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

Rexroth
Bosch Group

# Rexroth Frequency Converter EFC 3600

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Edition 01

Operating Instructions



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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.**

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În cazul în care documentele nu sunt în limba dumneavoastră maternă, contactați furnizorul dumneavoastră competent pentru Bosch Rexroth.

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**中文**

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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 | |
| 9 | Diagnosis | |
| 10 | Technical Data | |
| 11 | Electromagnetic Compatibility (EMC) | |
| 12 | Accessories | |
| 13 | Communication Protocols | |
| 14 | Maintenance | Maintenance information |
| 15 | Service and Support | Service information |
| 16 | Disposal and Environmental Protection | Environmental information |
| 17 | Appendix | Additional information |
| - | Index | Index information |
| - | Notes | Notes section |

**Fig.1-1: Chapters and contents**

Safety Instructions for Electric Drives and Controls

**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 General Information

Read and understand these safety instructions and all user documentation prior to working with the device. If you do not have the user documentation for the device, contact your responsible Bosch Rexroth sales representative or check www.boschrexroth.com/various/utilities/mediadirectory/ for available downloads of Safety Notes and Operating Instructions. If the device is resold, rented and/or passed on to others in any other form, then these safety instructions (official language version of the user) must be delivered with the device.

**⚠ WARNING**

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

Read these instructions before the initial start-up of the equipment in order to eliminate the risk of bodily harm or material damage. Follow these safety instructions at all times. Bosch Rexroth is not liable for damages resulting from failure to observe the warnings provided in this documentation.

- The devices have been designed for installation in industrial machinery.
- Proper and correct transport, storage, assembly and installation as well as care in operation and maintenance are prerequisites for optimal and safe operation of this device.
- Only use spare parts and accessories approved by the manufacturer.
- The information given in the documentation of the product with regard to the use of the delivered components contains only examples of applications and suggestions.
- Follow all safety regulations and requirements for the specific application as practiced in the country of use.
- The ambient conditions given in the product documentation must be observed.

- The machine and installation manufacturer must
  - make sure that the delivered components are suited for each individual application and check the information given in this document with regard to the use of the components.
  - make sure that this application complies with the applicable safety regulations and standards and carry out required measures, modifications and complements.
- Start-up of the delivered components is only permitted after the machine or installation in which they are installed complies with the national standards, safety instructions and application standards.
- Operation is only permitted if the national EMC standards for the application are met.
- The machine or installation manufacturer is responsible for compliance with the limiting values as prescribed in national standards.



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

## 2.2 Qualifications of Operating Personnel

- Only assign trained and qualified persons to work with electrical installations.
- Only persons who are trained and qualified for the use and operation of the device may work on this device or within its proximity. They need to have adequate knowledge in product assembly, mounting and operation. They are capable of understanding all warning messages marked in the instructions and respective prevention measures.
- Furthermore, they must be trained, instructed and qualified to switch electrical circuits and devices on and off in accordance with technical safety regulations and to mark them according to the requirements of safe work practices. They must have adequate safety equipment and be trained in first aid.

## 2.3 Declarations on Property Loss and Product Damage

- Safety-relevant are all such applications which can cause danger to persons and material damage.
- Only use safety-relevant applications that are clearly and explicitly approved in the Operating Instructions. If this is not the case, they are excluded.
- Read the operating, maintenance and safety instructions in your language before starting up the machine. If you find that you cannot completely understand the documentation for your product, please ask your supplier to clarify.

## 2.4 Explanation of Safety Symbols and Degrees of Hazard Seriousness

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

| Safety Symbols | Degree of Hazard Seriousness |
|---|---|
| ⚠ DANGER | Death or severe bodily harm will occur. |
| ⚠ WARNING | Death or severe bodily harm may occur. |
| ⚠ CAUTION | Minor or moderate injury or property damage may occur. |

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

## 2.5 Hazards by Improper Use

**⚠ DANGER**

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

**⚠ DANGER**

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

**⚠ WARNING**

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

**⚠ WARNING**

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

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

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

## 2.6 Instructions with Regard to Specific Dangers

**Protection Against Contact with Electrical Parts**

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

| ⚠ DANGER | High electrical voltage! Danger to life, electric shock and severe bodily injury! |
|---|---|

- Only those trained and qualified to work with or on electrical equipment are permitted to operate, maintain and repair this equipment.
- Follow general construction and safety regulations when working on electrical power installations.
- Before switching on the device, the equipment grounding conductor must have been non-detachably connected to all electrical equipment in accordance with the connection diagram.
- Do not operate electrical equipment at any time, even for brief measurements or tests, if the equipment grounding conductor is not permanently connected to the mounting points of the components provided for this purpose.
- Before working with electrical parts with voltage potentials higher than 50 V, the device must be disconnected from the mains voltage or power supply unit.
- With electrical drive and filter components, observe the following:
  - Wait for 10 minutes after switching off power to allow capacitors to discharge before beginning to work.

Safety Instructions for Electric Drives and Controls

- Measure the voltage on the capacitors before beginning to work to make sure that the equipment is safe to touch.

- Never touch the electrical connection points of a component while power is turned on.
- Install the covers and guards provided with the equipment properly before switching the device on. Before switching the equipment on, cover and safeguard live parts safely to prevent contact with those parts.
- A residual-current-operated circuit-breaker cannot be used for electric drives! Indirect contact must be prevented by other means, for example, by an over current protective device according to the relevant standards.
- Secure built-in devices from direct touching of electrical parts by providing an external housing. For example: a control cabinet.



Always observe the above requirements, in accordance with relevant international standards.

**With electrical drive and filter components, observe the following:**

**⚠ DANGER** **High housing voltage and large leakage current!**

**Risk of death or bodily injury by electric shock!**

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

## 2.7 Protection Against Electric Shock by Protective Low Voltage (PELV)

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

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

## 2.8 Protection Against Dangerous Movements

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

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

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

The monitoring in the drive components will normally be sufficient to avoid faulty operation in the connected drives. Regarding personal safety, especially the danger of bodily harm and material damage, this alone cannot be relied upon to ensure complete safety. Until the integrated monitoring functions become effective, it must be assumed in any case that faulty drive movements will occur. The extent of faulty drive movements depends upon the type of control and the state of operation.

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

- For the above reasons, ensure personal safety by means of qualified and tested higher-level monitoring devices or measures integrated in the installation. They have to be provided for by the user according to the specific conditions within the installation and a hazard and fault analysis. The safety regulations applicable for the instal-

lation have to be taken into consideration. Unintended machine motion or other malfunction is possible if safety devices are disabled, bypassed or not activated.

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

- Keep free and clear of the machine's range of motion and moving parts. Possible measures to prevent people from accidentally entering the machine's range of motion:
  - Use safety fences
  - Use of safety guard (cover)
  - Use of protective coverings
  - Install light curtains or light barrier
- Fences and coverings must be strong enough to resist maximum possible momentum.
- Mount the emergency stop switch in the immediate reach of the operator. Verify that the emergency stop works before start-up. Don't operate the device if the emergency stop is not working.
- Isolate the drive power connection by means of an emergency stop circuit or use a safety related starting lockout to prevent unintentional start.
- Make sure that the drives are brought to a safe standstill before accessing or entering the danger zone.

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

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

## 2.9 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

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

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

- Persons with heart pacemakers and metal implants are not permitted to enter the following areas:
  - Areas in which electrical equipment and parts are mounted, being operated or commissioned
  - Areas in which parts of motors with permanent magnets are being stored, repaired or mounted
- If it is necessary for somebody with a pacemaker to enter such an area, a doctor must be consulted prior to doing so. The interference immunity of present or future implanted heart pacemakers differs greatly, so that no general rules can be given.
- Those with metal implants or metal pieces, as well as with hearing aids must consult a doctor before they enter the areas described above. Otherwise health hazards may occur.

## 2.10 Protection Against Contact with Hot Parts

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

- Do not touch surfaces of device housings and chokes in the proximity of heat sources! Danger of burns!
- Do not touch housing surfaces of motors! Danger of burns!
- According to operating conditions, temperatures can be higher than 60 °C, 140 °F during or after operation.
- Before accessing motors after having switched them off, let them cool down for a sufficiently long time. Cooling down can require up to 140 minutes! Roughly estimated, the time required for cooling down is 5 times the thermal time constant specified in the Technical Data.
- After switching drive controllers or chokes off, wait for 15 minutes to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, the manufacturer of the end product, machine or installation, according to the respective safety regulations, has to take measures to avoid injuries caused by burns in the end application. These measures can be, for example: warnings, guards (shielding or barrier), technical documentation.

## 2.11 Protection During Handling and Mounting

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

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

- Observe the general construction and safety regulations on handling and assembly.
- Use suitable devices for assembly and transport.
- Avoid jamming and bruising by appropriate measures.
- Always use suitable tools. Use specific tools in different circumstances.
- Use lifting equipment and tools in the correct manner.
- If necessary, use suitable protective devices (for example safety goggles, safety shoes, safety gloves).
- Do not stand under hanging loads.
- Immediately clean up any spilled liquids because of the danger of skidding.

# 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/unpacking. If the model is wrong, please contact Bosch Rexroth distributor for replacement.

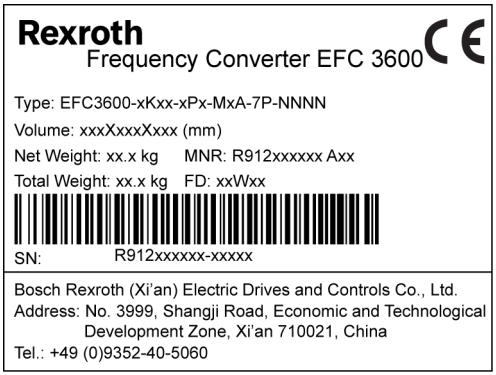



**Fig.4-1: Packing nameplate**

For the meaning of the typecode, please refer to chapter 17.3 "Appendix 3: Type Coding" on page 225.

### 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 for replacement.

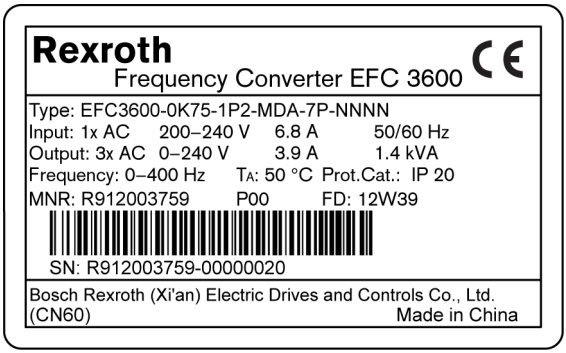



**Fig.4-2: Frequency converter nameplate**

### 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
  (Control cabinet mounting)
- Integrated brake chopper
- Operating panel
- Safety notes

**Optional accessories**

- Operating instructions
- Brake resistor
- RS232/485 adapter
- Adapter interface connection cable

Delivery and Storage

- Operating panel cable for cabinet mounting

## 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 |

**Fig.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 | -25…55 |
| Relative humidity | – | % | 5…95 |
| Absolute humidity | – | $g/m^3$ | 1…29 |
| Climate category (IEC 721) | – | – | 1K3 |
| Moisture condensation | – | – | not allowed |
| Icing | – | – | not allowed |

**Fig.4-2: Storage conditions**

# 5 Mounting and Installation

## 5.1 EFC 3600 Dimensions Figure

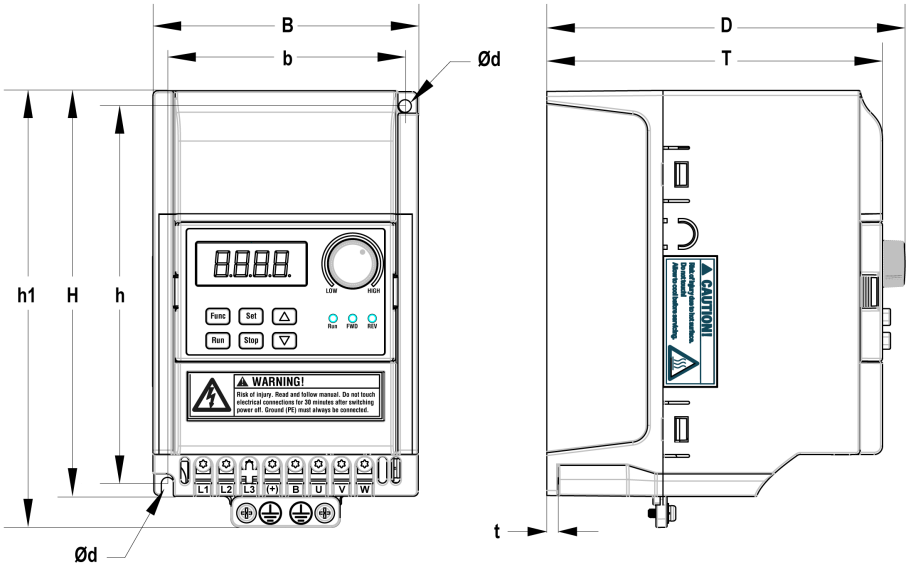



Fig.5-1: EFC 3600 figure of model A, B and C

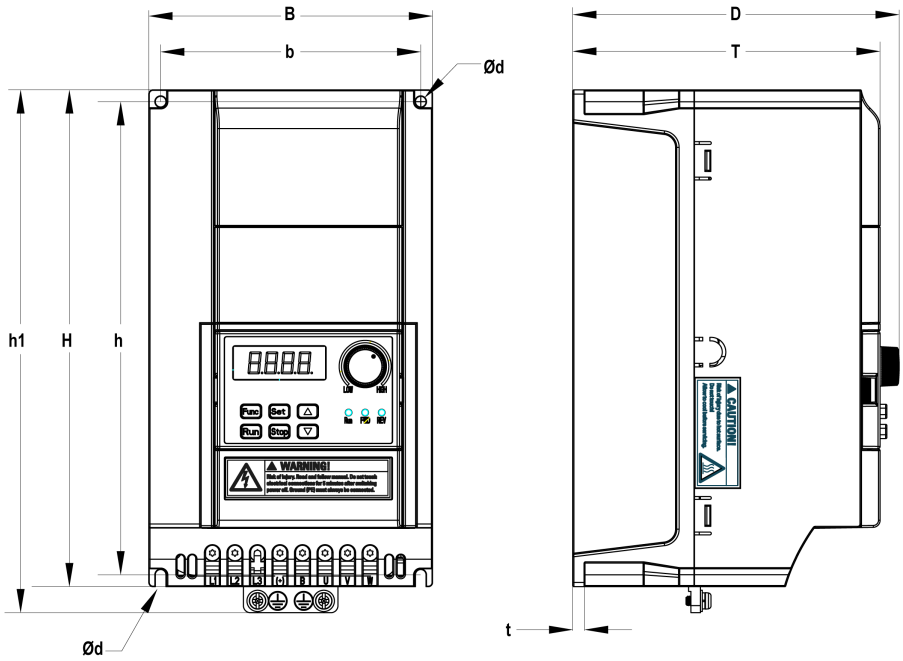



Fig.5-2: EFC 3600 figure of model D

## 5.2 EFC 3600 Dimensions

| Model | EFC 3600 type code① | Dimensions [mm] | | | | | | | | | Screw size②③ | Net weight [kg] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | B | b | H | h | h1 | Ød | D | T | t | | |
| A | 0K40-1P2-MDA | 90 | 80 | 135 | 125 | 146 | 4.5 | 113 | 105 | 5 | M4 | 0.96 |
| B | 0K40-3P4-MDA | 95 | 85 | 145 | 135 | 156 | 4.5 | 128 | 120 | 5 | M4 | 1.18 |
| | 0K75-1P2-MDA | | | | | | | | | | | 1.24 |
| | 0K75-3P4-MDA | | | | | | | | | | | 1.26 |
| C | 1K50-1P2-MDA | 95 | 85 | 185 | 175 | 196 | 4.5 | 133 | 125 | 5 | M4 | 1.61 |
| | 1K50-3P4-MDA | | | | | | | | | | | 1.52 |
| D | 2K20-1P2-MDA | 120 | 110 | 210 | 200 | 221 | 4.5 | 138 | 130 | 5 | M4 | 2.35 |
| | 2K20-3P4-MDA | | | | | | | | | | | 2.25 |
| | 4K00-3P4-MDA | | | | | | | | | | | 2.36 |

**Fig.5-1: EFC 3600 dimensions**



①: The complete type code for frequency converter is: EFC3600-xKxx-xPx-MDA-7P-NNNN, for details please see chapter 17.3 "Appendix 3: Type Coding" on page 225.

②: 2 screws are needed for mounting of EFC 3600 model A, B or C.

③: 4 screws are needed for mounting of EFC 3600 model 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.

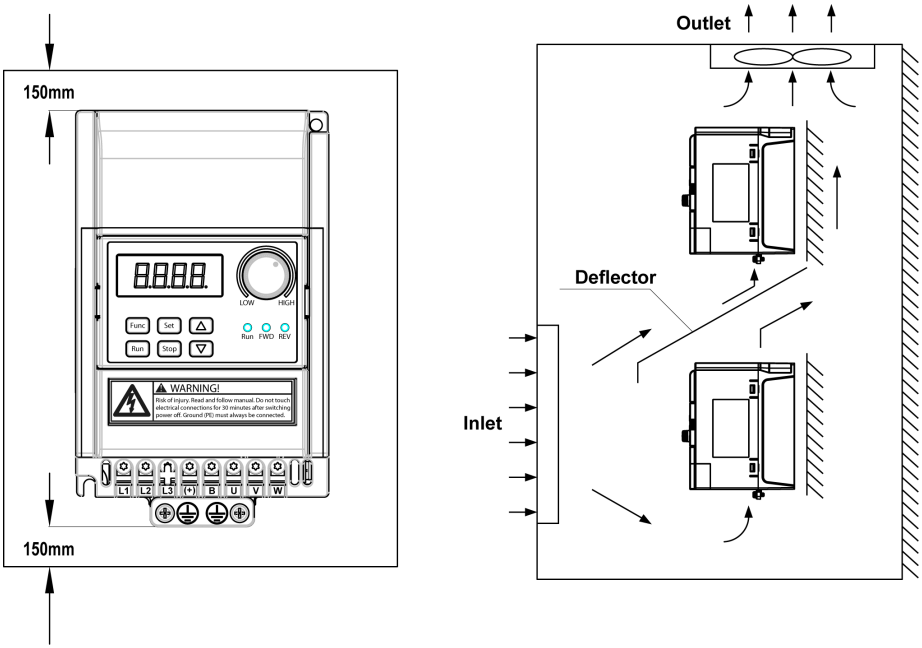



**Fig.5-3: EFC 3600 mounting**

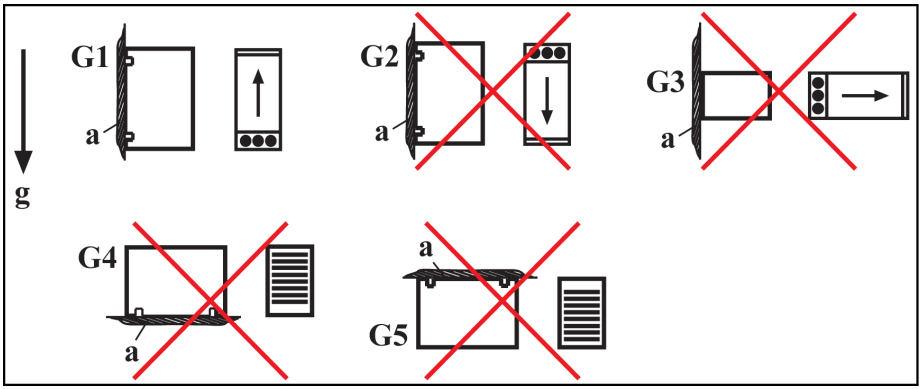
- EFC 3600 must be vertically installed.
- EFC 3600 has no side ventilation hole, which enables parallel mounting of EFC 3600 with zero distance.
- If one frequency converter is arranged above another, make sure that the upper limit of air temperature into the inlet is not exceeded (See fig. 10-1 "General technical data" on page 141).
- A baffle plate is recommended between the frequency converters to prevent the rising hot air being drawn into the upper frequency converter.

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

Only operate the components in their allowed mounting positions.

**Allowed mounting position of the components:**

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




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

**Fig.5-4: Frequency converter mounting position**

## 5.4 Block Diagram

### 5.4.1 1-phase 200 VAC Class

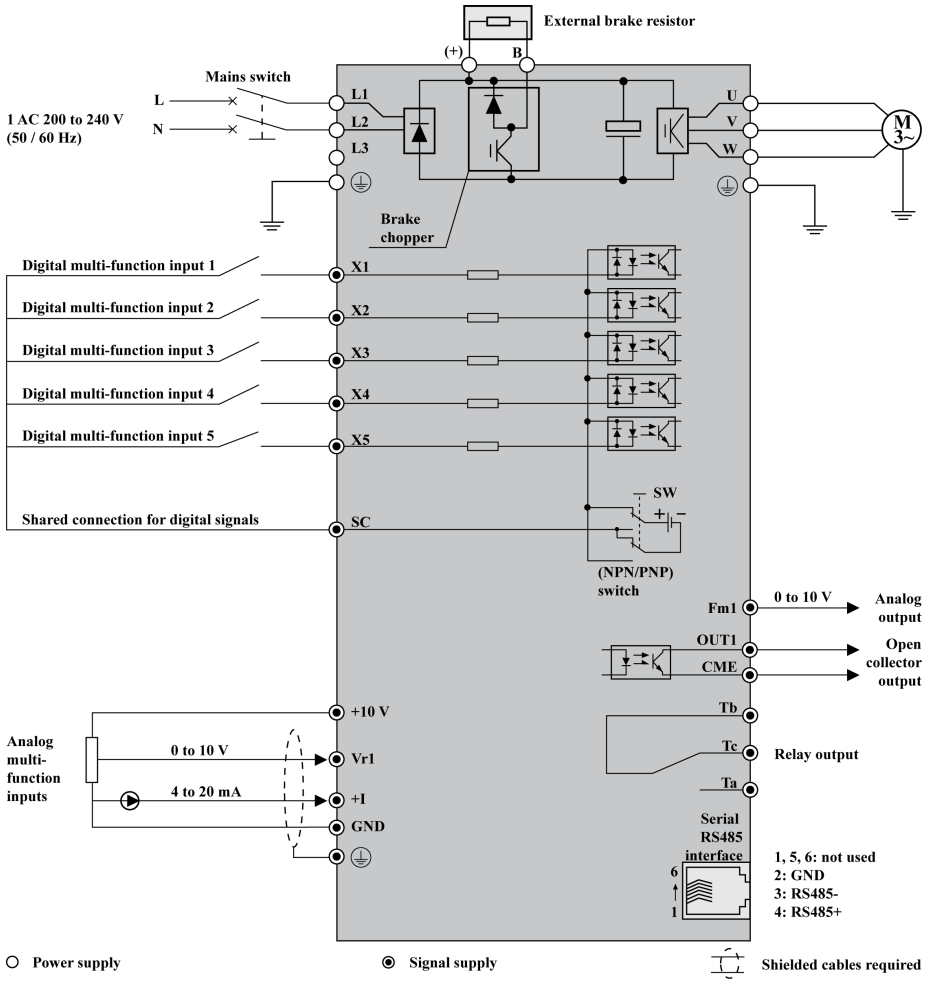



Fig.5-5: Block diagram (1AC)

It is recommended to use shielded cable to connect the motor.

