Rexroth
Bosch Group

Rexroth Frequency Converter Fv

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Edition 06

Instruction Manual

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

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Liability   The specified data is intended for product description purposes only and shall not be deemed to be a guaranteed characteristic unless expressly stipulated in the contract. All rights are reserved with respect to the content of this documentation and the availability of the product.

English   Do not attempt to install or put these products into operation until you have completely read, understood and observed the documents supplied with the product.

If no documents in your language were supplied, please consult your Bosch Rexroth sales partner.

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Français   Ne mettez les produits en service qu'après avoir lu complètement et après avoir compris et respecté les documents et les consignes de sécurité fournis avec le produit.

Si vous ne disposez pas de la documentation dans votre langue, merci de consulter votre partenaire Bosch Rexroth.

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Se não tiver disponível a documentação na sua língua dirija-se ao seu parceiro de venda responsável da Bosch Rexroth.

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Mocht u niet beschikken over documenten in uw landstaal, kunt u contact opnemen met uw plaatselijke Bosch Rexroth distributiepartner.

Svenska   Använd inte produkterna innan du har läst och förstått den dokumentation och de säkerhetsanvisningar som medföljer produkten, och följ alla anvisningar.

Kontakta din Bosch Rexroth återförsäljare om dokumentationen inte medföljer på ditt språk.

Suomi   Ota tuote käyttöön vasta sen jälkeen, kun olet lukenut läpi tuotteen mukana toimitetut asiakirjat ja turvallisuusohjeet, ymmärtänyt ne ja ottanut ne huomioon.

Jos asiakirjoja ei ole saatavana omalla äidinkielelläsi, ota yhteys asianomaiseen Bosch Rexroth myyntiedustajaan.

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Nemáte-li k dispozici podklady ve svém jazyce, obraťte se na příslušného obchodního partnera Bosch Rexroth.

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

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

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

Jeżeli brak jest dokumentów w Państwa języku, proszę się skontaktować z lokalnym partnerem handlowym Bosch Rexroth.

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

Если Вы не получили документацию на соответствующем национальном языке, обращайтесь к полномочному представителю фирмы Bosch Rexroth.

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Punerea în funcţiune a produselor trebuie efectuată după citirea, înţelegerea şi respectarea documentelor şi instrucţiunilor de siguranţă, care sunt livrate împreună cu produsele.

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

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Ürünleri beraberinde teslim edilen evrakları ve güvenlik talimatlarını tamamen okuduktan, anladıktan ve dikkate aldıktan sonrak i,leme koyun.

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

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

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本製品をお使いになる前に、必ず同封の文書および安全注意事項を全部お読みになり理解した上で指示に従って本製品を使用していただきますようお願いいたします。

同封の文書がお客様の言語で書かれていない場合は、どうぞ Bosch Rexroth 製品の販売契約店までお問い合わせください。

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

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

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1.1   Introduction to the Documentation

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<tr><td>⚠ WARNING</td><td>Personal injury and property damage caused by incorrect project planning for applications, machines and installations!</td></tr>
</table>

Do not attempt to install or put these products into operation until you have completely read, understood and observed this documentation and the documents supplied with the product.

If no documents in your language were supplied, please consult your Bosch Rexroth sales partner.

Chapters and Contents

Chapter	Title	Description
1	Introduction	Overview
2	Safety instructions for Electric Drives and Controls	Safety cautions
3	Important Directions for Use	
4	Fv Mounting	Product information (project specific)
5	Installation	
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–	Index	Index information

Tab. 1-1:   Chapters and contents

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

Please send your feedback via email to:

service.svc@boschrexroth.de

Introduction

1.2   Definition

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

- Fv: Rexroth Frequency Converter Fv
- FSWA: Engineering software
- FVAA: PROFIBUS adapter
- FVAE: Encoder adapter
- FVAM: Remote operation adapter
- FRKB: Interface adapter cable
- FRKS: Operating panel cable
- FELR: Brake resistor
- FELB: Brake chopper
- FENF: EMC filter

1.3 Type Coding

1.3.1 Type Coding of Fv

Fig. 1-1:   Type coding of Fv

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1.3.2   Type Coding of Fv Function Modules

Engineering software type coding
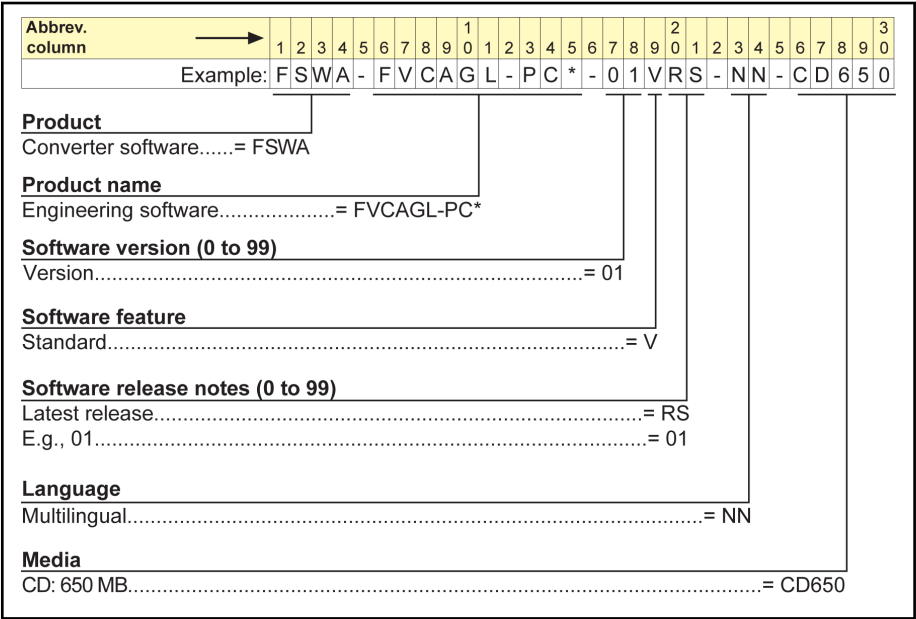
Fig. 1-2:   Engineering software type coding

1.3.3   Type Coding of Fv Accessories

PROFIBUS adapter type coding
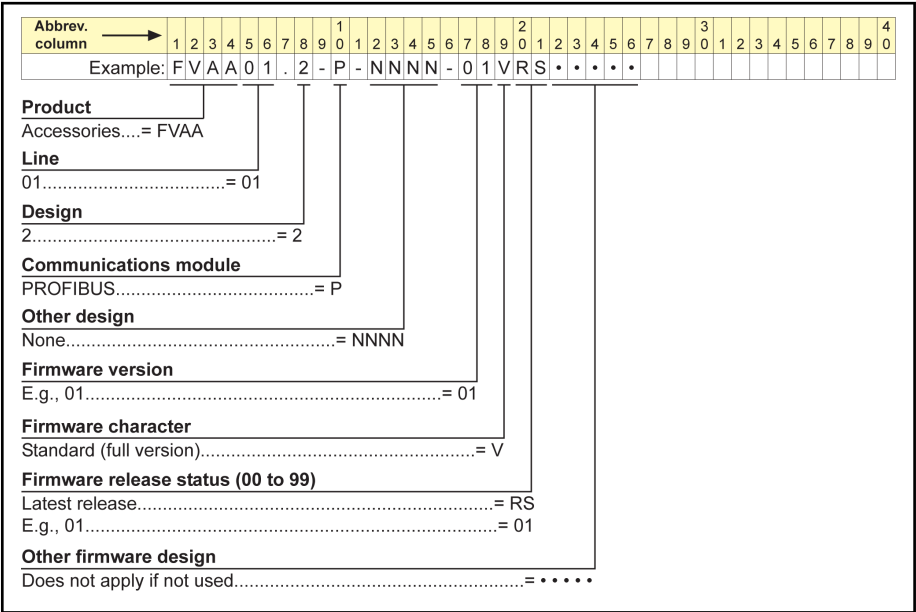
Fig. 1-3:   PROFIBUS adapter type coding

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Encoder adapter type coding

Fig. 1-4:   Encoder adapter type coding

Remote operation adapter

Fig. 1-5:   Remote operation adapter

Interface adapter cable type coding

Fig. 1-6:   Interface adapter cable type coding

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Operating panel cable type coding

Fig. 1-7:   Operating panel cable type coding

Brake resistor type coding

Fig. 1-8:   Brake resistor type coding

Introduction

External brake chopper type coding

Fig. 1-9:   External brake chopper type coding

EMC filter type coding

Fig. 1-10:   EMC filter type coding

Introduction

1.4   Delivery and Storage

1.4.1   Brief Introduction

Check the unit for transport damages, e.g. deformation or loose parts, **immediately** after receipt/unpacking. In case of damage, contact the forwarder at once and arrange for a thorough review of the situation.

☞   This is also applicable if the packaging is undamaged.

1.4.2   Scope of Supply

Standard supply

- Fv, protection class of IP 20 (Control cabinet mounting)
- Internal brake chopper (0K40...15K0)
- Operating panel
- Safety Instructions
- Instruction Manual (UL)
- Instruction Manual (Quick Start)
- EMC filter (EN 61800-3 Environment 2)

Optional accessories

- Instruction manual
- Remote operation adapter
- PROFIBUS adapter
- Encoder adapter
- RS232/485 adapter
- Engineering software
- Motor filter (dV/dt filter)
- Mains choke
- Brake resistor
- External brake chopper (18K5...90K0)

1.4.3 Transport of the Components

Ambient and operating conditions-Transport

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

Tab. 1-2:   Transport conditions

1.4.4 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, operate them once a year for at least 1 hour with power on:

- Fv with mains voltage U_{LN}
- FELB with DC bus voltage U_{DC}

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

Tab. 1-3:   Storage conditions

Introduction

1.5   Fv Description

1.5.1   Certification

CE certification

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

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

Tab. 1-4:   Conformity and standards

CE Label

Fig. 1-11:   CE label

High-Voltage Test According to standard EN 61800-5-1, all Fv components are tested with high voltage.

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UL Certification

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

UL listing

Fig. 1-12:   UL listing

UL standard   UL 508C

Company name   BOSCH REXROTH (XIAN) ELECTRIC DRIVES AND CONTROLS CO., LTD.

Category name   Power Conversion Equipment

File number   E328841

UL ratings   For using the components in the scope of UL, take the UL ratings of the individual component into account.

Make sure that the indicated short circuit rating SCCR is not exceeded (5000 Arms), e.g. by appropriate fuses in the mains supply of the supply unit.

Wiring material UL   In the scope of UL, use only copper conductors rated 60 ℃ and above.

For frequency converters 45K0...90K0, use only copper conductors rated 75 °C and above.

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RCM

Frequency converters Fv comply with the relevant ACMA standards made under the Radiocommunications Act 1992 and the Telecommunications Act 1997.These standards are referenced in notices made under section 182 of the Radiocommunications Act and 407 of the Telecommunications Act.

RCM label

Fig. 1-13:   RCM label

RCM standard
EN 61800-3:2004, Adjustable speed electrical power drive systems - Part3: EMC requirements and specific test methods

ACMA supplier code
E1066

CAN, ABN or ARBN
ABN / IRDN 89003258384

Category
Fv complies with the applicable requirements detailed in EN 61800-3:2004 (Category 3 limits) and is not intended to be used directly on a low-voltage public network which supplies domestic premises. Radio frequency interference is expected if used on such a network, in which supplementary mitigation measures are required.

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1.5.2   Properties of the Basic Device Fv

- Allowed ambient temperature: -10...40 ℃
- Protection class: IP 20 (Control cabinet mounting)
- Power range: 0.4...90 kW
- Power supply voltage: 3 AC 380...480 V (-15 % / +10 %)
- High start-up torque and precise motor speed control
- Overload capability:
  - 150 % of rated current for 60 s
  - 180 % of rated current for 10 s
- Output frequency: 0.00...400.00 Hz
- Pulse width modulation (PWM):

Model	Default value of PWM frequency [kHz]	Effective adjustable range of PWM frequency [kHz]
0K40...7K50	8.0	1.0 to 15.0
11K0...22K0	6.0	1.0 to 12.0
30K0...37K0	3.0	1.0 to 8.0
45K0...90K0	2.0	1.0 to 4.0

- Internal brake chopper (0K40...15K0) (brake resistor connected externally)
- Control mode:
  - V/f Control (V/f)
  - Sensorless Vector Control (SVC)
  - Field Oriented Vector Control (FOC)

1.5.3   Interfaces

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

1.5.4   Cooling Types

- Air cooling
- Forced, temperature-controlled air cooling

Introduction

1.6   Version Matching Table

Product	Product version	Product firmware version	Panel firmware version	PC software version	PROFIBUS DP version
FVCA01.2	AA1	02V01	02V01	02V01	AB1
	AT1 AU1	01V08	01V08	01V03	AB1
	AP1 AQ1 AR1 AS1	01V07	01V04	01V03	AB1
	AM1 AN1 AO1	01V06	01V03	01V03	AB1
FVCA01.1	A09 A10 A11 AL1	01V05	01V02	01V01	A00

Tab. 1-5:   Version matching table

2 Safety Instructions for Electric Drives and Controls

2.1 Definitions of Terms

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

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

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

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

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

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

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

Machine A machine is the entirety of interconnected parts or units at least one of which is movable. Thus, a machine consists of the appropriate machine drive elements, as well as control and power circuits, which have been assembled for a specific application. A machine is, for example, intended for processing, treatment, movement or packaging of a material. The term "machine" also covers a combination of machines which are arranged and controlled in such a way that they function as a unified whole.

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

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

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

Safety Instructions for Electric Drives and Controls

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

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

3) to attend a course of instruction in first aid

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

2.2   Explanation of Signal Words and the Safety Alert Symbol

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

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

2.3   General Information

2.3.1   Using the Safety Instructions and Passing Them on to Others

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

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

Safety Instructions for Electric Drives and Controls

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

2.3.2   Requirements for Safe Use

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

- Bosch Rexroth is not liable for damages resulting from failure to observe the safety instructions.

- Read the operating, maintenance and safety instructions in your language before commissioning. If you find that you cannot completely understand the application documentation in the available language, please ask your supplier to clarify.

- Proper and correct transport, storage, mounting and installation, as well as care in operation and maintenance, are prerequisites for optimal and safe operation of the component.

- Only qualified persons may work with components of the electric drive and control system or within its proximity.

- Only use accessories and spare parts approved by Bosch Rexroth.

- Follow the safety regulations and requirements of the country in which the components of the electric drive and control system are operated.

- Only use the components of the electric drive and control system in the manner that is defined as appropriate. See chapter "Appropriate Use".

- The ambient and operating conditions given in the available application documentation must be observed.

- Applications for functional safety are only allowed if clearly and explicitly specified in the application documentation "Integrated Safety Technology". If this is not the case, they are excluded. Functional safety is a safety concept in which measures of risk reduction for personal safety depend on electrical, electronic or programmable control systems.

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

  The machine and installation manufacturers must

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

  – make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.

- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.

- Operation is only allowed if the national EMC regulations for the application are met.

- The instructions for installation in accordance with EMC requirements can be found in the section on EMC in the respective application documentation.

Safety Instructions for Electric Drives and Controls

The machine or installation manufacturer is responsible for compliance with the limit values as prescribed in the national regulations.

- The technical data, connection and installation conditions of the components are specified in the respective application documentations and must be followed at all times.

National regulations which the user must take into account

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

2.3.3   Hazards by Improper Use

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

2.4   Instructions with Regard to Specific Dangers

2.4.1   Protection against Contact with Electrical Parts and Housings

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

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

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

- Only qualified persons are allowed to operate, maintain and/or repair the components of the electric drive and control system.

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

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

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

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

2.4.2 Protective Extra-Low Voltage as Protection Against Electric Shock

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

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

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

Safety Instructions for Electric Drives and Controls

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

2.4.3   Protection against Dangerous Movements

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

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

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

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

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

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

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

To avoid accidents, injury and/or property damage:

- Keep free and clear of the machine's range of motion and moving machine parts. Prevent personnel from accidentally entering the machine's range of motion by using, for example:
    - Safety fences
    - Safety guards
    - Protective coverings
    - Light barriers
- Make sure the safety fences and protective coverings are strong enough to resist maximum possible kinetic energy.
- Mount emergency stopping switches in the immediate reach of the operator. Before commissioning, verify that the emergency stopping equipment works. Do not operate the machine if the emergency stopping switch is not working.

Safety Instructions for Electric Drives and Controls

- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches / OFF buttons or use a safe starting lockout.

- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.

- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") for:
    - Maintenance and repair work
    - Cleaning of equipment
    - Long periods of discontinued equipment use

- Prevent the operation of high-frequency, remote control and radio equipment near components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

2.4.4 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

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

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

- Persons with heart pacemakers and metal implants are not allowed to enter the following areas:
    - Areas in which components of the electric drive and control systems are mounted, commissioned and operated.
    - Areas in which parts of motors with permanent magnets are stored, repaired or mounted.

- If it is necessary for somebody with a heart pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of implanted heart pacemakers differs so greatly that no general rules can be given.

- Those with metal implants or metal pieces, as well as with hearing aids, must consult a doctor before they enter the areas described above.

2.4.5 Protection Against Contact with Hot Parts

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

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!

- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.

- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140**

Safety Instructions for Electric Drives and Controls

minutes! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.

- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.

- Wear safety gloves or do not work at hot surfaces.

- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

2.4.6   Protection During Handling and Mounting

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

- Observe the relevant statutory regulations of accident prevention.

- Use suitable equipment for mounting and transport.

- Avoid jamming and crushing by appropriate measures.

- Always use suitable tools. Use special tools if specified.

- Use lifting equipment and tools in the correct manner.

- Use suitable protective equipment (hard hat, safety goggles, safety shoes, safety gloves, for example).

- Do not stand under hanging loads.

- Immediately clean up any spilled liquids from the floor due to the risk of falling!

3   Important Directions for Use

3.1   Appropriate Use

Bosch Rexroth products represent state-of-the-art developments and manu-facturing. 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 Fv Mounting

4.1 Mounting

The frequency converter must be sufficiently ventilated to avoid overheating. The recommended minimum vertical clearances between the frequency converter and adjacent items which may disturb the free flow of air are given below.
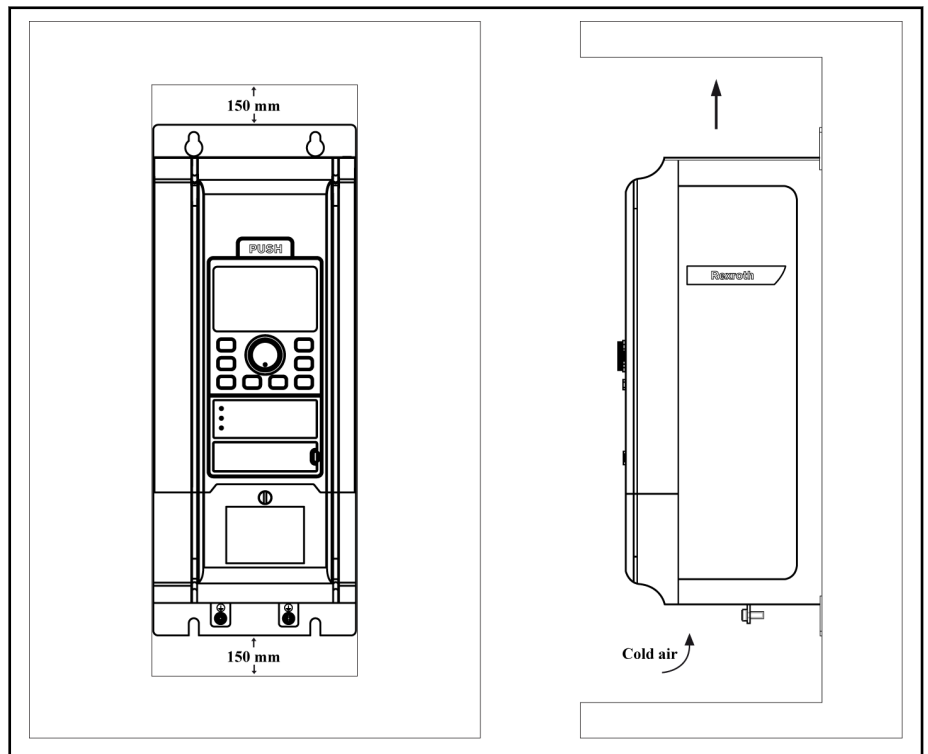
Fig. 4-1:   Fv mounting

☞
- Fv must be vertically installed.
- Fv has no side ventilation hole, which enables parallel mounting of Fv with zero distance.
- If one frequency converter is arranged above the other, make sure that the upper limit of air temperature into the inlet is not exceeded (See tab. 9-2 "General technical data" on page 160).
- A baffle plate is recommended between the frequency converters to prevent the rising hot air being drawn into the upper frequency converter if the upper temperature limit is exceeded.

Fv Mounting

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

Only operate the components in their allowed mounting modes.

Allowed mounting mode of the components:

Only the mounting mode G1 is allowed for Fv.
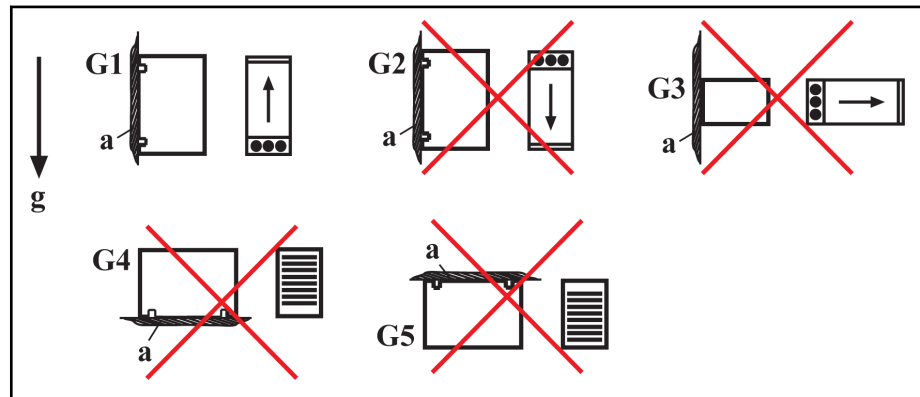
a	Mounting surface
g	Direction of gravitational force
G1	Normal mounting mode. The natural convection supports the forced cooling air current. This avoids the generation of pockets of heat in the component.
G2	180° to normal mounting mode
G3	Turned by 90° from vertical to horizontal mounting position
G4	Bottom mounting; mounting surface on bottom of control cabinet
G5	Top mounting; mounting surface at top of control cabinet
Fig. 4-2:	*Mounting mode*

4.2   Fv Dimensions and Figure

4.2.1   Fv Dimensions

Frame	Fv model	Dimensions [mm]										Screw size	Net weight [kg]
		B	b	T	t	H	h	h1	d	D	L1		
A	0K40 0K75 1K50	125	75	122	1.5	275	300	315	5.5	127	5.5	M5	2.7
	2K20												2.8
B	4K00	150	100	157	1.5	330	365	380	6.5	162	6.5	M6	4.8
	5K50 7K50												4.9
C	11K0	175	100	199	2	398	432	448	6.5	204	6.5	M6	8.8
	15K0												9.0
D	18K5 22K0	225	125	227	3.5	440	482	500	9	232	9	M8	16.5
E	30K0 37K0	250	150	251.5	3.5	525	567	585	9	256.5	9	M8	22.0
F	45K0	325	200	265	3.5	650	690	712.5	9	270	9	M8	37.0
	55K0												39.0
G	75K0	450	300	302.5	4	700	754	779	11	307	11	M10	56.7
	90K0												58.0

Tab. 4-1:   Fv dimensions

Fv Mounting

4.2.2   Fv Figure

☞   Please refer to the above table to select four screws for Fv mounting.

0K40...15K0
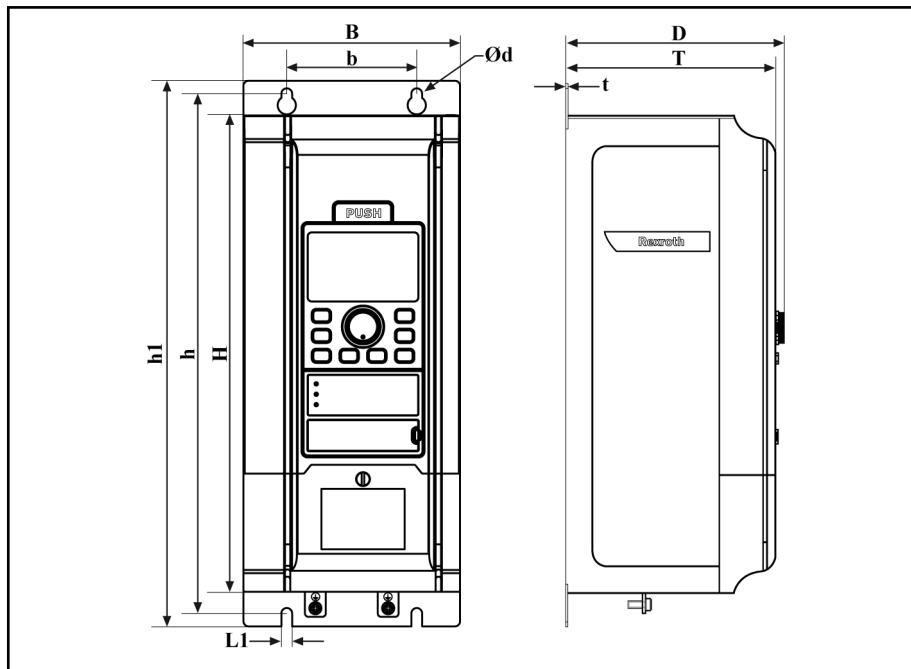
Fig. 4-3:   0K40...15K0 figure

18K5...37K0
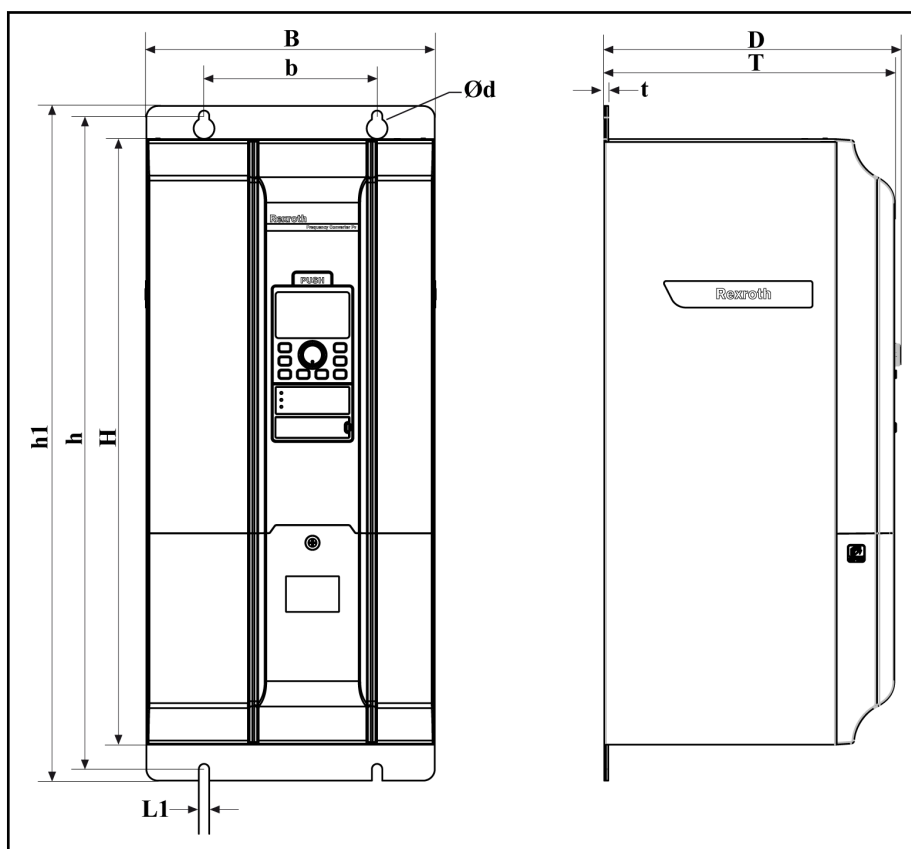
Fig. 4-4:   18K5...37K0 figure

Fv Mounting

45K0...90K0
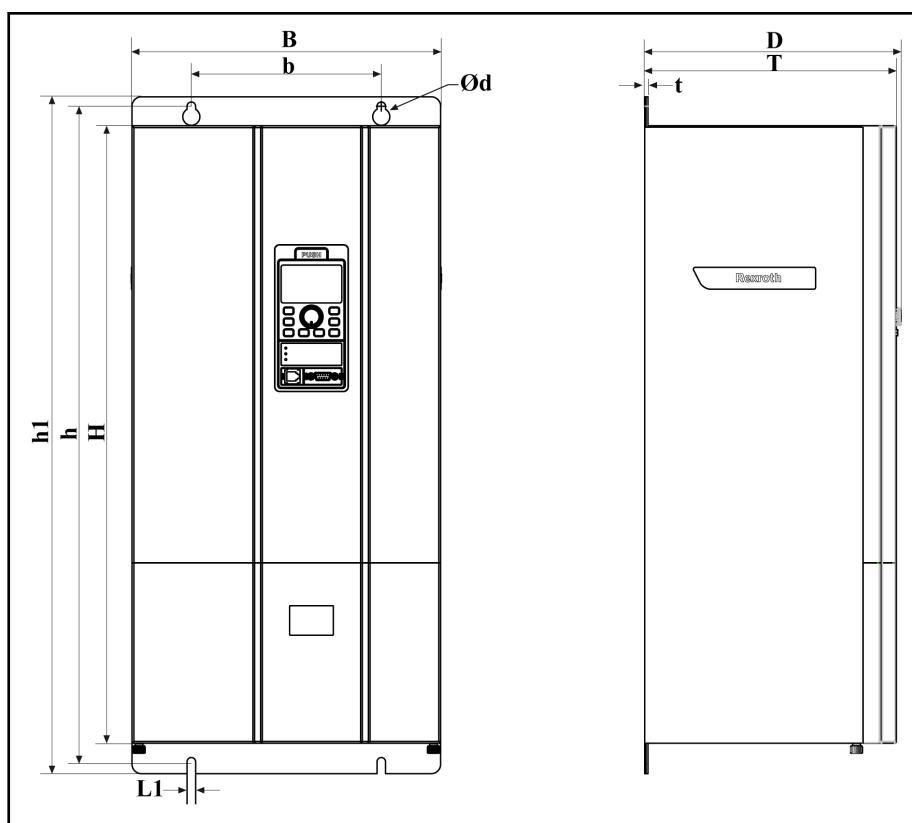
Fig. 4-5:   45K0...90K0 figure

5   Installation

5.1   Fv Disassembly and Assembly

5.1.1   Removal and Mounting of Operating Panel

Removal of operating panel

A. Start state   B. Press button PUSH   C. Press the panel box buckle to the indicated direction, rotate the panel box as the arrow shows to remove the panel box   D. Disassembly complete
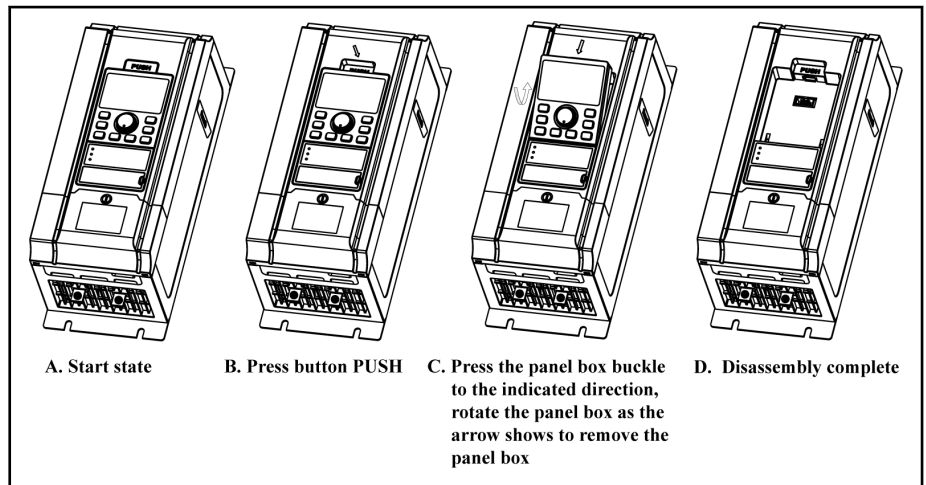
Fig. 5-1:   Removal of operating panel

Mounting of operating panel

A. Starting state   B. Insert the panel box into the upper cover, press the top buckle and button PUSH to push the panel box into the mounting slot.   C. Mounting complete
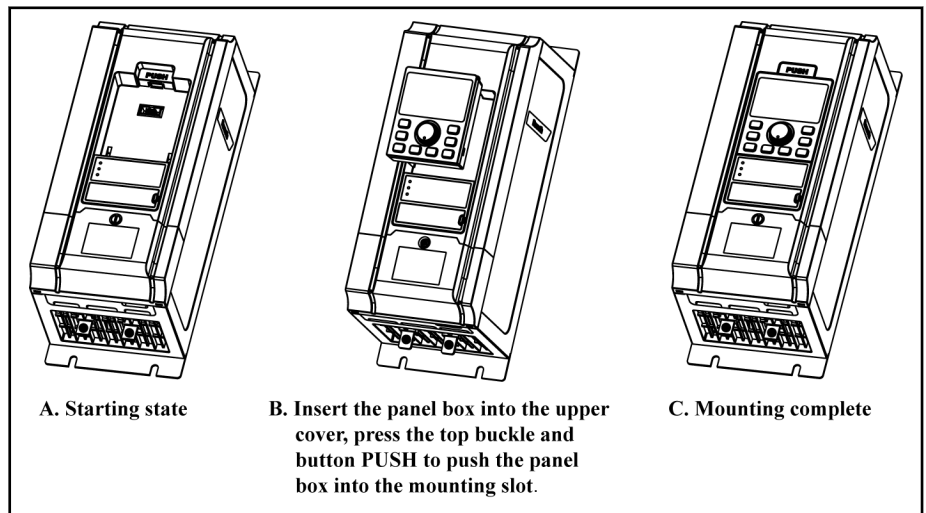
Fig. 5-2:   Mounting of operating panel

Installation

5.1.2   Removal and Mounting of Adapter

Removal of adapter

To remove the adapter, the panel needs to be removed first according to chapter 5.1.1 "Removal and Mounting of Operating Panel" on page 37.

