service and Support

Our worldwide service network provides an optimized and efficient support. Our experts offer you advice and assistance should you have any queries. You can contact us **24/7**.

Service Germany

Our technology-oriented Competence Center in Lohr, Germany, is responsible for all your service-related queries for electric drive and controls.

Contact the **Service Helpdesk & Hotline** under:

Phone:	**+49 9352 40 5060**
Fax:	**+49 9352 18 4941**
E-mail:	service.svc@boschrexroth.de
Internet:	www.boschrexroth.com

Additional information on service, repair (e.g. delivery addresses) and training can be found on our internet sites.

Service worldwide

Outside Germany, please contact your local service office first. For hotline numbers, refer to the sales office addresses on the internet.

Preparing information

To be able to help you more quickly and efficiently, please have the following information ready:

- Detailed description of malfunction and circumstances resulting in the malfunction
- Type plate name of the affected products, in particular type codes and serial numbers
- Your contact data (phone and fax number as well as your email address)

13 Environmental protection and disposal

13.1 Environmental protection

Production processes

The products are made with energy- and resource-optimized production processes which allow re-using and recycling the resulting waste. We regularly try to replace pollutant-loaded raw materials and supplies by more environment-friendly alternatives.

No release of hazardous substances

Our products do not contain any hazardous substances which may be released in the case of appropriate use. Normally, our products will not have any negativ influences on the environment.

Significant components

Basically, our products contain the following components:

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

Motors
- steel
- aluminum
- copper
- brass
- magnetic materials
- electronic components and modules

13.2 Disposal

Return of products

Our products can be returned to our premises free of charge for disposal. It is a precondition, however, that the products are free of oil, grease or other dirt.

Furthermore, the products returned for disposal must not contain any undue foreign material or foreign components.

Send the products ”free domicile” to the following address:

Bosch Rexroth AG
Electric Drives and Controls
Buergermeister-Dr.-Nebel-Strasse 2
97816 Lohr am Main, Germany

Packaging

The packaging materials consist of cardboard, wood and polystyrene. These materials can be recycled anywhere without any problem.

For ecological reasons, please refrain from returning the empty packages to us.

Batteries and accumulators

Batteries and accumulators can be labeled with this symbol.

The symbol indicating "separate collection" for all batteries and accumulators is the crossed-out wheeled bin.

The end user within the EU is legally obligated to return used batteries. Outside the validity of the EU Directive 2006/66/EC keep the stipulated directives.

Used batteries can contain hazardous substances, which can harm the environment or the people´s health when they are improper stored or disposed of.

After use, the batteries or accumulators contained in Rexroth products have to be properly disposed of according to the country-specific collection.

Recycling

Most of the products can be recycled due to their high content of metal. In order to recycle the metal in the best possible way, the products must be disassembled into individual modules.

Metals contained in electric and electronic modules can also be recycled by means of special separation processes.

Products made of plastics can contain flame retardants. These plastic parts are labeled according to EN ISO 1043. They have to be recycled separately or disposed of according to the valid legal requirements.

14 Appendix

14.1 Appendix I: Certification

14.1.1 CE

Declaration of conformity

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

EU directives	Standard
Low-Voltage Directive 2014/35/EU	EN 61800-5-1 (IEC 61800-5-1: 2007)
EMC Directive 2014/30/EU	EN 61800-3 (IEC 61800-3: 2004+A1: 2012)

Tab. 14-1: EU directives and standards

CE label

Fig. 14-1: CE label

High-voltage test

According to standard EN 61800-5-1, VFC x610 (0K40...90K0) components are tested with high voltage.

14.2 Appendix II: Type Coding

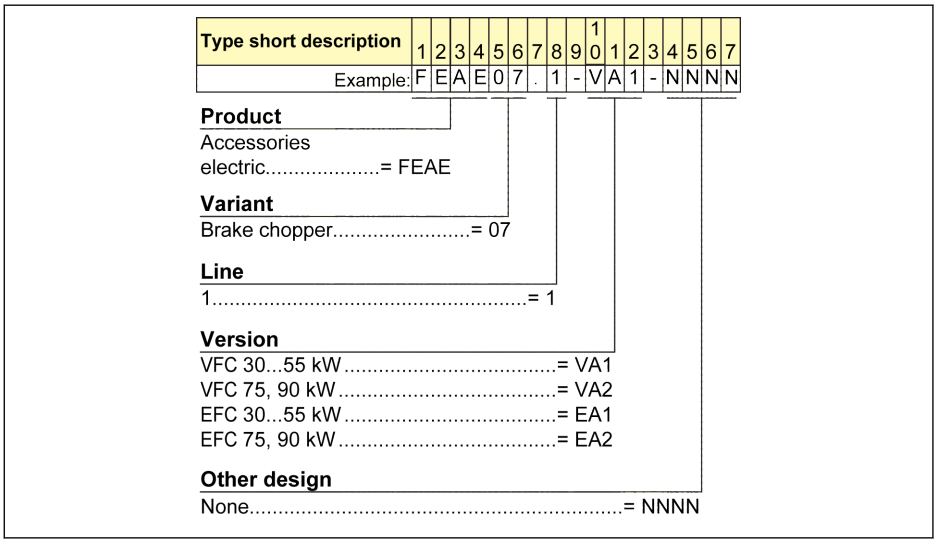


Fig. 14-2: Brake chopper type coding

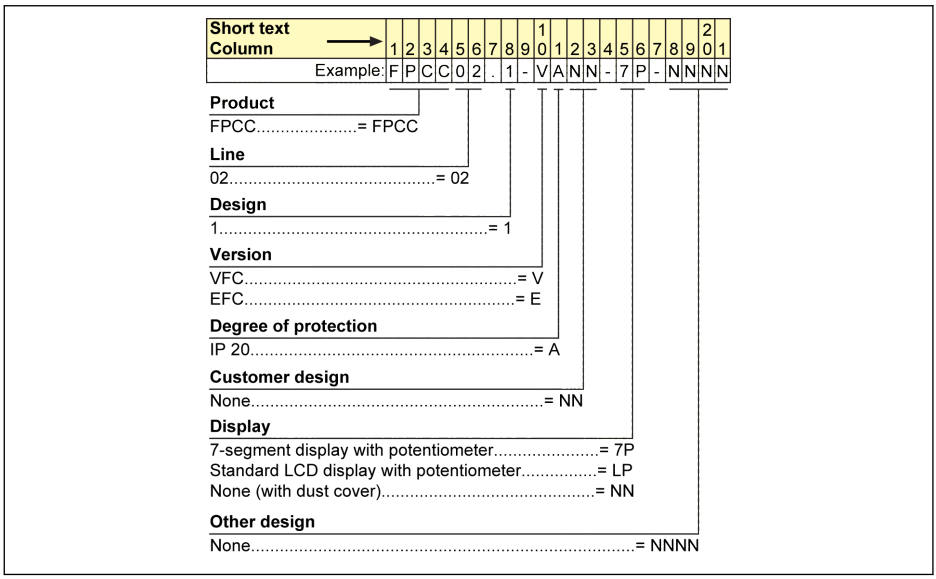


Fig. 14-3: Operating panel type coding

Notes

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