## 5.4.2 3-phase 400 VAC Class

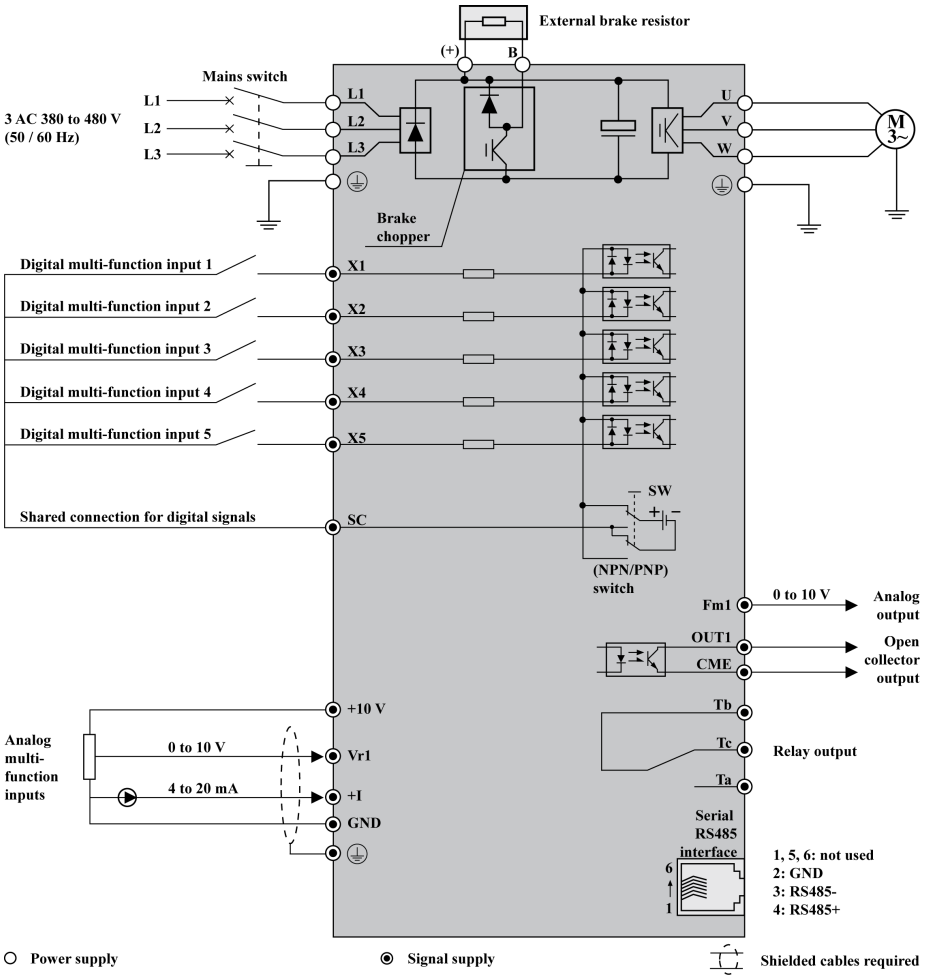



Fig.5-6: Block diagram (3AC)

It is recommended to use shielded cable to connect the motor.

## 5.5 Notes on Main Circuit Wiring

- Connect power supply only to the mains power supply terminals (L1, L2 and L3 for 3-phase; 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.
- Insulated crimp terminals must be used to connect terminals and conductors to ensure the reliability of connection.
- After wiring connection, remove all residual loose wires, which may fall into the frequency converter and cause a failure. Be careful not to allow swarf from drilling entering the frequency converter. Check the following points after the circuit connection is completed.
  1. Are all connections correct?
  2. Are there any missing connections?
  3. Do short circuits exist between terminals and wires or ground?
- To make changes in wiring, disconnect the power supply and wait for 10 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.

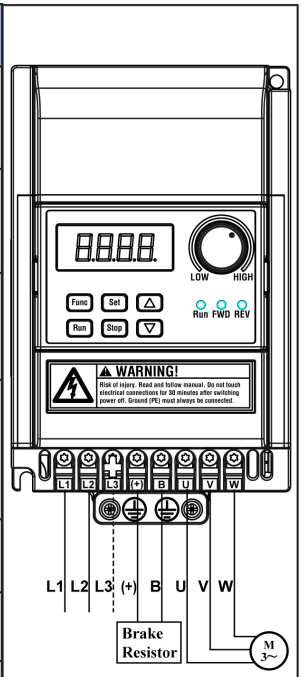
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☞ It is recommended to use shielded cables in accordance with specified EMC classification.

---

## 5.6 Main Circuit Wiring Diagram

| Name | 1-phase | 3-phase | Description |
|---|---|---|---|
| Power supply | L1 L2 | L1 L2 L3 | **Power supply**<br>Ensure that the power supply meets the rated values in this manual. |
| Fuse | | | **Fuse**<br>A frequency converter may take a high input current when being switched on. Please select an appropriate fuse.① |
| Electromagnetic contactor | | | **Electromagnetic contactor (MC)**<br>Do not use an MC as **Run/Stop** switch frequently. Ensure not exceed the frequency of once/15 minutes.② |
| AC input reactor | | | **AC input choke**<br>An AC input choke is recommended to improve power factors. The wiring length must be less than 10 m. |
| EMC filter | | | **EMC filter** |
| Frequency converter | N / N | | **Frequency converter**<br>See the figure on the right side for connections of other accessories. |
| AC output choke | | | **AC output choke**<br>When the connecting wire is longer than 50 m, an AC output choke is suggested to be added in order to avoid motor insulation destruction. |
| Motor | M 3~ | | **Motor** |




**Caution:**
**For a 1-phase 200 V frequency converter, terminal L3 is covered in the factory. It is not allowed to remove the cover.**

**Fig.5-7: Main circuit wiring diagram**

①: To select an appropriate fuse, please refer to fig. 5-12 "Fuse and cable dimensions" on page 35.

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

## 5.7 Main Circuit Terminals

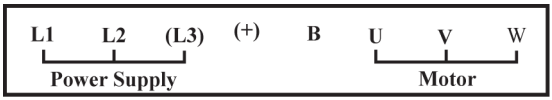



**Fig.5-8: Main circuit terminals (1x200 VAC)**

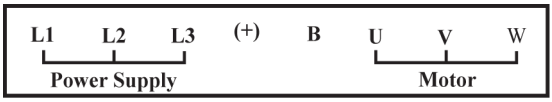



**Fig.5-9: Main circuit terminals (3x400 VAC)**

## 5.8 Main Circuit Terminals Description

| Terminal | Description |
|---|---|
| **1-phase 200 VAC 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 |
| ⏚ | Grounding and input PE |
| **3-phase 400 VAC 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 |
| ⏚ | Grounding and input PE |

**Fig.5-2: Main circuit terminals description**

- **Do not** use terminal L3 for 1P 200 VAC class models!
- Input PE terminals: located at bottom left of the heat sink ⏚.
- Grounding terminals: located at bottom right of the heat sink ⏚.

## 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 UL508A.



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. In table column “Nominal Current of Fuse [A]”, read corresponding information for fuse.



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.

| Power [kW] | Input side | | Output side | Screw torque for power cable terminals [Nm / lb-in] (screw size) | PE | |
|---|---|---|---|---|---|---|
| | Nominal current of Fuse [A] | Cable size [mm² / AWG] | Cable size [mm² / AWG] | | Cable size [mm² / AWG] | Torque [Nm / lb-in] (screw size) |
| 1-phase 200 VAC class | | | | | | |
| 0.4 | 10 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 0.75 | 16 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 1.5 | 20 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 2.2 | 25 | 3.5 / 12 | 3.5 / 12 | 1.2 / 10 (M4) | 6 / 8 | 1.2 / 10 (M4) |
| 3-phase 400 VAC class | | | | | | |
| 0.4 | 6 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 0.75 | 10 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 1.5 | 10 | 2.0 / 14 | 2.0 / 14 | 0.8 / 7 (M3) | 6 / 8 | 0.8 / 7 (M3) |
| 2.2 | 16 | 2.0 / 14 | 2.0 / 14 | 1.2 / 10 (M4) | 6 / 8 | 1.2 / 10 (M4) |
| 4.0 | 20 | 2.0 / 14 | 2.0 / 14 | 1.2 / 10 (M4) | 6 / 8 | 1.2 / 10 (M4) |

**Fig.5-3: Fuse and cable dimensions**

### 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).

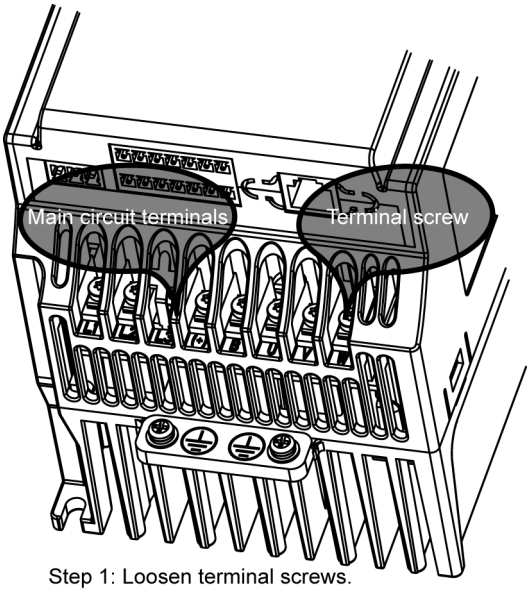
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- In the case of error (e.g. ground fault at connections L+, L-), fuses of characteristic **gL** (general-purpose fuse link for cables and lines) and **gG** (general-purpose fuse link for general installations) protect the **lines** in the frequency converter system.
- To **protect the semiconductors** in the input of supply units and frequency converters, you can use fuses of characteristic **gR**.

---

- USA/Canada: Class J; 600 V

## 5.10 Main Circuit Wiring Steps




Step 1: Loosen terminal screws.
Step 2: Place cables into screw holes.
Step 3: Tighten terminal screws.

**Fig.5-10: Main circuit wiring steps**

## 5.11 Notes on Control Circuit Wiring

- Terminal GND is the common terminal for analog signals, and SC is the common 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 circuits (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.

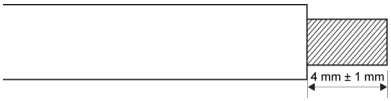



**Fig.5-11: Wire stripping length**

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

## 5.12 Control Circuit Terminals

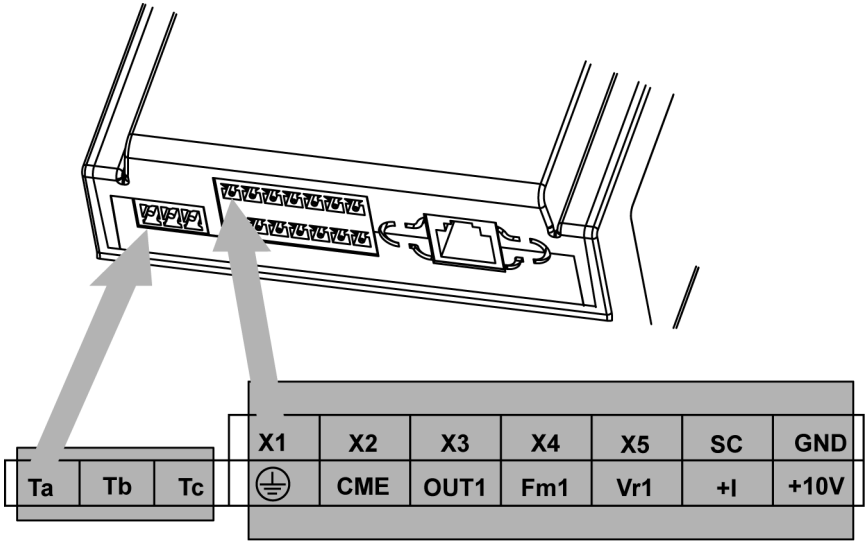



**Fig.5-12: Control circuit terminals**

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

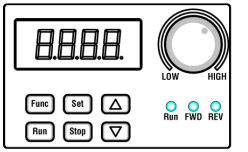
## 5.13 Control Circuit Terminals Description

| Type | Terminal | Signal function | Description | Signal requirement |
|---|---|---|---|---|
| Digital inputs | X1 ~ X5 | Multiple speed commands | Activated with “closed” | 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 set-point value specified | Power supply for speed commands | +10 V<br>(Max. current 30 mA) |
| | Vr1 | Analog frequency commands | Analog voltage input | Input voltage range:<br>0 ~ 10 V<br>Input resistance: 40 kΩ<br>Resolution: 1/1000 |
| | +I | | Analog current input | Input current range:<br>4 ~ 20 mA<br>Input resistance: 499 Ω<br>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:<br>DC 30 V, 50 mA |
| | Ta | Relay changeover contacts | Programmable relay output, see parameter [E1.02] | Rated capacity of contact transmitter:<br>250 VAC 3 A<br>30 VDC 3 A |
| | Tc | | | |
| | Tb | Relay shared contact | | |
| Analog outputs | Fm1-GND | Analog multi-function output 1 | Programmable analog output with multiple functions, see parameter [E1.30] | Output voltage:<br>0 ~ 10 V<br>Max. output current:<br>5 mA |

**Fig.5-4: Control circuit terminals description**

## 5.14 NPN / PNP Switch SW for the Digital Inputs

**Caution:**
**Switch OFF** the frequency converter before removal of the panel and switching NPN / PNP switch SW.




Remove the operating panel to see the NPN / PNP switch SW.

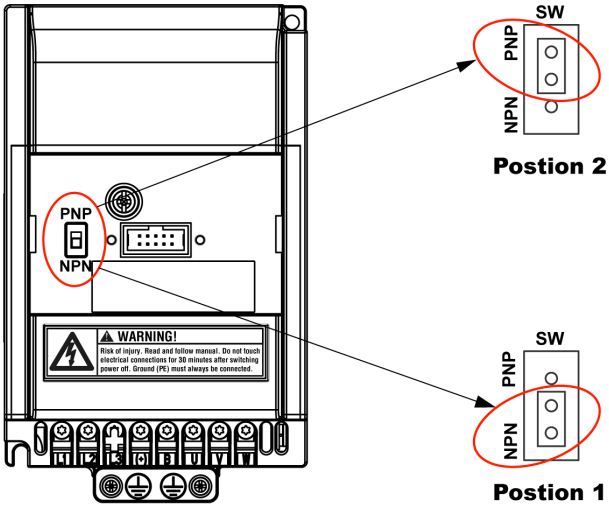



**Fig.5-13: NPN / PNP Switch SW for the Digital Inputs**

- The factory default setting is NPN.
- For disassembly and mounting of the operating panel, see chapter 14.4 "Operating Panel Removal and Mounting" on page 189.

## 5.15 NPN and PNP Modes

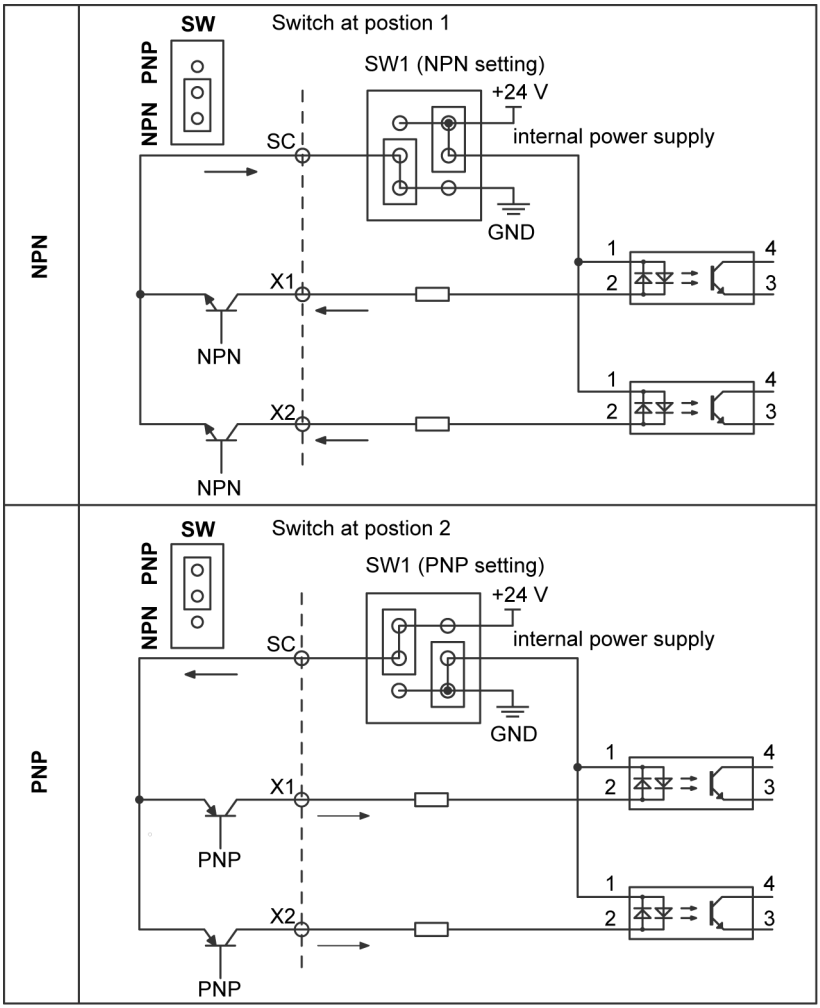



**Fig.5-14: NPN and PNP modes**

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

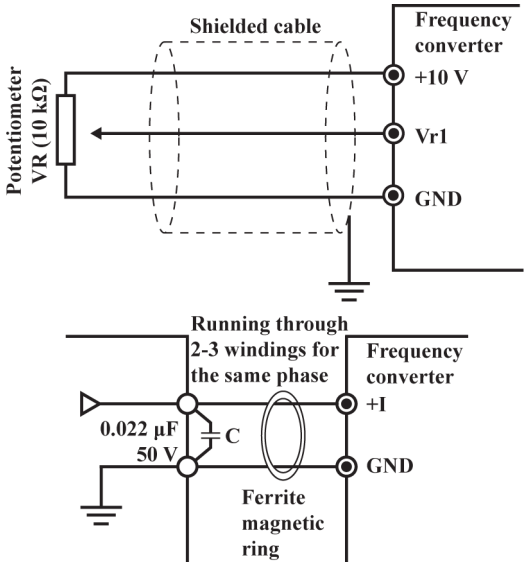



**Fig.5-15: Analog Input Terminals ( +10 V, Vr1, GND,+I )**

- 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 signal. In such cases, connect a capacitor and ferrite core at the output side of the analog signal, as shown above.

## 5.17 Recommendations on Control Circuit Wiring

0.2 ~ 1.5 $mm^2$ cables are recommended for wiring of the control circuit.

## 5.18 Control Circuit Wiring Steps

**Step 1: Press the white button of the connector.**

**Step 2: Place the prepared control wire into the connection hole.**

**Step 3: Stop pressing of the white button.**

**Step 4: Repeat Step 1 to Step 3 to connect all the necessary wires**

**Step 5: Push the connector into the control terminals socket.**

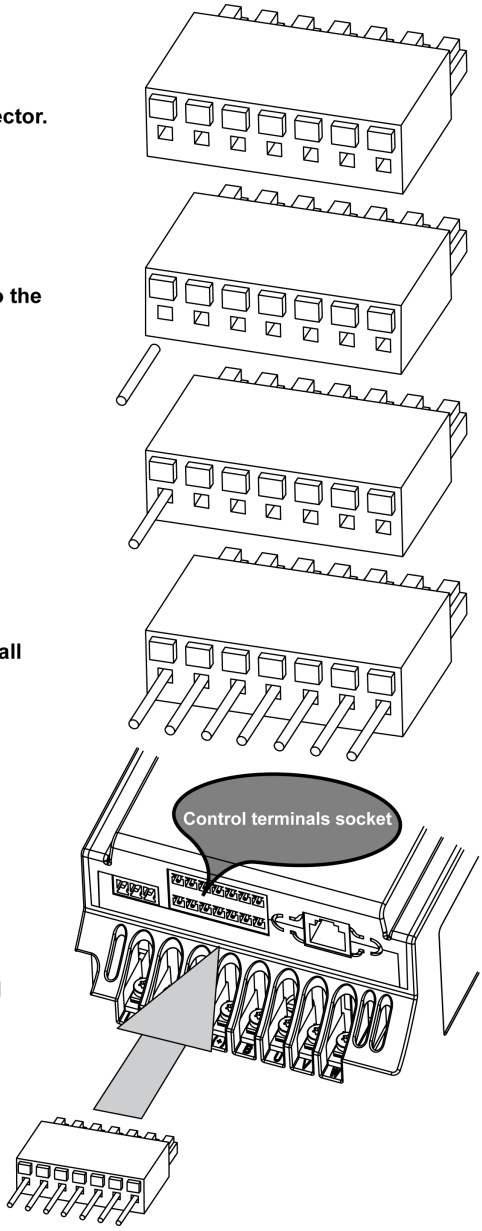



Fig.5-16: Control Circuit Wiring Steps

# 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.

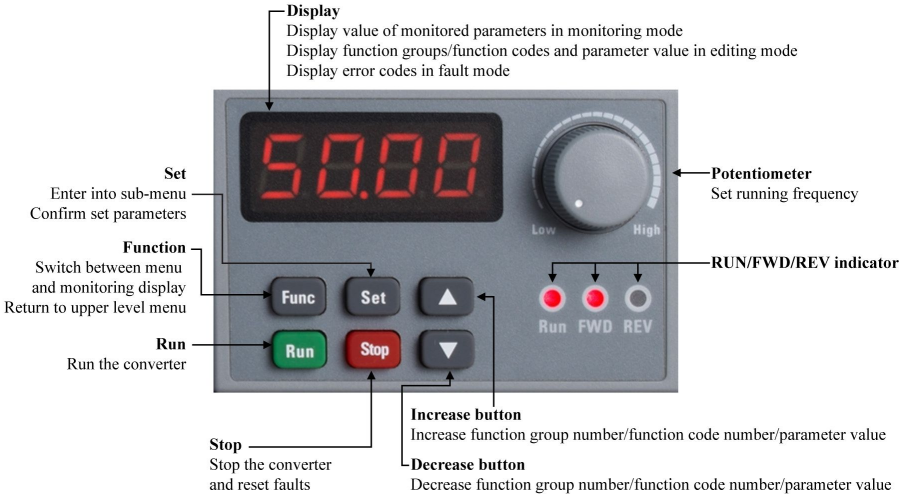



**Fig.6-1: Operating panel**

## 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

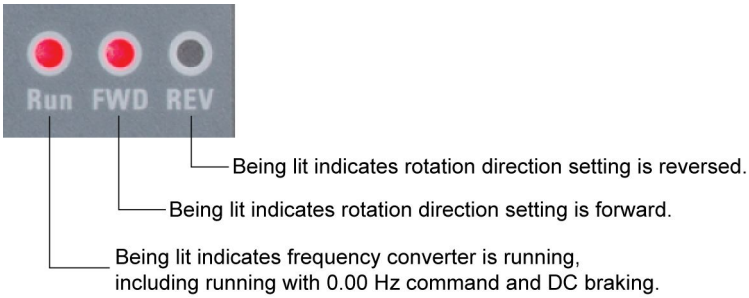



**Fig.6-3: LED indication description**

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

## 6.4 Menu Structure

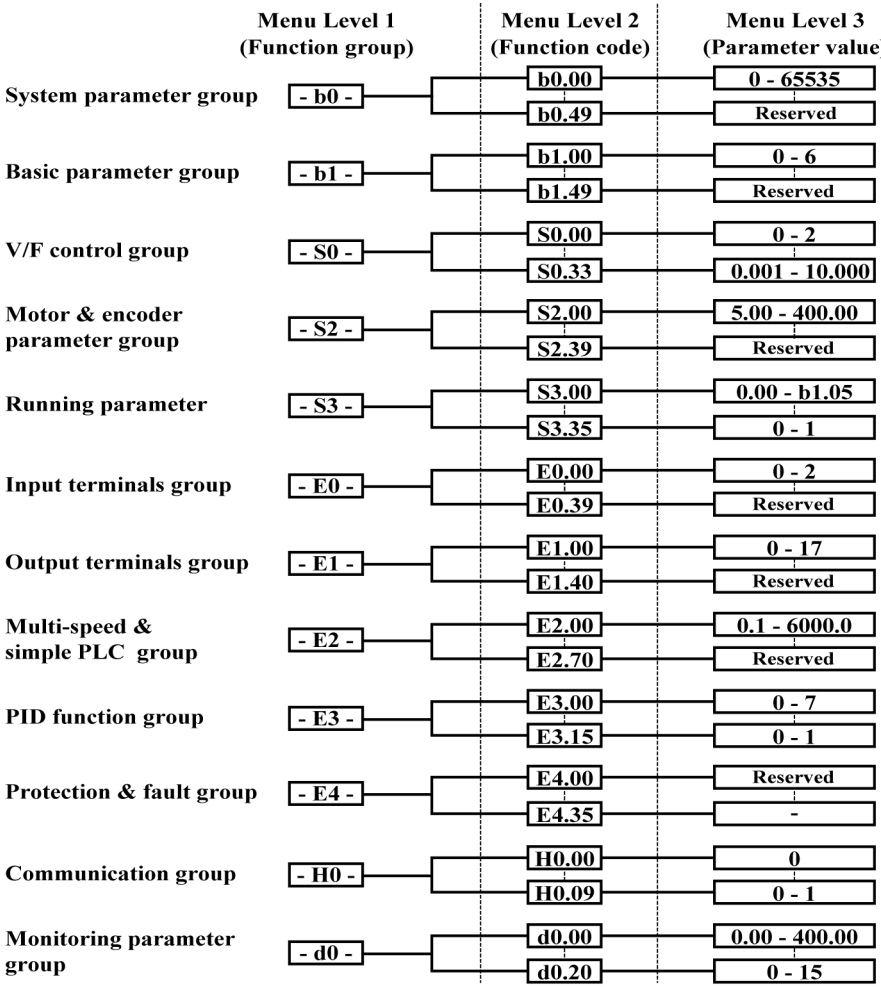



Fig.6-4: Menu structure

- 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 Example of Operating Panel Operation

