

Rexroth Frequency Converter EFC 3600

R912003768
Edition 03

Operating Instructions



Record of Revision

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| DOK-RCON03-EFC-3600***-IT03-EN-P | 2014/01 | Added CE, UL and RCM certification information; added accessories information |

Reference

For documentation available in other type or language, please consult your local sales partner or check www.boschrexroth.com/EFC3600.

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English

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.

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Před uvedením výrobků do provozu si přečtěte kompletní dokumentaci a bezpečnostní pokyny dodávané s výrobkem, pochopte je a dodržujte.

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Üzembe helyezés előtt olvassa el, értelmezze, és vegye figyelembe a csomagban található dokumentumban foglaltakat és a biztonsági útmutatásokat.

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

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

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Вводить изделие в эксплуатацию разрешается только после того, как Вы полностью прочли, поняли и учли информацию, содержащуюся в поставленных вместе с изделием документах, а также указания по технике безопасности.

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Ürünleri beraberinde teslim edilen evrakları ve güvenlik talimatlarını tamamen okuduktan, anladıktan ve dikkate aldıktan sonra kullanmaya başlayın.

Şayet size ulusal dilinizde evraklar teslim edilmemiş ise, sizinle ilgili olan Bosch Rexroth dağıtım ortağıyla iletişime geçin.

中文

请在完全通读、理解和遵守随同产品提供的资料和安全提示后才使用这些产品。

若产品资料还未翻译成您本国语言，请联系 Bosch Rexroth 相应的销售伙伴。

日本語

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한국어

먼저 회사의 제품을 받으신 다음 제품과 함께 배송된 안내서 및 안전에 관한 지침서를 충분히 숙지하여 이를 준수하여 주십시오.

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

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1 Introduction to the Documentation

WARNING

Personal injury and property damage caused by incorrect operations of 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 to the Documentation | Overview |
| 2 | Safety Instructions for Electric Drives and Controls | Safety cautions |
| 3 | Important Directions for Use | |
| 4 | Delivery and Storage | Product information |
| 5 | Mounting and Installation | |
| 6 | Operating Panel | Actual applications (for operators and repairers) |
| 7 | Commissioning | |
| 8 | Parameter Settings | |
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| 14 | Maintenance | Maintenance information |
| 15 | Service and Support | Service information |
| 16 | Environmental Protection and Disposal | Environmental information |
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Tab. 1-1: Chapters and contents

Feedback

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

Please send your feedback via email to: service.svc@boschrexroth.de

2 Safety Instructions for Electric Drives and Controls

2.1 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 ele-

ments, 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.

2.2 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.

2.3 General Information

2.3.1 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.

2.3.2 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)

2.3.3 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 batteries!
- Risk of injury by improper handling of pressurized lines!

2.4 Instructions with Regard to Specific Dangers

2.4.1 Protection Against Contact With Electrical Parts and Housings



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

Contact with parts conducting voltages above 50 volts 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 **5 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.

2.4.2 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 higher 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").

2.4.3 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.

2.4.4 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.

2.4.5 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.

2.4.6 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!

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 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 right to payment of damages resulting from inappropriate use are forfeited. The user alone carries all responsibility of the risks.

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

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

3.2 Inappropriate Use

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

Frequency converters shall not be used under following conditions:

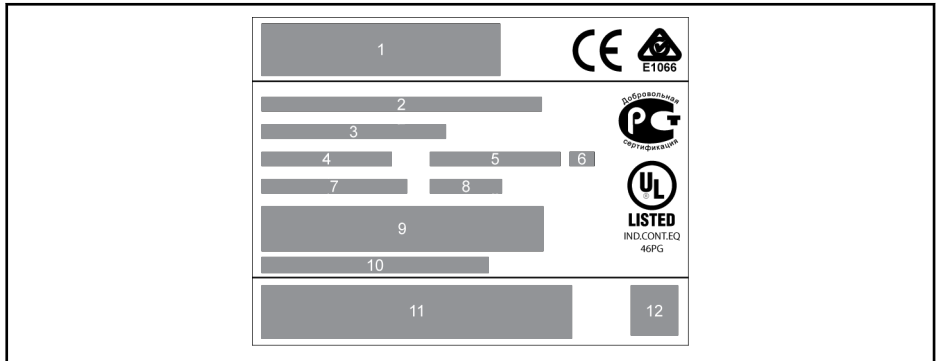
- They are subject to operating conditions that do not meet the specified ambient conditions. These include, for example, operation under water, extreme temperature fluctuations or extremely high temperatures.
- Furthermore, the frequency converters shall not be used in applications which have not been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

4 Delivery and Storage

4.1 Product Identification

4.1.1 Checking Information on 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 | 8 Production week: e.g. 12W39 means week 39 of year 2012 |
| 2 Type code | 9 Bar code |
| 3 Volume | 10 Serial number |
| 4 Net weight | 11 Manufacturer |
| 5 Material number | 12 2-D code |
| 6 Index | |
| 7 Mass weight | |

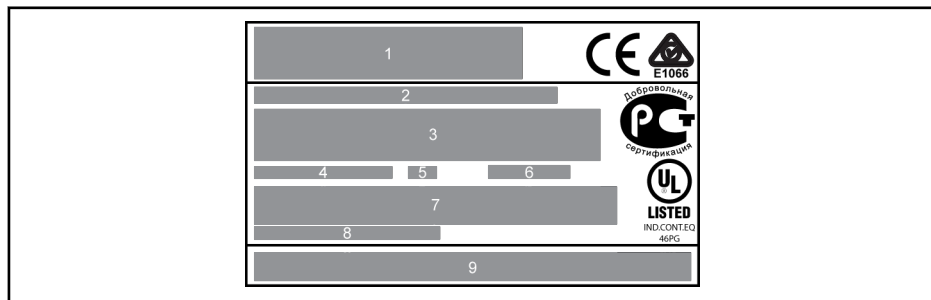
Fig. 4-1: Packing nameplate



For the definition of the typecode, please refer to [chapter 17.3 "Appendix 3: Type Coding"](#) on page 242.

4.1.2 Checking Information on Frequency Converter Nameplate

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



- | | | | |
|---|-----------------|---|--|
| 1 | Product series | 6 | Production week: e.g. 12W39 means week 39 of year 2012 |
| 2 | Type code | 7 | Bar code |
| 3 | Technical data | 8 | Serial number |
| 4 | Material number | 9 | Manufacturer |
| 5 | Index | | |

Fig. 4-2: Frequency converter nameplate

4.1.3 Visual Inspection of the Frequency Converter

Check the unit 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.

4.2 The Scope of Supply

Standard model

- Frequency Converter EFC 3600, protection class of IP20
(Mounting on the metal wall in control cabinet)
- Internal brake chopper
- Operating panel
- Safety instructions
- Instruction manual
- Instruction manual (UL)

Optional accessories

- Operating instructions
- Mains choke
- External EMC filter
- RS232/485 adapter
- Adapter interface connection cable
- Mounting plate for cabinet mounting
- Operating panel cable for cabinet mounting
- Shielded cable connection accessories
- Brake resistor
- Motor choke

4.3 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 |

Tab. 4-1: Transport conditions

4.4 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, remember to operate them once a year:

- Run frequency converter EFC 3600 under power U_{LN} for at least 1 hour.
- For more information of electrolytic capacitors, please contact service.

Ambient and operating conditions-Storage

| 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. 4-2: Storage conditions

5 Mounting and Installation

5.1 EFC 3600 Dimensions Figure

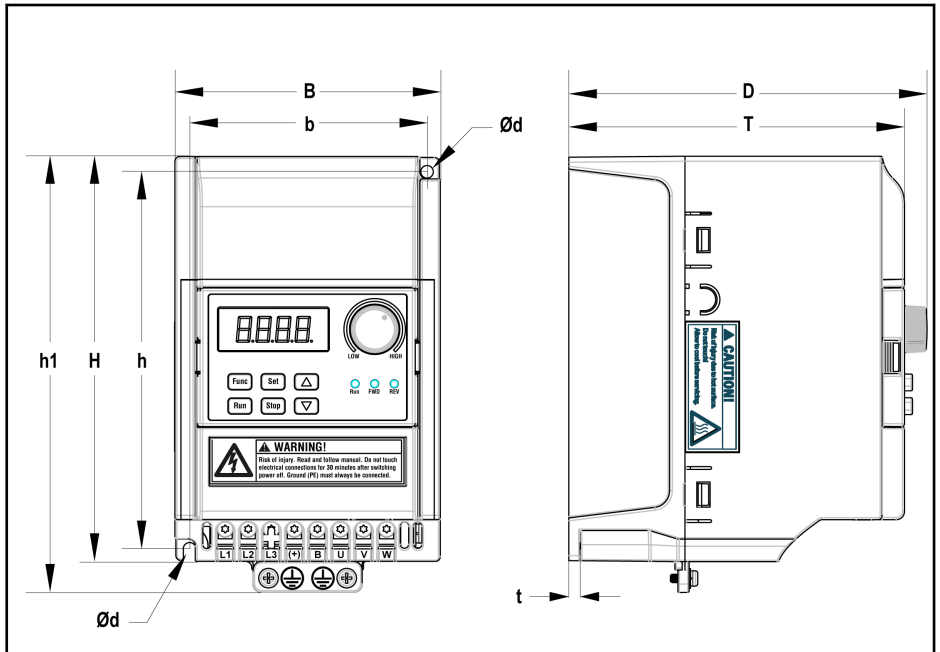


Fig. 5-1: EFC 3600 figure of frame A, B and C

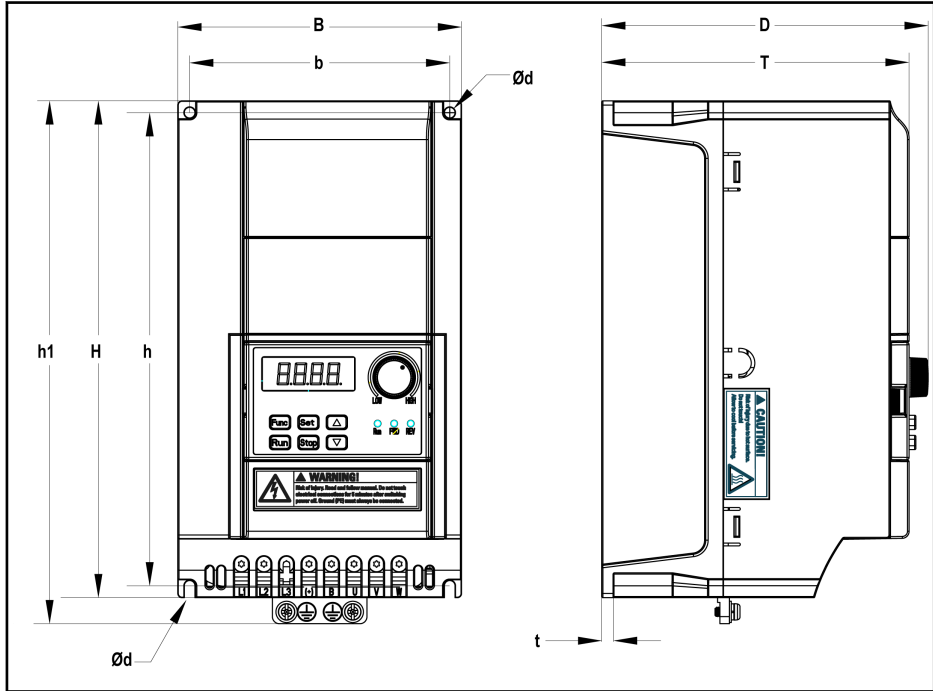


Fig. 5-2: EFC 3600 figure of frame D

5.2 EFC 3600 Dimensions

| Frame | EFC 3600 model | Dimensions [mm] | | | | | | | | | Screw size | Net weight [kg] |
|-------|----------------|-----------------|-----|-----|-----|-----|-----|-----|-----|---|------------|-----------------|
| | | B | b | H | h | h1 | Ød | D | T | t | | |
| A | OK40-1P2 | 90 | 80 | 135 | 125 | 146 | 4.5 | 113 | 105 | 5 | M4 | 0.96 |
| B | OK40-3P4 | 95 | 85 | 145 | 135 | 156 | 4.5 | 128 | 120 | 5 | M4 | 1.18 |
| | OK75-1P2 | | | | | | | | | | | 1.24 |
| | OK75-3P4 | | | | | | | | | | | 1.26 |
| C | 1K50-1P2 | 95 | 85 | 185 | 175 | 196 | 4.5 | 133 | 125 | 5 | M4 | 1.61 |
| | 1K50-3P4 | | | | | | | | | | | 1.52 |
| D | 2K20-1P2 | 120 | 110 | 210 | 200 | 221 | 4.5 | 138 | 130 | 5 | M4 | 2.35 |
| | 2K20-3P4 | | | | | | | | | | | 2.25 |
| | 4K00-3P4 | | | | | | | | | | | 2.36 |

Tab. 5-1: EFC 3600 dimensions



- ①: The complete type code for a frequency converter is:
EFC3600-xKxx-xPx-xDA-7P-NNNN, see [chapter 17.3 "Appendix 3: Type Coding"](#) on page 242.
- ②: 2 screws are needed for mounting of EFC 3600 frame A, B or C.
- ③: 4 screws are needed for mounting of EFC 3600 frame D.

5.3 EFC 3600 Mounting

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

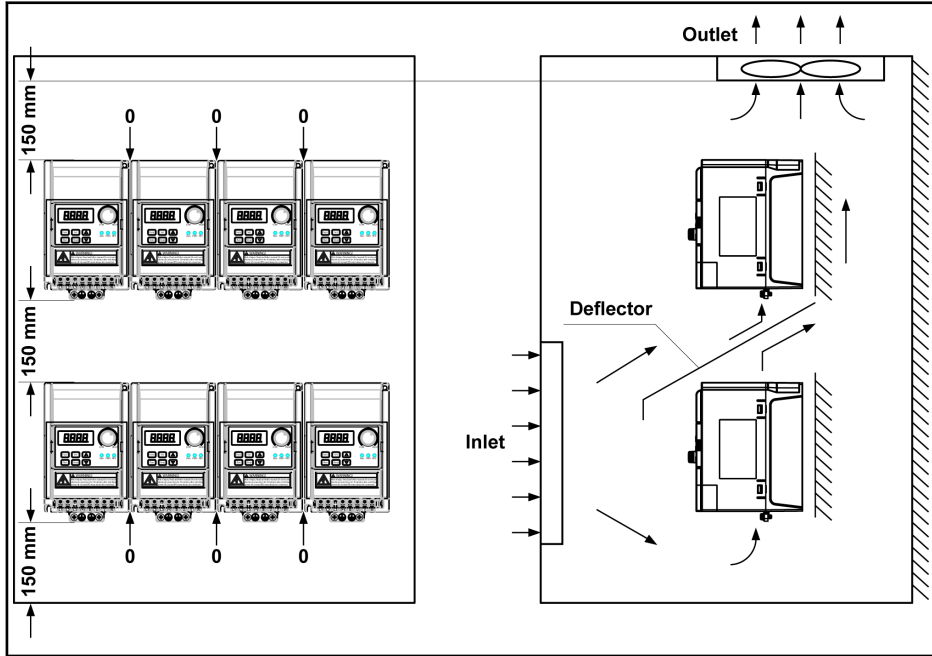


Fig. 5-3: EFC 3600 mounting



- EFC 3600 must be vertically installed.
- EFC 3600 has no side ventilation hole, which enables parallel mounting of EFC 3600 with zero distance.
- If one frequency converter is arranged above another, make sure that the upper limit of air temperature into the inlet is not exceeded (See [tab. 10-1 "General technical data" on page 137](#)).
- A baffle plate is recommended between the frequency converters to prevent the rising hot air being drawn into the upper frequency converter.

Frequency converter heat dissipation

| Frame | Model | Rated output current [A] | Heat dissipation | |
|----------------------|-------|--------------------------|------------------|---------|
| | | | [W] | [BTU/h] |
| 1-phase 200 V | | | | |
| A | 0K40 | 2.3 | 25 | 87 |
| B | 0K75 | 3.9 | 40 | 138 |
| C | 1K50 | 7.0 | 76 | 258 |
| D | 2K20 | 9.7 | 115 | 393 |
| 3-phase 400 V | | | | |
| B | 0K40 | 1.2 | 29 | 99 |
| B | 0K75 | 2.1 | 38 | 131 |
| C | 1K50 | 3.7 | 71 | 244 |
| D | 2K20 | 5.1 | 82 | 281 |
| D | 4K00 | 8.8 | 125 | 427 |

Tab. 5-2: Frequency converter heat dissipation



The heat dissipation data in the above table were all tested at PWM frequency of 8 kHz with the frequency converter.

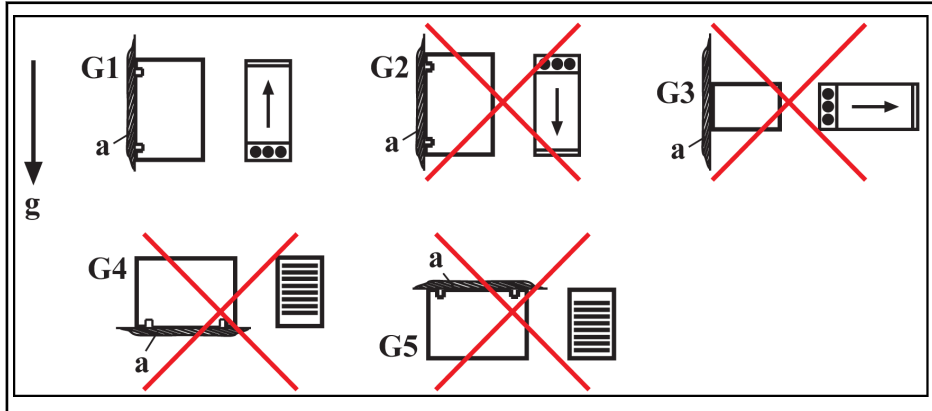
⚠ CAUTION

Risks of damage to the components!

Only operate the components in their allowed mounting modes.

Allowed mounting mode of the components:

Only the mounting mode G1 is allowed for EFC 3600. Please refer to the figure below.



a Mounting surface

g Direction of gravitational force

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

G2 180° to normal mounting mode

G3 Turned by 90° from vertical to horizontal mounting mode

G4 Bottom mounting; mounting surface on bottom of control cabinet

G5 Top mounting; mounting surface at top of control cabinet

Fig. 5-4: Frequency converter mounting mode

5.4 Block Diagram

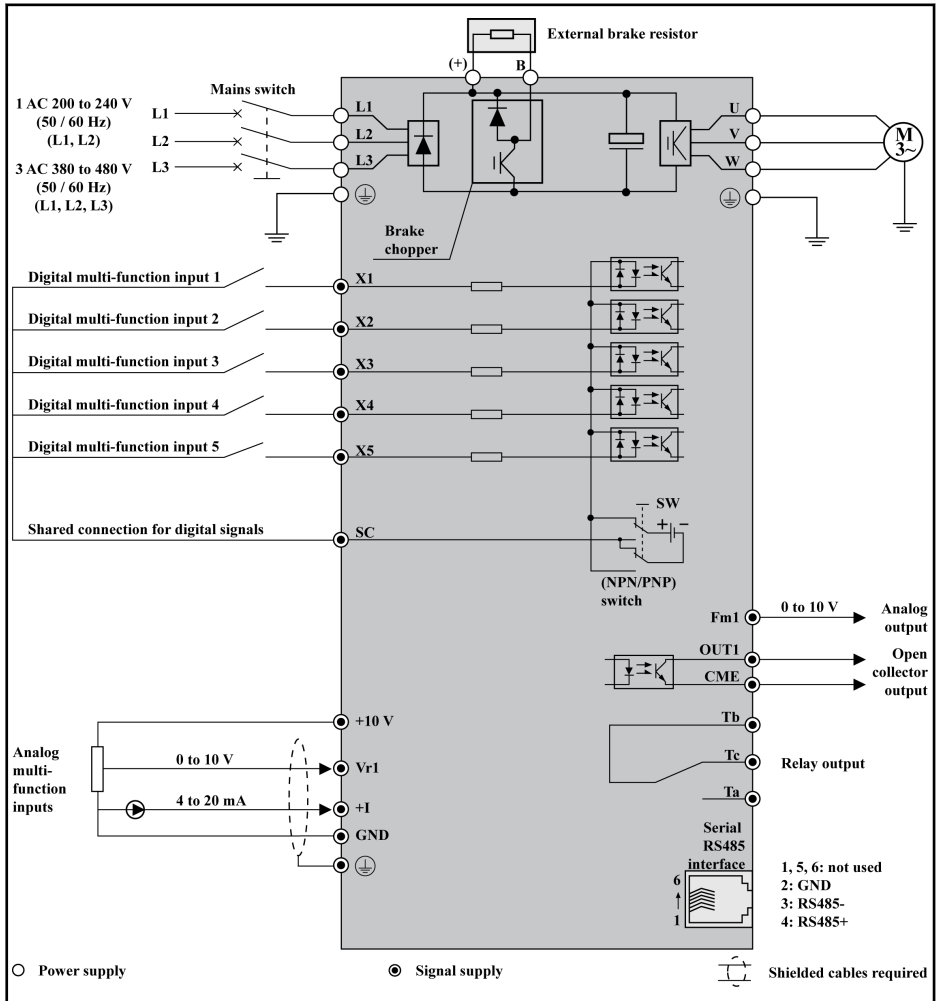




Fig. 5-5: Block diagram



The communication interface shown in the figure above is RJ11 for ModBus communication; for PROFIBUS communication interface DB9, see [chapter 13.3.3 "PROFIBUS Interface" on page 202](#).

5.5 Notes on Main Circuit Wiring

- Connect power supply only to the mains power supply terminals (L1, L2 and L3 for 3 phases; L1 and L2 for 1 phase). 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.
- Crimp terminals with insulated sleeve must be used to connect terminals and conductors to ensure the reliability of connection.
- After wiring connection, remove all residual loose wires, which may fall into the frequency converter and cause a failure. Be careful not to allow swarf from drilling entering the frequency converter. Check the following points after the circuit connection is completed.
 1. Are all connections correct?
 2. Are there any missing connections?
 3. Do short circuits exist between terminals and wires or ground?
- To make changes in wiring, disconnect the power supply and wait for 5 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 and the AC input power supply. It is preferable to connect a magnetic contactor (MC) in series to ensure both the action of frequency converter protection and shutting off of power supply (Surge absorbers should be added at both sides of the magnetic contactor).
- If the wire between the frequency converter and the motor is very long, particularly with low output frequency, the voltage drop may lead to a reduced torque output by the motor.
- Nothing other than the brake resistor may be connected between the terminal (+) and B. Do not short circuit!
- Electromagnetic interference: The inputs/outputs of frequency converters 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 converters. This may cause frequency converter failure or damage the capacitor or suppressor. Immediately remove any of such device if it has been installed.
- Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code [USA] and any additional local codes.

- After connecting the power supply terminals, the motor and the control terminals, place 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 frequency converter and power supply.
 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 of the motor cable should be securely connected to  on the bottom right of the heat sink. The shielded cables for the control signals should be connected to  on control terminal block.



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

5.6 Main Circuit Wiring Diagram

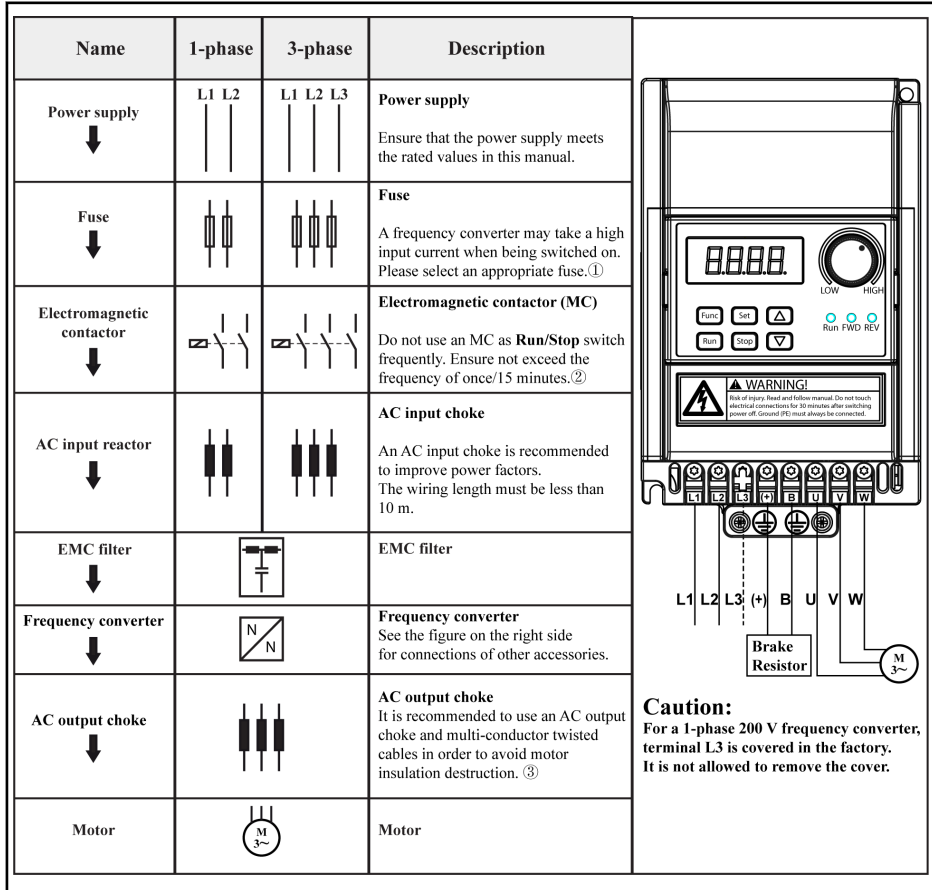


Fig. 5-6: Main circuit wiring diagram



①: To select an appropriate fuse, please refer to [tab. 5-4 "Fuse and cable dimensions"](#) on page 29.

②: Excessively frequent starting and stopping will shorten the life time of relay contacts and DC bus capacitors, and may destroy the resistor for capacitor charging and current limitation.

③: Whether using an AC output choke or not depends on the factors of: the length, shielding and distribution capacitance of the motor cables, as well as the insulation of the motor.

5.7 Main Circuit Terminals

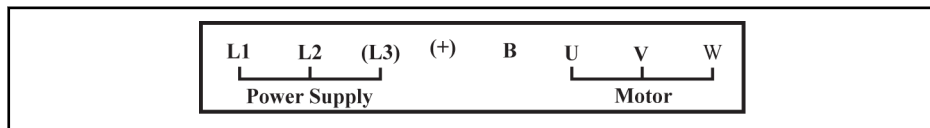


Fig. 5-7: Main circuit terminals (1x200 V)

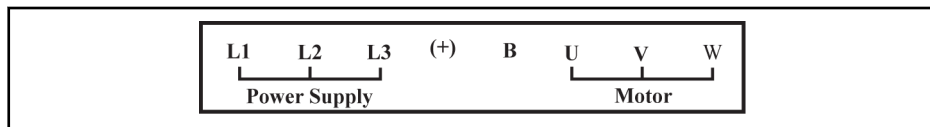


Fig. 5-8: Main circuit terminals (3x400 V)

5.8 Main Circuit Terminals Description

| Terminal | Description |
|-------------------------------|--|
| 1-phase AC 200 V class | |
| L1, L2 | Mains power supply inputs |
| U, V, W | Frequency converter outputs (to be connected to the motor) |
| B | Reserved terminal for external brake resistor |
| (+) | DC positive bus output |
| ⊕ | Input PE (located at bottom left of the heat sink) |
| ⊕ | Grounding (located at bottom right of the heat sink) |
| 3-phase AC 400 V class | |
| L1, L2, L3 | Mains power supply inputs |
| U, V, W | Frequency converter outputs (to be connected to the motor) |
| B | Reserved terminal for external brake resistor |
| (+) | DC positive bus output |
| ⊕ | Input PE (located at bottom left of the heat sink) |
| ⊕ | Grounding (located at bottom right of the heat sink) |

Tab. 5-3: Main circuit terminals description



Do not use terminal L3 for 1P AC 200 V class models!

5.9 Cable and Fuse Dimensions

5.9.1 Selection Standards

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.

5.9.2 Recommendation on Cable Dimensioning

1. Depends on the power of a frequency converter.
2. For corresponding fuse data, see column "Nominal Current of Fuse [A]" in the table below.



1. The cable dimensions for inputs and outputs are based on supply voltages of 1P 200 VAC / 3P 380 VAC.
2. For torque information, see the table below.

| Model | Input side | | Output side | Screw torque for power cable terminals [Nm / lb-in] (screw size) | PE | |
|------------------------------|--------------------------------|---------------------------------------|---------------------------------------|--|---------------------------------------|--|
| | Nominal current of Fuse [A] | Cable size [mm ² / AWG] | Cable size [mm ² / AWG] | | Cable size [mm ² / AWG] | Torque [Nm / lb-in] (screw size) |
| 1-phase 200 VAC class | | | | | | |
| OK40 | 10 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| OK75 | 16 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 1K50 | 20 | 3.5 / 12 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 2K20 | 25 | 5.3 / 10 | 3.5 / 12 | 1.2 / 10 (M4) | 6 / 8 | 0.8 / 7 (M3) |
| 3-phase 400 VAC class | | | | | | |
| OK40 | 6 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| OK75 | 10 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 1K50 | 10 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 10 / 8 | 0.8 / 7 (M3) |
| 2K20 | 16 | 2.0 / 14 | 2.0 / 14 | 1.2 / 10 (M4) | 10 / 8 | 0.8 / 7 (M3) |
| 4K00 | 20 | 2.0 / 14 | 2.0 / 14 | 1.2 / 10 (M4) | 10 / 8 | 0.8 / 7 (M3) |

Tab. 5-4: Fuse and cable dimensions



- For wiring, please use UL-listed clamp terminals.
- Please use copper wires of 75 °C and above.

5.9.3 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).



- 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** of frequency converters, you can use fuses of characteristic **gR**.

- USA/Canada: Class J; 600 V

5.10 Main Circuit Wiring Steps

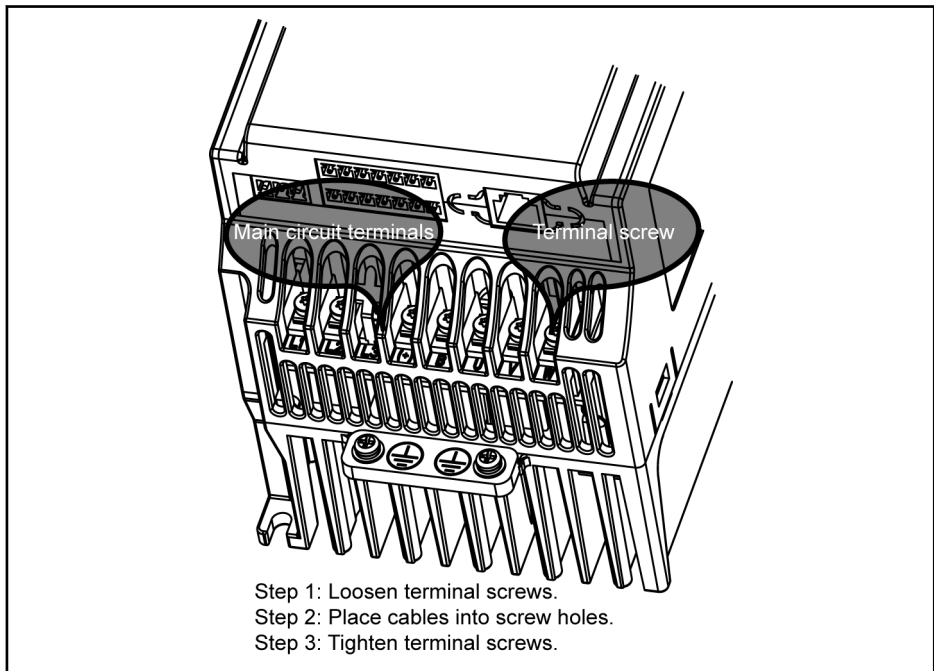


Fig. 5-9: Main circuit wiring steps

5.11 Grounding Screw Removal of Internal EMC Filter

- Step 1: Cut and remove the U-shape area as A indicated in the figure below.
- Step 2: Remove the screw as B indicated in the figure below.

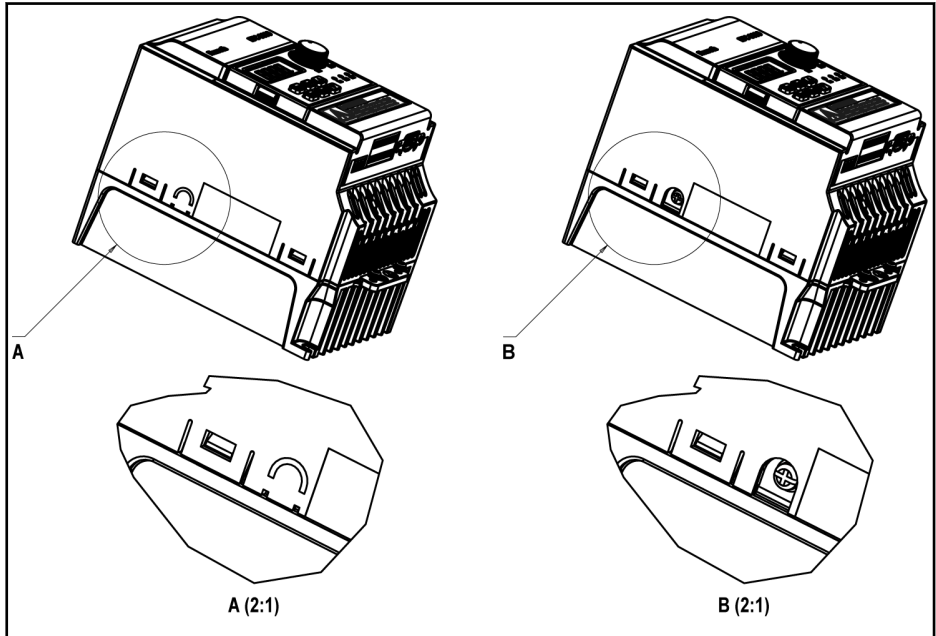


Fig. 5-10: Grounding screw location of internal EMC filter

5.12 Notes on Control Circuit Wiring

- Terminal GND is the shared terminal for analog signals, and SC is the shared terminal for digital signals. Do not ground these terminals. Shielded or twisted-pair cables should be used for control circuit terminals wiring and must be separated from the wiring of main circuit and high current circuit (including the control circuit of 200 V relay).
- 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; too short stripping may lead to wires becoming loose.

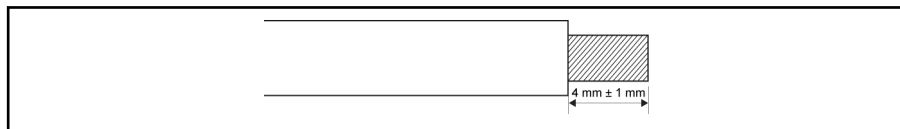


Fig. 5-11: Wire stripping length

- Disconnection of cables or damage of screws may cause incorrect operation if screws are not fixed correctly.

5.13 Control Circuit Terminals

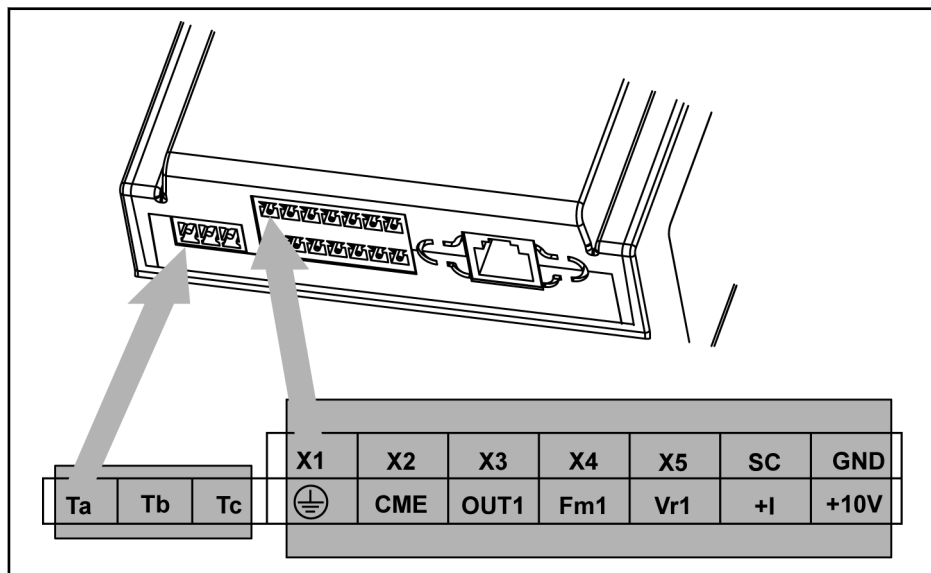


Fig. 5-12: Control circuit terminals



The sequence of the label and the terminals is as indicated by arrows in the above figure.

5.14 Control Circuit Terminals Description

| Type | Terminal | Signal function | Description | Signal requirement |
|-----------------|----------|--|--|---|
| Digital inputs | X1 ~ X5 | Multiple speed commands | Activated with "closed" see parameters E0.01 ~ E0.05, chapter 8.6 | 24 VDC 8 mA inputs via opto-electric couplers |
| | SC | Shared connection for digital signals | Isolated from GND | |
| Analog inputs | +10 V | Supply voltage for external frequency setpoint value specified | Power supply for speed commands | +10 V (Max. current 30 mA) |
| | Vr1 | Analog frequency commands | Analog voltage input | Input voltage range: 0 ~ 10 V Input resistance: 40 k Ω Resolution: 1/1000 |
| | +I | | Analog current input | Input current range: 4 ~ 20 mA Input resistance: 499 Ω Resolution: 1/800 |
| | GND | Shared connection for analog signals | Isolated from SC | – |
| | Earth | Shielding terminal | – | – |
| Digital outputs | OUT1-CME | Open collector output 1 | Programmable digital output with multiple functions, see parameter E1.00 | Open collector outputs: DC 30 V, 50 mA |
| | Ta | Relay changeover contacts | Programmable relay output, see parameter E1.02 | Rated capacity of contact transmitter: AC 250 V 3 A DC 30 V 3 A |
| | Tb | | | |
| Analog outputs | Fm1-GND | Analog multi-function output 1 | Programmable analog output with multiple functions, see parameter E1.30 | Output voltage: 0 ~ 10 V Max. output current: 5 mA |

Tab. 5-5: Control circuit terminals description

5.15 NPN / PNP Switch SW for the Digital Inputs

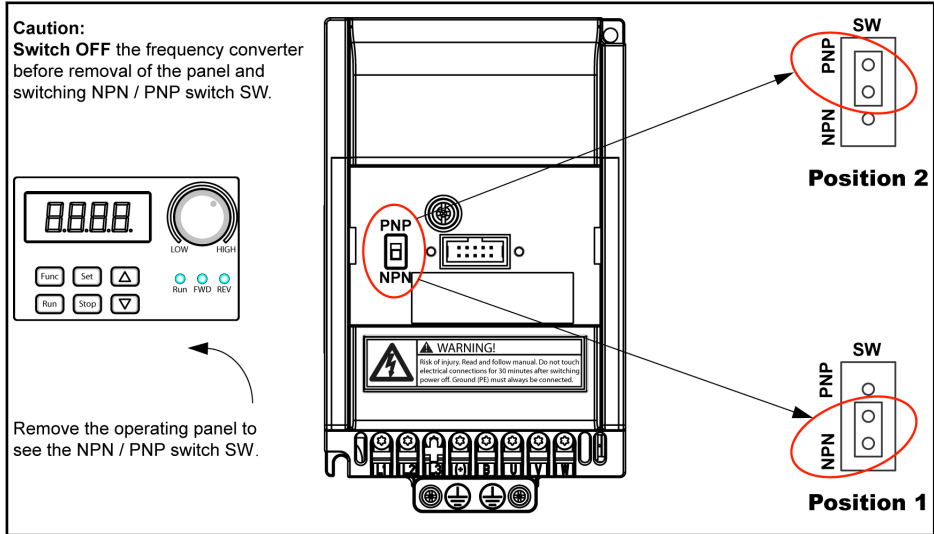


Fig. 5-13: NPN / PNP switch SW for the digital inputs



- The factory default setting of switch SW is NPN.
- For disassembly and mounting of the operating panel, see [chapter 14.4 "Operating Panel Removal and Mounting"](#) on page 213.

5.16 NPN and PNP Modes

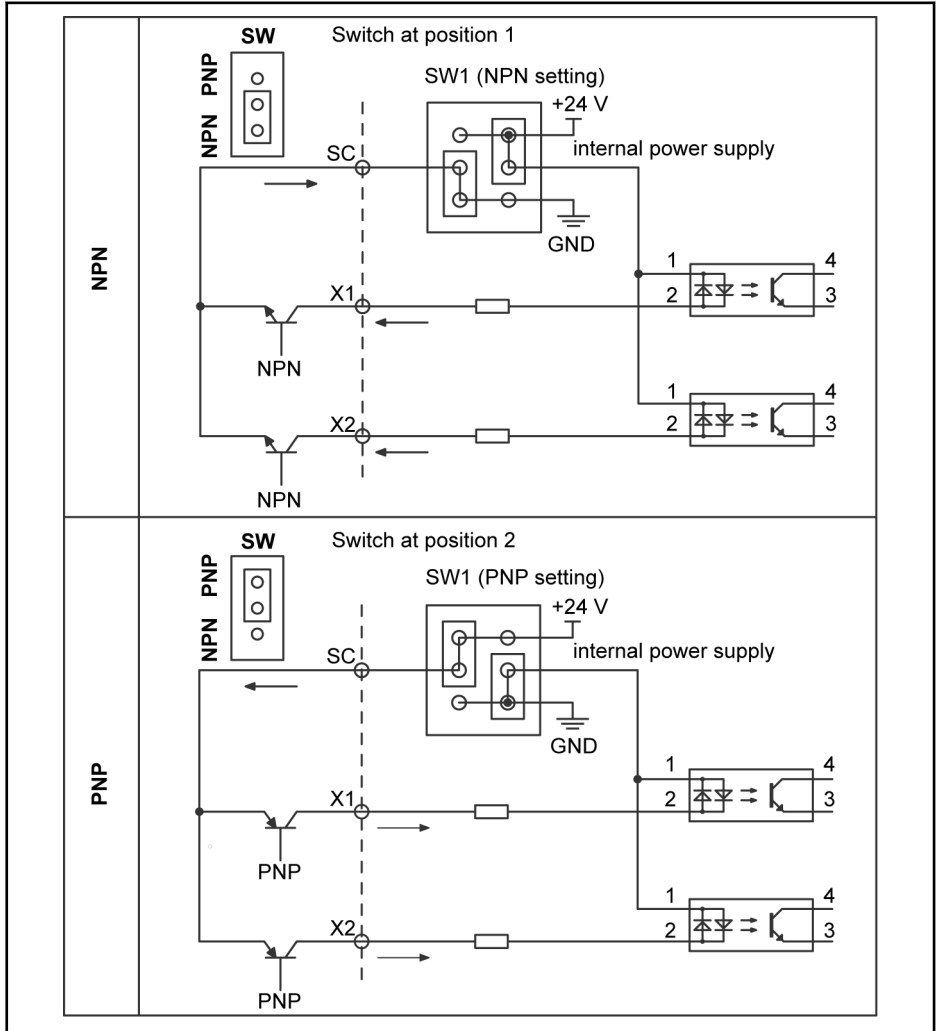


Fig. 5-14: NPN and PNP modes

5.17 Analog Input Terminals (+10 V, Vr1, GND,+I)

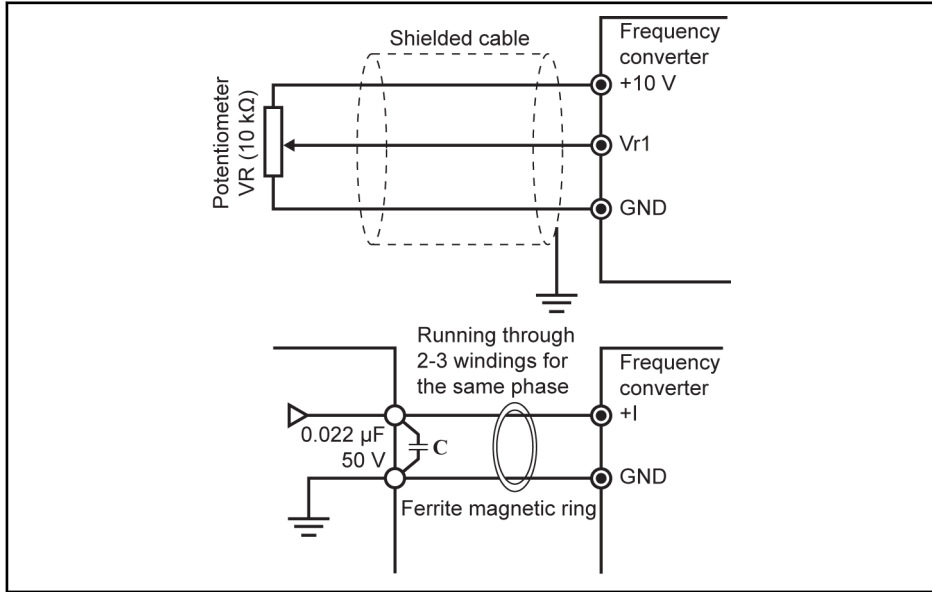


Fig. 5-15: Analog input terminals (+10 V, Vr1, GND,+I)



- For connections 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.
- Incorrect operation may occur due to interference on the analog signals. In such cases, connect a capacitor and ferrite core at the output side of the analog signal, as shown above.

5.18 Recommendations on Control Circuit Wiring

0.2 - 1.5 mm² cables are recommended for wiring of the control circuit.

5.19 Control Circuit Wiring Steps

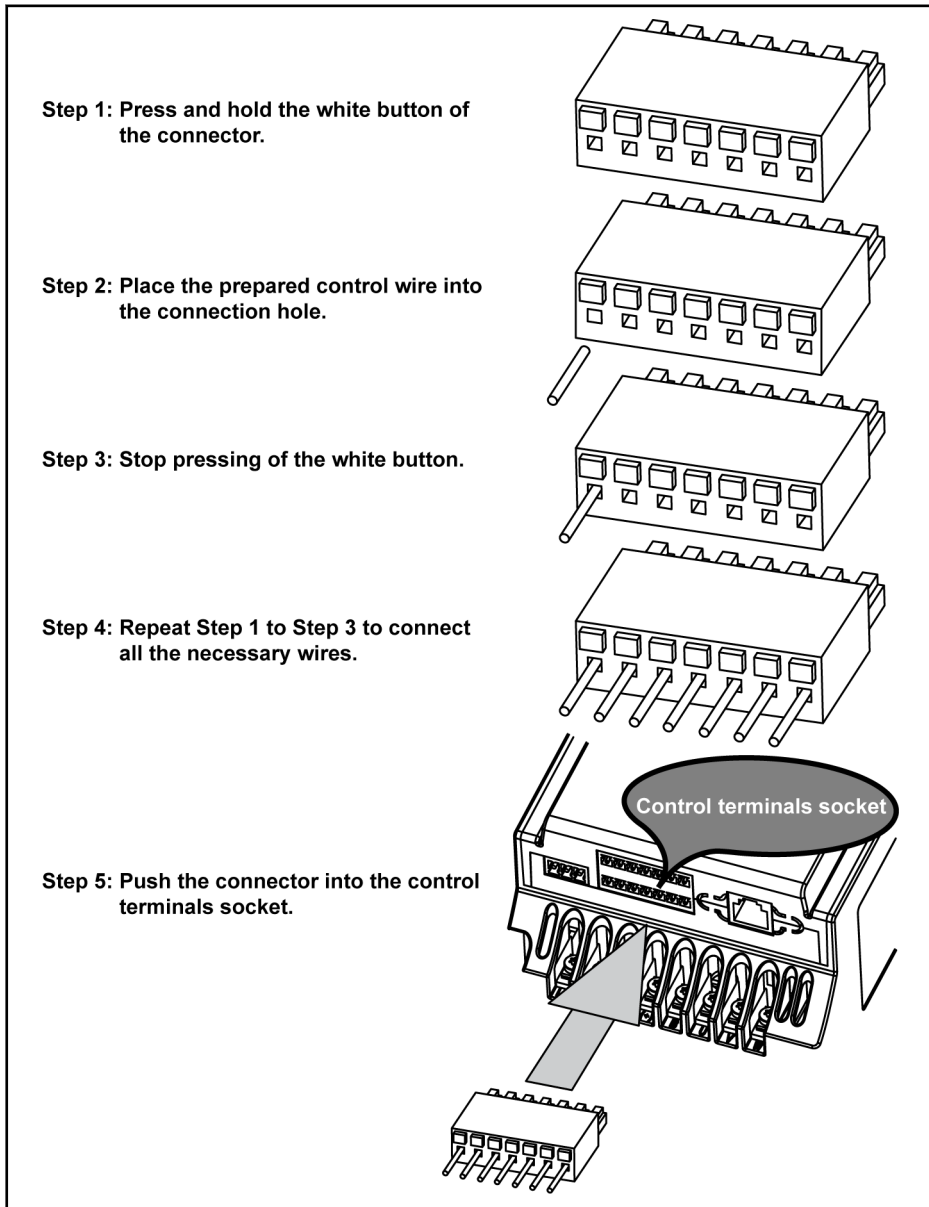


Fig. 5-16: Control circuit wiring steps

6 Operating Panel

6.1 Figure and Description

The operating panel is removable 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.