A. Start state   B. Press the adapter buckle to the   C. Disassembly complete
                           indicated direction, rotate and
                           remove the adapter.
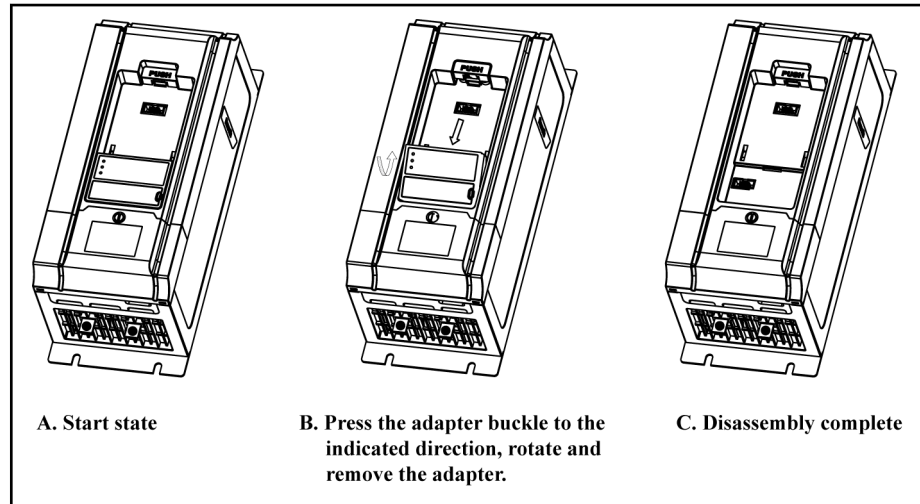
Fig. 5-3:   Removal of adapter

Mounting of adapter

A. Start state   B. Insert the adapter into   C. Mounting complete
                           the upper cover, press
                           the adapter into the slot.
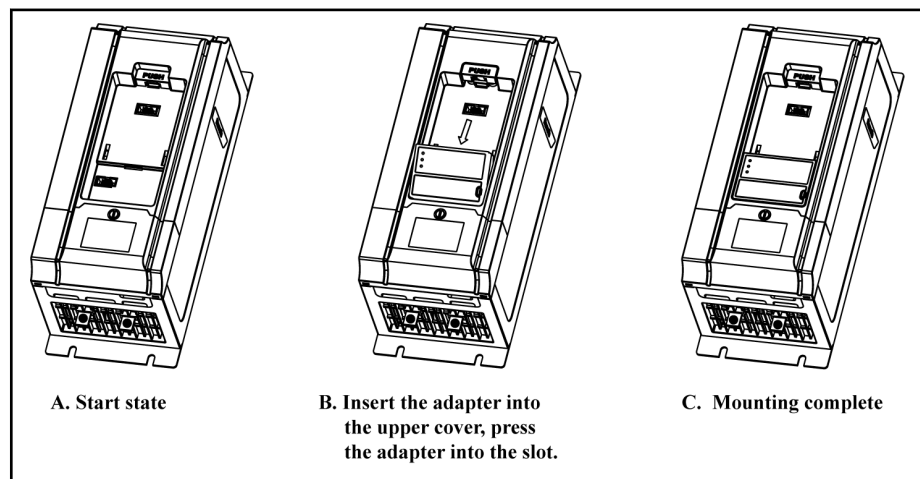
Fig. 5-4:   Mounting of adapter

Installation

5.2 Drive System Wiring

5.2.1 Block Diagram
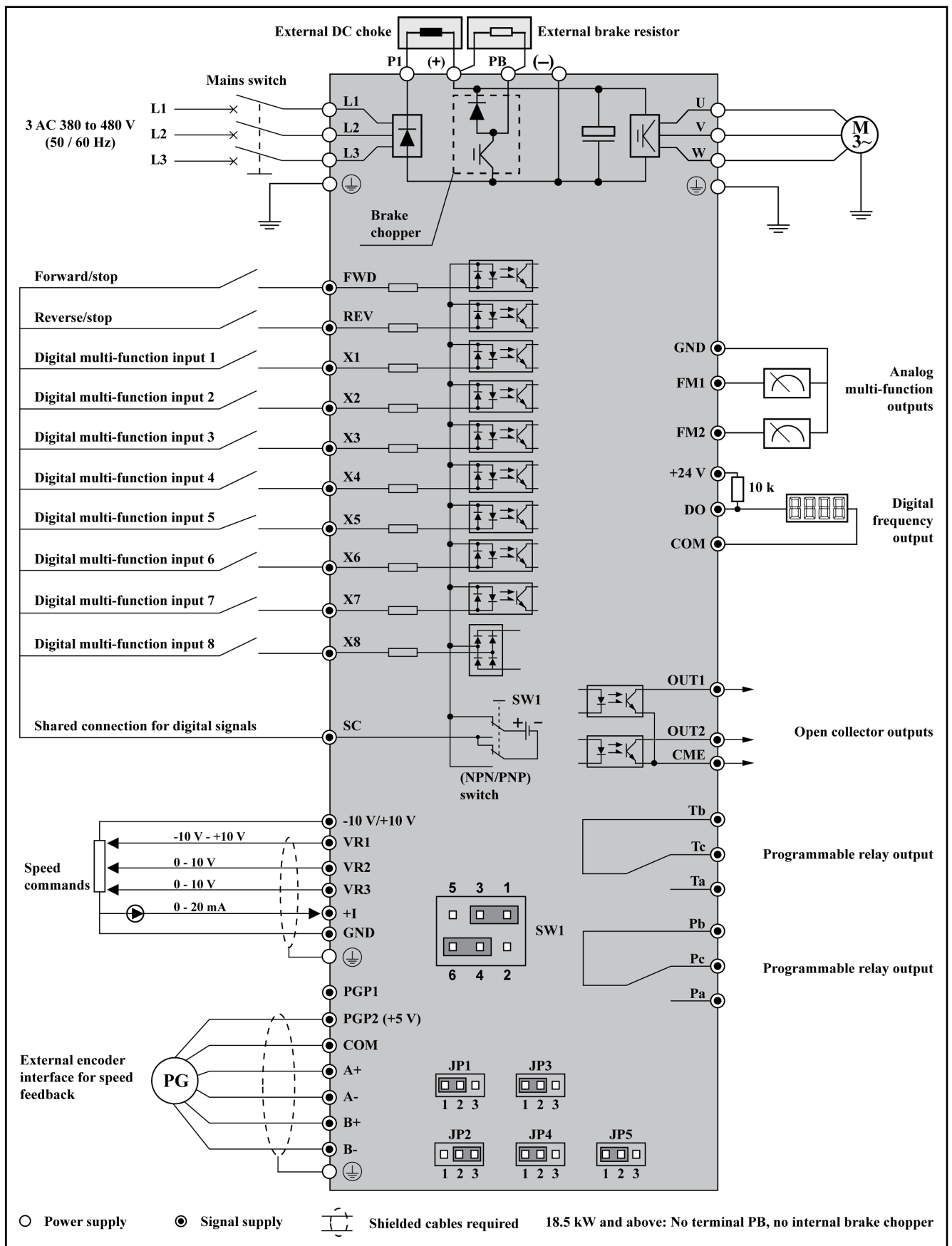
Fig. 5-5:   Block diagram

Installation

5.2.2   Main Circuit Wiring

Main circuit wiring cautions

- Connect power supply only to the main circuit terminals L1, L2 and L3. Connecting power supply to other terminals will damage the frequency converter. Ensure that the power supply voltage is within the allowable voltage range specified on the nameplate.

- The grounding terminal must be properly grounded to avoid electric shock or fire and reduce interference noise.

- Insulated crimp terminals must be used to connect terminals and conductors, to ensure the reliability of connection.

- After wiring connection, remove all wire residues, which may fall into the frequency converter and cause a failure. Be careful not to allow swarf from drilling entering the frequency converter. Check the following points after the circuit connection is completed.

  1. Are all connections correct?

  2. Are there any missing connections?

  3. Do short circuits exist between terminals and wires or ground?

- To make changes in wiring, disconnect the power and wait for 30 minutes to allow the capacitor of the DC circuit to discharge.

- For safety concerns, wiring shall be carried out with wire sizes in accordance with relevant electrical codes.

- A fuse must be provided between the main circuit terminals (L1, L2 and L3) and the 3-phase AC input power supply. It is preferable to connect a magnetic contactor (MC) in series to ensure both the action of frequency converter protection and shutting off of power supply (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 resistors may be connected between the terminal (+) and PB. Do not short circuit!

- Electromagnetic interference: The 3-phase inputs/outputs of frequency converter contain harmonic components, which may interfere with nearby communication devices (e.g. AM radio receiver). Therefore, an optional radio noise filter (only for the input side) or line noise filter may be installed to minimize interference.

- Do not attach power capacitor, surge suppressor or radio noise filter to the output side of frequency converter. This may cause frequency converter failure or damage the capacitor or suppressor. Immediately remove any such device which has been installed.

- Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code [USA] and any additional local codes.

- After connecting the power supply terminals, the motor and the control terminals, replace the cover back before switching on the power. Take account of the following instructions:

  1. Ensure that the power supply can provide appropriate voltage and current. Ensure that the rated current range of the circuit breaker is within that of the converter and the 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 shielding layer should be securely connected to the metal surface of control cabinet.

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

Main circuit wiring diagram

L1 L2 L3	Power supply	
Power supply	Ensure that the power supply meets the rated values in this manual.	
Fuse	**Fuse** The converter may take a high input current when being switched on. Please select an appropriate fuse.	
Electromagnetic contactor	**Electromagnetic contactor (MC)** Do not use an MC as the **Run/Stop** switch, because it will shorten the service life of frequency converter.	
AC input choke	**AC input choke** An AC input choke is recommended to improve power factors. The wiring length must be less than 10 m.	
AC input filter	**AC input filter**	
Frequency converter	**Frequency converter**	
AC output choke	**AC output choke** When the connecting wire is longer than 80 m, an AC output choke is suggested to be added in order to avoid motor insulation destruction.	
Motor	**Motor**	

Fig. 5-6:   *Main circuit wiring diagram*

Installation

☞   To select an appropriate fuse, please refer to chapter 5.2.4 "Cable and Fuse Dimensions" on page 45.

Main circuit wiring steps

A. Remove the screw which fixes the bottom cover, and remove the bottom cover accroding to the printed indication on it

B. Remove the protection bar on the terminals

C. Connect cables correctly to the labelled terminals and sort out the connected cables to the right positions

Main circuit terminals

E. Push back the bottom cover and fix the screw into the bottom cover to complete the connection

D. Put the protection bar on the connected terminals

Fig. 5-7:   0K40...15K0 main circuit wiring steps

A. **Remove the screw which fixes the bottom cover, and remove the bottom cover accroding to the printed indication on it**

B. **Remove the protection bar on the terminals**

C. **Connect cables correctly to the labelled terminals and sort out the connected cables to the right positions**

Main circuit terminals

E. **Push back the bottom cover and fix the screw into the bottom cover to complete the connection**

D. **Put the protection bar on the connected terminals**

Fig. 5-8:   18K5...37K0 main circuit wiring steps

Installation

A. Loosen two screws which fix the bottom cover

B. Remove the bottom cover according to the printed indication on it

C. Connect cables correctly to the labelled terminals, sort out the connected cables to the right positions

D. Push back the bottom cover, fix two screws into the bottom cover to complete the connection.
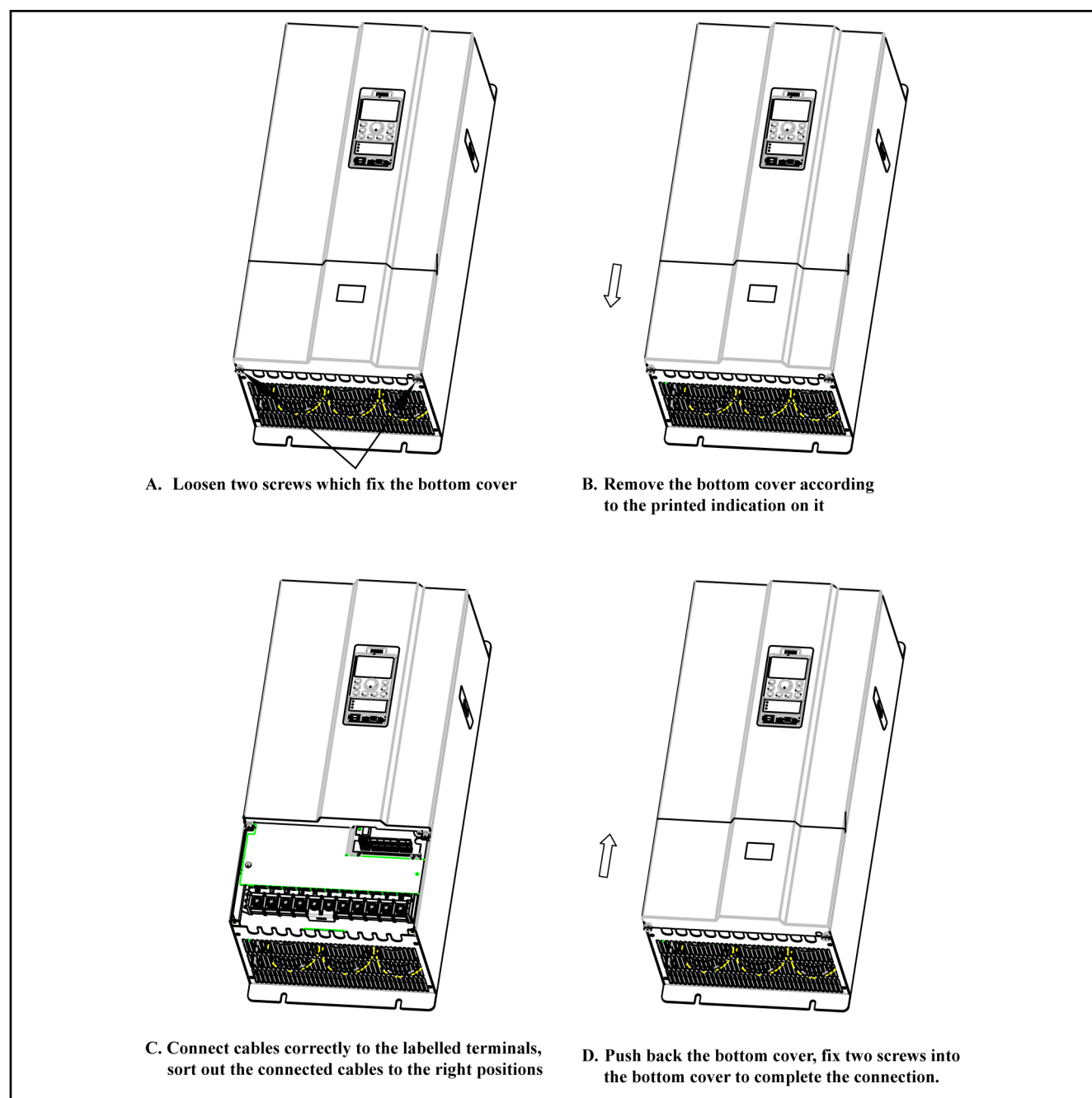
Fig. 5-9:   45K0...90K0 main circuit wiring steps

Installation

5.2.3   Control Circuit Wiring

- Terminal GND is the common terminal for analog signals, and SC is the common terminal for switch values. Do not ground these terminals. Shielded or twisted-pair cables should be used for wiring terminals for the control circuit and must be separated from the wiring of main circuit and high current circuits (including the control circuit of 200 V relay).

- 0.3...0.75 mm^2 cables are recommended for wiring of the control circuit.

- Please strip the wire insulation for wiring of the control circuit, according to the dimensions given below. Too long stripping may cause short circuit of adjacent wires, and too short stripping may lead wires becoming loose.

7 mm ± 1 mm
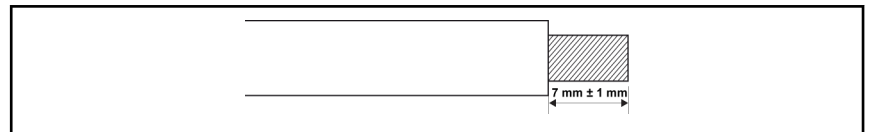
Fig. 5-10:   Wire stripping length

- If a post terminal or single-conductor wire is used, use a cable with a diameter of less than 0.9 mm. If the cable is larger than 0.9 mm, the screw may be stripped when being tightened up.

- Tighten up screws with typically 0.8 Nm / 7 lb-in torque after the cables are inserted into the terminals.

- Cables may become disconnected and cause incorrect operation if not tightened. However, over-tightening screws may break the component to cause short circuit and incorrect operation.

5.2.4   Cable and Fuse Dimensions

Introduction

The power cable 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 ℃).

The cable and fuse dimensions for USA / Canada are based on UL 508A.

☞   The manufacturer of the machine/installation is responsible for conformity with regional provisions and other standards that are relevant for the respective application and the place of installation. Also factors, such as installation methods, grounding, insulation and over-voltage protection must be taken into consideration.

National standards, such as NFPA in the USA, regional provisions, ground, operating temperature, operating cycles, over-voltage protection and system configuration can have a decisive impact on the dimensioning of the cables and therefore they must be given priority over the above factors.

☞   If, as a consequence of this, further requirement and cable designs arise that are not mentioned in this documentation, contact your Bosch Rexroth sales partner.

Installation

Recommendation on cable dimensioning:

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

Model	Input side			
	International without USA/Canada			
	Nominal current of fuse in [A]	Installation mode B1	Installation mode B2	Installation mode E
		Cable size in [mm²]	Cable size in [mm²]	Cable size in [mm²]
0K40	6	1.5	0.75	0.75
0K75	10	1.5	1	1
1K50	10	1.5	1	1
2K20	16	1.5	1	1
4K00	20	1.5	1.5	1.5
5K50	25	2.5	2.5	2.5
7K50	25	4	4	2.5
11K0	40	6	6	6
15K0	50	10	10	10
18K5	63	16	16	10
22K0	80	16	16	10
30K0	100	25	25	25
37K0	125	35	35	25
45K0	160	50	50	35
55K0	200	50	70 / 2*35	50
75K0	250	95 / 2*50	120 / 2*50	70 / 2*35
90K0	315	120 / 2*50	150 / 2*70	95 / 2*50

Tab. 5-1:   Recommended cable dimensions_input side_international without USA/Canada

1. Input side and Output side: The dimensioning is based on the supply voltage of 3P 380 VAC.
2. For screw torque information, see the following tables.
3. For "Installation mode", see fig. 5-11 "Cable installation types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)" on page 49.

Installation

Model	Input side				
	USA/Canada				
	Nominal current of fuse in [A]	Cable size in [AWG]	Screw torque for power cable terminals in [Nm / lb-in] (screw size)	Input PE[2]	
				Cable size in [mm²/AWG]	Torque in [Nm / lb-in] (screw size)
0K40	6	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
0K75	6	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
1K50	10	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
2K20	16	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
4K00	25	AWG12	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
5K50	40	AWG10	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
7K50	40	AWG10	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
11K0	70	AWG8	2.7 / 24 (M5)	10 / 8	2.0 / 18 (M5)
15K0	80	AWG6	2.7 / 24 (M5)	10 / 6	2.0 / 18 (M5)
18K5	80	AWG6	2.5/22 (M6)	10 / 6	2.5/22 (M6)
22K0	80	AWG6[1]	2.5/22 (M6)	10 / 6	2.5/22 (M6)
30K0	100	2*AWG6	2.5/22 (M6)	16 / 6	2.5/22 (M6)
37K0	125	2*AWG6	2.5/22 (M6)	25 / 4	2.5/22 (M6)
45K0	150	AWG1	8/71 (M8)	35 / 1	8/71 (M8)
55K0	175	AWG1/0	8/71 (M8)	50 / 1/0	8/71 (M8)
75K0	225	AWG3/0 / 2*AWG1	15...20 / 133...177 (M10)	70/2*35 / 2/0 / 2*1	15...20 / 133...177 (M10)
90K0	300	250 kcmil / 2*AWG1/0	15...20 / 133...177 (M10)	95/2*50 / 3/0 / 2*1/0	115...20 / 133...177 (M10)

Tab. 5-2:   *Recommended cable dimensions_input side_USA/Canada*

☞   [1]: For 22K0 (22 kW) frequency converters, only AWG6 cable of the copper 75 °C and above can be used.

[2]: The cables connecting to PE terminal should assemble the UL certificated wire connector which has suitable rating for wire gauge!

Installation

Model	Output side				
	International without USA/Canada	USA/Canada		Output PE[3]	
	Cable size in [mm²]	Cable size in [AWG]	Screw torque for power cable terminals in [Nm / lb-in] (screw size)	Cable size in [mm²/AWG]	Torque in [Nm / lb-in] (screw size)
0K40	0.75[1]	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
0K75	1[1]	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
1K50	1[1]	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
2K20	1[1]	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
4K00	1[1]	AWG14	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
5K50	1[1]	AWG12	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
7K50	2.5[1]	AWG10	1.7 / 15 (M4)	6 / 8	1.7 / 15 (M4)
11K0	6[1]	AWG8	2.7 / 24 (M5)	10 / 8	2.0 / 18 (M5)
15K0	6[1]	AWG8	2.7 / 24 (M5)	10 / 6	2.0 / 18 (M5)
18K5	10[1]	AWG6	2.5/22 (M6)	10 / 6	2.5/22 (M6)
22K0	10[1]	AWG6	2.5/22 (M6)	10 / 6	2.5/22 (M6)
30K0	16[1]	2*AWG6	2.5/22 (M6)	16 / 6	2.5/22 (M6)
37K0	25[1]	2*AWG6	2.5/22 (M6)	25 / 2x6	2.5/22 (M6)
45K0	35[2]	AWG1	8/71 (M8)	35 / 1	8/71 (M8)
55K0	35[2]	AWG1/0	8/71 (M8)	50 / 1/0	8/71 (M8)
75K0	70 / 2*35[2]	AWG3/0 / 2*AWG1	15...20 / 133...177 (M10)	70/2*35 / 2/0 / 2*1	15...20 / 133...177 (M10)
90K0	95 / 2*50[2]	250 kcmil / 2*AWG1/0	15...20 / 133...177 (M10)	95/2*50 / 3/0 / 2*1/0	115...20 / 133...177 (M10)

Tab. 5-3:   Recommended cable dimensions_output side

☞   [1]: Installation Mode E

[2]: Installation Mode B2

[3]: The cables connecting to PE terminal should assemble the UL certificated wire connector which has suitable rating for wire gauge!

Dimensioning variables of the table values

1. **Installation types:**

   - B1 according to IEC 60364-5-52, e.g. stranded wires routed in cable duct

   - B2 according to IEC 60364-5-52, e.g. multi-core line routed in cable duct

   - E according to EN 60204-1, e.g. multi-core line routed on open cable tray

   - According to NFPA 79 (external wiring), UL 508A (internal wiring), NEC, NFPA 70:

     – 1 cable with 3 conductors, 1 neutral conductor and 1 equipment grounding conductor

     – Routed in pipe on the wall

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

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

B1	Conductors in installation pipes and in installation channels that can be opened
B2	Cables or lines in installation pipes and in installation channels that can be opened
C	Cables or lines on walls
E	Cables or lines on open cable trays
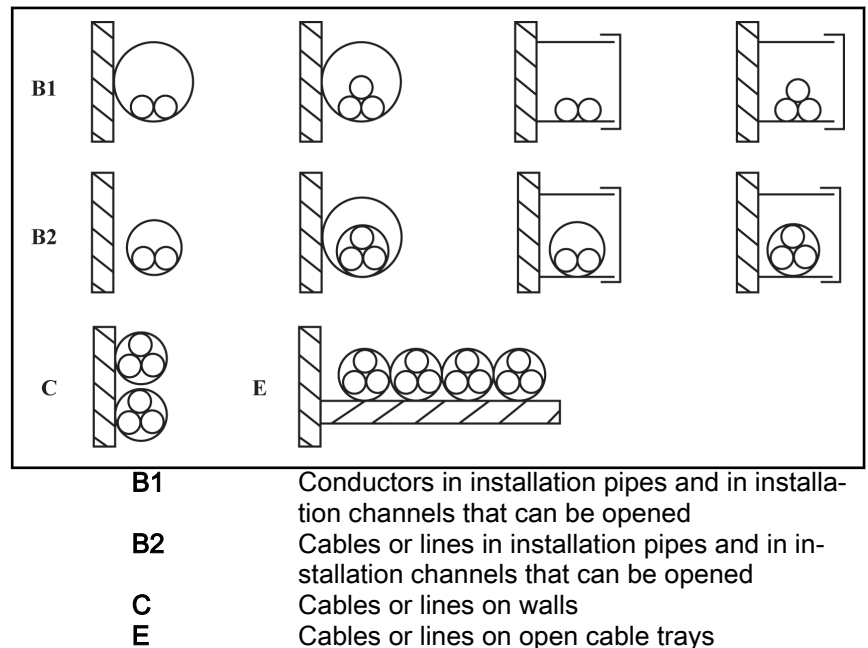
Fig. 5-11:   *Cable installation types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)*

2. **Recommendation for design of the fuses:**

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

☞   **Characteristics**

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

To **protect the semiconductors** in the frequency converters, you can use fuses of characteristic **gR**.