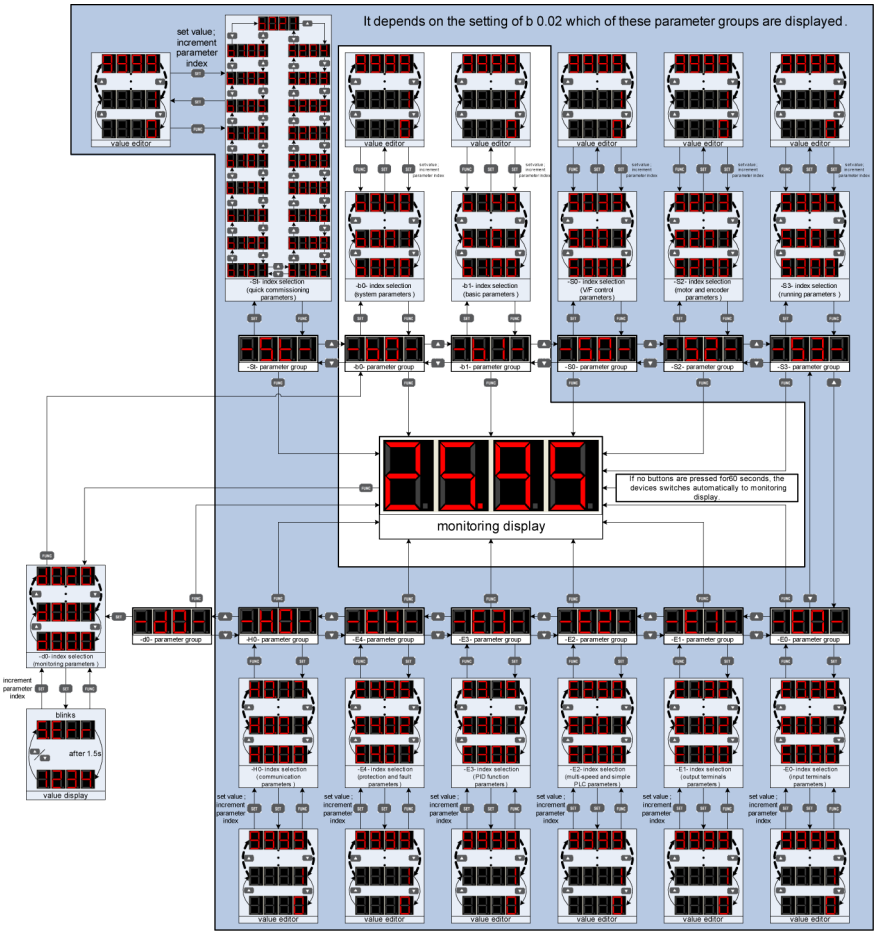



Fig.6-5: Example of operating panel operation

# 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 10 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, until 5.00 is displayed | The motor starts to run |
| 4 | Observe:<br>• Whether the motor runs in the correct direction<br>• Whether the motor runs smoothly<br>• Whether there is any abnormal noise or problem | Observe the running, and immediately stop the motor by shutting off the power if any abnormality occurs. Restart commissioning only after the fault causes have been removed |
| 5 | Rotate the potentiometer clockwise (rightwards) | The motor accelerates |
| 6 | Rotate the potentiometer counterclockwise (leftwards) | The motor decelerates |
| 7 | Press **Stop** key | When commissioning is complete, the command for stopping is activated. The frequency converter is ready for normal operation. |

**Fig.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 the control through terminals is selected), the frequency converter will give output.
- By factory default, EFC 3600 is set as:
  - The frequency converter is started or stopped via 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.
- The frequency converter initially displays output frequency after being energized. You may change it to another parameter as instructed in [b0.30] and [b0.31]. The factory defaults are based on standard applications with standard motors.

## 7.3 EFC 3600 Basic Parameter 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 parameter fast setting table is given below.



- Set [b0.02]=4 with **Func** and **Set** keys to show "-St-" group.
- For parameter attributes, see chapter 17.2.1 "Description of Attribute Symbols in Parameter Tables" on page 195.

| 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] | Lowest frequency | 0.00 ~ [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 ~ 6000.0s | 0.1s | 5.0s | Run/Stop |
| [b1.21] | Deceleration time 1 | 0.1 ~ 6000.0s | 0.1s | 5.0s | Run/Stop |
| [b1.22] | Acceleration/deceleration curve mode | 0 ~ 1 | 1 | 0 | Stop |
| [b1.30] | Starting mode | 0 ~ 2 | 1 | 0 | Stop |
| [b1.40] | Stopping mode | 0 ~ 2 | 1 | 0 | Stop |
| [S0.00] | V/F curve mode | 0 ~ 2 | 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 ~ 30000 rpm | 1 rpm | Depending on model | Stop |
| [S2.02] | Rated motor power | 0.1 ~ 1000.0 kW | 0.1 kW | Depending on model | Stop |

| Function code | Name | Setting range | Min. unit | Factory default | Attributes |
|---|---|---|---|---|---|
| [S2.03] | Rated motor voltage | 0 ~ 480 V | 1 V | Depending on model | Stop |
| [S2.04] | Rated motor current | 0.1 ~ 1000.0 A | 0.1 A | Depending on model | Stop |

**Fig.7-2: Basic parameter 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.

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

**Fig.7-3: Factory defaults**

## 7.5 Solutions for Simple Faults during Commissioning

| Simple faults | 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) |

**Fig.7-4: Solutions for simple faults during commissioning**

# 8 Parameter Settings

## 8.1 Group b0: System Parameters

| 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 password**: enter the correct user password and set [b0.00]=0 to deactivate the password.



- Once a user password is set, users may only read but not modify nor copy parameters if an incorrect password is entered.
- Please contact the manufacture if you forget the set 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 |

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

- 0: Basic parameters. In this mode, only parameters in group b (b0 and b1) are visible.

Parameter Settings

- 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 |
| [b1.04] | Digital set frequency |
| [b1.05] | Max. frequency |
| [b1.06] | Upper frequency |
| [b1.07] | Lowest 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 |

**Fig.8-1: Parameters in start-up mode**



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

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

Used to restore parameters to factory defaults. Recent 3 faults and the last fault related variables are recorded for further fault review. They can be deleted if necessary.

- 0: No action
- 1: Restore to factory defaults.

  All parameters except [S2.00] ~ [S2.15] (motor parameters), [E4.20 ]~ [E4.22], [E4.30] ~ [E4.35] (error messages), [b0.40] (system running time) are restored to factory defaults.
- 2: Remove error records

  Clearing parameters [E4.20] ~ [E4.22], [E4.30] ~ [E4.35].



After the 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 |

- 0: No action
- 1: Read parameter

  All except read-only parameters* are copied from the frequency converter to the operating panel.
- 2: Write parameter

  All except read-only parameters* 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.
- All operations are invalid during parameter replication.

Parameter Settings

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

Used for analog output function selection "terminal output voltage". Analog output voltage 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 parameter [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. Also 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 145.



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

Set [b0.21] ≥10 ("Max. frequency" [b1.05]).

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

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

| b0.30 | Running monitoring display |
|---|---|
| Setting range | 0 ~ 20 |
| Minimum unit | 1 |
| Factory default | 0 |
| **b0.31** | **Stop monitoring display** |

| | |
|---|---|
| Setting range | 0 ~ 20 |
| 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 AIV
- 9: Analog input AIC
- 10: User-defined set frequency
- 11: User-defined output frequency
- 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

| **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**

Parameter Settings

[d0.10]=[d0.02] x [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] x [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]=PID reference x [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 1000.0 and 9999.9, 1000 ~ 9999 is displayed without the display of the decimal point.
- If the display value is not less than 10000, 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.".

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

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

| 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 operating panel's potentiometer

- 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 [b1.01].

- 2: Given by external analog 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 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 via 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]).

Parameter Settings

– 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 |

With this parameter, the digital settings via ▲/▼ may be automatically saved at power off or stop.

- 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 via panel

  Using keys **Run** and **Stop** on the panel to run and stop the frequency converter.
- 1: Inputting commands via 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 via communication

  Running, stopping, forwarding or reversing of the frequency converter are controlled via communication. See chapter 13 "Communication Protocols" on page 172.

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 ~ [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 ~ [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 ~ [b1.07] |
| Minimum unit | 0.01 |
| Factory default | 0.00 |

Two running modes are available when the lowest 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: Run 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.

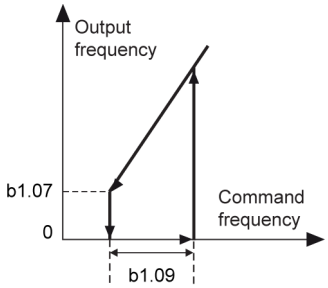



**Fig.8-1: [b1.08]=0**

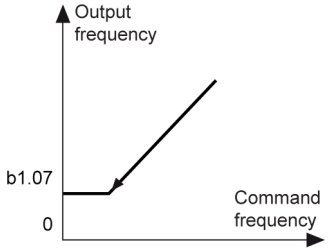



**Fig.8-2: [b1.08]=1**

| 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 (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 shows up.
- 2: Reverse only. When forward rotation command is active, the frequency converter will stop immediately and the error shows up.
- 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 via the operating panel.

- 0: Forward rotation
- 1: Reverse rotation

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

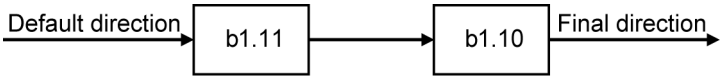



**Fig.8-3: Relationship between [b1.10] and [b1.11]**

| 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 128.

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 |

Parameter Settings

| Frequency source | RUN / STOP command source | Direction command source |
|---|---|---|
| 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 of the frequency command sources 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 (when [b1.15] is set to 2]) or larger than [b1.06] (when [b1.15] is set to 1). So the combined frequency is limited to the range of 0.00 Hz ~ [b1.06].

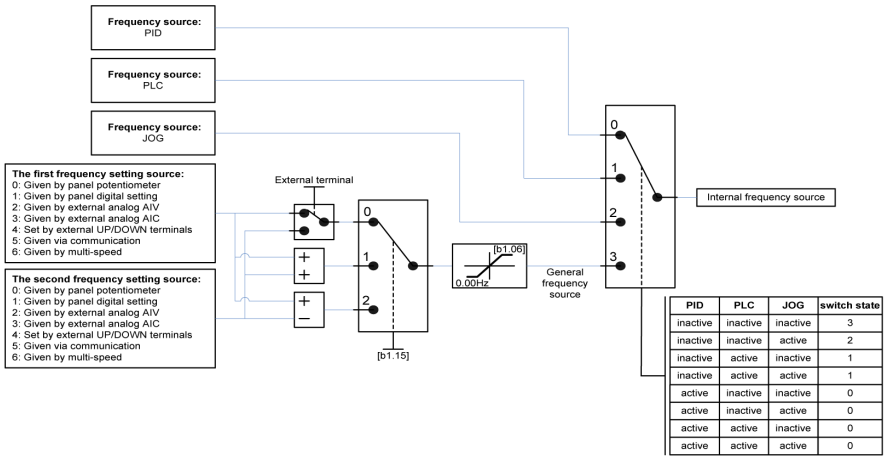



**Fig.8-4: Priority of frequency source**

- When the combination of two resources is inactive:

  The two frequency resources can be switched via external terminal ([E0.01] ~ [E0.05]=18), for more details, please 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 AIV
- 3: Given by external analog AIC
- 4: Set by external UP / DOWN terminals
- 5: Given via communication
- 6: Given by multi-speed

This parameter is similar to [b1.00], please see descriptions in [b1.00].

Parameter Settings

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

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

| b1.20 | Acceleration time 1 |
|---|---|
| Setting range | 0.1 ~ 6000.0s |
| Minimum unit | 0.1s |
| Factory default | 5.0s |
| **b1.21** | **Deceleration time 1** |
| Setting range | 0.1 ~ 6000.0s |
| Minimum unit | 0.1s |
| Factory default | 5.0s |

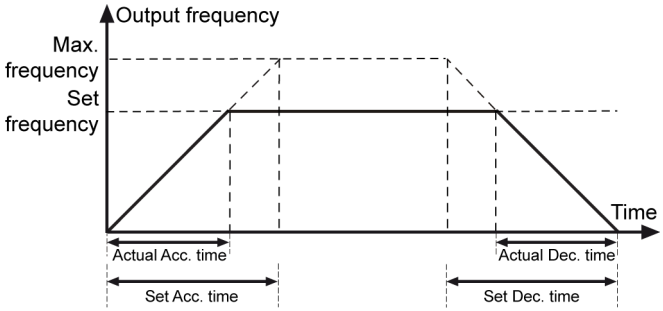



**Fig.8-5: Acc. / Dec. time**

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 via 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 % |

Used to set the acceleration / deceleration mode of the frequency converter to linear curve 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.

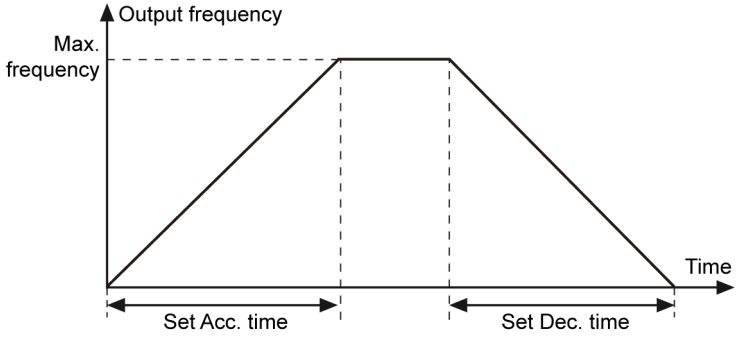



**Fig.8-6: Linear mode**

- [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.

Parameter Settings

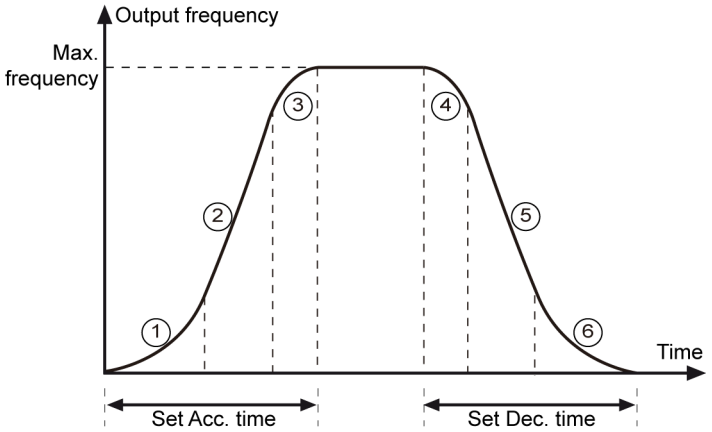



**Fig.8-7: S-curve**

- 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.

| | |
|---|---|
| **b1.25 ~ b1.29** | **Reserved** |
| **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 % (Rated frequency converter current) |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |

- [b1.30]=0: Start directly

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

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

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

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

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

☞ 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 x % of rated motor current.

Example: For a frequency converter of 0.75 kW / 200 V, the rated current is 3.9 A, the motor rated current is 3.45 A, when [b1.34] input is 100%, this parameter will activate the limitation function as the above described rule.

Parameter Settings

| b1.35~b1.39 | Reserved |
|---|---|
| **b1.40** | **Stopping mode** |
| Setting range | 0 ~ 2 |
| Minimum unit | 1 |
| Factory default | 0 |

- 0: Deceleration to stop

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

---

☞
- If a fault happens due to too fast deceleration, extend the deceleration time or calculate if additional brake choppers / resistors are required.
- If the frequency is lower than the "Stopping DC braking initial frequency" [b1.41] and "DC braking time" [b1.42]≠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 in 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 (deceleration time and stopping DC braking if necessary) 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 be disabled immediately and freewheel to stop, no matter its previous state. The frequency converter will only return to the running state when a run command is active and then the digital input goes inactive. 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 % (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≤[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.

Parameter Settings

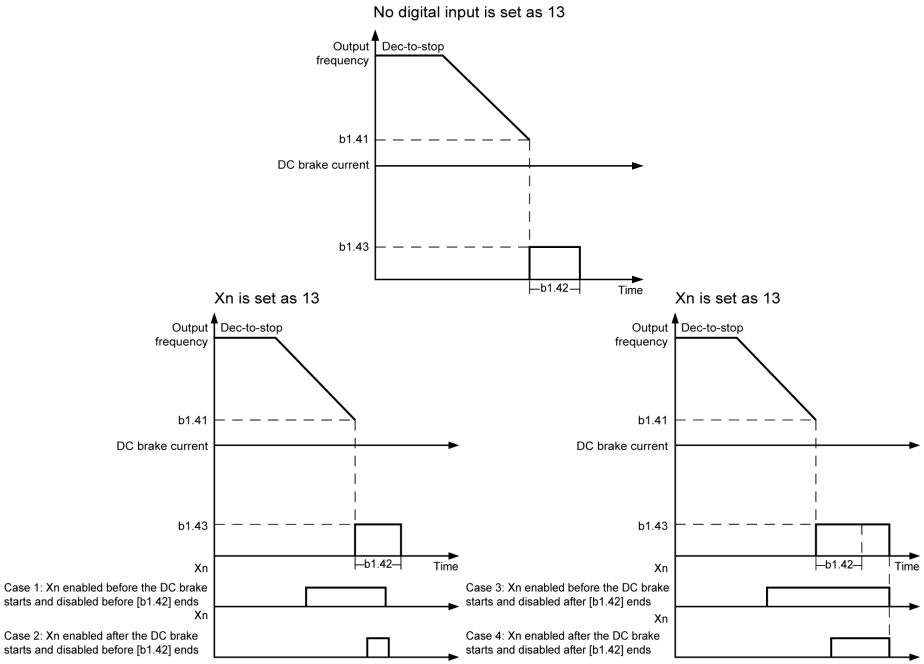



**Fig.8-8: Stopping DC braking**

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 |

“Overexcitation deceleration gain” is a gain to the V/F pattern needed for fine-tune of this function which determines the level of overexcitation.

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

| b1.46~b1.49 | Reserved |
|---|---|

## 8.3 Group S0: V/F control

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

- 0: Linear curve

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

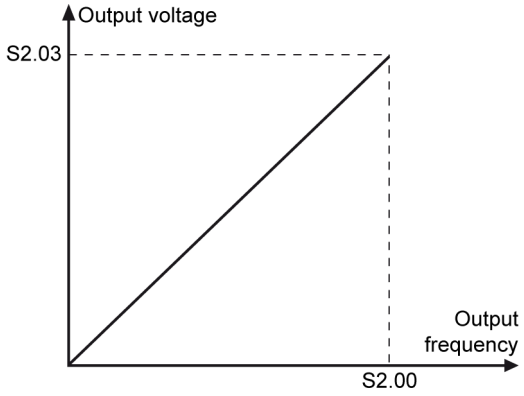



**Fig.8-9: Linear curve**

- 1: Square curve

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

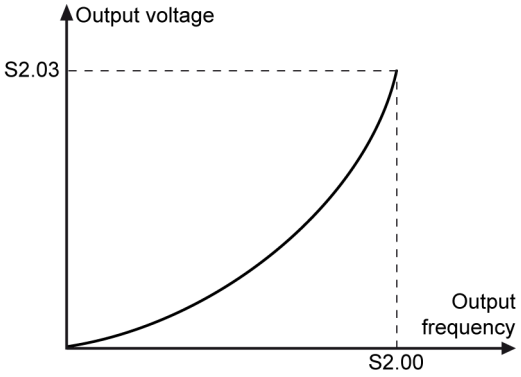



**Fig.8-10: Square curve**

- 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.

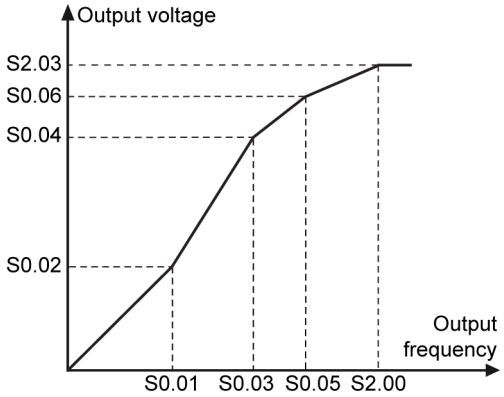



**Fig.8-11: User-defined multipoint curve**

**⚠ WARNING**

**Excessive low-frequency voltages may cause the motor to overheat and be destroyed, and the frequency converter may stall due to overcurrent or activate overcurrent protection!**

| S0.01 | V/F frequency 1 |
|---|---|
| Setting range | 0.00 ~ [S0.03] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |
| **S0.02** | **V/F voltage 1** |
| Setting range | 0.0 % ~ 120.0 % (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 % (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 % (Rated motor voltage) |
| Minimum unit | 0.1 % |
| Factory default | 0.0 % |

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

0 ≤ V/F frequency 1 ≤ V/F frequency 2 ≤ V/F frequency 3 ≤ Motor rated frequency

It is necessary to have voltages 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:

Parameter Settings

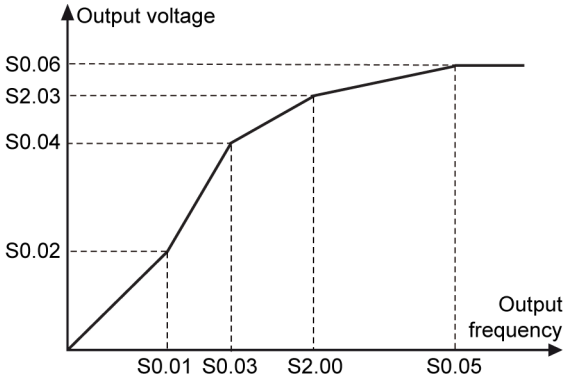



**Fig.8-12: [S0.05] "V/F frequency 3" above [S2.00] "motor rated frequency"**

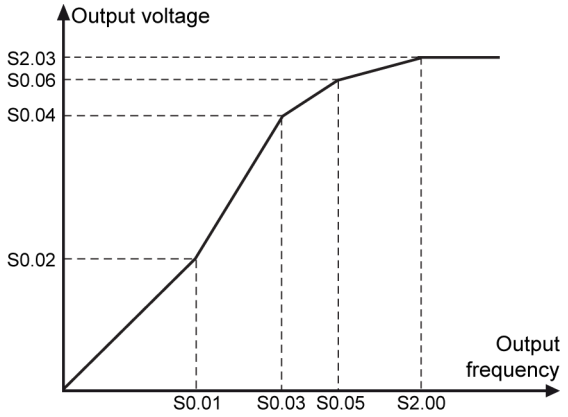



**Fig.8-13: [S0.05] "V/F frequency 3" below [S2.00] "motor rated frequency"**

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

| **S0.07~S0.19** | **Reserved** |
|---|---|
| **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 and improve the mechanical behavior of the motor, as shown in the figure below:

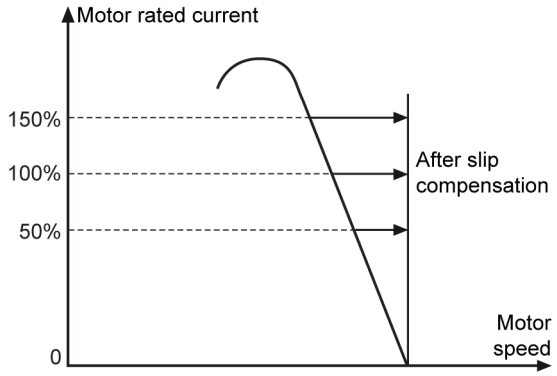



**Fig.8-14: Slip frequency compensation**

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 formular 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.8-15: 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 % (Rated motor voltage) |
| Minimum unit | 0.1 % |
| Factory default | 5.0 % |

Parameter Settings

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. This voltage boost is dependent on the corresponding parameters.

- [S0.21]=0.1 % ~ 20.0 %: manual torque 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 torque boost function is only valid before 25.00 Hz.