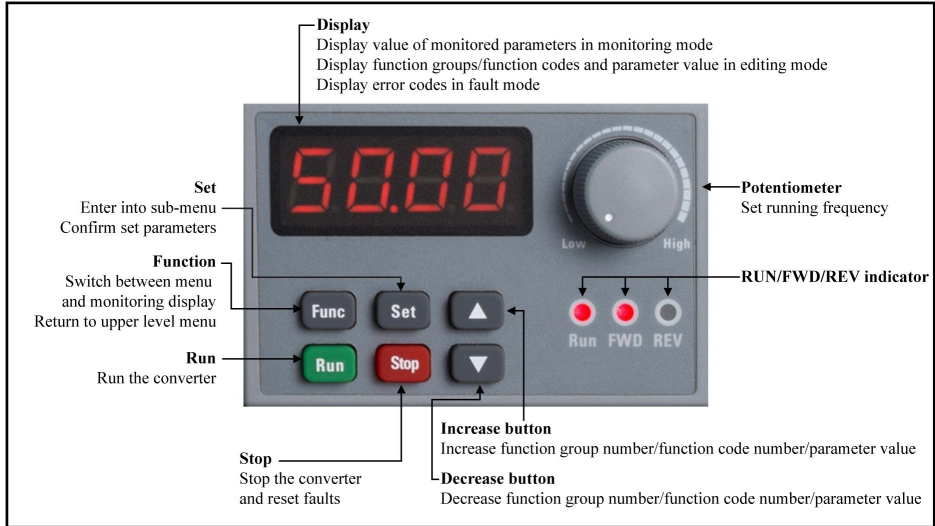


Fig. 6-1: Operating panel

6.2 Seven-segment Display

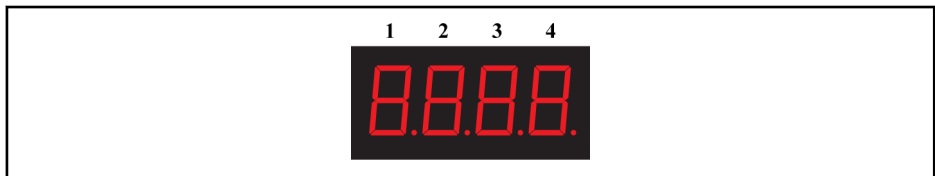


Fig. 6-2: Seven-segment display

Display has only 4 digits, but values with up to 5 digits may be displayed.

- To view the first 4 digits: press buttons **Func+▲**.
- To view the last 4 digits: press buttons **Func+▼**.

6.3 LED Indicator

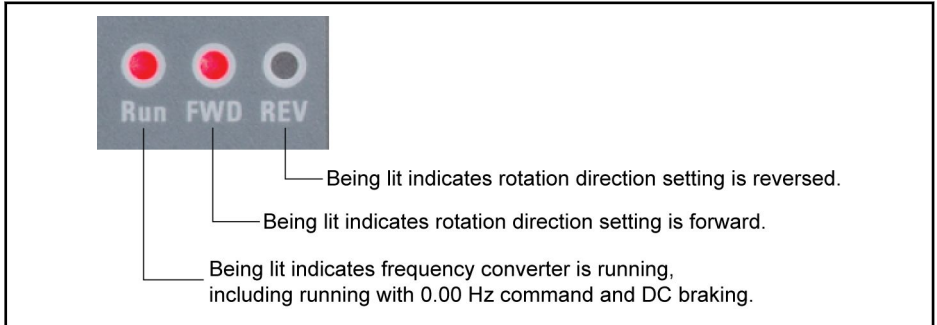


Fig. 6-3: LED indication description



The LED indicator **Run** also blinks during dead zone time of forward and reverse rotation, period of automatic error reset and waiting time for restarting after power fault.

6.4 Menu Structure

| | Menu Level 1 (Function group) | Menu Level 2 (Function code) | Menu Level 3 (Parameter value) |
|---------------------------------|----------------------------------|---------------------------------|-----------------------------------|
| System parameter group | - b0 - | b0.00 | 0 - 65535 |
| | | b0.49 | Reserved |
| Basic parameter group | - b1 - | b1.00 | 0 - 6 |
| | | b1.49 | Reserved |
| V/F control group | - S0 - | S0.00 | 0 - 2 |
| | | S0.33 | 0.001 - 10.000 |
| Motor & encoder parameter group | - S2 - | S2.00 | 5.00 - 400.00 |
| | | S2.39 | Reserved |
| Running parameter | - S3 - | S3.00 | 0.00 - [b1.05] |
| | | S3.35 | 0 - 1 |
| Input terminals group | - E0 - | E0.00 | 0 - 2 |
| | | E0.39 | Reserved |
| Output terminals group | - E1 - | E1.00 | 0 - 18 |
| | | E1.40 | Reserved |
| Multi-speed & simple PLC group | - E2 - | E2.00 | 0.1 - 6000.0 |
| | | E2.70 | Reserved |
| PID function group | - E3 - | E3.00 | 0 - 7 |
| | | E3.16 | 0.01 - 100.00% |
| Protection & fault group | - E4 - | E4.00 | Reserved |
| | | E4.35 | - |
| Communication group | - H0 - | H0.00 | 0 - 1 |
| | | H0.17 | 0 - 20 |
| Monitoring parameter group | - d0 - | d0.00 | 0.00 - 400.00 |
| | | d0.71 | 0.00 - 99.99 |

Fig. 6-4: Menu structure



- The digital operating panel can be used to toggle between menu options and set parameters with buttons **Func**, **Set**, **▲** and **▼**.
- The monitoring display mode will be activated if there is no operation for more than 60 seconds.

6.5 Operating Mode

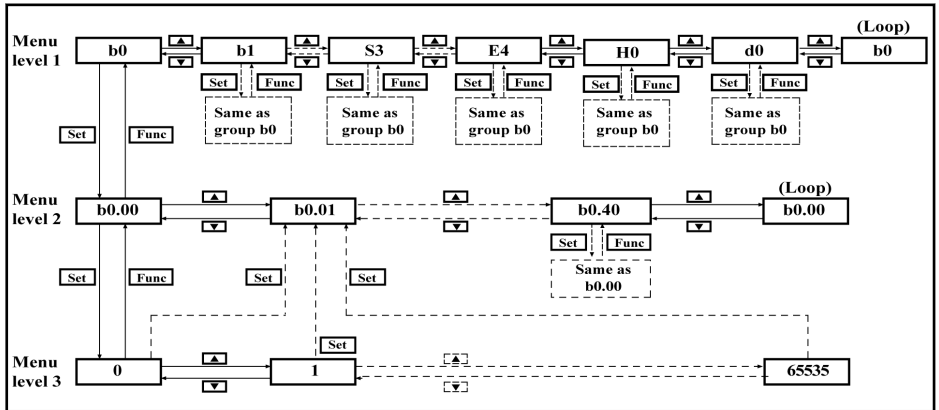


Fig. 6-5: Operating mode

6.6 Operating Example

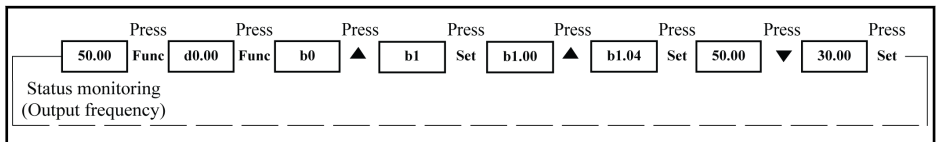


Fig. 6-6: Operating example

7 Commissioning

7.1 Checking and Preparation before Commissioning

WARNING

Ensure the plastic enclosure is in place before the device is powered on. Wait for at least **5 minutes** after powering off to allow the DC capacitor being discharged, and do not remove the upper cover during this period.

- ① Check if the wiring is correct. Particularly, ensure that the output terminals U, V and W of the frequency converter are not connected to the power supply and that the ground terminal is well connected.
- ② Ensure that there are no short circuits between terminals, live terminals or short circuit to ground.
- ③ Ensure that terminal connections, connectors and screws are secure.
- ④ Ensure that the motor is not connected to any load.
- ⑤ Check that all switches are off before powering on to ensure that the frequency converter will not be started and no unexpected action occurs.
- ⑥ It is suggested to connect U, V, W of the frequency converter to corresponding U, V, W of the motor.

7.2 Commissioning Process

| Step | Operation | Description |
|------|--|--|
| 1 | Rotate the potentiometer counterclockwise (leftwards) 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 till 5.00 is displayed | The motor starts to run |
| 4 | Observe: <ul style="list-style-type: none"> ● If the motor runs in the correct direction ● If the motor runs smoothly ● If there is any abnormal noise or problem | Observe the running, and immediately stop the motor by shutting off the power if any abnormality occurs Restart commissioning only after the error causes have been removed |
| 5 | Rotate the potentiometer clockwise | The motor accelerates |
| 6 | Rotate the potentiometer counterclockwise | The motor decelerates |
| 7 | Press Stop key | When commissioning is complete, execute the stopping command, the frequency converter is ready for normal operation |

Tab. 7-1: Commissioning process



- EFC 3600 has no internal contactor, and will be energized once the power supply is connected. When the **Run** key is pressed down (or "control by terminals" is activated), the frequency converter will give output.
- By factory default, EFC 3600 is set as:
 - The frequency converter is started or stopped by the operating panel control.
 - The output frequency is set by the potentiometer on the operating panel.
- After powering on, please confirm:
 - The set frequency is displayed (no error display)
 - The monitoring parameter is consistent with the actual situation.
- By factory defaults, the frequency converter displays output frequency in run mode and set frequency in stop mode as the monitoring parameters. You may change them to other parameters as described in parameters b0.30 and b0.31. The factory defaults are based on standard applications with standard motors.

7.3 EFC 3600 Basic Parameters Fast Settings

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



- Set [b0.02] = 4 with **Func** and **Set** keys to show group "-St-".
- For parameter attributes, see [chapter 17.2.1 "Description of Attribute Symbols in Parameter Tables"](#) on page 220.

| Function code | Name | Setting range | Min. unit | Factory default | Attributes |
|---------------|--------------------------------------|-------------------|-----------|------------------|------------|
| b0.21 | Carrier frequency | 1 ~ 15 kHz | 1 kHz | 4 kHz | Run/Stop |
| b1.00 | First frequency setting source | 0 ~ 6 | 1 | 0 | Stop |
| b1.02 | First Run command source | 0 ~ 2 | 1 | 0 | Stop |
| b1.05 | Max. frequency | 50.00 ~ 400.00 Hz | 0.01 Hz | 50.00 Hz | Stop |
| b1.06 | Upper frequency | [b1.07] ~ [b1.05] | 0.01 Hz | 50.00 Hz | Run/Stop |
| b1.07 | Lower frequency | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | Run/Stop |
| b1.04 | Digital set frequency | [b1.07] ~ [b1.06] | 0.01 Hz | 50.00 Hz | Run/Stop |
| b1.10 | Direction control | 0 ~ 3 | 1 | 0 | Stop |
| b1.20 | Acceleration time 1 | 0.1 ~ 6,000.0s | 0.1s | 5.0s | Run/Stop |
| b1.21 | Deceleration time 1 | | 0.1s | 5.0s | |
| b1.22 | Acceleration/deceleration curve mode | 0 ~ 1 | 1 | 0 | Stop |
| b1.30 | Starting mode | 0 ~ 2 | 1 | 0 | Stop |
| b1.40 | Stopping mode | | 1 | 0 | Stop |
| S0.00 | V/F curve mode | | 1 | 0 | Stop |
| S2.00 | Rated motor frequency | 5.00 ~ 400.00 Hz | 0.01 Hz | 50.00 Hz | Stop |
| S2.01 | Rated motor rotation speed | 1 ~ 30,000 rpm | 1 rpm | Depends on model | Stop |
| S2.02 | Rated motor power | 0.1 ~ 1,000.0 kW | 0.1 kW | | Stop |
| S2.03 | Rated motor voltage | 0 ~ 480 V | 1 V | | Stop |
| S2.04 | Rated motor current | 0.1 ~ 1,000.0 A | 0.1 A | | Stop |

Tab. 7-2: Basic parameters fast setting

7.4 Restore Parameters to Factory Defaults

If the frequency converter fails to run the motor due to incorrect parameter settings, a simple solution is to initialize the parameters to factory defaults. Setting [b0.05]=1 will start initialization.

Please be sure that the parameter settings match with the motor and the field applications after factory defaults restore. Adjust the parameter settings after factory defaults restore if necessary.

| | |
|--|---|
| Running frequency | Set by the potentiometer (b1.00) |
| Acceleration/Deceleration time | Linear, Acc. for 5s / Dec. for 5s (b1.20, b1.21) |
| Protection mode in case of motor overload or overheat | Motor rated current (S2.04), thermal motor time constant (S2.23), low speed derating frequency (E4.04), and zero speed load (E4.05) |
| Operating panel operation | Run, Stop keys as commands, potentiometer as frequency setting source |
| V/F curve mode | Linear |

Tab. 7-3: Parameter settings by factory defaults

7.5 Solutions for Simple Errors during Commissioning

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

Tab. 7-4: Solutions for simple errors during commissioning

8 Parameter Settings

8.1 Group b0: System Parameters

8.1.1 Password and Access Control

| | |
|-----------------|----------------------|
| b0.00 | User password |
| Setting range | 0 ~ 65535 |
| Minimum unit | 1 |
| Factory default | 0 |

- **Activate the user password protection:** the default value of the password is 0 (inactive), enter a new number between 1 and 65535 to activate the user password protection.
- **Modify the password:** enter the correct user password and then set a new number between 1 and 65535 to modify the user password.
- **Delete the password:** enter the correct user password and set [b0.00]=0 to delete the password.



- Once a user password is activated, users may only read but not modify nor copy parameters if an incorrect password is entered.
- Please contact service if you forget the user password.
- User password protection will not affect frequency modification with ▲/▼ keys in RUN mode. It means that the frequency may still be saved according to the selected saving mode when the frequency setting source is via digital setting. See descriptions in parameter b1.01.

| | |
|-----------------|------------------------------|
| b0.01 | Manufacturer password |
| Setting range | 0 ~ 65535 |
| Minimum unit | 1 |
| Factory default | 0 |



Manufacturer password is only available for service.

| | |
|--------------------------------|---------------------------------|
| b0.02 | Access authority setting |
| Setting range | 0 ~ 4 |
| Minimum unit | 1 |
| Factory default | 0 |
| b0.03 ~ b0.04: Reserved | |

Used to define the parameter access authority. Visible parameter groups are different in the display when the setting of this parameter differs.

- 0: Basic parameters. In this mode, only parameters in group b (b0 and b1) are visible.
- 1: Standard parameters. In this mode, parameters in group b and S (S0, S2 and S3) are visible.
- 2: Extended parameters. In this mode, parameters in group b, S and E (E0, E1, E2, E3 and E4) are visible.
- 3: Advanced parameters. In this mode, parameters in group b, S, E and H (H0) are visible.
- 4: Start-up mode. The parameters in this mode are not additional parameters, but only quick links to the respective parameters. See the table below for details:

| Function code | Name |
|---------------|--|
| b0.21 | Carrier frequency |
| b1.00 | First frequency setting source |
| b1.02 | First RUN command source |
| b1.05 | Max. frequency |
| b1.06 | Upper frequency |
| b1.07 | Lower frequency |
| b1.04 | Digital set frequency |
| b1.10 | Direction control |
| b1.20 | Acceleration time 1 |
| b1.21 | Deceleration time 1 |
| b1.22 | Acceleration / deceleration curve mode |
| b1.30 | Starting mode |
| b1.40 | Stopping mode |
| S0.00 | V/F curve mode |
| S2.00 | Rated motor frequency |
| S2.01 | Rated motor rotation speed |
| S2.02 | Rated motor power |
| S2.03 | Rated motor voltage |
| S2.04 | Rated motor current |

Tab. 8-1: Parameters in start-up mode



- Monitoring parameter group is always visible.
- User password protection will not affect the modification of b0.02.

8.1.2 System Configuration

| b0.05 | Parameter initialization |
|-----------------|---------------------------------|
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |

Used to restore parameters to factory defaults. A frequency converter can record the recent 3 errors and the relevant variables for the last error for error diagnosis. They can be deleted if necessary.

- 0: No action
- 1: Restore to factory defaults
All parameters are restored to factory defaults except S2.00 ~ S2.15 (motor parameters), E4.20 ~ E4.22, E4.30 ~ E4.35 (error messages) and b0.40 (system running time).
- 2: Delete error records
Clearing parameters E4.20 ~ E4.22, E4.30 ~ E4.35.



After this command is executed completely, parameter b0.05 will be set to zero automatically.

| b0.06 | Parameter replication |
|--------------------------------|------------------------------|
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |
| b0.07 ~ b0.19: Reserved | |

- 0: No action
- 1: Backup parameters from frequency converter to panel
All parameters, except read-only parameters* and b0.40 "Cumulative running time", are copied from the frequency converter to the operating panel.
- 2: Restore parameters from panel to frequency converter
All parameters, except read-only parameters* and b0.40 "Cumulative running time", are copied from the operating panel to the frequency converter.



- *Read-only parameters: all monitoring parameters d0.00 ~ d0.20; all error memory parameters E4.20 ~ E4.22 and E4.30 ~ E4.35.
- After the command is executed completely, parameter b0.06 will be set to zero automatically and "b0.20" will be displayed.
- Any of other operations is invalid during parameter replication.

8.1.3 Frequency Converter Configuration

| b0.20 | Frequency converter rated voltage setting |
|-----------------|--|
| Setting range | 200 V class: 200 ~ 240 V; 400 V class: 380 ~ 480 V |
| Minimum unit | 1 V |
| Factory default | 200 V class: 220 V; 400 V class: 380 V |

Used for analog output function selection "terminal output voltage". Analog output voltage of 10 V corresponds to 1.2 times of [b0.20], for example:

[b0.20]=220 V, the terminal output voltage 0 ~ 264 V corresponds to 0 / 2 ~ 10 V, see descriptions in parameters E1.30 ~ E1.32.

| b0.21 | Carrier frequency |
|-----------------|--------------------------|
| Setting range | 1 ~ 15 kHz |
| Minimum unit | 1 kHz |
| Factory default | 4 kHz |

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

For the temperature, voltage and current derating figures related to PWM frequency, please refer to [chapter 10.3 "Derating of Electrical Data" on page 139](#).



To obtain the best performance of the output frequency, the carrier frequency needs to be set as below:

Set [b0.21] $\geq 10 \times$ ('Max. frequency' [b1.05]).

| b0.22 | Automatic adjustment of carrier frequency |
|--------------------------------|--|
| Setting range | 0: OFF; 1: ON |
| Minimum unit | 1 |
| Factory default | 0 |
| b0.23 ~ b0.29: Reserved | |

The frequency converter is able to adjust the PWM frequency automatically based on its own temperature when this function is activated.

8.1.4 Monitoring Display

| | |
|-----------------|-----------------------------------|
| b0.30 | Running monitoring display |
| Setting range | 0 ~ 70 |
| Minimum unit | 1 |
| Factory default | 0 |
| b0.31 | Stop monitoring display |
| Setting range | 0 ~ 70 |
| Minimum unit | 1 |
| Factory default | 2 |

- 0: Output frequency
- 1: Output rotation speed
- 2: Set frequency
- 3: Set rotation speed
- 4: Output voltage
- 5: Output current
- 6: Output power
- 7: DC bus voltage
- 8: Analog input voltage (AIV)
- 9: Analog input current (AIC)
- 10: User-defined set velocity
- 11: User-defined output velocity
- 12: Digital input status
- 13: Digital output status
- 14: PID target engineering value
- 15: PID feedback engineering value
- 16: Module temperature
- 17: Firmware version 1
- 18: Firmware version 2
- 19: Firmware version 3
- 20: Actual carrier frequency
- 70: High resolution output current

The setting of parameter b0.30 decides which parameter of group d will be displayed in running monitoring mode.

- Example 1: [b0.30]=7

- In this case, [d0.07] will be displayed when the frequency converter is in running monitoring mode.

The setting of parameter b0.31 decides which parameter of group d will be displayed in stop monitoring mode.

- Example 2: [b0.31]=8

- In this case, [d0.08] will be displayed when the frequency converter is in stop monitoring mode.

| | |
|-----------------|--|
| b0.32 | User-defined proportion factor for velocity |
| Setting range | 0.01 ~ 100.0 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |
| b0.33 | PID reference / feedback coefficient |
| Setting range | 0.01 ~ 100.0 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |

Used for monitoring function. They only affect the displayed value of monitoring parameters regarding velocity or PID control parameters.

User-defined set velocity

$$[d0.10] = [d0.02] \times [b0.32]$$

With:

[d0.10]: User-defined set velocity

[d0.02]: Set frequency

[b0.32]: User-defined proportion factor for velocity

User-defined output velocity

$$[d0.11] = [d0.00] \times [b0.32]$$

With:

[d0.11]: User-defined output velocity

[d0.00]: Output frequency

[b0.32]: User-defined proportion factor for velocity

Users may convert the frequency to any other form they feel easy to understand via parameter b0.32.

PID reference engineering value

$$[d0.14] = \text{PID reference} \times [b0.33]$$

With:

[d0.14]: PID reference engineering value

[b0.33]: PID reference / feedback coefficient

PID feedback engineering value

[d0.15] = PID feedback x [b0.33]

With:

[d0.15]: PID feedback engineering value

[b0.33]: PID reference / feedback coefficient

Users may convert the PID engineering value to any other form they feel easy to understand via parameter b0.33.



In case the value of a monitoring parameter is too big to fit into the 4-digit display:

- If the display value is between 1,000.0 and 9,999.9, 1000 ~ 9999 is displayed without the display of the decimal point.
- If the display value is not less than 10,000, the higher 4 digits are displayed and the rightmost decimal point is lit to indicate that one more digit is hidden to the right, for example: "12340" is displayed as "1234.".

| | |
|--------------------------------|---|
| b0.34 | Time constant for high resolution output current |
| Setting range | 5 ~ 500 ms |
| Minimum unit | 1 ms |
| Factory default | 40 ms |
| b0.35 ~ b0.39: Reserved | |

Used to set the resolution of dynamic output current in applications where a high resolution value with two decimals are required for monitoring or control.

8.1.5 System Information

| | |
|--------------------------------|--------------------------------|
| b0.40 | Cumulative running time |
| Setting range | 0 ~ 65535 hours |
| Minimum unit | 1 hour |
| Factory default | 0 hour |
| b0.41 ~ b0.49: Reserved | |

Used to display the switching-on time of a frequency converter. When the cumulative running time exceeds 65535 hours, the counter remains at 65535.

8.2 Group b1: Basic Parameters

8.2.1 Basic Running Control

| b1.00 | The first frequency setting source |
|-----------------|------------------------------------|
| Setting range | 0 ~ 6 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Given by panel potentiometer
Set the frequency by adjusting the potentiometer on the operating panel.
- 1: Given by panel digital setting
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 running. See descriptions for parameter b1.01.
- 2: Given by external analog input voltage (AIV)
Set the frequency by external analog voltage input. The input resistance is 40 kΩ. Please also set parameters E0.10 ~ E0.28.
- 3: Given by external analog input current (AIC)
Set the frequency by external analog current input. The input resistance is 499 Ω. Please also set parameters E0.10 ~ E0.28.
- 4: Set by external **UP / DOWN** terminals
In this mode, the output frequency can be adjusted easily with the UP, DOWN and RESET terminals. For details, please see parameters S3.32 and S3.33.
- 5: Given by communication
Set output frequency by communication with an external computer or PLC. For relevant settings, please refer to parameters in group H.
- 6: Given by multi-speed
 - Set [b1.00]=6
 - When RUN / STOP command source is from panel, any 3 of parameters E0.01 ~ E0.05 need to be set as: one to 1 "Multi-speed control terminal 1", one to 2 "Multi-speed control terminal 2" and one to 3 "Multi-speed control terminal 3". Acceleration / deceleration time and rotation direction can be defined by multi-speed / PLC configuration (See parameters E2.35 ~ E2.50).
 - When RUN / STOP command source is from external terminals (2-wire / 3-wire control mode), the direction command source comes from 2-wire / 3-wire running control (E0.00). Other spare external terminals can be used for multi-frequency selection. Acceleration / deceleration time can be defined by multi-speed / PLC configuration (see parameters E2.35 ~ E2.50).

| | |
|-----------------|-------------------------------------|
| b1.01 | Digital set frequency saving |
| Setting range | 0 ~ 3 |
| Minimum unit | 1 |
| Factory default | 0 |

Used to decide if the digital settings via ▲/▼ will be automatically saved at power off or in stop mode.

- 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



Value changes set by b1.04 are always retained.

| | |
|-----------------|-------------------------------------|
| b1.02 | The first RUN command source |
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Inputting commands by operating panel
Using keys **Run** and **Stop** on the operating panel to run and stop the frequency converter.
- 1: Inputting commands by external terminals
Using external terminals to control run, stop, forward and reverse. For details, please refer to the description in group E0.
- 2: Inputting commands by communication
Running, stopping, forwarding or reversing of the frequency converter are controlled by communication. See [chapter 13 "Communication Protocols" on page 184](#).



If [b1.02] = 1 or 2, the **Stop** key on the operating panel can be enabled with S3.35.

| | |
|-----------------|------------------------------|
| b1.03 | Reserved |
| b1.04 | Digital set frequency |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 50.00 Hz |

When "The first frequency setting source" [b1.00]=1, the value of b1.04 is the set frequency.

| | |
|-----------------|------------------------|
| b1.05 | Max. frequency |
| Setting range | 50.00 ~ 400.00 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 50.00 Hz |
| b1.06 | Upper frequency |
| Setting range | [b1.07] ~ [b1.05] |
| Minimum unit | 0.01 Hz |
| Factory default | 50.00 Hz |
| b1.07 | Lower frequency |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |

- b1.05 is the maximum allowed output frequency of the frequency converter.
- The "Upper frequency" b1.06 and "Lower frequency" b1.07 represent the maximum and minimum allowed output frequency set according to the requirements in applications.

| | |
|-----------------|-----------------------------------|
| b1.08 | Lower frequency mode |
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |
| b1.09 | Hysteresis frequency width |
| Setting range | 0.00 Hz ~ [b1.07] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |

Two running modes are available when the lower frequency is reached:

- [b1.08]=0: Running with 0 Hz
When the lower frequency is reached, the frequency converter is running with 0 Hz. To avoid the tingle at lower frequency, a hysteresis frequency width is needed.
- [b1.08]=1: Running with lower frequency
If the lower frequency is reached, the frequency converter is running with the lower frequency. If command frequency is higher than [b1.07] + [b1.09] again, the output frequency will accelerate from [b1.07] to the command value according to the acceleration time.

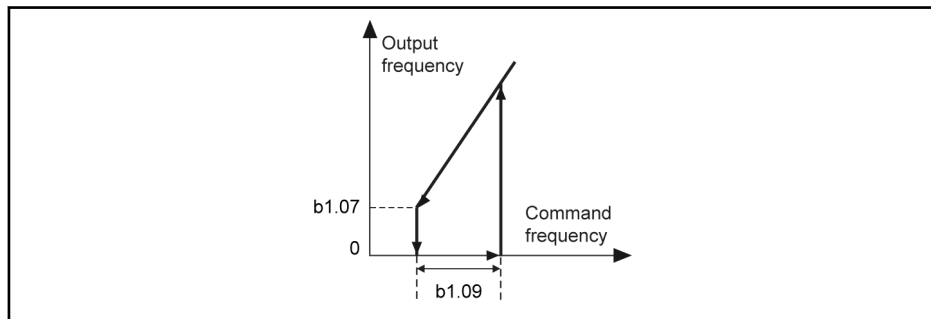


Fig. 8-1: [b1.08]=0

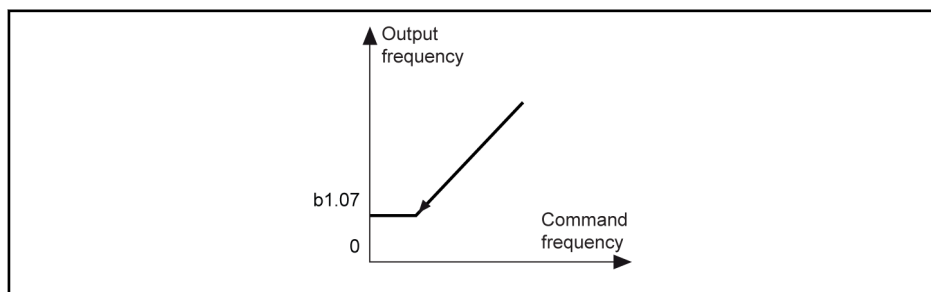


Fig. 8-2: [b1.08]=1

| b1.10 | Direction control |
|-----------------|-------------------|
| Setting range | 0 ~ 3 |
| Minimum unit | 1 |
| Factory default | 0 |

Used for general settings of direction control. It accepts all the direction control source (operating panel, communication and external terminal).

- 0: Both directions
- 1: Forward only. When reverse rotation command is active, the frequency converter will stop immediately and the error(s) shows up (dir1/dir2).
- 2: Reverse only. When forward rotation command is active, the frequency converter will stop immediately and the error(s) shows up (dir1/dir2).
- 3: Inverse default direction.

An adjustable dead zone time between forward and reverse can be set, please refer to S3.30.

| b1.11 | Operating panel controls direction |
|-----------------|------------------------------------|
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |

This parameter is only applicable for operations by the operating panel.

- 0: Forward rotation
- 1: Reverse rotation

The relationship between [b1.10] and [b1.11] is:

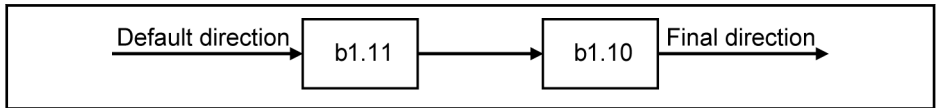


Fig. 8-3: Relationship between [b1.10] and [b1.11]

| Direction control [b1.10] | | Default direction [b1.11] | Final direction |
|---------------------------|---------------------------|---------------------------|-----------------|
| 0 | Both directions | Forward | Forward |
| | | Reverse | Reverse |
| 1 | Forward only | Forward | Forward |
| | | Reverse | STOP with error |
| 2 | Reverse only | Forward | STOP with error |
| | | Reverse | Reverse |
| 3 | Inverse default direction | Forward | Reverse |
| | | Reverse | Forward |



For "STOP with error", please see [chapter 9.5 "Diagnosis on Errors"](#) on page 126.

Normally, each RUN / STOP command source has its own direction command source. The generated direction is further controlled by internal direction control (b1.10).

| Frequency source | RUN / STOP command source | Direction command source |
|--|---|--|
| Multi-speed | Operating panel | Defined by multi-speed/PLC configuration |
| | 2-wire / 3-wire running control E0.00 | 2-wire / 3-wire running control E0.00 |
| | Communication | Communication |
| Other setting sources in b1.00 and b1.16 | Panel | Defined by b1.11 |
| | 2-wire / 3-wire running control E0.00 | 2-wire / 3-wire running control E0.00 |
| | Communication | Communication |
| b1.12~b1.14 | Reserved | |
| b1.15 | Combination frequency command source | |
| Setting range | 0 ~ 2 | |

| | |
|-----------------|---|
| Minimum unit | 1 |
| Factory default | 0 |

- 0: No combination
- 1: First frequency setting + second frequency setting
- 2: First frequency setting - second frequency setting

EFC 3600 has two frequency setting sources: the first frequency setting source b1.00 and the second frequency setting source b1.16. It is allowed to use any or the combination of them.

- When the combination of two sources is active:

The reference and calculation of each part of the combination follows the rules and definitions when it is used as a single command source input. Each part of the combination has the full frequency range, which means that the combined frequency may theoretically become smaller than 0.00 Hz ([b1.15] = 2) or larger than [b1.06] ([b1.15] = 1). So the combined frequency is limited to the range of 0.00 Hz ~ [b1.06].

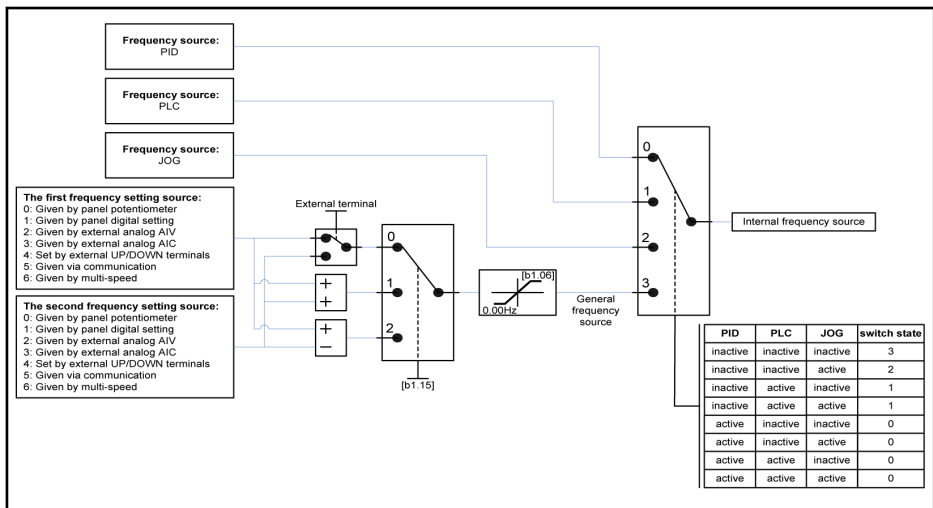


Fig. 8-4: Priority of frequency source

- When the combination of two sources is inactive:

The two frequency sources can be switched by external terminals ([E0.01] ~ [E0.05]=18), for details, see "Multi-function digital input terminals".

- When the combination is disabled and switching terminal is inactive, frequency command value is given by the first frequency setting source.
- When the combination is disabled and switching terminal is active, frequency command value is given by the second frequency setting source.

| | |
|-----------------|--|
| b1.16 | Second frequency setting source |
| Setting range | 0 ~ 6 |
| Minimum unit | 1 |
| Factory default | 2 |

- 0: Given by panel potentiometer
- 1: Given by panel digital setting
- 2: Given by external analog input voltage (AIV)
- 3: Given by external analog input current (AIC)
- 4: Set by external UP / DOWN terminals
- 5: Given by communication
- 6: Given by multi-speed



See descriptions for parameter b1.00.

| | |
|--------------------------------|--------------------------------------|
| b1.17 | The second RUN command source |
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |
| b1.18 ~ b1.19: Reserved | |

- 0: Inputting commands by operating panel
- 1: Inputting commands by external terminals
- 2: Inputting commands by communication

8.2.2 Acceleration/deceleration Control

| | |
|-----------------|----------------------------|
| b1.20 | Acceleration time 1 |
| Setting range | 0.1 ~ 6,000.0s |
| Minimum unit | 0.1s |
| Factory default | 5.0s |
| b1.21 | Deceleration time 1 |
| Setting range | 0.1 ~ 6,000.0s |
| Minimum unit | 0.1s |
| Factory default | 5.0s |

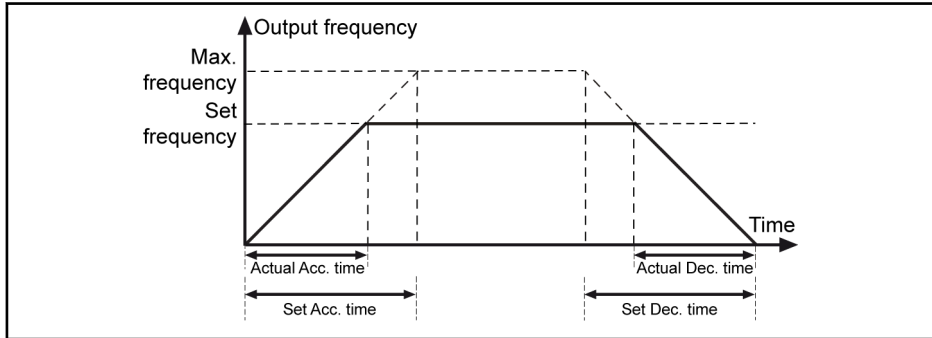


Fig. 8-5: Acceleration / Deceleration time

For EFC 3600, acceleration / deceleration time is defined as the time from zero to the Max. frequency and from the Max. frequency to zero. 4 groups of acceleration / deceleration time are available, which can be selected by external terminals. For related settings, please see E0.01 ~ E0.05 and E2.00 ~ E2.05.



Jog function has its own acceleration and deceleration time.

| | |
|--------------------------------|---|
| b1.22 | Acceleration / deceleration curve mode |
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |
| b1.23 | S curve starting phase proportion |
| Setting range | 0.0 % ~ 40.0 % |
| Minimum unit | 0.1 % |
| Factory default | 20.0 % |
| b1.24 | S curve stopping phase proportion |
| Setting range | 0.0 % ~ 40.0 % |
| Minimum unit | 0.1 % |
| Factory default | 20.0 % |
| b1.25 ~ b1.29: Reserved | |

Used to set the acceleration / deceleration mode of the frequency converter to linear mode or S-curve in start, stop, forward / reverse, acceleration / deceleration processes.

- [b1.22]=0: Linear mode

The output frequency is increased or decreased in linear as shown in figure below.

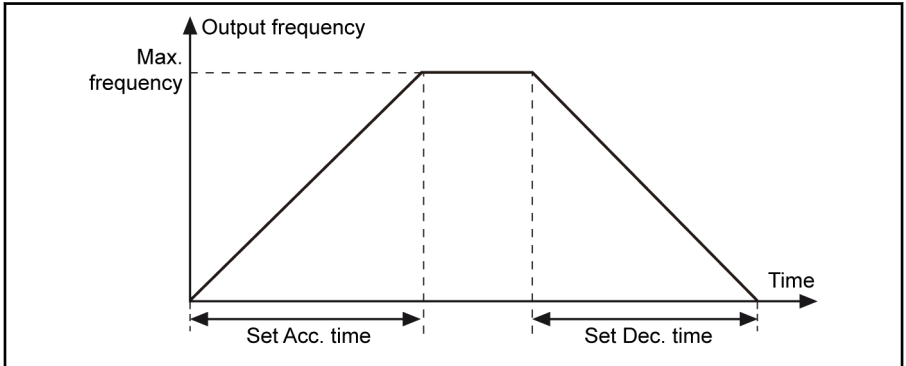


Fig. 8-6: Linear mode

- [b1.22]=1: S-curve

The output frequency is increased or decreased in an S-curve (the S-curve mode is used to achieve smooth start or stop) as shown in figure below.

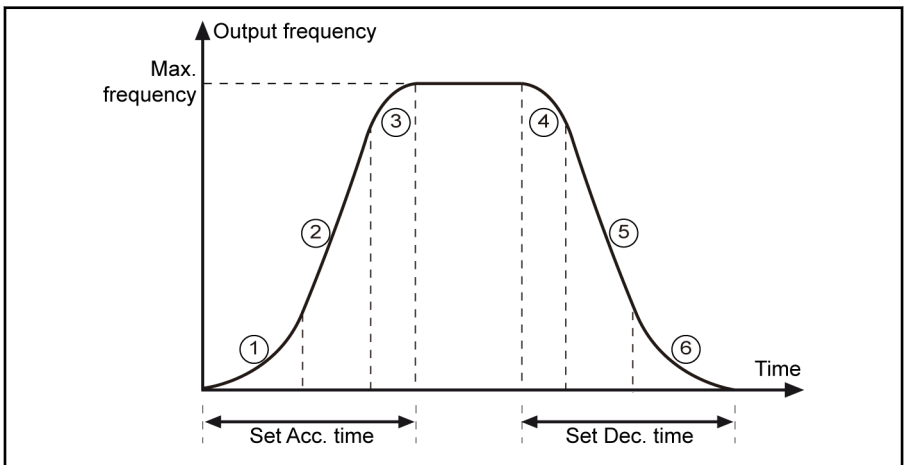


Fig. 8-7: S-curve



- Stage ① is defined by b1.23 with percent of acceleration time.
- Stage ④ is defined by b1.23 with percent of deceleration time.
- Stage ③ is defined by b1.24 with percent of acceleration time.
- Stage ⑥ is defined by b1.24 with percent of deceleration time.

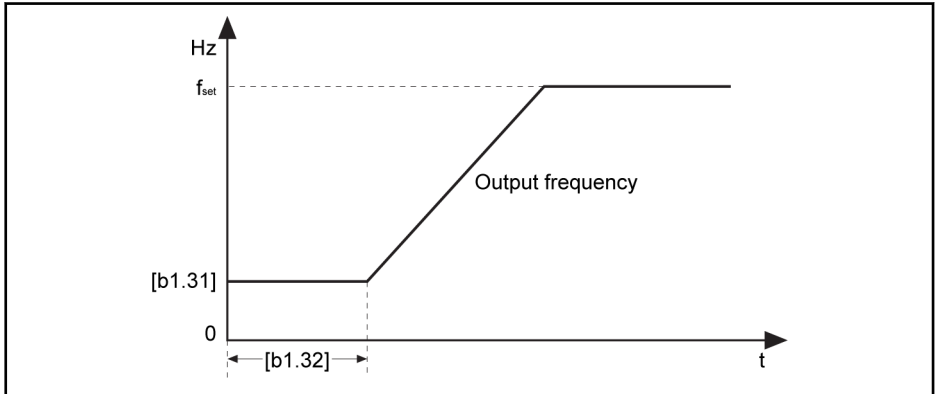
8.2.3 Starting configuration

| | |
|--------------------------------|---|
| b1.30 | Starting mode |
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |
| b1.31 | Starting frequency |
| Setting range | 0.00 ~ 50.00 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 0.05 Hz |
| b1.32 | Starting frequency holding time |
| Setting range | 0.0 ~ 20.0s |
| Minimum unit | 0.1s |
| Factory default | 0.1s |
| b1.33 | Starting DC braking time |
| Setting range | 0.0 ~ 20.0s (0.0 represents no action of starting DC braking) |
| Minimum unit | 0.1s |
| Factory default | 0.0s |
| b1.34 | Starting DC braking current |
| Setting range | 0.0 % ~ 150.0 % (of rated frequency converter current) |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |
| b1.35 ~ b1.39: Reserved | |

- [b1.30]=0: Start directly

This mode is suitable for circumstances with high static friction torque and low load inertia.

The frequency converter runs at "Starting frequency" [b1.31], for "Starting frequency holding time" [b1.32], and accelerates to set frequency with defined acceleration time.



f_{set} Set frequency

Fig. 8-8: Start directly

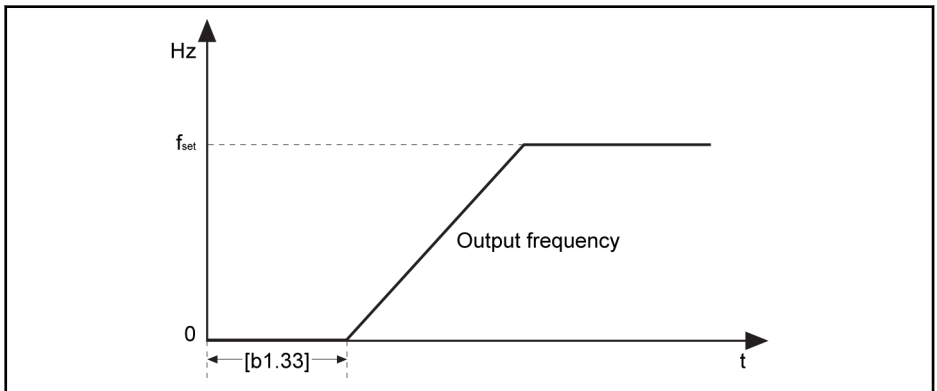


"Starting frequency holding time" b1.32 needs to be set as a non-zero value when the motor needs to be started with certain starting frequency.

- [b1.30]=1: Braking before start

This mode is suitable for circumstances where the load may encounter forward / reverse rotation when the frequency converter is in stop mode.

"Starting DC braking time" [b1.33] ≠ 0s, DC braking is executed before accelerating to "Starting frequency" [b1.31].



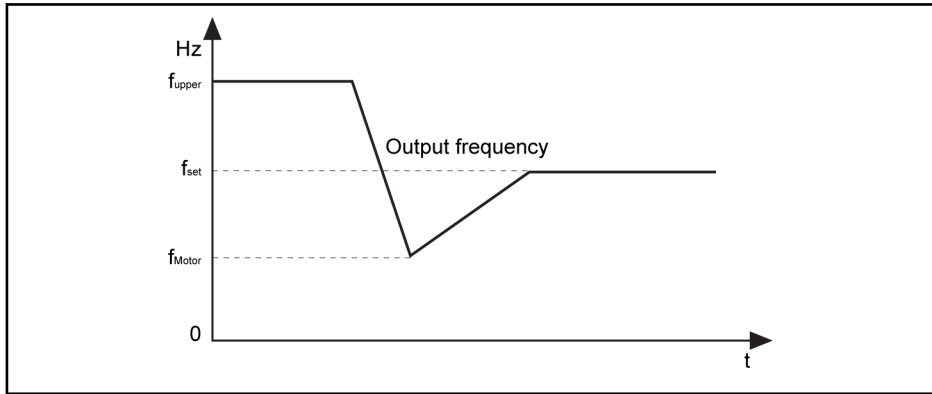
f_{set} Set frequency

Fig. 8-9: Braking before start

- [b1.30]=2: Start with speed capture

This mode is suitable for restarting after transient power fault in the case of a large inertia load.

The frequency converter firstly identifies the rotation speed and direction of the motor and then starts with the current frequency of the motor to realize smooth starting without shock to the rotating motor.



f_{upper} Upper frequency
 f_{set} Set frequency

f_{Motor} Motor frequency

Fig. 8-10: Start with speed capture



When the frequency converter is starting and accelerating, if the set frequency is lower than the "Starting frequency" [b1.31], the frequency converter firstly starts at the starting frequency and runs for "Starting frequency holding time" [b1.32], and then decelerates to the set frequency.

The actual starting DC braking current is calculated as below:

- If the x % of rated frequency converter current is lower than the rated motor current, then the actual starting DC braking current is x % of rated frequency converter current.
- If the x % of rated frequency converter current is higher than the rated motor current, then the actual starting DC braking current is the rated motor current.

Example: For a frequency converter of 0K75 / 200 V, the rated current is 3.9 A, the motor rated current is 3.45 A, when b1.34 input is 100 %, the actual starting DC braking current is 3.45 A.

8.2.4 Stopping Configuration

| b1.40 | Stopping mode |
|-----------------|---------------|
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Decelerating to stop

The frequency converter decelerates to stop according to the defined deceleration time.



- If an error happens due to too fast deceleration, extend the deceleration time or calculate if additional brake resistors are required.
- If the output frequency is lower than the "Stopping DC braking initial frequency" [b1.41] and "DC braking time" [b1.42] $\neq 0$, DC braking is activated. The DC braking current is decided by b1.43.
- DC braking is suitable for circumstances where regular deceleration to stop or quick stopping is required. The larger DC braking current, the larger braking force. However, the withstanding capability of the motor has to be taken into account.

● 1: Freewheeling to stop

Once the stopping command is activated, the frequency converter stops output and the motor mechanically freewheels to stop.

● 2: Freewheeling with STOP-command, decelerating when direction changes

This function also allows the frequency converter freewheeling to stop if STOP-command is active and decelerating to stop according to stopping mode (e.g., deceleration time and stopping DC braking) when direction change command is active during running.



The digital input "freewheeling to stop" is an additional source for the STOP command. When the digital input is active, the frequency converter will freewheels to stop immediately regardless of its previous status. The frequency converter will only return to the running state when a run command is active and the digital input has been deactivated. Please refer to E0.01 ~ E0.05 for more details.

| | |
|-----------------|---|
| b1.41 | Stopping DC braking initial frequency |
| Setting range | 0.00 ~ 50.00 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| b1.42 | Stopping DC braking time |
| Setting range | 0.0 ~ 20.0s (0.0 represents no action of stopping DC braking) |
| Minimum unit | 0.1s |
| Factory default | 0.0s |
| b1.43 | Stopping DC braking current |
| Setting range | 0.0 % ~ 150.0 % (of rated frequency converter current) |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |

There are two ways to carry out the stopping DC braking: parameter setting and digital input. DC-braking will only be activated, when

- a stop command is active, and
- [b1.40] = 0, and
- output frequency \leq [b1.41], and
- digital input "Stopping DC-braking enabled" is active, or [b1.42] > 0.



When [b1.42] > 0 and digital input "Stopping DC-braking enabled" (Xn terminal is set as 13) is active, the frequency converter will keep on DC-braking before the digital input goes inactive, even if the time [b1.42] is elapsed.

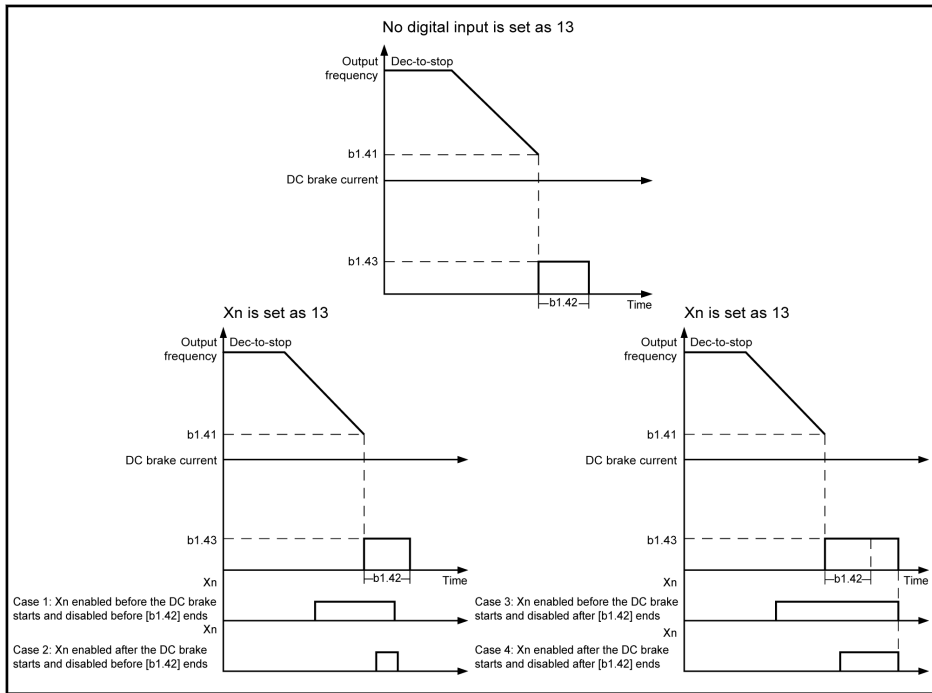


Fig. 8-11: Stopping DC braking



For the actual stopping DC braking current calculation, see descriptions in parameter b1.30.

| | |
|--------------------------------|---|
| b1.44: Reserved | |
| b1.45 | Overexcitation deceleration gain |
| Setting range | 1.00 ~ 1.40 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |
| b1.46 ~ b1.49: Reserved | |

Used for the fine tuning of over excitation deceleration to obtain a better level of over excitation in V/F control mode.