Installation

- USA/Canada: Class J; 600 V

Wiring dimensions for terminals

Fv model	Frame	Terminal type	Wiring dimensions [AWG]
0K40 0K75 1K50 2K20 4K00 5K50 7K50	A A A A B B B	Main circuit terminals are shown as fig. 5-12 "Main circuit terminals illustration_0K40...15K0" on page 51	10...20
		Control circuit terminals are shown as fig. 5-14 "Control circuit terminals_1" on page 54 fig. 5-15 "Control circuit terminals_2" on page 54 fig. 5-16 "Control circuit terminals_3" on page 54	16...26
11K0 15K0	C	Main circuit terminals are shown as fig. 5-12 "Main circuit terminals illustration_0K40...15K0" on page 51	4...10
		Control circuit terminals are shown as fig. 5-14 "Control circuit terminals_1" on page 54 fig. 5-15 "Control circuit terminals_2" on page 54 fig. 5-16 "Control circuit terminals_3" on page 54	16...26
18K5 22K0 30K0 37K0	D D E E	Main circuit terminals are shown as fig. 5-13 "Main circuit terminals illustration_18K5 and above" on page 51	2...12
		Control circuit terminals are shown as fig. 5-14 "Control circuit terminals_1" on page 54 fig. 5-15 "Control circuit terminals_2" on page 54 fig. 5-16 "Control circuit terminals_3" on page 54	16...26
45K0 55K0	F	Main circuit terminals are shown as fig. 5-13 "Main circuit terminals illustration_18K5 and above" on page 51	1 / 0... 8
		Control circuit terminals are shown as fig. 5-14 "Control circuit terminals_1" on page 54 fig. 5-15 "Control circuit terminals_2" on page 54 fig. 5-16 "Control circuit terminals_3" on page 54	16...26
75K0 90K0	G	Main circuit terminals are shown as fig. 5-13 "Main circuit terminals illustration_18K5 and above" on page 51	4...4 / 0
		Control circuit terminals are shown as fig. 5-14 "Control circuit terminals_1" on page 54 fig. 5-15 "Control circuit terminals_2" on page 54 fig. 5-16 "Control circuit terminals_3" on page 54	16...26

Tab. 5-4:   Wiring dimensions for terminals

5.3   Wiring Terminals Description

5.3.1   Main Circuit Terminals

Main circuit terminals description

Terminal	Description
L1, L2, L3	Mains supply input terminals
U, V, W	Frequency converter output terminals
PB	External brake resistor terminal
P1, (+)	DC choke input or DC positive bus output terminal
(−)	DC negative bus output terminal
⏚	Grounding terminal

Tab. 5-5:   Main circuit terminals description

Main circuit terminals illustration
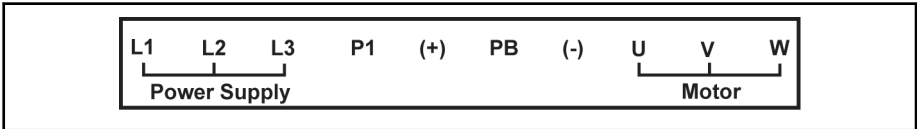
0K40...15K0

Fig. 5-12:   Main circuit terminals illustration_0K40...15K0

18K5 and above
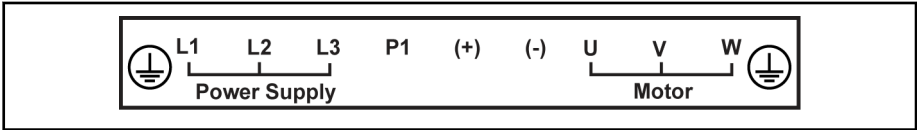
Fig. 5-13:   Main circuit terminals illustration_18K5 and above

Installation

5.3.2   Control Circuit Terminals

Control circuit terminals description

Type	Terminal	Signal function	Description	Signal requirement
Digital inputs	FWD	Forward/Stop	See parameters b1.02, E0.00	24 VDC 8 mA inputs via opto-electric couplers Depends on the position of NPN/PNP jumper SW1
Digital inputs	REV	Reverse/Stop	See parameters b1.02, E0.00	
Digital inputs	X1...X8	Multiple speed commands	Activated with "closed", see parameters E0.01...E0.08	
Digital inputs	SC	Shared connection for digital signals	Isolated from GND	
Analog inputs	±10 V	Supply voltage for external frequency setpoint value specified	Power supply for speed commands	±10 V (Max. current 10 mA)
Analog inputs	VR1	Analog frequency commands	Analog voltage frequency input 1	Input voltage range: -10...10 V Input resistance: 100 kΩ Resolution: 1 / 2000
Analog inputs	VR2		Analog voltage frequency input 2	Input voltage range: 0...10 V
Analog inputs	VR3		Analog voltage frequency input 3	Input resistance: 100 kΩ Resolution: 1 / 2000
Analog inputs	+I		Analog current frequency input	Input current range: 0...20 mA Input resistance: 165 Ω Resolution: 1 / 1000
Analog inputs	GND	Frame potential (0 V)	Isolated from COM	–

Type	Terminal	Signal function	Description	Signal requirement
Digital outputs	OUT1-CME	Open collector output 1	Can be programmed as multiple function digital outputs, see parameters E1.00, E1.01	Open collector outputs: Max. output voltage: +24 VDC Max. current: 50 mA
	OUT2-CME	Open collector output 2		
	DO-COM	Digital frequency output	Can be programmed as multiple function pulse outputs, see E1.16	Open collector outputs via optocouplers: Max. output frequency 50 kHz (set by E1.17) Max. output voltage: 24 VDC
	Ta	Relay changeover 1 contacts	Programmable multi-function relay outputs, see parameter E5.04 Ta-Tb always open Tb-Tc always closed (Tb is the shared terminal)	Rated capacity of contact transmitter: 250 VAC, 3 A 30 VDC, 3 A
	Tc			
	Tb	Relay 1 shared contact		
	Pa	Relay changeover 2 contacts	Programmable multi-function relay outputs, see parameter E1.02 Pa-Pb always open Pb-Pc always closed (Pb is the shared terminal)	Rated capacity of contact transmitter: 250 VAC, 3 A 30 VDC, 3 A
	Pc			
	Pb	Relay 2 shared contact		
	+24 V	24 VDC power supply positive	COM is 24 VDC power supply negative	–
Analog outputs	FM1-GND	Analog multi-function output 1	Programmable analog output with multiple functions. See parameters E1.10, E1.12, E1.13, E1.15 and E5.05...E5.12	Output voltage / current can be set via JP3 for FM1 and JP4 for FM2: FM1 output voltage: -10...10 V FM2 output voltage: 0...10 V Output current: 0...20 mA
	FM2-GND	Analog multi-function output 2		
Encoder signals	PGP1-COM	Supply voltage +24 V	Voltage supply 1 for the encoder Needs encoder adapter	Max. output current: 100 mA
	PGP2-COM JP5: 2-3	Supply voltage +12 V	Voltage supply 2 for the encoder Needs encoder adapter	Max. output current: 200 mA
	PGP2-COM JP5: 1-2 (Default)	Supply voltage +5 V	Voltage supply 2 for the encoder	Max. output current: 200 mA
	A+	Encoder signal A	See fig. 5-21 "Encoder jumper JP5" on page 57	Encoder supply voltage of differential inputs: +5 V, +12 V, and +24 V +12 V or +24 V encoder supply needs encoder adapter
	A-			
	B+	Encoder signal B		
	B-			

Tab. 5-6:   Control circuit terminals description

Installation

Control circuit terminals illustration
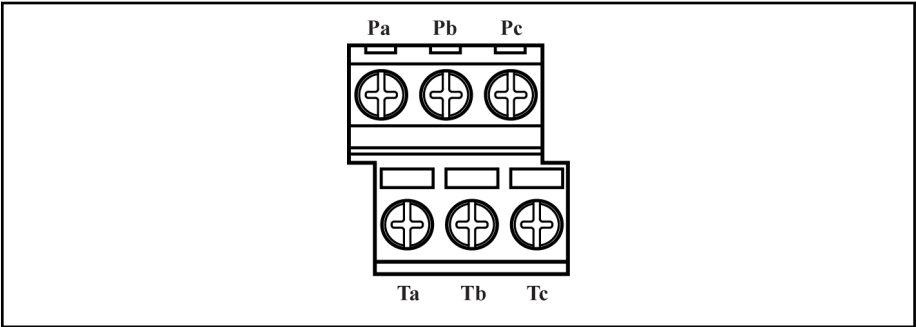
Fig. 5-14:   Control circuit terminals_1
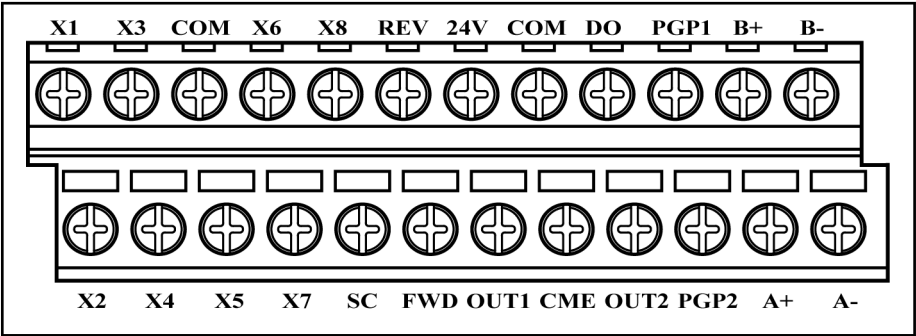
Fig. 5-15:   Control circuit terminals_2

Fig. 5-16:   Control circuit terminals_3

Installation
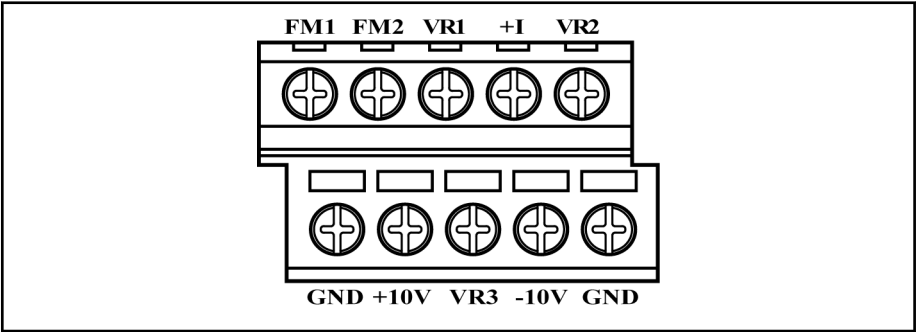
Analog input terminals (±10 V, VR1, VR2, VR3, GND, +I)
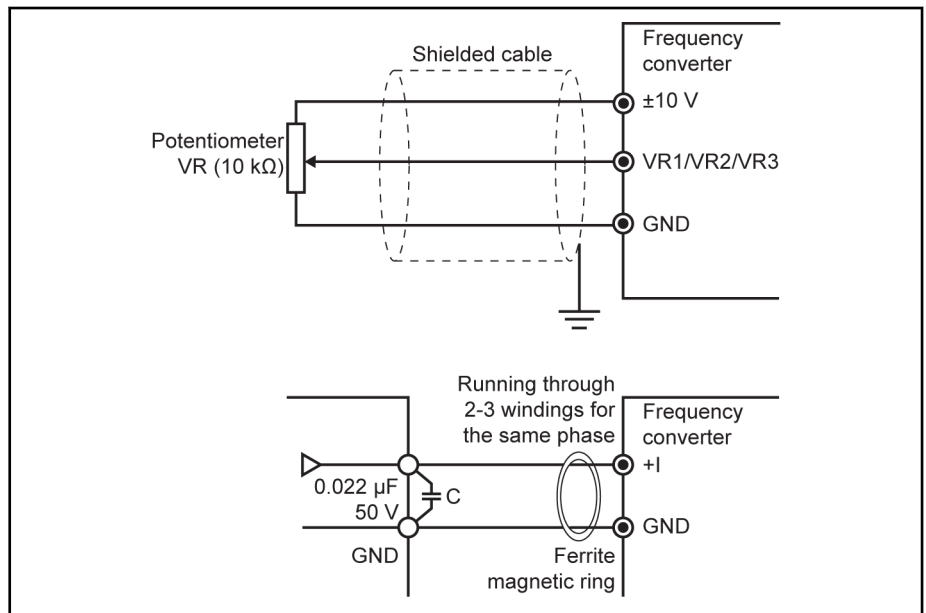
Fig. 5-17:   Analog input terminals (±10 V, VR1, VR2, VR3, GND, +I)

☞
1. For connection of low level analog signals, which are easily affected by external interference, the wiring length should be as short as possible (less than 20 m), shielded cables must be used.

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

5.3.3   Jumper Wiring

Fig. 5-18:   Jumper description

☞   Shown above are factory defaults.

Installation

5.3.4   NPN/PNP Jumper SW1
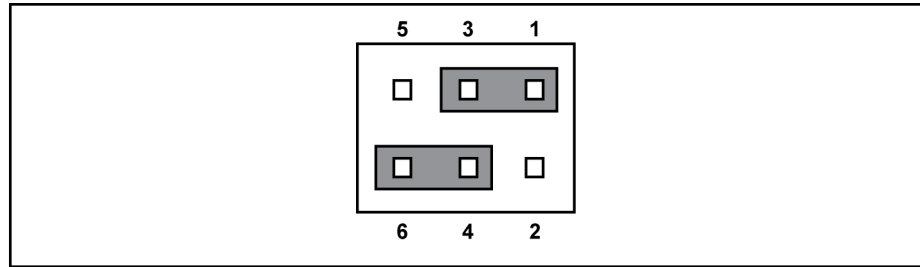
Fig. 5-19:   NPN/ PNP jumper SW1

☞   The factory default setting of the jumper is NPN (Jumper contact at 1−3, 4−6).

The jumper SW1 determines:

1. The internal 24 V power supply or an external 24 V power supply is used for the inputs.

2. The inputs are activated by connection of 24 V to an input (PNP / active input) or connection of 0 V to an input (NPN / passive input).

Modes and signal inputs

The jumper SW1 can switch between 0 V (NPN / passive input) and +24 V (PNP / active input) inputs, respective external +24 V power supply is also available, which improves the flexibility of signal input mode.
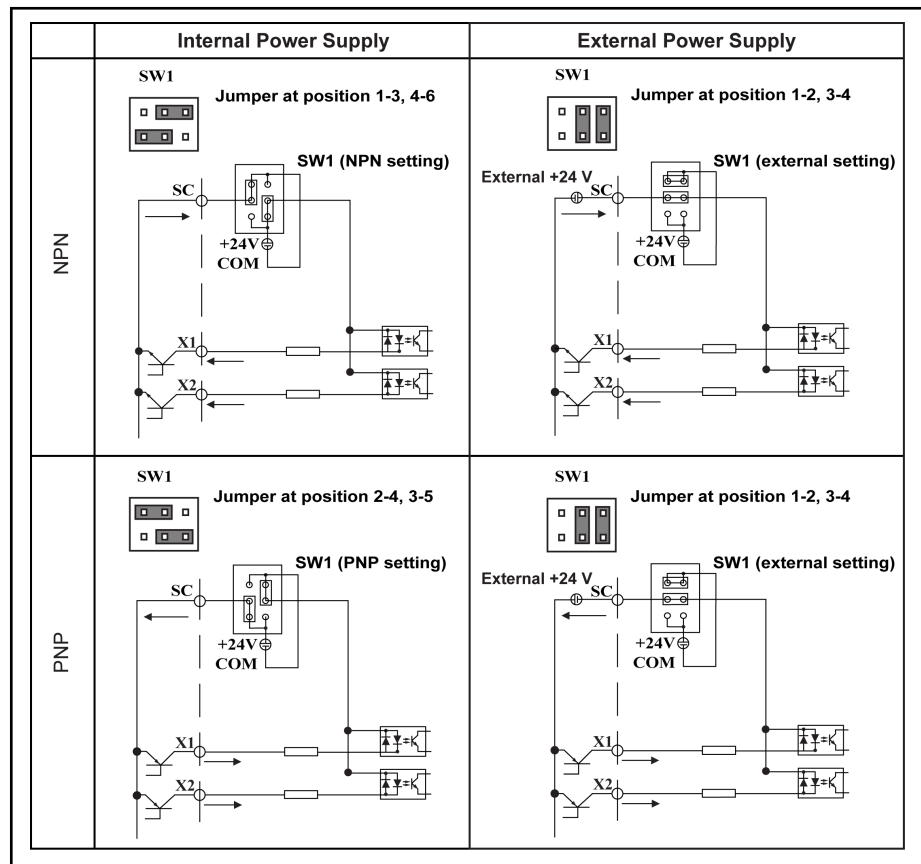
Fig. 5-20:   NPN/PNP modes and signal inputs

5.3.5   Encoder Signal Selection
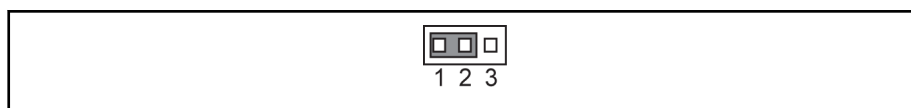
Fig. 5-21:   Encoder jumper JP5

☞   The factory default position of jumper JP5 is at 1-2.

Encoder input signals are set by jumper JP5:

Position 1-2: 5 V encoder power supply is provided by PGP2.

Position 2-3: 12 V encoder power supply is provided by PGP2.

The wiring of the encoder is described in the table below:

Encoder power supply		Encoder signal	Fv terminal wiring		Reference
Supply option	Voltage		Encoder signal wire	Other connection	
Internal	PGP1 (+24V)	A, B	A-, B-	Connect encoder adapter between Fv terminals and encoder signals	Wiring 1
		A+, A-, B+, B-	A+, A-, B+, B-		Wiring 2
	PGP2 (+12V)	A, B	A-, B-		Wiring 3
		A+, A-, B+, B-	A+, A-, B+, B-		Wiring 4
	PGP2 (+5V)	A, B	A-, B-	Connect A+, B+ to PGP2	Wiring 5
		A+, A-, B+, B-	A+, A-, B+, B-	–	Wiring 6
External	+24V	A, B	A-, B-	Connect encoder adapter between Fv terminals and encoder signals	Wiring 7
		A+, A-, B+, B-	A+, A-, B+, B-		Wiring 8
	+12V	A, B	A-, B-		Wiring 9
		A+, A-, B+, B-	A+, A-, B+, B-		Wiring 10
	+5V	A, B	A-, B-	Connect A+, B+ to external supply	Wiring 11
		A+, A-, B+, B-	A+, A-, B+, B-	–	Wiring 12

Tab. 5-7:   Encoder wiring description

Installation
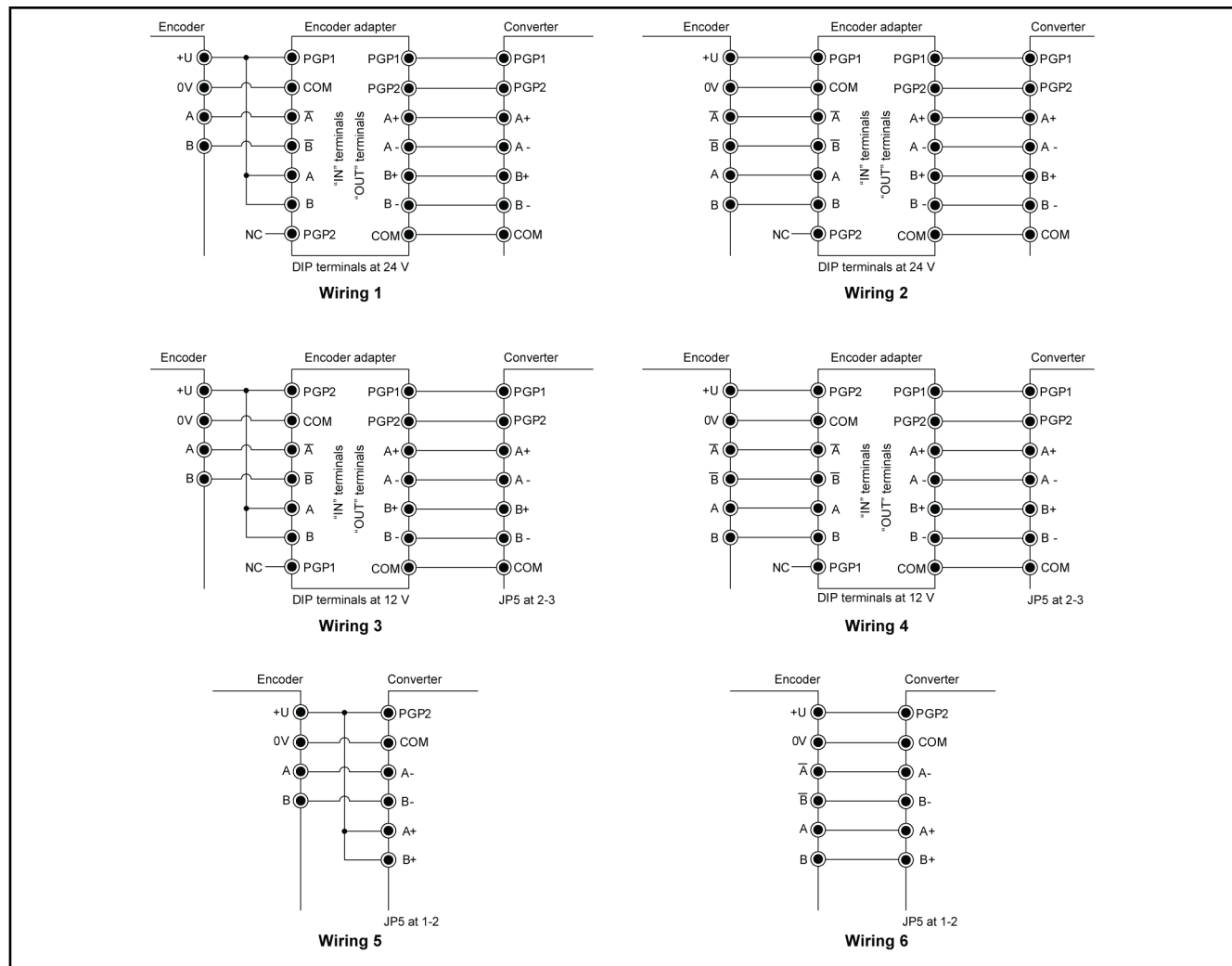
Fig. 5-22:   Encoder wiring 1...6
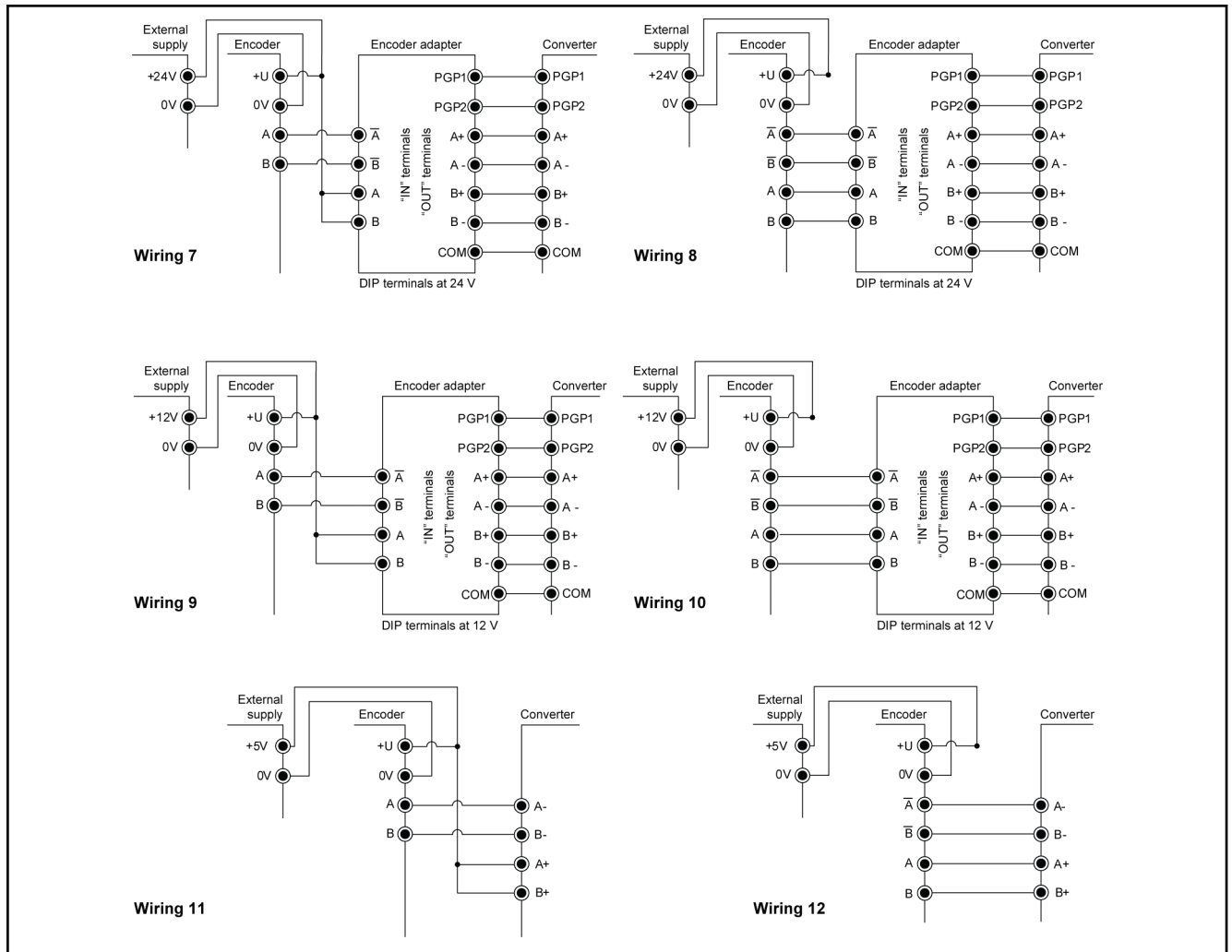
Fig. 5-23:   Encoder wiring 7...12

6 Commissioning

6.1 Operating Panel

6.1.1 Overview

The operating panel is at the center of the frequency converter and composed of two areas: display and keys. The display shows mode settings and operation state of the frequency converter. The keys allow the user to program the frequency converter.
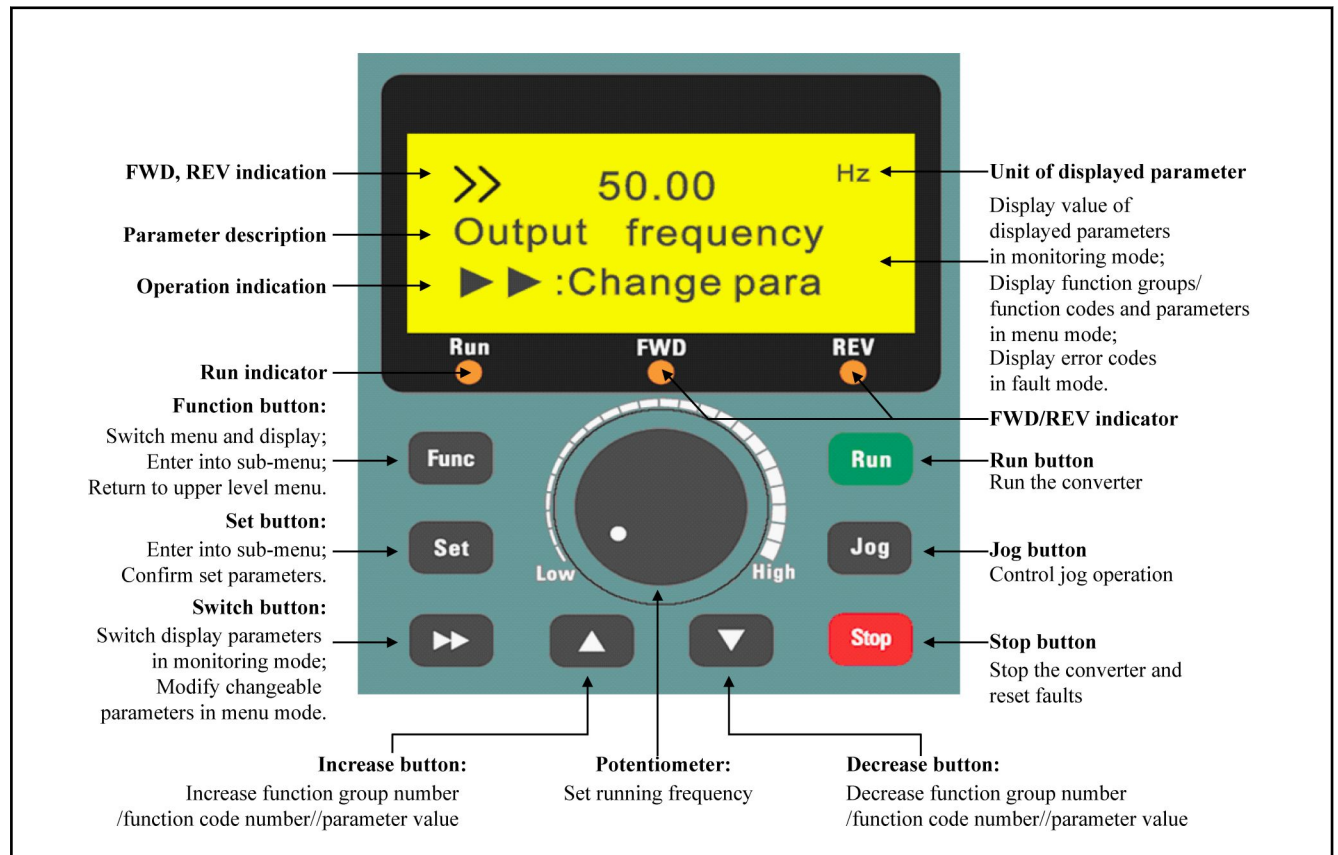
Fig. 6-1:   Fv operating panel

Commissioning

6.1.2   3-Level Menu Structure
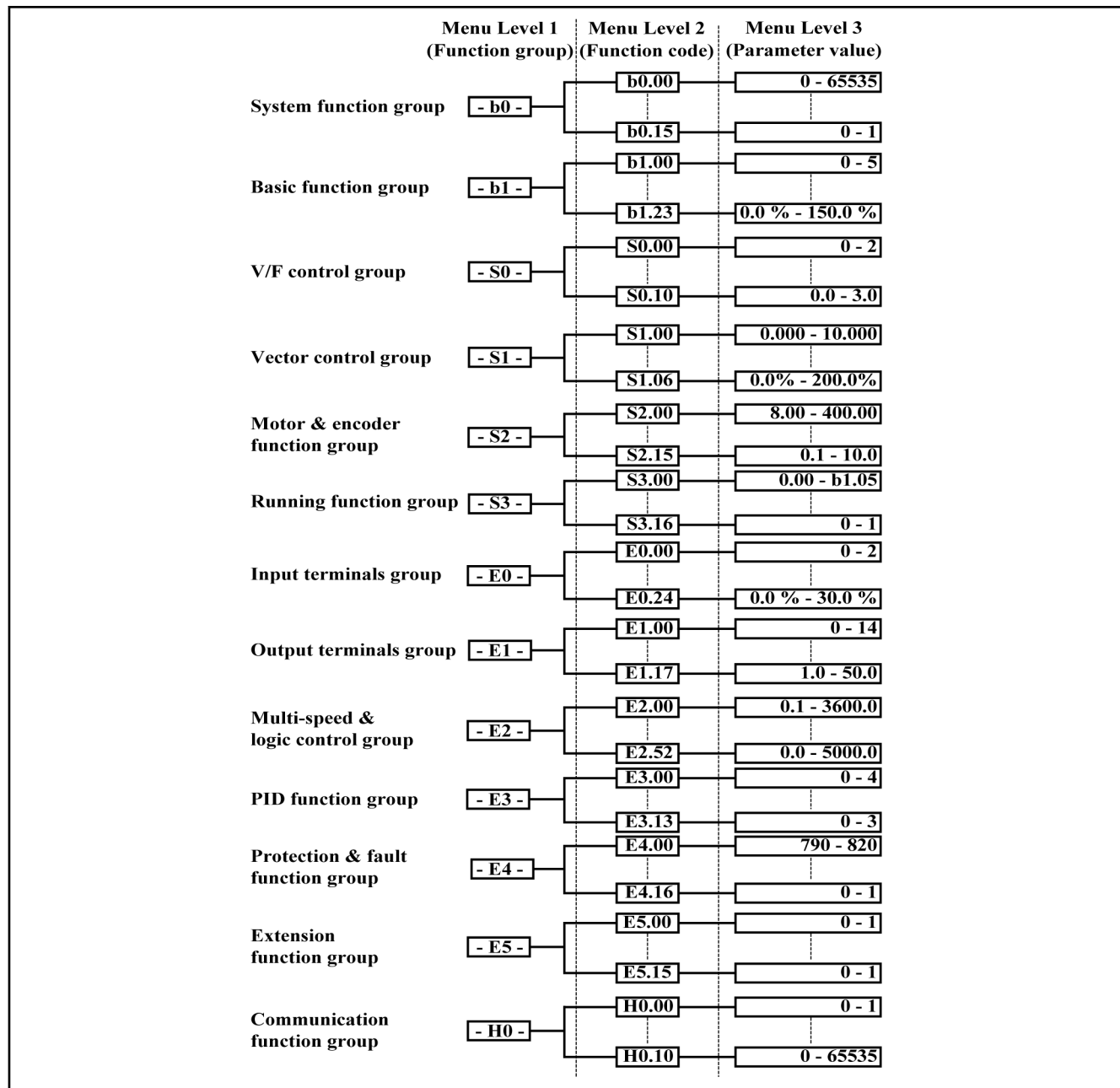
Fig. 6-2:   3-level menu structure

☞   The digital operating panel can be used to toggle between menu options, set parameters and reset the frequency converter after error with buttons **Func**, **Set**, ▲ and ▼.