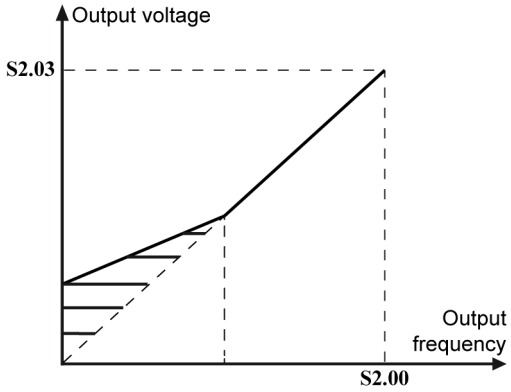



**Fig.8-16: Linear V/F curve manual torque increase**

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

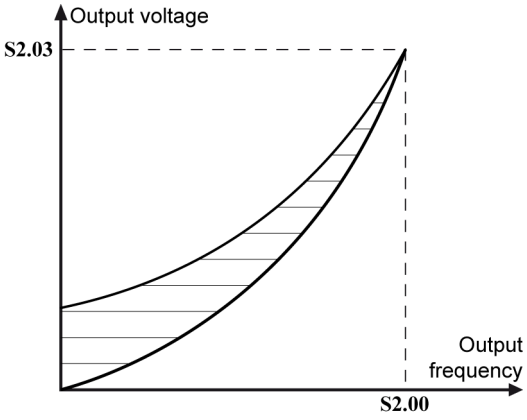



**Fig.8-17: Square V/F curve manual torque increase**

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

- [S0.21]=0.0 %: automatic torque boost

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

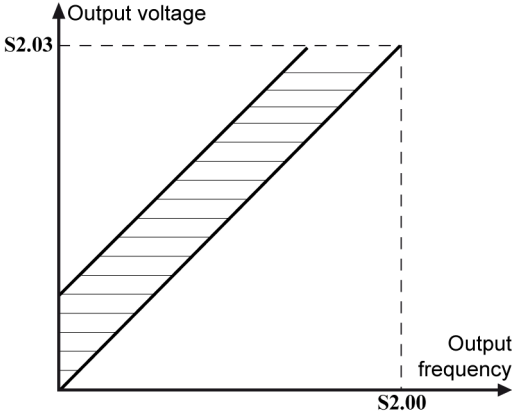



**Fig.8-18: Linear V/F curve auto torque boost**

Parameter Settings

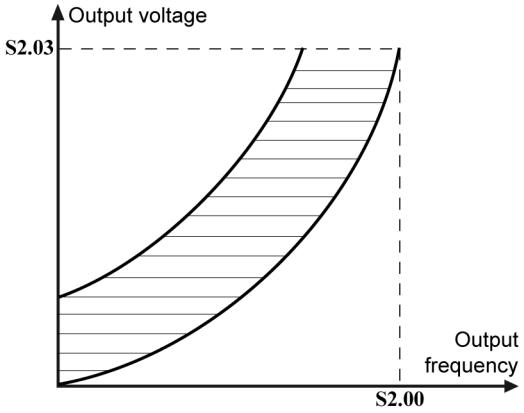



**Fig.8-19: Square V/F curve auto torque boost**

| S0.22 | I*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:

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

**Fig.8-20: 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, which are caused by bigger impact to DC bus voltage in case of heavy load.

| S0.30 | Current limitation control |
|---|---|
| Setting range | 0: OFF<br>1: OFF at constant speed<br>3: ON at constant speed |
| Minimum unit | 1 |
| Factory default | 0 |
| **S0.31** | **Automatic current limitation level** |
| Setting range | 20 % ~ 250 % (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 can be selected:

- [S0.30]=0: OFF.

  Current limitation control will not be disabled in any case.

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

  Current limitation control works during Acc. and Dec., but does not work 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 factor and I factor.

- The higher set value of proportion factor [S0.32], the faster the current change will be.
- The higher set value of I factor [S0.33], the less accuracy of current suppression.

- The default value of [S0.32] and [S0.33] can satisfy most applications, if slight modification is needed, please try to increase Proportion factor first to make sure there is no oscillation, 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 parameter will not be changed.

## 8.4 Group S2: Motor and Encoder 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 ~ 30000 rpm |
| Minimum unit | 1 rpm |
| Factory default | Depends on model |
| **S2.02** | **Rated motor power** |
| Setting range | 0.1 ~ 1000.0 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 |
| **S2.10** | **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 ~ 3000.0 mH |
| Minimum unit | 0.1 mH |
| Factory default | Depends on model |
| **S2.14** | **No-load current** |
| Setting range | 0.00 ~ [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 |

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

- [S2.15]=0: No action.
- [S2.15]=1: Calculation. After the calculation is finished, 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.

| | |
|---|---|
| **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 |

Parameter Settings

| | |
|---|---|
| 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 |

Used to protect the motor against overheat. There are two means of motor thermal protections.

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.

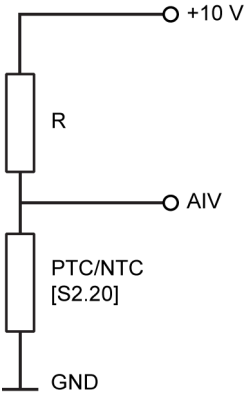



**Fig.8-21: Protection with temperature sensor**

- 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 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 motor is shown as below:

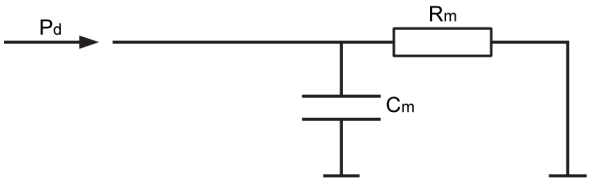



**Fig.8-22: Simplified thermal model of motor with PT1 model**



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 not exceeds 110 % of the motor rated current, and increase the value of [S2.23] appropriately.

## 8.5 Group S3: Running Parameters

| S3.00 | Jogging frequency |
|---|---|
| Setting range | 0.00 ~ [b1.05] |
| Minimum unit | 0.01 Hz |
| Factory default | 5.00 Hz |
| **S3.01** | **Jogging acceleration time** |
| Setting range | 0.1 ~ 6000.0s |
| Minimum unit | 0.1s |
| Factory default | 5.0s |
| **S3.02** | **Jogging deceleration time** |
| Setting range | 0.1 ~ 6000.0s |
| Minimum unit | 0.1s |
| Factory default | 5.0s |

- 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 in [S3.01] and [S3.02] no matter the frequency converter is in RUN mode or STOP mode. See more details in the figure below:

Parameter Settings

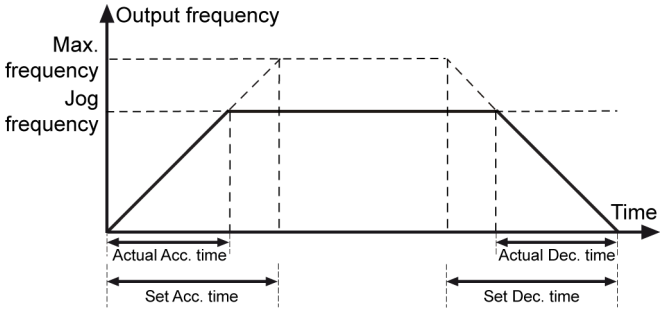



**Fig.8-23: Jogging Acc. / Dec. time**

- 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 activated during jogging reverse / forward, the frequency converter will STOP according to [b1.40] “Stopping mode”.

| 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 |

To avoid the mechanical resonance, this function is implemented to define 3 skip frequencies. 3 skip frequencies are supported as shown in the figure below:

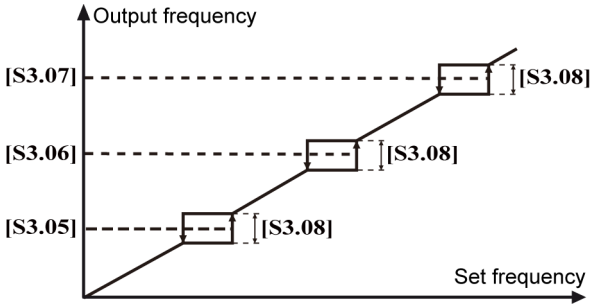



**Fig.8-24: Skip frequency and range**

- If 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 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 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 |

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

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

| S3.15 | Restarting after power fault |
|---|---|
| Setting range | 0 ~ 1 |
| Minimum unit | 1 |
| Factory default | 0 |

Parameter Settings

| S3.16 | Waiting time for restarting after power fault |
|---|---|
| Setting range | 0.0 ~ 10.0s |
| Minimum unit | 0.1s |
| Factory default | 1.0s |

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

  When other RUN command source is selected ([b1.02]≠0):
  - [S3.15]=1: the frequency converter will automatically start after waiting for the time of [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 before power off due to 3 wire control, then after power on, the restart of frequency converter will be decided by the statue of this 3-wire terminal sine it is responsible for STOP.
- If the frequency converter was running before power off due to a power supply interference, UE-1 will occur by 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 more 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.

| S3.20 | Brake chopper action point |
|---|---|
| Setting range | 200 V class: 300 ~ 390 V<br>400 V class: 600 ~ 885 V |
| Minimum unit | 1 V |
| Factory default | 200 V class: 390 V<br>400 V class: 885 V |
| S3.21 | Braking ratio |

| | |
|---|---|
| Setting range | 1 % ~ 100 % |
| Minimum unit | 1 % |
| Factory default | 100 % |
| **S3.30** | **Forward and reverse rotation dead zone time** |
| Setting range | 0.0 ~ 60.0s |
| Minimum unit | 0.1s |
| Factory default | 4.0s |

[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:

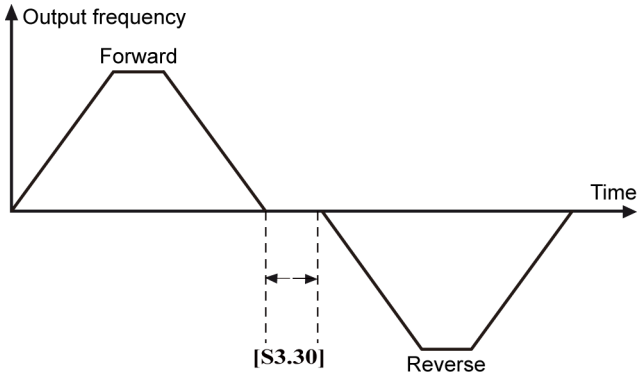



**Fig.8-25: Forward and reverse rotation dead zone time**

| | |
|---|---|
| **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 ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 0.00 Hz |

Used to change the output frequency. When [b1.00] or [b1.16] is set to 4, the UP / DOWN control is activated as the command value. 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.

Parameter Settings

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.

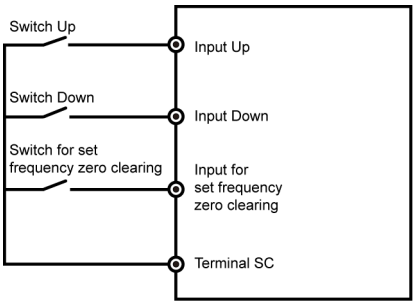



**Fig.8-26: External terminals Up / Down settings**

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 via UP / DOWN terminals will or not be saved after power off depends on 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 | Stop by Stop key |
|---|---|
| Setting range | 0: Only valid for operating panel control<br>1: Valid for all control means |
| Minimum unit | 1 |
| Factory default | 1 |

## 8.6 Group E0: Input Terminal Parameters

| 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

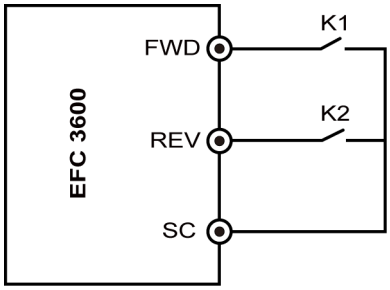



Fig.8-27: 2-wire control_1

| 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 [b1.40] and both directions LEDs (FWD and REV) are switched on.

Parameter Settings

- [E0.00]=1: Forward / Reverse, RUN / STOP

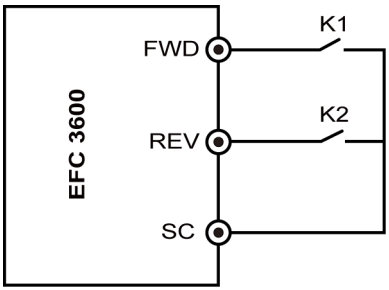



**Fig.8-28: 2-wire control_2**

| 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:

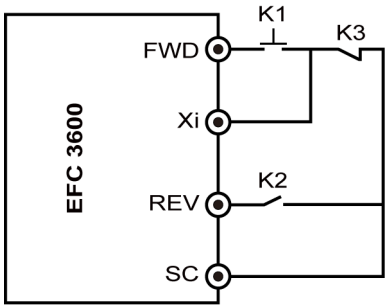



**Fig.8-29: 3-wire control**

– 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 |

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 3 terminals.

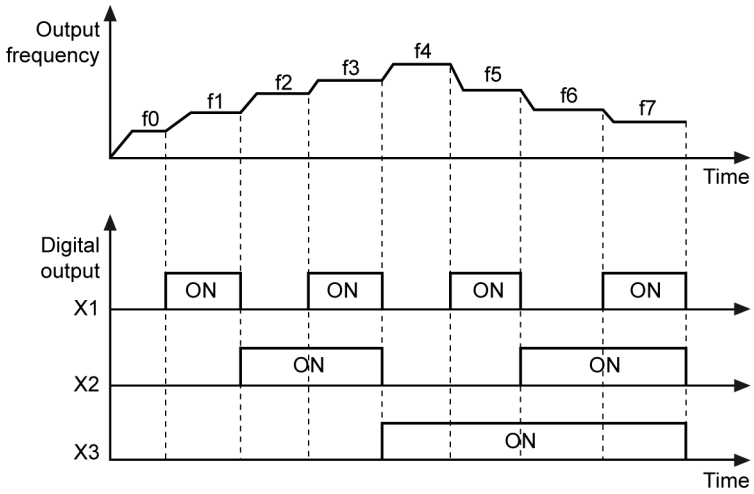



**Fig.8-30: Given by multi-speed**

| 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] |

**Fig.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])<br>Deceleration time 1 is selected ([b1.21]) |
| Inactive | Active | Acceleration time 2 is selected ([E2.00])<br>Deceleration time 2 is selected ([E2.01]) |
| Active | Inactive | Acceleration time 3 is selected ([E2.02])<br>Deceleration time 3 is selected (E2.03]) |
| Active | Active | Acceleration time 4 is selected ([E2.04])<br>Deceleration time 4 is selected ([E2.05]) |

**Fig.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 with 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 more 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 freewheeling to stop. While if this terminal is switched off, 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 |

Parameter Settings

| [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; when the terminal is switched off, 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, the new frequency command is accepted and the frequency converter accelerates / decelerates to the new frequency command.
- 19: External fault N.O. contact input
- 20: External fault N.C. contact input

  An external fault 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 fault N.O. contact input” and “External fault 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 keyboard error reset function does, which allows remote fault 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.

- 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].

| **E0.10** | **Analog input voltage (AIV) channel gain k1** |
|---|---|
| Setting range | 0.00 ~ 10.00 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |
| **E0.12** | **Analog input current (AIC) channel gain k3** |
| Setting range | 0.00 ~ 10.00 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |
| **E0.15** | **Analog channel filtering time** |
| Setting range | 0.000 ~ 2.000s |
| Minimum unit | 0.001s |
| Factory default | 0.100s |
| **E0.20** | **Analog setting curve selection** |

Parameter Settings

| | |
|---|---|
| Setting range | 0 ~ 3<br>0: AIC-reference characteristic curve 1, AIV-reference characteristic curve 1<br>1: AIC-reference characteristic curve 1, AIV-reference characteristic curve 2<br>2: AIC-reference characteristic curve 2, AIV-reference characteristic curve 1<br>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 ~ [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 ~ [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 ~ [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 ~ [b1.06] |
| Minimum unit | 0.01 Hz |
| Factory default | 50.00 Hz |

The frequency converter actually 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:

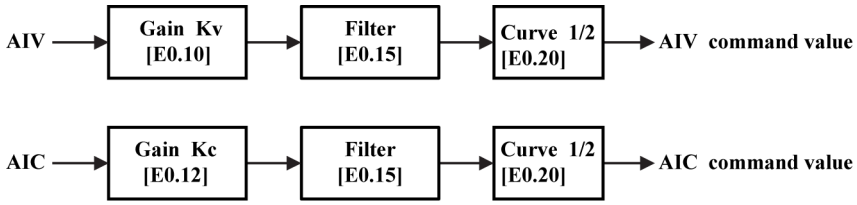



**Fig.8-31: Relationship between reference channel and set frequency**

- 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:

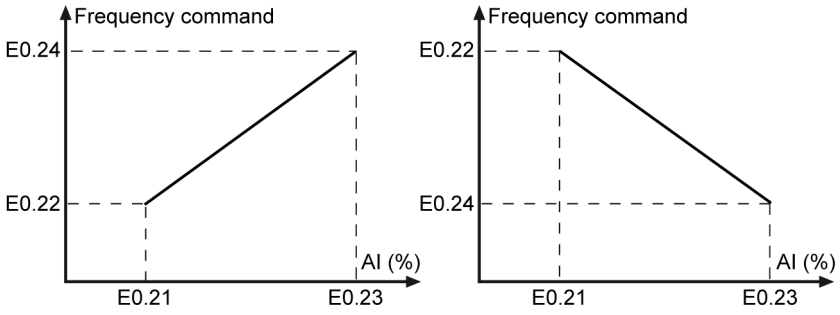



**Fig.8-32: Characteristics curve 1**

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

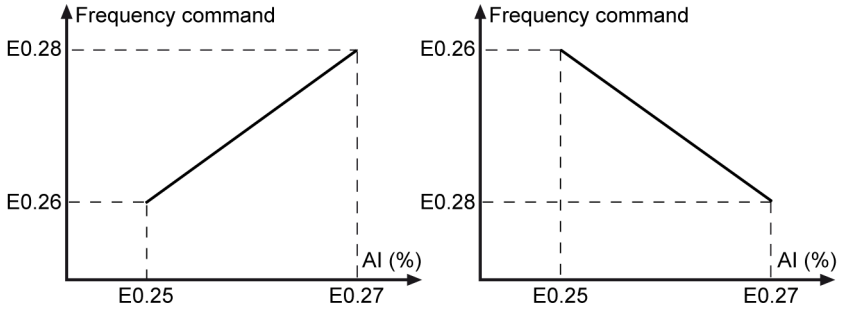



**Fig.8-33: Characteristics curve 2**

## 8.7 Group E1: Output Terminal Parameters

| E1.00 | OC outputs |
|---|---|
| Setting range | 0 ~ 17 |
| Minimum unit | 1 |
| Factory default | 1 |
| **E1.02** | **Relay outputs** |
| Setting range | 0 ~ 17 |
| Minimum unit | 1 |
| Factory default | 1 |

- 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].

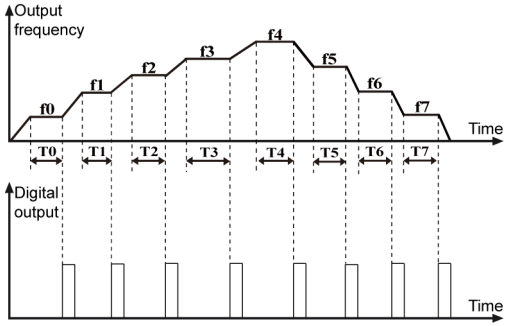



**Fig.8-34: Simple PLC phase completion indication**

---

☞ If the running time of one of the stages is so short that it is finished 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].

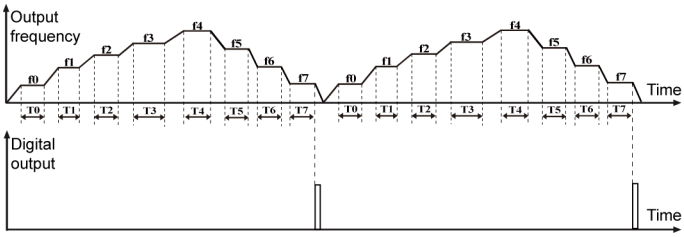



**Fig.8-35: [E2.30]=1, 2 or 3**

Parameter Settings

- 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 fault

  This signal is activated when the error "E-St" is generated, and deactivated when the error is reset. If the frequency converter stops because of the external fault, output is active. For "E-St", see "External digital input" group.
- 14: Fault 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 until next pulse arrives.
- 17: Middle counter value reached

  When number of input pulse equals to the setting value defined in [E1.13], the output is active until the next pulse after setting counter value comes.

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

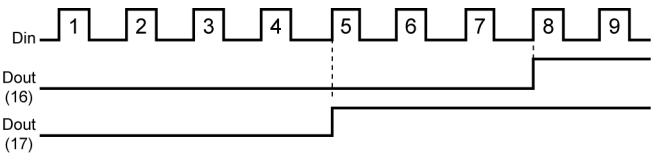



**Fig.8-36: Middle counter value reached**

| 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:

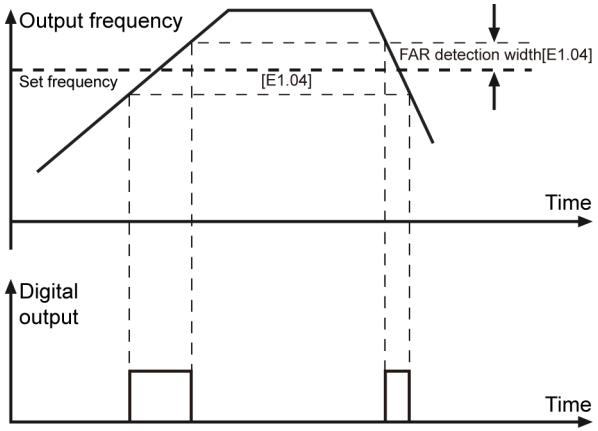



**Fig.8-37: Frequency arriving at detection width**

| | |
|---|---|
| **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 ~ [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 ~ [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 before

the output frequency is lower than the value set by "([E1.05] or [E1.07]) - (E1.06] or [E1.08])".

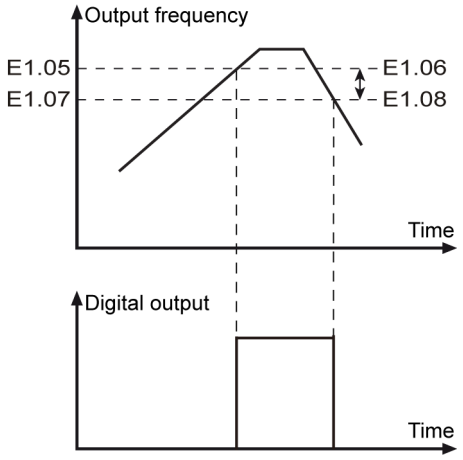



**Fig.8-38: Frequency detection level**

| E1.09 | Frequency converter overload pre-warning level setting |
|---|---|
| Setting range | 20.0 % ~ 200.0 % (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 % (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].

| 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 |

The corresponding digital output for "Middle / Target count value reached" should be configured, see more 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 until 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 switched to be 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.

| 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** |

Parameter Settings

| | |
|---|---|
| Setting range | 0.00 ~ 10.00 |
| Minimum unit | 0.01 |
| Factory default | 1.00 |

- [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, refers to 0 ~ max. frequency [b1.05]

  [E1.30]=1: Setting frequency. 0 ~ 10 V / 2 ~ 10 V, refers to 0 ~ max. frequency [b1.05]

  [E1.30]=2: Output current. 0 ~ 10 V / 2 ~ 10 V, refers to 0 ~ 2 x (rated current)

  [E1.30]=3: Reserved

  [E1.30]=4: Output voltage. 0 ~ 10 V / 2 ~ 10 V, refers to 0 ~ 1.2 x (rated voltage*)

  [E1.30]=5: Output power. 0 ~ 10 V / 2 ~ 10 V, refers to 0 ~ 1.2 x (rated power)

  [E1.30]=6: AIV. 0 ~ 10 V / 2 ~ 10 V, refers to 0 ~ 10 V

  [E1.30]=7: AIC. 0 ~ 10 V / 2 ~ 10 V, refers to 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

| E2.00 | Acceleration time 2 |
|---|---|
| Setting range | 0.1 ~ 6000.0s |
| 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" | |
| E2.10 | Multi-speed frequency 1 |
| Setting range | 0.00 ~ [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" | |

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 via multi-speed control terminals, together with forward / reverse control terminal (FWD-CM and REV-CM) and acceleration / decelera-

tion terminals. For multi-speed control, the acceleration time / deceleration time, rotation direction for each stage can be configured via 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 fig. 8-43 "Rotation direction and Acc. / Dec. for multi-speed / Simple PLC" on page 111.
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 preset acceleration / deceleration time, running frequency, running time and rotation direction. One cycle of simple PLC control is shown in the figure below.