- A higher gain will increase the braking capability of overexcitation.
- Reduce [b1.45] when the motor slip gets too high, which can trigger overcurrent (OC), frequency converter overload (OL-1), or motor overload (OL-2) errors.

8.3 Group S0: V/F Control

8.3.1 V/F Curve

| S0.00 | V/F control mode |
|-----------------|------------------|
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Linear mode

This mode refers to linear voltage / frequency control, which is suitable for normal constant torque loads as shown in the figure below.

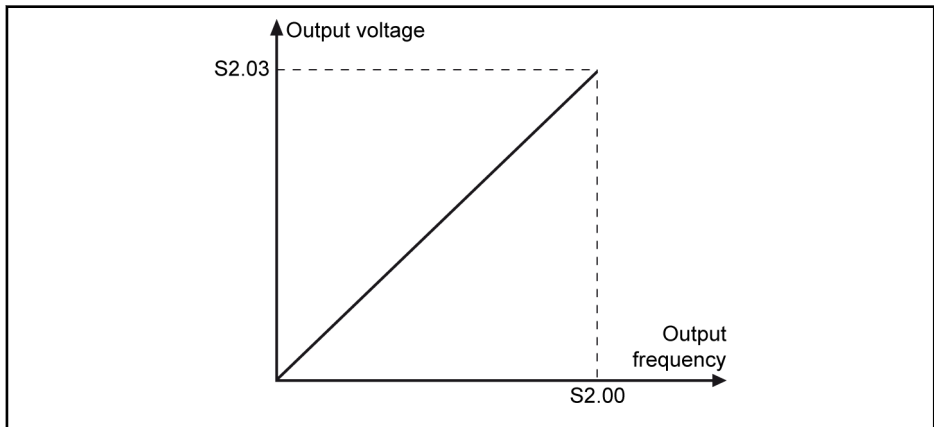


Fig. 8-12: Linear mode

- 1: Square curve

This mode refers to square voltage / frequency control, which is suitable for variable torque loads of fans, pumps, etc.

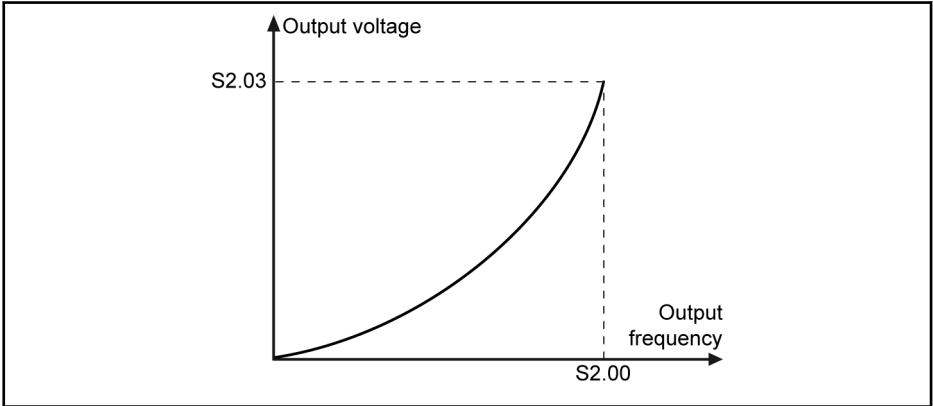


Fig. 8-13: Square curve

- 2: User-defined multipoint curve

Users can define a V/F curve with S0.01 - S0.06 for special loads of dewatering machines, centrifuges, etc.

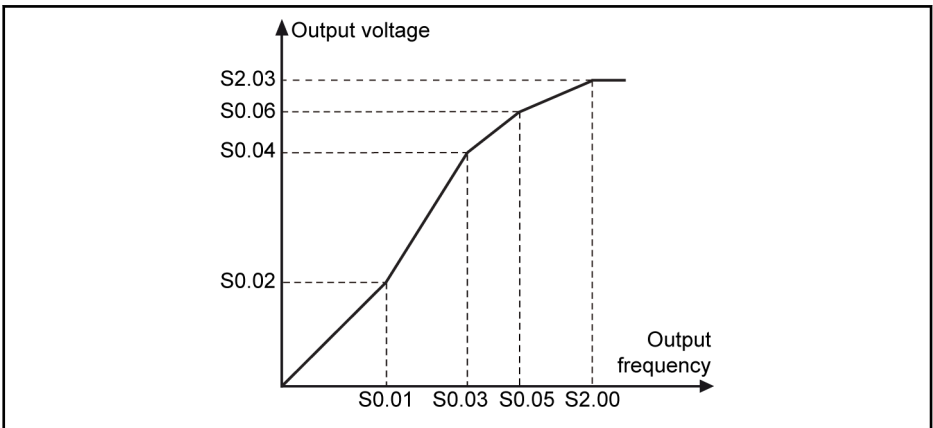


Fig. 8-14: User-defined multipoint curve

⚠ WARNING

Excessive voltage at low-frequency may cause the motor to overheat and be destroyed, and the frequency converter may stall due to over-current or activate overcurrent protection!

| | |
|------------------------------|--|
| S0.01 | V/F frequency 1 |
| Setting range | 0.00 Hz ~ [S0.03] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| S0.02 | V/F voltage 1 |
| Setting range | 0.0 % ~ 120.0 % (of rated motor voltage) |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |
| S0.03 | V/F frequency 2 |
| Setting range | [S0.01] ~ [S0.05] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| S0.04 | V/F voltage 2 |
| Setting range | 0.0 % ~ 120.0 % (of rated motor voltage) |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |
| S0.05 | V/F frequency 3 |
| Setting range | [S0.03] ~ [b1.05] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| S0.06 | V/F frequency 3 |
| Setting range | 0.0 % ~ 120.0 % (of rated motor voltage) |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |
| S0.07–S0.19: Reserved | |

Each V/F frequency is limited by neighboring V/F frequencies. In this case, the frequencies of these points must be set in an ascending sequence:

$$0 \leq \text{V/F frequency 1} \leq \text{V/F frequency 2} \leq \text{V/F frequency 3} \leq \text{Motor rated frequency}$$

It is necessary to have voltage above rated voltage in the field weakening range. For this,

- the maximum value of S0.05 "V/F frequency 3" can be above the rated frequency.
- the maximum value of S0.06 "V/F voltage 3" can be increased above 100 %.

There are two possibilities for the V/F curve:

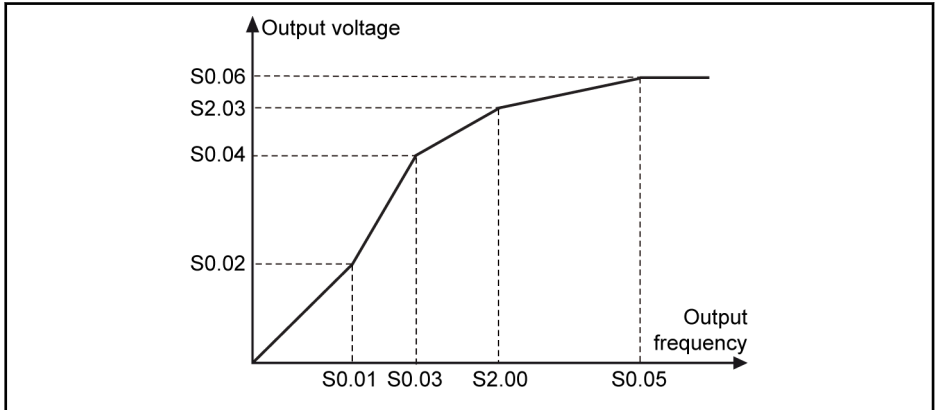


Fig. 8-15: [S0.05] "V/F frequency 3" above [S2.00] "motor rated frequency"

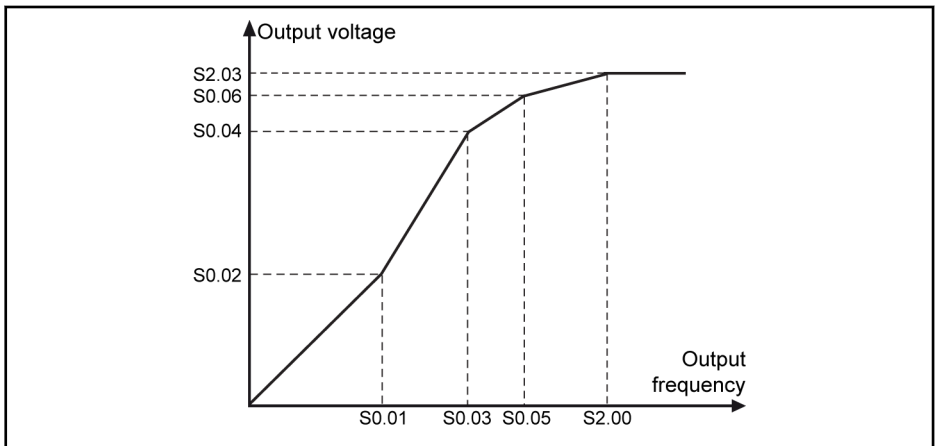


Fig. 8-16: [S0.05] "V/F frequency 3" below [S2.00] "motor rated frequency"

In this case, the output voltage is limited to 100 % even if [S0.06] "V/F voltage 3" is above 100 %.

8.3.2 Enhanced V/F Control

| S0.20 | Rated motor slip frequency |
|-----------------|----------------------------|
| Setting range | 0.00 ~ 20.00 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |

Used to compensate the speed difference caused by the load in V/F control, and to ensure that the rotator's speed is close to the synchronous speed with rated load and improve the mechanical behavior of the motor, as shown in the figure below:

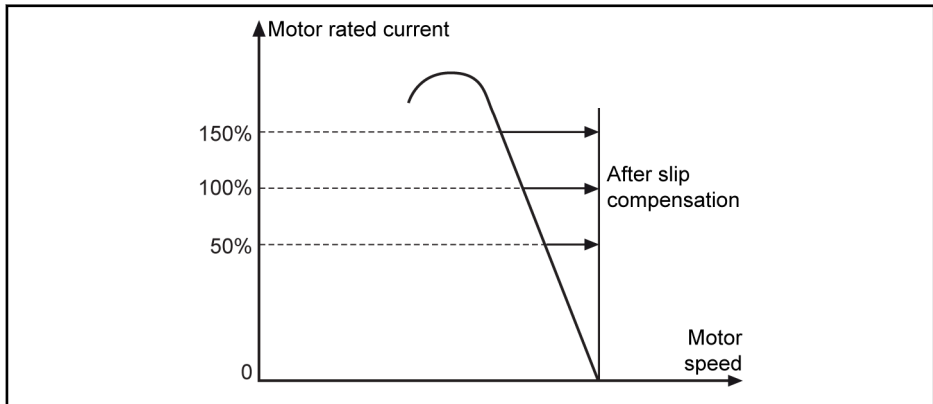


Fig. 8-17: Slip frequency compensation

This parameter should be set according to the data on the motor nameplate. If it is unavailable on the nameplate, please calculate the data with the formula below:

$$n_s = f_n \bullet 60 / p$$

$$s = \frac{n_s - n_n}{n_s}$$

$$f_s = s \bullet f_n$$

n_s synchronous speed
P numbers of pole pairs
S rated slip

n_n rated speed
f_s rated slip frequency
f_n rated frequency

Fig. 8-18: Slip frequency calculation



- If the slip frequency compensation is too large, the motor speed may exceed the synchronous speed.
- Slip compensation will not work under circumstances of acceleration, deceleration, regenerative mode and DC braking.

| | |
|-----------------|---|
| S0.21 | Voltage boost |
| Setting range | 0.0 % - 20.0 % (of rated motor voltage) |
| Minimum unit | 0.1 % |
| Factory default | 5.0 % |

To obtain higher output torque and better stabilization, especially in low speed range, the voltage generated at the motor resistor must be taken into account. So, a voltage boost must be provided by setting corresponding parameters.

- [S0.21]=0.1 % - 20.0 %: manual voltage boost

This value demonstrates the voltage boost value at zero frequency. For other frequency range, the voltage boost value is linear / square decreasing with increasing output frequency before a certain frequency.

For linear V/F curve, this function is only valid before half of base frequency, for example: if "Base frequency" [S2.00] is 50.00 Hz, then voltage boost function is only valid before 25.00 Hz.

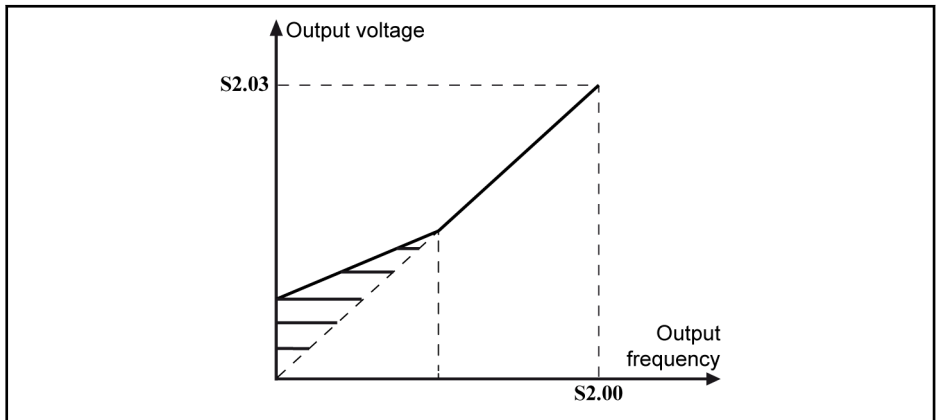


Fig. 8-19: Linear V/F curve manual voltage boost

For square V/F curve, this function is valid before base frequency, for example: if base frequency is 50.00 Hz, then voltage boost function is only valid before 50.00 Hz.

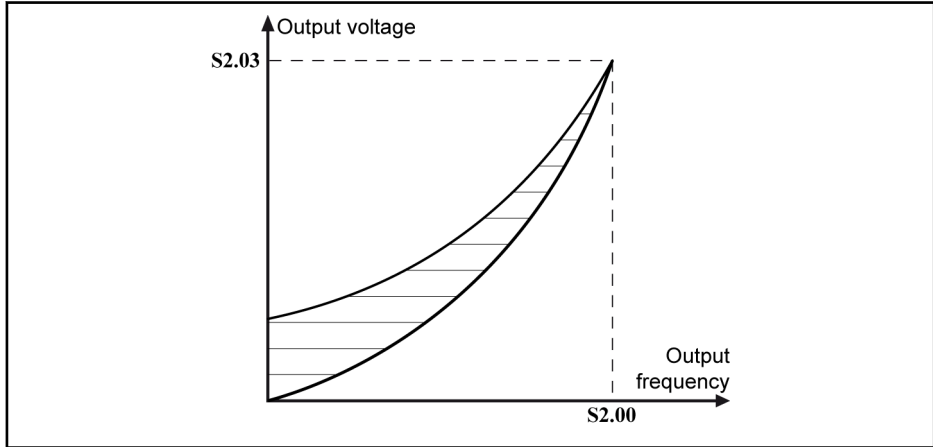


Fig. 8-20: Square V/F curve manual voltage boost



For user-defined curve, the boost rule is the same with linear V/F curve.

- [S0.21]=0.0 %: automatic voltage boost
Determines automatically the percentage of output voltage boost based on the output frequency and the load current. The linear and square V/F curves for automatic voltage boost are shown as below. See parameter S0.22 for more details.

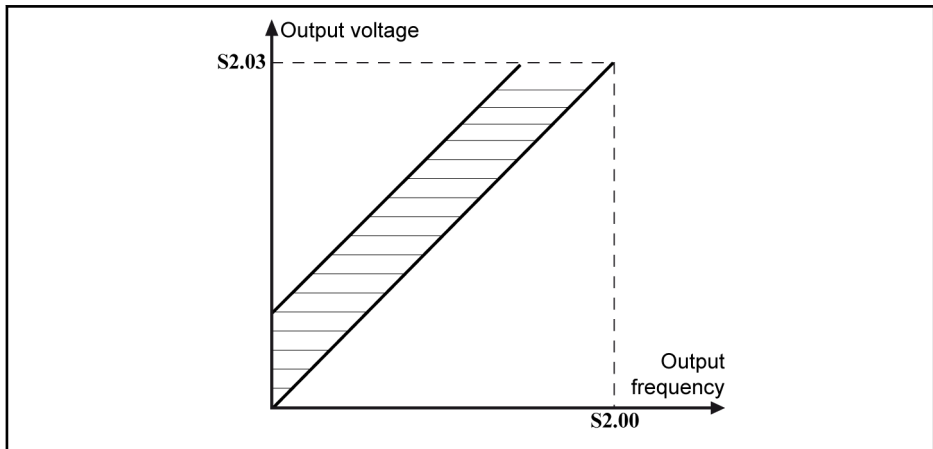


Fig. 8-21: Linear V/F curve auto voltage boost

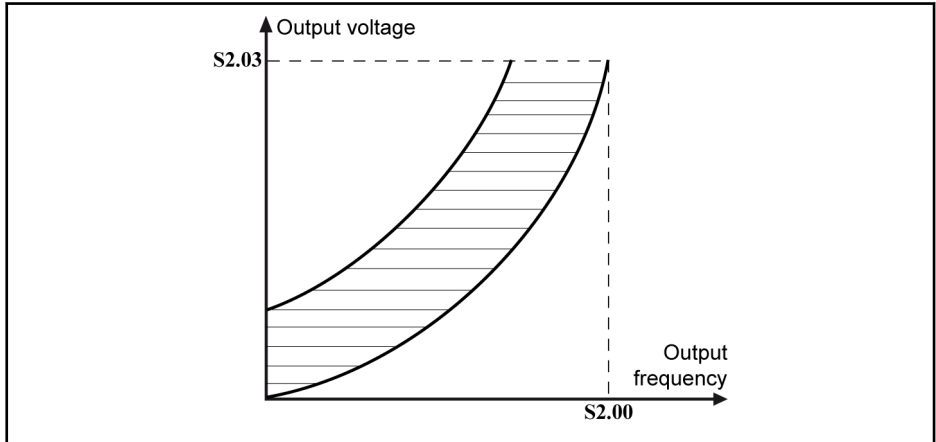


Fig. 8-22: Square V/F curve auto voltage boost

| S0.22 | I ² R boost factor |
|-----------------|-------------------------------|
| Setting range | 0 % ~ 320 % |
| Minimum unit | 1 % |
| Factory default | 100 % |

Used for further adjustment of the voltage boost. Its default value is 100 % which means no adjustment is needed. The formula is shown as below:

$$\text{Voltage boost} = \sqrt{3} * 0.5 * I_1 * R_1 * [S0.22]$$

Fig. 8-23: Voltage boost

R_1 : stator resistance

I_1 : stator current

Thus, R_1 should be preset or calculated or tuned, and then input to S2.10.

| S0.24 | Heavy load voltage stabilization |
|-----------------|----------------------------------|
| Setting range | 0: disable; 1: enable |
| Minimum unit | 1 |
| Factory default | 1 |

Used to depress the fluctuations in output voltage and current caused by big impact to DC bus voltage in case of heavy load.

| S0.25 | Anti hunting factor |
|-----------------|---------------------|
| Setting range | 0 % ~ 5,000 % |
| Minimum unit | 1 % |
| Factory default | 0 % |

Used to suppress the motor vibration in the case of light load or no load. Increasing of this value will bring better effect of vibration suppression (anti hunting), but too much increase will cause unstable running of the motor. Default value of 0 % means no vibration suppression.

| | |
|--------------------------------|-----------------------------------|
| S0.26 | Anti hunting filter factor |
| Setting range | 10 % ~ 2,000 % |
| Minimum unit | 1 % |
| Factory default | 100 % |
| S0.27 ~ S0.29: Reserved | |

The default value can suppress the vibration in most situations. However, adjustment of the value might be helpful in the following circumstances:

- Increase the value if the vibration suppression is not obvious, but too much increase will lead to slower response of suppression.
- Decrease the value if the vibration occurs at low speed.

8.3.3 No-trip Control

| | |
|-----------------|---|
| S0.30 | Current limitation control |
| Setting range | 0: OFF 1: OFF at constant speed 3: ON at constant speed |
| Minimum unit | 1 |
| Factory default | 0 |
| S0.31 | Automatic current limitation level |
| Setting range | 20 % ~ 250 % (of rated frequency converter current) |
| Minimum unit | 1 % |
| Factory default | 200 % |
| S0.32 | Current regulator proportion factor |
| Setting range | 0.000 ~ 1.000 |
| Minimum unit | 0.001 |
| Factory default | 0.060 |
| S0.33 | Current regulator integrating time constant |
| Setting range | 0.001 ~ 10.000 |
| Minimum unit | 0.001 |
| Factory default | 0.200 |

S0.30: Used to limit current, so that the tripping of frequency converter is avoided. The function is useful for loads with large inertia or sudden changes.

3 modes of current limitation control are available:

- [S0.30]=0: OFF.

Current limitation control is deactivated in any case.

- [S0.30]=1: OFF at constant speed.

Current limitation control works during Acc. and Dec., but is deactivated at constant speed.

- [S0.30]=3: ON at constant speed.

Current limitation control works in all cases: Acc., Dec. and constant speed.

The current regulator is a PI regulator with configurable P (Proportion) and I (Integration).

- The higher value of P factor S0.32, the faster the current change.
- The higher value of I factor S0.33, the less accuracy of current suppression.



- The default settings of S0.32 and S0.33 can satisfy most applications. If slight modification is needed, please try to increase P factor first to make sure there is no vibration, then decrease integrating time to make sure fast responding and no overshooting.
 - [E4.03] "Stall overcurrent prevention level" should be smaller than [S0.31] "Automatic current limitation level", otherwise warning "PrSE" will be displayed and the parameter will not be changed.
-

8.4 Group S2: Motor Parameters

8.4.1 Motor Nameplate Parameters

| | |
|--------------------------------|-----------------------------------|
| S2.00 | Rated motor frequency |
| Setting range | 5.00 ~ 400.00 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 50.00 Hz |
| S2.01 | Rated motor rotation speed |
| Setting range | 1 ~ 30,000 rpm |
| Minimum unit | 1 rpm |
| Factory default | Depends on model |
| S2.02 | Rated motor power |
| Setting range | 0.1 ~ 1,000.0 kW |
| Minimum unit | 0.1 kW |
| Factory default | Depends on model |
| S2.03 | Rated motor voltage |
| Setting range | 0 ~ 480 V |
| Minimum unit | 1 V |
| Factory default | Depends on model |
| S2.04 | Rated motor current |
| Setting range | 0.01 ~ 655.00 A |
| Minimum unit | 0.01 A |
| Factory default | Depends on model |
| S2.05 | Power-factor |
| Setting range | 0.50 ~ 0.95 |
| Minimum unit | 0.01 |
| Factory default | Depends on model |
| S2.06 ~ S2.09: Reserved | |

8.4.2 Motor Physical Data

| | |
|--------------------------------|----------------------------------|
| S2.10 | Stator resistance |
| Setting range | 0.00 ~ 50.00 Ω |
| Minimum unit | 0.01 Ω |
| Factory default | Depends on model |
| S2.11 | Rotator resistance |
| Setting range | 0.00 ~ 50.00 Ω |
| Minimum unit | 0.01 Ω |
| Factory default | Depends on model |
| S2.12 | Leakage inductance |
| Setting range | 0.00 ~ 200.00 mH |
| Minimum unit | 0.01 mH |
| Factory default | Depends on model |
| S2.13 | Mutual inductance |
| Setting range | 0.0 ~ 3,000.0 mH |
| Minimum unit | 0.1 mH |
| Factory default | Depends on model |
| S2.14 | No-load current |
| Setting range | 0.00 A ~ [S2.04] |
| Minimum unit | 0.01 A |
| Factory default | Depends on model |
| S2.15 | Physical data calculation |
| Setting range | 0 ~ 3 |
| Minimum unit | 1 |
| Factory default | 0 |
| S2.16 ~ S2.19: Reserved | |

The motor parameters (S2.00 ~ S2.05) must be set before using "Physical data calculation" S2.15. The necessary data can be found on the nameplate of motor.

- [S2.15] = 0: No action.
- [S2.15] = 1: Calculation. After the calculation is complete, parameters S2.10 ~ S2.14 will be updated.
- [S2.15] = 2: Automatic adjustment while the motor is in static mode.
- [S2.15] = 3: Automatic adjustment while the motor is rotating.

8.4.3 Motor Thermal Protection

| | |
|--------------------------------|---|
| S2.20 | Sensor type |
| Setting range | 0: PTC; 1: NTC |
| Minimum unit | 1 |
| Factory default | 0 |
| S2.21 | Input channel of motor temperature |
| Setting range | 0: Invalid; 1: Analog input voltage |
| Minimum unit | 1 |
| Factory default | 0 |
| S2.22 | Protection level |
| Setting range | 0.0 ~ 10.0 |
| Minimum unit | 0.1 |
| Factory default | 2.0 |
| S2.23 | Thermal motor time constant |
| Setting range | 0.0 ~ 400.0min |
| Minimum unit | 0.1min |
| Factory default | Depends on model |
| S2.24 ~ S2.39: Reserved | |

Used to protect the motor against overheat. Two means of motor thermal protections are available:

1. Protection with temperature sensor

A temperature sensor needs to be connected externally to the frequency converter. For this matter, 10 V and GND output pins are available on the external signal connector of the frequency converter.

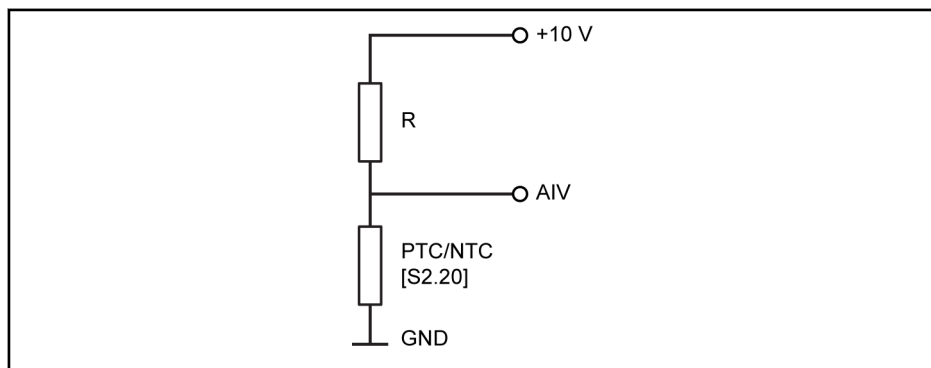


Fig. 8-24: Protection with temperature sensor



- For a good resolution of temperature with continuous sensors (in general: NTCs), the value of resistor R in the figure should be close to the sensor resistance at the motor temperature limit.
- For switching sensors (in general: PTCs), the value of resistor R in the figure should be close to the sensor resistance when the motor is at high temperature.
- A protection threshold may be defined by users according to the sensor's features. If AIV is defined for other purpose, the protection with sensor could not be enabled ([S2.21] is always 0).

2. Protection without temperature sensor

This function is based on the thermal model of the motor. The simplified thermal model of the motor is shown as below:

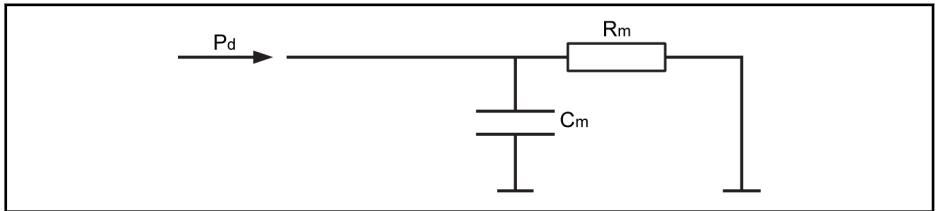


Fig. 8-25: Simplified thermal model of motor with PT1 model



The default value of "Thermal motor time constant" S2.23 is dependent on the device type. If "Motor overload protection" OL-2 happens frequently, please ensure that the output current of the frequency converter does not exceed 110 % of the motor rated current, and increase the value of S2.23 appropriately.

8.5 Group S3: Running Parameters

8.5.1 Jogging Parameters

| | |
|--------------------------------|----------------------------------|
| S3.00 | Jogging frequency |
| Setting range | 0.00 Hz ~ [b1.05] |
| Minimum unit | 0.01 Hz |
| Factory default | 5.00 Hz |
| S3.01 | Jogging acceleration time |
| Setting range | 0.1 ~ 6,000.0s |
| Minimum unit | 0.1 s |
| Factory default | 5.0s |
| S3.02 | Jogging deceleration time |
| Setting range | 0.1 ~ 6,000.0s |
| Minimum unit | 0.1 s |
| Factory default | 5.0s |
| S3.03 ~ S3.04: Reserved | |

- Jogging command input has the highest priority and is independent of the "RUN" / "STOP" command input. As long as jogging command is activated, the frequency converter will start immediately to run to the frequency defined by S3.00 with acceleration / deceleration time defined by parameters S3.01 and S3.02 no matter the frequency converter is in RUN mode or STOP mode. See details in the figure below:

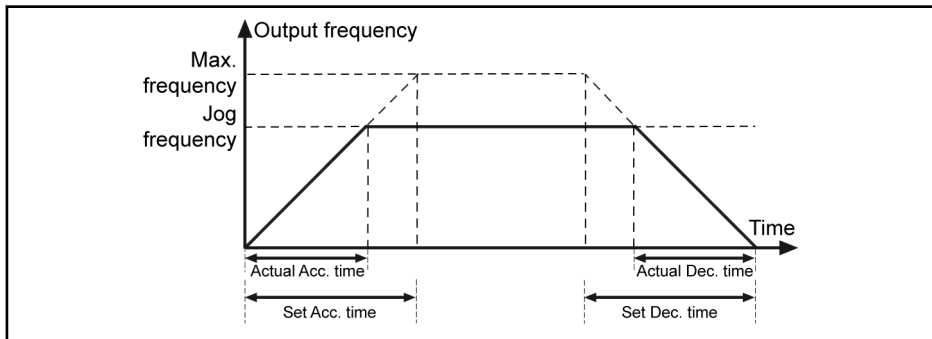


Fig. 8-26: Jogging acceleration / deceleration time

- Jogging command only comes from external terminals or communication.
- When jogging command is activated, the motor runs with predefined frequency; when the jogging command is inactive, the motor resumes the previous status.
- If jogging forward and jogging reverse are active at the same time, the frequency converter will STOP; if the jogging forward / reverse command is acti-

vated during jogging reverse / forward, the frequency converter will STOP according to the setting of "Stopping mode" [b1.40].

8.5.2 Skip Frequency

| | |
|-----------------|-----------------------------|
| S3.05 | Skip frequency 1 |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| S3.06 | Skip frequency 2 |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| S3.07 | Skip frequency 3 |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| S3.08 | Skip frequency range |
| Setting range | 0.00 ~ 30.00 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |

3 skip frequencies can be defined to avoid mechanical resonance. The setting ranges of the skip frequencies are shown in the figure below:

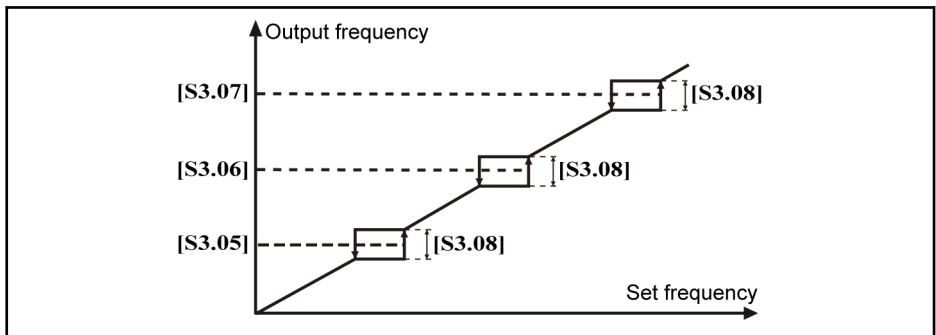


Fig. 8-27: Skip frequencies and ranges

- If the set frequency is in one range and previous output is above this area, the upper frequency (the skip frequency + skip range/2) is output;
- If the set frequency is in one range and previous output is below this area, the lower frequency (the skip frequency - skip range/2) is output;
- If the set frequency is in one range and previous output is within this area, previous output is output.



- If the set frequency is in the hysteresis range (including the boundaries) of defined skip frequency, the frequency is set to upper / lower limit of skip frequency range;
- If the skip frequency range is set to 0.00 Hz, no skip frequency control is enabled;
- Do not make the 3 frequency ranges overlap or nest in each other.

| | |
|--------------------------------|--|
| S3.09 | Skip window acceleration factor |
| Setting range | 1 ~ 100 |
| Minimum unit | 1 |
| Factory default | 1 |
| S3.10 ~ S3.14: Reserved | |

This parameter makes the acceleration inside the skip-window faster, with the range from 1 (normal acceleration) to 100 (acceleration is 100 times faster).



The resulting acceleration and deceleration time will be shorter than the set value when the factor is above 1.

8.5.3 Restarting after Power Fault

| | |
|--------------------------------|--|
| S3.15 | Restarting after power fault |
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |
| S3.16 | Waiting time for restarting after power fault |
| Setting range | 0.0 ~ 10.0s |
| Minimum unit | 0.1s |
| Factory default | 1.0s |
| S3.17 ~ S3.19: Reserved | |

- [S3.15] = 0: Prohibited. No restarting after power fault.
- [S3.15] = 1: Allowed. Restarting after power fault.

If [b1.02] = 0 (RUN command source is from panel), and the frequency converter was running before power off:

- [S3.15] = 1: the frequency converter will automatically start after waiting for the time set by S3.16 without pressing the Run key again after power on.
- [S3.15] = 0: the frequency converter only starts after the Run key is pressed.

If other RUN command source is selected ([b1.02] ≠ 0):

- [S3.15] = 1: the frequency converter will automatically start after waiting for the time set by S3.16 only if a running command exists after power on.

- [S3.15] = 0: the frequency converter will remain static, even if a running command exists after power on. To start the frequency converter, please cancel and reactivate the running command.



- If the frequency converter was running in 3-wire control mode before power fault, the restart of the frequency converter after power on depends on the state of the 3-wire terminal which is responsible for STOP.
- If the frequency converter was running before power fault due to a power supply interference, UE-1 will occur in undervoltage situation, the frequency converter will not restart automatically after input power supply recovers even [S3.15] = 1. This is different from the restarting by automatic fault reset, see details in E4.15 and E4.16.
- During the waiting time after power on, if the active run command source is from communication and there is request on the communication to stop the frequency converter, the frequency converter will not restart automatically.

8.5.4 Brake Chopper Control

| | |
|--------------------------------|--|
| S3.20 | Brake chopper action point |
| Setting range | 200 V class: 300 ~ 390 V; 400 V class: 600 ~ 885 V |
| Minimum unit | 1 V |
| Factory default | 200 V class: 390 V; 400 V class: 885 V |
| S3.21 | Braking duty cycle |
| Setting range | 1 % ~ 100 % |
| Minimum unit | 1 % |
| Factory default | 100 % |
| S3.22 ~ S3.29: Reserved | |

8.5.5 Additional Running Control

| | |
|------------------------|--|
| S3.30 | Forward and reverse rotation dead zone time |
| Setting range | 0.0 ~ 60.0s |
| Minimum unit | 0.1s |
| Factory default | 4.0s |
| S3.31: Reserved | |

S3.30 represents the waiting time when the frequency converter switches from forward / reverse rotation to reverse / forward rotation. See the figure below for more information:

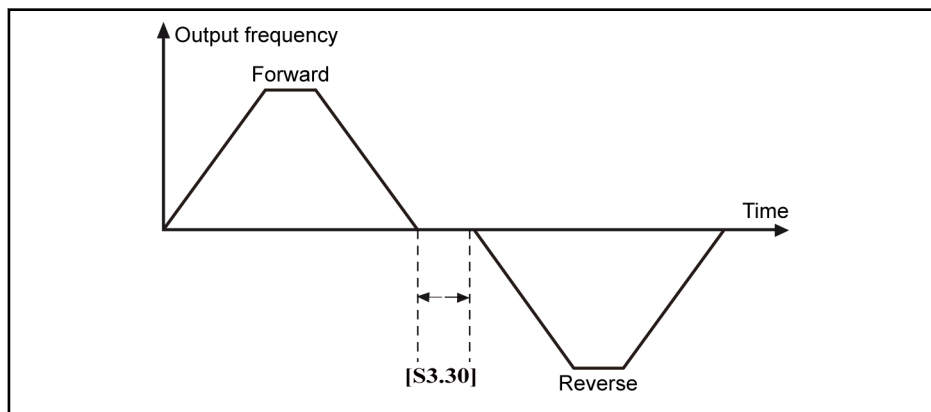


Fig. 8-28: Forward and reverse rotation dead zone time

| | |
|-----------------|--|
| S3.32 | UP / DOWN set velocity |
| Setting range | 0.10 ~ 100.0 Hz/s |
| Minimum unit | 0.01 Hz/s |
| Factory default | 1.00 Hz/s |
| S3.33 | UP / DOWN terminals initial frequency |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |

Used to change the output frequency. When [b1.00] / [b1.16] = 4, the UP / DOWN control is activated as the command source. In this mode, the output frequency can be adjusted easily with UP, DOWN and zeroing terminals. Please follow the following steps to adjust the output frequency.

1. Set [b1.00] / [b1.16]=4.
2. Define any 3 external control terminals in parameters E0.01 ~ E0.05 with one set to 9 "Frequency increment UP command", one set to 10 "Frequency decrement DOWN command", and another set to 11 "Zeroing of external terminal frequency setting".

3. Set S3.32 "UP / DOWN setting ratio" for the frequency change rate of terminals UP / DOWN.

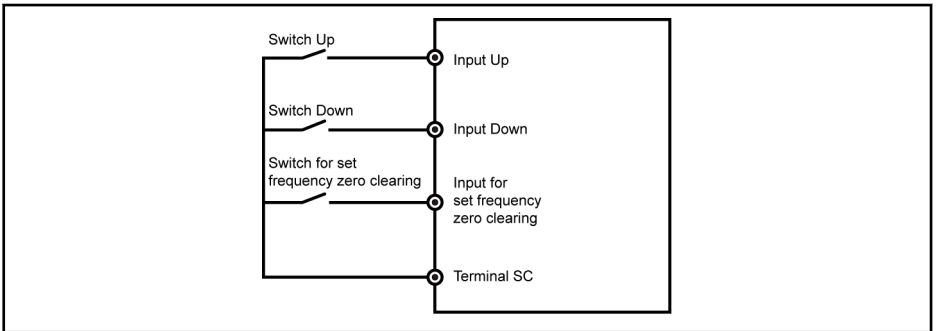


Fig. 8-29: External terminals Up / Down settings

The combination of the control terminals are described as below:

| Input for set frequency zero clearing | Open | | | | Closed |
|--|------|----------|----------|--------|--------|
| Input UP | Open | | Closed | | Either |
| Input DOWN | Open | Closed | Open | Closed | Either |
| Current set frequency of the frequency converter | Hold | Decrease | Increase | Hold | Zero |



- UP / DOWN / Zeroing terminals only work in RUN state.
- Whether the frequencies modified by UP / DOWN terminals will be saved or not after power off depends on the settings of parameter b1.01.

| S3.34 | Fan control |
|-----------------|-------------|
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Automatically controlled
Automatically control the start and stop of the cooling fan according to the detected temperature of the heat sink.
- 1: Always on
The fan will start as long as the frequency converter is "switched on".

| S3.35 | Stopping with Stop key |
|-----------------|---|
| Setting range | 0: Only valid for operating panel control; 1: Valid for all control means |
| Minimum unit | 1 |
| Factory default | 1 |

8.6 Group E0: Input Terminal Parameters

8.6.1 Multi-function Digital Input Terminals

| | |
|-----------------|--|
| E0.00 | 2-wire / 3-wire running control |
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |

In order to run the frequency converter with "2-wire / 3-wire running control", b1.02 / b1.17 needs to be set as 1.

For example: one terminal is assigned as FWD ([E0.01]=23) and connected to K1; another terminal is assigned as REV ([E0.02]=24) and connected to K2.

- [E0.00]=0: Forward / stop, reverse / stop

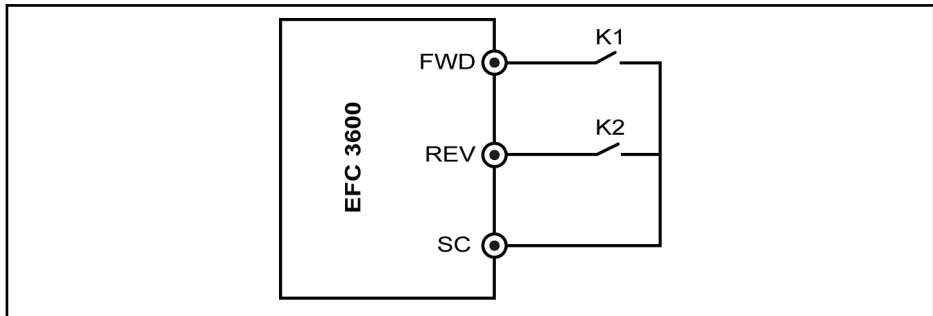


Fig. 8-30: 2-wire control_1

| K1 | K2 | Running status |
|----------|----------|----------------|
| Inactive | Inactive | Stop |
| Inactive | Active | Reverse |
| Active | Inactive | Forward |
| Active | Active | Stop |



If both terminals are active at the same time, the frequency converter stops according to the stopping mode configured by b1.40 and both LED indicators (FWD and REV) are switched on.

- [E0.00]=1: Forward / reverse, run / stop

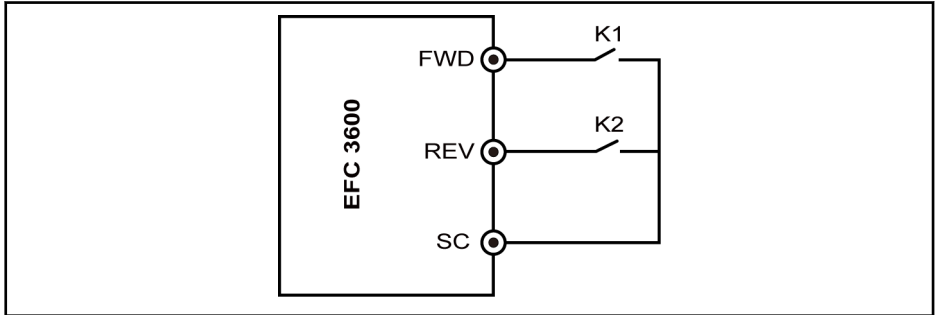


Fig. 8-31: 2-wire control_2

| K1 | K2 | Running status |
|----------|----------|----------------|
| Inactive | Inactive | Stop |
| Inactive | Active | Stop |
| Active | Inactive | Forward |
| Active | Active | Reverse |

- [E0.00]=2: 3-wire control

An additional terminal needs to be configured as "3-wire running control" and connected as below:

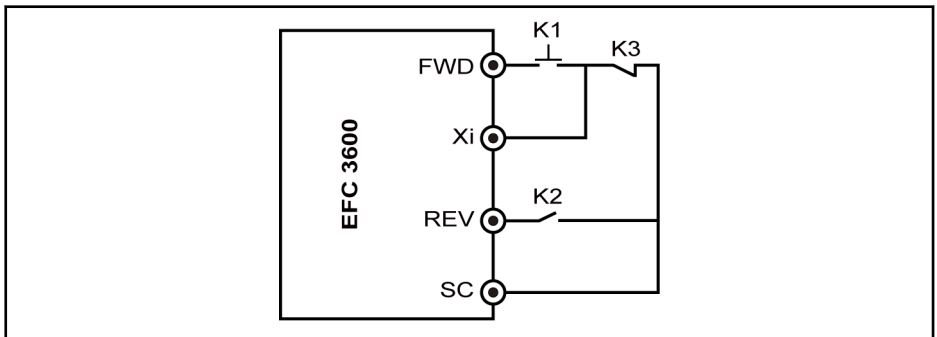


Fig. 8-32: 3-wire control

- – K1 is RUN command source
 - K2 is used for direction selection
 - 0=forward
 - 1=reverse
 - K3 is STOP command source (3-wire mode N.C. terminal)
 - FWD input is edge-sensitive
 - REV input is level-sensitive

- Preselect the direction before setting RUN command, otherwise direction will change (with a possible "dead zone time").



- When setting E0.00 "2-wire / 3-wire running control", 3-wire control can only be selected after the 3-wire input terminal has been mapped. Otherwise, "PrSE" warning occurs.
- When setting E0.01 ~ E0.05, the 3-wire input terminal can only be unselected after the 3-wire control has been disabled. Otherwise, "PrSE" warning occurs.

| | |
|--------------------------------|--------------------|
| E0.01 | Terminal X1 |
| Setting range | 0 ~ 28 |
| Minimum unit | 1 |
| Factory default | 0 |
| E0.02 | Terminal X2 |
| Setting range | 0 ~ 28 |
| Minimum unit | 1 |
| Factory default | 0 |
| E0.03 | Terminal X3 |
| Setting range | 0 ~ 28 |
| Minimum unit | 1 |
| Factory default | 0 |
| E0.04 | Terminal X4 |
| Setting range | 0 ~ 28 |
| Minimum unit | 1 |
| Factory default | 0 |
| E0.05 | Terminal X5 |
| Setting range | 0 ~ 28 |
| Minimum unit | 1 |
| Factory default | 0 |
| E0.06 ~ E0.09: Reserved | |

5 external digital input terminals are available with PNP and NPN input modes.

- 0: No action (The frequency converter has no action even if there is input signal. Multiple selection is possible.)
- 1: Multi-speed terminal 1
- 2: Multi-speed terminal 2
- 3: Multi-speed terminal 3



8 multi-speeds are available with the combinations of the above 3 terminals.

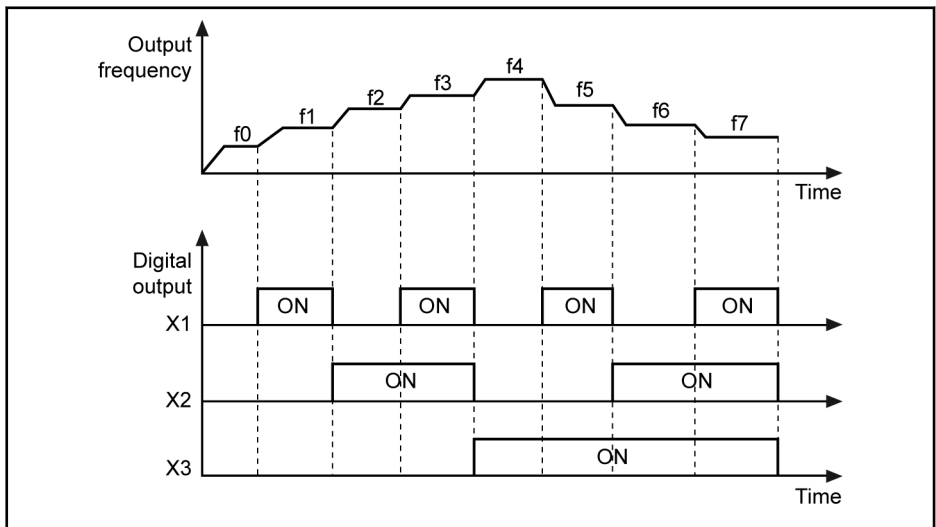


Fig. 8-33: Given by multi-speed

| X3 | X2 | X1 | Command frequency | Corresponding frequency and Acc. / Dec. time parameter |
|-----|-----|-----|-------------------------|--|
| OFF | OFF | OFF | Multi-speed frequency 0 | b1.04, E2.35 |
| OFF | OFF | ON | Multi-speed frequency 1 | E2.10, E2.37 |
| OFF | ON | OFF | Multi-speed frequency 2 | E2.11, E2.39 |
| OFF | ON | ON | Multi-speed frequency 3 | E2.12, E2.41 |
| ON | OFF | OFF | Multi-speed frequency 4 | E2.13, E2.43 |
| ON | OFF | ON | Multi-speed frequency 5 | E2.14, E2.45 |
| ON | ON | OFF | Multi-speed frequency 6 | E2.15, E2.47 |
| ON | ON | ON | Multi-speed frequency 7 | E2.16, E2.49 |

Tab. 8-2: Multi-speed terminal settings

- 4: Reserved
- 5: Acceleration / deceleration time terminal 1
- 6: Acceleration / deceleration time terminal 2

4 options of acceleration / deceleration time are available with the combinations of the 2 terminals, as shown in the table below.

| Acc. / Dec. time terminal 2 | Acc. / Dec. time terminal 1 | Selected Acc. / Dec. time |
|-----------------------------|-----------------------------|--|
| Inactive | Inactive | Acceleration time 1 is selected (b1.20) Deceleration time 1 is selected (b1.21) |
| Inactive | Active | Acceleration time 2 is selected (E2.00) Deceleration time 2 is selected (E2.01) |
| Active | Inactive | Acceleration time 3 is selected (E2.02) Deceleration time 3 is selected (E2.03) |
| Active | Active | Acceleration time 4 is selected (E2.04) Deceleration time 4 is selected (E2.05) |

Tab. 8-3: Acc. / Dec. time options

- 7: 3-wire running control

Used to control the frequency converter in 3-wire control mode. See parameter E0.00.

- 8: Freewheeling to stop enabled

"Freewheeling to stop enabled" generates a STOP command and forces the frequency converter to freewheel to stop regardless of the stopping mode configured by b1.40.

- 9: Frequency increment UP command

- 10: Frequency decrement DOWN command

- 11: Zeroing of external terminal frequency setting

The above three functions are used to change the frequency set by terminals UP / DOWN or clear the frequency to 0 Hz by the zeroing terminal. See parameters S3.32 and S3.33.

- 12: Reserved

- 13: Stopping DC braking enabled

This function is used when stopping mode is set with [b1.40]=0. For details, see parameters b1.40 ~ b1.43.