6.1.3   Operation Mode Description
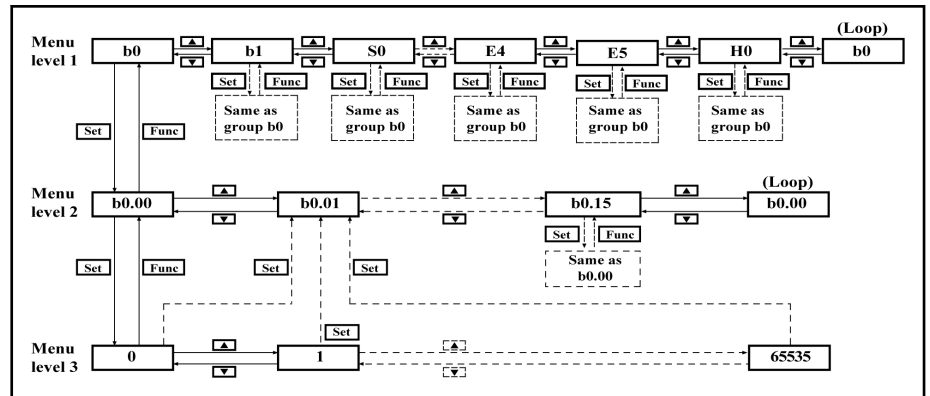
Fig. 6-3:   Operation mode description

6.1.4   Example of Operating Panel Operation
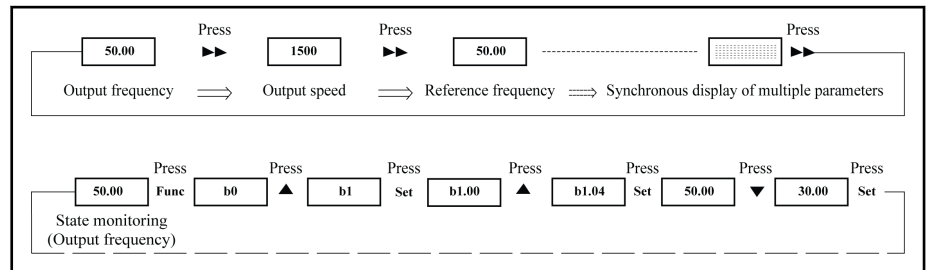
Fig. 6-4:   Example of operating panel operation

6.2   Commission Process

6.2.1   Check and Preparation before Commissioning

1. Check if the wiring is correct. Particularly, ensure that the output terminals U, V and W of the frequency converter are not connected to the power supply and that the ground terminal is well grounded.

2. Ensure that there are no short circuits between terminals, live terminals or short circuit to ground.

3. Ensure that terminal connections, connectors and screws are secure.

4. Ensure the motor is not connected to other loads.

5. Check that all inputs are off before powering on, to ensure that the frequency converter will be started as expected and no unexpected action occurs.

6. Make the following checks after powering on:

   - The set frequency flashes on the display (without error indication); if "software doesn't match" is displayed, it indicates the software version of operating panel and control board doesn't match, for which you need to consult the service.

   - The displayed parameters match with the field application.

Commissioning

6.2.2   Notes on Commissioning

1. The frequency converter 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 generate output.

2. By factory default, the frequency converter initially displays output frequency after being energized. You may change it to another parameter by changing the factory default of parameter b0.08. The factory defaults are based on standard applications with standard motors.

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

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

6.2.3   Fv Basic Parameter Fast Setting

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

Function code	Name	Setting range	Minimum unit	Factory default	Attribute
b0.04	Converter input supply voltage	380...480 V	1	380	◆
b1.09	Acceleration time 1	0.1...3,600.0 s	0.1	10.0	◇
b1.10	Deceleration time 1	0.1...3,600.0 s	0.1	10.0	◇
S2.00	Rated motor frequency	8.00...400.00 Hz	0.01	50.00	◆
S2.01	Rated motor rotation speed	1...24,000 rpm	1	1,440	◆
S2.02	Rated motor power	0.4...1,000.0 kW	0.1	Depends on model	◆
S2.03	Rated motor voltage	0...480 V	1	Depends on model	◆
S2.04	Rated motor current	0.1...1,000.0 A	0.1	Depends on model	◆

Tab. 6-1:   Basic parameter fast setting

6.2.4   Example: Commissioning of Frequency Converter with Potentiometer

The factory default output frequency setting of Fv is "Set by operating panel potentiometer".

Sequence	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: • if the motor runs in the correct direction • if the motor runs smoothly • if there is any abnormal noise or problem	Observe the running: If any abnormality occurs, stop the motor immediately by shutting off the power. Restart commissioning only after the error 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	Enter the command for stopping. The motor stops.

Tab. 6-2:   *Commissioning of converter with potentiometer*

☞   The factory default of the frequency control commands is "Set control commands by operating panel".

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

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

Output voltage / frequency	3P 380 VAC / 50 Hz SVPWM wave
Operating frequency	0.00...50.00 Hz
Acceleration / Deceleration time	Linear , Acceleration for 10 s / Deceleration for 10 s
Protection mode in case of motor overload	Rated motor current × 100 %
Operating panel options	**Run**, **Stop** control starting and stopping; panel potentiometer sets output frequency

Tab. 6-3:   *Factory defaults*

Commissioning

6.4 Solutions for Simple Error during Commissioning

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

Tab. 6-4:   Simple errors and respective solutions

6.5 Notes on Frequent Start and Stop

1. Do not use the electromagnetic contactor KM connected prior to terminals L1, L2 and L3 to start or stop the motor to avoid early aging and damage of the filter capacitor. External terminals **FWD**, **REV** and X1...X8 may be used to start and stop the frequency converter.

2. The current limiting resistor for capacitor charging may be damaged due to frequent start and stop of the motor with the electromagnetic contactor KM connected prior terminals L1, L2 and L3.

7   Parameter Settings

7.1   Main Functions

7.1.1   Control Command
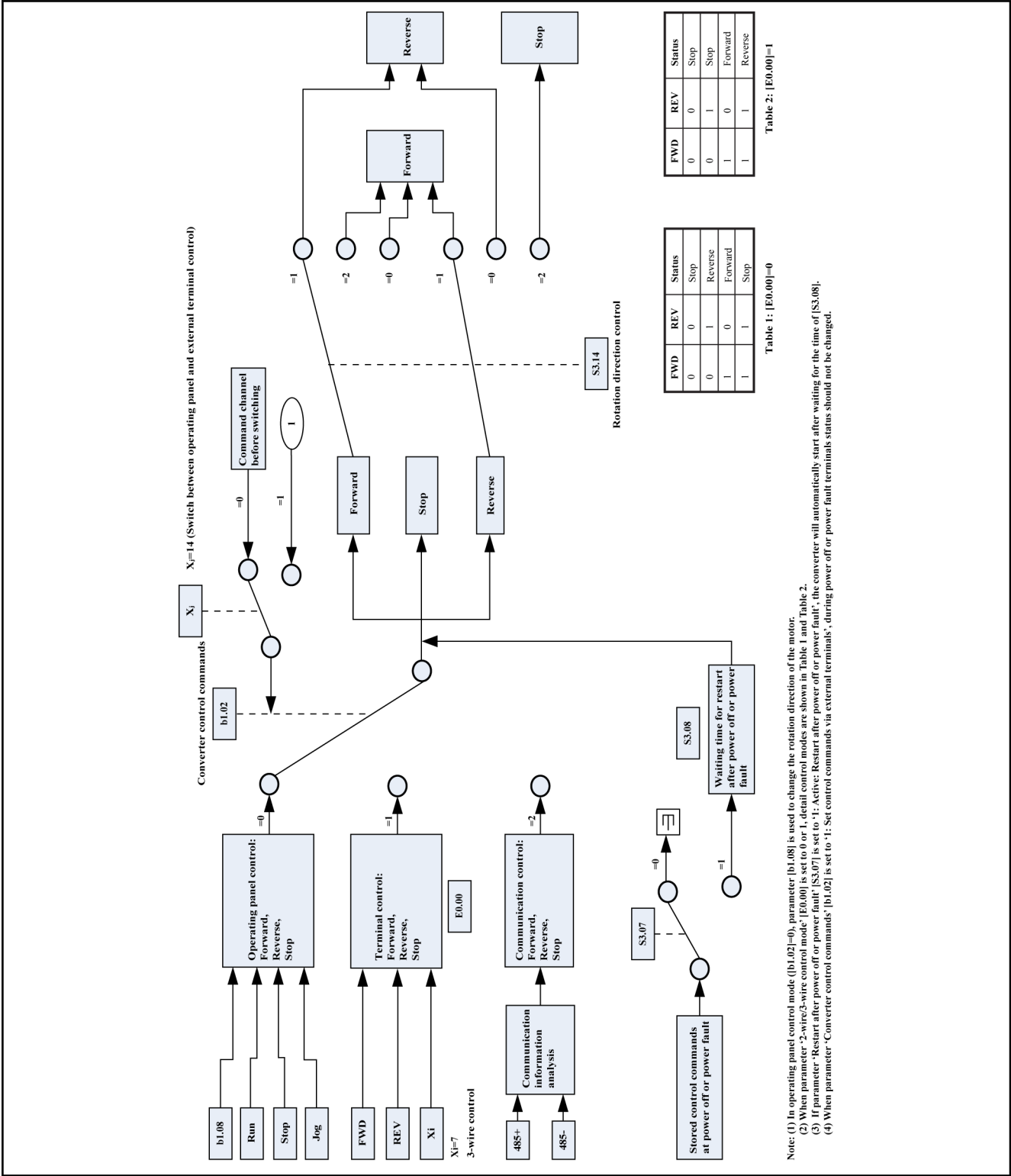
Fig. 7-1:   Control command

Parameter Settings

7.1.2   Frequency Setting
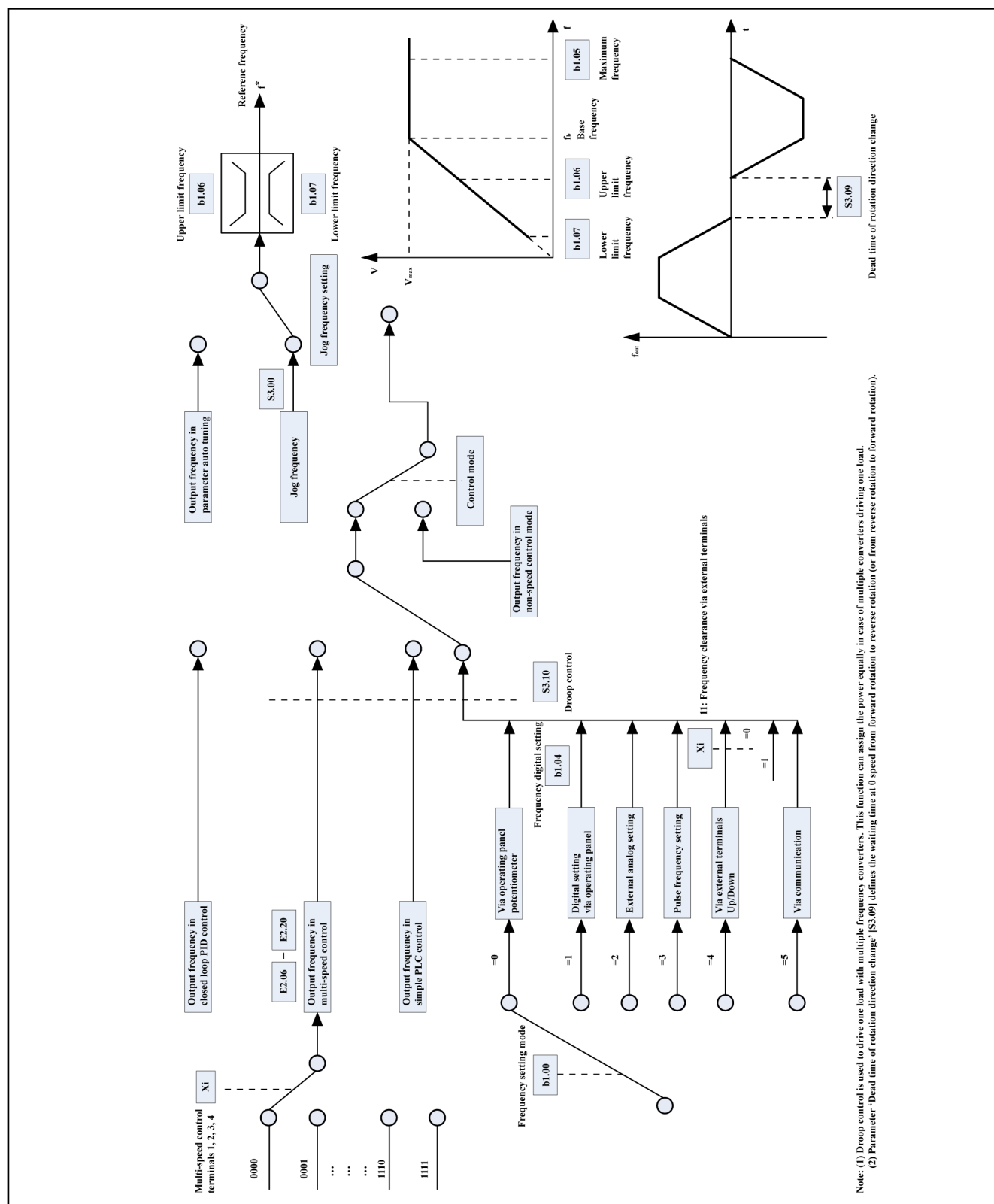
Fig. 7-2:   Frequency setting

7.1.3 Start Control
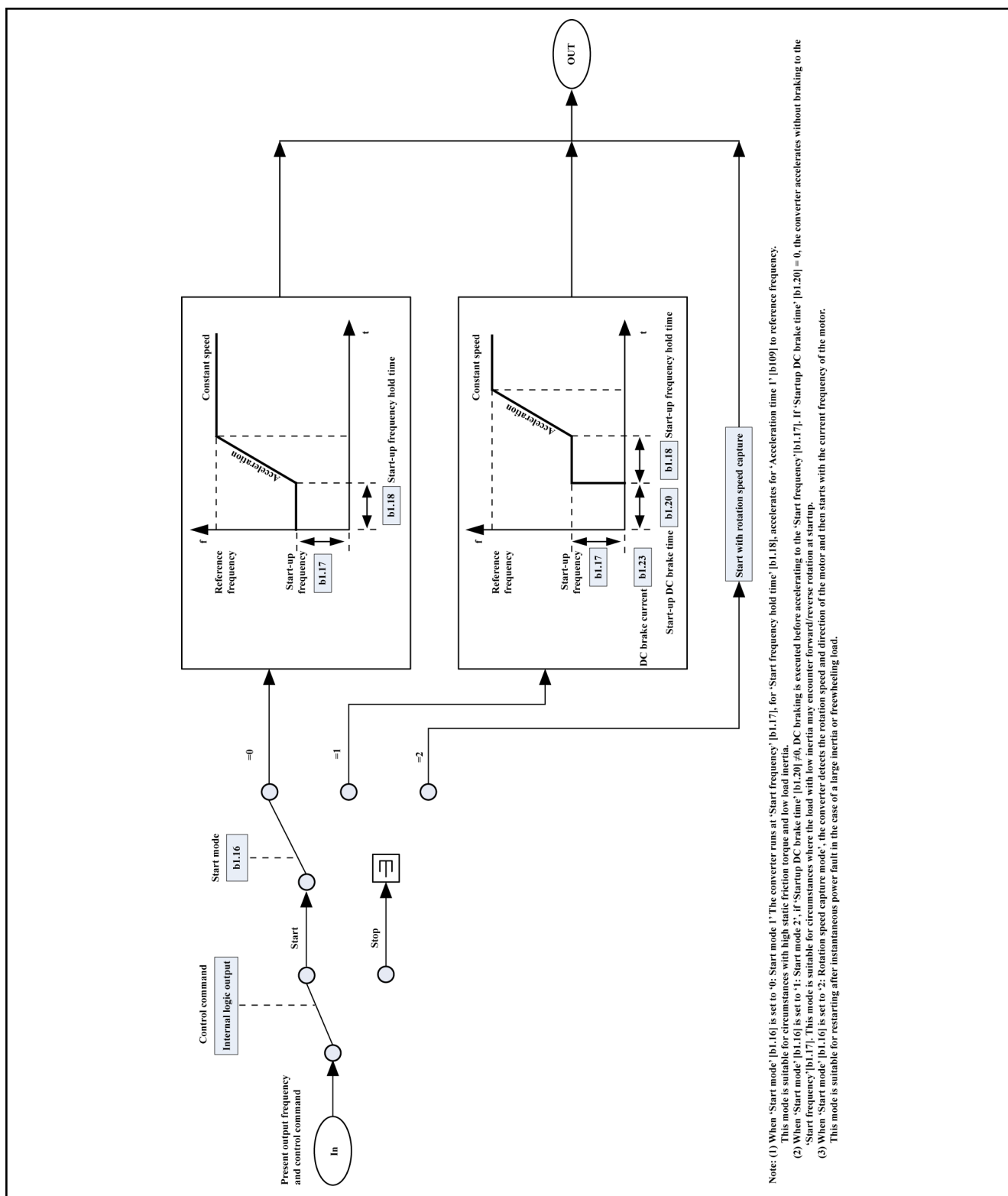
Fig. 7-3:   Start control

Parameter Settings

7.1.4   Stop Control
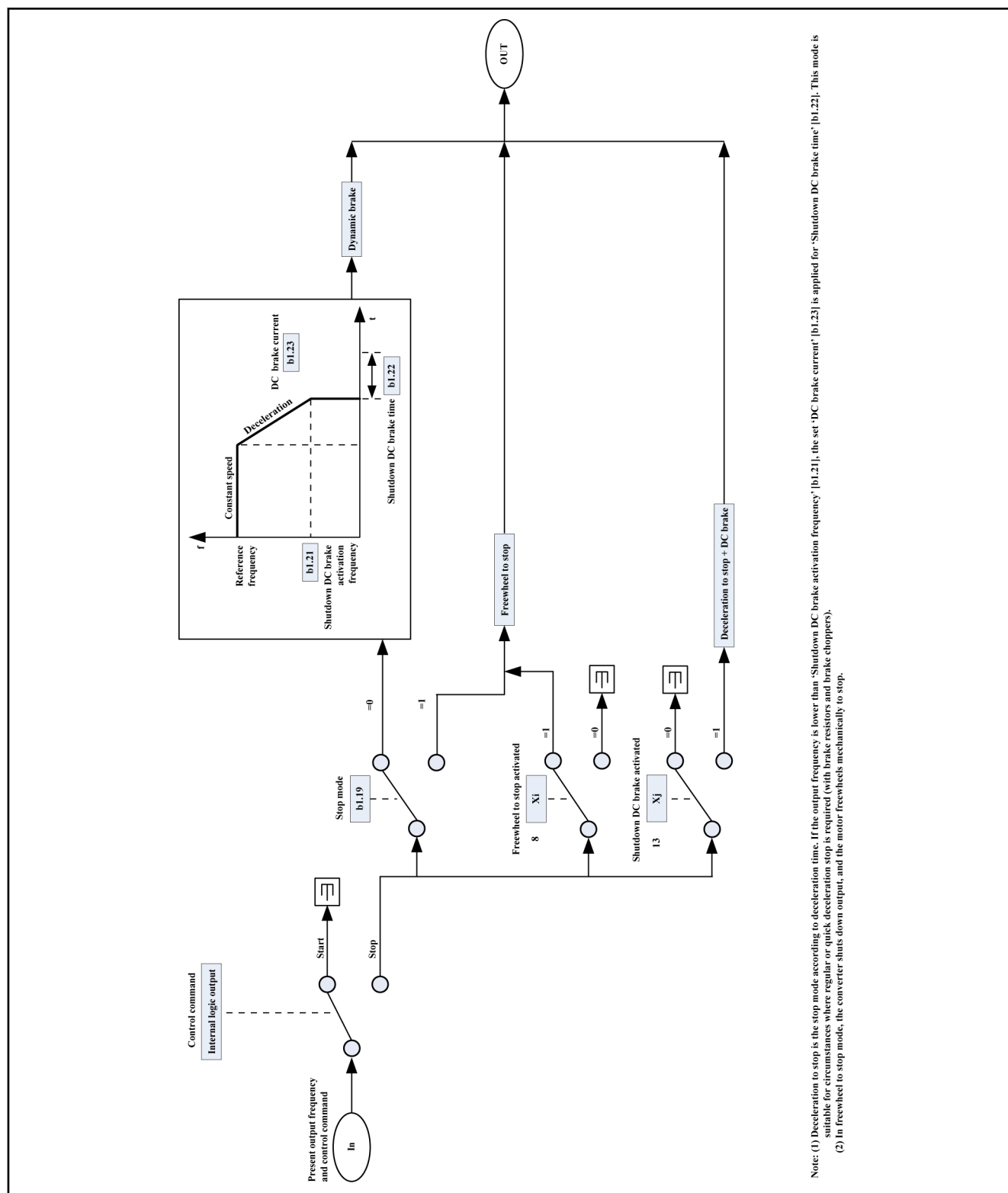
Fig. 7-4:   Stop control

7.1.5   Linear/S-curve Acceleration/Deceleration

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

Parameter Settings

7.1.6   Logic Control

Fig. 7-6:   Logic control

7.1.7 PID Control

Fig. 7-7:   PID control

Parameter Settings

7.1.8 Frequency Setting via Analog and Pulse Inputs

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

Parameter Settings

7.1.9 Multiple Function Digital Inputs

Fig. 7-9: Multiple function digital inputs

Parameter Settings

7.1.10   Analog Outputs

FM1 analog outputs

Set value	Function
0	Running frequency /rotation speed
1	Set frequency /rotation speed
2	Output current
3	Torque current

Set value	Function
4	Output voltage
5	Running frequency /rotation speed (including direction)
6	Set frequency /rotation speed (including direction)

FM2 analog outputs

Set value	Function
0	Running frequency /rotation speed
1	Set frequency /rotation speed
2	Output current

Set value	Function
3	Torque current
4	Output voltage

FM1

(-10 − +10 V / 0 − 20 mA)

FM1 negative gain setting   **E1.11**   K   **E1.12**   FM1 positive gain setting

FM1 functions   FM1 analog outputs   **E1.10**

=0 =1 =2 =3 =4 =5 =6

FM2

(0 − 10 V / 0 − 20 mA)

FM2 gain setting   **E1.15**   K

FM2 functions   FM2 analog outputs   **E1.13**

=0 =1 =2 =3 =4

Fig. 7-10:   Analog outputs

7.1.11 Digital Outputs

Set value	Function	Set value	Function
0	Converter ready to run	8	Simple PLC function complete
1	Converter in run	9	Converter over load pre-warning 1
2	DC braking	10	Motor over load pre-warning
3	Converter at 0 speed run	11	Over torque
4	Frequency/speed arrival	12	Frequency converter in fault
5	Frequency level detection signal FDT1	13	Fault auto reset signal output
6	Frequency level detection signal FDT2	14	Converter over load pre-warning 2
7	Under voltage stop	-	-

Note: (1) Parameter 'Frequency arrival detection width' [E1.03] is used to detect the difference between the output frequency and the reference frequency. If parameters [E1.00] to [E1.02] and [E5.04] are set to 4, the digital output terminals will output indication signals when the output frequency and its bias are within the setting range of [E1.03].

(2) Frequency detection level is used to detect if the output frequency is within the set FDT. If parameters [E1.00] to [E1.02] and [E5.04] are set to 5 or 6, the digital output terminals will output indication signals when the output frequency is within the setting range of FDT.

Fig. 7-11: Digital outputs

Parameter Settings

7.2   Description of Attribute Symbols in Parameter Tables

The meaning of attribute symbols in the parameter tables are explained in the table below.

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

Tab. 7-1:   Parameter attributes and descriptions

☞   Code: means function / parameter code, written in bx.xx, Sx.xx, Ex.xx and Hx.xx.

Value of function / parameter code: written in [bx.xx], [Sx.xx], [Ex.xx] and [Hx.xx].

Default: values that correspond to the factory default upon initialization at 50.00 Hz.

Attrib.: means attribute.

Parameter Settings

7.3   Parameters Functions

7.3.1   Category b: Basic Parameters

Group b0: System parameters

Code	Name	Setting range	Min.unit	Default	Attrib.
b0.00	User password	0...65,535	1	0	◇
b0.01	LCD language	0: Chinese; 1: English	1	0	◇
b0.02	Restore factory default	0: No action 1: Restore parameters to factory default Note: The value is automatically set to 0 after restoring factory default.	1	0	◆
b0.03	Parameter copy	0: No action 1: Copy from frequency converter to operating panel 2: Copy from operating panel to frequency converter Note: The value is automatically set to 0 after parameter copy.	1	0	◆
b0.04	Mains voltage	380...480 V	1	380	◆
b0.05	PWM frequency	1.0...15.0 kHz	0.1	Depends on model	◇
b0.06	Automatic adjustment of PWM frequency	0: OFF; 1: On	1	1	◆
b0.07	LCD backlight mode	0: Energy saving; 1: Always on	1	0	◇
b0.08	LCD display in run mode	0...17	1	0	◇
b0.09	LCD display in stop mode		1	2	◇
b0.10	Scale factor of user-defined value	0.1...1,000.0 %	0.1	100.0	◇
b0.11	Parameter filter setting	0: b Parameters; 1: b, S Parameters 2: b, S, E Parameters; 3: b, S, E, H Parameters	1	0	◇
b0.12	Heat sink temperature	25...100 °C	1	Measured	◎
b0.13	Total running time	0...65,535 hours	1	0	◎
b0.14	Firmware version	Read-only	–	–	◎
b0.15	Reserved	0, 1	1	0	◆

Setting range of parameters b0.08 and b0.09:

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: Torque current

9: Excitation current; 10: User-defined reference value

11: User-defined output value; 12: Reference torque

13: Digital inputs status; 14: Encoder speed feedback

15: Torque limit setting; 16: Speed limit setting; 17: Multi-monitoring display

Parameter Settings

Group b1: Basic parameters

Basic parameters

Code	Name	Setting range	Min. unit	Default	Attrib.
b1.00	Frequency setting mode	0: Set by operating panel potentiometer 1: Set by operating panel 2: Set by analog inputs 3: Set by pulse frequency 4: Set by digital inputs **Up/Down** 5: Set by communication	1	0	◆
b1.01	Saving options of digital set frequency	0: Not saved when powered off or stopped 1: Not saved when powered off; saved when stopped 2: Saved when powered off; not saved when stopped 3: Saved when powered off or stopped	1	0	◆
b1.02	Frequency converter control commands	0: Set control commands by operating panel 1: Set control commands by digital inputs 2: Set control commands by communication	1	0	◆
b1.03	Control mode	0: V/f control (V/f) 1: Sensorless vector control (SVC) 2: Field oriented vector control (FOC)	1	0	◆
b1.04	Digital set frequency	[b1.07]...[b1.06] Hz	0.01	50.00	◇
b1.05	Maximum frequency	50.00...400.00 Hz	0.01	50.00	◆
b1.06	Upper frequency	[b1.07]...[b1.05] Hz	0.01	50.00	◇
b1.07	Lower frequency	0.00...[b1.06] Hz	0.01	0.00	◇
b1.08	Operating panel controlled direction	0: Forward rotation; 1: Reverse rotation	1	0	◇

Acceleration / Deceleration time and modes

Code	Name	Setting range	Min. unit	Default	Attrib.
b1.09	Acceleration time 1	0.1...3,600.0 s	0.1	10.0	◇
b1.10	Deceleration time 1	0.1...3,600.0 s	0.1	10.0	◇
b1.11	Acceleration/deceleration mode	0: Linear mode; 1: S-curve mode	1	0	◆
b1.12	Time of S-curve rising section 1	0.0...40.0 % (of 'Acceleration time 1' [b1.09])	0.1	20.0	◆
b1.13	Time of S-curve rising section 3	0.0...40.0 % (of 'Acceleration time 1' [b1.09])	0.1	20.0	◆
b1.14	Time of S-curve falling section 4	0.0...40.0 % (of 'Deceleration time 1' [b1.10])	0.1	20.0	◆
b1.15	Time of S-curve falling section 6	0.0...40.0 % (of 'Deceleration time 1' [b1.10])	0.1	20.0	◆

Start or stop parameters

Code	Name	Setting range	Min. unit	Default	Attrib.
b1.16	Start mode	0: Start mode 1 1: Start mode 2 2: Rotation speed capture mode	1	0	◆
b1.17	Start frequency	0.00...15.00 Hz	0.01	0.50	◆
b1.18	Start frequency hold time	0.0...10.0 s	0.1	0.0	◆
b1.19	Stop mode	0: Decelerate to stop 1: Freewheel to stop	1	0	◆

DC brake

Code	Name	Setting range	Min. unit	Default	Attrib.
b1.20	Startup DC brake time	0.0...20.0 s (0.0 s deactivates DC braking)	0.1	0.0	◆
b1.21	Shutdown DC brake activation frequency	0.00...10.00 Hz	0.01	0.00	◆
b1.22	Shutdown DC brake time	0.0...20.0 s (0.0 s deactivates DC braking)	0.1	0.0	◆
b1.23	DC brake current	0.0...150.0 % (of rated frequency converter current)	0.1	0.0	◆