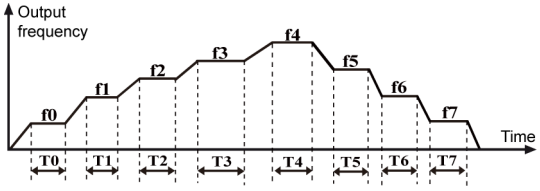



**Fig.8-39: Simple PLC control**

8 stages f0~f7 are set with parameters [b1.04], [E2.10]~[E2.16], and T0~T7 are set with parameters [E2.36], [E2.38], [E2.40], [E2.42], [E2.44], [E2.46], [E2.48] and [E2.50].

| 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. When PLC is in this mode, after the last stage the frequency converter decelerates to 0.00 Hz and then a STOP signal is generated. The frequency converter stops as configured in stopping mode.

- 2: Mode 2.

  Simple PLC runs in cycle and stops when the stopping command is entered. When PLC is in this mode, after the last stage the frequency converter decelerates to 0.00 Hz and then starts from the beginning of the PLC cycle.

- 3: Mode 3.

  After one cycle, the frequency converter keeps running at the set frequency of the last stage.

| **E2.31** | **Simple PLC time multiple** |
|---|---|
| Setting range | 1 ~ 60 |
| Minimum unit | 1 |
| Factory default | 1 |

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

[Stage x 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.

| **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 ~ 6000.0s |
| 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** |

Parameter Settings

| | |
|---|---|
| Stage 0 running time | |
| **E2.41** | **Stage 3 action selection** |
| See "Stage 0 action selection" | |
| **E2.42** | **Stage 3 running time** |
| Stage 0 running time | |
| **E2.43** | **Stage 4 action selection** |
| See "Stage 0 action selection" | |
| **E2.44** | **Stage 4 running time** |
| Stage 0 running time | |
| **E2.45** | **Stage 5 action selection** |
| See "Stage 0 action selection" | |
| **E2.46** | **Stage 5 running time** |
| Stage 0 running time | |
| **E2.47** | **Stage 6 action selection** |
| See "Stage 0 action selection" | |
| **E2.48** | **Stage 6 running time** |
| Stage 0 running time | |
| **E2.49** | **Stage 7 action selection** |
| See "Stage 0 action selection" | |
| **E2.50** | **Stage 7 running time** |
| Stage 0 running time | |

Definition of stage x action selection is shown as below:

- Display 2 (left most):
  - 0: forward running
  - 1: reverse running
- Display 1:
  - 1: Acceleration time 1, set with function code [b1.20]
  - 2: Acceleration time 2, set with function code [E2.00]
  - 3: Acceleration time 3, set with function code [E2.02]
  - 4: Acceleration time 4, set with function code [E2.04]
- Display 0 (right most):
  - 1: Deceleration time 1, set with function code [b1.21]
  - 2: Deceleration time 2, set with function code [E2.01]
  - 3: Deceleration time 3, set with function code [E2.03]
  - 4: Deceleration time 4, set with function code [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. PLC can be paused / prohibited by external terminals and PLC cycle / phase completion can be signalised by digital output. See more 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 | Via operating panel | Function codes: [E2.35], [E2.37], [E2.39], [E2.41], [E2.43], [E2.45], [E2.47], [E2.49] | Function codes: [E2.35], [E2.37], [E2.39], [E2.41], [E2.43], [E2.45], [E2.47], [E2.49] |
| | Via external terminals | External terminals, that is, 2-wire / 3-wire control mode | |
| | Via communication | Set by communication | |
| Simple PLC | Via operating panel | Function codes: [E2.35], [E2.37], [E2.39], [E2.41], [E2.43], [E2.45], [E2.47], [E2.49] | |
| | Via external terminals | | |
| | Via communication | | |

**Fig.8-4: Rotation direction and Acc. / Dec. for multi-speed / Simple PLC**

## 8.9 Group E3: PID Control

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 as the figure below:

Parameter Settings

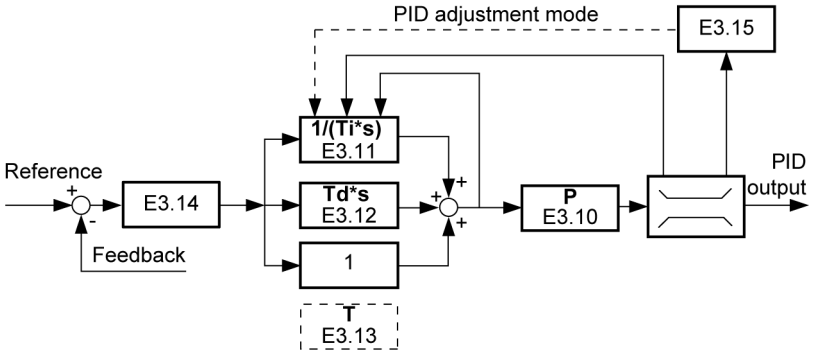



**Fig.8-40: PID control principle**

| 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

  When analog input voltage AIV is selected as the reference channel, the corresponding reference frequency is dependent on the parameter setting of [E0.10] and [E0.20] ~ [E0.28].
- 4 : Analog input current AIC

  When analog input current AIC is selected as the reference channel, the corresponding reference frequency is dependent on the parameter setting of [E0.12] and [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 [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 ~ 30000 rpm |
| Minimum unit | 1 rpm |
| Factory default | 0 rpm |
| **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 integral) |
| 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 oscillation.
  - 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 oscillation.
  - Special case: If Ti=0, I component is disabled.

If I component is disabled during PID control, it stops integration but keeps output at its current value (not cleared to zero); if I component is enabled again during PID operation, I component continues to work.

- 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 oscillation.
  - Special case: If Td=0, D component is disabled.

    If D component is disabled during PID control, it stops derivative, the current value is cleared to zero.
- T: Sample period

  Sample period is the sampling time of the PID control. This value should match with the selected time constant of Ti or Td. Normally, the sampling period should be less 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 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 follow 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.

## 8.10 Group E4: Error and Protection

| 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 ratio 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 (duty ratio) 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, over voltage errors may happen during braking.

- The time t2=1 / 100 Hz=10ms
- The time t1=t2 x [S3.21] / 100 %

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

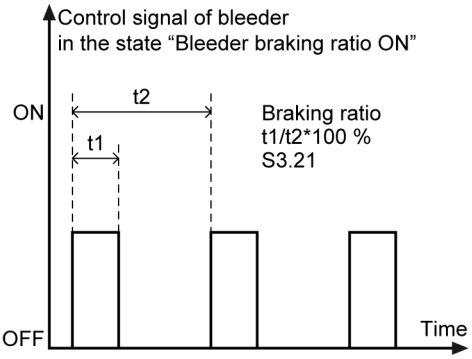



**Fig.8-41: Switching pattern_Maximum duty cycle**

**Hysteresis Voltage**

The hysteresis voltage of braking is fixed as below:

Parameter Settings

| 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:

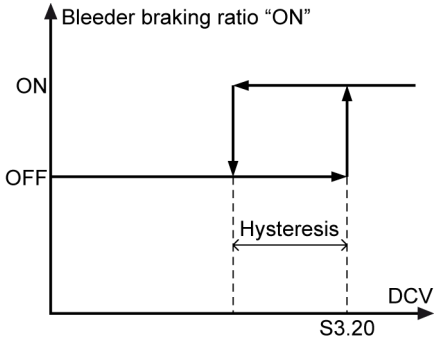



**Fig.8-42: Switching pattern_Hysteresis voltage**

When the duty cycle is set to 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<br>400 V class: 600 ~ 885 V |
| Minimum unit | 1 V |
| Factory default | 200 V class: 390 V<br>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

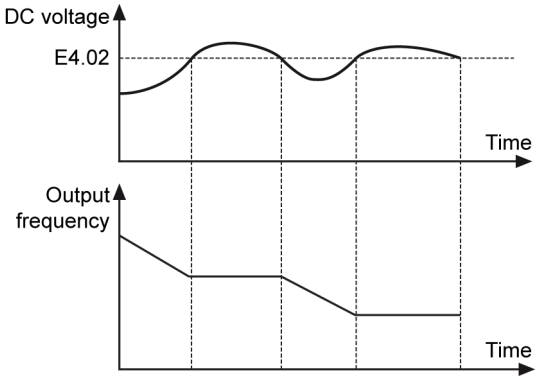



**Fig.8-43: Stall overvoltage prevention level_during deceleration**

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

| E4.03 | Stall overcurrent prevention level |
|---|---|
| Setting range | 20.0 % ~ 250.0 % (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 available during acceleration and 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 action will lead to longer acceleration time than settings.

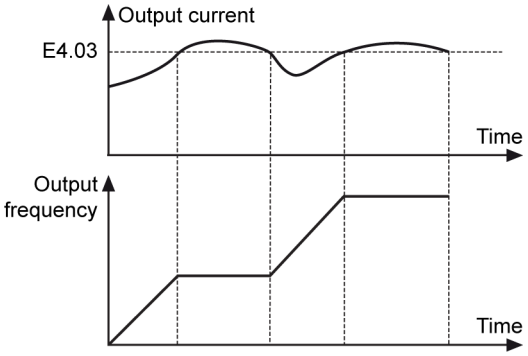



**Fig.8-44: Stall overcurrent prevention level_during acceleration**

**At constant speed**

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

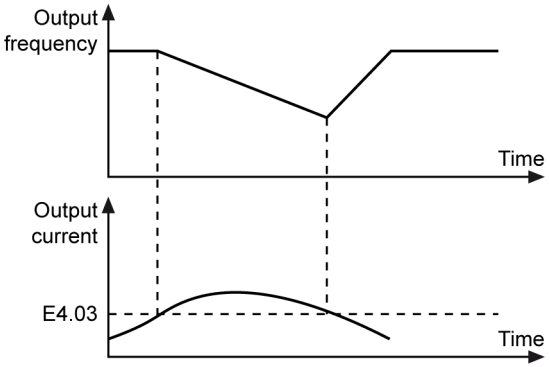



**Fig.8-45: Stall overcurrent prevention level_at constant speed**

| **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 linear 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, so the allowed continuous current is getting lower. In this case, the allowed time for overload is getting shorter. For a motor with external cooling, zero speed load [E4.05] is set to 100 %, and the low speed derating is switched off.

Example:

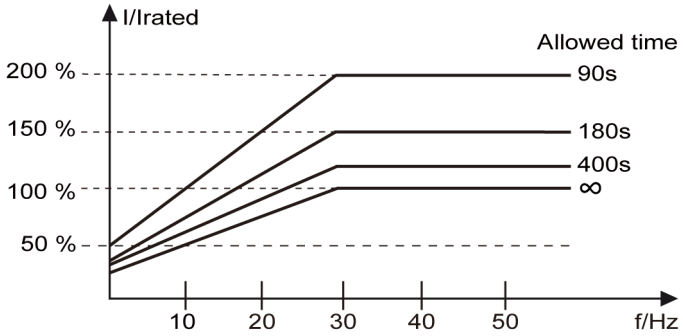



**Fig.8-46: Low speed derating frequency and zero speed load**

With:

- Low speed derating frequency [E4.04]=30 Hz
- Zero speed load [E4.05]=25 %
- Thermal time constant [S2.23]=280s

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

- 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

Parameter Settings

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 capacitors deterioration. The protection has no capability to detect the input phase loss in following circumstances:
  - No “RUN” command is present;
  - The output current is lower than ca. 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] "motor rated current".

| E4.15 | Number of fault 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 |

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

When a fault occurs, the frequency converter stops the output and the related error code is displayed at the same time. The system remains in idle mode for delay time [E4.16]. Then the error will automatically be 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. In this case, a manual error reset is required to resume the operation.

Automatic fault reset is valid for the following faults: 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.

| E4.20 | Last fault type |
|---|---|
| Setting range | 0 ~ 51 |
| Minimum unit | 1 |
| Factory default | 0 |
| **E4.21** | **2nd last fault type** |
| Setting range | 0 ~ 51 |
| Minimum unit | 1 |
| Factory default | 0 |
| **E4.22** | **3rd last fault type** |
| Setting range | 0 ~ 51 |
| Minimum unit | 1 |
| Factory default | 0 |

Used to record the recent three faults which can be viewed after reset. For fault types, please refer to chapter 9.5.1 "Error Description and Solution" on page 128.

| E4.30 | Output frequency at latest fault |
|---|---|
| Setting range | 0.00 ~ [b1.05] |
| **E4.31** | **Setting frequency at latest fault** |
| Setting range | 0.00 ~ [b1.05] |
| **E4.32** | **Output current at latest fault** |
| Setting range | 0.0 ~ 1000.0 |
| **E4.33** | **Output voltage at latest fault** |
| Setting range | 0 ~ 1000 V |
| **E4.34** | **DC bus voltage at latest fault** |
| Setting range | 0 ~ 1000 V |
| **E4.35** | **Module temperature at latest fault** |



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

Parameter Settings

## 8.11 Group H0: Communication

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

- [H0.00]=0: ModBus

See chapter 13 "Communication Protocols" on page 172.

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

Used to select data transmission rate 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 protocols.

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



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

| H0.03 | Local address |
|---|---|
| Setting range | 1 ~ 247 |
| Minimum unit | 1 |
| Factory default | 1 |

- In ModBus communication, the maximum number of frequency converters in the network is 247 (0 is broadcast address).

| 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 ([b1.40] stopping mode is inactive) after the communication timeout.
- 1: The motor continues running at the set frequency. For error / waring message, see chapter 9 "Diagnosis" on page 124.

# 9 Diagnosis

## 9.1 Diagnosis Messages when Booting the Device

| Displayed message | Diagnosis |
|---|---|
| 8.8.8.8. | This message will show up once the power is on, which detects the operating panel. |
| P.oFF | This message will show up when there is something wrong with the start-up (supply voltage is too weak or with defective softstart resistor), and the relay will not be switched on. |
| ESS- | This message will show up when the input voltage is too low and not stable at startup. |
| OE-4 | This message will show up when the input voltage is too high at startup. |
| FFE- | This message shows up when there is a firmware mismatching problem after successful startup. For possible reasons and solutions, please see chapter 9.5 "Diagnosis on Errors" on page 128. |
| "Monitoring parameter" | Monitoring parameters will be displayed on panel after a successful start-up, which are decided by [b0.30] and [b0.31]. |

## 9.2 Diagnosis on Parameter Operation

### 9.2.1 Parameter Groups

EFC 3600 is designed with 5 parameter groups which are b group "Basic Parameters", S group "Standard Parameters", E group "Extended Parameters", H0 group "Communication Parameters" and d0 group "Monitoring Parameters".

Different groups can be accessed depending on different settings of [b0.02], as shown below:

| b0.02 settings | Parameter groups can be assessed |
|---|---|
| 0 | b |
| 1 | b, S |
| 2 | b, S, E |
| 3 | b, S, E, H |
| 4 | b, Start-up mode parameters |

Diagnosis on each parameter group is shown as below:

| Parameter group | Displayed level 1 | Displayed level 2 | Description |
|---|---|---|---|
| Group b (b0 and b1) | -b0- | b0.00~b0.40 | Each group has many sub-menus. For details of each parameter, please see chapter 8 "Parameter Settings" on page 53. |
| | -b1- | b1.00~b1.45 | |
| Group S (S0, S2 and S3) | -S0- | S0.00~S0.33 | |
| | -S2- | S2.00~S2.23 | |
| | -S3- | S3.00~S3.35 | |
| Group E (E0, E1, E2, E3 and E4) | -E0- | E0.00~E0.28 | |
| | -E1- | E1.00~E1.32 | |
| | -E2- | E2.00~E2.50 | |
| | -E3- | E3.00~E3.15 | |
| | -E4- | E4.01~E4.35 | |
| Group H0 | H0 | H0.00~H0.09 | |
| Group d0 | d0 | d0.00~d0.20 | |

Press **RUN** key, the frequency converter will display the monitoring parameters according to [b0.30] "Running monitoring display".

### 9.2.2 Parameter Backup

For EFC 3600, all user parameter settings can be saved as backup to and read out from the operating panel.

| Displayed message | Diagnosis |
|---|---|
| "-""--""---""----" | During backup… |
| [b0.20] | Backup completed |
| EEPr | Backup failed |

### 9.2.3 Password

EFC 3600 provides the possibility to protect parameter values against accidental or unauthorized change by means of a password.

- If the user password [b0.00]=0, the user password protection is inactive, all user parameters can be read and modified.
- If the user password [b0.00]≠0, the user password protection is active, all the user parameters are read-only.

## 9.3 Diagnosis for Power Down/Drop

### 9.3.1 In Stop State

| Displayed message |
|---|
| P.oFF |

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 undervoltage 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.

### 9.3.2 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 undervoltage 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 | As described above, 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 cause 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:

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| OC-1 | Over current at constant speed | Sudden change in run mode | Reduce occurrence and scale of sudden change |
| | | Low mains voltage | Check the input power supply |
| | | Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| | | Too large inertia or load | Check motor power, converter power, load |
| | | The motor cable is too long | • Decrease the carrier frequency<br>• Select a larger frequency converter |
| | | Excessive torque compensation | • Check the amount of voltage boost<br>• Reduce the amount of voltage boost until the current becomes less |

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| OC-2 | Overcurrent during acceleration | The acceleration time is too short | Increase the acceleration time |
| | | Too large start frequency | Reduce the start frequency |
| | | Too large load rotation inertia, too large impact load | Increase the acceleration time, reduce sudden load change |
| | | Running command applied while motor is coasting | Restart after motor stop, or start with tracing speed ([b1.30]=2) |
| | | Improper 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 | • Check the amount of voltage boost<br>• Reduce the amount of voltage boost until the current becomes less |
| | | Improper motor parameter setting | Set correct motor parameters |
| OC-3 | Overcurrent during deceleration | The deceleration time is too short | Increase the deceleration time |
| | | Too large load rotation inertia | Use suitable brake component |
| | | Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| | | Over excitation | Reduce [b1.45] |
| | | Improper motor parameter setting | Set correct motor parameters |
| OE-1 | Overvoltage at constant speed | Surge voltage from the power supply | Check the input power supply |
| | | Motor to earth short circuit causes DC bus capacitors to be overcharged | Check the motor connection |
| | | Too large load rotation inertia | Use suitable brake component |
| | | Noise interference | Check the wiring of control circuit, main circuit and ground |

Diagnosis

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| OE-2 | Overvoltage during acceleration | Surge voltage from the power supply | Check the input power supply |
| | | Motor to earth short circuit causes DC bus capacitors to be overcharged | Check the motor connection |
| | | Direct start during motor running | Restart after motor stop, or start with tracing speed ([b1.30]) |
| | | Too short acceleration time | Increase the acceleration time ([b1.20]) or use S-curve ([b1.22]~[b1.24]) |
| OE-3 | Overvoltage during deceleration | Surge voltage from the power supply | Check the input power supply |
| | | Motor to earth short circuit causes DC bus capacitors to be overcharged | Check the motor connection |
| | | Too large load rotation inertia | Use suitable brake component |
| | | Too short deceleration time | • Increase the deceleration time ([b1.21])<br>• Use a brake resistor or a dynamic brake resistor unit<br>• Enable stall overvoltage prevention during deceleration ([E4.01]=1) |
| | | Incorrect wiring of brake resistor | Check the wiring according to the manual |
| | | The brake chopper is damaged | Replace the frequency converter |

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| OL-1 | Converter overload | Long time over load | Reduce over load time, reduce load |
| | | Too large proportion of V/F curve | Adjust V/F proportion and torque increase settings |
| | | Motor power and frequency converter power do not match | Motor power has to match with frequency converter power |
| | | Overload happens in case of lower speed | • Reduce the load in case of lower speed<br>• Lower the carrier frequency ([b0.21])<br>• Increase the frequency converter capacity |
| | | Too large load, too short acceleration/deceleration time or cycle | • Adjust the load, acceleration/deceleration time or cycle<br>• Increase the frequency converter capacity |
| | | Low mains voltage | Check the input power supply |
| | | Too much torque boost setting | Decrease the value of [S0.21] |

Diagnosis

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| OL-2 | Motor overload | Motor locked | Prevent motor lock |
| | | Normal motor runs long time with large load at low speed | • Increase frequency converter output frequency ([b1.04] or potentiometer)<br>• Reduce load<br>• Use variable frequency motor or set zero speed load ([E4.05]) to a higher value<br>• Set correct thermal motor time constant ([S2.23]) |
| | | Low mains voltage | Check the input power supply |
| | | Too large proportion of V/F curve | Adjust V/F proportion and torque increases |
| | | Too large sudden load change | Check load |
| | | Wrong input of motor rated current | Set correct motor rated current to [S2.04] |
| | | Multiple motors are running under same frequency converter | Do not connect more than one motor to the frequency converter |
| | | Over excitation | Reduce [b1.45] |
| EEP- | Flash read/ write error | Flash memory in a bad condition | Try to backup the data from the operating panel, and then replace the frequency converter |
| SPI- | SPI communication problem | EMC problem on the main board | Check the wiring of control circuit, main circuit and ground to find out the source of interference |
| | | Internal error on I/O board | Remove the EMC problem, if it happens again, replace the frequency converter |

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| E-St | External fault | External fault caused by input signals via external terminals | Check external terminal status, check respective reason to fault |
| | | 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 fault input ([E0.01]~[E0.05]=19,20) |
| RS- | External communication error | Device connection problem | Check device communication connection |
| | | Improper baud rate setting | Set proper baud rate |
| CF | Circuit fault (from current detection) | The offset is out of range due to EMC or defect of current detection | • Remove the EMC problem<br>If it fails again, replace the frequency converter |
| OT | Motor over temperature | Motor over heat | • Provide a better cooling condition<br>• Check the load |
| | | Temperature sensor defect | Replace the motor |
| | | Improper protection level | Different motor with different maximum temperature, configure the external division circuit and choose protection level [S2.22] |
| CPUd | Main board CPU trap error | CPU is disturbed by external noise and program run to illegal address | Check the wiring of control circuit, main circuit and ground to find out the source of interference |

Diagnosis

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| SC | Short circuit | Internal fault of IGBT | Replace the frequency converter |
| | | External short circuit of motor phase-phase | Check the motor |
| | | Earth surge | Remove the short circuit and check the motor |
| IPHL | Input phase loss (for 3 phase frequency converter) | Abnormal, omitted or broken connection of frequency converter power supply | Follow operating procedures to check power supply connections, remove omitted or broken connection |
| | | Broken fuse | Check fuse |
| | | Imbalance in the three phases of input power supply | Check if the imbalance situation exceeds requirements |
| | | Main circuit capacitor deterioration | Replace the frequency converter |
| OPHL | Output phase loss | Abnormal, omitted or broken connection of frequency converter outputs | Check the connections of frequency converter outputs, remove omitted or broken connections |
| | | Imbalance in the three phases of outputs | Check the motor |
| OH | Frequency converter over temperature | Frequency converter (heat sink) temperature is higher than max allowable temperature 85°C | • Reduce ambient temperature, improve ventilation and heat dissipation; clear dust, cotton wadding in air ducts; check fan and its power supply connection (if available)<br>• Reduce the load if it is too heavy<br>• Reduce the carrier frequency [b0.21] |
| | | Temperature detection circuit fault | Replace the frequency converter |

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| CPUC | I/O board trap error | CPU fatal error on I/O board | • Check the wiring of control circuit, main circuit and ground to find out the source of interference<br>• If it happens again, replace the frequency converter |
| CPUE | Removable panel trap error | CPU fatal on operating panel | • Check the wiring of control circuit, main circuit and ground to find out the source of interference<br>• If it happens again, replace the frequency converter |
| CE3- | SPI problem between removable panel board and I/O board | Problem with operating panel | • Check the wiring of control circuit, main circuit and ground to find out the source of interference<br>• If it happens again, replace the operating panel or the frequency converter |
| CE4- | Internal problem on operating panel | Problem with operating panel | • Check the wiring of control circuit, main circuit and ground to find out the source of interference<br>• If it happens again, replace the operating panel or the frequency converter |
| FFE- | Firmware does not match | operating panel may be placed to the frequency converter with older/newer firmware | Contact with technical service |
| | | I/O board may be removed to anther device | Contact with technical service |

Diagnosis

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| PSr- | Problem with power supply on the main board | 10 V overload situations on I/O board | Remove the overload situation |
| | | EMC problems at customer I/O interface | Remove the environmental interference or EMI |
| | | Internal problem | • Check the wiring of control circuit, main circuit and ground to find out the source of interference<br>• Replace the frequency converter |
| EEPr | EEPROM error on operating panel | Power failure while write / read | Parameter initialization |
| | | If error happens at normal power on, problems with operating panel | Replace the operating panel |
| | | Parameter compatibility because firmware update | Should be solved during development |
| ESS- | Soft start error | Soft start resistor value has been changed due to high over temperature | Replace the frequency converter |
| | | Mains input is unstable | Check the input power supply |
| | | Mains input is weak | Increase the power capacity |
| | | An input phase loss during start up (3 phase) | Remove the input phase loss situation |
| | | Main circuit capacitor deterioration | Replace the frequency converter |
| CE5- | Internal problem on main board | Problem with CPU on main board | • Check the wiring<br>• If it fails again, contact with technical service |

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| UE-1 | Undervoltage during run | Power failure during running | Check the input power supply |
| | | Main circuit capacitor deterioration | Replace the frequency converter |
| UH | Frequency converter under temperature | Ambient temperature is lower than -15°C | • Check the surrounding temperature of the frequency converter<br>• Provide a reasonable ambient temperature that frequency converter requires |
| | | Defect of temperature sensor | Replace the frequency converter |
| FHE- | Manufacturer parameter defect or dismatch to hardware | Parameter corruption | Contact with technical service |
| CE7- | 15 V Power supply error | Internal circuit failure | Contact with technical service |
| | | EMC problem | Remove the environmental interference or EMI |
| dir1 | Rotation direction error 1 | Parameter [b1.10], direction control=1, forward only. Direction command is reverse | Set the parameter correctly |
| dir2 | Rotation direction error 2 | Parameter [b1.10], direction control=2, reverse only. Direction command is forward | Set the parameter correctly |

Diagnosis

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| CE8- | Communication problem on I/O board (No communication frames received from I/O board) | EMC problem | Remove the environmental interference or EMI |
| | | Defect on I/O board | Replace the I/O board or drive |
| CE0- | Communication problem on main board (The communication frames received from main board are checksum erroneous) | EMC problem | Remove the environmental interference or EMI |
| | | Defect on main board | Replace the frequency converter |
| CE1- | Communication problem on operating panel (The communication frames received from removable panel are checksum erroneous) | EMC problem | Remove the environmental interference or EMI |
| | | Defect on removable board | Replace the removable board or frequency converter |

| Error code | Error name | Possible reason | Solution |
|---|---|---|---|
| CE2- | Communication problem on main board (There is no communication data from main board received in general) | EMC problem | Remove the environmental interference or EMI |
| | | Defect on main board | Replace the frequency converter |
| CE6- | Communication problem on removable board (There is no communication data from removable received in general) | EMC problem | Remove the environmental interference or EMI |
| | | Defect on removable board | Replace the removable board or frequency converter |
| CE9- | Firmware version error | Firmware version of I/O board does not match with others in the system | Contact with technical service |
| OE-4 | Overvoltage during stop | Power supply voltage is too high | Check the input power supply |
| | | Surge voltage from the power supply | Check the input power supply |
| | | Noise interference | • Check the wiring of control circuit, main circuit and ground to find out the source of interference<br>• Too much inertia on the load |

**Fig.9-1: Error description and solution**

Parameter initialization will reset all parameter settings to factory defaults. Please backup necessary data before this operation.