- 14: Reserved

- 15: Simple PLC prohibited

If the PLC is running and this terminal is switched on, the frequency converter will stop output and motor freewheels to stop. If this terminal is switched off at this time, the frequency converter will stay standstill until the next RUN command is activated.

| [E2.30] | XI = 15 | Simple PLC status |
|---------|---------|-------------------|
| ≠0 | OFF | Running |
| ≠0 | ON | Inactive |

| [E2.30] | Xi = 15 | Simple PLC status |
|---------|---------|-------------------|
| =0 | OFF | Inactive |
| =0 | ON | Inactive |

- 16: Simple PLC paused

When the terminal is switched on, the PLC running is paused and the frequency converter runs at zero speed; if the terminal is switched off at this time, the frequency converter resumes the status before the PLC pause. This function is dependent on the level of the input terminal signal.

| Step | Status of Xi = 16 | Status of Xa (RUN command) | Status of frequency converter | Comment |
|------|-------------------|----------------------------|---|---|
| 1 | Inactive | Active | Run | – |
| 2 | Active | Active | Decelerate to 0 Hz (no stop DC braking) | Dec. time is based on the current stage x configuration |
| 3 | Inactive | Active | Accelerate to last target stage | Acc. time is based on last target stage x configuration |
| 4 | Inactive | Inactive | Stop | Stop according to [b1.40] |
| 5 | Inactive | Active | Run | Restart from beginning |

- 17: Reserved

- 18: The second frequency command source enabled

This function is used to switch frequency command source between the first channel (b1.00) and the second channel (b1.16), which is level-sensitive. When this function is inactive, the first channel (b1.00) is active; when this function is active, the second channel (b1.16) is active.

If status of external terminals for frequency source switching is changed during running, a new frequency command is accepted and the frequency converter accelerates / decelerates to the new frequency command.

- 19: External error N.O. contact input

- 20: External error N.C. contact input

An external error signal is connected to these terminals and if the signal is active, the frequency converter indicates an “E-St” error and stops.

The reaction of the functions “External error N.O. contact input” and “External error N.C. contact input” is defined as below:

N.C.:

- If terminal is active (closed), there is no error.
- If terminal is inactive (open), there is an error.

N.O.:

- If terminal is inactive (open), there is no error.
- If terminal is active (closed), there is an error.

- 21: External RESET input

This function works in the same manner as the operating panel error reset function does, which allows remote error reset. "External RESET input" depends on the edge of the input signal (signal changes from inactive to active).

- 22: The second run command source enabled

This function is used to switch RUN / STOP command source between the first channel (b1.02) and the second channel (b1.17). When this terminal is inactive, the first channel (b1.02) is active; when this terminal is active, the second channel (b1.17) is active.

If the external digital input terminal which has been set as "22: The second run command source enabled" is activated while the frequency converter is in RUN state, the frequency converter will freewheel to stop.

- 23: Forward (FWD)
- 24: Reverse (REV)

These two functions are used for RUN / STOP command control, see parameter E0.00.

- 25: Forward jogging
- 26: Reverse jogging

For jogging functions, see parameters S3.00 ~ S3.02.

- 27: Counting input
- 28: Counting clear

The above two functions are counting functions of an external signal. See parameters E1.13 and E1.14.

8.6.2 Analog Input Channel Gain

| | |
|---------------------------------------|---|
| E0.10 | Analog input voltage (AIV) channel gain Kv |
| Setting range | 0.00 ~ 10.00 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |
| E0.12 | Analog input current (AIC) channel gain Kc |
| Setting range | 0.00 ~ 10.00 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |
| E0.11, E0.13 ~ E0.14: Reserved | |

8.6.3 Analog Input Filtering Time

| | |
|--------------------------------|--------------------------------------|
| E0.15 | Analog channel filtering time |
| Setting range | 0.000 ~ 2.000s |
| Minimum unit | 0.001s |
| Factory default | 0.100s |
| E0.16 ~ E0.19: Reserved | |

8.6.4 Analog Input Curve Configuration

| | |
|-----------------|--|
| E0.20 | Analog setting curve selection |
| Setting range | 0: AIC-reference characteristic curve 1, AIV-reference characteristic curve 1 1: AIC-reference characteristic curve 1, AIV-reference characteristic curve 2 2: AIC-reference characteristic curve 2, AIV-reference characteristic curve 1 3: AIC-reference characteristic curve 2, AIV-reference characteristic curve 2 |
| Minimum unit | 1 |
| Factory default | 0 |
| E0.21 | Curve 1 min. reference |
| Setting range | 0.0 % ~ [E0.23] |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |
| E0.22 | Frequency corresponding to curve 1 min. reference |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| E0.23 | Curve 1 max. reference |
| Setting range | [E0.21] ~ 100.0 % |
| Minimum unit | 0.1 % |
| Factory default | 100.0 % |
| E0.24 | Frequency corresponding to curve 1 max. reference |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 50.00 Hz |
| E0.25 | Curve 2 min. reference |
| Setting range | 0.0 % ~ [E0.27] |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |
| E0.26 | Frequency corresponding to curve 2 min. reference |

| | |
|--------------------------------|--|
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| E0.27 | Curve 2 max. reference |
| Setting range | [E0.25] ~ 100.0 % |
| Minimum unit | 0.1 % |
| Factory default | 100.0 % |
| E0.28 | Frequency corresponding to curve 2 max. reference |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 50.00 Hz |
| E0.29 ~ E0.39: Reserved | |

The frequency converter has two external analog inputs, AIV voltage signal (0 ~ 10 V) and AIC current signal (4 ~ 20 mA). When AIV or AIC input is used as the reference frequency channel, the relation between the reference channel and the set frequency is illustrated as below:

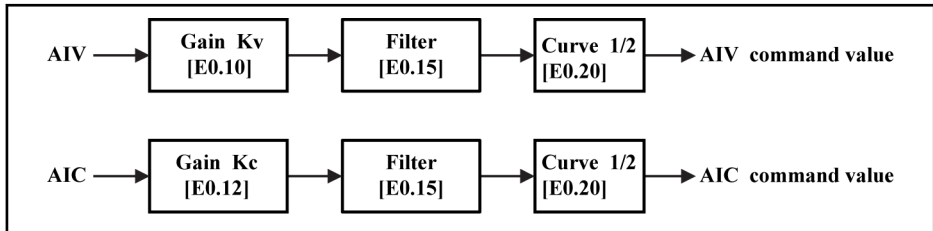


Fig. 8-34: Relationship between reference channel and set frequency

- The relationship between "the reference frequency after gain and filter processing" with "the set frequency commands" is determined by E0.21 ~ E0.28 and E0.20.
- AIC and AIV can use both curve 1 and curve 2.
- E0.21 ~ E0.24 are used to define characteristics of curve 1. See figure below:

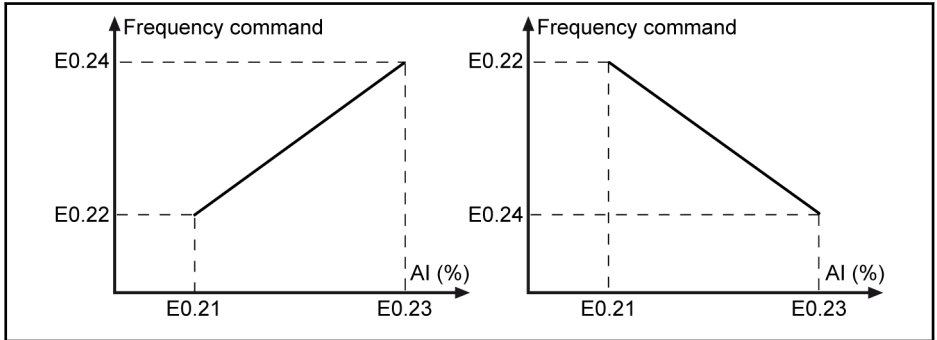


Fig. 8-35: Characteristics curve 1

- E0.25 ~ E0.28 are used to define characteristics of curve 2. See figure below:

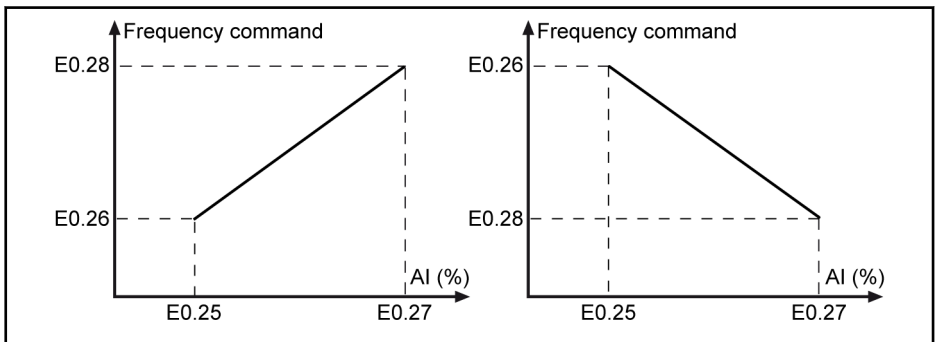


Fig. 8-36: Characteristics curve 2

8.7 Group E1: Output Terminal Parameters

8.7.1 Multi-function Output Terminals

| | |
|-------------------------------|---------------------|
| E1.00 | OUT1 output |
| Setting range | 0 ~ 18 |
| Minimum unit | 1 |
| Factory default | 1 |
| E1.02 | Relay output |
| Setting range | 0 ~ 18 |
| Minimum unit | 1 |
| Factory default | 1 |
| E1.01, E1.03: Reserved | |

- 0: Frequency converter ready for running
After powering on, if no error happens and there is no run command, output active indicates that the frequency converter is ready for running.
- 1: Frequency converter is running
The terminal outputs indicating signal when the frequency converter is running and has frequency output (including 0.00 Hz).
- 2: DC braking indication
When the frequency converter is in the starting or stopping DC braking, output is active.
- 3: Frequency converter running at zero speed
When the frequency converter is running with zero speed, output is active.



During dead zone time of rotation direction change, there is no output for this selection.

- 4: Frequency / speed arrival signal
See related parameter "Frequency arriving at detection width" E1.04.
- 5: Frequency level detection signal (FDT1)
- 6: Frequency level detection signal (FDT2)
See related parameters E1.05 ~ E1.08.
- 7: Simple PLC phase completion indication
When PLC mode [E2.30] = 1, 2 or 3, this terminal outputs a pulse at the end of every PLC stage. When a stage is finished a pulse is output with the duration of 0.5s. If one of the stages has a running time of 0.0s, this stage will be directly jumped over and there will be no pulse output. For details of simple PLC control, see parameters E2.10 ~ E2.16 and E2.30 ~ E2.50.

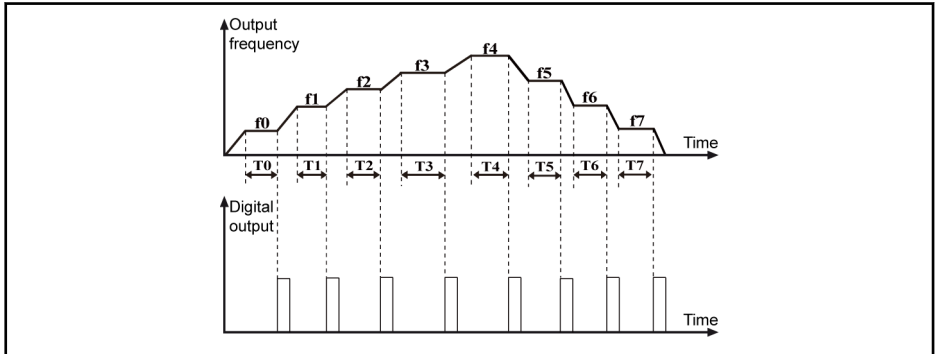


Fig. 8-37: Simple PLC phase completion indication



If the running time of one of the stages is so short that it finishes before the “phase completion” signal of the previous stage is deactivated, the signal remains active and the pulse duration calculation is restarted.

- 8: Simple PLC cycle completion indication

When PLC mode [E2.30]=1, 2 or 3, this terminal outputs a pulse (duration 0.5s) at the end of every cycle. See parameters E2.10 ~ E2.16 and E2.30 ~ E2.50.

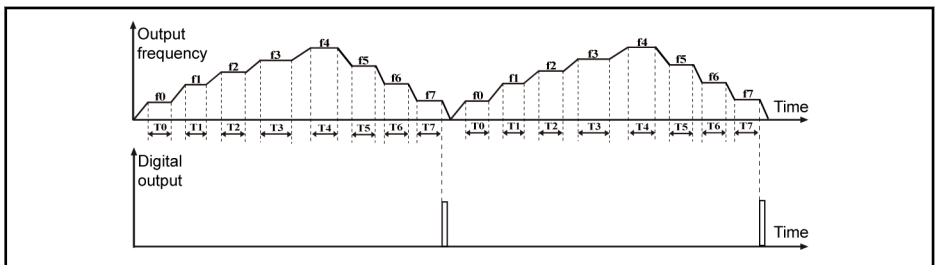


Fig. 8-38: [E2.30]=1, 2 or 3

- 9: Reserved
- 10: Under voltage indication

Active when DC bus voltage is lower than 230 VDC (200 V models) / 430 V (400 V models). It will be deactivated when DC bus voltage recovers and becomes stable.



Any soft start error will activate this digital output.

- 11: Frequency converter overload pre-warning
See parameters E1.09 and E1.11.
- 12: Motor overload pre-warning

See parameters E1.10 and E1.12.

- 13: Stopped by the external error

This signal is activated when the error "E-St" is generated, and deactivated when the error is reset. For "E-St", see "External digital input" group.

- 14: Error output

Active when error occurs; inactive when error is reset.

- 15: Reserved

- 16: Target counter value reached

When number of input pulse equals to the setting value defined in E1.14, the output is active till the next pulse of the input signal after the counter value is cleared.

- 17: Middle counter value reached

When number of input pulse equals to the value defined in E1.13, the output is active till the next pulse of the input signal after the counter value is cleared.

Example: [E1.13]=5, [E1.14]=8, the counter is reset with external terminal control, the output is described as below:

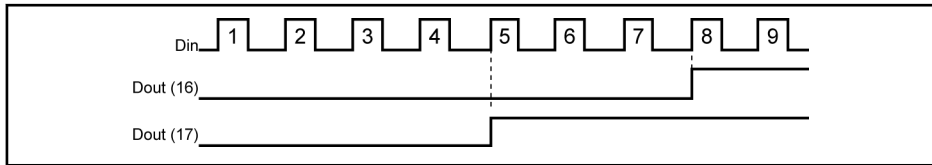


Fig. 8-39: Middle counter value reached

- 18: PID reference engineering value reached tolerance

When PID feedback engineering value reaches the tolerance window defined by E3.16, the output is active until the PID feedback engineering value leaves the window, see the figure below:

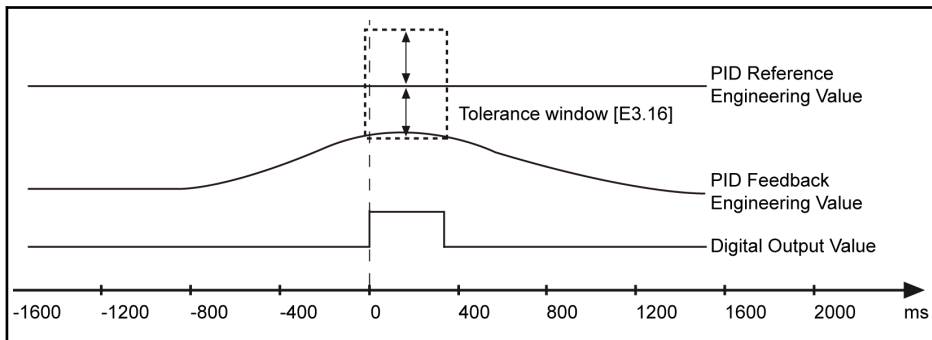


Fig. 8-40: Digital output behavior when PID reference engineering value reached

For details of PID regulation, see [chapter 8.9 "Group E3: PID Control" on page 111](#).

8.7.2 Frequency Detection

| E1.04 | Frequency arriving at detection width |
|-----------------|---------------------------------------|
| Setting range | 0.00 ~ 400.0 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 2.50 Hz |

This function is used to detect the difference between the output frequency and the set frequency. The indicative signals are outputted when the difference between the output frequency and the set frequency is within the range set in E1.04, as shown in the figure below:

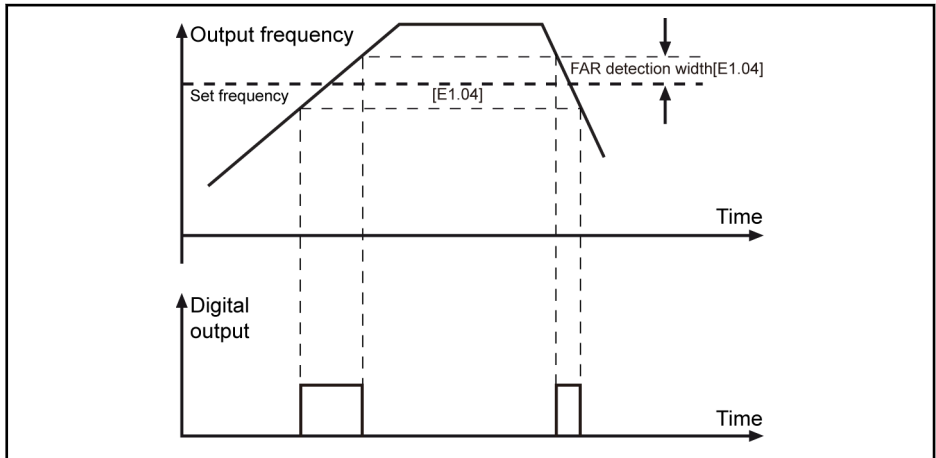


Fig. 8-41: Frequency arriving at detection width

| E1.05 | Frequency detection level FDT1 |
|-----------------|--------------------------------------|
| Setting range | 0.00 ~ 400.0 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 50.00 Hz |
| E1.06 | Frequency detection level FDT1 width |
| Setting range | 0.00 Hz ~ [E1.05] |
| Minimum unit | 0.01 Hz |
| Factory default | 1.00 Hz |
| E1.07 | Frequency detection level FDT2 |
| Setting range | 0.00 ~ 400.0 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 25.00 Hz |
| E1.08 | Frequency detection level FDT2 width |
| Setting range | 0.00 Hz ~ [E1.07] |

| | |
|-----------------|---------|
| Minimum unit | 0.01 Hz |
| Factory default | 1.00 Hz |

When the output frequency exceeds the frequency set by E1.05 or E1.07, the digital output "frequency level detection signal 1 or 2 (FDT1 or FDT2)" becomes active until the output frequency is lower than the value set by (E1.05 - E1.06) or (E1.07 - E1.08).

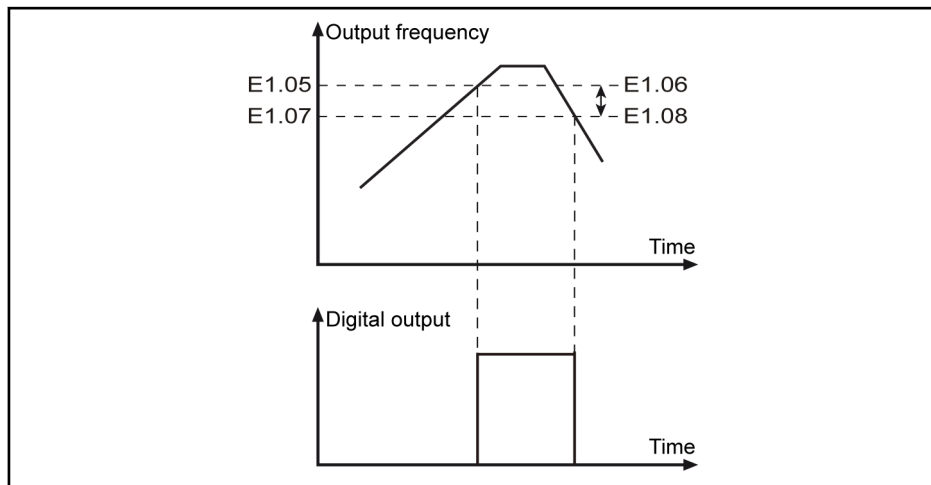


Fig. 8-42: Frequency detection level (FDT)

8.7.3 Overload Pre-warning

| | |
|-----------------|---|
| E1.09 | Frequency converter overload pre-warning level setting |
| Setting range | 20.0 % ~ 200.0 % (of rated frequency converter current) |
| Minimum unit | 0.1 % |
| Factory default | 110.0 % |
| E1.10 | Motor pre-warning level setting |
| Setting range | 100.0 % ~ 250.0 % (of rated motor current) |
| Minimum unit | 0.1 % |
| Factory default | 100.0 % |

When the output current exceeds the threshold defined in E1.09 for delay time defined in E1.11, the function is active. The signal is immediately deactivated when the output current is lower than the threshold defined in E1.09.

| | |
|-----------------|---|
| E1.11 | Frequency converter overload pre-warning delay |
| Setting range | 0.0 ~ 20.0s |
| Minimum unit | 0.1s |
| Factory default | 2.0s |
| E1.12 | Motor overload pre-warning delay |
| Setting range | 0.0 ~ 20.0s |
| Minimum unit | 0.1s |
| Factory default | 2.0s |

When the output current exceeds the threshold defined in E1.10 for delay time defined in E1.12, the function is active. The signal is immediately deactivated when the output current is lower than the threshold defined in E1.10.

8.7.4 External Signal Counter

| | |
|--------------------------------|---------------------------|
| E1.13 | Middle count value |
| Setting range | 0 ~ [E1.14] |
| Minimum unit | 1 |
| Factory default | 0 |
| E1.14 | Target count value |
| Setting range | [E1.13] ~ 9999 |
| Minimum unit | 1 |
| Factory default | 0 |
| E1.15 ~ E1.29: Reserved | |

The corresponding digital output for "Middle / Target count value reached" should be configured, see details in E1.00 and E1.02.

After the counter has reached its Middle /Target value [E1.13] / [E1.14], it remains at this value till it is reset by a valid edge of the input terminal signal parameterized as "clear counting". As long as the counter value is not reset, the digital outputs configured as "DOutx=16: Target counter value reached" and "DOutx=17: Middle counter value reached" remain active. These signals are reset by the next valid triggering edge of the input terminal signal parameterized as "counting signal input" after the counter value is cleared.



- If one of the parameters E1.13, E1.14 and / or digital input terminal configuration E0.01 ~ E0.05 is changed, the counter value is reset and digital outputs defined as "DOutx=16: Target counter value reached" and "DOutx=17: Middle counter value reached" are inactive immediately;
- The maximum allowed frequency of digital input is 50 Hz and the minimum allowed pulse width (both active and inactive) should be longer than 8ms.

8.7.5 Analog Output Terminal

| | |
|--------------------------------|------------------------------------|
| E1.30 | FM1 analog output selection |
| Setting range | 0 ~ 7 |
| Minimum unit | 1 |
| Factory default | 0 |
| E1.31 | FM1 channel mode |
| Setting range | 0: 0 ~ 10 V; 1: 2 ~ 10 V |
| Minimum unit | 1 |
| Factory default | 0 |
| E1.32 | FM1 gain setting |
| Setting range | 0.00 ~ 10.00 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |
| E1.33 ~ E1.40: Reserved | |

- E1.30 is used to define the function of analog outputs, as shown below:
 - [E1.30]=0: Output frequency. 0 ~ 10 V / 2 ~ 10 V, represents 0 ~ max. frequency [b1.05]
 - [E1.30]=1: Set frequency. 0 ~ 10 V / 2 ~ 10 V, represents 0 ~ max. frequency [b1.05]
 - [E1.30]=2: Output current. 0 ~ 10 V / 2 ~ 10 V, represents 0 ~ 2 x (rated current)
 - [E1.30]=3: Reserved
 - [E1.30]=4: Output voltage. 0 ~ 10 V / 2 ~ 10 V, represents 0 ~ 1.2 x (rated voltage*)
 - [E1.30]=5: Output power. 0 ~ 10 V / 2 ~ 10 V, represents 0 ~ 1.2 x (rated power)
 - [E1.30]=6: Analog input voltage. 0 ~ 10 V / 2 ~ 10 V, represents 0 ~ 10 V
 - [E1.30]=7: Analog input current. 0 ~ 10 V / 2 ~ 10 V, represents 4 ~ 20 mA



*: Frequency converter rated voltage is defined in parameter b0.20.

- E1.31 is used to select output signals 0 ~ 10 V or 2 ~ 10 V.
- E1.32 means the gain applied to analog output voltage.
 - For example: When the gain value is 0.00, then the analog output voltage will be 0 V. In the case of "FM1 channel mode" [E1.31]=1: 2 ~ 10 V and source value is 0,
 - if gain=1.00, the analog output voltage will be 2 V.
 - if gain=5.00, the analog output voltage will be 10 V.

8.8 Group E2: Multi-speed and Simple PLC

8.8.1 Acceleration/deceleration time 2, 3 and 4

| | |
|---------------------------------|----------------------------|
| E2.00 | Acceleration time 2 |
| Setting range | 0.1 ~ 6,000.0s |
| Minimum unit | 0.1s |
| Factory default | 5.0s |
| E2.01 | Deceleration time 2 |
| See E2.00 "Acceleration time 2" | |
| E2.02 | Acceleration time 3 |
| See E2.00 "Acceleration time 2" | |
| E2.03 | Deceleration time 3 |
| See E2.00 "Acceleration time 2" | |
| E2.04 | Acceleration time 4 |
| See E2.00 "Acceleration time 2" | |
| E2.05 | Deceleration time 4 |
| See E2.00 "Acceleration time 2" | |
| E2.06 ~ E2.09 | |

8.8.2 Multi-speed Frequency

| | |
|---|--------------------------------|
| E2.10 | Multi-speed frequency 1 |
| Setting range | 0.00 Hz ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| E2.11 | Multi-speed frequency 2 |
| See parameter E2.10 "Multi-speed frequency 1" | |
| E2.12 | Multi-speed frequency 3 |
| See parameter E2.10 "Multi-speed frequency 1" | |
| E2.13 | Multi-speed frequency 4 |
| See parameter E2.10 "Multi-speed frequency 1" | |
| E2.14 | Multi-speed frequency 5 |
| See parameter E2.10 "Multi-speed frequency 1" | |
| E2.15 | Multi-speed frequency 6 |
| See parameter E2.10 "Multi-speed frequency 1" | |
| E2.16 | Multi-speed frequency 7 |

See parameter E2.10 "Multi-speed frequency 1"

E2.17 ~ E2.29: Reserved

Parameters E2.10 ~ E2.16 together with b1.04 are used to set the frequencies in multi-speed control and simple PLC.

• Multi-speed control

8 multiple speeds can be set by multi-speed control terminals, together with forward / reverse control terminals (FWD-CM and REV-CM) and acceleration / deceleration terminals. For multi-speed control, the acceleration time / deceleration time, rotation direction for each stage can be configured by parameters E2.35, E2.37, E2.39, E2.41, E2.43, E2.45, E2.47 and E2.49.



1. Only 5 external terminals digital inputs are available for the frequency converter, so please properly assign these 5 terminals when acceleration / deceleration time terminal and FWD / REV terminal are needed.
2. b1.00 / b1.16 frequency setting source should be set to 6 before multi-speed control is activated.
3. The rotation direction of every stage depends not only on stage action selection but also on RUN command source, see more details in [tab. 8-4 "Rotation direction and Acc. / Dec. time for multi-speed / simple PLC"](#) on page 110.
4. If the set frequency of next stage is lower than current stage, it will decelerate to the next stage with the deceleration time of current stage; If the set frequency of next stage is higher than current stage, it will accelerate to the next stage with the acceleration time of next stage.

• Simple PLC control

Simple PLC is an automatic running mode according to the current acceleration / deceleration time, running frequency, running time and rotation direction. One cycle of simple PLC control is shown in the figure below.

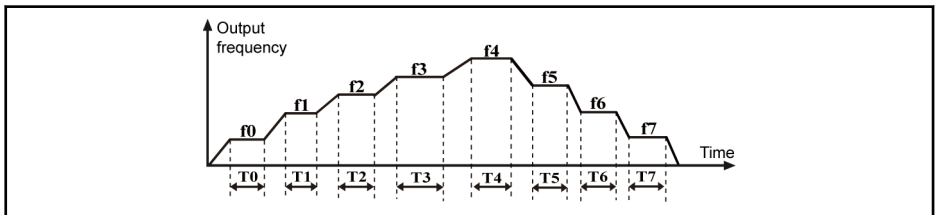


Fig. 8-43: Simple PLC control



8 stages $f_0 \sim f_7$ are set with parameters b1.04, E2.10 ~ E2.16, and $T_0 \sim T_7$ are set with parameters E2.36, E2.38, E2.40, E2.42, E2.44, E2.46, E2.48 and E2.50.

8.8.3 Simple PLC Basic Control

| | |
|-----------------|--------------------------------|
| E2.30 | Simple PLC running mode |
| Setting range | 0 ~ 3 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Inactive.
Simple PLC control is inactive.
- 1: Mode 1.
Simple PLC stops after one cycle. In this mode, the frequency converter decelerates to 0.00 Hz after the last stage and a STOP signal is generated. The frequency converter stops according to the configured stopping mode.
- 2: Mode 2.
Simple PLC runs in cycle repeatedly and stops when a stopping command is entered. In this mode, the frequency converter decelerates to 0.00 Hz after the last stage and then enters into simple PLC cycles again.
- 3: Mode 3.
After one cycle, the frequency converter keeps running at the set frequency of the last stage.

| | |
|--------------------------------|-----------------------------------|
| E2.31 | Simple PLC time multiplier |
| Setting range | 1 ~ 60 |
| Minimum unit | 1 |
| Factory default | 1 |
| E2.32 ~ E2.34: Reserved | |

The actual running time of each stage=[Stage running time] × [E2.31].

[Stage running time] has a possible maximum value of 6000.0s, the PLC time multiplier E2.31 has a maximum value of 60 and there are 8 possible stages (0-7), so the maximum duration of one PLC cycle calculates to: 8 × 6000.0s × 60=800 hours.

8.8.4 PLC Stage Control

| | |
|-----------------|--|
| E2.35 | Stage 0 action selection |
| Setting range | 011, 012, 013, 014, 021, 022, 023, 024, 031, 032, 033, 034, 041, 042, 043, 044, 111, 112, 113, 114, 121, 122, 123, 124, 131, 132, 133, 134, 141, 142, 143, 144 |
| Minimum unit | 1 |
| Factory default | 011 |
| E2.36 | Stage 0 running time |
| Setting range | 0.0 ~ 6,000.0s |

| | |
|--------------------------------|---------------------------------|
| Minimum unit | 0.1s |
| Factory default | 20.0s |
| E2.37 | Stage 1 action selection |
| See "Stage 0 action selection" | |
| E2.38 | Stage 1 running time |
| See "Stage 0 running time" | |
| E2.39 | Stage 2 action selection |
| See "Stage 0 action selection" | |
| E2.40 | Stage 2 running time |
| See "Stage 0 running time" | |
| E2.41 | Stage 3 action selection |
| See "Stage 0 action selection" | |
| E2.42 | Stage 3 running time |
| See "Stage 0 running time" | |
| E2.43 | Stage 4 action selection |
| See "Stage 0 action selection" | |
| E2.44 | Stage 4 running time |
| See "Stage 0 running time" | |
| E2.45 | Stage 5 action selection |
| See "Stage 0 action selection" | |
| E2.46 | Stage 5 running time |
| See "Stage 0 running time" | |
| E2.47 | Stage 6 action selection |
| See "Stage 0 action selection" | |
| E2.48 | Stage 6 running time |
| See "Stage 0 running time" | |
| E2.49 | Stage 7 action selection |
| See "Stage 0 action selection" | |
| E2.50 | Stage 7 running time |
| See "Stage 0 running time" | |
| E2.51 ~ E2.70: Reserved | |

Definition of each stage action selection is shown as below:

- Display 2 (left most):
 - 0: forward running
 - 1: reverse running
- Display 1:
 - 1: Acceleration time 1, set with parameter b1.20

- 2: Acceleration time 2, set with parameter E2.00
- 3: Acceleration time 3, set with parameter E2.02
- 4: Acceleration time 4, set with parameter E2.04
- Display 0 (right most):
 - 1: Deceleration time 1, set with parameter b1.21
 - 2: Deceleration time 2, set with parameter E2.01
 - 3: Deceleration time 3, set with parameter E2.03
 - 4: Deceleration time 4, set with parameter E2.05



1. If the running time of a stage is set to be 0, simple PLC will skip this stage.
2. PID control mode has higher priority compared with simple PLC control. That is, if the PID control mode is active, then simple PLC control will be disabled internally. So, the precondition of running simple PLC is to disable PID control.
3. Simple PLC can be paused / prohibited by external terminals and PLC cycle / phase completion can be signalized by digital output. See details in parameter E0.01 ~ E0.05 and E1.00 ~ E1.02.

Rotation direction command source differs if running command source is different, as shown in the table below:

| Frequency source | RUN command source | Rotation direction | Acc. / Dec. time |
|------------------|-----------------------|--|--|
| Multi-speed | By operating panel | parameters: E2.35, E2.37, E2.39, E2.41, E2.43, E2.45, E2.47, E2.49 | parameters: E2.35, E2.37, E2.39, E2.41, E2.43, E2.45, E2.47, E2.49 |
| | By external terminals | External terminals, that is, 2-wire / 3-wire control mode | |
| | By communication | Set by communication | |
| Simple PLC | By operating panel | parameters: | |
| | By external terminals | E2.35, E2.37, E2.39, E2.41, | |
| | By communication | E2.43, E2.45, E2.47, E2.49 | |

Tab. 8-4: Rotation direction and Acc. / Dec. time for multi-speed / simple PLC

8.9 Group E3: PID Control

8.9.1 PID Basic Configuration

PID control is a common approach used in process controls such as flow control, pressure control, temperature control and other process controls. Proportional, integral and derivative operations are based on the differences between reference values and their feedback, to adjust the output frequency of the frequency converter, form a negative feedback system, and keep the controlled values stable at reference values.

The basic control principle is shown in the figure below:

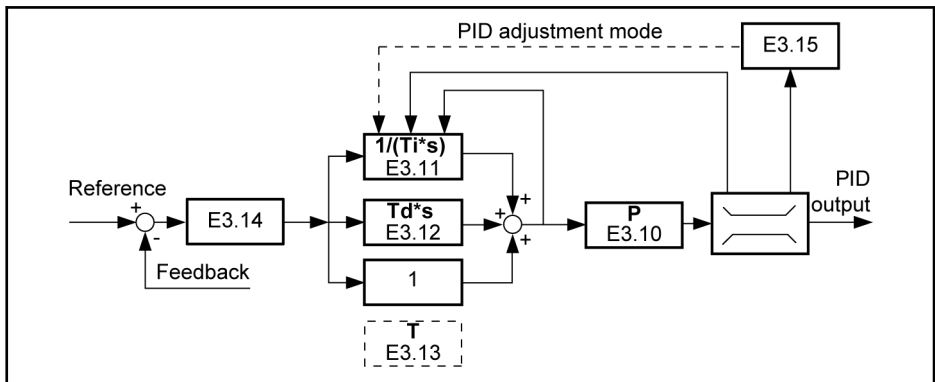


Fig. 8-44: PID control principle

| E3.00 | PID reference channel |
|-----------------|-----------------------|
| Setting range | 0 ~ 7 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: No PID control
- 1: Panel potentiometer
- 2: Panel digital setting
- 3: Analog input voltage (AIV)

For reference channel AIV, the corresponding reference frequency is dependent on the settings of parameter E0.10 and parameters E0.20 ~ E0.28.

- 4 : Analog input current (AIC)

For reference channel AIC, the corresponding reference frequency is dependent on the settings of parameter E0.12 and parameters E0.20 ~ E0.28.

- 5: Communication
- 6: Analog digital setting E3.03
- 7: Rotation speed digital setting E3.04

| | |
|-----------------|-----------------------------|
| E3.01 | PID feedback channel |
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Analog input current
- 1: Analog input voltage

Both of them have the nature of frequency, the corresponding reference frequency is related to parameters E0.10 ~ E0.28.

| | |
|--------------------------------|---------------------------------------|
| E3.03 | Analog digital setting |
| Setting range | 0.00 ~ 10.00 V |
| Minimum unit | 0.01 V |
| Factory default | 0.00 V |
| E3.04 | Rotation speed digital setting |
| Setting range | 0 ~ 30,000 rpm |
| Minimum unit | 1 rpm |
| Factory default | 0 rpm |
| E3.05 ~ E3.09: Reserved | |

8.9.2 PID Control

| | |
|-----------------|--|
| E3.10 | P: Proportion gain |
| Setting range | 0.000 ~ 10.000 |
| Minimum unit | 0.001 |
| Factory default | 1.500 |
| E3.11 | Ti: Integral time |
| Setting range | 0.00 ~ 100.00s (0.00 represents no integral) |
| Minimum unit | 0.01s |
| Factory default | 0.00s |
| E3.12 | Td: Derivative time |
| Setting range | 0.00 ~ 100.00s (0.00 represents no derivative) |
| Minimum unit | 0.01s |
| Factory default | 0.00s |
| E3.13 | T: Sample period |
| Setting range | 0.01 ~ 100.00s |
| Minimum unit | 0.01s |
| Factory default | 0.50s |

- P: Proportion gain

- Decides the gain of deviation.
- Larger P means larger scale and faster response, but too large P leads to vibration.
- P cannot eliminate deviation completely.
- Ti: Integral time
 - Used to eliminate the deviation.
 - Smaller Ti means faster response of frequency converter to deviation changes, but too small Ti leads to vibration.
 - Special case: If $T_i=0$, integration is disabled.
 - If integration is disabled during PID control, it stops integration but keeps output at its current value (not cleared to zero); if integration is enabled again during PID operation, integration continues.
- Td: Derivative time
 - Used to respond fast to changes of deviation between reference and feedback in the system.
 - Larger Td means faster response, but too large Td leads to vibration.
 - Special case: If $T_d=0$, derivative is disabled.
 - If derivative is disabled during PID control, it stops derivative, the current value is cleared to zero.
- T: Sample period

Sample period is the sampling time in PID control. This value should match with the selected time constant of Ti or Td. Normally, the sampling period should be shorter than 1/5 of the time constant.

| E3.14 | Deviation width |
|-----------------|--|
| Setting range | 0.0 % - 20.0 % (closed loop reference value) |
| Minimum unit | 0.1 % |
| Factory default | 2.0 % |

Used to set the limit of the deviation between reference and feedback signals to stop internal PID control and keep the output stable, provided the PID feedback deviation is within the setting range of E3.14.

| E3.15 | PID regulation mode |
|-----------------|----------------------------|
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |

When the output value of closed loop regulation reaches the upper ([b1.06]) or lower ([b1.07]) limit of frequency, the integral mode has two action options:

- 0: Stop integral regulation

The integral value remains unchanged. When the trend of reference values and feedback values changes, the integral value follows immediately the

change in the trend. When the output reaches its frequency limit, the integration stops.

- 1: Continue integral regulation

The integral value responds to the changes between reference and feedback values. When the output reaches the maximum frequency limit, the integrator continues up to its possible numerical integration limit, not the maximum frequency limit.

When the trend of reference and feedback values changes, more time is needed to eliminate the impact of continuous integral regulation before the integral value can follow the change in the trend.

| E3.16 | PID reference engineering value reached tolerance |
|-----------------|---|
| Setting range | 0.01 % ~ 100.00 % |
| Minimum unit | 0.01 % |
| Factory default | 1.00 % |

Used to set the tolerance window between "PID reference engineering value" and "PID feedback engineering value".

$$[E3.16] = \left| \frac{[d0.14] - [d0.15]}{[d0.14]} \right| \times 100 \%$$

[d0.14]: PID reference engineering value

[d0.15]: PID feedback engineering value

Fig. 8-45: PID reference engineering value reached tolerance calculation

For details of reference value (of pressure, flow, etc.) reaching the defined tolerance window, see [fig. 8-40 "Digital output behavior when PID reference engineering value reached"](#) on page 100.

8.10 E4: Error and Protection

8.10.1 Protection Configuration

| | |
|------------------------|---------------------------------------|
| E4.00: Reserved | |
| E4.01 | Overvoltage prevention setting |
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Both disabled
- 1: Stall protection enabled, braking disabled
- 2: Stall protection disabled, braking enabled

When [E4.01] = 0 / 1, the brake chopper will not work even its action point is reached.

When [E4.01] = 2, the brake chopper is enabled with the set braking duty cycle if its action point is reached, no matter the frequency converter is in stop or running mode.

Two factors decide the switching pattern: Maximum duty cycle and hysteresis voltage.

Maximum duty cycle

The switching time of the brake chopper is limited with parameter S3.21. If the value is set too low, the over voltage error may happen during braking.

- The time $t_2 = 1/100 \text{ Hz} = 10\text{ms}$
- The time $t_1 = t_2 \times [\text{S3.21}]/100 \%$

If the switching of the brake chopper is controlled by the maximum duty cycle, the switching pattern is shown as below:

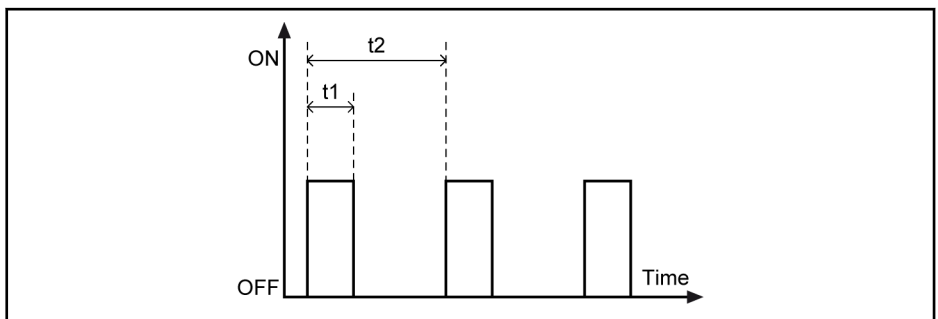


Fig. 8-46: Switching pattern_maximum duty cycle

Hysteresis voltage

The hysteresis voltage of braking is fixed as below:

| Model | Hysteresis voltage [V] |
|----------|------------------------|
| 1P 200 V | 10 |
| 3P 400 V | 15 |

When the brake chopper is controlled by the hysteresis voltage, the switching pattern is shown as below:

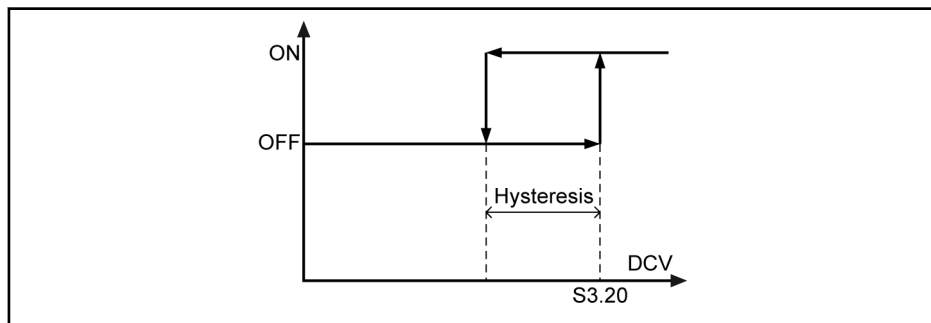


Fig. 8-47: Switching pattern_hysteresis voltage

When the duty cycle is set as 100 %, the switching will be only according to the hysteresis. It means that there is no switching after 10ms (100 Hz).

| E4.02 | Stall overvoltage prevention level |
|-----------------|--|
| Setting range | 200 V class: 300 ~ 390 V; 400 V class: 600 ~ 885 V |
| Minimum unit | 1 V |
| Factory default | 200 V class: 390 V; 400 V class: 885 V |

With stall overvoltage protection, the frequency converter detects the DC bus voltage during deceleration and compares it with "Stall overvoltage prevention level" [E4.02].

- When the DC bus voltage exceeds the stall over voltage protection level, the output frequency stops decreasing.
- When the DC bus voltage is lower than the stall overvoltage protection level, the frequency converter resumes deceleration.

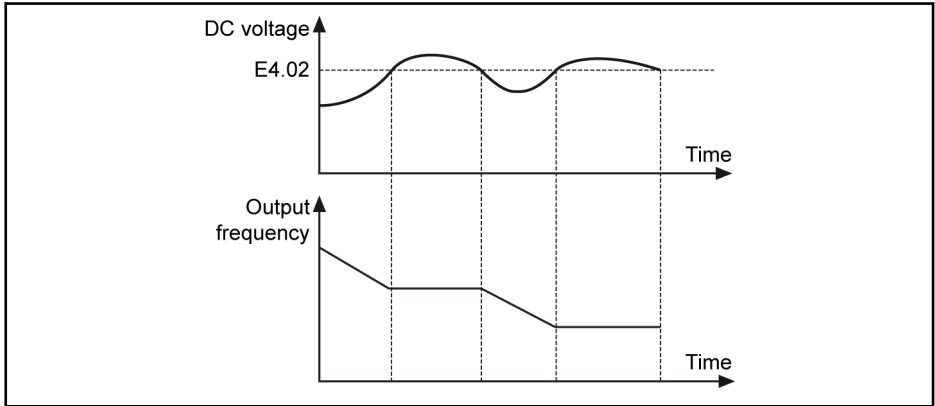


Fig. 8-48: Stall overvoltage prevention level_during deceleration



Excessive low settings of this parameter may not bring a successful motor deceleration.

| E4.03 | Stall overcurrent prevention level |
|-----------------|--|
| Setting range | 20.0 % ~ 250.0 % (of rated frequency converter output current) |
| Minimum unit | 0.1 % |
| Factory default | 200.0 % |

Used to prevent the motor from stalling due to the heavy load or too short acceleration time. This function is always active during acceleration and for running at constant speed.

During acceleration

- When the output current of the frequency converter is larger than the stall overcurrent prevention level [E4.03] during acceleration, the output frequency increasing will be stopped.
- When the current is lower than [E4.03], the acceleration resumes.

This function will lead to longer acceleration time than settings.

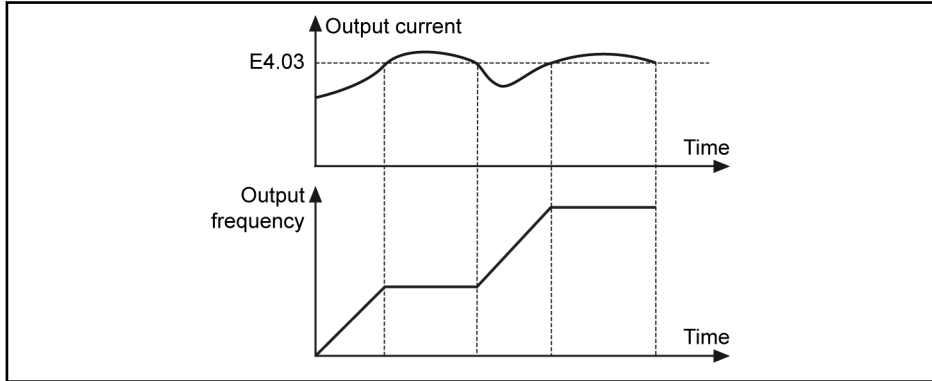


Fig. 8-49: Stall overcurrent prevention level_during acceleration

At constant speed

- When the output current exceeds the stall prevention level [E4.03], the frequency converter starts deceleration with the defined deceleration time.
- When the output current drops below [E4.03], the frequency converter accelerates to the set frequency with the defined acceleration time.

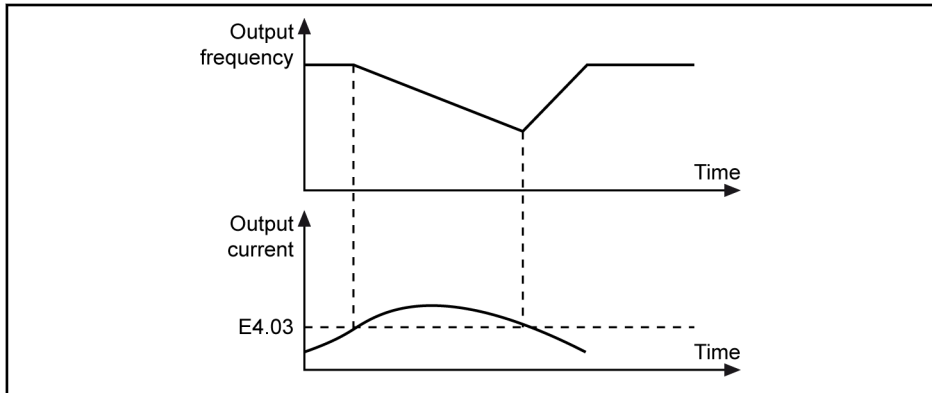


Fig. 8-50: Stall overcurrent prevention level_at constant speed

| | |
|-----------------|-------------------------------------|
| E4.04 | Low speed derating frequency |
| Setting range | 0.10 ~ 300.00 Hz |
| Minimum unit | 0.01 Hz |
| Factory default | 25.00 Hz |
| E4.05 | Zero speed load |
| Setting range | 25.0 % ~ 100.0 % |
| Minimum unit | 0.1 % |
| Factory default | 25.0 % |

- "Low speed derating frequency" means that when the frequency is higher than [E4.04], the allowed continuous current is the rated current [S2.04]. When the frequency is lower than [E4.04], the allowed continuous current is linearly reduced to zero speed load [S2.23] at standstill.
- "Zero speed load" means the allowed continuous current (percent of rated current) at standstill.

At low speed, the cooling of most motors may get worse, and allowed motor continuous current is getting lower. In this case, the allowed time for motor overload is getting shorter. In order to prevent motors from getting overloaded, please set parameters E4.05 and E4.05 appropriately. For a motor with external cooling, zero speed load E4.05 can be set to 100 %, and the low speed derating is switched off.

| | |
|----------------------|------------------------------|
| E4.06 | Phase loss protection |
| Setting range | 0 ~ 3 |
| Minimum unit | 1 |
| Factory default | 3 |
| E4.07 ~ E4.14 | |

- 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

When the input phase loss protection is active and the input phase loss error occurs, the panel displays "IPH.L"; when the output phase loss protection is active and the output phase loss error occurs, the panel displays "OPH.L".



- An input phase loss can also be triggered by line voltage imbalance or main circuit capacitors deterioration. The protection has no capability to detect the input phase loss in following circumstances:
 - No "RUN" command;
 - The output current is lower than 30 % of frequency converter rated current;
 - During motor deceleration.
- There will be a dead zone to detect output phase loss in the following cases:
 - The output frequency is lower than 1 Hz;
 - During DC braking;
 - During speed detection restarting;
 - During motor parameters auto-tuning;
 - Wrong settings of S2.04 "rated motor current".