Parameter Settings

7.3.2   Category S: Standard Parameters

Group S0: V/f control

Code	Name	Setting range	Min. unit	Default	Attrib.
S0.00	V/f mode	0: Linear mode 1: Square mode 2: User-defined multipoint mode	1	0	◆
S0.01	V/f frequency 1	0.00...[S0.03] Hz	0.01	0.00	◆
S0.02	V/f voltage 1	0.0...120.0 % (of 'Rated motor voltage' [S2.03])	0.1	0.0	◆
S0.03	V/f frequency 2	[S0.01]...[S0.05] Hz	0.01	0.00	◆
S0.04	V/f voltage 2	0.0...120.0 % (of 'Rated motor voltage' [S2.03])	0.1	0.0	◆
S0.05	V/f frequency 3	[S0.03]...[b1.05] Hz	0.01	0.00	◆
S0.06	V/f voltage 3	0.0...120.0 % (of 'Rated motor voltage' [S2.03])	0.1	0.0	◆
S0.07	Slip compensation	0.00...10.00 Hz	0.01	0.00	◆
S0.08	Torque increase	0.0...20.0 % (of rated frequency converter voltage) • 0.0 %: Automatic increase • 0.1 %...20.0 %: Manual increase	0.1	0.1	◆
S0.09	Automatic voltage stabilization	0: Not active 1: Always active 2: Not active during deceleration and braking	1	0	◆
S0.10	Oscillation suppression gain	0.0...3.0 (0.0: deactivated)	0.1	0.3	◇

Group S1: Vector control

Code	Name	Setting range	Min. unit	Default	Attrib.
S1.00	Speed feedback proportional gain	0.000...10.000	0.001	1.000	◆
S1.01	Speed feedback integral time	0.000...10.000 s (0.000 s means inactive)	0.001	1.000	◆
S1.02	Torque limit	0.0...200.0 % (of rated motor current)	0.1	150.0	◆
S1.03	Slip compensation gain	50.0...250.0 %	0.1	100.0	◆
S1.04	Torque control selection	0: Inputs control 1: Always active	1	0	◆
S1.05	Torque control reference	0: Input +I 1: Input VR1 2: Digital setting 3: Set by communication	1	0	◆
S1.06	Torque digital setting	0.0...200.0 %	0.1	100.0	◇

Parameter Settings

Group S2: Motor and encoder parameters

Motor nameplate parameters

Code	Name	Setting range	Min. unit	Default	Attrib.
S2.00	Rated motor frequency	8.00...400.00 Hz	0.01	50.00	◆
S2.01	Rated motor rotation speed	1...24,000 rpm	1	1,440	◆
S2.02	Rated motor power	0.4...1,000.0 kW	0.1	Depends on model	◆
S2.03	Rated motor voltage	0...900 V	1		◆
S2.04	Rated motor current	0.1...1,000.0 A	0.1		◆

Motor parameters and adjustment

Code	Name	Setting range	Min. unit	Default	Attrib.
S2.05	Stator resistance factor	0.00...50.00 %	0.01	Depends on model	◆
S2.06	Rotator resistance factor	0.00...50.00 %	0.01		◆
S2.07	Leakage inductance factor	0.00...50.00 %	0.01		◆
S2.08	Mutual inductance factor	0.0...2,000.0 %	0.1		◆
S2.09	No-load current	0.0...1,000.0 A	0.1		◆
S2.10	Parameter auto-tuning	0: No action 1: Auto tuning with running motor 2: Auto tuning with static motor Warning: Motor load has to be removed before using auto-tuning function. Note: The value is automatically set to 0 after auto-tuning.	1	0	◆
S2.11	Reserved	0, 1	1	0	◆

Encoder parameters

Code	Name	Setting range	Min. unit	Default	Attrib.
S2.12	Pulses per revolution of pulse encoder	1...20,000	1	1,024	◆
S2.13	Pulse encoder direction reverse	0: No reverse 1: Reverse	1	0	◆
S2.14	Pulse encoder error detection extent	0.0...1,000.0 rpm (0.0 rpm: No break protection)	0.1	0.0	◆
S2.15	Pulse encoder error detection time	0.1...10.0 s	0.1	1.0	◆

Parameter Settings

Group S3: Control parameters

Jog

Code	Name	Setting range	Min. unit	Default	Attrib.
S3.00	Jog frequency	0.00...[b1.05] Hz	0.01	5.00	◆
S3.01	Jog acceleration time	0.1...3,600.0 s	0.1	5.0	◇
S3.02	Jog deceleration time	0.1...3,600.0 s	0.1	5.0	◇

Skip frequency

Code	Name	Setting range	Min. unit	Default	Attrib.
S3.03	Skip frequency 1	[b1.07]...[b1.06] Hz	0.01	0.00	◆
S3.04	Skip frequency 2	[b1.07]...[b1.06] Hz	0.01	0.00	◆
S3.05	Skip frequency 3	[b1.07]...[b1.06] Hz	0.01	0.00	◆
S3.06	Skip frequency range	0.00...30.00 Hz	0.01	0.00	◆

Restart after power off or power fault

Code	Name	Setting range	Min. unit	Default	Attrib.
S3.07	Restart after power off or power fault	0: Deactivated 1: Activated	1	0	◆
S3.08	Waiting time to restart after power off or power fault	0.1...10.0 s	0.1	1.0	◆

Other parameters in Group S3

Code	Name	Setting range	Min. unit	Default	Attrib.
S3.09	Direction change dead time	0.0...3,600.0 s	0.1	4.0	◆
S3.10	Droop control	0.00...10.00 Hz	0.01	0.00	◆
S3.11	Setting velocity by **Up/Down**	0.01...100.00 Hz/s	0.01	0.08	◇
S3.12	Brake chopper threshold	600...785 V	1	770	◆
S3.13	Braking duty cycle	0...100 %	1	100	◆
S3.14	Motor rotation direction	0: Standard motor direction 1: Reverse standard motor direction 2: Deactivate reverse motor rotation	1	0	◆
S3.15	**Stop** key validity	0: Valid only for operating panel control 1: Valid for all control means	1	1	◆
S3.16	Fan control	0: Temperature controlled 1: Always on	1	0	◇

Parameter Settings

7.3.3   Category E - Extended Parameters

Group E0: Analog and digital inputs

Multi- function digital inputs

Code	Name	Setting range	Min. unit	Default	Attrib.
E0.00	2-wire/3-wire control mode	0: Forward/Stop, Reverse/Stop 1: Forward/Reverse, Run/Stop 2: 3-wire control	1	0	◆
E0.01 ... E0.08	Digital input X1 ... Digital input X8	0...29	1	0	◆

Setting range of parameters E0.00...E0.08:

0: Inactive (allows multiple selection)

1: Multi-speed control 1

2: Multi-speed control 2

3: Multi-speed control 3

4: Multi-speed control 4

5: Acceleration/deceleration time 1

6: Acceleration/deceleration time 2

7: 3-wire control

8: Freewheel to stop

9: Frequency increment **Up**

10: Frequency decrement **Down**

11: Set frequency to 0

12: Reserved

13: Activate shutdown DC brake

14: Switch between operating panel and digital inputs control

15: Logic control deactivated

16: Logic control paused

17: Switch between speed and torque control

18: Switch between VR1 and +I analog reference

19: External error N.O. contact input

20: External error N.C. contact input

21: External **Reset** input

22: Activate communication control

23: Torque limit set by VR1 enabled

24: Torque limit set by VR2 enabled

25: Forward jogging

26: Reverse jogging

27: Process PID deactivated

28: Speed limit set by VR1 enabled

29: Speed limit set by VR2 enabled

Parameter Settings

Analog inputs

Code	Name	Setting range	Min. unit	Default	Attrib.
E0.09	Source of analog frequency setting	0...7	1	0	◆
E0.10	VR1 channel amplification factor k1	0.00...10.00	0.01	1.00	◆
E0.11	VR2 channel amplification factor k2	0.00...10.00	0.01	1.00	◆
E0.12	+I channel amplification factor k3	0.00...10.00	0.01	1.00	◆
E0.13	Reference frequency curve	0...31	1	0	◆
E0.14	Analog channel filter time	0.000...2.000 s	0.001	0.100	◆
E0.15	Maximum input pulse frequency	1.0...50.0 kHz	0.1	20.0	◆
E0.16	Curve 1 minimum reference	0.0 %...[E0.18]	0.1	0.0	◆
E0.17	Frequency corresponding to curve 1 minimum reference	0.00...[b1.06] Hz	0.01	0.00	◆
E0.18	Curve 1 maximum reference	[E0.16]...100.0 %	0.1	100.0	◆
E0.19	Frequency corresponding to curve 1 maximum reference	0.00...[b1.06] Hz	0.01	50.00	◆
E0.20	Curve 2 minimum reference	0.0 %...[E0.22]	0.1	0.0	◆
E0.21	Frequency corresponding to curve 2 minimum reference	0.00...[b1.06] Hz	0.01	0.00	◆
E0.22	Curve 2 maximum reference	[E0.20]...100.0 %	0.1	100.0	◆
E0.23	Frequency corresponding to curve 2 maximum reference	0.00...[b1.06] Hz	0.01	50.00	◆
E0.24	Analog reference forward/reverse dead zone control value at -10...+10 V	0.0...30.0 %	0.1	0.0	◆

Setting range of parameter E0.09:

0: k1 × VR1

1: k2 × VR2

2: k3 × (+I)

3: k1 × VR1 + k2 × VR2

4: k1 × VR1 + k3 × (+I)

5: k2 × VR2 + k3 × (+I)

6: k1 × VR1 (only valid for -10...+10 V forward/reverse control)

7: k4 × VR3

Setting range of parameter E0.13:

bit4: VR3 reference frequency characteristic curve

0: Curve 1; 1: Curve 2

bit3: Pulse reference frequency characteristic curve

0: Curve 1; 1: Curve 2

bit2: +I reference frequency characteristic curve

0: Curve 1; 1: Curve 2

bit1: VR2 reference frequency characteristic curve

0: Curve 1; 1: Curve 2

bit0: VR1 reference frequency characteristic curve

0: Curve 1; 1: Curve 2

Parameter Settings

Group E1: Digital and analog outputs

Multi-function digital outputs

Code	Name	Setting range	Min. unit	Default	Attrib.
E1.00	Open collector output OUT1		1	1	◆
E1.01	Open collector output OUT2	0...14	1	1	◆
E1.02	Relay outputs Pa, Pb and Pc		1	1	◆
E1.03	Frequency arrival detection width	0.0...20.0 % (of maximum frequency [b1.05])	0.1	5.0	◇
E1.04	Frequency detection level FDT1	0.0...100.0 % (of maximum frequency [b1.05])	0.1	90.0	◇
E1.05	Frequency detection level FDT1 width	0.0...100.0 % (of maximum frequency [b1.05])	0.1	5.0	◇
E1.06	Frequency detection level FDT2	0.0...100.0% (of maximum frequency [b1.05])	0.1	50.0	◇
E1.07	Frequency detection level FDT2 width	0.0...100.0 % (of maximum frequency [b1.05])	0.1	5.0	◇
E1.08	Frequency converter over load pre-warning 1 level setting	20.0...100.0 % (of rated frequency converter current)	0.1	100.0	◇
E1.09	Motor over load pre-warning level setting	100.0...250.0 % (of rated motor current)	0.1	100.0	◇

Setting range of parameters E1.00...E1.02:

0: Frequency converter is ready to run

1: Frequency converter is running

2: DC brake active

3: Frequency converter runs at zero speed

4. Frequency/speed arrival signal

5. Frequency level detection signal (FDT1)

6. Frequency level detection signal (FDT2)

7: Logic control phase completed

8: Under voltage stop

9: Frequency converter over load pre-warning 1

10: Motor over load pre-warning

11: Over torque

12: Frequency converter in error

13: Error auto reset signal output

14: Frequency converter over load pre-warning 2

Parameter Settings

Analog outputs

Code	Name	Setting range	Min. unit	Default	Attrib.
E1.10	FM1 analog output	0: Output frequency / rotation speed 1: Set frequency / rotation speed 2: Output current 3: Torque current 4: Output voltage 5: Output frequency / rotation speed (including direction) 6: Set frequency / rotation speed (including direction)	1	0	◇
E1.11	FM1 negative gain setting	0.00...10.00	0.01	1.00	◇
E1.12	FM1 positive gain setting	0.00...10.00	0.01	1.00	◇
E1.13	FM2 analog output	0: Output frequency / rotation speed 1: Set frequency / rotation speed 2: Output current 3: Torque current 4: Output voltage	1	1	◇
E1.14	Reserved	0, 1	1	0	◆
E1.15	FM2 gain setting	0.00...10.00	0.01	1.00	◇

DO pulse outputs

Code	Name	Setting range	Min. unit	Default	Attrib.
E1.16	Pulse outputs	0: Output frequency 1: Output voltage 2: Output current	1	0	◇
E1.17	Maximum output pulse frequency	1.0...50.0 kHz	0.1	10.0	◇

Group E2: Multi-Speed and logic control

Acceleration/deceleration time

Code	Name	Setting range	Min. unit	Default	Attrib.
E2.00	Acceleration time 2	0.1...3,600.0 s	0.1	10.0	◇
E2.01	Deceleration time 2	0.1...3,600.0 s	0.1	10.0	◇
E2.02	Acceleration time 3	0.1...3,600.0 s	0.1	10.0	◇
E2.03	Deceleration time 3	0.1...3,600.0 s	0.1	10.0	◇
E2.04	Acceleration time 4	0.1...3,600.0 s	0.1	10.0	◇
E2.05	Deceleration time 4	0.1...3,600.0 s	0.1	10.0	◇

Multi-speed frequency

Code	Name	Setting range	Min. unit	Default	Attrib.
E2.06	Multi-speed frequency 1	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.07	Multi-speed frequency 2	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.08	Multi-speed frequency 3	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.09	Multi-speed frequency 4	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.10	Multi-speed frequency 5	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.11	Multi-speed frequency 6	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.12	Multi-speed frequency 7	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.13	Multi-speed frequency 8	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.14	Multi-speed frequency 9	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.15	Multi-speed frequency 10	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.16	Multi-speed frequency 11	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.17	Multi-speed frequency 12	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.18	Multi-speed frequency 13	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.19	Multi-speed frequency 14	[b1.07]...[b1.06] Hz	0.01	0.00	◇
E2.20	Multi-speed frequency 15	[b1.07]...[b1.06] Hz	0.01	0.00	◇

Logic control

Code	Name	Setting range	Min. unit	Default	Attrib.
E2.21	Logic control mode	0: Inactive; 1: Mode 1 2: Mode 2; 3: Mode 3	1	0	◆
E2.22	Logic control time factor	1...60	1	1	◆
E2.23	Stage 1 action selection	0...31	1	0	◆
E2.24	Stage 1 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.25	Stage 2 action selection	0...31	1	0	◆
E2.26	Stage 2 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.27	Stage 3 action selection	0...31	1	0	◆
E2.28	Stage 3 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.29	Stage 4 action selection	0...31	1	0	◆
E2.30	Stage 4 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.31	Stage 5 action selection	0...31	1	0	◆
E2.32	Stage 5 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.33	Stage 6 action selection	0...31	1	0	◆
E2.34	Stage 6 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.35	Stage 7 action selection	0...31	1	0	◆
E2.36	Stage 7 running time	0.0...5,000.0 s	0.1	0.0	◆

Parameter Settings

Code	Name	Setting range	Min. unit	Default	Attrib.
E2.37	Stage 8 action selection	0...31	1	0	◆
E2.38	Stage 8 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.39	Stage 9 action selection	0...31	1	0	◆
E2.40	Stage 9 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.41	Stage 10 action selection	0...31	1	0	◆
E2.42	Stage 10 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.43	Stage 11 action selection	0...31	1	0	◆
E2.44	Stage 11 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.45	Stage 12 action selection	0...31	1	0	◆
E2.46	Stage 12 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.47	Stage 13 action selection	0...31	1	0	◆
E2.48	Stage 13 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.49	Stage 14 action selection	0...31	1	0	◆
E2.50	Stage 14 running time	0.0...5,000.0 s	0.1	0.0	◆
E2.51	Stage 15 action selection	0...31	1	0	◆
E2.52	Stage 15 running time	0.0...5,000.0 s	0.1	0.0	◆

Group E3: PID control

Code	Name	Setting range	Min. unit	Default	Attrib.
E3.00	PID control mode	0: PID control inactive 1: Analog input + analog feedback 2: Analog digital setting + analog feedback 3: Analog input + pulse encoder feedback 4: Rotation speed digital setting + pulse encoder feedback	1	0	◆
E3.01	Analog digital setting	0.00...10.00 V	0.01	0.00	◇
E3.02	Rotation speed digital setting	0...24,000 rpm	1	0	◇
E3.03	Analog feedback channel	0: +I direct action 1: +I inverse action 2: VR1 direct action 3: VR1 inverse action 4: VR2 direct action 5: VR2 inverse action 6: VR3 direct action 7: VR3 inverse action	1	0	◆
E3.04	P: Proportional gain	0.000...10.000	0.001	1.500	◇
E3.05	Ti: Integral time	0.00...100.00 s (0.00 represents no integral)	0.01	0.00	◇
E3.06	Td: Derivative time	0.00...100.00 s (0.00 represents no derivative)	0.01	0.00	◇

Parameter Settings

Code	Name	Setting range	Min. unit	Default	Attrib.
E3.07	T: Sampling period	0.01...100.00 s	0.01	0.50	◇
E3.08	Deviation limit	0.0...20.0 % (of closed loop reference)	0.1	2.0	◇
E3.09	PID adjustment mode	0: Stop integral adjustment, when output frequency reaches upper/lower limit frequency 1: Continue integral adjustment, when output frequency reaches upper/lower limit frequency	1	0	◇
E3.10	PID output action	0: Direct action 1: Inverse action	1	0	◆
E3.11	PID feedforward	0: Deactivated 1: Activated	1	0	◆
E3.12	PID feedforward limit	0.00...5.00 Hz	0.01	1.00	◆
E3.13	PID analog signal channel	0: +I; 1: VR1; 2: VR2; 3: VR3	1	1	◆

Group E4: Protection and error parameters

Protection parameters

Code	Name	Setting range	Min. unit	Default	Attrib.
E4.00	Software over voltage protection threshold	790...820 V	1	810	◆
E4.01	Stall over voltage function	0: Deactivated 1: Activated	1	0	◆
E4.02	Stall over voltage protection level	120.0...150.0 % (of rated frequency converter peak voltage)	0.1	130.0	◆
E4.03	Stall over current protection level	20.0...200.0 % (of rated frequency converter output current)	0.1	150.0	◆
E4.04	Motor over load protection	0: Inactive 1: Heat protection active at low-speed 2: Heat protection inactive at low-speed	1	1	◇
E4.05	Motor over load protection factor	50.0...110.0 %	0.1	100.0	◇
E4.06	Type of temperature sensor for motor over heat protection	0: PTC temperature sensor 1: NTC temperature sensor	1	0	◆
E4.07	Input channel options of motor over heat protection	0: Deactivated; 1: VR1; 2: VR2; 3: VR3	1	0	◇
E4.08	Motor over heat reference	0.0...10.0 V	0.1	2.0	◆
E4.09	Phase loss protection	0: Both input and output phase loss protection active 1: Only input phase loss protection active 2: Only output phase loss protection active 3: Neither input or output loss protection active	1	0	◇
E4.10	Reserved	0, 1	1	0	◆

Parameter Settings

Error parameters

Code	Name	Setting range	Min. unit	Default	Attrib.
E4.11	Number of error reset attempts	0...3 (0: Inactive for auto reset)	1	0	◆
E4.12	Interval between reset attempts	2...60 s	1	10	◆
E4.13	Last error		1	0	◎
E4.14	2nd last error	0...24	1	0	◎
E4.15	3rd last error		1	0	◎
E4.16	Delete error record	0: Inactive; 1: Delete error record Note: The value is automatically set to 0 after the operation.	1	0	◆

Setting range of parameters E4.13...E4.15:

0: No error record

1: Over current at constant speed (O.C.-1)

2: Over current during acceleration (O.C.-2)

3: Over current during deceleration (O.C.-3)

4: Over voltage at constant speed (O.E.-1)

5: Over voltage during acceleration (O.E.-2)

6: Over voltage during deceleration (O.E.-3)

7: Frequency converter over load (O.L.-1)

8: Motor over load (O.L.-2); 9: CPU read/write error (R.E.)

10: Operating panel read/write error (KEY-)

11: External device error (E.-St)

12: Communication error (R.S.)

13: Circuit disconnection (C.F.)

14: Pulse encoder speed detection error (PULS)

15: Motor overheat (M.O.H.); 16: EMI error (CPU-)

17: Short circuit (S.C.) ;18: Reserved

19: L1, L2, L3 input phase loss (IPH.L)

20: U, V, W output phase loss (OPH.L)

21: Frequency converter overheat (C.O.H.)

22: Parameter setting error (PRSE)

23: Parameter auto-tuning error (TUNE)

24: Frequency converter over load pre-warning 2 (O.L.-3)

Parameter Settings

Group E5: Extended parameters

Code	Name	Setting range	Min. unit	Default	Attrib.
E5.00	VR3 channel amplification factor k4	0.00...10.00	0.01	1.00	◆
E5.01	Pulse input filtering time	0...9	1	0	◆
E5.02	Reserved	0, 1	1	0	◆
E5.03	Reserved	0, 1	1	0	◆
E5.04	Relay Ta, Tb and Tc output	0...14	1	12	◆
E5.05	FM1 output lower limit	0.0 %...[E5.07]	0.1	0.0	◇
E5.06	Output corresponding to [E5.05]	0.00...10.00 V	0.01	0.00	◇
E5.07	FM1 output upper limit	[E5.05]...100.0 %	0.1	100.0	◇
E5.08	Output corresponding to [E5.07]	0.00...10.00 V	0.01	10.00	◇
E5.09	FM2 output lower limit	0.0 %...[E5.11]	0.1	0.0	◇
E5.10	Output corresponding to [E5.09]	0.00...10.00 V	0.01	0.00	◇
E5.11	FM2 output upper limit	[E5.09]...100.0 %	0.1	100.0	◇
E5.12	Output corresponding to [E5.11]	0.00...10.00 V	0.01	10.00	◇
E5.13	Delay time for frequency converter overload pre-warning 1	0.0...20.0 s	0.1	2.0	◆
E5.14	Reserved	0, 1	1	0	◆
E5.15	Reserved	0, 1	1	0	◆

Setting range of parameter E5.04:

0: Frequency converter is ready to run

1: Frequency converter is running

2: DC brake active

3: Frequency converter runs at zero speed

4: Frequency / speed arrival signal

5: Frequency level detection signal FDT1

6: Frequency level detection signal FDT2

7: Logic control phase completed

8: Under voltage stop

9: Frequency converter overload pre-warning 1

10: Motor overload pre-warning

11: Over torque

12: Frequency converter in error

13: Error auto reset signal output

14: Frequency converter overload pre-warning 2

Parameter Settings

7.3.4   Category H: Advanced Parameters

Group H0: Communication parameters

Code	Name	Setting range	Min. unit	Default	Attrib.
H0.00	Communication protocol	0: ModBus; 1: PROFIBUS	1	0	◆
H0.01	Baud rate	0: 1,200 bps; 1: 2,400 bps; 2: 4,800 bps 3: 9,600 bps; 4: 19,200 bps; 5: 38,400 bps	1	3	◆
H0.02	Data format	0: N, 8, 2 (1 start bit, 8 data bits, 2 stop bits, without check) 1: E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even check) 2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd check)	1	0	◆
H0.03	Local address	ModBus: 0...247 (0 represents broadcast address) PROFIBUS: 0...126 (0 means deactivated)	1	0	◆
H0.04	PZD4, PZD3 setting	0...255	1	0	◆
H0.05	PZD6, PZD5 setting	0...255	1	0	◆
H0.06	PZD8, PZD7 setting	0...255	1	0	◆
H0.07	PZD10, PZD9 setting	0...255	1	0	◆
H0.08	Communication discon-nection detection time	0.0...60.0 s (0.0: deactivated)	0.1	10.0	◆
H0.09	Communication discon-nection action	0: Stop; 1: Keep running	1	0	◆
H0.10	Reserved	0...65,535	1	0	◆

Parameter Settings

7.4   Notes on Function Groups

7.4.1   Category b: Basic Parameters

Group b0: System parameters

b0.00	User password		Factory default	0
	Setting range	0...65,535	Minimum unit	1

User password protects frequency converter parameters from being modified by unauthorized people.

• Set password: Set a number between 1...65,535 to activate the user password function.

• Delete password: Enter the correct user password and set [b0.00] = 0 to deactivate the password.

• Modify password: Enter the correct user password and set a new number between 1...65,535 to modify the user password.

☞ 1. After a user password has been set, users may only read but not modify nor copy parameters if an incorrect password is entered.

2. Please contact the manufacturer if you forget the set password.

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

LCD / Menu language is available in

• 0: Chinese

• 1: English

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

• 0: No action

• 1: Restore factory default

☞ 1. All parameters (except S2.00...S2.09 and E4.13...E4.15) will be restored to factory defaults.

2. b0.02 is automatically set to 0 after the parameters have been set to factory defaults.

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

• 0: No action

• 1: Copy parameters from frequency converter to operating panel

  Parameter settings of the frequency converter (except E4.13...E4.15) will be uploaded to the operating panel.

• 2: Copy parameters from operating panel to frequency converter

  Parameter settings of the frequency converter (except E4.13...E4.15) will be downloaded to the frequency converter.

Parameter Settings

☞   1. b0.03 is automatically set to 0 after parameters have been copied.

2. Any other operations are invalid in parameter copy process.

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

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

- Used to set the PWM frequency. (The setting of this parameter may also avoid resonance point of mechanical constructions.)
  - A higher PWM frequency may
    - to motor: reduce the noise, power loss and temperature.
    - to frequency converter: increase power loss and temperature.
  - A lower PWM frequency may
    - reduce line to ground current leakage, the interference caused by the frequency converter.
    - increase the higher harmonic component of output current, motor power loss and temperature.
- The factory default values and effective adjustable ranges of Fv PWM frequency are shown in the table below.

Model	Default value of PWM frequency [kHz]	Effective adjustable range of PWM frequency [kHz]
0K40...7K50	8.0	1.0...15.0
11K0...22K0	6.0	1.0...12.0
30K0...37K0	3.0	1.0...8.0
45K0..90K0	2.0	1.0...4.0

Tab. 7-2:   Factory default values and effective adjustable ranges of Fv PWM frequency

☞   For the temperature, voltage and current derating figures related to PWM frequency, see chapter 9.3 "Derating of Electrical Data" on page 162.

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

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

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

- 0: Energy saving

The LCD backlight will be inactive automatically if no key has been pressed for 80 seconds. If the LCD backlight is inactive, the first key press will activate the backlight, press again to execute the command.

- 1: Always on

  The LCD backlight will be always active.

☞ It is recommended to set the LCD backlight mode to "1: Always on" when [b1.02] = 1 or 2.

b0.08	LCD display in run mode		Factory default	0
	Setting range	0...17	Minimum unit	1
b0.09	LCD display in stop mode		Factory default	2
	Setting range	0...17	Minimum unit	1

- 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: Torque current
- 9: Excitation current
- 10: User-defined reference value
- 11: User-defined output value
- 12: Reference torque
- 13: Digital inputs status
- 14: Encoder speed feedback
- 15: Torque limit setting
- 16: Speed limit setting
- 17: Multi-monitoring display

When [b0.08] or [b0.09] = 13, "Digital inputs status" is displayed as a decimal value which represents OPEN or CLOSED of 10 digital inputs X1...X8, FWD and REV. The value of "Digital inputs status" is 0 to 3377.

For example, if "1234" is displayed to indicate the "Digital inputs status", the respective status of each digital input is shown as the table below.

Parameter Settings

	Displayed value	**1234**									
	bit	4th number (x 1000 +)		3rd number (x 100 +)		2nd number (x 10 +)			1st number (x 1)		
Decimal	bit value	0		0		0			0		
		1		1		1			1		
		2		2		2			2		
		3		3		3			3		
						4			4		
						5			5		
						6			6		
						7			7		
Binary	bit value	0	0	0	0	0	0	0	0	0	0
		0	1	0	1	0	0	1	0	0	1
		1	0	1	0	0	1	0	0	1	0
		1	1	1	1	0	1	1	0	1	1
						1	0	0	1	0	0
						1	0	1	1	0	1
						1	1	0	1	1	0
						1	1	1	1	1	1
Digital input		REV	FWD	X8	X7	X6	X5	X4	X3	X2	X1
Status		OPEN	**CLOSED**	**CLOSED**	OPEN	OPEN	**CLOSED**	**CLOSED**	**CLOSED**	OPEN	OPEN

Tab. 7-3:   Explanation to displayed value of digital inputs status

When [b0.08] or [b0.09] = 17, the monitoring values displayed in the LCD panel from top to bottom are: output frequency, output current, DC bus voltage, output voltage, output rotation speed and output power.

☞   There are totally 18 status parameters, all of which can be displayed by switching ►► in either running or stopping mode.

b0.10	Scale factor of user-defined value		Factory default	100.0
	Setting range	0.1...1,000.0 %	Minimum unit	0.1

• Valid only for 'LCD display value in run mode' [b0.08] or 'LCD display value in stop mode' [b0.09] = 10 or 11.

• 'LCD display value in run mode' [b0.08] or 'LCD display value in stop mode' [b0.09] equals to 'User-defined value' multiplied by 'Scale factor of user-defined value' [b0.10].

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

• Only parameters of the selected groups are visible.

Parameter Settings

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

Tab. 7-4:   *Parameter filter range*

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

- Displays the power module (IGBT) and heat sink temperature (in °C).
    - '––' is displayed when the temperature is lower than 25 °C.
    - Overheat protection is activated at 85 °C.

b0.13	Total running time		Factory default	0
	Setting range	0...65,535 hours	Minimum unit	1

- Displays the total running time of the frequency converter.

☞   b0.13 will not be reset with 'Restore factory default' b0.02.

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

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

Group b1: Basic parameters

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

- 0: Set by operating panel potentiometer

    Set the frequency by adjusting the operating panel's potentiometer.

- 1: Set by operating panel

    - Use the value of parameter b1.04 as the set frequency.
    - Use ▲ and ▼ keys to change the output frequency value when the frequency converter is in run mode.

Parameter Settings

☞   –   In run mode

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

–   In stop mode

If 'Digital set frequency saving' [b1.01] = 1 or 3, the current running frequency will be saved in parameter b1.04.

●   2: Set by analog inputs

Set the frequency by external analog signals using the independent channels VR1, VR2, VR3 and +I.