### 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 freewheel 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 fault 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 is lost. System status at latest fault are recorded in [E4.30]~[E4.35].

### 9.5.5 Automatic Fault Reset

An automatic fault 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 P.M. output, the system will remain in idle mode for the delay time [E4.16]. Then the error will automatically be 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 fault reset sequence (during the delay time between a fault 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 %)<br>3 AC 380 ~ 480 V (-15 % / +10 %) |
| 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)<br>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, and then 100 % of rated current for 540s<br>200 % of rated current for 1s, and then 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<br>100 % * rated torque at 1.5 kHz |
| Frequency resolution | Analog setting: 1/1000 of max. frequency<br>Digital setting: 0.01 Hz |
| Frequency control accuracy | Analog setting: ±0.1 % of max. frequency (25 ± 10 ℃)<br>Digital setting: ±0.01 % of max. frequency (-10 ~ 50 ℃) |
| 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<br>DC brake time: 0 ~ 20s |

Technical Data

| | |
|---|---|
| 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 startup, 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 anytime |
| 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 |
| 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** | |
| Brake resistor, input choke, output filter, communication cable for cabinet control, etc. | |
| **Environment** | |
| Power reduction/Maximum installation height | Up to 1000m above sea level: none<br>1000 ~ 4000m above sea level: 1 % / 100m |
| Ambient temperature | -10 ~ 50 ℃ (Operating)<br>-20 ~ 60 ℃ (Storage) |
| Relative humidity | < 90 % RH (Without condensation) |
| Shocking | 1g (< 20 Hz)<br>6g (20 ~ 50 Hz) |
| Allowed pollution degree | 2 (EN 50178) |
| **Construction** | |
| Degrees of protection | IP20 (Mounting on the metal wall in control cabinet) |
| Cooling type | Natural cooling (≤0.75 kW)<br>Enforced air cooling (>0.75 kW) |
| **Standards and Certifications** | |
| CE; UL (in progress) | |
| **Mounting mode** | |
| Wall mounting | |

**Fig.10-1: General technical data**

## 10.2 Electrical Parameter

| 1-phase 200 V series | | | | | |
|---|---|---|---|---|---|
| Model EFC 3600-□□□□-1P2-MDA-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-MDA-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 |

**Fig.10-2: Electrical parameter**



□□□□: 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 ℃.

- 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.



For a single phase 2.2 kW model, 10 % of load needs to be reduced for every 5 ℃ temperature increase when the frequency converter is working at 40 ~ 50 ℃.

### 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 currents. This rated current is available with the specified rated voltage. With deviating voltages in the permissible range, please pay attention to the following:

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

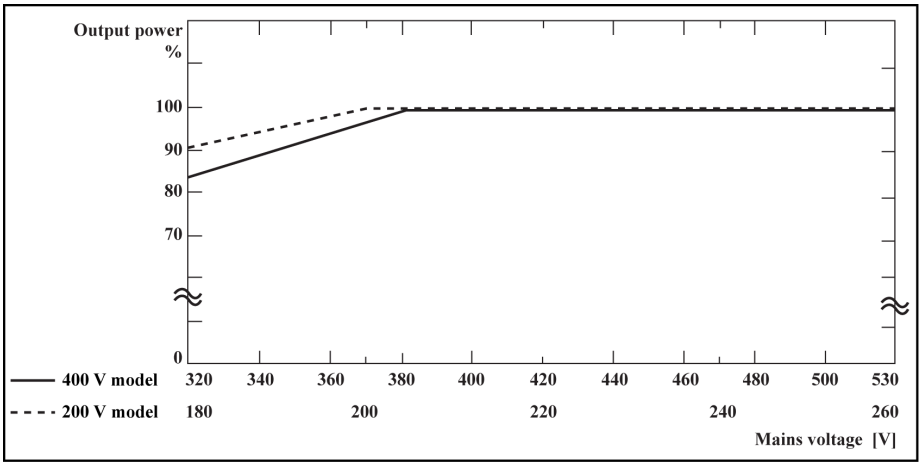



Fig.10-1: Derating and mains voltage



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

### 10.3.3 Derating and Output Current

For the whole range of EFC 3600 from 0.4 ~ 4.0 kW, 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.

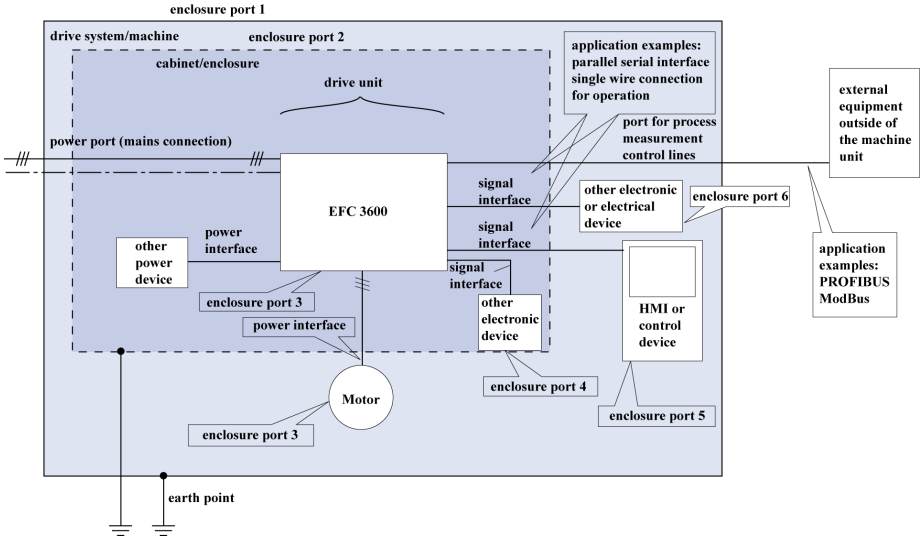



Fig.11-1: Noise immunity in the drive system

**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 electro-magnetic field, amplitude modulated | IEC 61000-4-3 | 80 to 1000 MHz 10 V/m<br>1.4 to 2.0 GHz 3 V/m<br>2.0 to 2.7 GHz 1 V/m<br>80 % AM (1 kHz) | A |
| Power ports | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz | B |
| | Surge 1.2/50 µs, 8/20 µs | IEC 61000-4-5 | 1 kV [a], 2 kV [b] | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 MHz to 80 MHz 10 V<br>80 % AM (1 kHz) | A |
| Power interfaces | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz<br>Capacitive clamp | B |
| Signal interfaces | Fast transient-burst | IEC 61000-4-4 | 1 kV/5 kHz<br>Capacitive clamp | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 MHz to 80 MHz 10 V<br>80 % AM (1 kHz) | A |
| Ports of process measurement control lines | Fast transient-burst | IEC 61000-4-4 | 2 kV/5 kHz<br>Capacitive clamp | B |
| | Conducted radio-frequency common mode | IEC 61000-4-6 | 0.15 MHz to 80 MHz 10 V<br>80 % AM (1 kHz) | A |

**Fig.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 electro-magnetic field, amplitude modulated | IEC 61000-4-3 | 80 – 1000 MHz 3 V/m<br>1.4 – 2.0 GHz 3 V/m<br>2.0 – 2.7 GHz 1 V/m<br>80% AM (1 kHz) | A |
| Power ports | Fast transient-burst | IEC 61000-4-4 | 1 kV/5 kHz | B |
| | Surge 1.2/50 µs, 8/20 µs | IEC 61000-4-5 | 1 kV [a], 2 kV [b] | B |
| | Conducted radio-frequen-cy common mode | IEC 61000-4-6 | 0.15 – 80 MHz 3 V<br>80 % AM (1 kHz) | A |
| Power interfaces | Fast transient-burst | IEC 61000-4-4 | 1 kV/5 kHz<br>Capacitive clamp | B |
| Ports of process measurement control lines | Fast transient-burst | IEC 61000-4-4 | 0.5 kV/5 kHz<br>Capacitive clamp | B |
| | Conducted radio-frequen-cy common mode | IEC 61000-4-6 | 0.15 – 80 MHz 3 V<br>80 % AM (1 kHz) | A |

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

- CD: Contact discharge.
- AD: Air discharge.
- AM: Amplitude modulation.
- [c]: Coupling line to line.
- [d]: Coupling line to earth.

Electromagnetic Compatibility (EMC)

**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 |

**Fig.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 currents with variable amplitude and frequency in the motor.

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

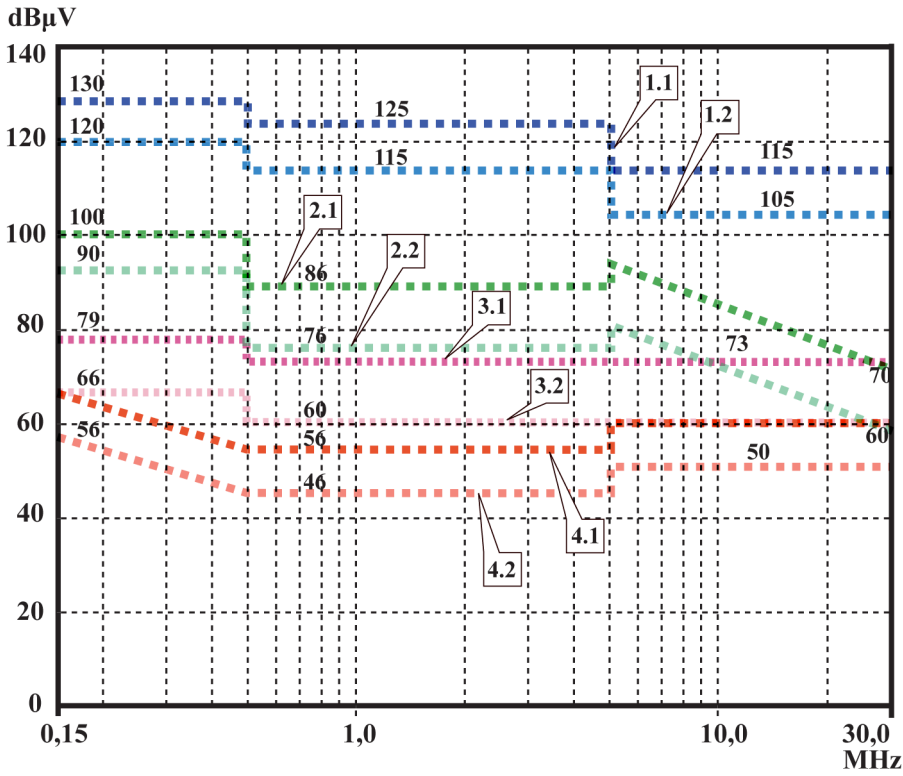
If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

**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<br>2nd environment | None | One of the following 3 requirements must have been fulfilled:<br>• Mains connection current>400 A, IT mains or required dynamic drive behavior not reached by means of EMC filter.<br>• Adjust limit values to use and operation on site.<br>• User has to carry out and provide evidence of EMC planning. | None | – |
| Category C3<br>2nd environment | Class A;<br>group 2,<br>I>100 A | Limit value in industrial areas to be complied with for applications operated at supply mains with nominal currents>100 A | A2.1 | 1.1<br>1.2 |
| Category C3<br>2nd environment | Class A;<br>group 2,<br>I≤100 A | Limit value in industrial areas to be complied with for applications operated at supply mains with nominal currents≤100 A | A2.2 | 2.1<br>2.2 |
| Category C2<br>1st environment | Class A;<br>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<br>3.2 |
| Category C1<br>1st environment | Class B;<br>group 1 | Limit value in residential areas to be complied with | B1 | 4.1<br>4.2 |

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

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.

**⚠ 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.

Electromagnetic Compatibility (EMC)

## 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 routs between lines with high potential of noise and noise-free lines; therefore, signal, mains and motor lines and power cables have to be routed separately from another. Minimum distance: 10 cm. Provide separate DOK-RCON03-EFC3600****-IB01-EN-P Rexroth Frequency Converter EFC 3600 Bosch Rexroth AG 87/123 Technical Data 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 shield motor power cable or run motor power cables in a shielded duct;
- Use the shortest possible motor power cable;
- Ground shield of motor power cable at both ends over the largest possible surface area to establish a good electrical connection;
- It is recommended to run motor lines in shielded form inside the control cabinet;
- Do not use any steel-shielded lines;
- The shield of the motor power cable must not be interrupted by mounted components, such as output chokes, sine filter or motor filters.

### 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.

Electromagnetic Compatibility (EMC)

- 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 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. 11-7 "Control cabinet mounting according to interference areas – exemplary arrangements" on page 159.

We distinguish three areas:

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

   This includes:

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

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

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

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

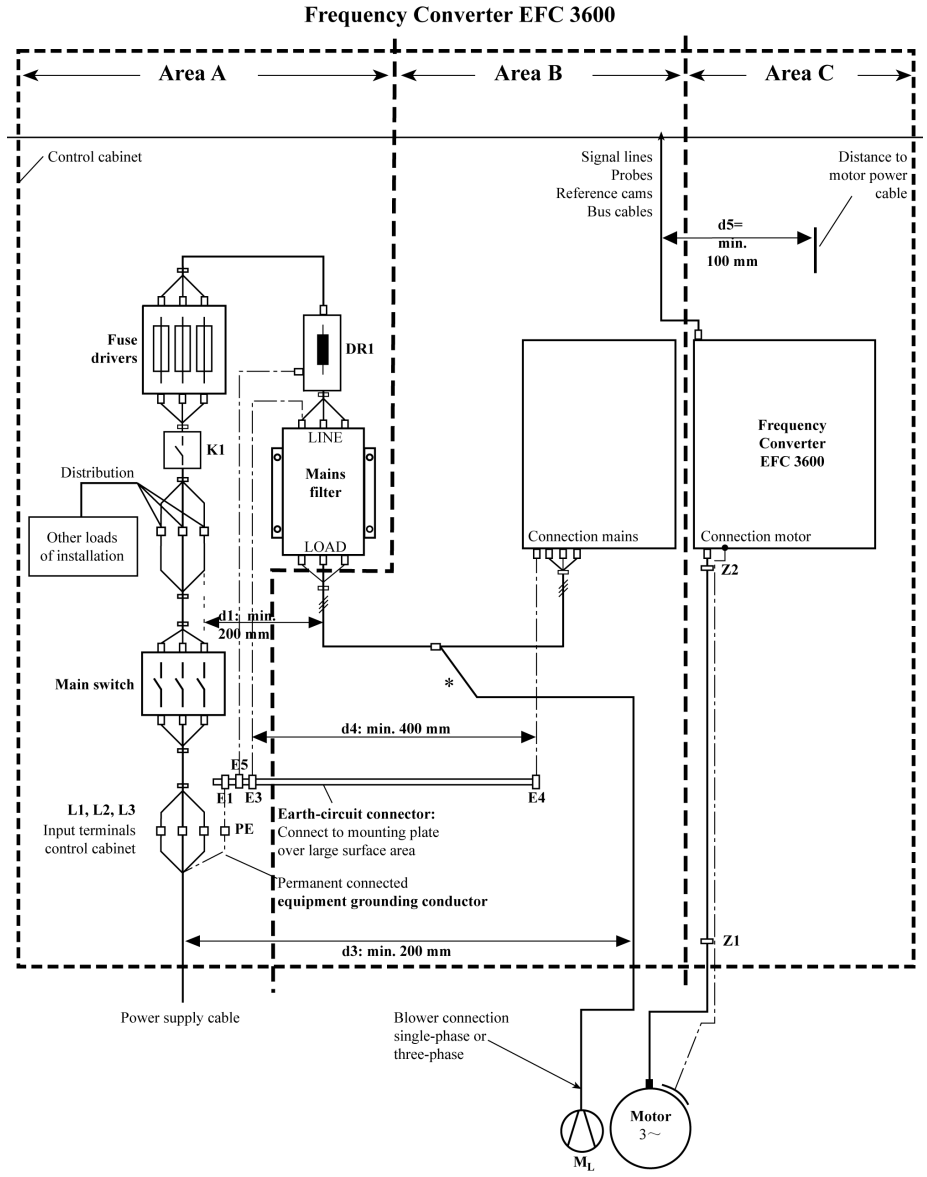
   - Motor power cables including single cores

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

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

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

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



Electromagnetic Compatibility (EMC)

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

**Fig.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 and not to the supply side of the transformer.

Electromagnetic Compatibility (EMC)

#### 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 d4=400 mm, in order to minimize interference injection from ground and ground cables to the power input lines.

See also "Division into Areas (zones)" on page 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 $mm^2$ 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 at the drive controller.

#### Influence of the Motor Power Cable

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

- Run the shortest possible motor power cables.

#### Routing the Motor Power Cables and Motor Encoder Cables

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

Route the motor power cables and motor encoder cables

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

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

#### Routing the Motor Power Cables and Mains Connection Lines

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

Ideally, the outlet of the motor power cables at the control cabinet should be provided in a distance of at least **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.

Electromagnetic Compatibility (EMC)

#### Connection Elements

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

#### Metal Surfaces

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

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

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

#### Ground Wires and Shield Connections

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

### 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 d5=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 $mm^2$.

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

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

### 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 currents.

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

# 12 Accessories

## 12.1 Brake Resistor

### 12.1.1 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.

### 12.1.2 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.

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

**OT** Braking ratio **Tb** Braking time
**Tc** Cycle time

**Fig.12-1: Braking ratio**

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

**Fig.12-1: Brake resistor selection_braking ratio OT=10 %**

- The full typecode for frequency converter is: EFC3600-□□□□-□□□-□□□-7P-NNNN
- The full typecode for brake resistor is: FELR01.1N-□□□□-□□□□□-□-560-NNNN

□ 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-MDA | Internal | – | 0100-N400R-D | 400 Ω/100 W | 1 |
| 0.75 | | 0K75-1P2-MDA | Internal | – | 0200-N190R-D | 190 Ω/200 W | 1 |
| 1.5 | | 1K50-1P2-MDA | Internal | – | 0400-N095R-D | 95 Ω/400 W | 1 |
| 2.2 | | 2K20-1P2-MDA | Internal | – | 0500-N065R-D | 65 Ω/500 W | 1 |
| 0.4 | 3x400 V | 0K40-3P4-MDA | Internal | – | 0100-N2K0R-D | 2000 Ω/100 W | 1 |
| 0.75 | | 0K75-3P4-MDA | Internal | – | 0200-N1K0R-D | 1000 Ω/200 W | 1 |
| 1.5 | | 1K50-3P4-MDA | Internal | – | 0400-N500R-D | 500 Ω/400 W | 1 |
| 2.2 | | 2K20-3P4-MDA | Internal | – | 0500-N330R-D | 330 Ω/500 W | 1 |
| 4.0 | | 4K00-3P4-MDA | Internal | – | 1K00-N180R-D | 180 Ω/1000 W | 1 |

**Fig.12-2: 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, 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 $P_R=K * P_{max} * OT\ \%$, 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.