8.10.2 Error Reset

| | |
|--------------------------------|--|
| E4.15 | Number of error reset attempts |
| Setting range | 0 ~ 3 |
| Minimum unit | 1 |
| Factory default | 0 |
| E4.16 | Interval between reset attempts |
| Setting range | 2 ~ 60s |
| Minimum unit | 1s |
| Factory default | 10s |
| E4.17 ~ E4.19: Reserved | |

Automatic error reset function is used to ensure continuous running without human intervention in the case of occasional errors, such as overcurrent and overvoltage at start-up and in run mode. This function can be activated by setting E4.15 to a non-zero value.

When an error occurs, the frequency converter stops the output and the respective error code is displayed at the same time. The system remains in idle mode for delay time [E4.16]. Then the error will be automatically reset and a run command will be generated to restart the frequency converter. This sequence will be performed [E4.15] times in a row. If the error still exists, the frequency converter remains in idle mode and stops performing automatic restart attempts. In this case, a manual error reset is required to resume the operation.

Automatic error reset is valid for the following errors: OC-1, OC-2, OC-3, OE-1, OE-2, OE-3, OE-4, OL-1, OL-2, UE-1, E-St, OH and UH.

8.10.3 Error Code Memory

| | |
|--------------------------------|---------------------------------------|
| E4.20 | Last error type |
| Display range | 0 ~ 51 |
| E4.21 | 2nd last error type |
| Display range | 0 ~ 51 |
| E4.22 | 3rd last error type |
| Display range | 0 ~ 51 |
| E4.23 ~ E4.29: Reserved | |

Used to record the recent three errors which can be viewed after reset. For error types, please refer to [chapter 9.5.1 "Error Description and Solution"](#) on page 126.

8.10.4 System Status at the Latest Error

| | |
|---------------|---|
| E4.30 | Output frequency at latest error |
| Display range | 0.00 Hz ~ [b1.05] |
| E4.31 | Setting frequency at latest error |
| Display range | 0.00 Hz ~ [b1.05] |
| E4.32 | Output current at latest error |
| Display range | 0.0 ~ 1,000.0 A |
| E4.33 | Output voltage at latest error |
| Display range | 0 ~ 1,000 V |
| E4.34 | DC bus voltage at latest error |
| Display range | 0 ~ 1,000 V |
| E4.35 | Module temperature at latest error |



Parameters E4.30 ~ E4.35 are read only. To clear the errors records, refer to parameter b0.05 "Parameter initialization".

8.11 Group H0: Communication

| H0.00 | Communication protocol |
|-----------------|------------------------|
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: ModBus
- 1: ModBus / PROFIBUS

It is ModBus for EFC3600-xKxx-xPx-MDA-7P-NNNN models; it is PROFIBUS for EFC3600-xKxx-xPx-PDA-7P-NNNN models.

See [chapter 13 "Communication Protocols" on page 184](#).

| H0.01 | Baud rate |
|-----------------|-----------|
| Setting range | 0 ~ 5 |
| Minimum unit | 1 |
| Factory default | 3 |

Used to set data transmission rate of ModBus communication between the external computer and the frequency converter. Available baud rate includes:

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

| H0.02 | Data format |
|-----------------|-------------|
| Setting range | 0 ~ 3 |
| Minimum unit | 1 |
| Factory default | 0 |

Used to set data format in ModBus protocol.

- 0: N, 8, 1 (1 start bit, 8 data bits, 1 stop bit, without check)
- 1: E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even parity)
- 2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd parity)
- 3: N, 8, 2 (1 start bit, 8 data bits, 2 stop bits, without check)



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

| | |
|--------------------------------|------------------------------------|
| H0.03 | Local address |
| Setting range | ModBus: 1 ~ 247; PROFIBUS: 1 ~ 126 |
| Minimum unit | 1 |
| Factory default | 1 |
| H0.04 ~ H0.07: Reserved | |

- In ModBus communication, the maximum number of frequency converters in the network is 247 (0 is broadcast address).
- In PROFIBUS communication,
 - the maximum number of frequency converters in the network is 126.
 - local address change with any of the slaves requires re-power of that slave.

| | |
|-----------------|--|
| H0.08 | Communication disruption detection time |
| Setting range | 0.0 ~ 60.0s |
| Minimum unit | 0.1s |
| Factory default | 0.0s |
| H0.09 | Communication disruption action |
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 1 |

When [H0.08] = 0.0s, the disruption detection is disabled, otherwise the detection is enabled.

If the interval between the current communication and the next exceeds the time defined in H0.08, a communication error / warning is reported and the action is defined by H0.09:

- 0: The motor freewheels to stop after the communication timeout no matter the settings of parameter b1.40 "Stopping mode".
- 1: The motor continues running at the set frequency. For error / warning message, see [chapter 9 "Diagnosis" on page 124](#).

| | |
|----------------------|-----------------------------|
| H0.10 ~ H0.17 | PZD3 ~ PZD10 setting |
| Setting range | 0 ~ 20 |
| Minimum unit | 1 |
| Factory default | 0 |

Used to set monitoring parameters of PZD (slave to master) area in PROFIBUS communication, see [chapter 17.2.13 "Group d: Monitoring Parameters" on page 241](#).

9.3.2 In Run State

| Displayed message |
|-------------------|
| UE-1 |

If the DC bus voltage drops down below a certain value under the following two situations, the messages above will show up:

1. Normal power down: this will cause DC bus voltage down below the under-voltage threshold along with this message.
2. Sudden power drop: this will cause that DC bus voltage drops at first down below the undervoltage threshold along with this message but then recovers before CPU voltage dropped to power down level, soft restart will be activated again and this message will be reset automatically.

9.4 Diagnosis on Warnings

EFC 3600 has totally 4 kinds of warning messages as shown in the table below:

| Displayed message | Diagnosis |
|-------------------|---|
| PrSE | If any contradiction exists in parameter settings, the set value is invalid and this message will show up. After 1.5s, the previous data will be displayed. |
| S.Err | This message will show up if the user tries to change a parameter which is read-only or protected by a password in RUN state. After 1.5s, the previous data will be displayed. |
| P.oFF | This message will show up only when power down/drop happens in STOP state. |
| C-dr | This message will show up if communication disruption timeout exceeds the value defined in H0.08 when H0.09 "Communication disruption action" is set to "1: continues running". |



All warnings will not lead to automatic shutdown.

9.5 Diagnosis on Errors

9.5.1 Error Description and Solution

When EFC 3600 detects a status or situation that affects or prevents correct operation, an error message will be generated, as shown below:

OC-1: Overcurrent at constant speed

| Possible reason | Solution |
|--|---|
| Sudden load change in run mode | Reduce occurrence and scale of sudden change |
| Low mains voltage | Check input power supply |
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| Excessive inertia or load | Check power of motor and frequency converter, check load |
| The motor cable is too long | <ul style="list-style-type: none"> ● Decrease the carrier frequency ● Use a frequency converter with larger power |
| Excessive torque compensation | Reduce voltage boost setting till the current decreases |

OC-2: Overcurrent during acceleration

| Possible reason | Solution |
|--|--|
| Excessively short acceleration time | Increase acceleration time |
| Excessive start-up frequency | Reduce start-up frequency |
| Excessive load rotation inertia or impact | Increase acceleration time, reduce sudden load change |
| Running command active while motor is coasting | Restart after motor stop or start with tracing speed ([b1.30]=2) |
| Wrong V/F curve setting | Adjust V/F curve |
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| Excessive torque compensation | Reduce voltage boost setting till the current decreases |
| Wrong motor parameters setting | Correct motor parameters setting |

OC-3: Overcurrent during deceleration

| Possible reason | Solution |
|--|---|
| Excessively short deceleration time | Increase deceleration time |
| Excessive load rotation inertia | Use suitable brake components |
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |

| Possible reason | Solution |
|-------------------------------|----------------------------------|
| Over excitation | Reduce [b1.45] |
| Wrong motor parameter setting | Correct motor parameters setting |

OE-1: Overvoltage at constant speed

| Possible reason | Solution |
|---|---|
| Surge voltage from power supply | Check input power supply |
| Motor to earth short circuit causes DC bus capacitors overcharged | Check motor connection |
| Excessive load rotation inertia | Use suitable brake components |
| Noise interference | Check wiring of control circuit, main circuit and grounding |

OE-2: Overvoltage during acceleration

| Possible reason | Solution |
|---|--|
| Surge voltage from power supply | Check input power supply |
| Motor to earth short circuit causes DC bus capacitors overcharged | Check motor connection |
| Direct start during motor running | Restart after motor stop or start with tracing speed ([b1.30]=2) |
| Excessively short acceleration time | Increase acceleration time (b1.20) or use S-curve (b1.22~b1.24) |

OE-3: Overvoltage during deceleration

| Possible reason | Solution |
|---|--|
| Surge voltage from power supply | Check input power supply |
| Motor to earth short circuit causes DC bus capacitors overcharged | Check motor connection |
| Excessive load rotation inertia | Use suitable brake components |
| Excessively short deceleration time | <ul style="list-style-type: none"> ● Increase deceleration time (b1.21) ● Use a brake resistor or a dynamic brake resistor unit ● Enable stall overvoltage prevention during deceleration ([E4.01]=1) |
| Wrong wiring of brake resistor | Check the wiring |
| The brake chopper is damaged | Contact with service |

OL-1: Frequency converter overload

| Possible reason | Solution |
|---|---|
| Long time overload | Reduce overload time, reduce load |
| Excessive proportion of V/F curve | Adjust V/F proportion and torque boost |
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| Overload happens at lower speed | <ul style="list-style-type: none"> ● Reduce load at lower speed ● Reduce the carrier frequency (b0.21) ● Use a frequency converter with larger power |
| Excessive load, excessive short Acc./Dec. time or cycle | <ul style="list-style-type: none"> ● Adjust load, acceleration/deceleration time or cycle ● Use a frequency converter with larger power |
| Low mains voltage | Check input power supply |
| Excessive torque compensation | Reduce voltage boost setting till the current decreases |

OL-2: Motor overload

| Possible reason | Solution |
|--|---|
| Motor locked | Prevent motor lock |
| Normal motor runs long time with large load at low speed | <ul style="list-style-type: none"> ● Increase frequency converter output frequency (b1.04 or potentiometer) ● Reduce load ● Use variable frequency motor or set zero speed load (E4.05) to a higher value ● Set correct thermal motor time constant (S2.23) |
| Low mains voltage | Check input power supply |
| Excessive proportion of V/F curve | Adjust V/F proportion and voltage boost |
| Excessive sudden load change | Check load |
| Wrong input of rated motor current | Correct rated motor current in S2.04 |
| Multiple motors are driven by one frequency converter | Connect only one motor to the frequency converter |
| Over excitation | Reduce [b1.45] |
| Wrong motor overload curve at low speed | Adjust settings of S2.23, E4.04 and E4.05 according to actual motor situations |

EFP-: Flash read/write error

| Possible reason | Solution |
|---------------------------------|--|
| Flash memory in a bad condition | Try to backup the data with the operating panel, and then contact with service |

SPI-: SPI communication problem

| Possible reason | Solution |
|-------------------------------|--|
| EMC problem on the main board | Check the wiring of control circuit, main circuit and grounding to find out the source of interference |
| Internal error on I/O board | Remove the EMC problem, if it happens again, contact with service |

E-St: External error

| Possible reason | Solution |
|---|---|
| External error caused by input signals via external terminals | Check external terminals status |
| Wrong wiring / setting of multi-function external terminals | Ensure the right external signals have been connected correctly to the right multi-function external terminals which are assigned for external error input ([E0.01]–[E0.05]=19, 20) |
| Converter stop caused by E-Stop active command via ModBus communication | Check the stop command via ModBus communication (0X0088: stop according to parameter setting; 0X0090: E-stop active). If converter receives 0X0090, E-St will be displayed |

RS-: Communication disconnection error

| Possible reason | Solution |
|----------------------------|---------------------------------------|
| Device connection problem | Check device communication connection |
| Communication target error | Check status of communication target |

CF: Circuit error (from current detection)

| Possible reason | Solution |
|--|---|
| The offset is out of range due to EMC or defect of current detection | Remove EMC problem; if it happens again, contact with service |

Ot: Motor over temperature

| Possible reason | Solution |
|-------------------------------|--|
| Excessive load or bad cooling | <ul style="list-style-type: none"> ● Check load ● Provide a better cooling condition |
| Temperature sensor defect | Check the motor temperature feedback signal |
| Wrong protection level | Different motor with different maximum temperature, configure external division circuit and set the protection level (S2.22) |

CPUd: Main board CPU trap error

| Possible reason | Solution |
|--|--|
| CPU is disturbed by external noise and the program runs to illegal address | Check the wiring of control circuit, main circuit and grounding to find out the source of interference |
| Wrong parameters setting | Set [b0.05] = 1 for parameters initialization |

SC: Short circuit of IGBT

| Possible reason | Solution |
|---|--|
| External phase-phase short circuit of motor | Check motor |
| Earth surge | Remove the short circuit and check motor |
| Internal error of IGBT | Contact with service |

IPH.L: Input phase loss (for 3p frequency converter)

| Possible reason | Solution |
|---|---|
| Abnormal, omitted or broken connections of frequency converter power supply | Follow operating procedures to check power supply connections, remove omitted or broken connections |
| Broken fuse | Check fuse |
| Imbalance in the three phases of input power supply | Check if the imbalance situation exceeds requirements |
| Main circuit capacitor deterioration | Contact with service |

OPH.L: Output phase loss

| Possible reason | Solution |
|--|--|
| Abnormal, omitted or broken connections of frequency converter outputs | Check the connections of frequency converter outputs, remove omitted or broken connections |
| Imbalance in the three phases of outputs | Check motor |

OH: Frequency converter over temperature

| Possible reason | Solution |
|---|---|
| Frequency converter (heat sink) temperature is higher than max. allowable temperature 85 °C | <ul style="list-style-type: none"> ● Reduce ambient temperature, improve ventilation and heat dissipation; clear dust, cotton wadding in air ducts; check fan and its power supply connection (if available) ● Reduce load if necessary ● Reduce carrier frequency (b0.21) |
| Temperature detection circuit error | Contact with service |

CPUC: I/O board trap error

| Possible reason | Solution |
|-----------------------------------|---|
| Fatal error with CPU on I/O board | <ul style="list-style-type: none"> ● Check the wiring of control circuit, main circuit and grounding to find out the source of interference ● If it happens again, contact with service |

CPUE: Operating panel trap error

| Possible reason | Solution |
|---|---|
| Fatal error with CPU on operating panel | <ul style="list-style-type: none"> ● Check the wiring of control circuit, main circuit and grounding to find out the source of interference ● If it happens again, contact with service |

CE3-: SPI problem between operating panel board and I/O board

| Possible reason | Solution |
|------------------------------|--|
| Problem with operating panel | <ul style="list-style-type: none"> ● Check the wiring of control circuit, main circuit and grounding to find out the source of interference ● If it happens again, replace the operating panel or contact with service |

CE4-: Internal problem on operating panel

| Possible reason | Solution |
|------------------------------|--|
| Problem with operating panel | <ul style="list-style-type: none"> ● Check the wiring of control circuit, main circuit and grounding to find out the source of interference ● If it happens again, replace the operating panel or contact with service |

FFE-: Firmware does not match

| Possible reason | Solution |
|--|----------------------|
| Operating panel may be placed to the frequency converter with older/newer firmware | Contact with service |
| I/O board may be removed to another device | Contact with service |

PSr-: Problem with power supply on the main board

| Possible reason | Solution |
|---------------------------------------|--|
| 10 V overload on I/O board | Remove overload |
| EMC problem at customer I/O interface | Remove the environmental interference or EMI |
| Internal problem | <ul style="list-style-type: none"> ● Check the wiring of control circuit, main circuit and grounding to find out the source of interference ● Contact with service |

EEPr: EEPROM error on operating panel

| Possible reason | Solution |
|--|--------------------------|
| Control circuit power failure while write / read | Parameter initialization |
| Error happens at normal power on, means problem with operating panel | Replace operating panel |
| Panel firmware version does not match with that of the main board | Contact with service |

ESS-: Soft start error

| Possible reason | Solution |
|--|------------------------------|
| Soft start resistor value has been changed due to over temperature | Contact with service |
| Power failure | Check the input power supply |
| Input phase loss occurs during start-up (3 phase) | Remove the input phase loss |
| Main circuit capacitor deterioration | Contact with service |

CE5-: Internal problem on main board

| Possible reason | Solution |
|--------------------------------|--|
| Problem with CPU on main board | Check the wiring, contact with service if it fails again |

UE-1: Undervoltage during running

| Possible reason | Solution |
|--------------------------------------|--------------------------|
| Power failure during running | Check input power supply |
| Main circuit capacitor deterioration | Contact with service |

UH: Frequency converter under temperature

| Possible reason | Solution |
|--|--|
| Ambient temperature is lower than -15 °C | Provide a reasonable ambient temperature that frequency converter requires |
| Temperature sensor defect | Check the motor temperature feedback signal |

FHE-: Manufacturer parameter defect or mismatches with hardware

| Possible reason | Solution |
|----------------------|----------------------|
| Parameter corruption | Contact with service |

CE7-: 15 V power supply error

| Possible reason | Solution |
|--------------------------|--|
| Internal circuit failure | Contact with service |
| EMC problem | Remove the environmental interference or EMI |

dir1: Rotation direction error 1

| Possible reason | Solution |
|---|-------------------------------|
| Direction control [b1.10] = '1: Forward only'. Direction command is reverse | Correct the parameter setting |

dir2: Rotation direction error 2

| Possible reason | Solution |
|---|-------------------------------|
| Direction control [b1.10] = '2: Reverse only'. Direction command is forward | Correct the parameter setting |

CE8-: Communication problem on I/O board (No communication frames received)

| Possible reason | Solution |
|---------------------|---|
| EMC problem | Remove the environmental interference or EMI |
| Defect on I/O board | Replace the I/O board or contact with service |

CE0-: Communication problem on main board (The communication frames are checksum erroneous)

| Possible reason | Solution |
|----------------------|--|
| EMC problem | Remove the environmental interference or EMI |
| Defect on main board | Contact with service |

CE1-: Communication problem on operating panel (The communication frames are checksum erroneous)

| Possible reason | Solution |
|---------------------------|---|
| EMC problem | Remove the environmental interference or EMI |
| Defect on operating panel | Replace the operating panel or contact with service |

CE2-: Communication problem on main board (No communication data from main board received)

| Possible reason | Solution |
|----------------------|--|
| EMC problem | Remove the environmental interference or EMI |
| Defect on main board | Contact with service |

CE6-: Communication problem on operating panel (No communication data from operating panel received)

| Possible reason | Solution |
|---------------------------|---|
| EMC problem | Remove the environmental interference or EMI |
| Defect on operating panel | Replace the operating panel or contact with service |

CE9-: Firmware version error

| Possible reason | Solution |
|--|----------------------|
| Firmware version of I/O board does not match with others in the system | Contact with service |

OE-4: Overvoltage during stop

| Possible reason | Solution |
|-------------------------------------|---|
| Excessive inertia on the load | <ul style="list-style-type: none"> ● Increase deceleration time ● Use suitable brake components |
| Surge voltage from the power supply | Check input power supply |

t-Er: Motor parameter identification error

| Possible reason | Solution |
|--|--|
| Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| Wrong setting of motor parameters | Correct motor parameters setting according to motor name-plate |
| No connection of converter and motor | Check motor cable connections |

SEr-: Service data handling error (the main board does not receive the answer after the retry limit)

| Possible reason | Solution |
|------------------------------|---|
| EMC problem | Remove the environmental interference or EMI |
| Problem with operating panel | <ul style="list-style-type: none"> ● Check the wiring of control circuit, main circuit and grounding to find out the source of interference ● If remote cable is be used, please use shielded cable ● If it happens again, replace the operating panel or contact with service |

9.5.2 Error Reactions of the Frequency Converter

If an error happens in running state, the frequency converter has to perform a suitable error reaction. For general errors, the frequency converter will free-wheel to stop. Some errors may be associated with special error reaction (e.g. communication error), which are configurable. If a configurable error reaction is set to "ignore error", then the error is neither displayed nor stored in the error memory.

9.5.3 Clearing an Error Message

An error message can be cleared by the following actions:

- Press the **STOP** button.
- Activate the digital I/O terminal configured as "external error reset".



All other buttons or run commands from external sources are ignored before the error is reset. After reset, the display returns to the state before the error occurred.

9.5.4 Error Memory

Several diagnostic messages of errors are written to the error memory. 3 recent errors are stored in E4.20-E4.22. The latest error is always stored in E4.20, and the previous error codes are shifted one place back in the FIFO. The oldest error (value of E4.22 before the new error occurred) will be shifted out of the FIFO and lost. System status at the latest error are recorded in E4.30-E4.35.

9.5.5 Automatic Error Reset

An automatic error reset mechanism can be configured by setting E4.15 to a non-zero value. If an error occurs, the normal error reaction and diagnosis is performed as described above. After the frequency converter has stopped the PWM output, the system will remain in idle mode for the delay time [E4.16]. Then the error will be automatically reset and a run command will be generated to restart the frequency converter. This sequence will be performed [E4.15] times in a row. If the error still exists, the frequency converter remains in idle mode and no longer performs automatic restart attempts. A manual reset is required to resume the operation.

If a manual error reset (via STOP button or I/O terminal, see above) is requested while the error is displayed during the automatic error reset sequence (during the delay time between an error and the automatic restart attempt), the sequence will be interrupted and the error is reset. The frequency converter remains in idle mode and no longer performs automatic restart attempts.

If the frequency converter is successfully restarted, then the number of automatic restart attempts will be reset to E4.15.

10 Technical Data

10.1 General Technical Data

| Input | |
|--|--|
| Power supply voltage | 1 AC 200 ~ 240 V (-10 % / +10 %) (TN-Net) 3 AC 380 ~ 480 V (-15 % / +10 %) (TN-Net) |
| Power supply frequency | 50 ~ 60 Hz (±5 %) |
| Output | |
| Rated output voltage | Corresponding to input voltage |
| Rated power | 0.4 ~ 2.2 kW (1P AC 200 ~ 240 V) 0.4 ~ 4.0 kW (3P AC 380 ~ 480 V) |
| Output frequency | 0 ~ 400 Hz |
| Switching frequency | 1 ~ 15 kHz |
| Frequency converter efficiency | > 95 % |
| Overload capability | 150 % of rated current for 60s + 100 % of rated current for 540s 200 % of rated current for 1s + 100 % of rated current for 19s |
| Main functions | |
| Control mode | V/F control |
| V/F curve | Linear mode, square curve mode, user-defined multi-point curve mode |
| Speed regulation range | 1:50 |
| Start-up torque | 150 % × rated torque at 3 Hz 100 % × rated torque at 1.5 kHz |
| Frequency resolution | Analog setting: 1/1000 of max. frequency Digital setting: 0.01 Hz |
| Frequency control accuracy | Analog setting: ±0.1 % of max. frequency (25 °C ± 10 °C) Digital setting: ±0.01 % of max. frequency (-10 °C ~ 50 °C) |
| Multiple speed control | Via simple PLC or control terminals |
| Acceleration/deceleration curve mode | Linear, S-curve |
| DC brake | DC brake activation frequency: 0 ~ 50 Hz DC brake time: 0 ~ 20s |
| Status messages via multi-function output signal | Frequency converter in running, frequency converter for running, DC braking indication, frequency converter running at zero speed, FDT1/FDT2, frequency / velocity arrival signal, undervoltage blockage stopped, motor/frequency converter overload pre-warning, external fault stop, error output, target/middle count value arrived, simple PLC phase/cycle completion indication |

| | |
|---|--|
| Main control functions | Automatic PWM frequency adaptation, main and auxiliary reference, slip compensation, torque boost, automatic voltage stabilization selection, DC brake, restarting after power fault immediately, intelligent fan control, 2-wire / 3-wire control, quick start-up, parameter copy, PID control, multi-speed control, no-trip control, etc. |
| Customized functions | |
| Control commands | Set by operating panel, control terminals and communication |
| Frequency setting | Set by digital operating panel, analog voltage, analog current, communication, potentiometer, simple PLC and output of PID, which can be switched freely |
| Auxiliary frequency setting | Flexible frequency trimming and frequency synthesis, etc. |
| Analog output terminal | Analog output, 0 / 2 ~ 10 V, to output running frequency, set frequency, output current, output power, output voltage, analog input voltage and analog input current |
| Communication | |
| Communication protocol | ModBus (MDA models); ModBus or PROFIBUS (PDA models) |
| Communication interface | RS485 |
| Operating panel | |
| 7-Segment display | Displaying of various parameters, including output rotation speed, output frequency, set frequency, set rotation speed, output voltage, output current, output power, analog input, DC bus voltage, analog output, digital input status, user-defined set frequency, user-defined output frequency, PID target engineering value, PID feedback engineering value, module temperature, actual carrier frequency, firmware version, etc. |
| LED indicator | Showing setting direction, RUN status |
| Protection | |
| Short circuit between phase protection, ground fault protection, overload protection, overvoltage protection, undervoltage protection, motor/frequency converter thermal protection, intelligent overload protection (reduce carrier frequency at O.H.), stall prevention, etc. | |
| Optional parts | |
| Mains choke, EMC filter, brake resistor, motor choke, interface adapter cable, communication cable for cabinet control, mounting plate for control cabinet, etc. | |
| 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 ~ 50 °C (Operating); -20 ~ 60 °C (Storage) |
| Relative humidity | < 90 % RH (Without condensation) |
| Shocking | 1 g (< 20 Hz); 6 g (20 ~ 50 Hz) |
| Allowed pollution degree | 2 (EN 50178) |

| | |
|-------------------------------------|---|
| Construction | |
| Degrees of protection | IP 20 (Mounting on the metal wall in control cabinet) |
| Cooling type | Natural cooling ($\leq 0K75$); Enforced air cooling ($\geq 1K50$) |
| Standards and certifications | |
| CE, UL, RCM | |
| Mounting mode | |
| Wall mounting | |

Tab. 10-1: General technical data

10.2 Electrical Data

| 1-phase 200 V series | | | | | |
|-------------------------------------|------|------|------|------|------|
| Model EFC 3600-□□□□-1P2-xDA-7P-NNNN | 0K40 | 0K75 | 1K50 | 2K20 | – |
| Power class [kW] | 0.4 | 0.75 | 1.5 | 2.2 | – |
| Rated input current [A] | 5.8 | 9.6 | 15.0 | 19.7 | – |
| 200 V rated output current [A] | 2.3 | 3.9 | 7.0 | 9.7 | – |
| 240 V rated output current [A] | 1.9 | 3.3 | 5.8 | 8.1 | – |
| Rated output apparent power [kVA] | 0.8 | 1.4 | 2.4 | 3.4 | – |
| 3-phase 400 V series | | | | | |
| Model EFC 3600-□□□□-3P4-xDA-7P-NNNN | 0K40 | 0K75 | 1K50 | 2K20 | 4K00 |
| Power class [kW] | 0.4 | 0.75 | 1.5 | 2.2 | 4.0 |
| Rated input current [A] | 1.3 | 2.3 | 3.9 | 5.6 | 9.8 |
| 380 V rated output current [A] | 1.2 | 2.1 | 3.7 | 5.1 | 8.8 |
| 480 V rated output current [A] | 1.0 | 1.6 | 2.9 | 4.0 | 7.0 |
| Rated output apparent power [kVA] | 0.8 | 1.4 | 2.4 | 3.4 | 5.8 |

Tab. 10-2: Electrical data



□□□□: is a substitute for different power.

- i.e. 0K40 means 0.4 kW.

10.3 Derating of Electrical Data

10.3.1 Derating and Ambient Temperature

The ambient temperature for EFC 3600 is -10 ~ 50 °C.

- If the ambient temperature is within this range, there will be no need for derating.
- If the ambient temperature is out of this range, there will be no possibility to install and run the frequency converter, even the performance data have been additionally reduced.

10.3.2 Derating and Mains Voltage

Reduced over current based on mains voltage.

The EFC 3600 frequency converters are thermally dimensioned for the rated current. This rated current is available with the specified rated voltage. With deviating voltages in the permissible range, please pay attention to the following:

- $U_{\text{mains}} < U_{\text{rated}}$: With mains voltage below the rated voltage, no higher current may be withdrawn to ensure that the dissipated power remains.
- $U_{\text{mains}} > U_{\text{rated}}$: With mains voltage above the rated voltage, a reduction of the permissible output permanent current takes place to compensate for the increased switching losses.

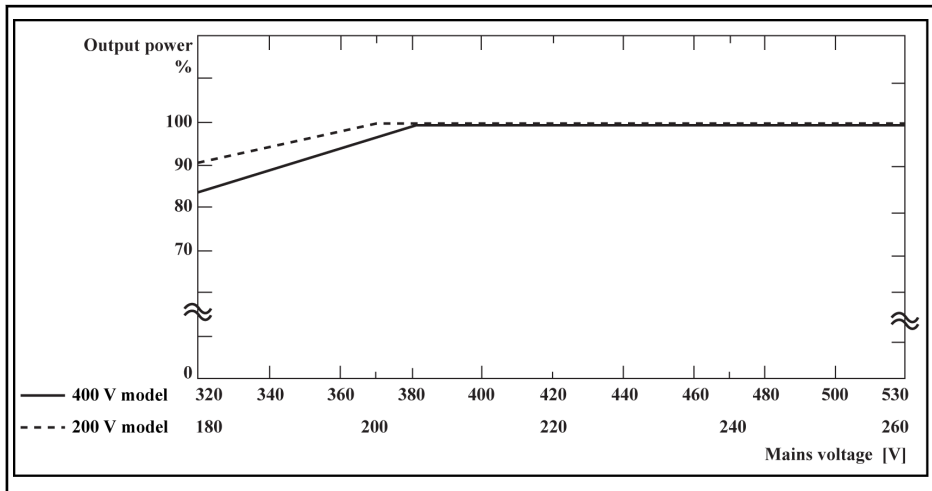


Fig. 10-1: Derating and mains voltage



- 400 V model:
 1 % power derating upon every 4 V decreasing when mains voltage < 380 V.
- 200 V model:
 1 % power derating every 2 V decreasing when mains voltage < 200 V.

10.3.3 Derating and Output Current

For the whole power range of EFC 3600 from 0K40 to 4K00, current derating based on pulse frequency is unnecessary.

11 Electromagnetic Compatibility (EMC)

11.1 EMC Requirements

11.1.1 General Information

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

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

11.1.2 Noise Immunity in the Drive System

Basic structure for noise immunity

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

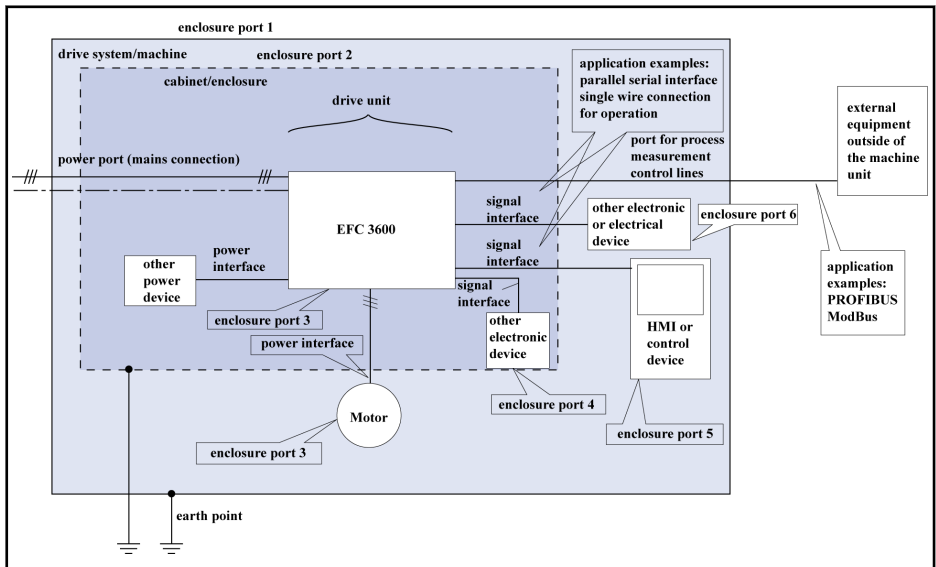


Fig. 11-1: Noise immunity in the drive system

Minimum immunity requirements for PDSs intended for use in the second environment

| Port | Phenomenon | Basic standard for test method | Level | Performance (acceptance criterion) |
|--|--|--------------------------------|---|------------------------------------|
| Enclosure port | ESD | IEC 61000-4-2 | 4 kV CD or 8 kV AD if CD impossible | B |
| | Radio-frequency electromagnetic field, amplitude modulated | IEC 61000-4-3 | 80 ~ 1000 MHz 10 V/m 1.4 ~ 2.0 GHz 3 V/m 2.0 ~ 2.7 GHz 1 V/m 80 % AM (1 kHz) | A |
| Power ports | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz | B |
| | Surge 1.2/50 μ s, 8/20 μ s | IEC 61000-4-5 | 1 kV ^a , 2 kV ^b | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 ~ 80 MHz 10 V 80 % AM (1 kHz) | A |
| Power interfaces | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz Capacitive clamp | B |
| Signal interfaces | Fast transient-burst | IEC 61000-4-4 | 1 kV/5 kHz Capacitive clamp | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 ~ 80 MHz 10 V 80 % AM (1 kHz) | A |
| Ports of process measurement control lines | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz Capacitive clamp | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 ~ 80 MHz 10 V 80 % AM (1 kHz) | A |

Tab. 11-1: Minimum immunity requirements for PDSs intended for use in the second environment

Minimum immunity requirements for PDSs intended for use in the first environment

| Port | Phenomenon | Basic standard for test method | Level | Performance (acceptance criterion) |
|--|--|--------------------------------|--|------------------------------------|
| Enclosure port | ESD | IEC 61000-4-2 | 4 kV CD or 8 kV AD if CD impossible | B |
| | Radio-frequency electromagnetic field, amplitude modulated | IEC 61000-4-3 | 80 ~ 1000 MHz 3 V/m 1.4 ~ 2.0 GHz 3 V/m 2.0 ~ 2.7 GHz 1 V/m 80 % AM (1 kHz) | A |
| Power ports | Fast transient-burst | IEC 61000-4-4 | 1 kV/5 kHz | B |
| | Surge 1.2/50 μ s, 8/20 μ s | IEC 61000-4-5 | 1 kV ^a , 2 kV ^b | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 ~ 80 MHz 3 V 80 % AM (1 kHz) | A |
| Power interfaces | Fast transient-burst | IEC 61000-4-4 | 1 kV/5 kHz Capacitive clamp | B |
| Ports of process measurement control lines | Fast transient-burst | IEC 61000-4-4 | 0.5 kV/5 kHz Capacitive clamp | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 ~ 80 MHz 3 V 80 % AM (1 kHz) | A |

Tab. 11-2: Minimum immunity requirements for PDSs intended for use in the first environment

- CD: Contact discharge
- AD: Air discharge
- AM: Amplitude modulation
- ^a: Coupling line to line
- ^b: Coupling line to earth



Category C1 is only for conducted emission, radiated emission needs checking with metallic cabinet. For installation, see [chapter 11.3 "EMC Measures for Design and Installation"](#) on page 149.

Evaluation criterion

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

Tab. 11-3: Evaluation criterion

11.1.3 Noise Emission of the Drive System

Causes of noise emission

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

The steeper voltage rises, the higher clock rate and the resulting harmonics cause unwanted but physically unavoidable emission of interference voltage and interference fields (wide band interference). The interference mainly is asymmetric interference against ground.

The propagation of this interference strongly depends on:

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

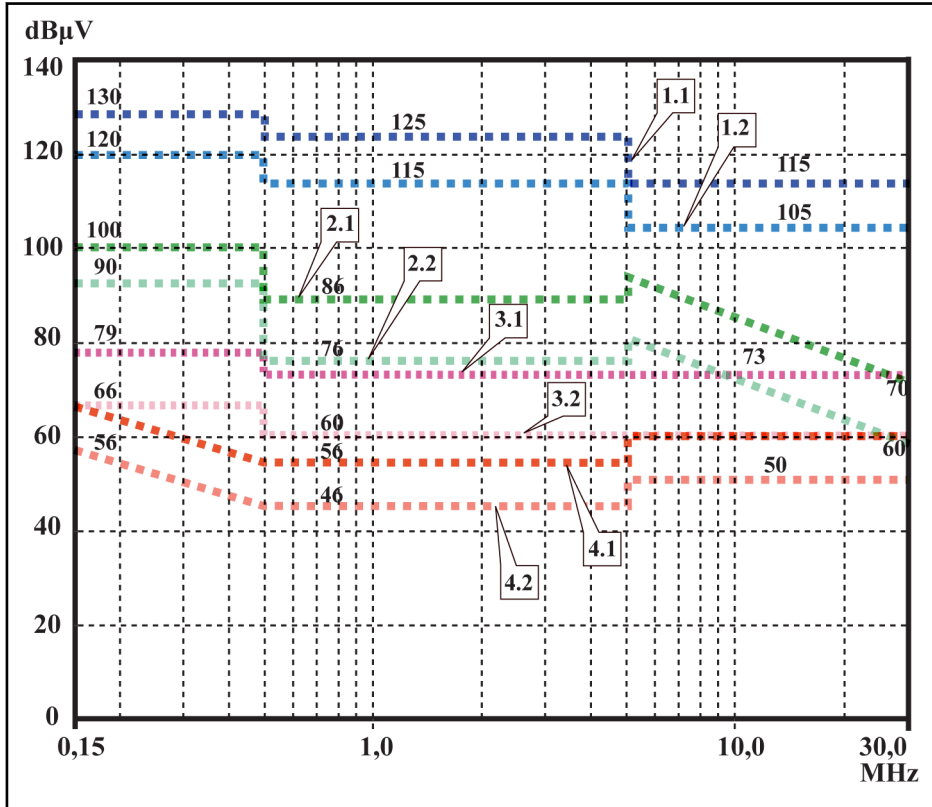
If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

Limit values for line-based disturbances

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

| IEC / EN 61800-3 | CISPR 11 | Explanation | In this document | Curves of limit value characteristic |
|--|-----------------------------------|---|------------------|--------------------------------------|
| Category C4 2 nd environment | None | <p>One of the following 3 requirements must have been fulfilled:</p> <ul style="list-style-type: none"> ● Mains connection current > 400 A, IT mains or required dynamic drive behavior not reached by means of EMC filter. ● Adjust limit values to use and operation on site. ● User has to carry out and provide evidence of EMC planning. | None | – |
| Category C3 2 nd 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 current > 100 A | A2.1 | 1.1 1.2 |
| Category C3 2 nd 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 current ≤ 100 A | A2.2 | 2.1 2.2 |
| Category C2 1 st environment | Class A; group 1 | Limit value in residential area or at facilities at low-voltage mains supplying buildings in residential areas to be complied with | A1 | 3.1 3.2 |
| Category C1 1 st environment | Class B; group 1 | Limit value in residential areas to be complied with | B1 | 4.1 4.2 |

Tab. 11-4: Limit values for line-based disturbances



1.1 C3 2nd environment, QP, I > 100 A (class A, group 2, I > 100 A)

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

2.1 C3 2nd environment, QP, I ≤ 100 A (class A, group 2, I ≤ 100 A)

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

3.1 C2 1st environment, QP (1st environment, even if source of interference in 2nd environment) (class A, group 1)

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

4.1 C1 1st environment, QP (1st environment, even if source of interference in 2nd environment) (class B, group 1)

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

Fig. 11-2: Limit values for line-based disturbances (IEC 61800-3); limit characteristic through frequency range



- Limit value for 1st environment is also relevant, if source of interference of 2nd environment affects 1st environment.
- Designations “class” and “group” according to CISPR 11.
- QP: 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 ($> 100\text{ A}$ or $\leq 100\text{ A}$) is specified by the local power supply company at the connection point of the mains. For industrial companies, for example, such connection points are the interconnecting stations from the power supply company.

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



According to IEC 61800-3, components of EFC 3600 drive system are products of

- category C3: with internal EMC filter
- category C1: with external EMC filter

EFC 3600 frequency converter with internal EMC filter is applicable to industrial environment (category C3). With installation of an external EMC filter, EFC 3600 can fulfill C1 requirements.

The grounding of the internal EMC filter can be disconnected by removal of the grounding screw, see [chapter 5.11 "Grounding Screw Removal of Internal EMC Filter"](#) on page 31.

⚠ WARNING

In a domestic environment (category C1) EFC 3600 frequency converter with internal EMC filter may cause radio interference in which case supplementary mitigation measures may be required.

See the following chapters for the limit classes (as per categories C1, C2, C3, C4 according to EN 61800-3) which can be reached for Bosch Rexroth Frequency Converter EFC 3600.

11.2 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 internal and external EMC filters.

- Category C3 requirements according to product standard EN 61800-3 have been complied with for EFC 3600 with an internal EMC filter.
- Category C1 requirements according to product standard EN 61800-3 have been complied with for EFC 3600 with an external EMC filter.
- Minimum immunity requirements in the second environment according to product standard EN 61800-3 have been complied with for EFC 3600 with internal and external EMC filters.

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, EFC 3600 drive system is complied with product standard EN 61800-3 C3 (with internal EMC filters) or EN 61800-3 C1 (with external EMC filters). The drive system is listed in the declaration of EMC conformity. This fulfills the legal requirements according to EMC directive.

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

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

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

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

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

11.3 EMC Measures for Design and Installation

11.3.1 Rules for Design of Installations with Drive Controllers in Compliance with EMC

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

Mains Filter

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

Control Cabinet Grounding

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

Line Routing

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

The lines with high potential of noise include:

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

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

Interference Suppression Elements

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

- Contactors
- Relays
- Solenoid valves
- 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 (transmitter **and** receiver) over the largest possible surface area and with low impedance. This avoids low frequency interference current (in the mains frequency range) on the shield.

Analog Signal Lines

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

Connection of Mains Choke

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

Installation of Motor Power Cable

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

11.3.2 EMC-optimal Installation in Facility and Control Cabinet

General Information

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



- For EMC-optimal installation in the control cabinet, use a separate control cabinet panel for the drive components.
 - Frequency converters need to be mounted in metal cabinet and connected to power supply with grounding.
 - For frequency converters with internal filter, 15 m shielded cable was used between the motor and frequency converter in the EMC test; for frequency converters with external filter, 5 m shielded cable was used between the motor and the frequency converter in the EMC test.
 - For the end application system with frequency converters, the conformity of EMC directions needs to be confirmed.
-

Division into Areas (zones)

Exemplary arrangements in the control cabinet: See [fig. 11-3 "Control cabinet mounting according to interference areas – exemplary arrangements"](#) on page 153.

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 mm² or, even better, via grounding straps with the same cross section. Make sure connection points have good contact.

11.3.3 Control Cabinet Mounting according to Interference Areas – Exemplary Arrangements

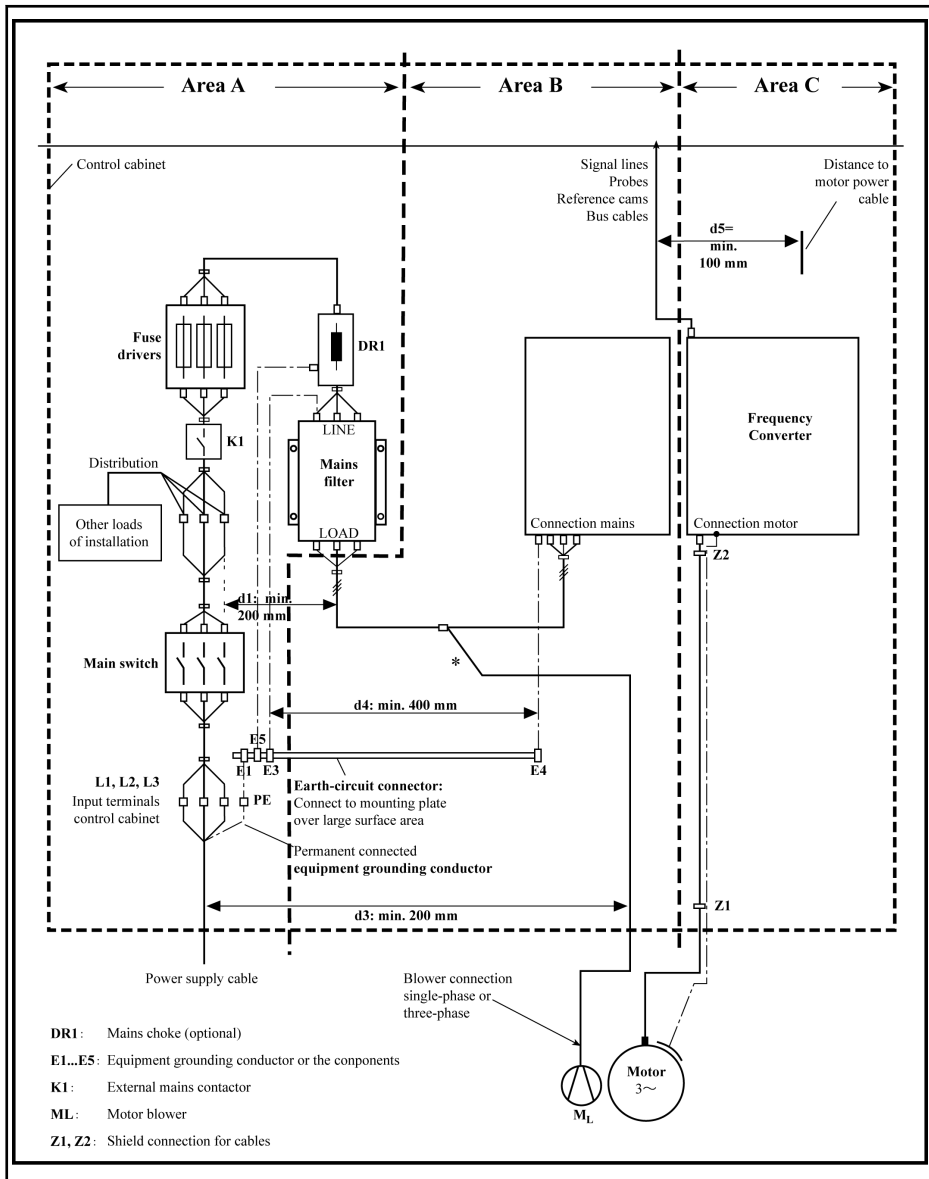


Fig. 11-3: Control cabinet mounting according to interference areas – exemplary arrangements

11.3.4 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 beginning 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 MHz and the limit values at the connection points of the machine or installation will thereby be exceeded.

Routing and Connecting a Neutral Conductor (N)

If a neutral conductor is used together with a three-phase connection, it must not be installed unfiltered in areas B and C, 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 frequency converter with **only infeeding supply units**, via the available three phase filter of the frequency converter

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

Loads at Mains Filter of frequency converter

- Only operate allowed loads at the mains filter of the frequency converter!

Shielding Mains Supply Lines in Control Cabinet

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

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

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

Mains Filters for AC Drives

Ideally, mount the external 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 external filter, their current may be a maximum of 10 % of the three-phase operating current. A highly imbalanced load of the external filter would deteriorate its interference suppression capacity.

If the mains voltage is higher than 480 V, connect the external filter to the output side of the transformer instead of 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 frequency converter should be at least $d_4=400$ 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 0 .

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 mm² or to be complemented by a second equipment grounding conductor via separate terminal connectors (according to EN 61800-5-1: 2007, section 4.3.5.4). If the cross section of the outer conductor is bigger, the cross section of the equipment grounding conductor must be accordingly bigger.

11.3.5 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 frequency converter to the mains via a mains filter. See "[Division into Areas \(zones\)](#)" on page 0 .

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 frequency converter.

Run the connection between control voltage connection of the frequency converter 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).

11.3.6 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 of the drive controller.

Influence of the Motor Power Cable

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

- Run the shortest possible motor power cables.

Routing the Motor Power Cables and Motor Encoder Cables

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

Route the motor power cables and motor encoder cables

- with a distance of at least **d5=100 mm** to interference-free lines, as well as to signal cables and signal lines
(alternatively separated by a grounded distance plate)
- in separate cable ducts, if possible

Routing the Motor Power Cables and Mains Connection Lines

For 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 **ducts**.

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

11.3.7 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 frequency converter, 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 connec-

tion 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 chromated, 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 current mainly flow on the surface of the conductor.

11.3.8 Installing Signal Lines and Signal Cables

Line Routing

The following measures are recommend:

- Route signal and control lines separately from the power cables with a minimum distance of $d_5=100$ mm (see "[Division into Areas \(zones\)](#)" on page 0) 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 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.

11.3.9 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 current.

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.