☞   1. VR1 for 0...10 V or -10...+10 V

–   Unipolar analog signal

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

–   Bipolar analog signal

Input of bipolar level signals will be processed as values with motor direction information.

2. VR2 / VR3 for 0...10 V

3. +I is for 0...20 mA (with channel input resistance of 165 Ω).

4. For details of analog inputs settings, see parameters E0.09...E0.24.

●   3: Set by pulse frequency

Set output frequency by external pulse frequency signals using digital input X8 (signal range is 9...30 V, maximum pulse frequency of 50 kHz).

☞   Please also set 'Maximum input pulse frequency' E0.15. 'Digital input X8' E0.08 is automatically set to 0 (invalid).

●   4: Set by digital inputs **Up/Down**

Set output frequency by digital inputs

–   Step 1

Define any 3 digital inputs in parameters E0.01...E0.08

–   set one input to 9: Frequency incremental **Up** command

–   set one input to 10: Frequency decrement **Down** command

–   set one input to 11: Set frequency to 0

–   Step 2

Set 'Frequency changing rate' S3.11 for the frequency change rate of the digital inputs **Up/Down**.

Parameter Settings
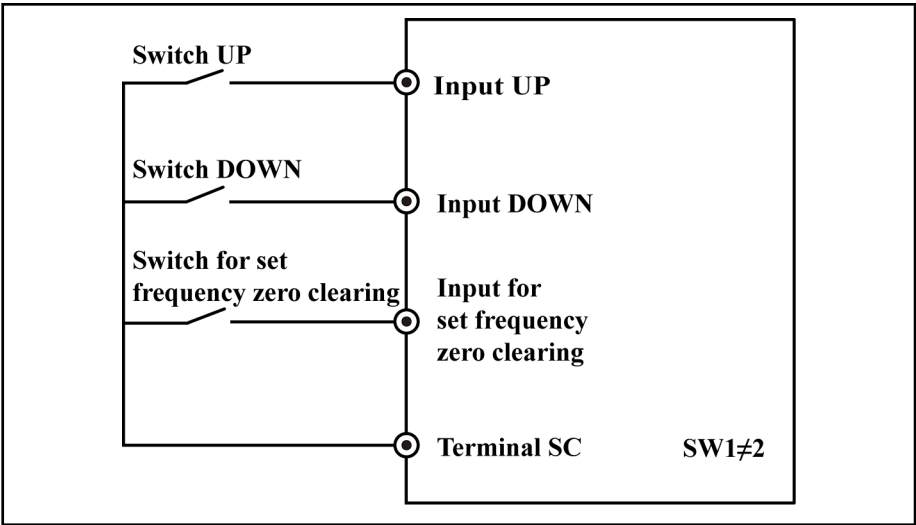
Fig. 7-12: Frequency setting by digital inputs

Input for set frequency zero clearing	Open				Closed
Input Up	Open		Closed		Open/ Closed
Input Down	Open	Closed	Open	Closed	
Output frequency reaction	Hold	Decrease	Increase	Hold	Zero

Tab. 7-5: Relationship between terminal status and frequency converter set frequency

☞
- Digital inputs **Up**, **Down** and **the input for set frequency zero clearing** are only active in run mode.
- At power on, b1.04 is used as start-up frequency.
- In run mode

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

    If 'Digital set frequency saving' [b1.01] = 1 or 3, the current running frequency will be saved in parameter b1.04.

- 5: Set by communication

    Set output frequency by communication with the external computer or internal logic control (see parameters in Group H).

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

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

Parameter Settings

b1.02	Frequency converter control commands		Factory default	0
	Setting range	0...2	Minimum unit	1

Used to set input modes of frequency converter control commands. Control commands include run, stop, forward, reverse, Jog, etc.

- 0: Set control commands by operating panel

  Use operating panel keys (**Run**, **Stop** and **Jog**, etc.) to control run, stop, etc.

- 1: Set control commands by digital inputs

  Use digital inputs **FWD**, **REV**, etc. to control run, stop, forward or reverse, etc. See parameters in group E0.

- 2: Set control commands by communication

  Use communication to control run, stop, forward or reverse, etc. See the instructions for communication in chapter 12 "Communication Protocols" on page 207.

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

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

- 0: V/f control (V/f)

  This mode is applicable to most applications. Select this mode if it is impossible to conduct auto-tuning or obtain accurate motor parameters.

  – V/f control without pulse encoder: is used to drive multiple motors with one frequency converter.

  – V/f control with pulse encoder: is used when high accuracy of speed control is required. See parameters S2.12...S2.15 for related settings.

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

- 1: Sensorless vector control (SVC)

  For high performance applications where no pulse encoder is necessary, while high torque at low-frequency and high accuracy of speed control are required.

- 2: Field oriented vector control (FOC)

  – For high accuracy applications with speed and torque control.

  – A pulse encoder is necessary. See parameters S2.12...S2.15 for related settings.

Parameter Settings

☞ 1. Accurate motor parameters are required for vector control. Motor parameters can be obtained by auto-tuning function, see parameters S2.00...S2.10 for related settings. If auto-tuning is impossible and the accurate motor parameters are known, first set parameters S2.00...S2.04 with values found on the motor nameplate, and then set parameters S2.05 to S2.09.

2. In vector control mode, please set the parameters of rotation speed controller to obtain good static and dynamic control. See parameters S1.00 and S1.01 for related information.

3. In vector control mode, one frequency converter can only drive one motor.

4. In V/f control mode, see parameters in group S for related settings.

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

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

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

- 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.

F_L: lower frequency; F_H: upper frequency; F_b: rated frequency of motor; F_{max}: Max. frequency
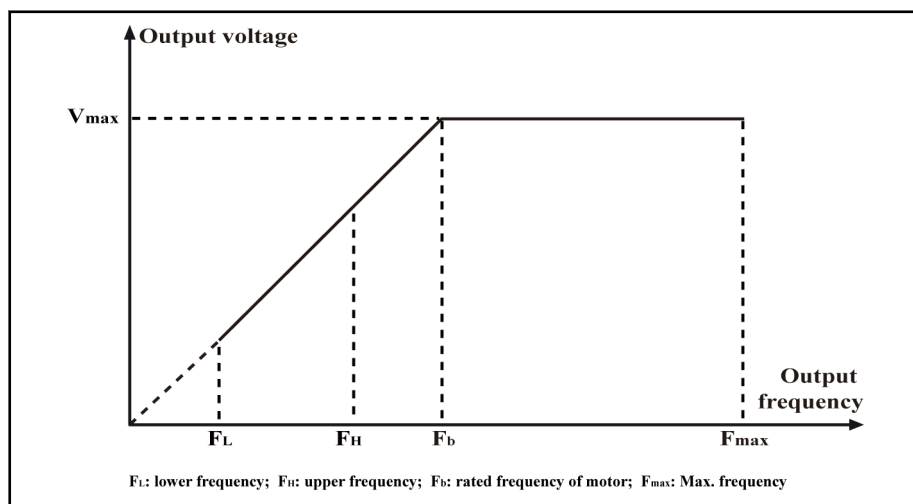
Fig. 7-13:   Maximum frequency_upper frequency_lower frequency

Parameter Settings

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

This parameter is used to change the rotation direction of motor when running commands are set by the operating panel ([b1.02] = 0).

- 0: Forward rotation
- 1: Reverse rotation

b1.09	Acceleration time 1		Factory default	10.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1
b1.10	Deceleration time 1		Factory default	10.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1

- The acceleration time is the duration, in which the frequency converter changes the output frequency from 0 Hz...'Maximum frequency' [b1.05]. Shown as T1 in figure below.

- The deceleration time is the duration, in which the frequency converter changes the output frequency from 'Maximum frequency' [b1.05]...0 Hz. Shown as T2 in figure below.
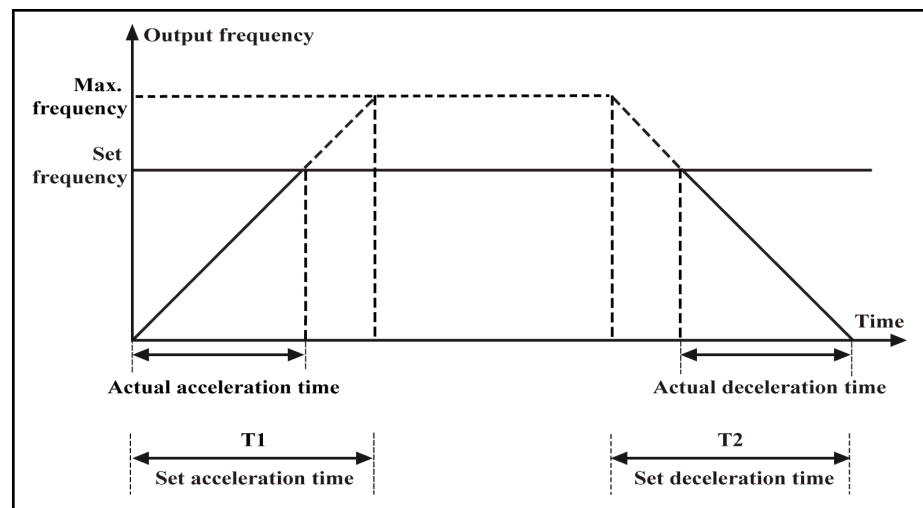
Fig. 7-14:   Acceleration time1 & Deceleration time 1

- 4 groups of acceleration/deceleration time are available, which can be selected via digital inputs. See parameters E0.01...E0.08 and E2.00...E2.05.

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

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

- 0: Linear mode

   The output frequency is increased or decreased linearly as shown in figure below.
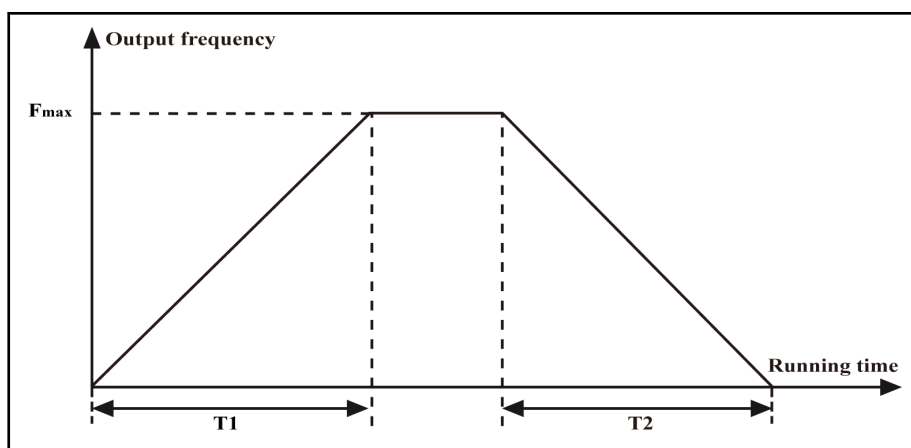
Fig. 7-15:   Linear acceleration/deceleration mode

- 1: S-curve mode

  The output frequency is increased or decreased in an S-curve as shown in figure below.
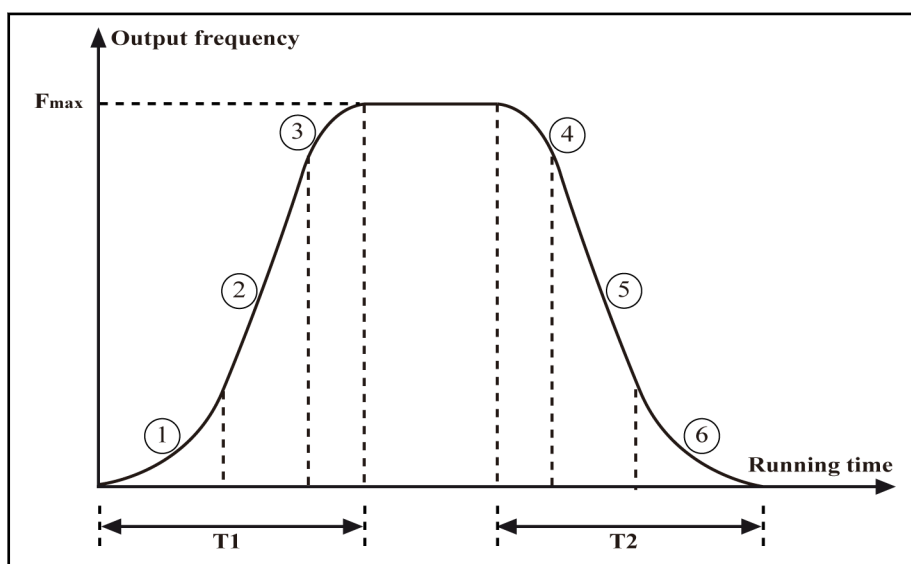
Fig. 7-16:   S-curve acceleration/deceleration mode

☞   The S-curve mode is used to achieve smooth start or stop.

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

Parameter Settings

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

Parameters b1.12...b1.15 are used to define the acceleration and deceleration settings of the S-curve.

b1.16	Start mode	Factory default	0
	Setting range	0: Start mode 1 1: Start mode 2 2: Rotation speed capture mode	Minimum unit	1
b1.17	Start frequency	Factory default	0.50
	Setting range	0.00...15.00 Hz	Minimum unit	0.01
b1.18	Start frequency hold time	Factory default	0.0
	Setting range	0.0...10.0 s	Minimum unit	0.1s

Following start modes are available for different applications.

- 0: Start mode 1
    - The frequency converter runs at 'Start frequency' [b1.17], for 'Start frequency hold time' [b1.18], accelerates for 'Acceleration time 1' [b1.09] to set frequency.
    - This mode is suitable for circumstances with high static friction torque and low load inertia.
- 1: Start mode 2
    - If 'Startup DC brake time' [b1.20] ≠ 0, DC brake is executed before accelerating to 'Start frequency' [b1.17]. If 'Startup DC brake time' [b1.20] = 0, the frequency converter accelerates without braking to 'Start frequency' [b1.17].
    - This mode is suitable for circumstances where the load may encounter forward/reverse rotation when the frequency converter is in stop mode.
- 2: Rotation speed capture mode
    - The frequency converter detects the rotation speed and direction of the motor and then starts with the current frequency of the motor.
    - This mode is suitable for restarting after instantaneous power fault in the case of a large inertia or freewheeling load, in which the motor can be restarted without impact.

☞   At startup, if the set frequency is lower than the 'Start frequency' [b1.17], the frequency converter first accelerates to 'Start frequency' [b1.17], after 'Start frequency hold time' [b1.18], the frequency converter decelerates to the set frequency.

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

- 0: Decelerate to stop

Parameter Settings

The frequency converter decelerates to stop according the deceleration time.

☞
1. In case of too fast deceleration an error may happen, extend the deceleration time or calculate if additional brake units / resistors are required.

2. If the output frequency is lower than 'Shutdown DC brake activation frequency' [b1.21], the set 'DC brake current' [b1.23] is applied, for 'Shutdown DC brake time' [b1.22]. This mode is suitable for circumstances where regular or quick deceleration stop is required (with brake resistors or brake units).

- 1: Freewheel to stop

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

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

- If 'Start mode' [b1.16] is '1: Start mode 2', apply 'DC brake current' [b1.23] for 'Startup DC brake time' [b1.20].

- If 'Startup DC brake time' [b1.20] is 0.0s, the frequency converter starts directly without DC brake. The larger the DC brake current, the larger the braking force is. The setting needs take the withstanding capability of the motor into account.

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

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

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

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

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

Parameter Settings

7.4.2   Category S: Standard Parameters

Group S0: V/f control

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

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

● 0: Linear mode

Suitable for constant torque load (shown as curve 0 in figure below)

● 1: Square mode

Suitable for variable torque loads (shown as curve 1 in figure below)
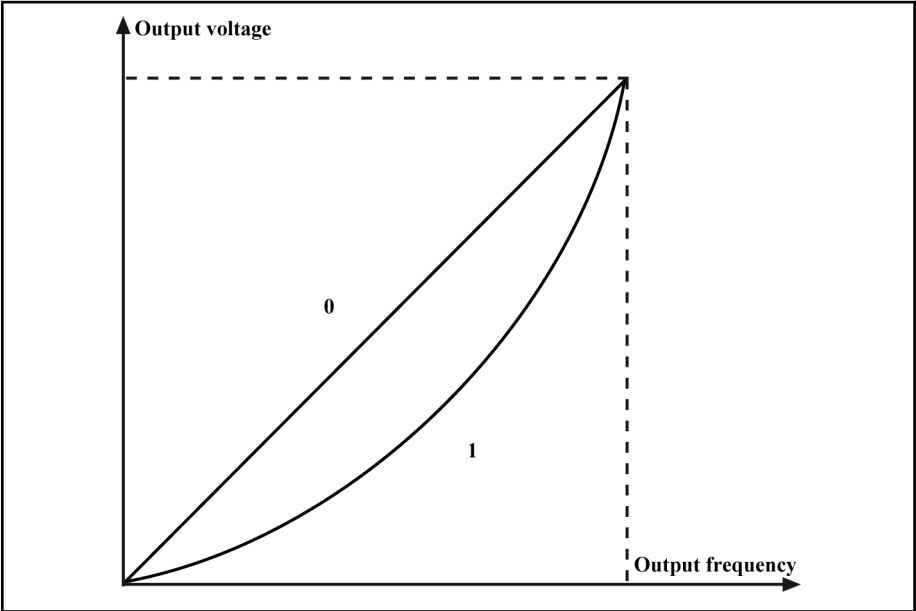
Fig. 7-17:   Linear and square V/f curves

● 2: User-defined multipoint mode

Used to set a user defined V/f curve with parameters S0.01...S0.06. Suitable for special applications (shown in figure below).

Parameter Settings
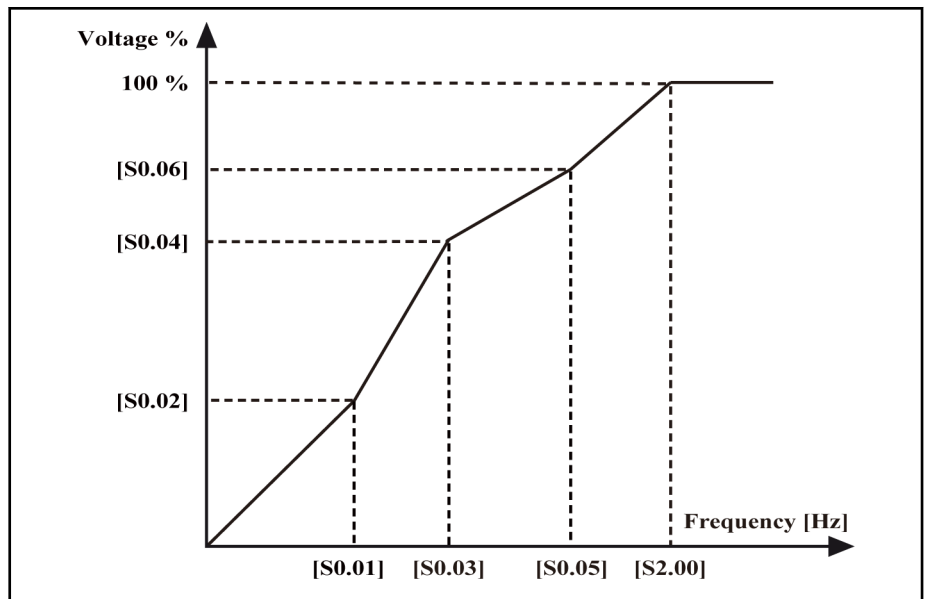
Fig. 7-18:   *User defined V/f curve*

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

⚠ **CAUTION**

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

Parameter Settings

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

- Compensates the speed difference of the motor and the output of the frequency converter caused by the load in case of V/f control so that the rotor speed gets closer to that of the synchronous speed at its rated load.

- Improves the mechanical behavior of the motor. Should be set according to the rated motor slip frequency shown on motor plate.

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

- 0.0 %: Automatic increase

    Determines automatically the percentage of output voltage increase based on output frequency and load current.

The linear and square V/f curve automatic torque increase are shown in figures below.
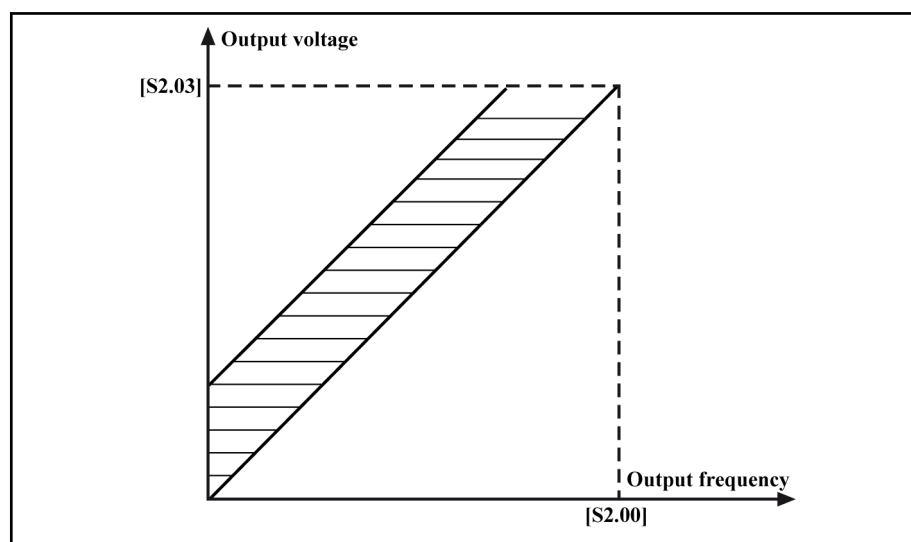
Fig. 7-19:   Linear V/f curve automatic torque increase

Fig. 7-20:   Square V/f curve automatic torque increase

- 0.1...20.0 %: Manual increase

  Used to increase the frequency converter's output voltage and compensate the stator voltage decrease, to generate sufficient torque and improve the low-frequency torque characteristics of V/f control.

  Large increase may cause high current leading to motor over heat and may result in motor damage or frequency converter protection.

Linear and square V/f curve manual torque increase are shown in figures below.
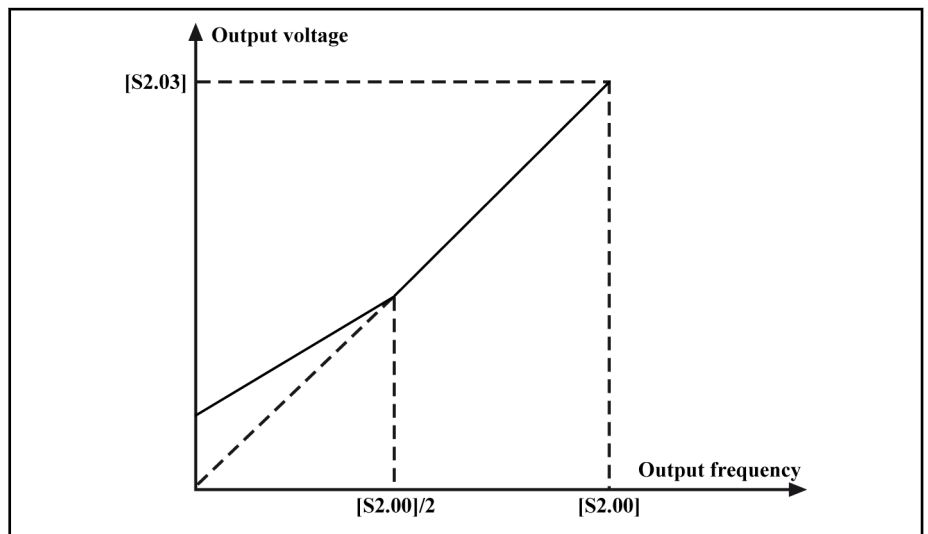
Fig. 7-21:   Linear V/f curve manual torque increase

Parameter Settings
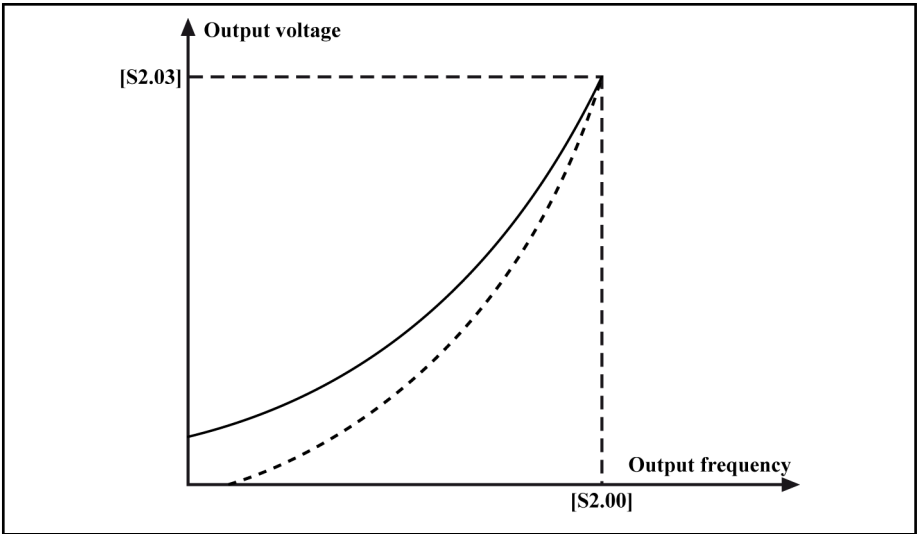
Fig. 7-22:   Square V/f curve manual torque increase

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

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

- 0: Not active

- 1: Always active

  Select this option if brake resistor is in place or no quick deceleration is necessary.

- 2: Not active during deceleration and braking

  Select this option if quick deceleration is necessary and no brake resistor is in place, which can reduce significantly the possibility of over voltage warnings.

	Oscillation constraint gain	Factory default	0.3
S0.10	Setting range	0.0...3.0	Minimum unit	0.1

When the motor reaches the mechanical resonance point, the frequency converter output current has surge. In this situation, increase the value of this parameter steadily can constrain current surge effectively till the elimination of the motor oscillation.

Group S1: Vector control

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

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

Parameter Settings

- Larger proportional gain leads to faster response.

- Too large proportional gain may cause oscillation.

- Smaller proportional gain leads to slower response.

- Larger integral time leads to slower dynamic response of the system and the control on external disturbance is weakened.

- Smaller integral time leads to faster dynamic response of the system.

- Excessively small integral time may cause oscillation.

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

- The proportional gain should be increased without causing oscillation.

- The integral time should be decreased to allow the system to have quick response and smaller overshoot.

☞ Improper settings may lead to excessive speed overshoot or overvoltage errors during fall back from the overshoot.

S1.02	Torque limit		Factory default	150.0
	Setting range	0.0...200.0 %	Minimum unit	0.1

Used to limit the maximum torque current of the frequency converter during startup or braking. The limit value is a percentage of rated motor current.

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

S1.03	Slip compensation gain		Factory default	100.0
	Setting range	50.0...250.0 %	Minimum unit	0.1

Used to maintain constant motor speeds with load changes. When the load increases, the motor slip increases, and the rotation speed decreases.

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

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

- 0: Digital inputs control

    The multi-function digital inputs can be used to switch between torque control and speed control (see parameters in group E0).

    – Speed control

        – Speed commands are used to control motor actions and the speed controller is active.

        – Output frequency changes according to set frequency and the output torque changes with the load torque.

        – The output torque is limited by 'Torque limit' [S1.02]. If the load torque is larger than 'Torque limit' [S1.02], the output frequency will be different from set frequency because of torque limitation.

Parameter Settings

– Torque control

– Speed controller is inactive and the output torque changes according to the torque set by "Torque control reference" [S1.05].

– Output frequency changes with the load speed.

– The output frequency is limited by 'Upper frequency' [b1.06]. If the load speed is larger than 'Upper frequency' [b1.06], the output torque will be different from the set torque because of speed limitation.

- 1: Always active

  Torque control is always active.

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

S1.05	Torque control reference		Factory default	0
	Setting range	0: Input +I 1: Input VR1 2: Digital setting 3: Set via communication	Minimum unit	1

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

- 0: Input +I

  – The reference torque is set with the analog terminal +I.

  – The maximum value of +I input current corresponds to 200 % of the rated torque.

  – +I can only generate positive torque.

- 1: Input VR1

  – The reference torque is set with the analog terminal VR1.

  – The maximum value of VR1 input voltage corresponds to 200 % of the rated torque.

  – VR1 can set positive and negative torque. In this case, the torque direction is determined by the polarity of the input voltage regardless settings of 'Operating panel controlled direction' b1.08 and 'Motor standard rotation direction' S3.14.

  – When [b1.03] = 2 , [S1.05] = 1, if setting [E0.01]...[E0.08] = 28 and the torque control is activated, the frequency converter will show the error "PRSE".

- 2: Digital setting

  The torque command is set by parameter S1.06.

- 3: Set by communication

  The torque command is set by communication. The settings of 0...2,000 correspond to 0.0 %...200.0 % of rated torque. See chapter 12 "Communication Protocols" on page 207.

S1.06	Torque digital setting		Factory default	100.0
	Setting range	0.0...200.0 %	Minimum unit	0.1

When 'Torque control reference' S1.05 is set as 2 and the torque control function is activated, the value of S1.06 is the torque control command. The

Parameter Settings

value of this parameter is a percentage of the frequency converter rated torque.

Group S2: Motor and encoder parameters

S2.00	Rated motor frequency		Factory default	50.00
	Setting range	8.00...400.00 Hz	Minimum unit	0.01
S2.01	Rated motor rotation speed		Factory default	1,440
	Setting range	1...24,000 rpm	Minimum unit	1
S2.02	Rated motor power		Factory default	Depends on model
	Setting range	0.4...1,000.0 kW	Minimum unit	0.1
S2.03	Rated motor voltage		Factory default	Depends on model
	Setting range	0...900 V	Minimum unit	1
S2.04	Rated motor current		Factory default	Depends on model
	Setting range	0.1...1,000.0 A	Minimum unit	0.1

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

S2.05	Stator resistance factor		Factory default	Depends on model
	Setting range	0.00...50.00 %	Minimum unit	0.01
S2.06	Rotor resistance factor		Factory default	Depends on model
	Setting range	0.00...50.00 %	Minimum unit	0.01
S2.07	Leakage inductance factor		Factory default	Depends on model
	Setting range	0.00...50.00 %	Minimum unit	0.01
S2.08	Mutual inductance factor		Factory default	Depends on model
	Setting range	0.0...2,000.0 %	Minimum unit	0.1
S2.09	No-load current		Factory default	Depends on model
	Setting range	0.0...1,000.0 A	Minimum unit	0.1
S2.10	Parameter auto-tuning		Factory default	0
	Setting range	0...2	Minimum unit	1

The motor parameters (S2.00...S2.04) must be set according to the motor nameplate before using 'Parameter auto-tuning' [S2.10].