## 12.1.3 Brake Resistor in Aluminium Housing

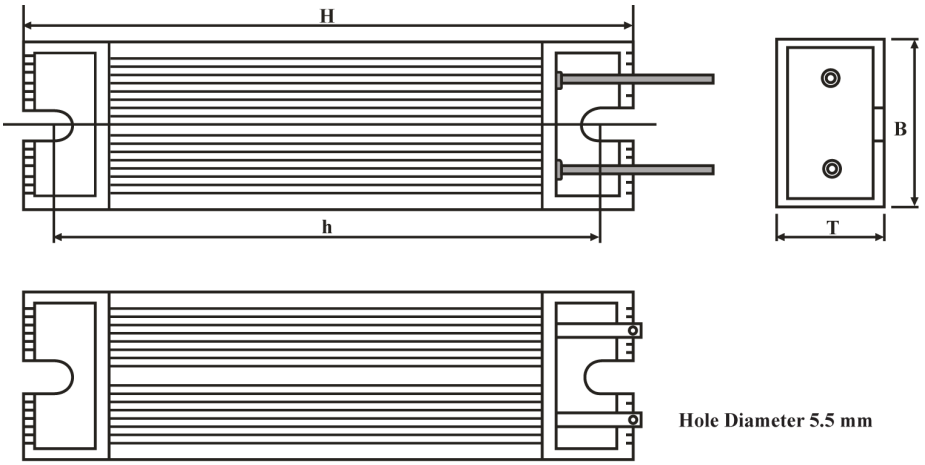



Figure A

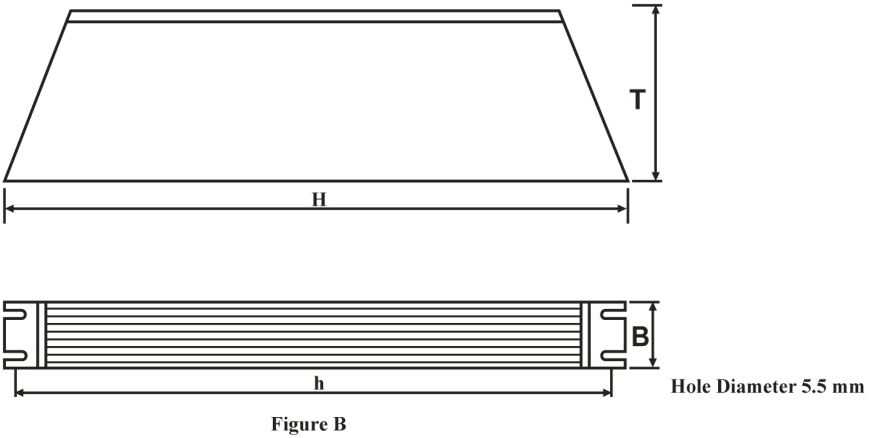



Figure B

Fig.12-2: Brake resistor in aluminum housing

Accessories

| Brake resistor typcode | Impedance [Ω] | Power [W] | Figure | Dimensions [mm] | | | | | Wiring [mm²] | Terminal [mm] | Wiring length [mm] | Weight [kg] | Type |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | H | h | B | b | T | | | | | |
| 0500-N065R-D | 65 | 500 | A | 335 | 317 | 60 | – | 30 | 1.5 | M6 | 500 | 1.03 | Al.① |
| 0500-N180R-D | 180 | 500 | | 335 | 317 | 60 | – | 30 | 1.5 | M6 | 500 | 1.03 | Al. |
| 0500-N330R-D | 330 | 500 | | 335 | 317 | 60 | – | 30 | 1.5 | M6 | 500 | 1.03 | Al. |
| 0400-N095R-D | 95 | 400 | | 265 | 247 | 60 | – | 30 | 1.5 | M6 | 500 | 0.8 | Al. |
| 0400-N500R-D | 500 | 400 | | 265 | 247 | 60 | – | 30 | 1.5 | M6 | 500 | 0.8 | Al. |
| 0300-N065R-D | 65 | 300 | | 215 | 197 | 60 | – | 30 | 1.5 | M6 | 500 | 0.62 | Al. |
| 0300-N330R-D | 330 | 300 | | 215 | 197 | 60 | – | 30 | 1.5 | M6 | 500 | 0.62 | Al. |
| 0200-N095R-D | 95 | 200 | | 165 | 147 | 60 | – | 30 | 1.5 | M6 | 500 | 0.464 | Al. |
| 0200-N190R-D | 190 | 200 | | 165 | 147 | 60 | – | 30 | 1.5 | M6 | 500 | 0.464 | Al. |
| 0200-N500R-D | 500 | 200 | | 165 | 147 | 60 | – | 30 | 1.5 | M6 | 500 | 0.464 | Al. |
| 0200-N1K0R-D | 1000 | 200 | | 165 | 147 | 60 | – | 30 | 1.5 | M6 | 500 | 0.464 | Al. |
| 0100-N190R-D | 190 | 100 | | 165 | 148 | 40 | – | 20 | 1.5 | M6 | 500 | 0.24 | Al. |
| 0100-N400R-D | 400 | 100 | | 165 | 148 | 40 | – | 20 | 1.5 | M6 | 500 | 0.24 | Al. |
| 0100-N1K0R-D | 1000 | 100 | | 165 | 148 | 40 | – | 20 | 1.5 | M6 | 500 | 0.24 | Al. |
| 0100-N2K0R-D | 2000 | 100 | | 165 | 148 | 40 | – | 20 | 1.5 | M6 | 500 | 0.24 | Al. |
| 0060-N400R-D | 400 | 60 | | 115 | 98 | 40 | – | 20 | 1.5 | M6 | 500 | 0.165 | Al. |
| 0060-N2K0R-D | 2000 | 60 | | 115 | 98 | 40 | – | 20 | 1.5 | M6 | 500 | 0.165 | Al. |
| 1K00-N180R-D | 180 | 1000 | B | 400 | 384 | 50 | 30 | 107 | – | M6 | – | 3.6 | Al. |

**Fig.12-3: Aluminium brake resistor dimensions**

①: Al. means aluminum housing brake resistor.

## 12.2 Communication Interface

### 12.2.1 RS485/RS232 Adapter

RS232/RS485 adapter (FEAA01.1-RS485-RS232-NNNN-NN, see chapter 17.3 "Appendix 3: Type Coding" on page 225) is used to connect the RS485 interface (ModBus) with RS232 interface of a PC or other control units.

### 12.2.2 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 225), is used to connector the frequency converter to the RS485/232 adapter.

## 12.3 Accessories for Control Cabinet Mounting

### 12.3.1 Operating Panel Cable for Control Cabinet Mounting

The cable FRKS0001/001,0, which is 1 m long (see chapter 17.3 "Appendix 3: Type Coding" on page 225), is used to connect the operating panel for control cabinet mounting with the frequency converter. The cable FRKS0002/003,0, which is 3 m long (see chapter 17.3 "Appendix 3: Type Coding" on page 225), can be also used for the connection of the operating panel. For connection of the FRKS0001 or FRKS0002 cable, it is necessary to remove the panel at the frequency converter and connect the cable there.

# 13 Communication Protocols

## 13.1 Brief Introduction

EFC 3600 frequency converters provide standard RS485 communication port to realize the communication between the master station via ModBus protocol. With the help of a PC, a PLC or an external computer a "single master/multiple slaves" network control can be realized (setting of frequency control command and running frequency, modification of function code parameters, monitoring of frequency converter running status and failure messages) to address the specific requirements of applications.

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

**Transmission**

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

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

**Fig.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 an address (from 1 ~ 247).

For RTU transmission mode, three type character formats 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.

And the character or byte is sent in this order (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 |

**Fig.13-2: RTU transmission mode**

Message frames are separated by a silent interval of at least 3.5 character times. The entire frame must be transmitted as a continuous stream of bytes. If the interval of two separated frames is less than 3.5 character times, 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 character times occurs between two bytes, the message frame is declared incomplete and should be discarded by the receiver.

## 13.2.2 Interface

The communication interface of EFC 3600 frequency converters is shown as below:

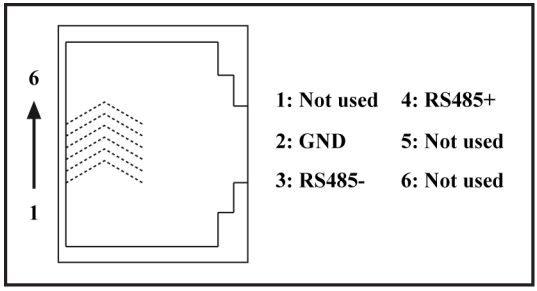



**Fig.13-1: Communication interface**

### 13.2.3 ModBus Function Codes and Message Format

#### Supported Functions

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

**Fig.13-3: 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 1st word | Number of words | CRC16 |
|---|---|---|---|---|
| | | Hi \| Lo | Hi \| Lo | Lo \| Hi |

**Fig.13-4: Function 3_Request from the master**

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

**Fig.13-5: Function 3_Response from the slave**

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

**Fig.13-6: 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 |

**Fig.13-7: Function 8_Master request and Slave response (in same format)**

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

**Fig.13-8: Function 16_Request from the master**

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

**Fig.13-9: Function 16_Response from the slave**

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

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

**Fig.13-10: Function 23_Request from the master**

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

**Fig.13-11: Function 23_Response from the slave**

### Function codes 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.

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-12: Function 0x03_Request from RTU master**

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

**Fig.13-13: 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 frequency writing!

– For details of user writing permission, please see chapter 17.2.1 "Description of Attribute Symbols in Parameter Tables" on page 195.

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:

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-14: Function 0x06_Request from RTU master**

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-15: 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:

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-16: Function 0x08_Request from RTU master**

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-17: 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:

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-18: Function 0x10_Request from RTU master**

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-19: 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:

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-20: Function 0x17_Request from RTU master**

| 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 |
| End | Transmission time for 3.5 bytes |

**Fig.13-21: Function 0x17_Response from RTU slave**

### Error code and exception code

If the 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

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

- 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 high byte representing the function code group and a low 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(**) |

**Fig.13-22: Frequency converter parameter registers**



(*): The manufacturer parameter groups (P-group) 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 (d0-group) are always write-protected.

Examples:

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

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

Access to a non-existing function code will be acknowledged with exception code 3 (see chapter 13.2.3 "ModBus Function Codes and Message Format" on page 174).

- 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 |

**Fig.13-23: 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 via 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. Any 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 inverter 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 ~ 11 | – | Error code (equal to [E4.20]) |
| 10 ~ 8 | – | Reserved |
| 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 |

**Fig.13-24: 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 via communication" and the RUN command source is set to "Inputting commands via communication". It is required for the motor connected to the frequency converter to run with 50Hz (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 | 0x0001<br>0x1388 | 0xFA9E |
| Response | 0x01 | 0x10 | 0x4000 | 0x0002 | N/A | N/A | 0x0854 |

- 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 | 0x6687 |
| Response | 0x01 | 0x03 | N/A | N/A | 0x04 | 0x00E2<br>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 | 0x0008 | 0xCC9D |
| Response | 0x01 | 0x06 | 0x4000 | N/A | N/A | 0x0008 | 0xCC9D |

### 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 and various frequency converters, which are connected by shielded twisted pair cables via RS232/485 adapters. The slave at the end of the network needs a termination resistor with recommended value of 120 Ω, 0.25 W.

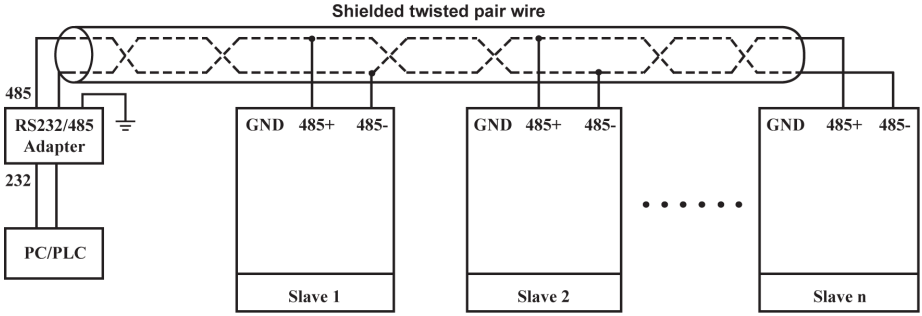



Fig.13-2: Communication networking

**⚠ WARNING** **Cables may only be connected when the frequency converter is turned off!**

### Recommendations on networking

- Use shielded twisted pair cable to connect RS485 links.
- ModBus cable should be adequately away from power cables (30 cm in minimum).

Communication Protocols

- Avoid crossing of ModBus cables and power cables and use orthogonal crossing if crossing must be used.
- The shield layer of cables should be connected to protected ground or to equipment ground if the equipment ground has already been connected to protected ground. Do not directly ground any point of the RS485 network.
- In no circumstance should ground cables constitute a loop.

# 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 10 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 ℃ (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 | |

**Fig.14-1: Daily inspection list**

Maintenance

## 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 |

**Fig.14-2: Periodic inspection list**

## 14.4 Operating Panel Removal and Mounting

**Step 1: Press the operating panel buckles**

**Step 2: Pull up the operating panel vertically**

**Step 3: Remove one screw**

**Step 4: Remove the communication adapter**

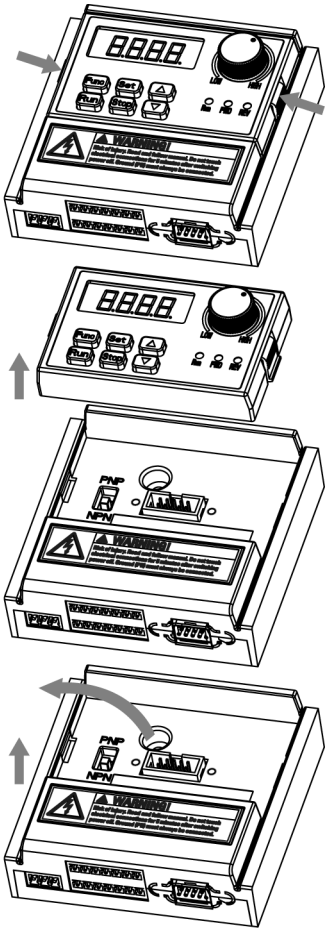
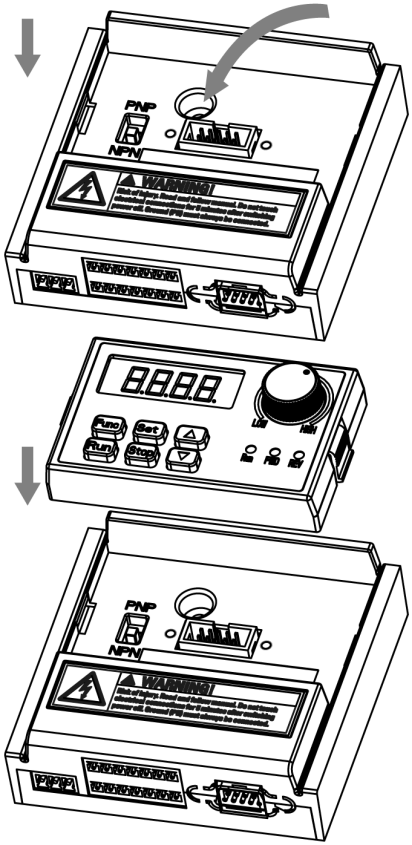



Fig.14-1: Operating panel removal

**Step 2: Tighten one screw**

**Step 1: Mount the communication adapter**




**Step 3: Push down the operating panel vertically**

Fig.14-2: Operating panel mounting

## 14.5 Fan Removal and Mounting

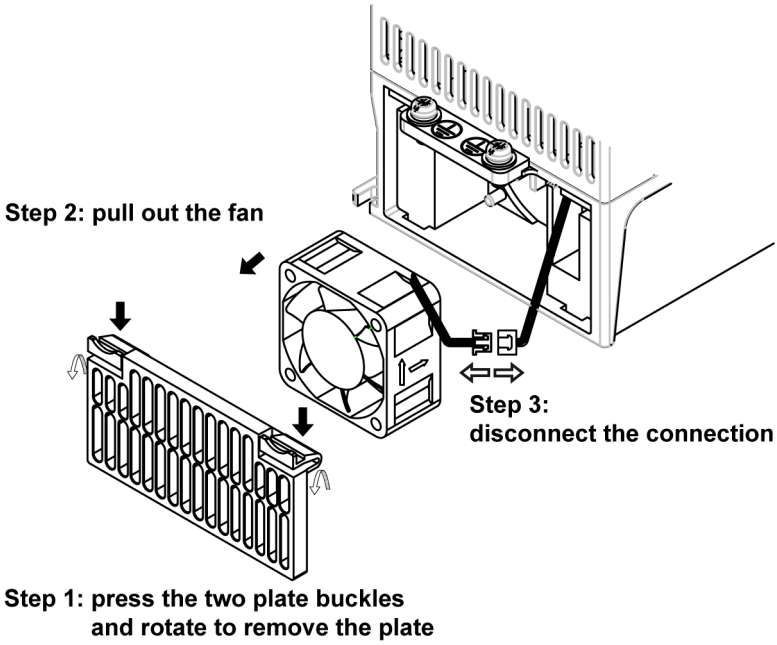



Fig.14-3: Fan removal

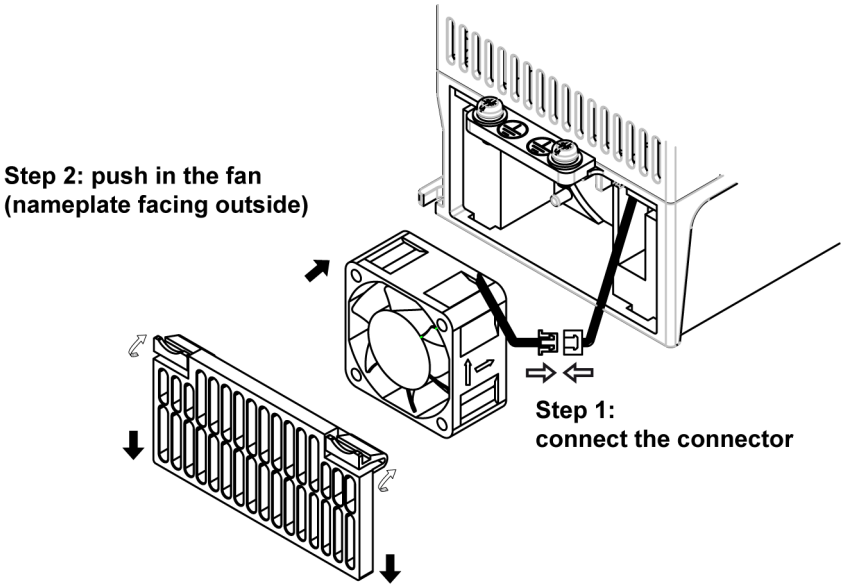



Fig.14-4: Fan mounting

# 15 Service and Support

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

| | Helpdesk | Service Hotline Germany | Service Hotline Worldwide |
|---|---|---|---|
| Time[1)] | Mon. - Fri.<br>7:00 am - 6:00 pm CET | Mon. - Fri.<br>6:00 pm - 7:00 am CET<br>Sat. - Sun.<br>0:00 am - 12:00 pm CET | Outwith Germany please contact our sales/service office in your area first.<br>For hotline numbers refer to the sales office addresses on the Internet. |
| Phone | +49 (0) 9352 40 5060 | +49 (0) 171 333 88 26<br>or<br>+49 (0) 172 660 04 06 | |
| Fax | +49 (0) 9352 18 4941 | – | |
| e-mail | service.svc@boschrexroth.de | – | |
| Internet | http://www.boschrexroth.com<br>You will also find additional notes regarding service, maintenance (e.g. delivery addresses) and training. | | |

[1)] Central European Time (CET)

### Preparing Information

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

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

# 16 Disposal and Environmental Protection

## 16.1 Disposal

### Packaging materials

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

## 16.2 Environmental Protection

### No Release of Hazardous Substances

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

Materials contained in the electronic devices:

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

### Recycling

Due to their high content of metals most of the product components can be recycled. In order to recycle the metal in the best possible way it is necessary to disassemble the products into individual modules. The metals contained in the electric and electronic modules can also be recycled by means of specific separation processes. The synthetic materials remained after these processes can be thermally recycled.

# 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
- FELR: Brake resistor
- FEAA: RS485/232 interface adapter
- FRKB: Interface adapter cable
- FRKS: Operating panel cable

## 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 can't be modified. |

**Fig.17-1: Description of attribute symbols in parameter tables**

### 17.2.2 Group b0: System Parameters

**Password and access control**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b0.00 | User password | 0 ~ 65535 | 1 | 0 | RUN/ STOP |
| b0.01 | Manufacturer password | 0 ~ 65535 | 1 | 0 | STOP |

Appendix

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b0.02 | Access authority setting | 0: Basic parameters<br>1: Standard parameters<br>2: Extended parameters<br>3: Advanced parameters<br>4: Start-up mode | 1 | 0 | RUN/ STOP |
| b0.03 | Reserved | – | – | – | – |
| b0.04 | Reserved | – | – | – | – |

**System configuration**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b0.05 | Parameter initialization | 0: No action<br>1: Restore factory default<br>2: Remove error record<br>Note: The value is automatically set to be 0 after the operation. | 1 | 0 | STOP |
| b0.06 | Parameter replication | 0: No action<br>1: Read parameter<br>2: Write parameter<br>Note: The value is automatically set to be 0 after the operation. | 1 | 0 | STOP |
| b0.07 ~ b0.19 | Reserved | – | – | – | – |

**Frequency Converter configuration**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b0.20 | Frequency converter rated voltage setting | 200 V: 200 ~ 240 V<br>400 V: 380 ~ 480 V | 1 V | 220 V<br>380 V | STOP |
| b0.21 | Carrier frequency | 1 ~ 15 kHz | 1 kHz | 4 kHz | RUN/STOP |

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b0.22 | Automatic adjustment of carrier frequency | 0: OFF<br>1: ON | 1 | 0 | STOP |
| b0.23 ~ b0.29 | Reserved | – | – | – | – |

**Monitoring display**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b0.30 | Running monitoring display | 0: Output frequency<br>1: Output rotation speed<br>2: Set frequency | 1 | 0 | RUN/ STOP |
| b0.31 | Stop monitoring display | 3: Set rotation speed<br>4: Output voltage<br>5: Output current<br>6: Output power<br>7: DC bus voltage<br>8: Analog input AIV<br>9: Analog input AIC<br>10: User-defined set frequency<br>11: User-defined output frequency<br>12: Digital input status<br>13: Digital output status<br>14: PID target engineer value<br>15: PID feedback engineer value<br>16: Module temperature<br>17: Firmware version 1<br>18: Firmware version 2<br>19: Firmware version 3<br>20: Actual carrier frequency | 1 | 2 | RUN/ STOP |

Appendix

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b0.32 | User-defined proportion factor for velocity | 0.01 ~ 100.00 | 0.01 | 1.00 | RUN/ STOP |
| b0.33 | PID reference / feedback coefficient | 0.01 ~ 100.00 | 0.01 | 1.00 | RUN/ STOP |
| b0.34 ~ b0.39 | Reserved | – | – | – | – |

**System information**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| 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**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b1.00 | First frequency setting source | 0: Given by panel potentiometer<br>1: Given by panel digital setting<br>2: Given by external analog AIV<br>3: Given by external analog AIC<br>4: Set by external UP/DOWN terminals<br>5: Given via communication<br>6: Given by multi-speed | 1 | 0 | STOP |
| b1.01 | Digital set frequency saving | 0: Not saved when powered off and stopped<br>1: Not saved when powered off; saved when stopped<br>2: Saved when powered off; not saved when stopped<br>3: Saved when powered off and stopped | 1 | 0 | STOP |
| b1.02 | First RUN command source | 0: Inputting commands with panel<br>1: Inputting commands via external terminals<br>2: Inputting commands via communication | 1 | 0 | STOP |
| b1.03 | Reserved | – | – | – | – |
| b1.04 | Digital set frequency | [b1.07] ~ [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 |

Appendix

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b1.07 | Lower frequency | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| b1.08 | Lower frequency mode | 0: Running with 0 Hz<br>1: Run with lower frequency | 1 | 0 | STOP |
| b1.09 | Hysteresis frequency width | 0.00 ~ [b1.07] | 0.01 | 0.00 | STOP |
| b1.10 | Direction control | 0: Both directions<br>1: Forward only<br>2: Reverse only<br>3: Inverse default direction | 1 | 0 | STOP |
| b1.11 | Operating panel control direction | 0: Forward; 1: Reverse | 1 | 0 | RUN/ STOP |
| b1.12 ~ b1.14 | Reserved | – | – | – | – |
| b1.15 | Combination frequency command source | 0: No combination<br>1: First frequency setting+ second frequency setting<br>2: First frequency setting - second frequency setting | 1 | 0 | STOP |
| b1.16 | Second frequency setting source | 0: Given by panel potentiometer<br>1: Given by panel digital setting<br>2: Given by external analog input voltage (AIV)<br>3: Given by external analog input current (AIC)<br>4: Set by external UP/DOWN terminals<br>5: Given via communication<br>6: Given by multi-speed | 1 | 2 | STOP |

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b1.17 | Second RUN command source | 0: Inputting commands with panel<br>1: Inputting commands via external terminals<br>2: Inputting commands via communication | 1 | 1 | STOP |
| b1.18 ~ b1.19 | Reserved | – | – | – | – |

**Acceleration/deceleration control**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b1.20 | Acceleration time 1 | 0.1 ~ 6000.0s | 0.1s | 5.0s | RUN/ STOP |
| b1.21 | Deceleration time 1 | 0.1 ~ 6000.0s | 0.1s | 5.0s | RUN/ STOP |
| b1.22 | Acceleration / deceleration curve mode | 0: Linear<br>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 | – | – | – | – |

Appendix

### Starting configuration

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b1.30 | Starting mode | 0: Start directly<br>1: Braking before start<br>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 (0.0 represents no action of starting DC braking) | 0.1s | 0.0s | STOP |
| b1.34 | Starting DC braking current | 0.0 % ~ 150.0 %<br>(Rated frequency converter current) | 0.1 % | 0.0 % | STOP |
| b1.35 ~ b1.39 | Reserved | – | – | – | – |

### Stopping configuration

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b1.40 | Stopping mode | 0: Deceleration to stop<br>1: Freewheeling to stop<br>2: Freewheeling under STOP-command, decelerating under direction change | 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<br>(0.0 represents no action of stopping DC braking) | 0.1s | 0.0s | STOP |