12 Accessories

12.1 Mains Choke

12.1.1 Mains Choke Selection

| EFC 3600 model | Mains choke type |
|----------------|----------------------------|
| OK40-1P2 | FENL01.1E-2100-N0010-N-240 |
| OK75-1P2 | |
| 1K50-1P2 | FENL01.1E-0700-N0030-N-240 |
| 2K20-1P2 | |
| OK40-3P4 | FENL01.1E-2800-N0005-N-480 |
| OK75-3P4 | |
| 1K50-3P4 | FENL01.1E-2000-N0007-N-480 |
| 2K20-3P4 | FENL01.1E-1400-N0010-N-480 |
| 4K00-3P4 | FENL01.1E-0930-N0015-N-480 |

Tab. 12-1: Mains choke selection

12.1.2 Dimensions

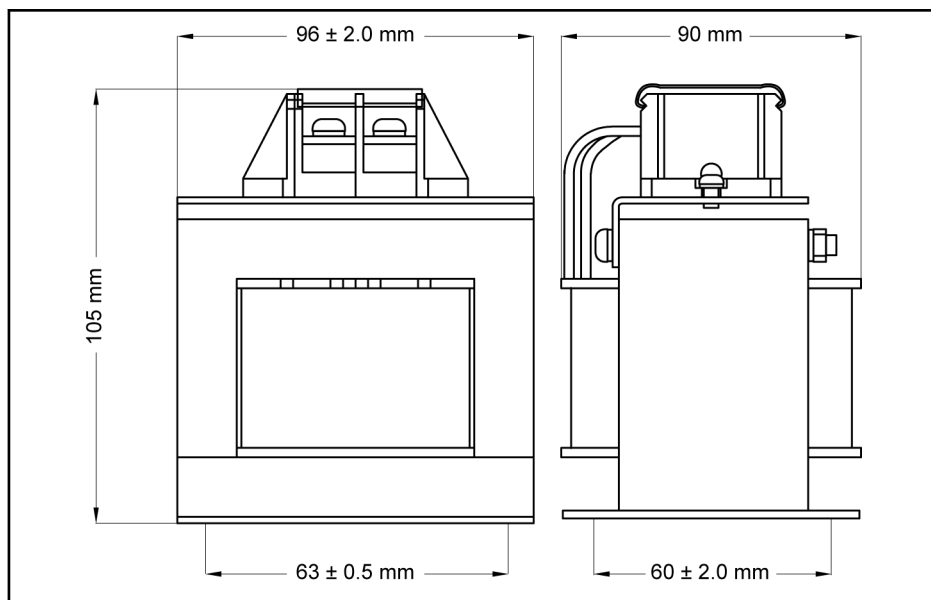


Fig. 12-1: FENL01.1E-2100-N0010-N-240

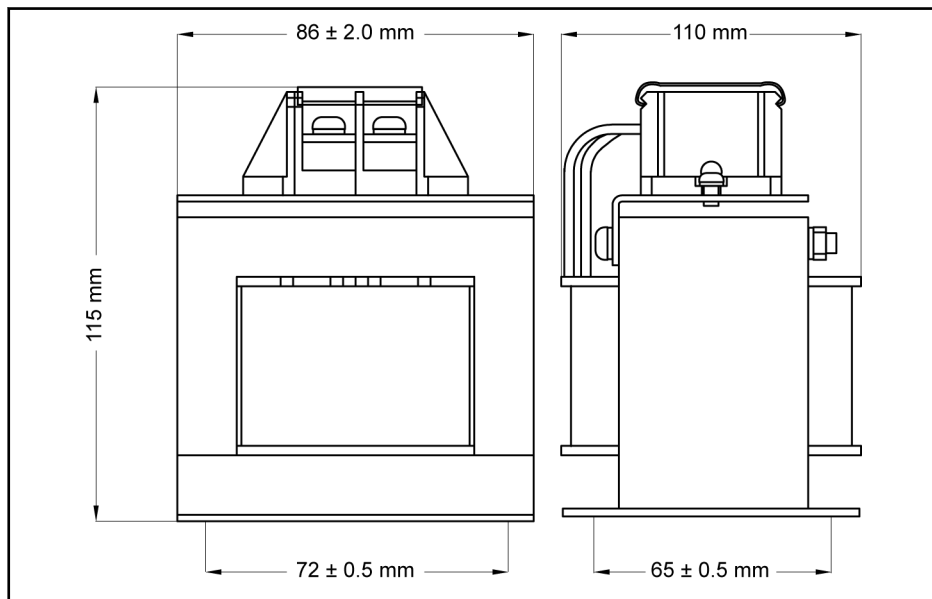


Fig. 12-2: FENL01.1E-0700-N0030-N-240

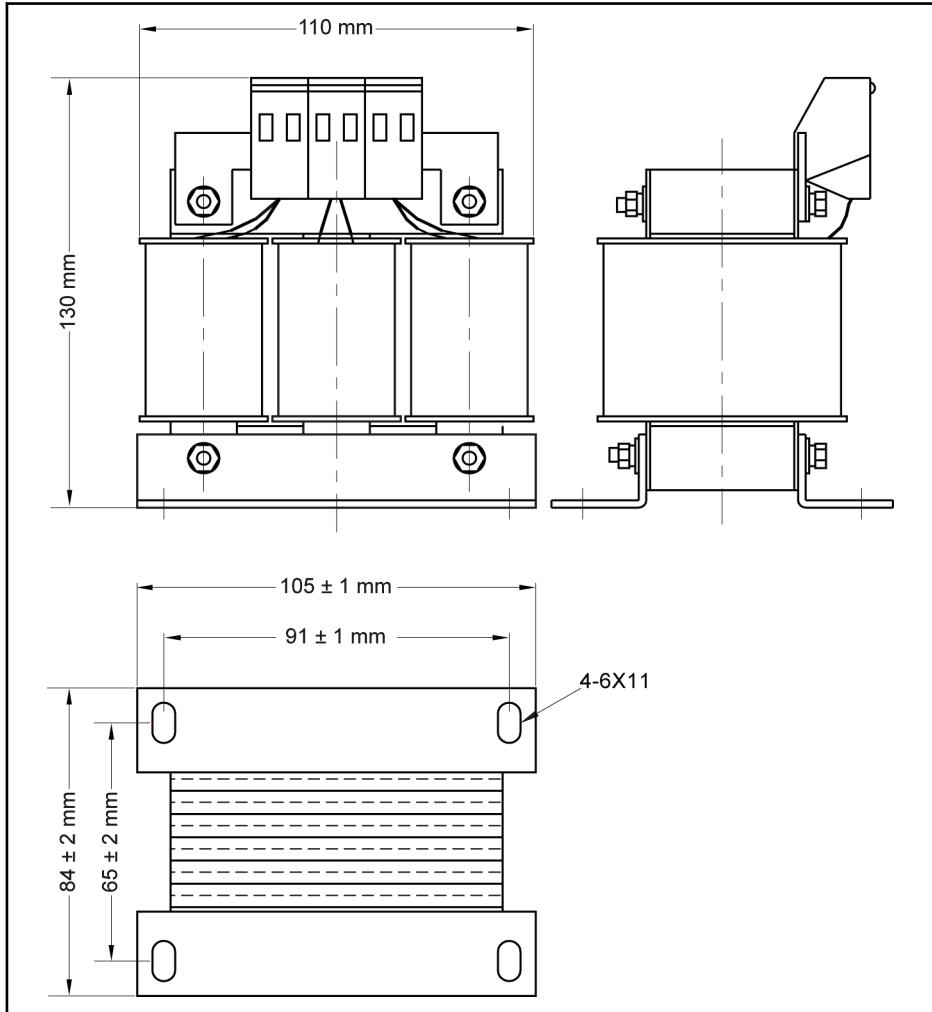


Fig. 12-3: FENL01.1E-(2800-N0005/2000-N0007/1400-N0010)-N-480

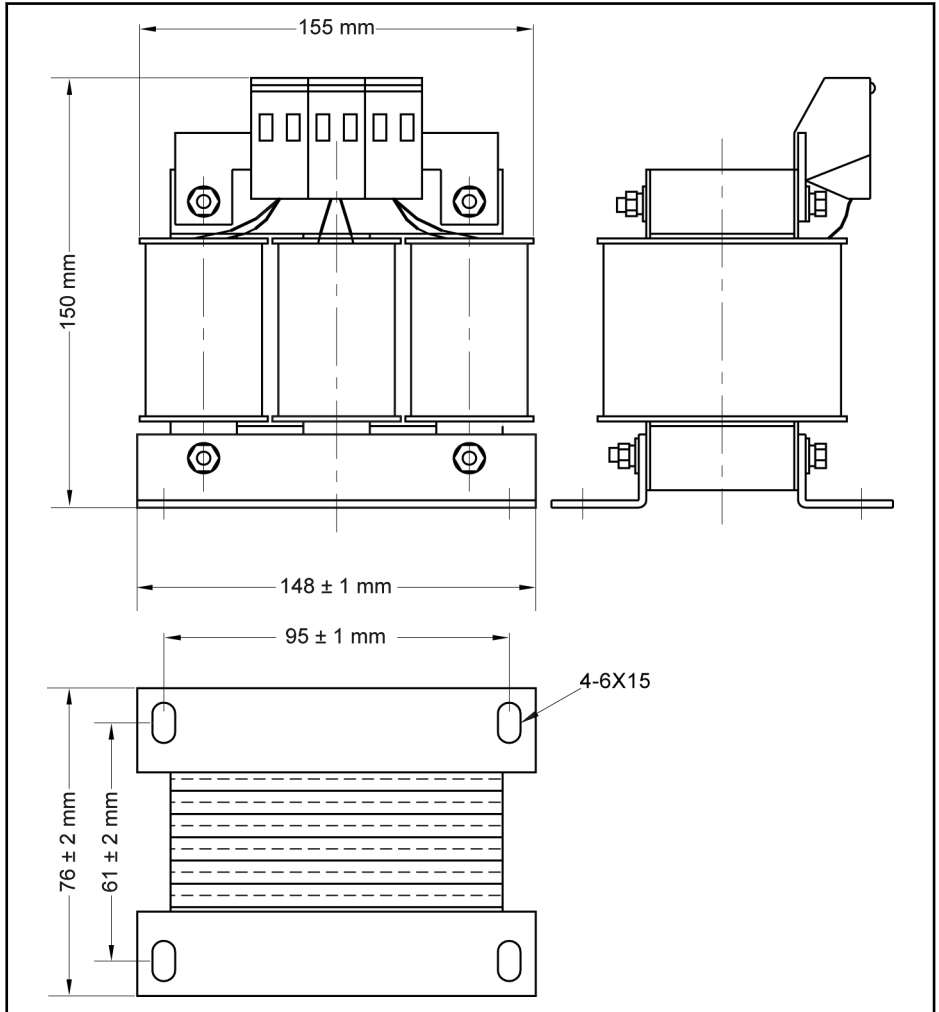


Fig. 12-4: FENL01.1E-0930-N0015-N-480

12.1.3 Electrical data

| Description | 2100- N0010 | 0700- N0030 | 2800- N0005 | 2000- N0007 | 1400- N0010 | 0930- N0015 |
|-----------------------|----------------------|----------------|---------------------|----------------|----------------|----------------|
| Rated voltage | AC 200 V /50 Hz | | AC 380 V /50 Hz | | | |
| Rated current [A] | 10 | 30 | 5 | 7 | 10 | 15 |
| Rated inductance [mH] | 2.1 | 0.7 | 2.8 | 2.0 | 1.4 | 0.93 |
| Dielectric strength | 3,000 V / 5 mA / 10s | | 3000 V / 5 mA / 60s | | | |
| Insulation resistance | ≥ 100 MΩ | | | | | |

Tab. 12-2: Electrical data

12.2 EMC Filter

12.2.1 The Function of EMC Filter

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

12.2.2 External EMC Filter Type

| EFC 3600 model | External EMC filter type |
|----------------|--------------------------|
| OK40-1P2 | E0006-A-240 |
| OK75-1P2 | E0010-A-240 |
| 1K50-1P2 | E0020-A-240 |
| 2K20-1P2 | E0025-A-240 |
| OK40-3P4 | E0008-A-480 |
| OK75-3P4 | |
| 1K50-3P4 | |
| 2K20-3P4 | |
| 4K00-3P4 | E0020-A-480 |

Tab. 12-3: External EMC filter type



- For definition of model or type, see [chapter 17.3 "Appendix 3: Type Coding" on page 242](#).
- The EMC filters listed above are recommended based on tests with 5 m motor cables. If longer motor cables are needed, please use appropriate EMC filters.

12.2.3 Technical Data

Dimensions



Mounting position and distances

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

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



Fig. 12-5: E0006-A-240

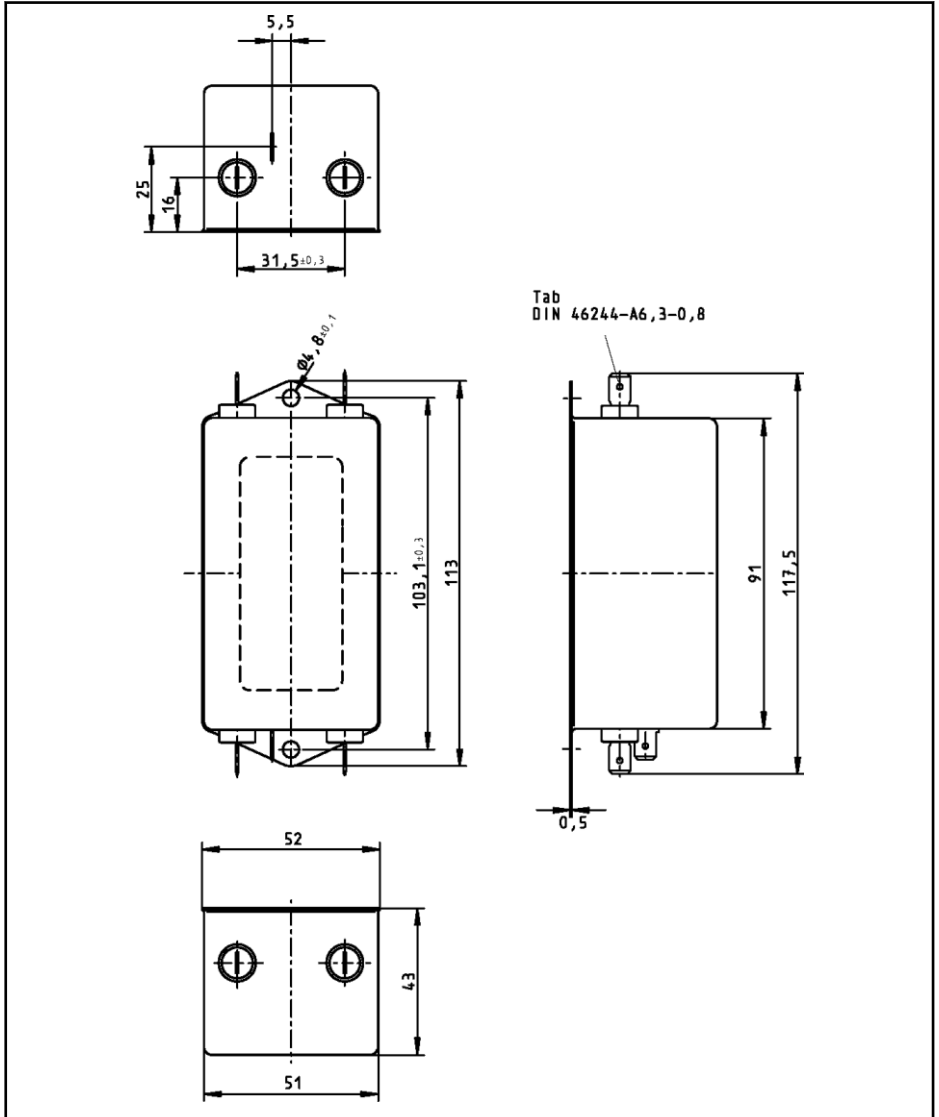


Fig. 12-6: E0010-A-240

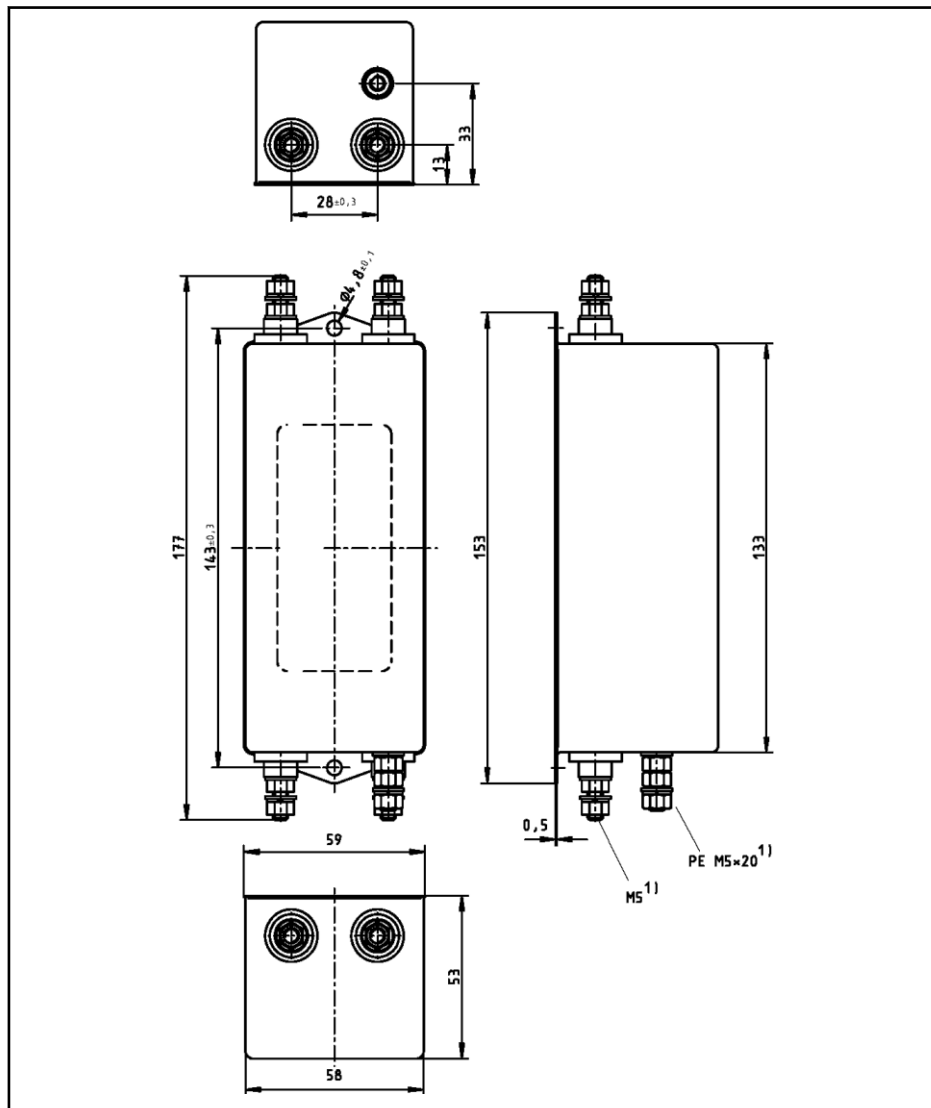


Fig. 12-7: E0020-A-240_E0025-A-240

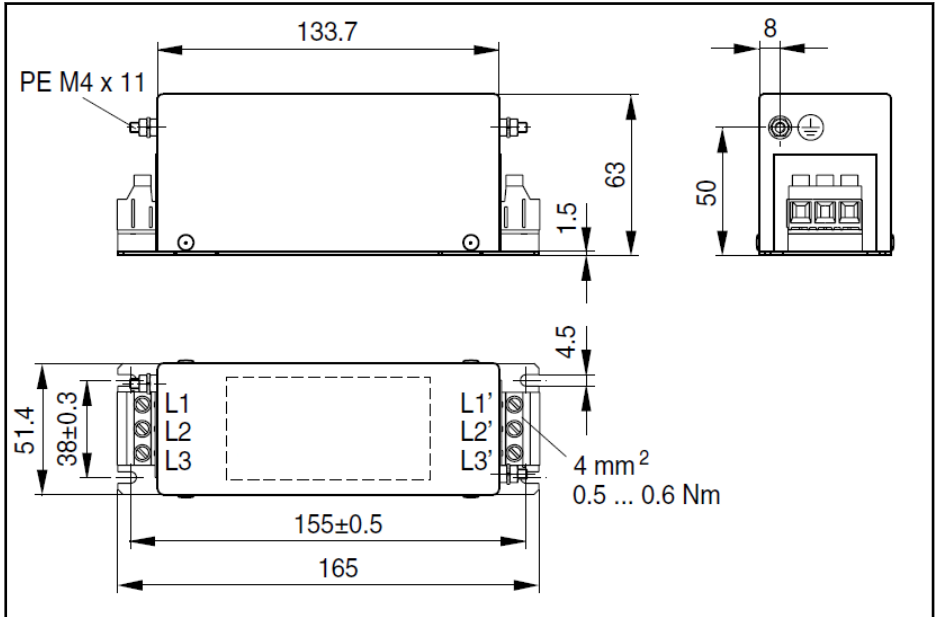


Fig. 12-8: E0008-A-480

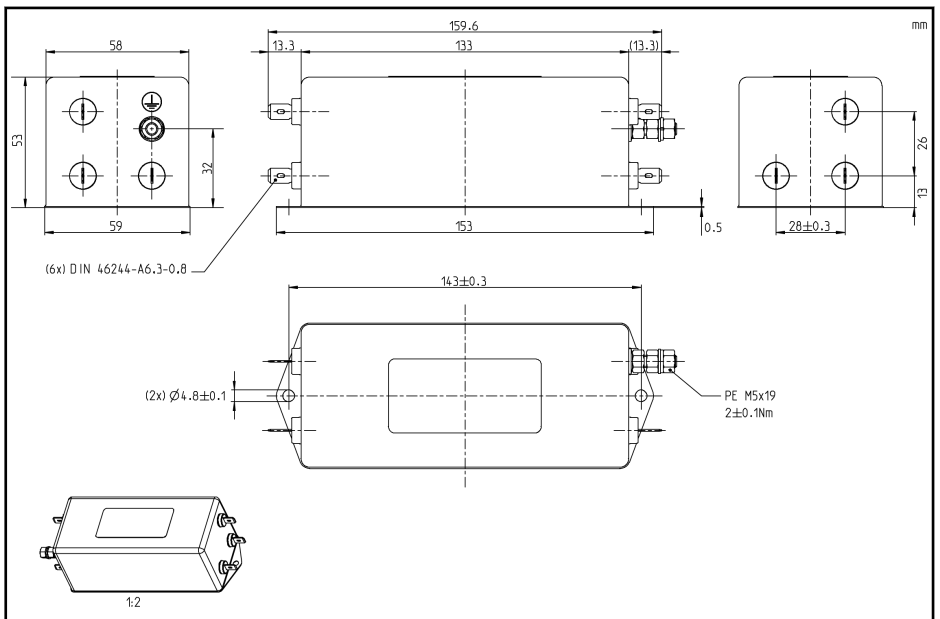


Fig. 12-9: E0020-A-480

Electrical data



Using EMC filters in mains grounded via outer conductor.

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

| Description | Symbol | Unit | E0006-A-240 | E0010-A-240 | E0020-A-240 | E0025-A-240 | E0008-A-480 | E0020-A-480 |
|---|---------------|-----------------|---------------|-------------|-------------|-------------|---------------|-------------|
| Degree of protection according to IEC 60529 | - | - | IP 20 | | | | | |
| Listing according to UL standard (UL) | - | - | UL 1283 | | | | | |
| Listing according to CSA standard (UL) | - | - | C22.2 No.8 | | | | | |
| Mass (weight) | m | kg | 0.26 | 0.42 | 0.86 | 0.87 | 0.58 | 0.75 |
| Mains voltage three-phase at TNS, TN-C, TT mains | U_{LN} | V | 200...240 | | | | 380...480 | |
| Mains voltage three-phase at Corner- grounded-Delta mains | U_{LN} | V | Not allowed | | | | | |
| Mains voltage three-phase at IT mains | U_{LN} | V | Not allowed | | | | | |
| Tolerance U_{LN} (UL) | | % | -10 %...+10 % | | | | -15 %...+10 % | |
| Input frequency (UL) | f_{LN} | Hz | 50...60 | | | | | |
| Nominal current | I_{L_cont} | A | 6 | 10 | 20 | 25 | 8 | 20 |
| Calculation of leakage current | I_{leak} | mA | < 0.5 | < 0.5 | < 3.5 | < 3.5 | 13 | 3.1 |
| Required wire size according to IEC 60364-5-52; at I_{L_cont} | A_{LN} | mm ² | 2 | 2 | 3.5 | 5.3 | 4 | 5 |
| Required wire size according to UL 508 A (internal wiring); at I_{L_cont} (UL) | A_{LN} | AWG | 14 | 14 | 12 | 10 | 10 | 10 |

Tab. 12-4: Electrical data

12.3 Brake Resistor

12.3.1 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. 720 VDC for 400 V model, and 380 VDC for 200 V model) 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 items 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.

12.3.2 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.

$$OT = \frac{T_b}{T_c} * 100\%$$

OT (On Time percentage) Braking ratio
T_b Braking time

T_c

Engineering cycle
time in application

Fig. 12-10: Braking ratio



For definition of typecode, see [chapter 17.3 "Appendix 3: Type Coding"](#) on page 242.

| EFC 3600 frequency converter | | Brake chopper | | Brake resistor | | | |
|---------------------------------|----------|------------------|----------|----------------|--------------|--------------|---|
| Model [kW] | Typecode | Type- code | Qty. | Typecode | Parameter | Qty. | |
| 0.4 | 1x200 V | 0K40-1P2 | Internal | – | 0060-N400R-D | 400 Ω/60 W | 1 |
| 0.75 | | 0K75-1P2 | Internal | – | 0100-N190R-D | 190 Ω/100 W | 1 |
| 1.5 | | 1K50-1P2 | Internal | – | 0200-N095R-D | 95 Ω/200 W | 1 |
| 2.2 | | 2K20-1P2 | Internal | – | 0300-N065R-D | 65 Ω/300 W | 1 |
| 0.4 | 3x400 V | 0K40-3P4 | Internal | – | 0060-N2K0R-D | 2000 Ω/60 W | 1 |
| 0.75 | | 0K75-3P4 | Internal | – | 0100-N1K0R-D | 1000 Ω/100 W | 1 |
| 1.5 | | 1K50-3P4 | Internal | – | 0200-N500R-D | 500 Ω/200 W | 1 |
| 2.2 | | 2K20-3P4 | Internal | – | 0300-N330R-D | 330 Ω/300 W | 1 |
| 4.0 | | 4K00-3P4 | Internal | – | 0500-N180R-D | 180 Ω/500 W | 1 |

Tab. 12-5: Brake resistor selection_braking ratio OT=10 %



□ means the typecode listed in the table; Qty. means Quantity.

| EFC 3600 frequency converter | | Brake chopper | | Brake resistor | | | |
|---------------------------------|----------|------------------|----------|----------------|--------------|--------------|---|
| Model [kW] | Typecode | Type- code | Qty. | Typecode | Parameter | Qty. | |
| 0.4 | 1x200 V | 0K40-1P2 | Internal | – | 0100-N400R-D | 400 Ω/100 W | 1 |
| 0.75 | | 0K75-1P2 | Internal | – | 0200-N190R-D | 190 Ω/200 W | 1 |
| 1.5 | | 1K50-1P2 | Internal | – | 0400-N095R-D | 95 Ω/400 W | 1 |
| 2.2 | | 2K20-1P2 | Internal | – | 0500-N065R-D | 65 Ω/500 W | 1 |
| 0.4 | 3x400 V | 0K40-3P4 | Internal | – | 0100-N2K0R-D | 2000 Ω/100 W | 1 |
| 0.75 | | 0K75-3P4 | Internal | – | 0200-N1K0R-D | 1000 Ω/200 W | 1 |
| 1.5 | | 1K50-3P4 | Internal | – | 0400-N500R-D | 500 Ω/400 W | 1 |
| 2.2 | | 2K20-3P4 | Internal | – | 0500-N330R-D | 330 Ω/500 W | 1 |
| 4.0 | | 4K00-3P4 | Internal | – | 1K00-N180R-D | 180 Ω/1000 W | 1 |

Tab. 12-6: Brake resistor selection_braking ratio OT=20 %



- In the tables, 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 brake torque increases based on 100 %, the resistance of the brake resistor should decrease by the same amount, and 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 unit. 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 unit.
 - 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 $P_{max} = U_d^2 / R_b$. According to the actual working condition, the braking ratio OT 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 $P_R = K \times P_{max} \times OT$, 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.
-

12.3.3 Brake Resistor in Aluminum Housing

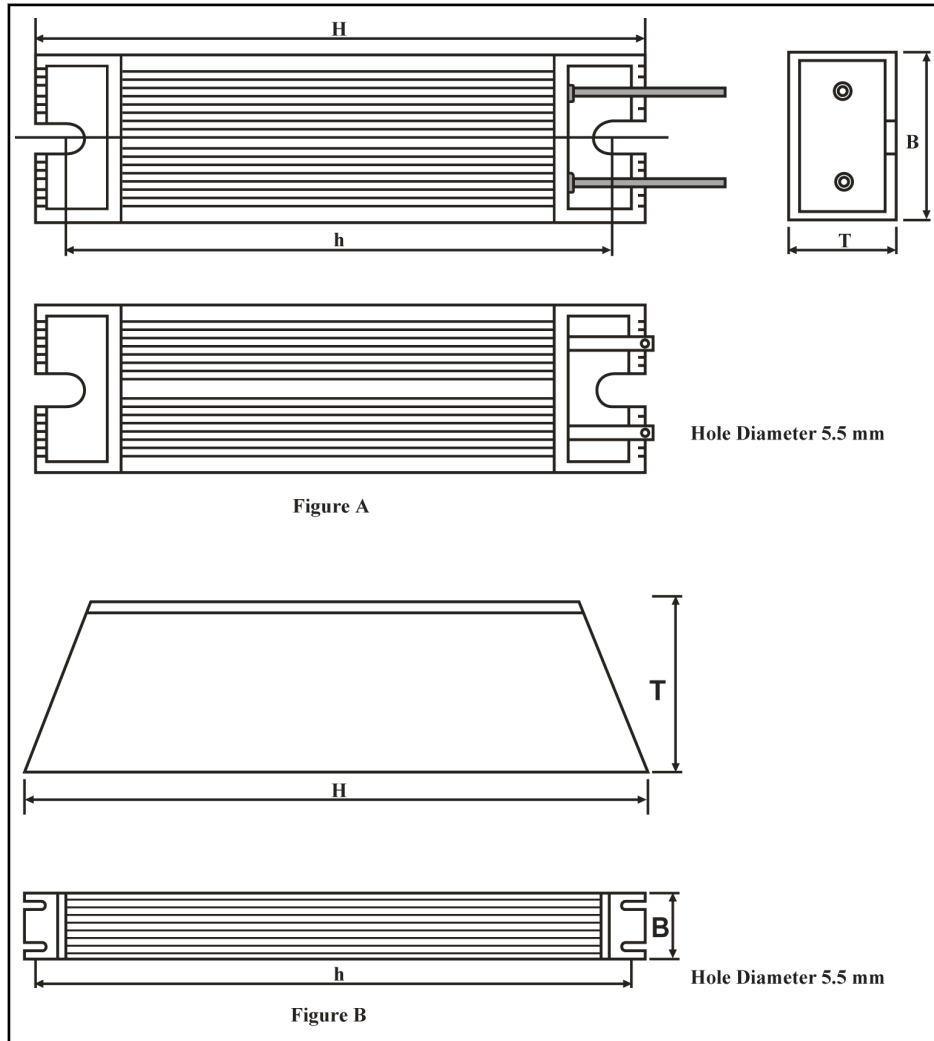


Fig. 12-11: Brake resistor in aluminum housing

| Brake resistor typecode | Impedance [Ω] | Power [W] | Figure | Dimensions [mm] | | | | | Wiring [mm ²] | Terminal [mm] | Wiring length [mm] | Weight [kg] |
|----------------------------|---------------------------|--------------|--------|-----------------|-----|----|----|-----|---------------------------|---------------|-----------------------|-------------|
| | | | | H | h | B | b | T | | | | |
| 0500-N065R-D | 65 | 500 | A | 335 | 317 | 60 | – | 30 | 1.5 | M6 | 500 | 1.03 |
| 0500-N180R-D | 180 | 500 | | 335 | 317 | 60 | – | 30 | 1.5 | M6 | 500 | 1.03 |
| 0500-N330R-D | 330 | 500 | | 335 | 317 | 60 | – | 30 | 1.5 | M6 | 500 | 1.03 |
| 0400-N095R-D | 95 | 400 | | 265 | 247 | 60 | – | 30 | 1.5 | M6 | 500 | 0.8 |
| 0400-N500R-D | 500 | 400 | | 265 | 247 | 60 | – | 30 | 1.5 | M6 | 500 | 0.8 |
| 0300-N065R-D | 65 | 300 | | 215 | 197 | 60 | – | 30 | 1.5 | M6 | 500 | 0.62 |
| 0300-N330R-D | 330 | 300 | | 215 | 197 | 60 | – | 30 | 1.5 | M6 | 500 | 0.62 |
| 0200-N095R-D | 95 | 200 | | 165 | 147 | 60 | – | 30 | 1.5 | M6 | 500 | 0.464 |
| 0200-N190R-D | 190 | 200 | | 165 | 147 | 60 | – | 30 | 1.5 | M6 | 500 | 0.464 |
| 0200-N500R-D | 500 | 200 | | 165 | 147 | 60 | – | 30 | 1.5 | M6 | 500 | 0.464 |
| 0200-N1K0R-D | 1000 | 200 | | 165 | 147 | 60 | – | 30 | 1.5 | M6 | 500 | 0.464 |
| 0100-N190R-D | 190 | 100 | | 165 | 148 | 40 | – | 20 | 1.5 | M6 | 500 | 0.24 |
| 0100-N400R-D | 400 | 100 | | 165 | 148 | 40 | – | 20 | 1.5 | M6 | 500 | 0.24 |
| 0100-N1K0R-D | 1000 | 100 | | 165 | 148 | 40 | – | 20 | 1.5 | M6 | 500 | 0.24 |
| 0100-N2K0R-D | 2000 | 100 | | 165 | 148 | 40 | – | 20 | 1.5 | M6 | 500 | 0.24 |
| 0060-N400R-D | 400 | 60 | 115 | 98 | 40 | – | 20 | 1.5 | M6 | 500 | 0.165 | |
| 0060-N2K0R-D | 2000 | 60 | 115 | 98 | 40 | – | 20 | 1.5 | M6 | 500 | 0.165 | |
| 1K00-N180R-D | 180 | 1000 | B | 400 | 384 | 50 | 30 | 107 | – | M6 | – | 3.6 |

Tab. 12-7: Aluminum brake resistor dimensions

12.4 Motor Choke

12.4.1 Motor Choke Selection

| EFC 3600 model | Motor choke type |
|----------------|----------------------------|
| 0K40-1P2 | FEMLO1.1E-1400-N0005-N-480 |
| 0K40-3P4 | |
| 0K75-3P4 | |
| 0K75-1P2 | FEMLO1.1E-1000-N0007-N-480 |
| 1K50-3P4 | |
| 1K50-1P2 | FEMLO1.1E-0700-N0010-N-480 |
| 2K20-3P4 | |
| 2K20-1P2 | |
| 4K00-3P4 | FEMLO1.1E-0470-N0015-N-480 |

Tab. 12-8: Motor choke selection

12.4.2 Dimensions

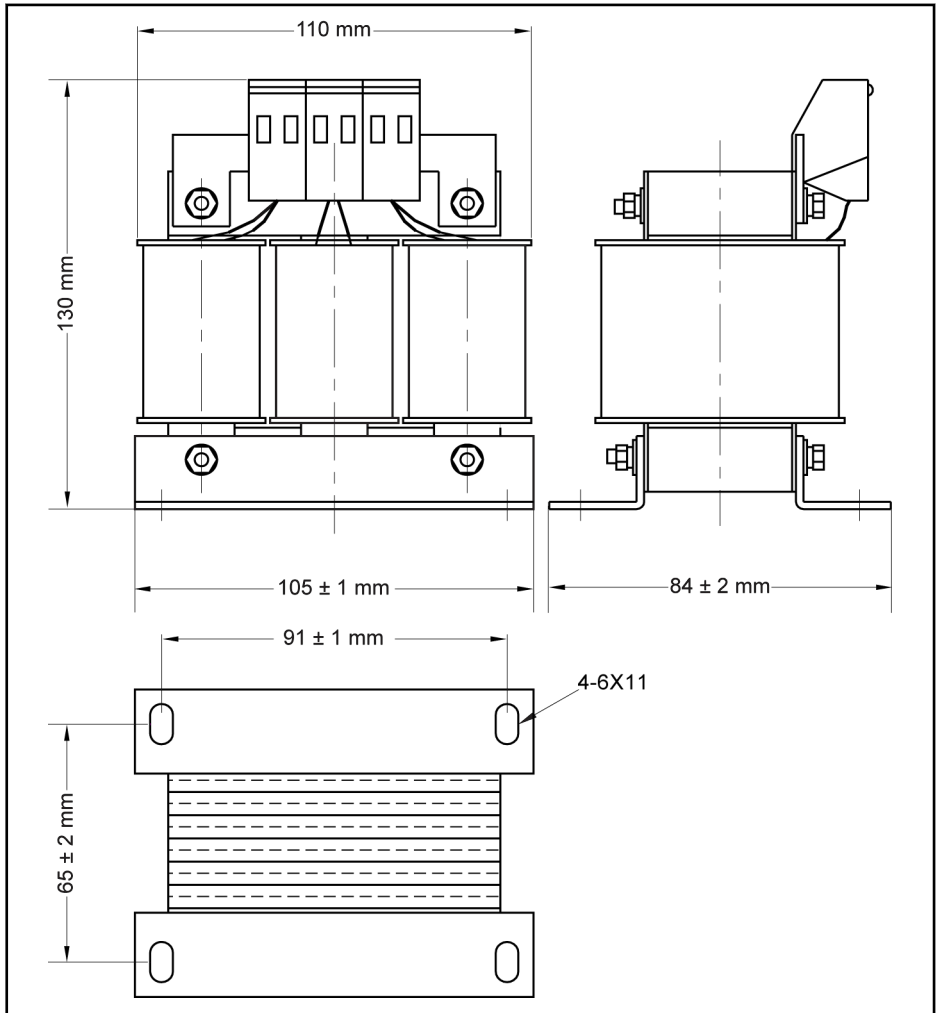


Fig. 12-12: FEMLO1.1E-(1400-N0005/1000-N0007/0700-N0010)-N-480

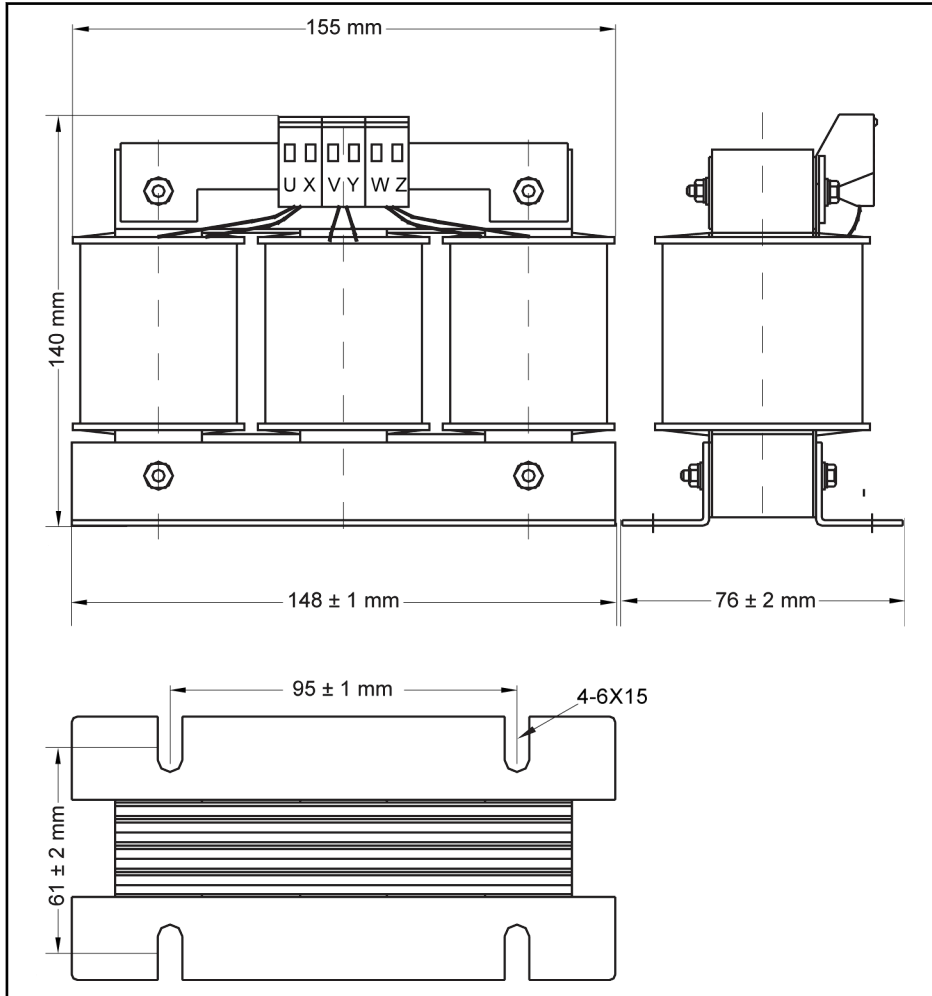


Fig. 12-13: FEMLO1.1E-0470-N0015-N-480

12.4.3 Electrical data

| Description | 1400-N0005 | 1000-N0007 | 0700-N0010 | 0470-N0015 |
|-----------------------|----------------------|------------|------------|------------|
| Rated voltage | AC 380 V / 50 Hz | | | |
| Rated current [A] | 5 | 7 | 10 | 15 |
| Rated inductance [mH] | 1.4 | 1.0 | 0.7 | 0.47 |
| Dielectric strength | 3,000 V / 5 mA / 10s | | | |
| Insulation resistance | ≥ 100 MΩ | | | |

Tab. 12-9: Electrical data

12.5 Communication Interface

12.5.1 RS485/RS232 Adapter

RS232/RS485 adapter (FEAA01.1-RS485-RS232-NNNN-NN, see [chapter 17.3 "Appendix 3: Type Coding" on page 242](#)) is used to connect the RS485 interface (ModBus) with RS232 interface of a PC or other control units.

12.5.2 Cable for RS485/RS232 Adapter

The cable FRKB0002/005,0, which is 1 m long (see [chapter 17.3 "Appendix 3: Type Coding" on page 242](#)), is used to connector the frequency converter to the RS485/232 adapter.

12.6 Operating Panel Cable for Control Cabinet Mounting

12.6.1 Control Cabinet Mounting Plate

The operating panel (FPCC, see [fig. 17-2 "Operating panel type coding" on page 243](#)) is mounted at the control cabinet. The user can operate and control the frequency converter from the outside of the control cabinet conveniently. To realize this function, the user needs order the mounting plate (FVAM, see [fig. 17-9 "Operating panel mounting plate for control cabinet" on page 248](#)) for control cabinet mounting and its accessories additionally.

Recommended opening dimensions at control cabinet

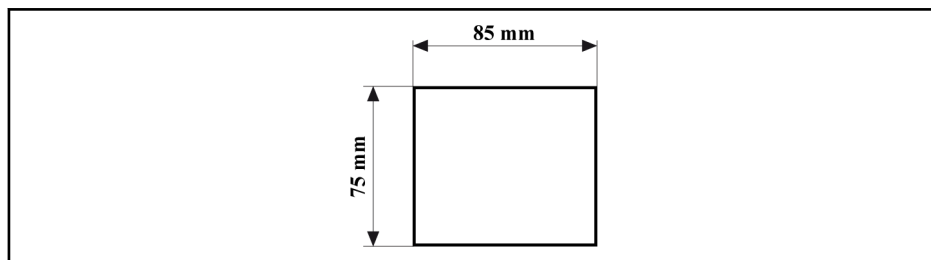


Fig. 12-14: Recommended opening dimensions at control cabinet

Mounting the plate and the operating panel

Step 1: Push the mounting plate into the opening in the direction perpendicular to the control cabinet, the back view is as below.

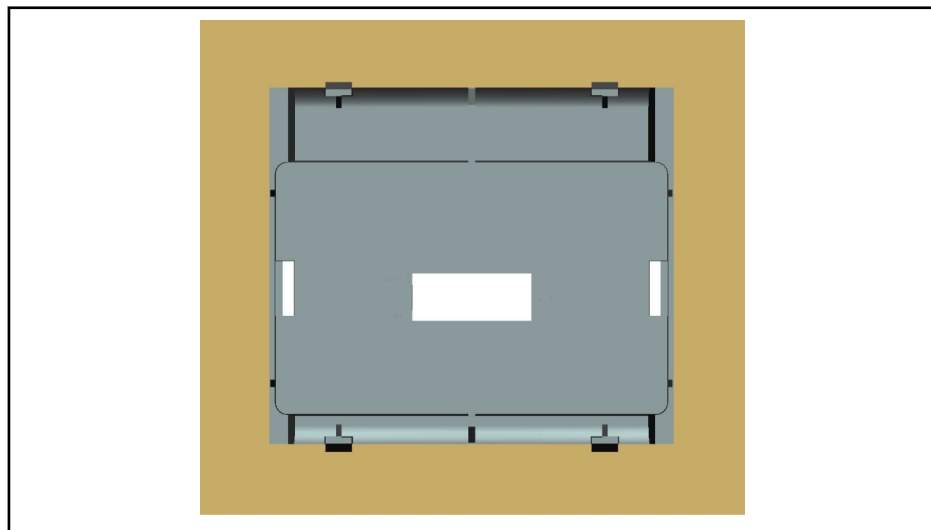


Fig. 12-15: Push the mounting plate into the opening

Step 2: Fix the mounting plate with a metal bar and 2 M4x8 screws, the back view is as below.

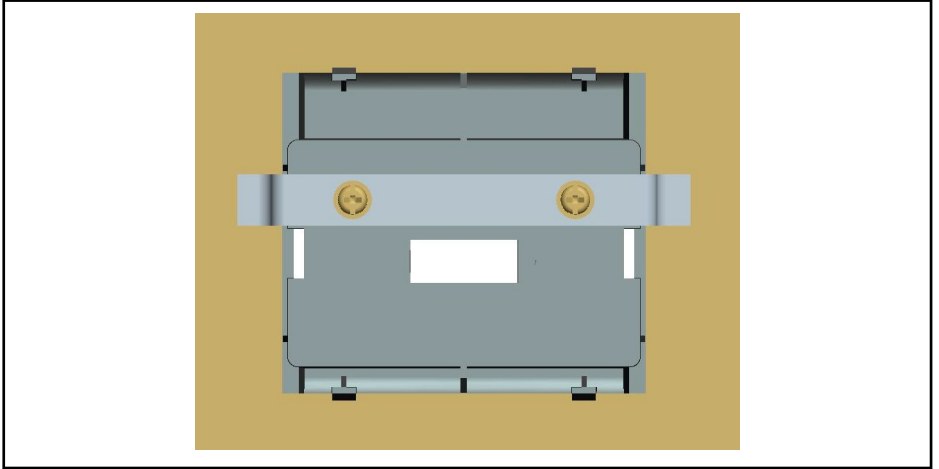


Fig. 12-16: Fix the mounting plate

Step 3: Push the operating panel in the direction perpendicular to the mounting plate, the front view is as below.

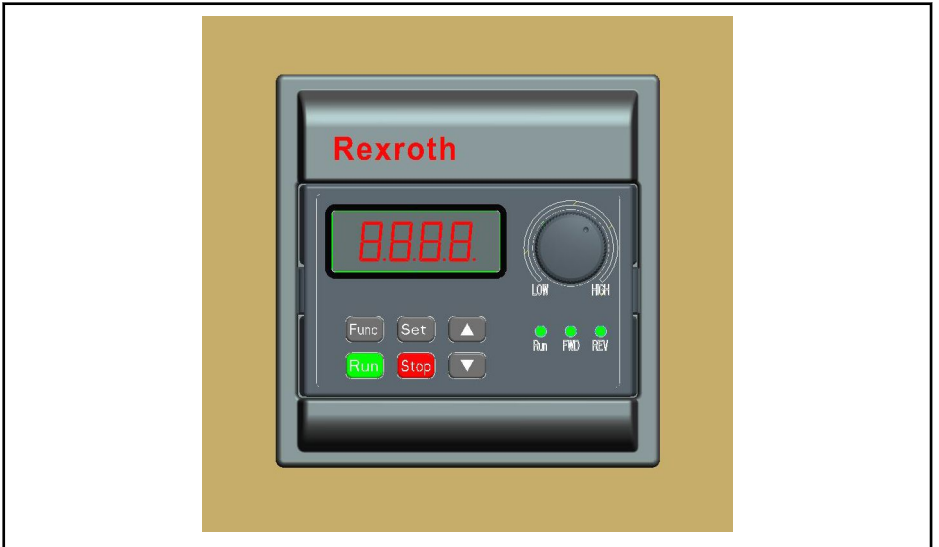


Fig. 12-17: Mount the operating panel

Step 4: Connect the operating panel to the frequency converter with the connection cable and fix the cable connector on the mounting plate with 2 M3x10 screws.

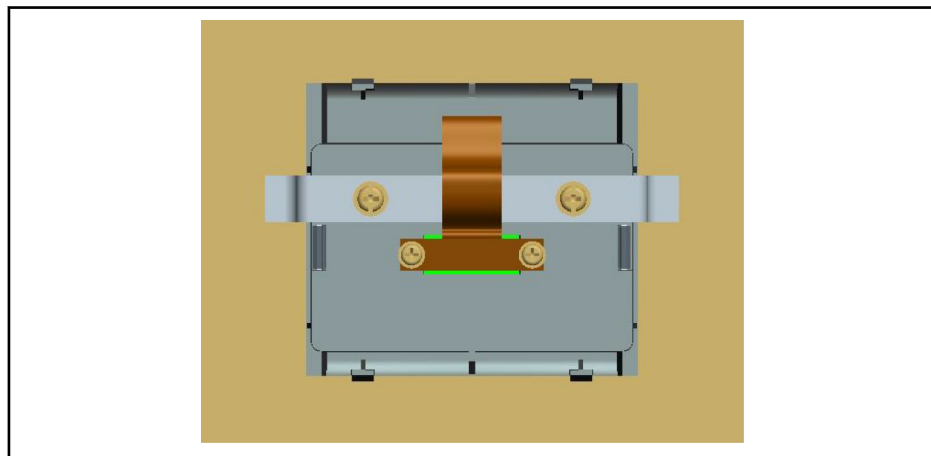


Fig. 12-18: Connect and fix the cable

12.6.2 Operating Panel Cable for Control Cabinet Mounting

The cable FRKS0005/001,0, which is 1 m long (see [chapter 17.3 "Appendix 3: Type Coding" on page 242](#)), is used to connect the operating panel for control cabinet mounting with the frequency converter. The cable FRKS0004/003,0, which is 3 m long (see [chapter 17.3 "Appendix 3: Type Coding" on page 242](#)), can be also used for the connection of the operating panel. For connection of the FRKS0005 or FRKS0004 cable, it is necessary to remove the panel at the frequency converter and connect the cable there.

12.7 Accessories for Shielded Cable Connection

The shielding layer of shielded cables must be reliably connected to the shielding terminals of the frequency converter. Accessories (a holder and two screws) for shielded cable connection are available for the connection convenience.

Connection steps

Step 1: Loosen two screws near symbols  on the heat sink of the frequency converter.

Step 2: Place component ① of the holder under the screw gaskets, and then tighten the two screws.

Step 3: Insert the shielded cables through component ② of the holder with the shielding layer reliable contact with the metal.

Step 4: Tighten two screws of the accessories (component ③).