- [S2.10] = 0: No action
- [S2.10] = 1: Auto tuning with running motor

Parameter Settings

'Auto tuning with running motor' can ensure the dynamic control performance of the frequency converter. Before using 'Auto tuning with running motor', any load must be removed from the motor. Parameters S2.05...S2.09 will be updated during auto tuning.

- [S2.10] = 2: Auto tuning with static motor

Parameters S2.05...S2.07 will be updated during auto tuning.

☞

1. 'Parameter auto-tuning' [S2.10] is '1: Auto tuning with running motor' and over current or over voltage occurs, increase the parameters 'Acceleration time 1' [b1.09] and 'Deceleration time 1' [b1.10].

2. 'Parameter auto-tuning' [S2.10] is '2: Auto tuning with static motor', ensure the motor is stopped before starting auto-tuning; otherwise auto-tuning may end in abnormal results.

3. In applications where it is not possible to use auto-tuning, accurate motor parameter values must be entered to parameters S2.00...S2.09. However, the motor's nameplate parameters must be entered first.

S2.11	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
S2.12	Pulses per revolution of pulse encoder		Factory default	1,024
	Setting range	1...20,000	Minimum unit	1
S2.13	Pulse encoder direction reverse		Factory default	0
	Setting range	0, 1	Minimum unit	1
S2.14	Pulse encoder error detection extent		Factory default	0.0
	Setting range	0.0...1,000.0 rpm (0.0: No break protection)	Minimum unit	0.1
S2.15	Pulse encoder error detection time		Factory default	1.0
	Setting range	0.1...10.0 s	Minimum unit	0.1

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

- Parameter S2.12 is used to set the number of pulses per revolution of the pulse encoder.

- Parameter S2.13 is used to change the phase sequence, if the encoder phases are reversely connected.

- If the set frequency is larger than 'Pulse encoder error detection extent' [S2.14] and the actual speed is smaller than 'Pulse encoder error detection extent' [S2.14] and lasts for ' Pulse encoder error detection time' [S2.15], the frequency converter will apply error protection to the pulse encoder.

Group S3: Control parameters

S3.00	Jog frequency		Factory default	5.00
	Setting range	0.00...[b1.05] Hz	Minimum unit	0.01
S3.01	Jog acceleration time		Factory default	5.0
S3.02	Setting range	0.1...3,600.0 s	Minimum unit	0.1
	Jog deceleration time		Factory default	5.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1

- Parameter S3.00 is used to set jog frequency.
- Parameters S3.01 and S3.02 are used to define the jog acceleration and deceleration time, as shown in figure below.
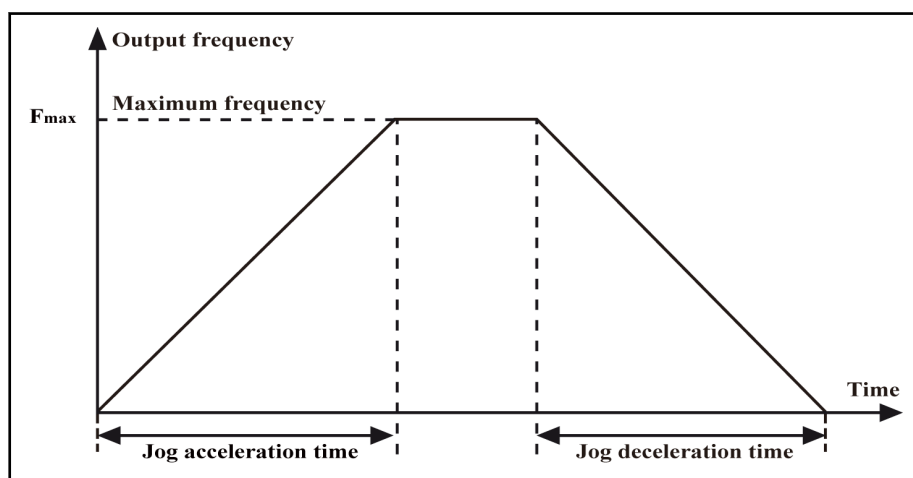
Fig. 7-23:　　Jog frequency setting

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

☞　　Jog is deactivated in torque control mode.

S3.03	Skip frequency 1		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
S3.04	Skip frequency 2		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
S3.05	Skip frequency 3		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
S3.06	Skip frequency range		Factory default	0.00
	Setting range	0.00...30.00 Hz	Minimum unit	0.01

- Three skip frequencies may be set to avoid mechanical resonance points
  - If the output frequency falls within the skip frequency range, the output frequency will be automatically set to the upper or lower limit of the skip frequency range.
  - If no skip frequency is used, the skip frequency range needs to be set as 0.00 Hz.

Parameter Settings

- This function is inactive during acceleration/deceleration (only available for steady state output).
- Do not make the three skip frequency ranges overlap or nest in each other.
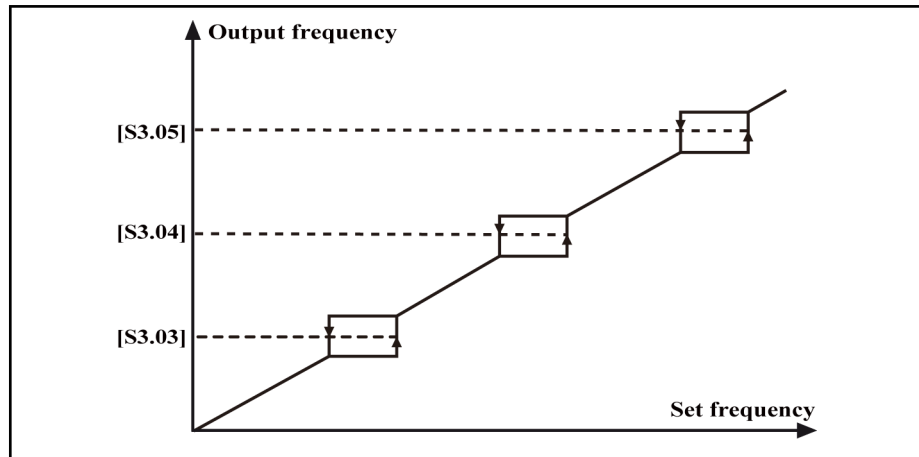
Fig. 7-24: *Skip frequencies and ranges*
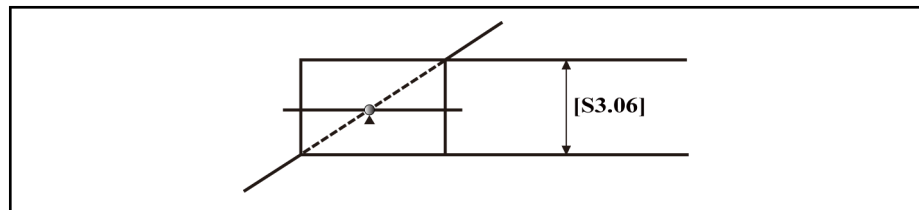
Fig. 7-25: *Frequency output forbidden point*

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

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

- 0: Deactivated: No restart after power off or power fault.
- 1: Activated: Restart after power off or power fault.
  - For a running frequency converter, when 'Frequency converter control commands' b1.02 is '0: Set control commands by operating panel' and no stop signal input:
    - If parameter [S3.07] = 1, the frequency converter will automatically start after waiting for the time of [S3.08].
    - If parameter [S3.07] = 0, the frequency converter only starts after the **Run** key is pressed down.
  - For a running frequency converter, when 'frequency converter control commands' [b1.02] is '1: Set control commands by digital inputs' or '2: Set control commands by communication' and there is running command input:
    - If parameter [S3.07] = 1, the frequency converter will automatically start after waiting for the time of [S3.08].

Parameter Settings

> – If parameter [S3.07] = 0, the frequency converter only starts after reissuing the running command.
>
> – When 'frequency converter control commands' [b1.02] is '1: Set control commands by digital inputs', do not change the state of digital inputs during power off or power fault.

⚠ WARNING   Ensure running safety!

S3.09	Direction change dead time		Factory default	4.0
	Setting range	0.0...3,600.0 s	Minimum unit	0.1

Waiting time when the frequency converter switches from forward rotation to reverse rotation, and vice versa, while the rotation speed is zero.
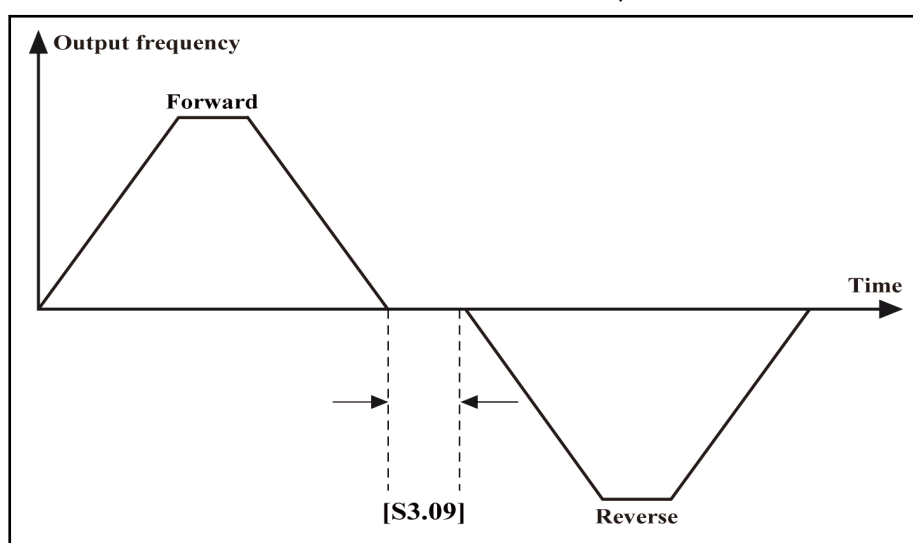
Fig. 7-26:   Direction change dead time

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

Used to change the decrease value of the output frequency.

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

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

Change the value gradually in case of adjustment. The relationship between the load and output frequency is shown in figure below.

Parameter Settings
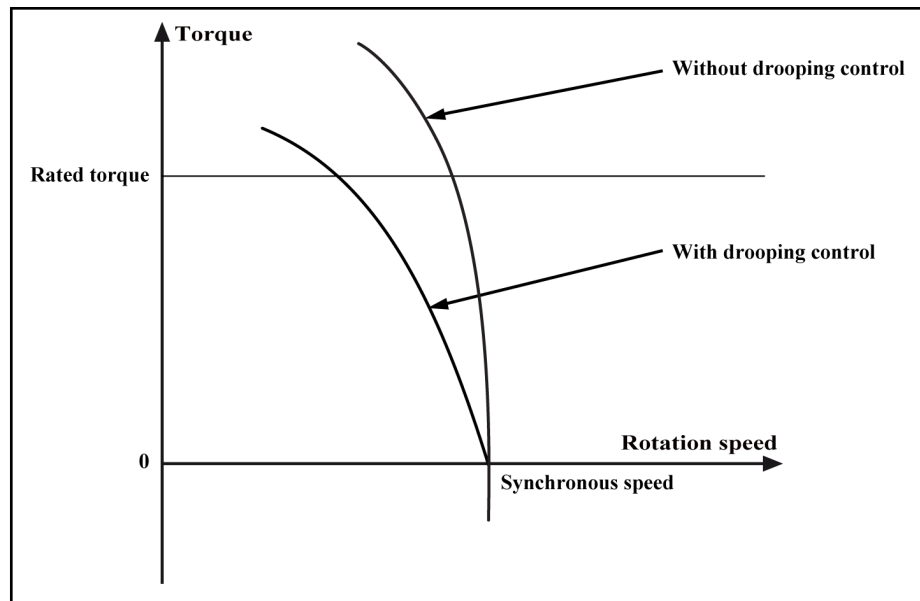
Fig. 7-27:   Droop control

S3.11	Setting velocity of **Up/Down**		Factory default	0.08
	Setting range	0.01...100.00 Hz/s	Minimum unit	0.01

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

S3.12	Brake chopper threshold		Factory default	770
	Setting range	600...785 V	Minimum unit	1
S3.13	Braking duty cycle		Factory default	100
	Setting range	0...100 %	Minimum unit	1

● Only for models with internal choppers, resistance and power of brake resistors need to be considered.

● A suitable brake voltage set via 'Brake chopper threshold' [S3.12] executes a fast brake to stop.

● Braking duty cycle = (Brake on time / Brake cycle) × 100 %

● Parameters S3.12 and S3.13 are used together. The braking duty cycle needs to be set appropriately according to loads.

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

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

● 0: Standard motor direction

● 1: Reverse standard motor direction

● 2: Deactivate reverse motor rotation

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

● 0: Valid only for operating panel control

Parameter Settings

Stop key is only valid when 'frequency converter control commands' b1.02 is set to '0: Set control commands by operating panel'.

- 1: Valid for all control means

Stop key is valid for all settings of 'frequency converter control commands' b1.02.

☞
- **Stop** key as an error reset key is valid for all settings of 'frequency converter control commands' b1.02.

- If the frequency converter is controlled by external commands and stopped with the **Stop** key, the external commands have to be disabled and then re-enabled before restarting the frequency converter.

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

- 0: Temperature controlled

Automatically controls the start and stop of the cooling fan according to the detected temperature of the heat sink.

- 1: Always on

The fan is always active when the frequency converter is running.

Parameter Settings

7.4.3   Category E: Extended Parameters

Group E0: Analog and digital inputs

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

- 0: Forward/Stop, Reverse/Stop

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

Tab. 7-6:   2-wire control mode 1

- 1: Forward/Reverse, Run/Stop

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

Tab. 7-7:   2-wire control mode 2
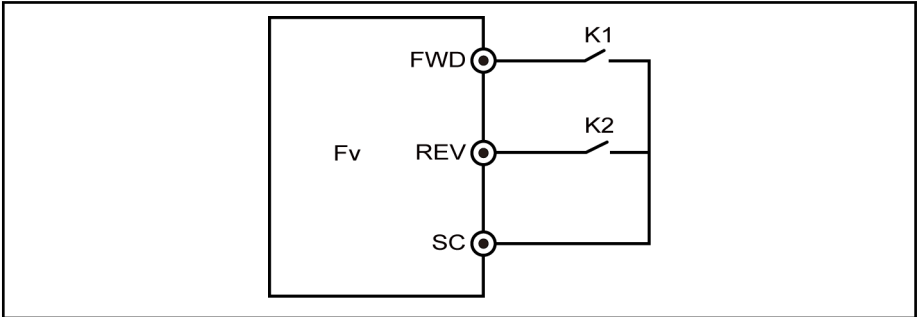
K1   is N.O. switch, which is activated with pulse edges
K2   is for direction selection (0: forward; 1: reverse)
SW1 jumper position cannot be set as 1-2, 3-4
Fig. 7-28:   2-wire control mode

- 2: 3-wire control

Parameter Settings
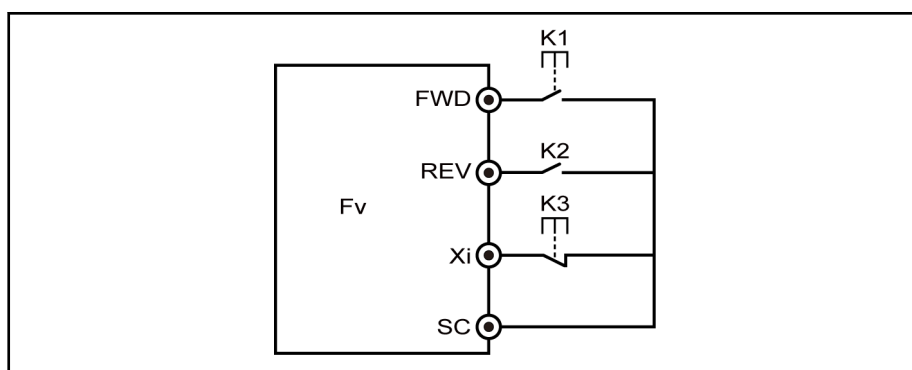
K1	is N.O. switch, which is activated with pulse edges
K3	is N.C. switch, which is activated with pulse edges
K2	is for direction selection (0: forward; 1: reverse)
SW1 jumper position	cannot be set as 1-2, 3-4

Fig. 7-29:   *3-wire control mode*

☞   If one of the digital inputs Xi (I = 1...8) is set to 7, "3-wire control" is selected.

E0.01	Digital input X1		Factory default	0
	Setting range	0...29	Minimum unit	1
E0.02	Digital input X2		Factory default	0
	Setting range	0...29	Minimum unit	1
E0.03	Digital input X3		Factory default	0
	Setting range	0...29	Minimum unit	1
E0.04	Digital input X4		Factory default	0
	Setting range	0...29	Minimum unit	1
E0.05	Digital input X5		Factory default	0
	Setting range	0...29	Minimum unit	1
E0.06	Digital input X6		Factory default	0
	Setting range	0...29	Minimum unit	1
E0.07	Digital input X7		Factory default	0
	Setting range	0...29	Minimum unit	1
E0.08	Digital input X8		Factory default	0
	Setting range	0...29	Minimum unit	1

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

- 0: Inactive

  The frequency converter is inactive even if there is input signal. Unused inputs are suggested to be set to 0 (inactive) to avoid malfunction, multiple selection is possible.

- 1: Multi-speed control 1

- 2: Multi-speed control 2

- 3: Multi-speed control 3

Parameter Settings

- 4: Multi-speed control 4

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

For example, if digital inputs X1, X2, X3 and X4 are set as multi-speed inputs: [E0.01] = 1, [E0.02] = 2, [E0.03] = 3 and [E0.04] = 4, multi-speed control can be set with external switches. Run, Stop and direction can be set with FWD and REV, as shown in figure below.
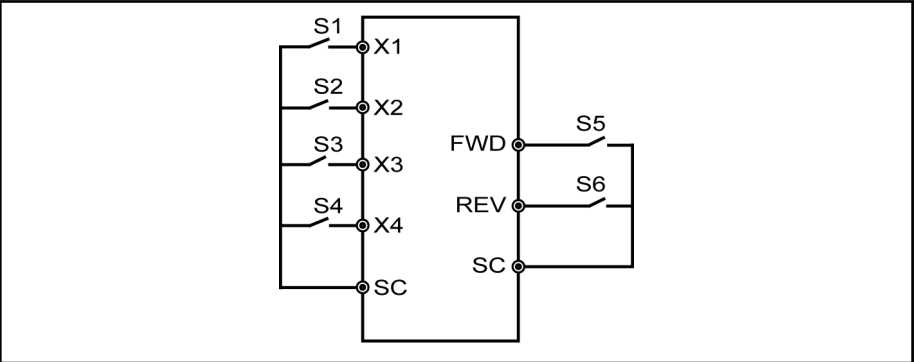
SW1 jumper position cannot be set as 1-2, 3-4

Fig. 7-30:   Multi-speed control wiring

Multi-speed frequencies can be set with the combination of switches S1, S2, S3 and S4. The control process is shown in figure below.
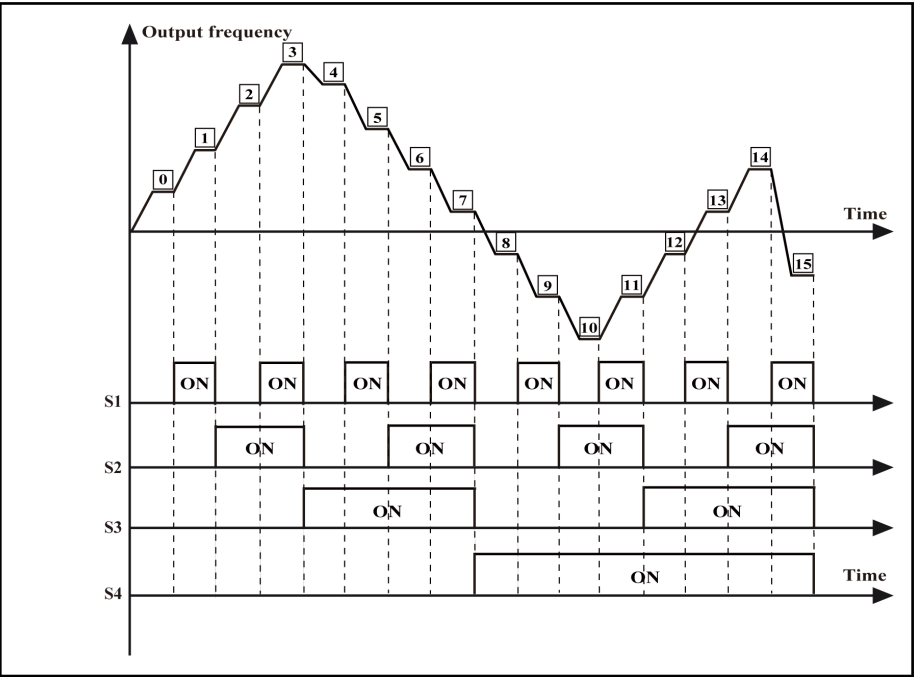
Fig. 7-31:   Multi-speed control process

Combination of digital inputs				Selected frequency	Corresponding parameter
S4	S3	S2	S1		
OFF	OFF	OFF	OFF	Multi-speed frequency 0	b1.00
OFF	OFF	OFF	ON	Multi-speed frequency 1	E2.06
OFF	OFF	ON	OFF	Multi-speed frequency 2	E2.07

Parameter Settings

Combination of digital inputs				Selected frequency	Corresponding parameter
S4	S3	S2	S1		
OFF	OFF	ON	ON	Multi-speed frequency 3	E2.08
OFF	ON	OFF	OFF	Multi-speed frequency 4	E2.09
OFF	ON	OFF	ON	Multi-speed frequency 5	E2.10
OFF	ON	ON	OFF	Multi-speed frequency 6	E2.11
OFF	ON	ON	ON	Multi-speed frequency 7	E2.12
ON	OFF	OFF	OFF	Multi-speed frequency 8	E2.13
ON	OFF	OFF	ON	Multi-speed frequency 9	E2.14
ON	OFF	ON	OFF	Multi-speed frequency 10	E2.15
ON	OFF	ON	ON	Multi-speed frequency 11	E2.16
ON	ON	OFF	OFF	Multi-speed frequency 12	E2.17
ON	ON	OFF	ON	Multi-speed frequency 13	E2.18
ON	ON	ON	OFF	Multi-speed frequency 14	E2.19
ON	ON	ON	ON	Multi-speed frequency 15	E2.20

Tab. 7-8:   Multi-speed digital inputs

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

  Four options of acceleration/deceleration time are available with the combinations of the two inputs, as shown in table below.

Combination of digital inputs		Selected acceleration /deceleration time	Corresponding parameter
Acc./Dec. time 2	Acc./Dec. time 1		
OFF	OFF	Acceleration time 1	b1.09
		Deceleration time 1	b1.10
OFF	ON	Acceleration time 2	E2.00
		Deceleration time 2	E2.01
ON	OFF	Acceleration time 3	E2.02
		Deceleration time 3	E2.03
ON	ON	Acceleration time 4	E2.04
		Deceleration time 4	E2.05

Tab. 7-9:   Multi-speed acceleration/deceleration time

- 7: 3-wire control

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

- 8: Freewheel to stop

  – Used for large inertia loads without requirement to stop time.

  – The frequency converter blocks output and the motor's stopping is not controlled by the frequency converter.

- 9: Frequency increment **Up**

Parameter Settings

- 10: Frequency decrement **Down**

  These two inputs are used to change the set frequency with digital inputs **Up/Down**. See parameters b1.00 and S3.11.

- 11: Set frequency to 0

  Used to clear the frequency set by digital inputs **Up/Down** and change the set frequency to 0.

- 12: Reserved

- 13: Activate DC brake

  When the frequency converter is decelerating to stop, if the output frequency reaches the shutdown DC brake activation frequency, this input is active and the frequency converter directly switches to the shutdown DC brake status. See parameters b1.21 and b1.23. Parameter b1.22 is inactive in this case.

- 14: Switch between operating panel and digital inputs control

  Used to switch between control with operating panel and with digital inputs, when [b1.02] = 0 or [b1.02] = 1.

- 15: Logic control deactivated

  Used to control the operation of logic control.

[E2.21]	Xi = 15	Logic control status
≠ 0	OFF	Running (Factory default)
≠ 0	On	Inactive
= 0	OFF	Inactive
= 0	On	Inactive

Tab. 7-10:   Logic control status

- 16: Logic control paused

  When the digital input is of On, the logic control is paused and the frequency converter runs at zero speed; when the digital input is of OFF, the frequency converter resumes the status before the logic control pause.

- 17: Switch between speed control and torque control

  Used to switch between speed control and torque control in vector control with feedback. The related parameter is S1.04.

  – When parameter [S1.04] = 0, the digital input is disconnected to activate speed control; and when the digital input is connected to activate torque control.

  – When parameter [S1.04] =1, torque control is always on regardless of the status of the digital inputs.

- 18: Switch between VR1 analog reference and +I analog reference

  The switching rule is shown in table below.

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

Parameter Settings

Parameter setting	Digital input is OFF	Digital input is ON
[b1.00] = 2 , [E0.09] = 2 (k3 × (+I))	Reference channel is k3 × (+I)	Reference channel is k1 × VR1
[b1.00] = 2 , [E0.09] = 3 (k1 × VR1 + k2 × VR2)	Reference channel is k1 × VR1 + k2 × VR2	Reference channel is k3 × (+I) + k2 × VR2
[b1.00] = 2 , [E0.09] = 4 (k1 × VR1 + k3 × (+I))	Inactive	Inactive
[b1.00] = 2 , [E0.09] = 5 (k2 × VR2 + k3 × (+I))	Reference channel is k2 × VR2 + k3 × (+I)	Reference channel is k2 × VR2 + k1 × VR1
[b1.00] = 2 , [E0.09] = 6 (k1 × VR1)	Inactive	Inactive

Tab. 7-11:   Switch between VR1 analog reference and +I analog reference

☞
- k1: VR1 channel amplification factor, see parameter E0.10.
- k2: VR2 channel amplification factor, see parameter E0.11.
- k3: +I channel amplification factor, see parameter E0.12.

- 19: External error N.O. contact input
- 20: External error N.C. contact input

  When an external error signal is sent to the frequency converter, the frequency converter responses with 'E.-St' alarm and stops. This is to facilitate the monitoring and interlinking of the external devices.

- 21: External **Reset** input
  - Same like reset by operating panel.
  - Allows remote error reset.

- 22: Activate communication control
  - Used to switch between control by operating panel and by communication, when [b1.02] = 0.
  - Used to switch between control by digital inputs and by communication, when [b1.02] = 1.

- 23: Torque limit set by VR1 enabled

  Used to enable the VR1 analog channel to set the torque limit when the frequency converter works in speed mode.

  VR1, 0...10 V corresponding torque: 0...200 %

- 24: Torque limit set by VR2 enabled

  Used to enable the VR2 analog channel to set the torque limit when the frequency converter works in speed mode.

  VR2, 0...10 V corresponding torque: 0...200 %

- 25: Forward jogging

  Used to enable forward jogging.

- 26: Reverse jogging

  Used to enable reverse jogging.

  The logic relation between forward/reverse jogging frequency and running frequency is shown as below:

Parameter Settings
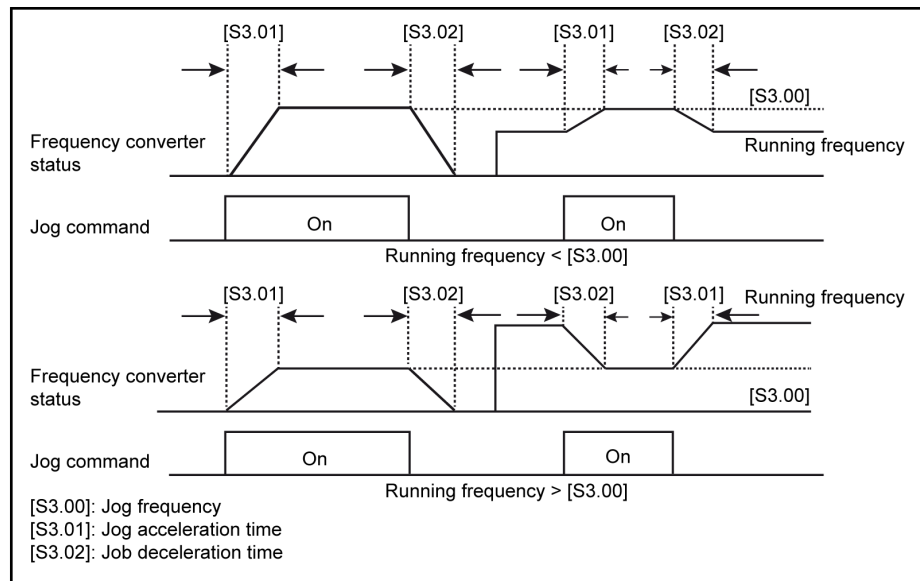
Fig. 7-32:   *Relation between forward/reverse jogging frequency and running fre-quency*

- 27: Process PID deactivated

  - When [E0.01]...[E0.08] = 27 and the corresponding multi-function digital input terminal is closed, or when [E3.00] = 0, the PID function is deactivated and the frequency converter runs with set frequency, which is decided by E3.00.

  - When [E3.11] = 0, the set frequency is decided by E3.00.

    - When [E3.00] = 0, the set frequency is decided by b1.00.

    - When [E3.00] = 1 or 3, the set frequency is analog signal input.

    - When [E3.00] = 2, the set frequency is analog digital setting.

    - When [E3.00] = 4, the set frequency is rotation speed digital setting.

  - When [E3.11] = 1, the set frequency is decided by b1.00.

Process PID control is illustrated as below:
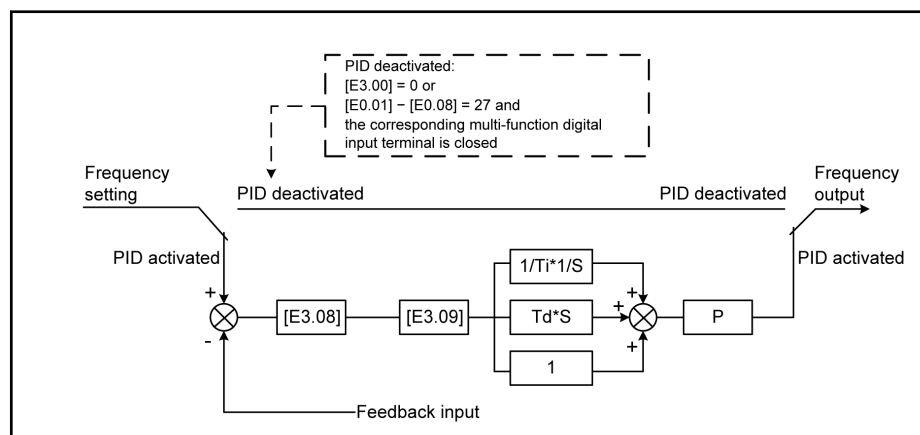
Fig. 7-33:   *PID control*

- 28: Speed limit set by VR1 enabled

  Used to enable the VR1 analog channel to set the speed limit when the frequency converter works in torque mode.