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| b1.43 | Stopping DC braking current | 0.0 % ~ 150.0 % (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**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S0.00 | V/F curve mode | 0: Linear<br>1: Square curve<br>2: Self-defined multipoint curve | 1 | 0 | STOP |
| S0.01 | V/F frequency 1 | 0.00 ~ [S0.03] | 0.01 Hz | 0.00 Hz | STOP |
| S0.02 | V/F voltage 1 | 0.0 % ~ 120.0 % (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 % (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 % (Rated motor voltage) | 0.10 % | 0.00 % | STOP |
| S0.07 ~ S0.19 | Reserved | – | – | – | – |

### Enhanced V/F control

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S0.20 | Rated motor slip frequency | 0.00 ~ 20.00 Hz | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| S0.21 | Voltage boost | 0.0 % ~ 20.0 %<br>(0.0 means automatic torque boost) | 0.1 % | 5.0 % | RUN/ STOP |
| S0.22 | I*R boost factor | 0 % ~ 320 % | 1 % | 100 % | RUN/ STOP |
| S0.23 | Reserved | – | – | – | – |
| S0.24 | heavy load voltage stabilization | 0: Disable<br>1: Enable | 1 | 1 | RUN/ STOP |
| S0.25 ~ S0.29 | Reserved | – | – | – | – |

### No-trip control

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S0.30 | Current limitation control | 0: OFF<br>1: OFF at constant speed<br>3: ON at constant speed | 1 | 0 | STOP |
| S0.31 | Automatic current limitation level | 20 % ~ 250 %<br>(frequency converter rated 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 and Encoder Parameters

**Motor nameplate parameters**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S2.00 | Rated motor frequency | 5.00 ~ 400.00 Hz | 0.01 Hz | 50.00 Hz | STOP |
| S2.01 | Rated motor rotation speed | 1 ~ 30000 rpm | 1 rpm | on model | STOP |
| S2.02 | Rated motor power | 0.1 ~ 1000.0 kW | 0.1 kW | on model | STOP |
| S2.03 | Rated motor voltage | 0 ~ 480 V | 1 V | on model | STOP |
| S2.04 | Rated motor current | 0.01 ~ 655.00 A | 0.01 A | on model | STOP |
| S2.05 | Power-factor | 0.50 ~ 0.95 | 0.01 | on model | STOP |
| S2.06 ~ S2.09 | Reserved | – | – | – | – |

**Motor physical data**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S2.10 | Stator resistance | 0.00 ~ 50.00 Ω | 0.01 Ω | on model | STOP |
| S2.11 | Rotator resistance | 0.00 ~ 50.00 Ω | 0.01 Ω | on model | STOP |
| S2.12 | Leakage inductance | 0.00 ~ 200.00 mH | 0.01 mH | on model | STOP |
| S2.13 | Mutual inductance | 0.0 ~ 3000.0 mH | 0.1 mH | on model | STOP |
| S2.14 | No-load current | 0.0 ~ [S2.04] | 0.1A | on model | STOP |
| S2.15 | Physical data calculation | 0: No action<br>1: Calculation<br>2: Auto tuning while motor is in static<br>3: Auto tuning while motor is rotating | 1 | 0 | STOP |
| S2.16 ~ S2.19 | Reserved | – | – | – | – |

**Motor thermal protection**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S2.20 | Sensor type | 0: PTC; 1: NTC | 1 | 0 | STOP |
| S2.21 | Input channel of motor temperature | 0: Invalid; 1: AIV | 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 | on model | STOP |
| S2.24 ~ S2.29 | Reserved | – | – | – | – |

**Encoder**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S2.30 ~ S2.39 | Reserved | – | – | – | – |

### 17.2.6 Group S3: Running Parameters

**Jogging parameters**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S3.00 | Jogging frequency | 0.00 ~ [b1.05] | 0.01 Hz | 5.00 Hz | RUN/ STOP |
| S3.01 | Jogging acceleration time | 0.1 ~ 6000.0s | 0.1s | 5.0s | RUN/ STOP |
| S3.02 | Jogging deceleration time | 0.1 ~ 6000.0s | 0.1s | 5.0s | RUN/ STOP |
| S3.03 ~ S3.04 | Reserved | – | – | – | – |

### Skip frequency

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S3.05 | Skip frequency 1 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | STOP |
| S3.06 | Skip frequency 2 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | STOP |
| S3.07 | Skip frequency 3 | 0.00 ~ [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

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S3.15 | Restarting after power fault | 0: Prohibited<br>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

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| S3.20 | Brake chopper action point | 200 V class: 300 ~ 390 V<br>400 V class: 600 ~ 885 V | 1 V | 390 V<br>885 V | STOP |
| S3.21 | Braking ratio | 1 % ~ 100 % | 1 % | 100 % | STOP |
| S3.22 ~ S3.29 | Reserved | – | – | – | – |

**Additional running control**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| 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 | [b1.07] ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| S3.34 | Fan control | 0: Automatically controlled<br>1: Always on | 1 | 0 | RUN/ STOP |
| S3.35 | Stopping with **Stop** key | 0: Only valid for control with keyboard<br>1: Valid for all control means | 1 | 1 | RUN/ STOP |

## 17.2.7 Group E0: Input Terminals

**Multi-function digital input terminals**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E0.00 | 2-wire/3-wire running control | 0: Forward/stop, reverse/stop<br>1: Forward/reverse, run/stop<br>2: 3-wire control | 1 | 0 | STOP |
| E0.01 | X1 terminal | 0 ~ 28 | 1 | 0 | STOP |
| E0.02 | X2 terminal | | 1 | 0 | STOP |
| E0.03 | X3 terminal | | 1 | 0 | STOP |
| E0.04 | X4 terminal | | 1 | 0 | STOP |
| E0.05 | X5 terminal | | 1 | 0 | STOP |
| E0.06 ~ E0.09 | Reserved | – | – | – | – |

Setting range of [E0.01] ~ [E0.05] is as below:

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: Second frequency command source enabled
19: External fault NO contact input
20: External fault NC contact input
21: External RESET input
22: Second run command source enable
23: Forward (FWD)
24: Reverse (REV)
25: Forward jog
26: Reverse jog
27: Counting input
28: Counting clear

### Analog input channel gain

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E0.10 | Analog input voltage (AIV) channel gain k1 | 0.00 ~ 10.00 | 0.01 | 1.00 | RUN/STOP |
| E0.11 | Reserved | – | – | – | – |
| E0.12 | Analog input current (AIC) channel gain k3 | 0.00 ~ 10.00 | 0.01 | 1.00 | RUN/STOP |
| E0.13 ~ E0.14 | Reserved | – | – | – | – |

### Analog input filtering time

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| 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

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E0.20 | Analog setting curve selection | 0 ~ 3<br>0 = AIC-reference characteristic curve 1; AIV-reference characteristic curve 1<br>1 = AIC-reference characteristic curve 1; AIV-reference characteristic curve 2<br>2 = AIC-reference characteristic curve 2; AIV-reference characteristic curve 1<br>3 = AIC-reference characteristic curve 2; AIV-reference characteristic curve 2 | 1 | 0 | RUN/ STOP |
| E0.21 | Curve 1 min. reference | 0.0 % ~ [E0.23] | 0.10 % | 0.00 % | RUN/ STOP |
| E0.22 | Frequency corresponding to curve 1 min. reference | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| E0.23 | Curve 1 max. reference | [E0.21] ~ 100.0 % | 0.10 % | 100.00 % | RUN/ STOP |
| E0.24 | Frequency corresponding to curve 1 max. reference | 0.00 ~ [b1.06] | 0.01 Hz | 50.00 Hz | RUN/ STOP |
| E0.25 | Curve 2 min. reference | 0.0 % ~ [E0.27] | 0.10 % | 0.00 % | RUN/ STOP |
| E0.26 | Frequency corresponding to curve 2 min. reference | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| E0.27 | Curve 2 max. reference | [E0.25] ~ 100.0 % | 0.10 % | 100.00 % | RUN/ STOP |

Appendix

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E0.28 | Frequency corresponding to curve 2 max. reference | 0.00 ~ [b1.06] | 0.01 Hz | 50.00 Hz | RUN/ STOP |
| E0.29 ~ E0.39 | Reserved | – | – | – | – |

## 17.2.8 Group E1: Output Terminals

**Multi-function output terminals**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E1.00 | OC output | 0: Frequency converter ready for running | 1 | 1 | STOP |
| E1.01 | Reserved | | – | – | – |
| E1.02 | Relay output | 1: Frequency converter in running<br>2: DC braking indication<br>3: Frequency converter running at zero speed<br>4: Frequency/speed arrival signal<br>5: Frequency level detection signal (FDT1)<br>6: Frequency level detection signal (FDT2)<br>7: Simple PLC phase completion indication<br>8: Simple PLC cycle completion indication<br>9: Reserved<br>10: Under-voltage indication<br>11: Frequency converter overload pre-warning<br>12: Motor overload pre-warning<br>13: Stopped by external fault<br>14: Fault output<br>15: Reserved<br>16: Target counter value reached<br>17: Middle counter value reached | 1 | 1 | STOP |
| E1.03 | Reserved | – | – | – | – |

Appendix

### Frequency detection

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E1.04 | Frequency arriving at detection width | 0.00 ~ 400.0 | 0.01 | 2.50 | RUN/STOP |
| E1.05 | Frequency detection level FDT1 | 0.00 ~ 400.0 | 0.01 | 50.00 | RUN/STOP |
| E1.06 | Frequency detection level FDT1 width | 0.00 ~ [E1.05] | 0.01 | 1.00 | RUN/STOP |
| E1.07 | Frequency detection level FDT2 | 0.00 ~ 400.0 | 0.01 | 25.00 | RUN/STOP |
| E1.08 | Frequency detection level FDT2 width | 0.00 ~ [E1.07] | 0.01 | 1.00 | RUN/STOP |

### Overload pre-protection

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E1.09 | Frequency converter overload pre-warning level setting | 20.0 % ~ 200.0 % (Rated frequency converter current) | 0.1 % | 110.0 % | STOP |
| E1.10 | Motor overload pre-warning level setting | 100.0 % ~ 250.0 % (Rated motor current) | 0.1 % | 100.0 % | RUN/ STOP |
| E1.11 | Frequency converter overload pre-warning delay | 0.0 ~ 20.0 | 0.1 | 2.0 | STOP |
| E1.12 | Motor overload pre-warning delay | 0.0 ~ 20.0 | 0.1 | 2.0 | RUN/ STOP |

### External signal counter

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| 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

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E1.30 | FM1 analog output selection | 0: Running frequency<br>1: Set frequency<br>2: Output current<br>3: Reserved<br>4: Output voltage<br>5: Output power<br>6: Analog input voltage<br>7: Analog input current | 1 | 0 | RUN/ STOP |
| E1.31 | FM1 channel mode | 0: 0 ~ 10 V<br>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**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E2.00 | Acceleration time 2 | 0.1 ~ 6000.0s | 0.1s | 10.0s | RUN/ STOP |
| E2.01 | Deceleration time 2 | 0.1 ~ 6000.0s | 0.1s | 10.0s | RUN/ STOP |
| E2.02 | Acceleration time 3 | 0.1 ~ 6000.0s | 0.1s | 10.0s | RUN/ STOP |
| E2.03 | Deceleration time 3 | 0.1 ~ 6000.0s | 0.1s | 10.0s | RUN/ STOP |
| E2.04 | Acceleration time 4 | 0.1 ~ 6000.0s | 0.1s | 10.0s | RUN/ STOP |
| E2.05 | Deceleration time 4 | 0.1 ~ 6000.0s | 0.1s | 10.0s | RUN/ STOP |
| E2.06 ~ E2.09 | Reserved | – | – | – | – |

**Multi-speed frequency**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E2.10 | Multi-speed frequency 1 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| E2.11 | Multi-speed frequency 2 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| E2.12 | Multi-speed frequency 3 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| E2.13 | Multi-speed frequency 4 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| E2.14 | Multi-speed frequency 5 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| E2.15 | Multi-speed frequency 6 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E2.16 | Multi-speed frequency 7 | 0.00 ~ [b1.06] | 0.01 Hz | 0.00 Hz | RUN/ STOP |
| E2.17 ~ E2.19 | Reserved | – | – | – | – |

**Simple PLC basic control**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E2.30 | Simple PLC running mode | 0: No action<br>1: Mode 1<br>2: Mode 2<br>3: Mode 3 | 1 | 0 | STOP |
| E2.31 | Simple PLC time multiple | 1 ~ 60 | 1 | 1 | STOP |
| E2.32 ~ E2.34 | Reserved | – | – | – | – |

**PLC stage control**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E2.35 | Stage 0 action selection | 011, 012, 013, 014<br>021, 022, 023, 024<br>031, 032, 033, 034<br>041, 042, 043, 044<br>111, 112, 113, 114<br>121, 122, 123, 124<br>131, 132, 133, 134<br>141, 142, 143, 144 | 1 | 011 | STOP |
| E2.36 | Stage 0 running time | 0.0 ~ 6000.0s | 0.1s | 20.0s | STOP |
| E2.37 | Stage 1 action selection | See "Stage 0 action selection" | 1 | 011 | STOP |

Appendix

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E2.38 | Stage 1 running time | 0.0 ~ 6000.0s | 0.1s | 20.0s | STOP |
| E2.39 | Stage 2 action selection | See "Stage 0 action selection" | 1 | 011 | STOP |
| E2.40 | Stage 2 running time | 0.0 ~ 6000.0s | 0.1s | 20.0s | STOP |
| E2.41 | Stage 3 action selection | See "Stage 0 action selection" | 1 | 011 | STOP |
| E2.42 | Stage 3 running time | 0.0 ~ 6000.0s | 0.1s | 20.0s | STOP |
| E2.43 | Stage 4 action selection | See "Stage 0 action selection" | 1 | 011 | STOP |
| E2.44 | Stage 4 running time | 0.0 ~ 6000.0s | 0.1s | 20.0s | STOP |
| E2.45 | Stage 5 action selection | See "Stage 0 action selection" | 1 | 011 | STOP |
| E2.46 | Stage 5 running time | 0.0 ~ 6000.0s | 0.1s | 20.0s | STOP |
| E2.47 | Stage 6 action selection | See "Stage 0 action selection" | 1 | 011 | STOP |
| E2.48 | Stage 6 running time | 0.0 ~ 6000.0s | 0.1s | 20.0s | STOP |
| E2.49 | Stage 7 action selection | See "Stage 0 action selection" | 1 | 011 | STOP |
| E2.50 | Stage 7 running time | 0.0 ~ 6000.0s | 0.1s | 20.0s | STOP |
| E2.51 ~ E2.70 | Reserved | – | – | – | – |

## 17.2.10 Group E3: PID Function

### PID basic configuration

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E3.00 | PID reference channel | 0: No PID control<br>1: Panel potentiometer<br>2: Panel digital setting<br>3: Analog input AIV<br>4: Analog input AIC<br>5: Analog digital setting [E3.03]<br>6: Rotation speed digital setting [E3.04]<br>7: Communication | 1 | 0 | STOP |
| E3.01 | PID feedback channel | 0: AIC<br>1: AIV | 1 | 0 | STOP |
| E3.02 | Reserved | – | – | – | – |
| E3.03 | Analog digital setting | 0.00 ~ 10.00 V | 0.01 | 0.00 | RUN/ STOP |
| E3.04 | Rotation speed digital setting | 0 ~ 30000 rpm | 1 rpm | 0 rpm | RUN/ STOP |
| E3.05 ~ E3.09 | Reserved | – | – | – | – |

### PID control

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E3.10 | P: Proportional gain | 0.0 ~ 10.000 | 0.001 | 1.500 | RUN/ STOP |
| E3.11 | Ti: Integral time | 0.00 ~ 100.00s<br>(0.00 represents no integral) | 0.01s | 0.00s | RUN/ STOP |

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E3.12 | Td: Derivative time | 0.00 ~ 100.00s<br>(0.00 represents no derivative) | 0.01s | 0.00s | RUN/ STOP |
| E3.13 | T: Sampling 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: Stop integral adjustment, when frequency arriving at upper/lower limit<br>1: Continue integral adjustment, when frequency arriving at upper/lower limit | 1 | 0 | RUN/ STOP |

### 17.2.11 Group E4: Protection and Fault

**Protection configuration**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E4.00 | Reserved | – | – | – | – |
| E4.01 | Overvoltage prevention setting | 0: both disabled<br>1: Stall protection enabled, braking disabled<br>2: Stall protection disabled, braking enabled | 1 | 0 | STOP |
| E4.02 | Stall overvoltage prevention level | 200V class: 300 ~ 390 V<br>400V class: 600 ~ 885 V | 1 V | 390 V<br>885 V | STOP |
| E4.03 | Stall overcurrent prevention level | 20.0 % ~ 200.0 %<br>(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 |

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E4.06 | Phase loss protection | 0: Both input and output phase loss protection active<br>1: Only input phase loss protection active<br>2: Only output phase loss protection active<br>3: Both input and output phase loss protection inactive | 1 | 3 | RUN/ STOP |
| E4.07 ~ E4.14 | Reserved | – | – | – | – |

**Fault reset**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E4.15 | Number of fault reset attempts | 0 ~ 3<br>(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**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E4.20 | Last fault type | 0 ~ 51 | 1 | 0 | read only |
| E4.21 | Second last fault type | | 1 | 0 | read only |
| E4.22 | Third last fault type | | 1 | 0 | read only |
| E4.23 ~ E4.29 | Reserved | – | – | – | – |

- 0: No error
- 1: OC-1, means overcurrent happens when constant speed running
- 2: OC-2, means overcurrent happens when acceleration
- 3: OC-3, means overcurrent happens when deceleration
- 4: OE-1, means overvoltage happens when constant speed running
- 5: OE-2, means overvoltage happens when acceleration

Appendix

- 6: OE-3, means overvoltage happens when deceleration
- 7: OL-1, means frequency converter overload
- 8: OL-2, means 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 fault
- 12: RS-, external communication error
- 13: CF, circuit fault, when there is something wrong with current detection
- 14: Reserved
- 15: OT, motor over temperature
- 16: CPU-, CPU is disturbed by external signal and program run to illegal address
- 17: SC, short circuit of IGBT happens
- 18: IPHL, input phase loss
- 19: OPHL, output phase loss
- 20: OH, frequency converter over temperature
- 21: PRSE, parameter set error

**System status at the latest fault**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| E4.30 | Output frequency at latest fault | 0.00 ~ [b1.05] | 0.01 | 0.00 | read only |
| E4.31 | Setting frequency at latest fault | 0.00 ~ [b1.05] | 0.01 | 0.00 | read only |
| E4.32 | Output current at latest fault | 0.0 ~ 1000.0 | 0.1 | 0.0 | read only |
| E4.33 | Output voltage at latest fault | 0 ~ 1000 V | 1 | 0 | read only |
| E4.34 | DC bus voltage at latest fault | 0 ~ 1000 V | 1 | 0 | read only |
| E4.35 | Module temperature at latest fault | – | 1 | 0 | read only |

## 17.2.12 Group H0: Communication

### General communication configuration

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| H0.00 | Communication protocol | 0: ModBus | 1 | 0 | STOP |
| H0.01 | Baud rate | 0: 1200 bps<br>1: 2400 bps<br>2: 4800 bps<br>3: 9600 bps<br>4: 19200 bps<br>5: 38400 bps | 1 | 3 | STOP |
| H0.02 | Data format | 0: N, 8, 1 (1 start bit, 8 data bits, 1 stop bit, no check)<br>1: E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even parity)<br>2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd parity)<br>2: N, 8, 2 (1 start bit, 8 data bits, 1 stop bit, no parity) | 1 | 0 | STOP |
| H0.03 | Local address | 1 ~ 247 | 1 | 1 | STOP |
| H0.04 ~ H0.07 | Reserved | – | – | – | – |
| H0.08 | Communication disruption detection time | 0.0 (invalid),<br>0.1 ~ 60.0s | 0.1s | 0.0s | STOP |
| H0.09 | Communication disruption action | 0: Freewheeling stop<br>1: Keep running | 1 | 1 | STOP |

### 17.2.13 Group D: Monitoring Parameters

**Monitoring parameters**

| Function code | Name | Setting range | Min. unit | Factory default | Attribute |
|---|---|---|---|---|---|
| d0.00 | Output frequency | 0.00 ~ 400.0 | 0.01 Hz | 0 | read only |
| d0.01 | Output velocity | 0 ~ 65535 | rps | 0 | read only |
| d0.02 | Setting frequency | 0.00 ~ 400.0 | 0.01 Hz | 0 | read only |
| d0.03 | Setting velocity | 0 ~ 65535 | 1 | 0 | read only |
| d0.04 | Output voltage | 0 ~ 480 | 1 V | 0 | read only |
| d0.05 | Output current | 0.0 ~ 1000.0 | 0.1 A | 0 | read only |
| d0.06 | Output power | 0.0 ~ 1000.0 | 0.1 kW | 0 | read only |
| d0.07 | DC bus voltage | 0 ~ 800 | 1 V | 0 | read only |
| d0.08 | Analog input AIV | 0.0 ~ 10.0 | 0.1 V | 0 | read only |
| d0.09 | Analog input AIC | 0.0 ~ 20.0 | 0.1 mA | 0 | read only |
| d0.10 | Self-defined setting velocity | 0.0 ~ 6000.0 | 0.1 | 0 | read only |
| d0.11 | Self-defined output velocity | 0.0 ~ 6000.0 | 0.1 | 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 engineer value | 0.0 ~ 6000.0 | 0.1 | 0 | read only |
| d0.15 | PID feedback engineer value | 0.0 ~ 6000.0 | 0.1 | 0 | read only |
| d0.16 | Module temperature | – | 1 | 0 | read only |
| d0.17 | Software version 1 | 0.00 ~ 99.99 | 0.01 | * | 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 | 1 kHz | * | read only |

## 17.3 Appendix 3: Type Coding

### 17.3.1 EFC 3600 Type Coding

| Short text Column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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

Appendix

## 17.3.2 Type Coding of EFC 3600 Function Modules

### Operating Panel Type Coding

| Short text / Column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Example: | F | P | C | C | 0 | 1 | . | 1 | - | E | B | N | N | - | 7 | P | - | N | N | N | N |

**Product**
FPCC.....= FPCC

**Line**
01.....= 01

**Design**
1.....= 1

**Version**
Extended.....= E

**Performance**
Basic.....= B

**Customer design**
None.....= NN

**Display**
Seven-segment display.....= 7

**Display version**
With potentiometer.....= P

**Other design**
None.....= NNNN

Fig.17-2: Operating panel type coding

## 17.3.3 Type Coding of EFC 3600 Accessories

### Braking Resistor Type Coding

| Short text / Column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Example: | F | E | L | R | 0 | 1 | . | 1 | N | - | 0 | 0 | 8 | 0 | - | N | 7 | 5 | 0 | R | - | D | - | 5 | 6 | 0 | - | N | N | N | N |

**Product**
FELR.....= FELR

**Line**
01.....= 01

**Design**
1.....= 1

**Mounting mode**
Free mounting solution.....= N

**Rated power**
E.g., 80 W.....= 0080

**Additional option**
None.....= N

**Resistance**
E.g., 750R.....= 750R

**Degree of protection**
IP 33 .....= D
IP 20 .....= A

**DC bus nominal voltage**
560 VDC.....= 560

**Other design**
None.....= NNNN

Fig.17-3: Braking resistor type coding

Appendix

## Interface Adapter Type Coding

| Short text Column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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.....= PROFI
RS232.....= RS232

**Cable**
Without cable.....= NNNN

**Other design**
None.....= NN

Fig.17-4: Interface adapter type coding

## Interface Adapter Cable Type Coding

| Short text Column | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Example: | F | R | K | B | 0 | 0 | 0 | 2 | / | 0 | 0 | 5 | , | 0 |

**Product**
Interface Adapter cable.....FRKB

**Cable number**
ModBus至RS485.....= 0002

**Length**
5 m.....= 005,0

Fig.17-5: Interface adapter cable type coding

## Operating Panel Cable Type Coding

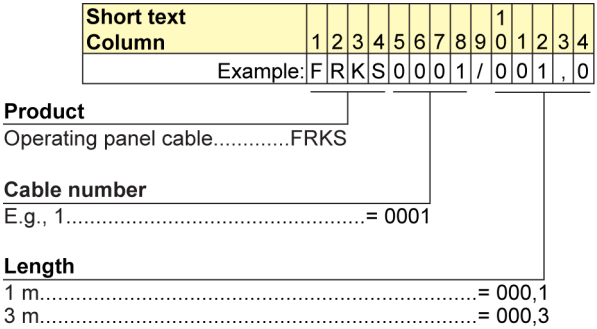



Fig.17-6: Operating panel cable type coding

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