Dimensions and connection figure

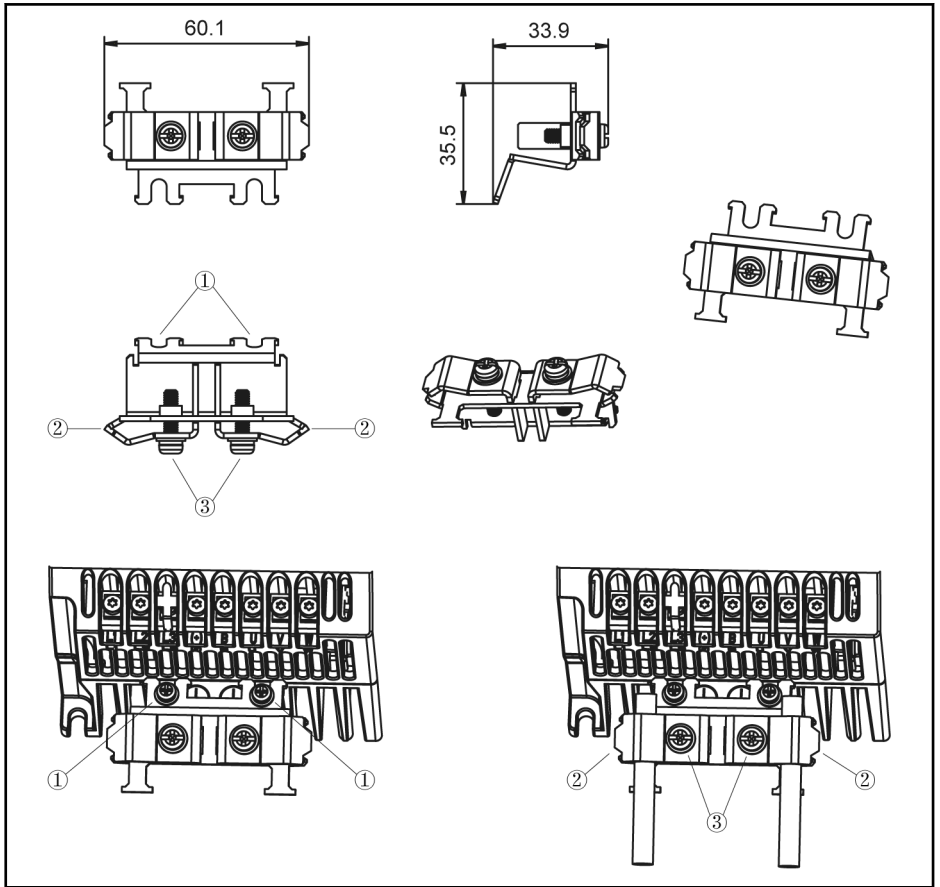


Fig. 12-19: Shielded cable connection with accessories

13 Communication Protocols

13.1 Brief Introduction

EFC 3600 frequency converters provide standard RS485 communication port to realize the communication between the master and slaves via ModBus or PROFIBUS protocol. ^①With 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 parameters, monitoring of frequency converter running status and failure messages) to address the specific requirements of applications.



^① : Notes on EFC 3600 available communication protocols

- EFC3600-xKxx-xPx-MDA-7P-NNNN (MDA) models: only ModBus protocol available
- EFC3600-xKxx-xPx-PDA-7P-NNNN (PDA) models: ModBus and PROFIBUS protocols optional

13.2 ModBus Protocol

13.2.1 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 message exchange by polling the slave stations. Unless being approved by the master station, no slave station may send message. In case of an error during data exchange, if no response is received, the master station will query the slave stations absent from the polling.
- If a slave station is unable to recognize a message from the master station, an exception response will be sent to the master station.
- Slave stations cannot communicate with each other but through the master's software which reads data from one slave station and sends them to another. There are two types of dialogs between the master station and the slave stations:
 - The master station sends a request to a slave station and waits for its response.
 - The master station sends a request to all slave stations and does not wait for their response (broadcasting).

Transmission

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

| Slave address | Function code | Data | CRC |
|---------------|---------------|-----------------|------------------|
| 1 byte | 1 byte | 0 ~ 252 byte(s) | CRC low CRC high |

Tab. 13-1: Typical RTU frame format



Data are transmitted in binary codes.

- The address 0 is reserved as broadcast address.
- All slave nodes must recognize the broadcast address for writing function (no need of reply).
- The master node has no specific address, only the slave nodes must have addresses (from 1 ~ 247).

For RTU transmission mode, four types of character format are shown below:

- 1 start bit, 8 data bits, 1 stop bit, no parity;
- 1 start bit, 8 data bits, 1 stop bit, even parity;
- 1 start bit, 8 data bits, 1 stop bit, odd parity;
- 1 start bit, 8 data bits, 2 stop bits, no parity.

The character or byte is sent in the following sequence (from left to right):

| <-Least Significant Bit (LSB) | | | | | Most Significant Bit (MSB)-> | | | | | |
|-------------------------------|---|---|---|---|------------------------------|---|---|---|--------|------|
| With parity checking | | | | | | | | | | |
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Parity | Stop |
| Without parity checking | | | | | | | | | | |
| Start | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Stop | Stop |

Tab. 13-2: RTU transmission mode

Message frames are separated by a silent interval of at least 3.5 characters' time. The entire frame must be transmitted as a continuous stream of bytes. If the interval of two separated frames is less than 3.5 characters' time, then the slave address of second frame will be treated as the part of first frame by mistake, due to the confusion of the frames, the CRC check will fail and lead to communication fault. If a silent interval of more than 1.5 characters' time occurs between two bytes, the message frame is regarded incomplete and discarded by the receiver.

13.2.2 ModBus Interface

ModBus RJ11 communication interface for MDA models

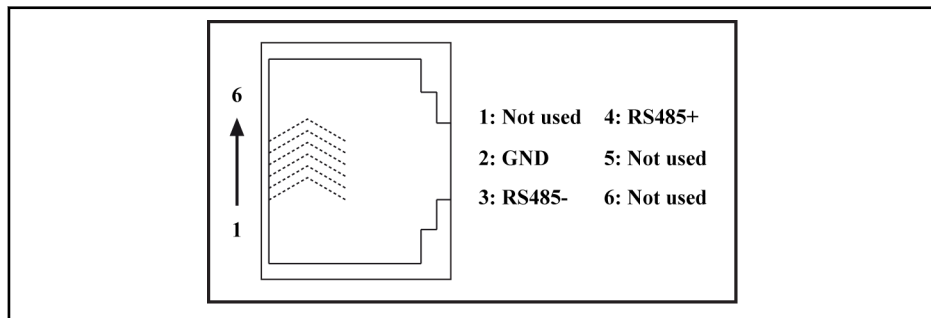


Fig. 13-1: ModBus RJ11 communication interface

ModBus DB9 communication interface for PDA models

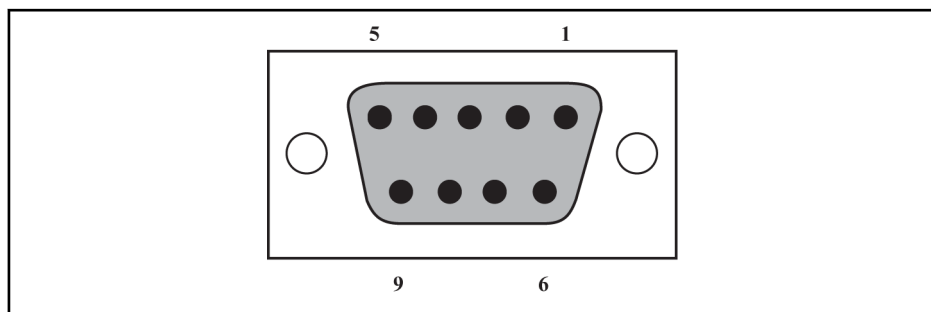


Fig. 13-2: ModBus DB9 communication interface

| Pin | Signal | Pin | Signal | Pin | Signal |
|-----|----------|-----|----------|-----|----------|
| 1 | Not used | 2 | Not used | 3 | RS485+ |
| 4 | Not used | 5 | GND | 6 | +5V |
| 7 | Not used | 8 | RS485- | 9 | Not used |

Tab. 13-3:

13.2.3 ModBus Function and Message Format

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 EFC 3600 and their limits are shown in the table below:

| Code | Function name | Broadcast | Max. value of N |
|---------|-----------------------------|-----------|-----------------|
| 3=0x03 | Read N register words | NO | 16 |
| 6=0x06 | Write one register word | YES | – |
| 8=0x08 | Diagnosis | NO | – |
| 16=0x10 | Write N register words | YES | 16 |
| 23=0x17 | Read/write N register words | NO | 16 |

Tab. 13-4: EFC 3600 ModBus functions and limits



"Read" and "Write" are considered from the prospect of the master station.

ModBus message formats are different according to the function codes shown below.

| Slave No. | 0x03 | Address of 1 st word | Number of words | CRC16 |
|-----------|------|---------------------------------|-----------------|---------|
| | | Hi Lo | Hi Lo | Lo Hi |

Tab. 13-5: Function 3_Request from the master

| Slave No. | 0x03 | Number of bytes | 1 st word value | – | Last word value | CRC16 |
|-----------|------|---------------------------|----------------------------|---|-----------------|---------|
| | | Depends on master request | Hi Lo | | Hi Lo | Lo Hi |

Tab. 13-6: Function 3_Response from the slave

| Slave No. | 0x06 | Address of word | Value of word | CRC16 |
|-----------|------|-----------------|---------------|---------|
| | | Hi Lo | Hi Lo | Lo Hi |

Tab. 13-7: Function 6_Master request and slave response (in same format)

| Slave No. | 0x08 | Test word 1 | Test word 2 | CRC16 |
|-----------|------|-------------|-------------|---------|
| | | Hi Lo | Hi Lo | Lo Hi |

Tab. 13-8: Function 8_Master request and slave response (in same format)

| Slave No. | 0x10 | Address of 1 st word | Number of words | Number of bytes | 1 st word value | – | Last word value | CRC16 |
|-----------|------|---------------------------------|-----------------|-----------------|----------------------------|---|-----------------|-------|
| | | Hi Lo | Hi Lo | | Hi Lo | | Hi Lo | |

Tab. 13-9: Function 16_Request from the master

| Slave No. | 0x10 | Address of 1 st word | Number of words | CRC16 |
|-----------|------|---------------------------------|-----------------|---------|
| | | Hi Lo | Hi Lo | Lo Hi |

Tab. 13-10: Function 16_Response from the slave

| Slave No. | 0x17 | Address of 1 st word to be read | Number of words to be read | Address of 1 st word to be written |
|-----------|------|--|----------------------------|---|
| | | Hi Lo | Hi Lo | Hi Lo |

| Number of words to be written | Number of bytes to be written | Value of 1 st word to be written | – | Value of last word to be written | CRC16 |
|-------------------------------|-------------------------------|---|---|----------------------------------|---------|
| Hi Lo | | Hi Lo | | | Hi Lo |

Tab. 13-11: Function 23_Request from the master

| Slave No. | 0x17 | Number of bytes read | 1 st word value read | – | Last word value read | CRC16 |
|-----------|------|----------------------|---------------------------------|---|----------------------|-------|
| | | | Hi Lo | | Hi Lo | |

Tab. 13-12: Function 23_Response from the slave

Function example

Function 0x03: Read N register words, range: 1 ~ 16

Example: It is necessary to read 2 continuous words starting from communication register 0100H of the slave frequency converter addressed at 01H. The frame structure is described in the tables below.

| | |
|------------------------------|---------------------------------|
| Message 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 |
| CRC lower byte | C5H |
| CRC higher byte | F7H |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-13: Function 0x03_Request from RTU master

| | |
|---------------------------------------|---------------------------------|
| Message 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 |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-14: Function 0x03_Response from RTU slave

Function 0x06: Write one register word

CAUTION

Frequent writing may damage the internal registers!

- When data is written into the internal registers, there is a limit on the writing times. The register address may be damaged once the writing times is beyond the writing limit. So please avoid frequent writing!
- For details of user writing permission, please see [chapter 17.2.1 "Description of Attribute Symbols in Parameter Tables"](#) on page 220.

Example: Write 0000H to communication register address 0005H of the slave frequency converter with address 01H. The frame structure is described in the tables below:

| | |
|---------------------------------------|---------------------------------|
| Message 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 | 05H |
| Higher byte of write data | 00H |
| Lower byte of write data | 00H |
| CRC lower byte | 99H |
| CRC higher byte | CBH |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-15: Function 0x06_Request from RTU master

| | |
|---------------------------------------|---------------------------------|
| Message 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 | 05H |
| Higher byte of write data | 00H |
| Lower byte of write data | 00H |
| CRC lower byte | 99H |
| CRC higher byte | CBH |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-16: Function 0x06_Response from RTU slave

Function 0x08: Diagnostics

Example: To test the communication loop of 2 continuous words 1234H and 5678H with frequency converter slave address 01H, the frame structure is described in the tables below:

| | |
|-----------------------------|---------------------------------|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| ModBus function code | 08H |
| Higher byte of sub-function | 00H |
| Lower byte of sub-function | 00H |
| Higher byte of test word 1 | 12H |
| Lower byte of test word 1 | 34H |
| Higher byte of test word 2 | 56H |
| Lower byte of test word 2 | 78H |
| CRC lower byte | 73H |
| CRC higher byte | 33H |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-17: Function 0x08_Request from RTU master

| | |
|-----------------------------|---------------------------------|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| ModBus function code | 08H |
| Higher byte of sub-function | 00H |
| Lower byte of sub-function | 00H |
| Higher byte of test word 1 | 12H |
| Lower byte of test word 1 | 34H |
| Higher byte of test word 2 | 56H |
| Lower byte of test word 2 | 78H |
| CRC lower byte | 73H |
| CRC higher byte | 33H |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-18: Function 0x08_Response from RTU slave

Function 0x10: Write N register words, range 1 ~ 16

Example: To modify 2 continuous registers start from 0114H with words 0032H and 0032H with slave frequency converter address 01H. The frame structure is described in the tables below:

| | |
|---|---------------------------------|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| ModBus function code | 10H |
| Higher byte of write register start address | 01H |
| Lower byte of write register start address | 14H |
| 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 | 32H |
| Higher byte of data in register 010AH | 00H |
| Lower byte of data in register 010AH | 32H |
| CRC lower byte | DEH |
| CRC higher byte | DAH |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-19: Function 0x10_Request from RTU master

| | |
|---|---------------------------------|
| Message start | Transmission time for 3.5 bytes |
| Slave address | 01H |
| ModBus function code | 10H |
| Higher byte of write register start address | 01H |
| Lower byte of write register start address | 14H |
| Higher byte of register number | 00H |
| Lower byte of register number | 02H |
| CRC lower byte | 00H |
| CRC higher byte | 30H |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-20: Function 0x10_Response from RTU slave

Function 0x17: Read/Write N register words, range 1 ~ 16

Example: To read data in 2 continuous registers starting from address 0114H, write 00C8H and 00C8H to 2 continuous registers starting from address 0117H. The frame structure is described in the tables below:

| | |
|---|---------------------------------|
| Message 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 | 14H |
| Higher byte of read register number | 00H |
| Lower byte of read register number | 02H |
| Higher byte of write register start address | 01H |
| Lower byte of write register start address | 17H |
| 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 register 0109H | 00H |
| Lower byte of data in register 0109H | C8H |
| Higher byte of data in register 010AH | 00H |
| Lower byte of data in register 010AH | C8H |
| CRC lower byte | 38H |
| CRC higher byte | E3H |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-21: Function 0x17_Request from RTU master

| | |
|------------------------------------|---------------------------------|
| Message 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 | 32H |
| Higher byte of read register 0101H | 00H |
| Lower byte of read register 0101H | 32H |
| CRC lower byte | D9H |
| CRC higher byte | 3DH |
| Message end | Transmission time for 3.5 bytes |

Tab. 13-22: Function 0x17_Response from RTU slave

Error code and exception code

If a slave receives the request without a communication error, but cannot handle it, the slave will return an exception response which includes error code and

exception code informing the master of the nature of the error. The error code is formed by setting the MSB of the function code to 1 (i.e. function code plus with 0x80, like 0x83, 0x86, 0x90, 0x97), then the exception response has a format shown below.

| Slave No. | Error code | Exception code | CRC16 |
|-----------|------------|----------------|---------|
| | | | Lo Hi |

Exception codes for EFC 3600 frequency converters:

- 1=Parameter cannot be modify owing to user password locked
- 2=The function requested is not recognized by the slave, i.e. not equal to 3, 6, 8, 16 or 23
- 3=The word address indicated in the request do not exist in the slave
- 4=The word values indicated in the request are not permissible in the slave
- 5=Parameters cannot be modify in run mode
- 6=Parameters are read-only that cannot be modified
- 7=Invalid operation which is decided by the function of frequency converter^(*)
- 9=EEPROM read/write error
- B=Function code 3, read range exceeds 16



- ^(*) includes situations listed below:
 - Write operations on b0.06 parameter replication, b0.30 running monitoring display, b0.31 stop monitoring display and S2.15 physical data calculation, are prohibited.
 - Write operations on b0.00 user password, b0.01 manufacture password and b0.05 parameter initialization only support Function 6.
 - Multi-function digital input terminals (E0.01 ~ E0.05) writing operation do not permit repeated nonzero value.

13.2.4 Communication Mapping Register Address Distribution

Frequency converter parameter registers

Frequency 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 frequency converter parameter registers via ModBus communication. The characteristics and scope of reading and writing function codes are in compliance with the frequency converter function code description. The address of a frequency converter parameter register is composed of a higher byte representing the function code group and a lower byte representing the index in the group. The groups are mapped as follows:

| Address high byte | 0x00 | 0x01 | 0x02 | 0x03 | 0x04 | 0x05 | 0x06 | 0x07 | 0x08 | 0x09 | 0x0A | 0x0B | 0x0C | 0x0D |
|-------------------|------|------|------|----------|------|------|------|------|------|------|------|------|-------------------|--------------------|
| Group | b0 | b1 | S0 | Reserved | S2 | S3 | E0 | E1 | E2 | E3 | E4 | H0 | P0 ^(*) | d0 ^(**) |

Tab. 13-23: Frequency converter parameter registers



(^{*}): The manufacturer parameter group (Group P0) can always be read (independent of the manufacturer password setting). It depends on the password setting if the parameter can be modified over communication.

(^{**}): Parameters of the monitoring group (Group d0) are always write-protected.

Examples:

To read out the module temperature (d0.16) of EFC 3600 frequency converter, use register address 0x0D10 (0x0D = Group d0, index 0x10=16).

To set V/f curve mode (S0.00) of EFC 3600 frequency converter, use register address 0x0200 (0x02 = Group S0, index 0).

Access to a non-existing function code will be acknowledged with exception code 3 (see [chapter 13.2.3 "ModBus Function and Message Format" on page 187](#)).

Communication control registers

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

| bit | Value | Description |
|------|-------|--|
| 15-8 | – | Reserved |
| 7 | 1 | Control word active |
| | 0 | Inactive |
| 6 | 1 | Stop Acc. / Dec. active (stop the internal Acc. / Dec. ramp generator) |
| | 0 | Inactive |
| 5 | 1 | Fault reset active |
| | 0 | Inactive |
| 4 | 1 | E-stop active |
| | 0 | Inactive |
| 3 | 1 | Stop according to parameter setting |
| | 0 | Inactive |
| 2 | 1 | Reverse |
| | 0 | Forward |
| 1 | 1 | Jog active (jogging direction determined by bit 2) |
| | 0 | Inactive |
| 0 | 1 | Run command active |
| | 0 | Inactive |

Tab. 13-24: Communication control registers

The address of frequency setting register for communication control is 0x4001. This register is for read and write. When b1.00 "First frequency setting source" is set to "5: Given by communication", the frequency converter can be set with writing data to this address.

If the communication frame check is successful (CRC valid), the frequency converter always accepts the content of the control word. All conflicts (e.g. run command and stop command active at the same time) are resolved by the application functionality (RUN/STOP generator, jog control, ...). This assures that the frequency converter will always react in the same manner, independent of the run command source.

Communication state feedback registers (0x5000)

The frequency converter state can be monitored by reading the register. This register is read-only. The definition of each bit is shown in the table below:

| bit | Value | Description |
|--------|-------|--------------------------------|
| 15 ~ 8 | – | Error code (equals to [E4.20]) |
| 7 | 1 | Error |
| | 0 | No error |
| 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 | Running |
| | 0 | Stop |
| 0 | 1 | Reverse |
| | 0 | Forward |

Tab. 13-25: Communication state feedback registers (0x5000)

13.2.5 ModBus Communication Example

One slave address is 01H. The frequency setting of the frequency converter has been set to "Given by communication" and the RUN command source is set to "Inputting commands by communication". 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 (function 16) of the ModBus protocol. The messages of the requests from the master and responses from the slave are shown in table below:

- Example 1: Start 01# frequency converter for forward rotation at frequency of 50.00 Hz (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 | 0x0081 0x1388 | 0x9F12 |
| Response | 0x01 | 0x10 | 0x4000 | 0x0002 | N/A | N/A | 0x5408 |

- Example 2: Read the output frequency of 01# frequency converter and output velocity

| | Slave address | Function code | Start address | Number of address | Bytes of data | Data content | CRC code |
|-----------------|---------------|---------------|---------------|-------------------|---------------|------------------|----------|
| Request | 0x01 | 0x03 | 0x0D04 | 0x0002 | N/A | N/A | 0x8766 |
| Response | 0x01 | 0x03 | N/A | N/A | 0x04 | 0x00E2 0x0015 | 0x9BCA |

- Example 3: Stop 01# frequency converter according to the stopping mode 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 | 0x0088 | 0x9C6C |
| Response | 0x01 | 0x06 | 0x4000 | N/A | N/A | 0x0088 | 0x9C6C |

13.2.6 Special Notes

1. The external computer can not write to function codes b0.06 "Parameter replication", b0.30 "running monitoring display" and b0.31 "Stop monitoring display".
2. b0.00 "User password" and b0.05 "Parameter initialization" do not support multiple write including single write in multiple write; Motor nameplate parameters and motor physical data should not be modified simultaneously; Multi-function digital input terminals (E0.01 ~ E0.05) writing operation do not permit repeated nonzero value.
3. If the communication protocol is changed, baud rate, data frame and local address will be restored to factory default.
4. The read response of user password and manufacture password is "0000" in case of external computer reading.
5. The external computer can set, modify or cancel user password, the specific operation is same to the situation when "Running command source" is from keyboard.
6. The access to control registers and state registers is not limited by user password.

13.2.7 Communication Networking

Networking

The communication network is shown in figure below, with a PC, a PLC or an external computer as the master and all frequency converters as slaves, which are connected by shielded twisted pair cables. The slave at the end of the network needs a termination resistor with recommended value of 120 Ω , 0.25 W.

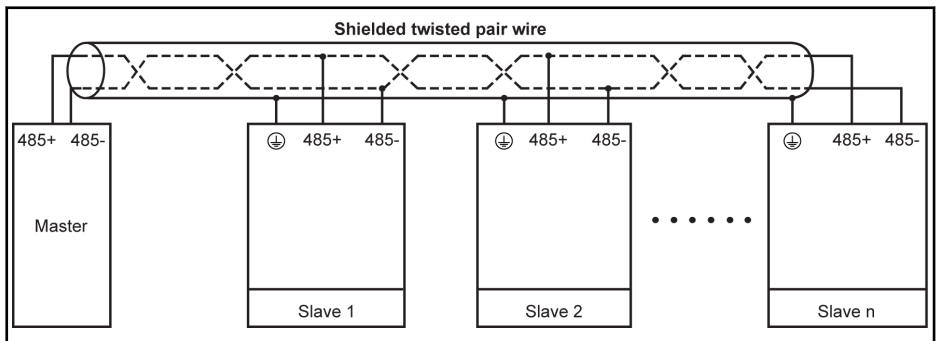


Fig. 13-3: Communication networking

⚠ WARNING

Cables may only be connected when the frequency converters are switched 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 shielding 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.

13.3 PROFIBUS Protocol

13.3.1 Protocol Description

PROFIBUS is an open serial communication standard, which enables data exchange among various automation control devices. PROFIBUS mainly includes three types: PROFIBUS-FMS (Fieldbus Message Specifications), PROFIBUS-DP (Distributed Peripheral Equipment) and PROFIBUS-PA (Process Automation). EFC 3600 PDA models support PROFIBUS-DP Protocol.

PROFIBUS is widely used in various industries such as manufacturing automation and process automation, building, transportation, electric power, 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 table below.

| Protocol frame (header) | User data (control message/status message) | Protocol frame (end) |
|----------------------------|---|-------------------------|
| | | |

Tab. 13-26: 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 ~ 1,200 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, which is able to select the nodes responsive to commands from the master.



PROFIBUS protocol is described in details in standard EN 50170.

13.3.2 PROFIBUS Function

The PROFIBUS DP communication network is able to realize the following functions:

- Sending control commands to the frequency converter (such as start, stop, jog, etc.).
- Sending frequency setting message to the frequency converter.
- Reading operating status message from the frequency converter (such as run, rotation direction, rotation speed, error message, etc.).
- Reading or modifying frequency converter parameters.
- Resetting the frequency converter in case of error.

13.3.3 PROFIBUS Interface

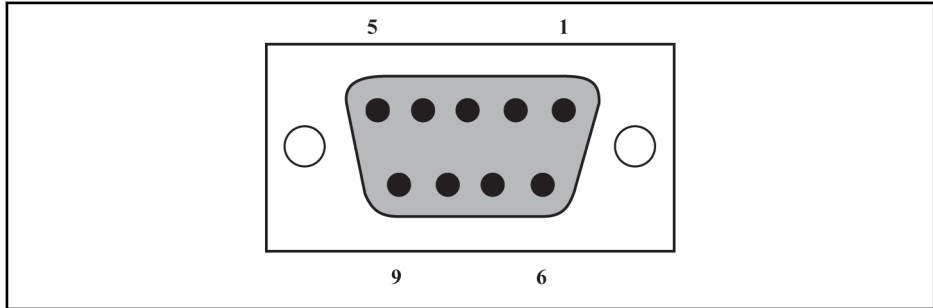


Fig. 13-4: PROFIBUS DB9 interface

| Pin | Terminal sign | Terminal name | Function description |
|-----|---------------|----------------------------|-----------------------|
| 1 | NC | – | Reserved |
| 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 |

Tab. 13-27: Pin definition of PROFIBUS DB9 interface

13.3.4 Requirements for PROFIBUS Link

Cables used in PROFIBUS are shielded twisted pair cables. The shielding 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 ~ 200 Ω . Cable capacity (among conductors) should be < 60 pF/m, and conductor cross section should be \geq 0.22 (24 AWG). Two kinds of cables are used for PROFIBUS with detail definitions stated in table below.

| Cable data | Type A | Type B |
|-------------------------|-------------------------------------|----------------------------------|
| Impedance | 135 ~ 165 Ω (f = 3 ~ 20 MHz) | 100 ~ 130 Ω (f > 100 kHz) |
| Capacity | < 30 pF/m | < 60 pF/m |
| Resistance | \leq 110 Ω /km | \leq 110 Ω /km |
| Conductor cross section | \geq 0.34 (22 AWG) | \geq 0.22 (24 AWG) |

Tab. 13-28: Type of PROFIBUS cable



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

13.3.5 Relationship between Communication Rate and Cables

Relationship between communication rate and cable length is described in table below.

| 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 | 1,000 | 1,000 |
| 187.5 kbps | 1000 | 600 |
| 500 kbps | 400 | 200 |
| 1.5 Mbps | 200 | 200 |
| 3 ~ 12 Mbps | 100 | 100 |

Tab. 13-29: Relationship between communication rate and cable length

13.3.6 EMC Measures

The following EMC measures needs to be taken in order to improve the stability of PROFIBUS communication network:

- The shielding layer of the communication cables must be well grounded at all stations; a large area is required for the connection of the shielding layer to obtain a low impedance.
- A certain wiring distance (≥ 20 cm) must be kept between the communication cables and the power cables.
- Communication cables and power cables must be orthogonal in case of crossing.
- All stations in the network must be grounded to the same grounding network.

13.3.7 Periodical Data Communication

PPO data type

PROFIBUS-DP defines data structure for periodical data communication as PPO (the Parameter Process date Object). EFC 3600 PDA models support 5 PPO types shown in figure below. PPO message is divided into two data areas in terms of transmission data contents:

Parameter area (PKW area): read or write a parameter of a of slave.

Process data area (PZD area): including control word and set 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 detailed descriptions of PKW parameter area and PZD process data area, please refer to descriptions follow.

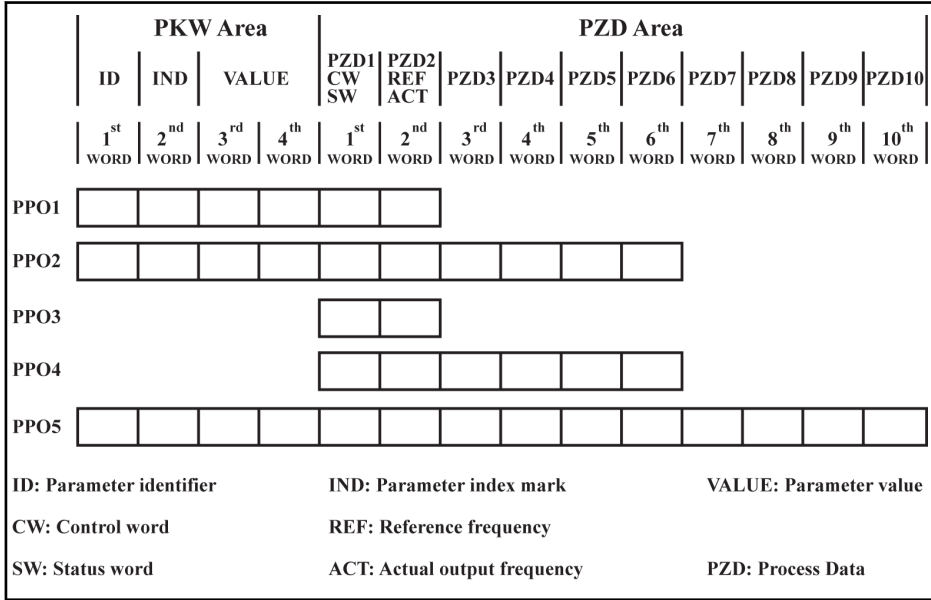


Fig. 13-5: PPO type

PKW parameter area

PKW parameter area description

This data area is composed of ID, IND, VALUE_high and VALUE_low, as shown in figure below. They are used to read or modify the parameter of a parameter of a frequency converter, but only one parameter can be read or modified each time. When master sends request and slave responds, bit definition for each specific word in PKW area is shown in the tables below. If a frequency converter fails to execute PKW area request command, an error code will be returned to the master in VALUE_low. Refer to [tab. 13-32 "PKW area error codes"](#) on page 206 for details.

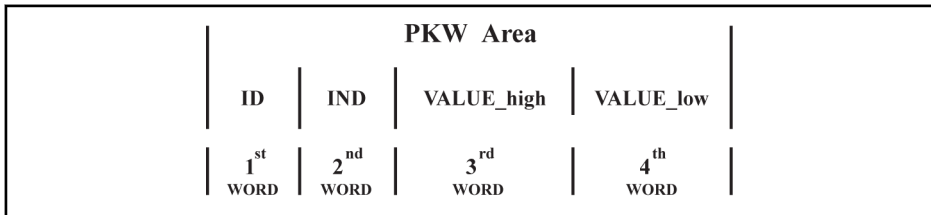


Fig. 13-6: PKW area data format

Request data frame in PKW area

| Word | Identifier | bit | Value | Description |
|-----------------|------------|--------|-------|--|
| 1 st | ID | 15 ~ 8 | 00H | Reserved |
| | | 7 ~ 0 | 00H | No request |
| | | | 01H | Read |
| | | | 02H | Write |
| 2 nd | IND | 15 ~ 8 | xxH | Group No. for parameter |
| | | 7 ~ 0 | xxH | Index No. of function code within the group |
| 3 rd | VALUE_high | 15 ~ 0 | 00H | Reserved |
| 4 th | VALUE_low | 15 ~ 0 | xxxxH | For a read request: Not used For a write request: Parameter value |

Tab. 13-30: Request data frame in PKW area_from master to slave

Response data frame in PKW area

| Word | Identifier | bit | Value | Description |
|-----------------|------------|--------|-------|---|
| 1 st | ID | 15 ~ 8 | 00H | Reserved |
| | | 7 ~ 0 | 00H | No request |
| | | | 01H | Successful read |
| | | | 02H | Successful write |
| | | | 07H | Error |
| 2 nd | IND | 15 ~ 8 | xxH | Group No. for parameter |
| | | 7 ~ 0 | xxH | Index No. of function code within the group |
| 3 rd | VALUE_high | 15 ~ 0 | 00H | Reserved |
| 4 th | VALUE_low | 15 ~ 0 | xxxxH | For a successful request: Parameter value Read or write error: Error code For no request situation: 0 |

Tab. 13-31: 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 code | Command codes (bit15 to 12 of ID) are not 0, 1 or 2. |
| 3 | Invalid parameter address | Invalid function group or index number of the function group, or insufficient access/rights |
| 4 | Invalid parameter value | Data to write out of range |
| 5 | Forbid write in running mode | Frequency converter is running |
| 6 | Parameter read-only | Parameter are read-only, can not be written |
| 7 | Invalid operation | Function code does not support write or multiple write via external computer |
| 8 | EEPROM access error | EEPROM write operation is incomplete |

Tab. 13-32: PKW area error codes

Example of parameter operation in PKW area

Example description

In applications, the master and the frequency converters communicate with messages in PPO structure. Among the 5 PPOs stated in [fig. 13-5 "PPO type" on page 204](#), 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.

Example 1

Reading value of parameter b1.20 'Acceleration time 1'. 0x01 is the parameter group, 0x14 is the index No. of the function code within the parameter group, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---------------------------------|--------|--------|------------|-----------|
| Request data frame of PKW area | 0x0001 | 0x0114 | 0x0000 | 0x0000 |
| Response data frame of PKW area | 0x0001 | 0x0114 | 0x0000 | 0x0032 |

Tab. 13-33: Example 1_request and response data frames of PKW area

Example 2

Modifying value of parameter b1.20 'Acceleration time 1'. 0x01 is the parameter group, 0x14 is the index No. of the function code within the parameter group. If the modifying value is 0x0064, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---------------------------------|--------|--------|------------|-----------|
| Request data frame of PKW area | 0x0002 | 0x0114 | 0x0000 | 0x0064 |
| Response data frame of PKW area | 0x0002 | 0x0114 | 0x0000 | 0x0064 |

Tab. 13-34: Example 2_request and response data frames of PKW area

Example 3

Modifying value of parameter b1.20 'Acceleration time 1'. 0x01 is the parameter group, 0x14 is the index No. of the function code within the parameter group. If the modifying value is 0xFFFF, then request and response data frames in PKW area are shown in table below:

| | ID | IND | VALUE_high | VALUE_low |
|---------------------------------|--------|--------|------------|-----------|
| Request data frame of PKW area | 0x0002 | 0x0114 | 0x0000 | 0xFFFF |
| Response data frame of PKW area | 0x0007 | 0x0114 | 0x0000 | 0x0064 |

Tab. 13-35: Example 3_request and response data frames of PKW area

PZD process data area**PZD process data area description**

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 to 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 H0.10 to H0.17.

For control word, status word and parameter addresses, see descriptions in [chapter 13.2.4 "Communication Mapping Register Address Distribution"](#) on page 195.

Examples for operation of PZD process data area

Example 1

The master communicates with the slave via PPO4. We need set monitoring parameters corresponding to PZD3 - PZD6, see [fig. 13-5 "PPO type" on page 204](#).

If we need to start frequency converter for forward rotation at 50.00 Hz (0x1388), and request PZD3 to reflect output current, PZD4 to reflect output voltage, PZD5 to reflect DC bus voltage, PZD6 to reflect module temperature, respective parameters are set as: [H0.10]=5, [H0.11]=4, [H0.12]=7, [H0.13]=16. Complete PPO request and response messages are shown in table below.

| | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|----------------------|--------|--------|--------|--------|--------|--------|
| PPO request message | CW | REF | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0x0081 | 0x1388 | | | | |
| PPO response message | SW | ACT | 0x0000 | 0x0206 | 0x02DD | 0x0019 |
| | 0xxx02 | 0x1388 | | | | |

Tab. 13-36: Example 1 for PZD process data area_request and response messages of PPO



The higher byte of the status word is the latest error code (0x00 means no error).

Example 2

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

| | PZD1 | PZD2 | PZD3 | PZD4 | PZD5 | PZD6 |
|----------------------|--------|--------|--------|--------|--------|--------|
| PPO request message | CW | REF | 0x0000 | 0x0000 | 0x0000 | 0x0000 |
| | 0x0088 | 0x1388 | | | | |
| PPO response message | SW | ACT | 0x0000 | 0x0000 | 0x0049 | 0x0013 |
| | 0xxx00 | 0x0000 | | | | |

Tab. 13-37: Example 2 for PZD process data area_request and response messages of PPO

Communication parameter configuration

Communication related parameter settings

| Parameter | Name | Setting range of parameter |
|-----------|--|--|
| b1.00 | First frequency setting source | 5: Set by communication |
| b1.02 | First RUN command source | 2: Set control commands by communication |
| b1.16 | Second frequency setting source | 5: Set by communication |
| b1.17 | Second RUN command source | 2: Set control commands by communication |
| H0.00 | Communication protocols | 1: PROFIBUS protocols |
| H0.03 | Local address | 1 ~ 126 |
| H0.08 | Communication disconnection detection time | 0.0 ~ 60.0s (0.0s: deactivated) |
| H0.09 | Communication disconnection action | 0: Stop; 1: Continue running |
| H0.10 | PZD3 setting | 0 ~ 20 |
| H0.11 | PZD4 setting | 0 ~ 20 |
| H0.12 | PZD5 setting | 0 ~ 20 |
| H0.13 | PZD6 setting | 0 ~ 20 |
| H0.14 | PZD7 setting | 0 ~ 20 |
| H0.15 | PZD8 setting | 0 ~ 20 |
| H0.16 | PZD9 setting | 0 ~ 20 |
| H0.17 | PZD10 setting | 0 ~ 20 |

Tab. 13-38: PROFIBUS-DP communication parameters



In the operation controlled by communication, if the frequency converter is stopped by the **Stop** key on the operating panel, the frequency converter stops responding to the control commands by communication. To enable the control by communication, re-power the frequency converter or send **Stop** command to the frequency converter by communication.

Parameter configuration of master

For master related parameter configuration, refer to descriptions for 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 are determined by the master.

GSD file

Users may log on the website of the company at www.boschrexroth.com/EFC3600 to download or contact sales personnel to obtain the GSD file BREFC01.zip. For installation and PROFIBUS system configuration method, please refer to respective instructions of system configuration software.

14 Maintenance

14.1 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 electrical equipment are permitted to operate, maintain and repair this equipment.
- 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. Ensure that the mains voltage is not reconnected.
- 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. 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 5 minutes.

14.2 Daily Inspection

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

| Inspection category | Inspection item | Inspection criteria | Inspection result |
|---------------------|-------------------------|--|-------------------|
| Ambient conditions | Temperature | -10 ~ 50 °C (no frost or condensation) | |
| | Relative humidity | <90 %RH (no condensation) | |
| | Dust, water and leakage | No heavy dust or sign of leakage (visual inspection) | |
| | Gas | No strange smell | |
| | Sound | No strange sound | |
| | Operating panel display | No error code | |
| Frequency converter | Fan | No blockage or contamination | |
| Motor | Sound | No strange sound | |

Tab. 14-1: Daily inspection list

14.3 Periodic Inspection

In addition to daily inspection, periodic inspection of frequency converters 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 | 1-phase: 200~240 V (-10 % / +10 %) 3-phase: 380~480 V (-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 | | |
| Frequency converter | Visual appearance | No deformation | Contact service engineers |
| | 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 |
| DC bus capacitor | No leakage, color change, crack or expansion with safety valve shut down | Replace DC bus capacitor (must be operated by service engineers) | |
| Accessories | Connection | No loose connection | Tighten terminal screw |
| | Cable | No color change or damage | Replace cable |

Tab. 14-2: Periodic inspection list

14.4 Operating Panel Removal and Mounting

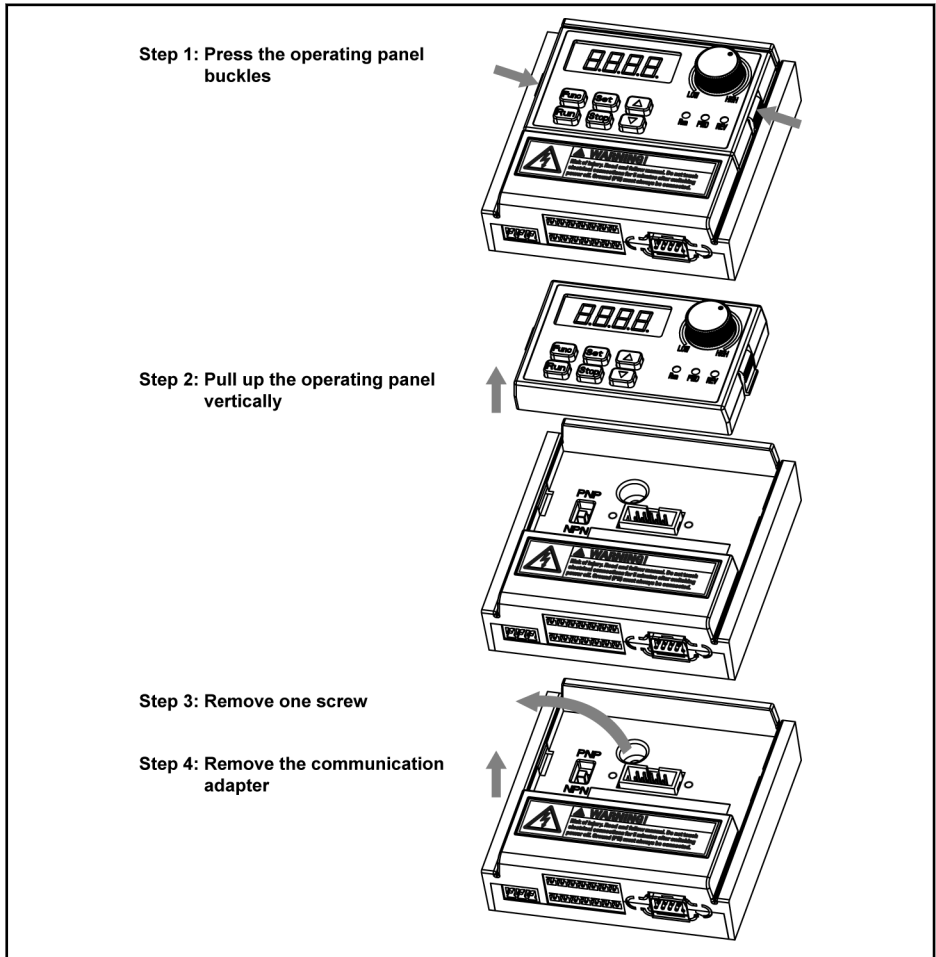


Fig. 14-1: Operating panel removal

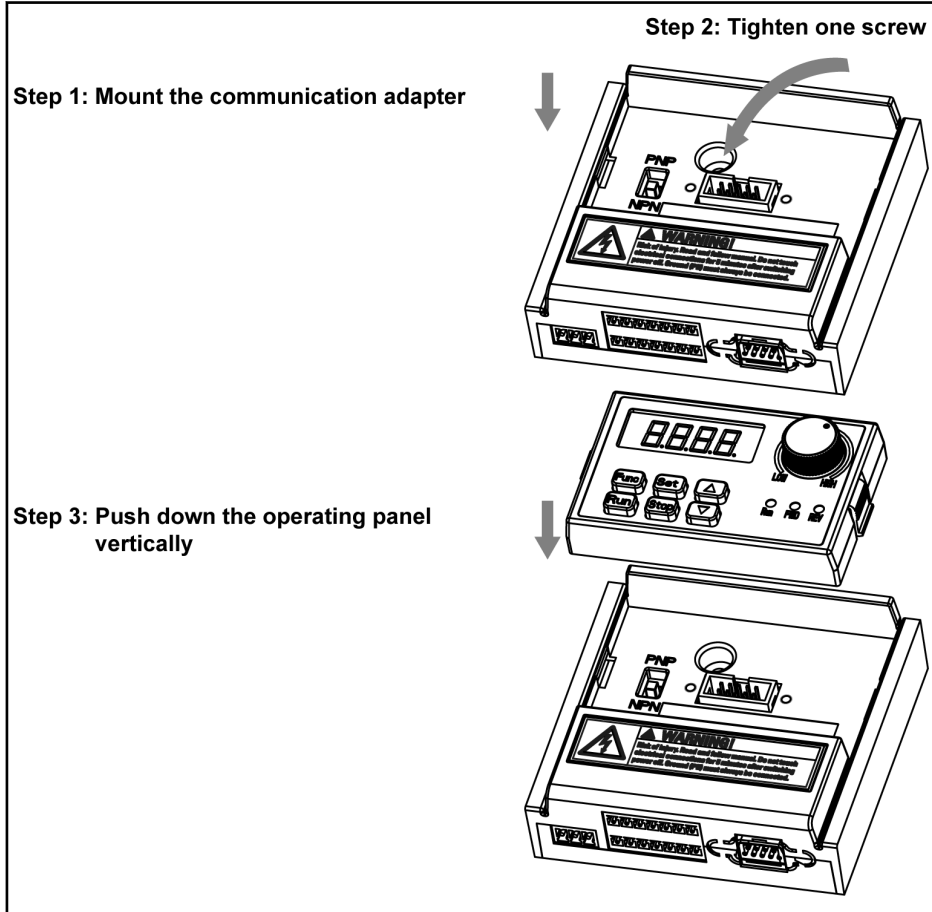


Fig. 14-2: Operating panel mounting

14.5 Fan Removal and Mounting

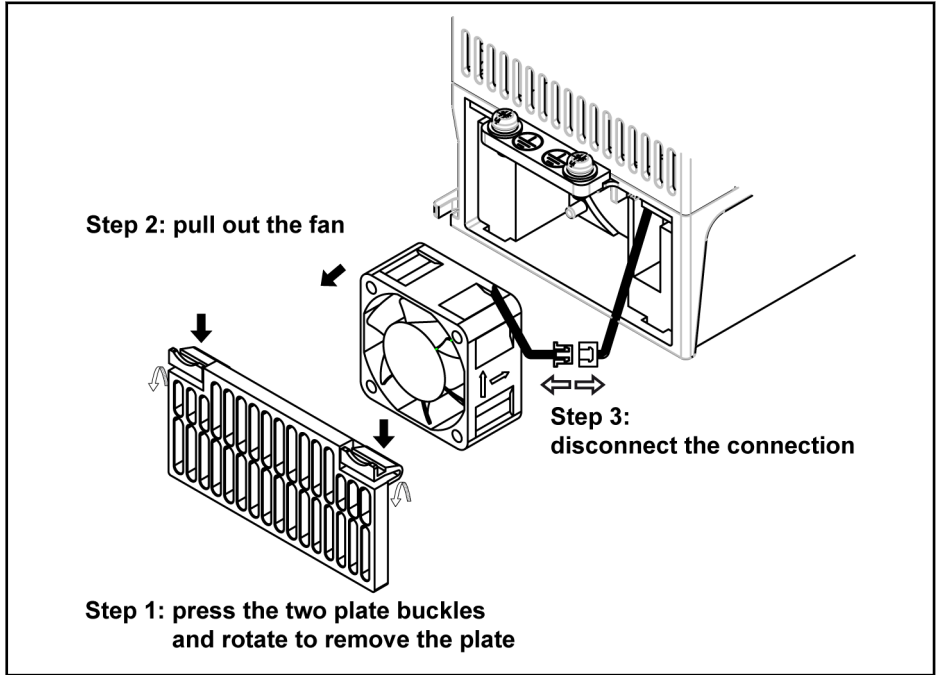


Fig. 14-3: Fan removal

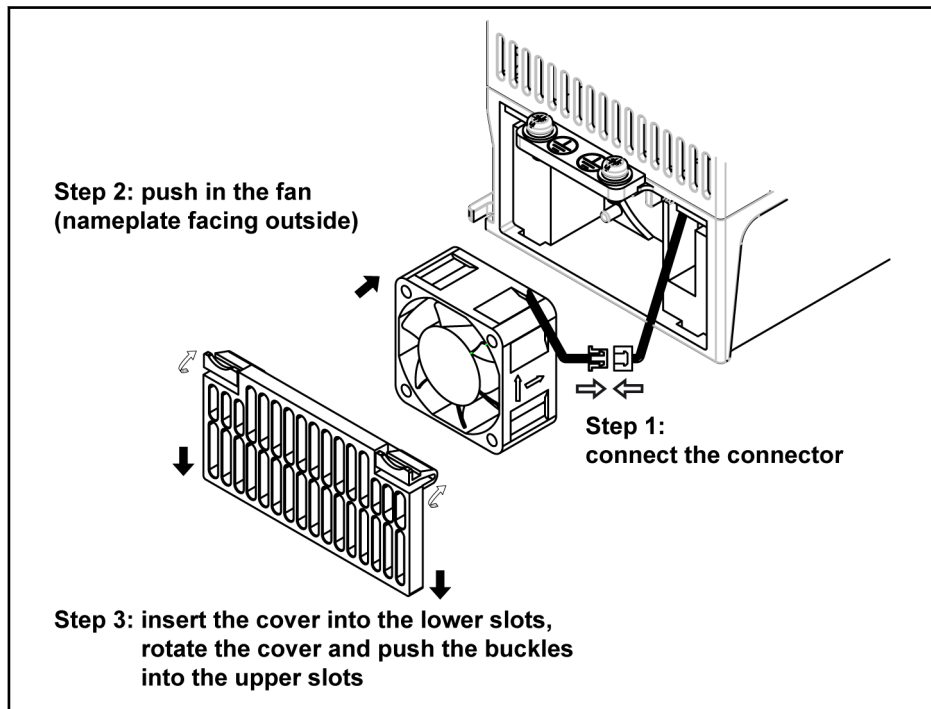


Fig. 14-4: Fan mounting

15 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: <http://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)

16 Environmental Protection and Disposal

16.1 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 negative 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

16.2 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

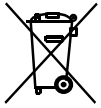
Packaging

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 improperly 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.

17 Appendix

17.1 Appendix 1: Abbreviations

Rexroth EFC 3600 Frequency Converter drive system is composed of individual parts (components) for application in different circumstances.

- EFC 3600: EFC 3600 frequency converter
- FPCC: Operating panel
- FENL: Mains choke
- FENF: External EMC filter
- FEAA: Interface adapter
- FRKB: Interface adapter cable
- FRKS: Operating panel cable
- FSAM: Operating panel mounting plate for control cabinet
- FELR: Brake resistor
- FEML: Motor choke

17.2 Appendix 2: Parameter List

17.2.1 Description of Attribute Symbols in Parameter Tables

| Parameter attribute | Description |
|---------------------|---|
| RUN/STOP | Parameter setting can be modified when the frequency converter is in RUN or STOP mode. |
| STOP | Parameter setting can only be modified when the frequency converter is in STOP mode. |
| mpwd | Parameter setting can only be modified when the manufacturer password protection is disabled. |
| read only | Parameter setting is read-only and cannot be modified. |

Tab. 17-1: Description of attribute symbols in parameter tables



- Code: means function / parameter code, written in bx.xx, Ex.xx, Sx.xx, Hx.xx and dx.xx.
- Value of function / parameter code: written in [bx.xx], [Ex.xx], [Sx.xx], [Hx.xx], and [dx.xx].
- Default: values that correspond to the factory default upon initialization at 50 Hz.
- Attri.: means attribute.

17.2.2 Group b0: System Parameters

Password and access control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|--------------|--------------------------|---|-----------|---------|----------|
| b0.00 | User password | 0 ~ 65535 | 1 | 0 | RUN/STOP |
| b0.01 | Manufacturer password | 0 ~ 65535 | 1 | 0 | STOP |
| b0.02 | Access authority setting | 0: Basic parameters 1: Standard parameters 2: Extended parameters 3: Advanced parameters 4: Start-up mode | 1 | 0 | RUN/STOP |
| b0.03, b0.04 | | | | | Reserved |

System configuration

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|--------------------------|---|-----------|---------|----------|
| b0.05 | Parameter initialization | 0: No action 1: Restore to factory default 2: Remove error records | 1 | 0 | STOP |
| b0.06 | Parameter replication | 0: No action 1: Backup parameters from frequency converter to panel 2: Restore parameters from panel to frequency converter | 1 | 0 | STOP |
| b0.07 ~ b0.19 | | | | | Reserved |



For parameters b0.05 and b0.06, the value is automatically set to be 0 after the operation.

Frequency converter configuration

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---|--------------------|-----------|---------|----------|
| b0.20 | Rated frequency converter voltage setting | 200 V: 200 ~ 240 V | 1 V | 220 V | STOP |
| | | 400 V: 380 ~ 480 V | | 380 V | |
| b0.21 | Carrier frequency | 1 ~ 15 kHz | 1 kHz | 4 kHz | RUN/STOP |
| b0.22 | Automatic adjustment of carrier frequency | 0: OFF; 1: ON | 1 | 0 | STOP |
| b0.23 ~ b0.29 | | | | | Reserved |

Monitoring display

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|--|---------------|-----------|---------|----------|
| b0.30 | Running monitoring display | 0 ~ 70 | 1 | 0 | RUN/STOP |
| b0.31 | Stop monitoring display | | 1 | 2 | RUN/STOP |
| b0.32 | User-defined proportion factor for velocity | 0.01 ~ 100.00 | 0.01 | 1.00 | RUN/STOP |
| b0.33 | PID reference / feedback coefficient | | | | RUN/STOP |
| b0.34 | Time constant for high resolution output current | 5 ~ 500 ms | 1 ms | 40 ms | RUN/STOP |
| b0.35 ~ b0.39 | | | | | Reserved |

Setting range of b0.30 ~ b0.31:

- 0: Output frequency
- 1: Output rotation speed
- 2: Set frequency
- 3: Set rotation speed
- 4: Output voltage
- 5: Output current
- 6: Output power
- 7: DC bus voltage
- 8: Analog input voltage (AIV)
- 9: Analog input current (AIC)
- 10: User-defined set velocity
- 11: User-defined output velocity
- 12: Digital input status
- 13: Digital output status
- 14: PID target engineer value
- 15: PID feedback engineer value
- 16: Module temperature

- 17: Firmware version 1
 18: Firmware version 2
 19: Firmware version 3
 20: Actual carrier frequency
 70: High resolution output current

System Information

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|-------------------------|-----------------|-----------|---------|----------|
| b0.40 | Cumulative running time | 0 ~ 65535 hours | 1 hour | 0 | mpwd |
| b0.41 ~ b0.49 | | | | | Reserved |

17.2.3 Group b1: Basic Parameters

Basic running control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------|--------------------------------------|--|-----------|----------|----------|
| b1.00 | First frequency setting source | 0 ~ 6 | 1 | 0 | STOP |
| b1.01 | Digital set frequency saving | 0 ~ 3 | 1 | 0 | STOP |
| b1.02 | First RUN command source | 0 ~ 2 | 1 | 0 | STOP |
| b1.04 | Digital set frequency | 0.00 Hz ~ [b1.06] | 0.01 Hz | 50.00 Hz | RUN/STOP |
| b1.05 | Max. frequency | 50.00 ~ 400.00 Hz | 0.01 Hz | 50.00 Hz | STOP |
| b1.06 | Upper frequency | [b1.07] ~ [b1.05] | 0.01 Hz | 50.00 Hz | RUN/STOP |
| b1.07 | Lower frequency | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/STOP |
| b1.08 | Lower frequency mode | 0: Running with 0 Hz 1: Run with lower frequency | 1 | 0 | STOP |
| b1.09 | Hysteresis frequency width | 0.00 Hz ~ [b1.07] | 0.01 Hz | 0.00 Hz | |
| b1.10 | Direction control | 0: Both directions 1: Forward only 2: Reverse only 3: Inverse default direction | 1 | 0 | STOP |
| b1.11 | Operating panel control direction | 0: Forward; 1: Reverse | 1 | 0 | RUN/STOP |
| b1.15 | Combination frequency command source | 0 ~ 2 | 1 | 0 | STOP |
| b1.16 | Second frequency setting source | 0 ~ 6 | 1 | 2 | STOP |

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------------------------------------|---------------------------|---------------|-----------|---------|----------|
| b1.17 | Second RUN command source | 0 ~ 2 | 1 | 1 | STOP |
| b1.03, b1.12 ~ b1.14, b1.18 ~ b1.19 | | | | | Reserved |

Setting range of b1.00 and b1.16:

- 0: Given by panel potentiometer
- 1: Given by panel digital setting
- 2: Given by external analog input voltage (AIV)
- 3: Given by external analog input current (AIC)
- 4: Given by external **UP / DOWN** terminals
- 5: Given by communication
- 6: Given by multi-speed

Setting range of b1.01:

- 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

Setting range of b1.02 and b1.17:

- 0: Inputting commands by operating panel
- 1: Inputting commands by external terminals
- 2: Inputting commands by communication

Setting range of b1.15:

- 0: No combination
- 1: First frequency setting+ second frequency setting
- 2: First frequency setting - second frequency setting

Acceleration/deceleration control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|--|------------------------------|-----------|---------|----------|
| b1.20 | Acceleration time 1 | 0.1 ~ 6,000.0s | 0.1s | 5.0s | RUN/STOP |
| b1.21 | Deceleration time 1 | 0.1 ~ 6,000.0s | 0.1s | 5.0s | RUN/STOP |
| b1.22 | Acceleration / deceleration curve mode | 0: Linear mode 1: S-curve | 1 | 0 | STOP |
| b1.23 | S curve starting phase proportion | 0.0 % ~ 40.0 % | 0.1 % | 20.0 % | STOP |
| b1.24 | S curve stopping phase proportion | 0.0 % ~ 40.0 % | 0.1 % | 20.0 % | STOP |
| b1.25 ~ b1.29 | | | | | Reserved |

Starting configuration

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---------------------------------|---|-----------|---------|----------|
| b1.30 | Starting mode | 0: Start directly 1: Braking before start 2: Start with speed capture | 1 | 0 | STOP |
| b1.31 | Starting frequency | 0.00 ~ 50.00 Hz | 0.01 Hz | 0.05 Hz | STOP |
| b1.32 | Starting frequency holding time | 0.0 ~ 20.0s | 0.1s | 0.1s | STOP |
| b1.33 | Starting DC braking time | 0.0 ~ 20.0s (0.0s: no action of starting DC braking) | 0.1s | 0.0s | STOP |
| b1.34 | Starting DC braking current | 0.0% ~ 150.0% (of rated frequency converter current) | 0.1% | 0.0% | STOP |
| b1.35 ~ b1.39 | | | | | Reserved |

Stopping configuration

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---------------------------------------|--|-----------|---------|----------|
| b1.40 | Stopping mode | 0: Decelerating to stop 1: Freewheeling to stop 2: Freewheeling with STOP-command, decelerating when direction changes | 1 | 0 | STOP |
| b1.41 | Stopping DC braking initial frequency | 0.00 ~ 50.00 Hz | 0.01 Hz | 0.00 Hz | STOP |
| b1.42 | Stopping DC braking time | 0.0 ~ 20.0s (0.0 represents no action of stopping DC braking) | 0.1s | 0.0s | STOP |
| b1.43 | Stopping DC braking current | 0.0% ~ 150.0% (of rated frequency converter current) | 0.1% | 0.0% | STOP |
| b1.44 | Reserved | – | – | – | – |
| b1.45 | Over excitation gain | 1.00 ~ 1.40 | 0.01 | 1.00 | RUN/STOP |
| b1.46 ~ b1.49 | | | | | Reserved |

17.2.4 Group S0: V/F control

V/F curve

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|-----------------|---|-----------|---------|----------|
| S0.00 | V/F curve mode | 0: Linear mode 1: Square curve 2: User-defined multipoint curve | 1 | 0 | STOP |
| S0.01 | V/F frequency 1 | 0.00 Hz ~ [S0.03] | 0.01 Hz | 0.00 Hz | STOP |
| S0.02 | V/F voltage 1 | 0.0 % ~ 120.0 % (of rated motor voltage) | 0.10 % | 0.00 % | STOP |
| S0.03 | V/F frequency 2 | [S0.01] ~ [S0.05] | 0.01 Hz | 0.00 Hz | STOP |
| S0.04 | V/F voltage 2 | 0.0 % ~ 120.0 % (of rated motor voltage) | 0.10 % | 0.00 % | STOP |
| S0.05 | V/F frequency 3 | [S0.03] ~ [b1.05] | 0.01 Hz | 0.00 Hz | STOP |
| S0.06 | V/F voltage 3 | 0.0 % ~ 120.0 % (of rated motor voltage) | 0.10 % | 0.00 % | STOP |
| S0.07 ~ S0.19 | | | | | Reserved |

Enhanced V/F control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|----------------------|----------------------------------|---|-----------|---------|----------|
| S0.20 | Rated motor slip frequency | 0.00 ~ 20.00 Hz | 0.01 Hz | 0.00 Hz | RUN/STOP |
| S0.21 | Voltage boost | 0.1 % ~ 20.0 %: manual voltage boost 0.0 %: automatic voltage boost (of rated motor voltage) | 0.1 % | 5.0 % | RUN/STOP |
| S0.22 | I ² R boost factor | 0 % ~ 320 % | 1 % | 100 % | RUN/STOP |
| S0.24 | Heavy load voltage stabilization | 0: Disable; 1: Enable | 1 | 1 | RUN/STOP |
| S0.25 | Anti hunting factor | 0 % ~ 5,000 % | 1 % | 0 % | RUN/STOP |
| S0.26 | Anti hunting filter factor | 10 % ~ 2,000 % | 1 % | 100 % | RUN/STOP |
| S0.23, S0.27 ~ S0.29 | | | | | Reserved |

No-trip control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------|---|---|-----------|---------|--------|
| S0.30 | Current limitation control | 0: OFF 1: OFF at constant speed 3: ON at constant speed | 1 | 0 | STOP |
| S0.31 | Automatic current limitation level | 20 % ~ 250 % (of rated frequency converter current) | 1 % | 200 % | STOP |
| S0.32 | Current regulator proportion factor | 0.000 ~ 1.000 | 0.001 | 0.060 | STOP |
| S0.33 | Current regulator integrating time constant | 0.001 ~ 10.000 | 0.001 | 0.200 | STOP |

17.2.5 Group S2: Motor Parameters

Motor nameplate parameters

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|----------------------------|------------------|-----------|------------------|----------|
| S2.00 | Rated motor frequency | 5.00 ~ 400.00 Hz | 0.01 Hz | 50.00 Hz | STOP |
| S2.01 | Rated motor rotation speed | 1 ~ 30,000 rpm | 1 rpm | Depends on model | STOP |
| S2.02 | Rated motor power | 0.1 ~ 1,000.0 kW | 0.1 kW | | STOP |
| S2.03 | Rated motor voltage | 0 ~ 480 V | 1 V | | STOP |
| S2.04 | Rated motor current | 0.01 ~ 655.00 A | 0.01 A | | STOP |
| S2.05 | Power-factor | 0.50 ~ 0.95 | 0.01 | | STOP |
| S2.06 ~ S2.09 | | | | | Reserved |

Motor physical data

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---------------------------|--|---------------|------------------|----------|
| S2.10 | Stator resistance | 0.00 ~ 50.00 Ω | 0.01 Ω | Depends on model | STOP |
| S2.11 | Rotator resistance | | | | |
| S2.12 | Leakage inductance | 0.00 ~ 200.00 mH | 0.01 mH | | STOP |
| S2.13 | Mutual inductance | 0.0 ~ 3,000.0 mH | 0.1 mH | | STOP |
| S2.14 | No-load current | 0.0 A ~ [S2.04] | 0.1 A | | STOP |
| S2.15 | Physical data calculation | 0: No action 1: Calculation 2: Automatic adjustment while the motor is in static mode 3: Automatic adjustment while the motor is rotating | 1 | 0 | STOP |
| S2.16 ~ S2.19 | | | | | Reserved |

Motor thermal protection

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|------------------------------------|---------------------------------------|-----------|------------------|----------|
| S2.20 | Sensor type | 0: PTC; 1: NTC | 1 | 0 | STOP |
| S2.21 | Input channel of motor temperature | 0: Invalid 1: Analog input voltage | 1 | 0 | |
| S2.22 | Protection level | 0.0 ~ 10.0 | 0.1 | 2.0 | STOP |
| S2.23 | Thermal motor time constant | 0.0 ~ 400.0 min | 0.1 min | Depends on model | STOP |
| S2.24 ~ S2.39 | | | | | Reserved |

17.2.6 Group S3: Running Parameters

Jogging parameters

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---------------------------|-------------------|-----------|---------|----------|
| S3.00 | Jogging frequency | 0.00 Hz ~ [b1.05] | 0.01 Hz | 5.00 Hz | RUN/STOP |
| S3.01 | Jogging acceleration time | 0.1 ~ 6,000.0s | 0.1s | 5.0s | RUN/STOP |
| S3.02 | Jogging deceleration time | 0.1 ~ 6,000.0s | 0.1s | 5.0s | RUN/STOP |
| S3.03 ~ S3.04 | | | | | Reserved |

Skip frequency

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---|-------------------|-----------|---------|----------|
| S3.05 | Skip frequency 1 | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | STOP |
| S3.06 | Skip frequency 2 | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | STOP |
| S3.07 | Skip frequency 3 | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | STOP |
| S3.08 | Skip frequency range | 0.00 ~ 30.00 Hz | 0.01 Hz | 0.00 Hz | STOP |
| S3.09 | Skip frequency window acceleration factor | 1 ~ 100 | 1 | 1 | STOP |
| S3.10 ~ S3.14 | | | | | Reserved |

Restarting after power fault

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---|---------------------------|-----------|---------|----------|
| S3.15 | Restarting after power fault | 0: Prohibited; 1: Allowed | 1 | 0 | STOP |
| S3.16 | Waiting time for restarting after power fault | 0.0 ~ 10.0s | 0.1s | 1.0s | STOP |
| S3.17 ~ S3.19 | | | | | Reserved |

Brake chopper control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|----------------------|----------------------------|--------------------------|-----------|---------|----------|
| S3.20 | Brake chopper action point | 200 V class: 300 ~ 390 V | 1 V | 390 V | STOP |
| | | 400 V class: 600 ~ 885 V | | 885 V | |
| S3.21 | Braking duty cycle | 1 % ~ 100 % | 1 % | 100 % | STOP |
| S3.22 ~ S3.29, S3.31 | | | | | Reserved |

Additional running control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------|---|---|-----------|-----------|----------|
| S3.30 | Forward and reverse rotation dead zone time | 0.0 ~ 60.0s | 0.1s | 4.0s | STOP |
| S3.32 | UP/DOWN set velocity | 0.10 ~ 100.00 Hz/s | 0.01 Hz/s | 1.00 Hz/s | RUN/STOP |
| S3.33 | UP/DOWN terminals initial frequency | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/STOP |
| S3.34 | Fan control | 0: Automatically controlled 1: Always on | 1 | 0 | RUN/STOP |
| S3.35 | Stopping with Stop key | 0: Only valid for operating panel control 1: Valid for all control means | 1 | 0 | RUN/STOP |

17.2.7 Group E0: Input Terminals

Multi-function digital input terminals

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|-------------------------------|--|-----------|---------|----------|
| E0.00 | 2-wire/3-wire running control | 0: Forward/stop, reverse/stop 1: Forward/reverse, run/stop 2: 3-wire control | 1 | 0 | STOP |
| E0.01 | Terminal X1 | 0 ~ 28 | 1 | 0 | STOP |
| E0.02 | Terminal X2 | | 1 | 0 | STOP |
| E0.03 | Terminal X3 | | 1 | 0 | STOP |
| E0.04 | Terminal X4 | | 1 | 0 | STOP |
| E0.05 | Terminal X5 | | 1 | 0 | STOP |
| E0.06 ~ E0.09 | | | | | Reserved |

Setting range of E0.01 ~ E0.05:

0: No action (multiple choices allowed)

1: Multi-speed control terminal 1

2: Multi-speed control terminal 2

3: Multi-speed control terminal 3; 4: Reserved

5: Acceleration/deceleration time terminal 1

6: Acceleration/deceleration time terminal 2

7: 3-wire running control

8: Freewheeling to stop enabled

9: Frequency increment UP command

10: Frequency decrement DOWN command

11: Zeroing of external terminal frequency setting; 12: Reserved

13: Stopping DC braking enabled; 14: Reserved

15: Simple PLC prohibited; 16: Simple PLC paused; 17: Reserved

18: The second frequency command source enabled

19: External error N.O. contact input

20: External error N.C. contact input

21: External RESET input

22: The second run command source enabled

23: Forward (FWD); 24: Reverse (REV)

25: Forward jogging; 26: Reverse jogging

27: Counting input; 28: Counting clear

Analog input channel gain

| Code | Name | Setting range | Min. unit | Default | Attri. |
|----------------------|--|---------------|-----------|---------|----------|
| E0.10 | Analog input voltage (AIV) channel gain Kv | 0.00 ~ 10.00 | 0.01 | 1.00 | RUN/STOP |
| E0.12 | Analog input current (AIC) channel gain Kc | 0.00 ~ 10.00 | 0.01 | 1.00 | RUN/STOP |
| E0.11, E0.13 ~ E0.14 | | | | | Reserved |

Analog input filtering time

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|-------------------------------|----------------|-----------|---------|----------|
| E0.15 | Analog channel filtering time | 0.000 ~ 2.000s | 0.001s | 0.100s | RUN/STOP |
| E0.16 ~ E0.19 | | | | | Reserved |

Analog input curve configuration

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---|-------------------|-----------|----------|----------|
| E0.20 | Analog setting curve selection | 0 ~ 3 | 1 | 0 | RUN/STOP |
| E0.21 | Curve 1 min. reference | 0.0 % ~ [E0.23] | 0.1 % | 0.0 % | RUN/STOP |
| E0.22 | Frequency corresponding to curve 1 min. reference | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E0.23 | Curve 1 max. reference | [E0.21] ~ 100.0 % | 0.1 % | 100.0 % | RUN/STOP |
| E0.24 | Frequency corresponding to curve 1 max. reference | 0.00 Hz ~ [b1.06] | 0.01 Hz | 50.00 Hz | RUN/STOP |
| E0.25 | Curve 2 min. reference | 0.0 % ~ [E0.27] | 0.1 % | 0.0 % | RUN/STOP |
| E0.26 | Frequency corresponding to curve 2 min. reference | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E0.27 | Curve 2 max. reference | [E0.25] ~ 100.0 % | 0.1 % | 100.0 % | RUN/STOP |
| E0.28 | Frequency corresponding to curve 2 max. reference | 0.00 Hz ~ [b1.06] | 0.01 Hz | 50.00 Hz | RUN/STOP |
| E0.29 ~ E0.39 | | | | | Reserved |

Setting range of E0.20:

- 0: AIC-reference characteristic curve 1, AIV-reference characteristic curve 1
- 1: AIC-reference characteristic curve 1, AIV-reference characteristic curve 2
- 2: AIC-reference characteristic curve 2, AIV-reference characteristic curve 1
- 3: AIC-reference characteristic curve 2, AIV-reference characteristic curve 2

17.2.8 Group E1: Output Terminals

Multi-function output terminals

| Code | Name | Setting range | Min. unit | Default | Attri. |
|--------------|--------------|---|-----------|---------|----------|
| E1.00 | OUT1 output | 0: Frequency converter ready for running 1: Frequency converter is running 2: DC braking indication 3: Frequency converter running at zero speed 4: Frequency/speed arrival signal 5: Frequency level detection signal (FDT1) 6: Frequency level detection signal (FDT2) 7: Simple PLC phase completion indication 8: Simple PLC cycle completion indication 9: Reserved | | | |
| E1.02 | Relay output | 10: Under voltage indication 11: Frequency converter overload pre-warning 12: Motor overload pre-warning 13: Stopped by external error 14: Error output 15: Reserved 16: Target counter value reached 17: Middle counter value reached 18: PID reference engineering value reached tolerance | 1 | 1 | STOP |
| E1.01, E1.03 | | | | | Reserved |

Frequency detection

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------|---------------------------------------|-------------------|-----------|----------|----------|
| E1.04 | Frequency arriving at detection width | 0.00 ~ 400.0 Hz | 0.01 Hz | 2.50 Hz | RUN/STOP |
| E1.05 | Frequency detection level FDT1 | 0.00 ~ 400.0 Hz | 0.01 Hz | 50.00 Hz | RUN/STOP |
| E1.06 | Frequency detection level FDT1 width | 0.00 Hz ~ [E1.05] | 0.01 Hz | 1.00 Hz | RUN/STOP |
| E1.07 | Frequency detection level FDT2 | 0.00 ~ 400.0 Hz | 0.01 Hz | 25.00 Hz | RUN/STOP |
| E1.08 | Frequency detection level FDT2 width | 0.00 Hz ~ [E1.07] | 0.01 Hz | 1.00 Hz | RUN/STOP |

Overload pre-warning

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------|--|---|-----------|---------|----------|
| E1.09 | Frequency converter overload pre-warning level setting | 20.0 % ~ 200.0 % (of rated frequency converter current) | 0.1 % | 110.0 % | STOP |
| E1.10 | Motor overload pre-warning level setting | 100.0 % ~ 250.0 % (of rated motor current) | 0.1 % | 100.0 % | RUN/STOP |
| E1.11 | Frequency converter overload pre-warning delay | 0.0 ~ 20.0s | 0.1s | 2.0s | RUN/STOP |
| E1.12 | Motor overload pre-warning delay | 0.0 ~ 20.0s | 0.1s | 2.0s | RUN/STOP |

External signal counter

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|--------------------|----------------|-----------|---------|----------|
| E1.13 | Middle count value | 0 ~ [E1.14] | 1 | 0 | RUN/STOP |
| E1.14 | Target count value | [E1.13] ~ 9999 | 1 | 0 | RUN/STOP |
| E1.15 ~ E1.29 | | | | | Reserved |

Analog output terminal

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|-----------------------------|--|-----------|---------|----------|
| E1.30 | FM1 analog output selection | 0: Running frequency 1: Set frequency 2: Output current 3: Reserved 4: Output voltage 5: Output power 6: Analog input voltage 7: Analog input current | 1 | 0 | RUN/STOP |
| E1.31 | FM1 channel mode | 0: 0 ~ 10 V 1: 2 ~ 10 V | 1 | 0 | RUN/STOP |
| E1.32 | FM1 gain setting | 0.00 ~ 10.00 | 0.01 | 1.00 | RUN/STOP |
| E1.33 ~ E1.40 | | | | | Reserved |

17.2.9 Group E2: Multi-speed and Simple PLC

Acceleration/deceleration time 2, 3 and 4

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---------------------|----------------|-----------|---------|----------|
| E2.00 | Acceleration time 2 | 0.1 ~ 6,000.0s | 0.1s | 10.0s | RUN/STOP |
| E2.01 | Deceleration time 2 | | 0.1s | 10.0s | RUN/STOP |
| E2.02 | Acceleration time 3 | | 0.1s | 10.0s | RUN/STOP |
| E2.03 | Deceleration time 3 | | 0.1s | 10.0s | RUN/STOP |
| E2.04 | Acceleration time 4 | | 0.1s | 10.0s | RUN/STOP |
| E2.05 | Deceleration time 4 | | 0.1s | 10.0s | RUN/STOP |
| E2.06 ~ E2.09 | | | | | Reserved |

Multi-speed frequency

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|-------------------------|-------------------|-----------|---------|----------|
| E2.10 | Multi-speed frequency 1 | 0.00 Hz ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E2.11 | Multi-speed frequency 2 | | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E2.12 | Multi-speed frequency 3 | | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E2.13 | Multi-speed frequency 4 | | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E2.14 | Multi-speed frequency 5 | | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E2.15 | Multi-speed frequency 6 | | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E2.16 | Multi-speed frequency 7 | | 0.01 Hz | 0.00 Hz | RUN/STOP |
| E2.17 ~ E2.29 | | | | | Reserved |

Simple PLC basic control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|----------------------------|---|-----------|---------|----------|
| E2.30 | Simple PLC running mode | 0: No action; 1: Mode 1 2: Mode 2; 3: Mode 3 | 1 | 0 | STOP |
| E2.31 | Simple PLC time multiplier | 1 ~ 60 | 1 | 1 | STOP |
| E2.32 ~ E2.34 | | | | | Reserved |

PLC stage control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|--------------------------|--|----------------|---------|----------|
| E2.35 | Stage 0 action selection | 011, 012, 013, 014, 021, 022, 023, 024, 031, 032, 033, 034, 041, 042, 043, 044, 111, 112, 113, 114, 121, 122, 123, 124, 131, 132, 133, 134, 141, 142, 143, 144 | 1 | 011 | STOP |
| E2.37 | Stage 1 action selection | | 1 | 011 | STOP |
| E2.39 | Stage 2 action selection | | 1 | 011 | STOP |
| E2.41 | Stage 3 action selection | | 1 | 011 | STOP |
| E2.43 | Stage 4 action selection | | 1 | 011 | STOP |
| E2.45 | Stage 5 action selection | | 1 | 011 | STOP |
| E2.47 | Stage 6 action selection | | 1 | 011 | STOP |
| E2.49 | Stage 7 action selection | | 1 | 011 | STOP |
| E2.36 | Stage 0 running time | | 0.0 ~ 6,000.0s | 0.1s | 20.0s |
| E2.38 | Stage 1 running time | 0.1s | | 20.0s | STOP |
| E2.40 | Stage 2 running time | 0.1s | | 20.0s | STOP |
| E2.42 | Stage 3 running time | 0.1s | | 20.0s | STOP |
| E2.44 | Stage 4 running time | 0.1s | | 20.0s | STOP |
| E2.46 | Stage 5 running time | 0.1s | | 20.0s | STOP |
| E2.48 | Stage 6 running time | 0.1s | | 20.0s | STOP |
| E2.50 | Stage 7 running time | 0.1s | | 20.0s | STOP |
| E2.51 ~ E2.70 | | | | | Reserved |

17.2.10 Group E3: PID Control

PID basic configuration

| Code | Name | Setting range | Min. unit | Default | Attri. |
|----------------------|--------------------------------|---|-----------|---------|----------|
| E3.00 | PID reference channel | 0: No PID control 1: Panel potentiometer 2: Panel digital setting 3: Analog input voltage (AIV) 4: Analog input current (AIC) 5: Communication 6: Analog digital setting E3.03 7: Rotation speed digital setting E3.04 | 1 | 0 | STOP |
| E3.01 | PID feedback channel | 0: AIC; 1: AIV | 1 | 0 | STOP |
| E3.03 | Analog digital setting | 0.00 ~ 10.00 V | 0.01 V | 0.00 V | RUN/STOP |
| E3.04 | Rotation speed digital setting | 0 ~ 30,000 rpm | 1 rpm | 0 rpm | RUN/STOP |
| E3.02, E3.05 ~ E3.09 | | | | | Reserved |

PID control

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------|---|---|-----------|---------|----------|
| E3.10 | P: Proportional gain | 0.000 ~ 10.000 | 0.001 | 1.500 | RUN/STOP |
| E3.11 | Ti: Integral time | 0.00 ~ 100.00s (0.00 represents no integral) | 0.01s | 0.00s | RUN/STOP |
| E3.12 | Td: Derivative time | 0.00 ~ 100.00s (0.00 represents no derivative) | 0.01s | 0.00s | RUN/STOP |
| E3.13 | T: Sample period | 0.01 ~ 100.00s | 0.01s | 0.50s | RUN/STOP |
| E3.14 | Deviation limit | 0.0 % ~ 20.0 % (closed loop reference value) | 0.1 % | 2.0 % | RUN/STOP |
| E3.15 | PID regulation mode | 0 ~ 1 | 1 | 0 | RUN/STOP |
| E3.16 | PID reference engineering value reached tolerance | 0.01 % ~ 100.00 % | 0.01 % | 1.00 % | RUN/STOP |

Setting range of E3.15:

0: Stop integral regulation, when frequency arrives at upper/lower limit

1: Continue integral regulation, when frequency arrives at upper/lower limit

17.2.11 Group E4: Error and Protection

Protection configuration

| Code | Name | Setting range | Min. unit | Default | Attri. |
|----------------------|------------------------------------|--|-----------|----------------|----------|
| E4.01 | Overvoltage prevention setting | 0 ~ 2 | 1 | 0 | STOP |
| E4.02 | Stall overvoltage prevention level | 200V class: 300 ~ 390 V 400V class: 600 ~ 885 V | 1 V | 390 V 885 V | STOP |
| E4.03 | Stall overcurrent prevention level | 20.0 % ~ 200.0 % (of rated frequency converter output current) | 0.1 % | 200.0 % | STOP |
| E4.04 | Low speed derating frequency | 0.10 ~ 300.00 Hz | 0.01 Hz | 25.00 Hz | RUN/STOP |
| E4.05 | Zero speed load | 25.0 % ~ 100.0 % | 0.1 % | 25.0 % | RUN/STOP |
| E4.06 | Phase loss protection | 0 ~ 3 | 1 | 3 | RUN/STOP |
| E4.00, E4.07 ~ E4.14 | | | | | Reserved |

Setting range of E4.01:

- 0: Both disabled
- 1: Stall protection enabled, braking disabled
- 2: Stall protection disabled, braking enabled

Setting range of E4.06:

- 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

Error reset

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---------------------------------|--------------------------|-----------|---------|----------|
| E4.15 | Number of error reset attempts | 0 ~ 3 (0: No auto reset) | 1 | 0 | STOP |
| E4.16 | Interval between reset attempts | 2 ~ 60s | 1s | 10s | STOP |
| E4.17 ~ E4.19 | | | | | Reserved |

Error code memory

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|------------------------|---------------|-----------|---------|-----------|
| E4.20 | Last error type | 0 ~ 51 | 1 | 0 | read only |
| E4.21 | Second last error type | | 1 | 0 | read only |
| E4.22 | Third last error type | | 1 | 0 | read only |
| E4.23 ~ E4.29 | | | | | Reserved |

Setting range of E4.20 ~ E4.22:

0: No error

1: OC-1, overcurrent happens at constant speed

2: OC-2, overcurrent happens during acceleration

3: OC-3, overcurrent happens during deceleration

4: OE-1, overvoltage happens at constant speed

5: OE-2, overvoltage happens during acceleration

6: OE-3, overvoltage happens during deceleration

7: OL-1, frequency converter overload

8: OL-2, motor overload

9: EEP-, read/write EEP error, when read and write EEP/flash, error happens

10: SPI-, internal communication error

11: E-St, external error

12: RS-, external communication error

13: CF, circuit error, when there is something wrong with current detection

14: Reserved

15: Ot, motor over temperature

16: CPUd, CPU is disturbed by external signal and program run to illegal address

17: SC, short circuit of IGBT happens

18: Reserved

19: IPH.L, input phase loss

20: OPH.L, output phase loss

21: OH, frequency converter over temperature

22: Reserved

23: CPUC, I/O board trap error

24: CPUE, operating panel trap error

25: CE3-, SPI problem between operating panel board and I/O board

26: CE4-, internal problem on operating panel

27: FFE-, firmware does not match

- 28: PSr-, problem with power supply on the main board
- 31: ESS-, soft start error
- 32: CE5-, internal problem on main board
- 33: UE-1, undervoltage during run
- 34: UH, frequency converter under temperature
- 35: FHE-, manufacturer parameter defect or mismatch to hardware
- 36: CE7-, 15 V power supply error
- 37: dir1, rotation direction error 1
- 38: dir2, rotation direction error 2
- 39: CE8-, communication problem on I/O board (No communication frames received from I/O board)
- 40: CE0-, communication problem on main board (The communication frames received from main board are checksum erroneous)
- 41: CE1-, communication problem on operating panel (The communication frames received from removable panel are checksum erroneous)
- 42: CE2-, communication problem on main board (There is no communication data from main board received in general)
- 43: CE6-, communication problem on removable board (There is no communication data from removable received in general)
- 44: CE9-, firmware version error
- 45: EEPr, EEPROM error on operating panel
- 47: OE-4, overvoltage during stop
- 50: t-Er, motor parameter identification error
- 51: SEr-, service data handling error (the main board does not receive the answer after the retry limit)

System status at the latest error

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------|------------------------------------|-------------------|-----------|---------|-----------|
| E4.30 | Output frequency at latest error | 0.00 Hz ~ [b1.05] | 0.01 Hz | 0.00 Hz | read only |
| E4.31 | Setting frequency at latest error | 0.00 Hz ~ [b1.05] | 0.01 Hz | 0.00 Hz | read only |
| E4.32 | Output current at latest error | 0.0 ~ 1,000.0 A | 0.1 A | 0.0 A | read only |
| E4.33 | Output voltage at latest error | 0 ~ 1,000 V | 1 V | 0 V | read only |
| E4.34 | DC bus voltage at latest error | 0 ~ 1,000 V | 1 V | 0 V | read only |
| E4.35 | Module temperature at latest error | – | 1 | 0 | read only |

17.2.12 Group H0: Communication

General communication configuration

| Code | Name | Setting range | Min. unit | Default | Attri. |
|---------------|---|--|-----------|---------|----------|
| H0.00 | Communication protocol | 0: ModBus 1: ModBus / PROFIBUS | 1 | 0 | STOP |
| H0.01 | Baud rate | 0: 1200 bps 1: 2400 bps 2: 4800 bps 3: 9600 bps 4: 19200 bps 5: 38400 bps | 1 | 3 | STOP |
| H0.02 | Data format | 0 ~ 3 | 1 | 0 | STOP |
| H0.03 | Local address | ModBus: 1 ~ 247 PROFIBUS: 1 ~ 126 | 1 | 1 | STOP |
| H0.08 | Communication disruption detection time | 0.0 ~ 60.0s (0.0s: invalid) | 0.1s | 0.0s | STOP |
| H0.09 | Communication disruption action | 0: Freewheeling to stop 1: Keep running | 1 | 1 | STOP |
| H0.10 | PZD3 setting | 0 ~ 20 | 1 | 0 | STOP |
| H0.11 | PZD4 setting | 0 ~ 20 | 1 | 0 | STOP |
| H0.12 | PZD5 setting | 0 ~ 20 | 1 | 0 | STOP |
| H0.13 | PZD6 setting | 0 ~ 20 | 1 | 0 | STOP |
| H0.14 | PZD7 setting | 0 ~ 20 | 1 | 0 | STOP |
| H0.15 | PZD8 setting | 0 ~ 20 | 1 | 0 | STOP |
| H0.16 | PZD9 setting | 0 ~ 20 | 1 | 0 | STOP |
| H0.17 | PZD10 setting | 0 ~ 20 | 1 | 0 | STOP |
| H0.04 ~ H0.07 | | | | | Reserved |



Ⓢ: it is ModBus for EFC3600-xKxx-xPx-MDA-7P-NNNN models; it is PROFIBUS for EFC3600-xKxx-xPx-PDA-7P-NNNN models.

Setting range of H0.02:

- 0: N, 8, 1 (1 start bit, 8 data bits, 1 stop bit, no check)
- 1: E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even parity)
- 2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd parity)
- 3: N, 8, 2 (1 start bit, 8 data bits, 1 stop bit, no parity)

17.2.13 Group d: Monitoring Parameters

Monitoring parameters

| Code | Name | Setting range | Min. unit | Default | Attri. |
|-------|---------------------------------|------------------|-----------|------------------|-----------|
| d0.00 | Output frequency | 0.00 ~ 400.00 Hz | 0.01 Hz | 0.00 Hz | read only |
| d0.01 | Output velocity | 0 ~ 65535 rps | 1 rps | 0 rps | read only |
| d0.02 | Setting frequency | 0.00 ~ 400.0 Hz | 0.01 Hz | 0.00 Hz | read only |
| d0.03 | Setting velocity | 0 ~ 65535 rps | 1 rps | 0 rps | read only |
| d0.04 | Output voltage | 0 ~ 480 V | 1 V | 0 V | read only |
| d0.05 | Output current | 0.0 ~ 1,000.0 A | 0.1 A | 0.0 A | read only |
| d0.06 | Output power | 0.0 ~ 1,000.0 kW | 0.1 kW | 0.0 kW | read only |
| d0.07 | DC bus voltage | 0 ~ 800 V | 1 V | 0 V | read only |
| d0.08 | Analog input AIV | 0.0 ~ 10.0 V | 0.1 V | 0.0 V | read only |
| d0.09 | Analog input AIC | 0.0 ~ 20.0 mA | 0.1 mA | 0.0 mA | read only |
| d0.10 | Self-defined setting velocity | 0.0 ~ 6,000.0 | 0.1 | 0.0 | read only |
| d0.11 | Self-defined output velocity | 0.0 ~ 6,000.0 | 0.1 | 0.0 | read only |
| d0.12 | Digital input status | 0 ~ 31 | 1 | 0 | read only |
| d0.13 | Digital output status | 0 ~ 3 | 1 | 0 | read only |
| d0.14 | PID reference engineering value | 0.0 ~ 6,000.0 | 0.1 | 0.0 | read only |
| d0.15 | PID feedback engineering value | 0.0 ~ 6,000.0 | 0.1 | 0.0 | read only |
| d0.16 | Module temperature | – | 1 | 0 | read only |
| d0.17 | Software version 1 | 0.00 ~ 99.99 | 0.01 | Depends on model | read only |
| d0.18 | Software version 2 | 0.00 ~ 99.99 | 0.01 | | read only |
| d0.19 | Software version 3 | 0.00 ~ 99.99 | 0.01 | | read only |
| d0.20 | Actual carrier frequency | 1 ~ 15 kHz | 1 kHz | | read only |
| d0.70 | High resolution output current | 0.00 ~ 300.00 A | 0.01 A | | read only |
| d0.71 | Boot-Loader software version | 0.00 ~ 99.99 | 0.01 | | read only |

17.3 Appendix 3: Type Coding

17.3.1 EFC 3600 Type Coding

| Short text | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | | | |
|------------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|--|--|
| Column | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Example: | E | F | C | 3 | 6 | 0 | 0 | - | 0 | K | 4 | 0 | - | 1 | P | 2 | - | M | D | A | - | 7 | P | - | N | N | N | N | | | |
| Product | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EFC..... = EFC | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Motor control | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Enhanced V/f control..... = 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Line | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| General..... = 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Standard..... = 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Option | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Standard..... = 0 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Power | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E.g., 400 W..... = 0K40 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Phases | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Single phase..... = 1P | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Three phases..... = 3P | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mains connecting voltage | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 200 V..... = 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Communication module | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| ModBus..... = M | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| EMC filter | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Industrial area, class C3..... = D | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Degree of protection | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| IP 20..... = A | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Display | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Seven-segment display..... = 7 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Display design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| With potentiometer..... = P | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Other design | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| None..... = NNNN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Fig. 17-1: EFC 3600 type coding

17.3.2 Type Coding of EFC 3600 Function Modules

Operating panel type coding

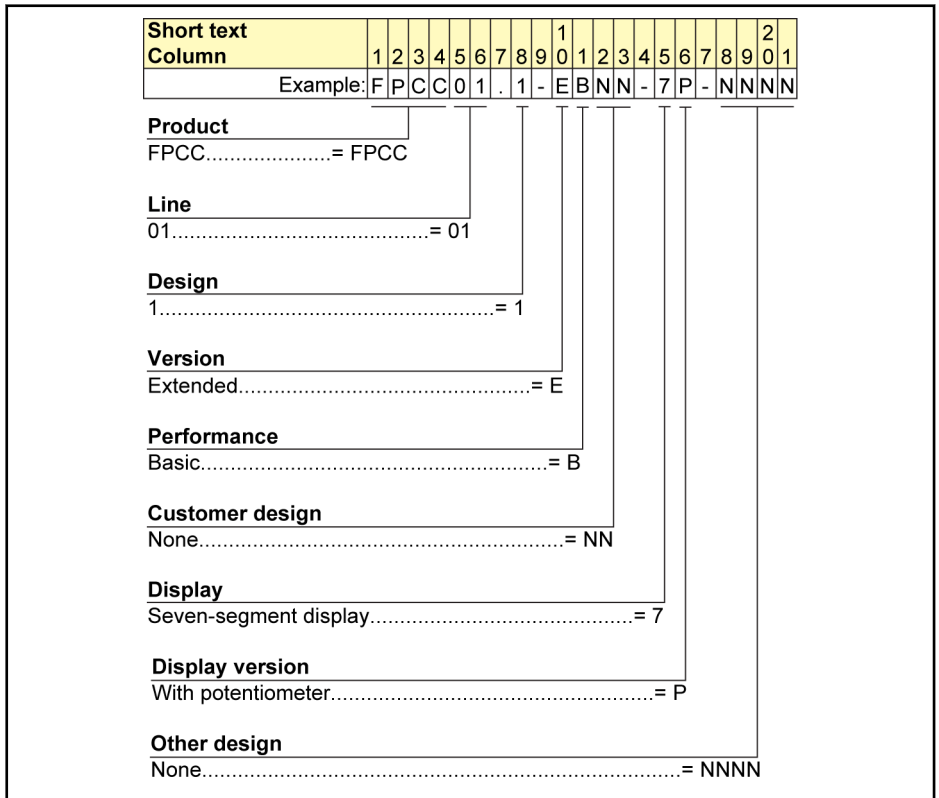


Fig. 17-2: Operating panel type coding

17.3.3 Type Coding of EFC 3600 Accessories

Mains choke type coding

| Short text column → | 1 | | | | | | | | | 2 | | | | | | | | | 3 | | | | | | | | | 4 | | | | | | | | | | | | | | | | | | | | | | | | |
|---|------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|--|--|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | | |
| Example: | F | E | N | L | 0 | 1 | . | 1 | E | - | 2 | 8 | 0 | 0 | - | N | 0 | 0 | 5 | - | N | - | 4 | 8 | 0 | - | B | - | N | N | N | N | | | | | | | | | | | | | | | | | | | | |
| Product | FENL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| FENL..... = FENL | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Line | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1..... = 01 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 1..... = 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Supply system | E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Only for feeding units..... = E | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nominal inductance | 2800 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E.g. 2.8 mH..... = 2800 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Additional option | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| None..... = N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Nominal current | 0005 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E.g. 5 A..... = 0005 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Degree of protection | N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| IP00..... = N | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Mains connecting voltage | 480 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 x AC 380...480 V -15...+10 %, 50/60 Hz..... = 480 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 3 x AC 380V ±10%..... = 380 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Environment | B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Category C1 per DIN EN 61800-3..... = B | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Other design | NNNN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| None..... = NNNN | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Fig. 17-3: Mains choke type coding

Interface adapter type coding

| Short text | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 2 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Example: | F | E | A | A | 0 | 2 | . | 1 | - | M | O | D | B | * | - | P | R | O | F | I | - | N | N | N | N | - | N | N |
| Product Interface adapter.....= FEAA | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Line 02.....= 02 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design 1.....= 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Input ModBus.....= MODB* RS485.....= RS485 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Output PROFIBUS.....= PROF I RS232.....= RS232 | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Cable Without cable.....= NNNN | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Other design None.....= NN | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Fig. 17-5: Interface adapter type coding

Interface adapter cable type coding

| Short text | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 1 | 2 | 3 | 4 | | | |
|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|--|--|
| Column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | | |
| Example: | F | R | K | B | 0 | 0 | 0 | 2 | / | 0 | 0 | 5 | , | 0 | | |
| Product Interface adapter cable.....FRKB | | | | | | | | | | | | | | | | |
| Cable number ModBus to RS485.....= 0002 | | | | | | | | | | | | | | | | |
| Length 5 m.....= 005,0 | | | | | | | | | | | | | | | | |

Fig. 17-6: Interface adapter cable type coding

Operating panel cable type coding

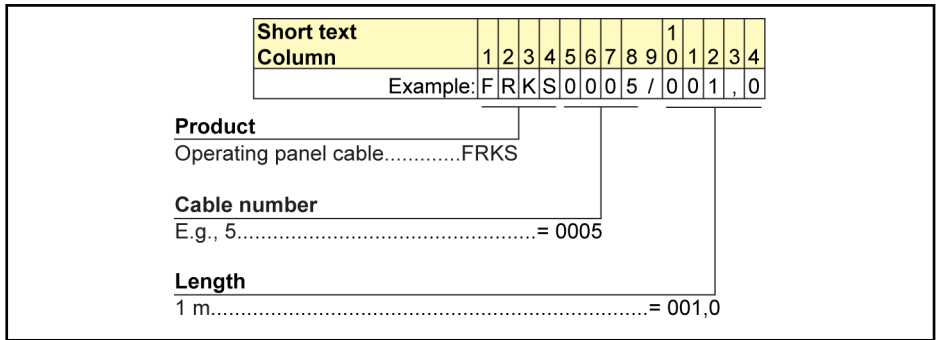


Fig. 17-7: Operating panel cable_FRKS0005

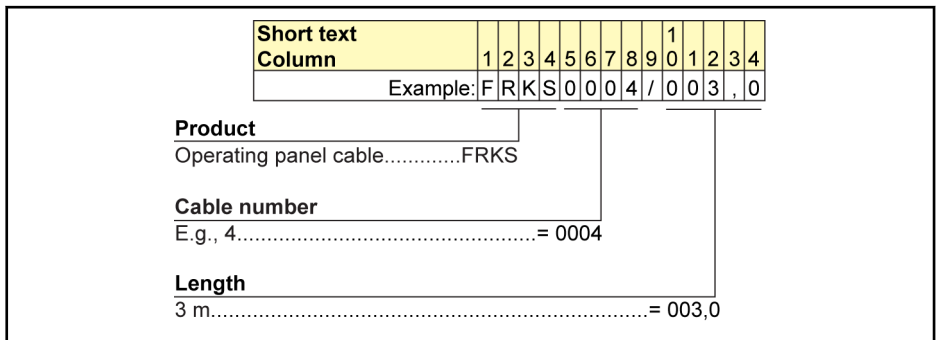


Fig. 17-8: Operating panel cable_FRKS0004

Operating panel mounting plate for control cabinet

| Short text column | 1 | | | | | | | | | 2 | | | | | | | | | 3 | | | | | | | | | | | | | | | | | | |
|----------------------------|--|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | | | | | | | | |
| Example: | F | S | A | M | 0 | 1 | . | 1 | - | E | * | - | B | - | M | O | U | N | T | I | N | G | - | P | L | A | T | E | - | F | P | C | C | 0 | 1 | . | 1 |
| Product | FSA..... = FSA | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Kind of Accessories | Electrical = M | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Line | 01..... = 01 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Design | 1..... = 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Product reference | E.g., Extended Version, Edition B, Mounting Plate for FPCC01.1 ... = E*-B-MOUNTING-PLATE-FPCC01.1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

Fig. 17-9: Operating panel mounting plate for control cabinet

17.4 Appendix 4: Certification

17.4.1 CE

Declaration of conformity

For all Frequency Converters EFC 3600, 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.

| 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) |

Tab. 17-2: Conformity and standards

CE label



Fig. 17-12: CE label

High-voltage test

According to standard EN 61800-5-1, all EFC 3600 components are tested with high voltage.

17.4.2 UL

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

UL listing



Fig. 17-13: UL listing

UL standard

UL 508C

Company name

BOSCH REXROTH (XIAN) ELECTRIC DRIVES AND CONTROLS CO., LTD.

Category name

Power Conversion Equipment

File number

E328841

UL ratings

For using the components in the scope of UL, take the UL ratings of the individual component into account.

Make sure that the indicated short circuit rating SCCR is not exceeded (5000 Arms), e.g. by appropriate fuses in the mains supply of the supply unit.

Wiring material UL

In the scope of UL, use only copper conductors rated 75 °C and above, class 1.

17.4.3 RCM

Frequency converters EFC3600 comply with the relevant ACMA standards made under the Radiocommunications Act 1992 and the Telecommunications Act 1997. These standards are referenced in notices made under section 182 of the Radiocommunications Act and 407 of the Telecommunications Act.

RCM label



Fig. 17-14: RCM label

RCM standard

EN 61800-3:2004, Adjustable speed electrical power drive systems - Part3: EMC requirements and specific test methods

ACMA supplier code

E1066

CAN, ABN or ARBN

ABN / IRDN 89003258384

Category

EFC 3600 complies with the applicable requirements detailed in EN 61800-3:2004 (Category 3 limits) and is not intended to be used directly on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if used on such a network, in which supplementary mitigation measures are required.

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Notes

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