VR1, 0...10 V corresponding speed: (0...100 %) × [b1.06]

- 29: Speed limit set by VR2 enabled

   Used to enable the VR2 analog channel to set the speed limit when the frequency converter works in torque mode.

   VR2, 0...10 V corresponding speed: (0...100 %) × [b1.06]

E0.09	Source of analog frequency setting		Factory default	0
	Setting range	0: k1 × VR1 1: k2 × VR2 2: k3 × (+I) 3: k1 × VR1 + k2 × VR2 4: k1 × VR1 + k3 × (+I) 5: k2 × VR2 + k3 × (+I) 6: k1 × VR1 (only valid for -10...+10 V forward/reverse control) 7: k4 × VR3	Minimum unit	1
E0.10	VR1 channel amplification factor k1		Factory default	1.00
	Setting range	0.00...10.00	Minimum unit	0.01
E0.11	VR2 channel amplification factor k2		Factory default	1.00
	Setting range	0.00...10.00	Minimum unit	0.01
E0.12	+I channel amplification factor k3		Factory default	1.00
	Setting range	0.00...10.00	Minimum unit	0.01
E0.13	Reference frequency curve		Factory default	0
	Setting range	0...31	Minimum unit	1
E0.14	Analog channel filter time		Factory default	0.100
	Setting range	0.000...2.000 s	Minimum unit	0.001
E0.15	Maximum input pulse frequency		Factory default	20.0
	Setting range	1.0...50.0 kHz	Minimum unit	0.1
E0.16	Curve 1 minimum reference		Factory default	0.0
	Setting range	0.0 %...[E0.18]	Minimum unit	0.1
E0.17	Frequency corresponding to curve 1 minimum reference		Factory default	0.00
	Setting range	0.00...[b1.06] Hz	Minimum unit	0.01
E0.18	Curve 1 maximum reference		Factory default	100.0
	Setting range	[E0.16]...100.0 %	Minimum unit	0.1
E0.19	Frequency corresponding to curve 1 maximum reference		Factory default	50.00
	Setting range	0.00...[b1.06] Hz	Minimum unit	0.01
E0.20	Curve 2 minimum reference		Factory default	0.0
	Setting range	0.0 %...[E0.22]	Minimum unit	0.1

Parameter Settings

E0.21	Frequency corresponding to curve 2 minimum reference		Factory default	0.00
	Setting range	0.00...[b1.06] Hz	Minimum unit	0.01
E0.22	Curve 2 maximum reference		Factory default	100.0
	Setting range	[E0.20]...100.0 %	Minimum unit	0.1
E0.23	Frequency corresponding to curve 2 maximum reference		Factory default	50.00
	Setting range	0.00...[b1.06] Hz	Minimum unit	0.01
E0.24	Analog reference forward/reverse dead zone control value at -10...+10 V		Factory default	0.0
	Setting range	0.0...30.0 %	Minimum unit	0.1

- When VR1, VR2, VR3, +I or pulse frequency (PULSE) input is used as reference frequency channel, the relationship between reference channel and reference frequency is shown in figure below.
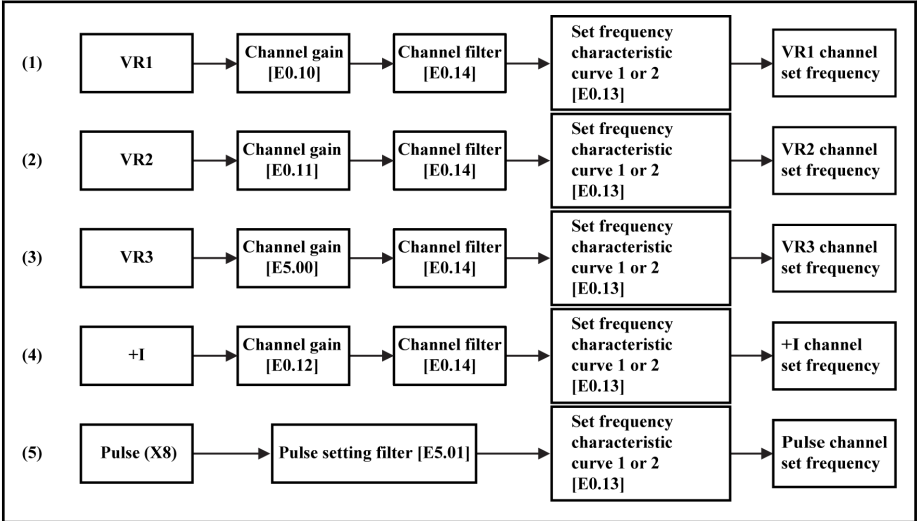
Fig. 7-34:   Reference frequency channel and reference frequency

- For reference frequency signals after gain and filter processing, their relationship with the set frequencies is determined by curve 1 or curve 2. Curve 1 is defined with E0.16...E0.19, and curve 2 is defined with E0.20...E0.23. Either of them can independently realize direct and inverse actions, as shown in figure below.

Parameter Settings
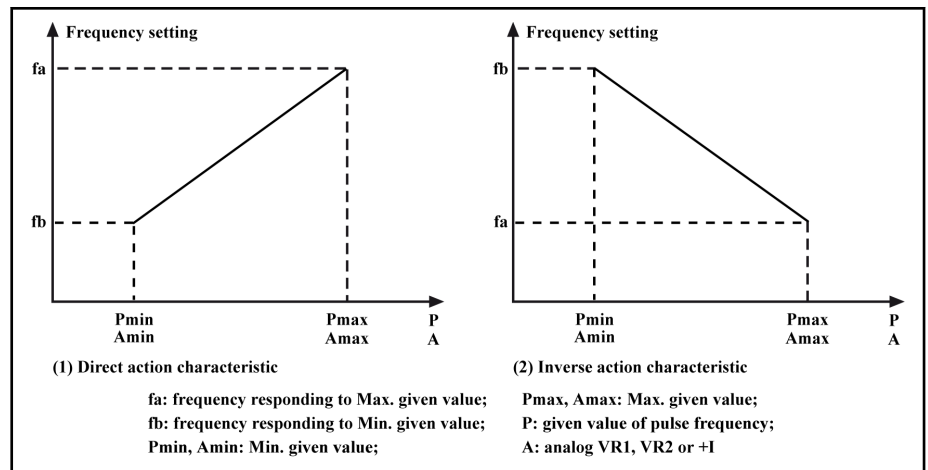
Fig. 7-35:   Output frequency characteristics curves

- Analog input A being 100 % corresponds to 10 V or 20 mA, and pulse frequency P being 100 % corresponds to the maximum input pulse frequency defined with E0.15.

- Parameter E0.13 is used to select output frequency characteristic curves for VR1, VR2, VR3, +I and PULSE frequency reference channels, as shown in figure below.
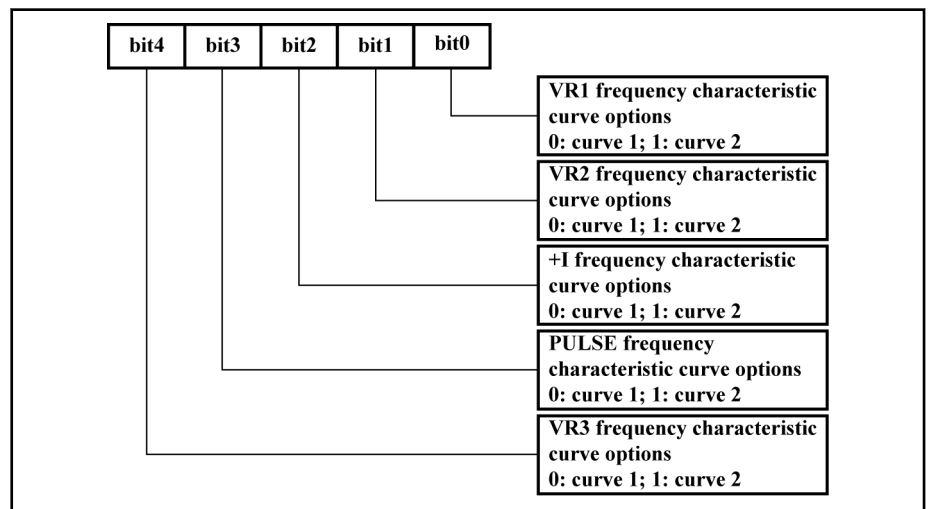
Fig. 7-36:   Reference frequency curve selection

- Parameter E0.14 is used to define the analog channel filter time constant for filtering processing of input signals. Longer filter time means stronger anti-interference capability and slower response; shorter filtering time means weaker anti-interference capability and faster response.

- Parameter E0.09 is used to select the source of analog reference frequency. VR2, VR3 and +I inputs are inactive if [E0.09] = 6.

- If [E0.09] = 6, VR1 input inverse frequency characteristic curve is deactivated.

- If [E0.09] = 6 and the voltage range of VR1 analog input is -10 V...0 V...+10 V, direction information exists. In this case, the direction control by operating panel or digital inputs is automatically deactivated, and is not subject to the rotation direction parameter S3.14, and the dead zone is determined with E0.24.

Parameter Settings

- If [E0.09] = 6, parameter E0.24 can be used to define the forward and reverse rotation dead zone of the motor, i.e. the range for treating input signals as zero, as shown in figure below.
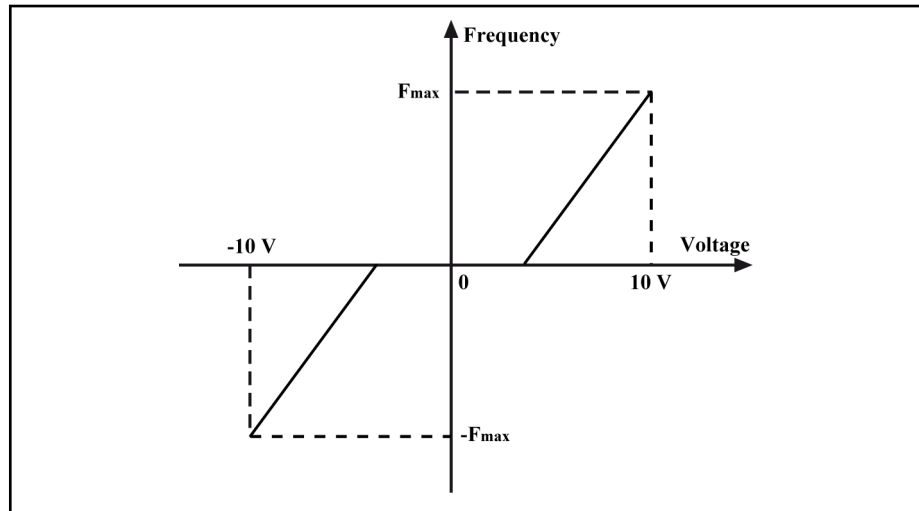
Fig. 7-37:   Reference frequency and analog input voltage when [E0.09] = 6

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

Group E1: Analog and digital outputs

E1.00	Open collector output OUT1		Factory default	1
	Setting range	0...14	Minimum unit	1
E1.01	Open collector output OUT2		Factory default	1
	Setting range	0...14	Minimum unit	1
E1.02	Relay outputs Pa, Pb and Pc		Factory default	1
	Setting range	0...14	Minimum unit	1

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

- 0: Frequency converter is ready to run

  Output indicating signal when the frequency converter is free of error and ready to run after the main circuit and the control circuit power supplies have been established.

- 1: Frequency converter is running

  Output indicating signal when the frequency converter is running and has frequency output.

- 2: DC brake active

  Output indicating signal when the frequency converter is in DC braking process.

- 3: Frequency converter runs at zero speed

  Output indicating signal when the frequency converter runs at 0 Hz.

- 4: Frequency/speed arrival signal

  See related parameter 'Frequency arrival detection width' E1.03.

Parameter Settings

- 5: Frequency level detection signal (FDT1)

  See related parameters E1.04...E1.05.
- 6: Frequency level detection signal (FDT2)

  See related parameters E1.06...E1.07.
- 7: Logic control phase completed

  Pulse output indicating signal when each phase is complete in logic control.
- 8: Under voltage stop

  Output indicating signal when the frequency converter is at under voltage.
- 9: Frequency converter over load pre-warning 1

  Output indicating signal after the output current exceeds the set value of parameter E1.08 for the time set by E5.13.
- 10: Motor over load pre-warning

  Output indicating signal when the output current exceeds the set value of parameter E1.09 'Motor over load pre-warning level setting'.
- 11: Over torque

  Output indicating signal when the motor torque exceeds the torque limit settings in vector control.
- 12: Frequency converter in error

  Output indicating signal when the frequency converter is in error.
- 13: Error auto reset signal output

  Output indicating signal when the frequency converter tries to auto reset.
- 14: Frequency converter over load pre-warning 2

  Output indicating signal when load of K1 times rated current is applied to the frequency converter for T1 seconds and warning message O.L.-3 occurs on panel at the same time. Error message O.L.-1 occurs if the same load keeps for another T2 seconds. The relationship of T1, T2 and K1 are shown below:

Load K1 (%)	T1/s	T2/s
110...115	3600	360
116...120	1800	180
121...130	600	60
131...140	300	30
141...150	60	6
151...160	30	3
161...170	20	2
171...180	10	1
181...190	5	0.5
191...200	1	0.1

Tab. 7-12:   K1, T1 and T2 relationship

Parameter Settings

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

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

If parameters E1.00...E1.02 are set to '4: Frequency/speed arrival signal', the difference between the output frequency and the set frequency is within the setting range of this parameter, and the output indicating signals are shown in figure below.
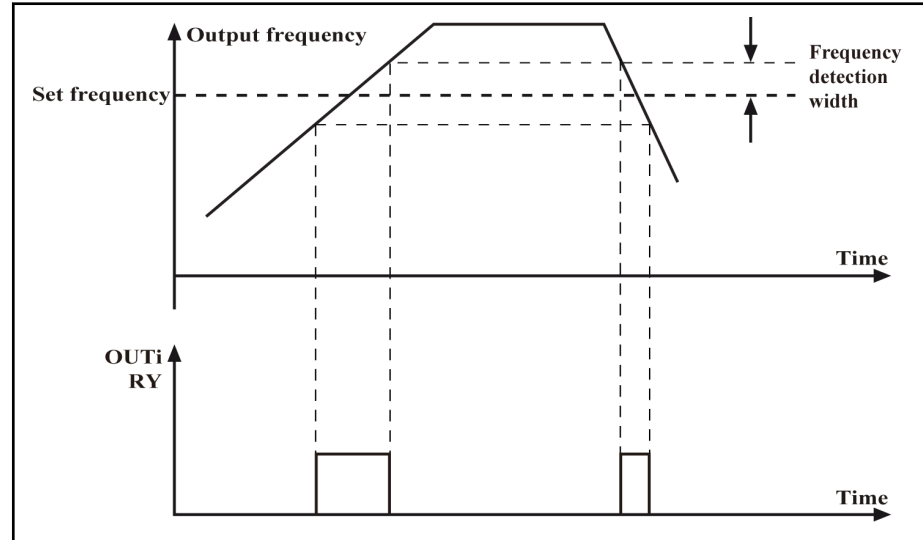
Fig. 7-38:   Frequency arrival signal

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

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

- Output indicating signal when parameters E1.00...E1.02 are set to '5: Frequency level detection signal (FDT1)' or '6: Frequency level detection signal (FDT2)', and the frequency converter output frequency is within the corresponding FDT range.

Parameter Settings
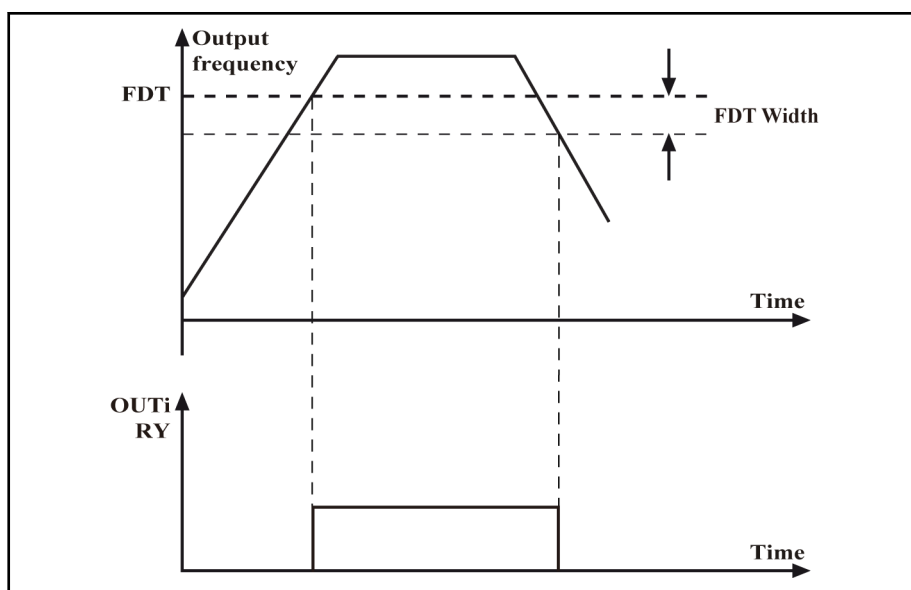
Fig. 7-39:   Frequency level detection signal

E1.08	Frequency converter over load pre-warning 1 level setting		Factory default	100.0
	Setting range	20.0...100.0 % (of rated frequency converter current)	Minimum unit	0.1

Output indicating signal when parameters E1.00...E1.02 or E5.04 are set to '9: Frequency converter over load pre-warning 1' and the frequency converter output current exceeds the value '[E1.08] × frequency converter rated current' over the time set by [E5.13].

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

Output indicating signal when parameters E1.00...E1.02 are set to '10: Motor over load pre-warning', and the frequency converter output current exceeds the value '[E1.09] × motor rated current'.

E1.10	FM1 analog output		Factory default	0
	Setting range	0...6	Minimum unit	1
E1.11	FM1 negative gain setting		Factory default	1.00
	Setting range	0.00...10.00	Minimum unit	0.01
E1.12	FM1 positive gain setting		Factory default	1.00
	Setting range	0.00...10.00	Minimum unit	0.01

The output range of the analog output terminal FM1 can be set by parameters E5.05...E5.08.

- Output voltage signal: -10...10 V

- Output current signal: 0...20 mA

Either voltage or current signals are determined with JP3 and JP4 on the control board:

Parameter Settings

- If JP3 is set to 1-2, FM1 outputs voltage signals; if JP3 is set to be 2-3, FM1 outputs current signals.
- If JP4 is set to 1-2, FM2 outputs voltage signals; if JP4 is set to be 3-4, FM2 outputs current signals.
- Analog outputs are set with parameter 'FM1 analog outputs' E1.10, as shown in table below.

[E1.10]	Outputs	Range
0	Output frequency / rotation speed	0...maximum output frequency, corresponding to analog outputs set by E5.06...E5.08
1	Reference frequency / rotation speed	0...maximum reference frequency, corresponding to analog outputs set by E5.06...E5.08
2	Output current	0...2 times of rated current, corresponding to analog outputs set by E5.06...E5.08
3	Torque current	0 %...200 % of rated torque current, corresponding to analog outputs set by E5.06...E5.08
4	Output voltage	0...1.2 times of rated voltage, corresponding to analog outputs set by E5.06...E5.08
5	Output frequency / rotation speed (including direction)	0...maximum output frequency, corresponding to analog outputs set by E5.06...E5.08 (0...10 V at forwarding, -10 V...0 at reversing)
6	Reference frequency / rotation speed (including direction)	0...maximum reference frequency, corresponding to analog outputs set by E5.06...E5.08 (0...10 V at forwarding, -10 V...0 at reversing)

Tab. 7-13:   Meanings of analog outputs

- Parameter 'FM1 gain setting' E1.12 is used to set the gain of FM1.

E1.13	FM2 analog output		Factory default	1
	Setting range	0...4	Minimum unit	1
E1.14	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
E1.15	FM2 gain setting		Factory default	1.00
	Setting range	0.00...10.00	Minimum unit	0.01

The output range of the analog output terminal FM2 can be set by parameters E5.09...E5.12. For details, refer to descriptions of parameters E1.10...E1.12.

E1.16	Pulse output		Factory default	0
	Setting range	0...2	Minimum unit	1
E1.17	Maximum output pulse frequency		Factory default	10.0
	Setting range	1.0...50.0 kHz	Minimum unit	0.1

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

- If parameter 'Pulse output' E1.16 is set to '0: Output frequency', when the output frequency reaches the maximum frequency F_{max}, the corresponding set value of parameter 'Maximum output pulse frequency' E1.17 is output via output DO.

Parameter Settings

- If parameter 'Pulse output' E1.16 is set to '1: Output voltage', when the output voltage reaches 500 V, the corresponding set value of parameter 'Maximum output pulse frequency' E1.17 is output via output DO.

- If parameter 'Pulse output' E1.16 is set to '2: Output current', when the output current reaches the rated current, half of the corresponding set value of parameter 'Maximum output pulse frequency' E1.17 is output via output DO.

Group E2: Multi-Speed and logic control

E2.00	Acceleration time 2		Factory default	10.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1
E2.01	Deceleration time 2		Factory default	10.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1
E2.02	Acceleration time 3		Factory default	10.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1
E2.03	Deceleration time 3		Factory default	10.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1
E2.04	Acceleration time 4		Factory default	10.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1
E2.05	Deceleration time 4		Factory default	10.0
	Setting range	0.1...3,600.0 s	Minimum unit	0.1

- Acceleration/deceleration time 2, 3, 4 are defined the same meanings as that of Parameter 'Acceleration time 1' b1.09 / 'Deceleration time 1' b1.10.

- Multifunction digital input Xi is used to select different acceleration/deceleration time, see descriptions of parameters E0.01...E0.08.

E2.06	Multi-speed frequency 1		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.07	Multi-speed frequency 2		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.08	Multi-speed frequency 3		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.09	Multi-speed frequency 4		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.10	Multi-speed frequency 5		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.11	Multi-speed frequency 6		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.12	Multi-speed frequency 7		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01

Parameter Settings

E2.13	Multi-speed frequency 8		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.14	Multi-speed frequency 9		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.15	Multi-speed frequency 10		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.16	Multi-speed frequency 11		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.17	Multi-speed frequency 12		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.18	Multi-speed frequency 13		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.19	Multi-speed frequency 14		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01
E2.20	Multi-speed frequency 15		Factory default	0.00
	Setting range	[b1.07]...[b1.06] Hz	Minimum unit	0.01

Parameters E2.06 to E2.20 are used to set the speeds (frequencies) in each phase of multi-speed control and logic control.

- Multi-speed control

  16 multiple speeds (Speed 0...Speed 15) can be set via multi-speed inputs, together with inputs forward/reverse (FWD-COM and REV-COM) and acceleration/deceleration inputs.

  – Running time of each speed is decided by the hold time of corresponding logic combination.

  – Output frequency is decided by parameters E2.06...E2.20 corresponding to each speed. For details of multi-speed running, see parameters E0.01...E0.08.

- Logic control

  Automatic control according the current acceleration/deceleration time, output frequency, running time and rotation direction. One cycle of logic control is shown in the figure below.
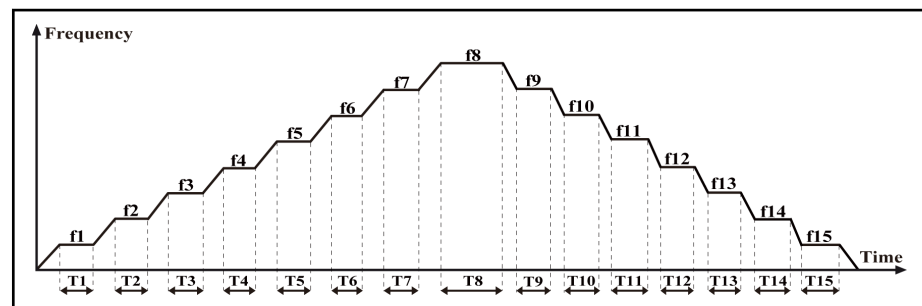

Fig. 7-40:   Logic control

☞   f1...f15 are set by parameters E2.06...E2.20, and T1...T15 are set by parameters E2.22...E2.52.

E2.21	Logic control mode		Factory default	0
	Setting range	0...3	Minimum unit	1

- 0: Inactive. Logic control is inactive.
- 1: Mode 1. Logic control stops after one cycle.
- 2: Mode 2. Frequency converter runs repeatedly, will be stopped by stop commands.
- 3: Mode 3. Frequency converter keeps running at the set frequency of the last phase after one cycle.

E2.22	Logic control time factor		Factory default	1
	Setting range	1...60	Minimum unit	1

The actual run time of each stage is "Set time × parameter 'Logic control time factor' E2.22".

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

- The set frequency of stage 1 is defined by parameter 'Multi-speed frequency 1' E2.06.
- Used to define running direction and acceleration/deceleration time of stage 1.
- To set '0...31', a binary to decimal conversion is needed based on the data format shown in the table below and the options for each bit below the table.

bit4	bit3	bit2	bit1	bit0

Tab. 7-14:   Binary format of parameter E2.23

- The options of each bit are listed below.
  - bit4
    - 0: Forward
    - 1: Reverse
  - bit3 and bit2
    - 00: set by parameter 'Acceleration time 1' b1.09
    - 01: set by parameter 'Acceleration time 2' E2.00
    - 10: set by parameter 'Acceleration time 3' E2.02
    - 11: set by parameter 'Acceleration time 4' E2.04
  - bit1 and bit0
    - 00: set by parameter 'Deceleration time 1' b1.10
    - 01: set by parameter 'Deceleration time 2' E2.01
    - 10: set by parameter 'Deceleration time 3' E2.03
    - 11: set by parameter 'Deceleration time 4' E2.05
- Example: Forward rotation, setting acceleration time with 'Acceleration time 2' E2.00, setting deceleration time with parameter 'Deceleration time 3' E2.03
  - Forward: bit4 = 0
  - setting acceleration time with 'Acceleration time 2' E2.00: bit3 = 0, bit2 = 1 ('bit3 and bit2' = 01)

Parameter Settings

–   setting deceleration time with 'Deceleration time 3' E2.03: bit1 = 1, bit0 = 0 ('bit1 and bit0' = 10)

The binary format of the example is shown as the table below.

0	0	1	1	0

Tab. 7-15:   Example binary format

Conversion of binary format to decimal format:

$[E2.23] = 0 \times 2^4 + 0 \times 2^3 + 1 \times 2^2 + 1 \times 2^1 + 0 \times 2^0 = 6$

E2.24	Stage 1 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1

Used to set the running time of stage 1, related parameter 'Logic control time factor' E2.22.

E2.25	Stage 2 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.26	Stage 2 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.27	Stage 3 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.28	Stage 3 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.29	Stage 4 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.30	Stage 4 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.31	Stage 5 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.32	Stage 5 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.33	Stage 6 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.34	Stage 6 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.35	Stage 7 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.36	Stage 7 running time		Factory default	0.0
	Setting range	0.0...5,000.0s	Minimum unit	0.1
E2.37	Stage 8 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1

Parameter Settings

E2.38	Stage 8 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.39	Stage 9 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.40	Stage 9 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.41	Stage 10 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.42	Stage 10 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.43	Stage 11 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.44	Stage 11 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.45	Stage 12 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.46	Stage 12 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.47	Stage 13 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.48	Stage 13 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.49	Stage 14 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.50	Stage 14 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1
E2.51	Stage 15 action selection		Factory default	0
	Setting range	0...31	Minimum unit	1
E2.52	Stage 15 running time		Factory default	0.0
	Setting range	0.0...5,000.0 s	Minimum unit	0.1

- To set stage 2...stage 15, please refer to the description for stage 1.
- If the running time of a stage is set to 0, logic control will skip this stage.
- If parameter 'Motor standard rotation direction' S3.14 is set to '2: Deactivate reverse motor rotation', logic control will stop immediately when a reverse rotation command is executed.
- For logic control with external inputs, see parameters E0.01...E0.08.

Parameter Settings

Group E3: PID control

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

Based on proportional, integral and differential calculations of the difference between the reference and the feedback, a negative feedback system can be formed with the adjustment of the frequency converter output frequency to limit the difference from the reference. The basic control principle is shown in figure below.
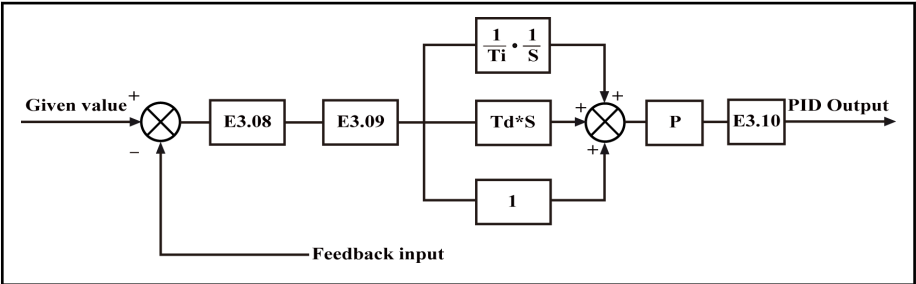

Fig. 7-41:   Process PID control

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

E3.00	PID control mode		Factory default	0
	Setting range	0... 4	Minimum unit	1

- 0: PID control inactive
- 1: Analog input + analog feedback
- 2: Analog digital setting + analog feedback
- 3: Analog input + pulse encoder feedback

  In this mode, parameter 'Control mode' b1.03 needs to be set as '0: V/F control'.

- 4: Rotation speed digital setting + pulse encoder feedback

  In this mode, parameter 'Control mode' b1.03 needs to be set as '0: V/F control'.

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

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

E3.02	Rotation speed digital setting		Factory default	0
	Setting range	0...24,000 rpm	Minimum unit	1

- Active when parameter 'PID control mode' E3.00 is set to '4: Rotation speed digital setting + pulse encoder feedback'.
- In closed loop PID control, configuration of reference, feedback and control mode is shown in table below.

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

Tab. 7-16:   Configuration in closed loop PID control

E3.03	Analog feedback channel		Factory default	0
	Setting range	0...3	Minimum unit	1

Used to select analog feedback channel when [E3.00] = 1 or 2:

- 0: +I direct action is the feedback in the PID control
- 1: +I inverse action is the feedback in the PID control
- 2: VR1 direct action is the feedback in the PID control
- 3: VR1 inverse action is the feedback in the PID control
- 4: VR2 direct action is the feedback in the PID control
- 5: VR2 inverse action is the feedback in the PID control
- 6: VR3 direct action is the feedback in the PID control
- 7: VR3 inverse action is the feedback in the PID control
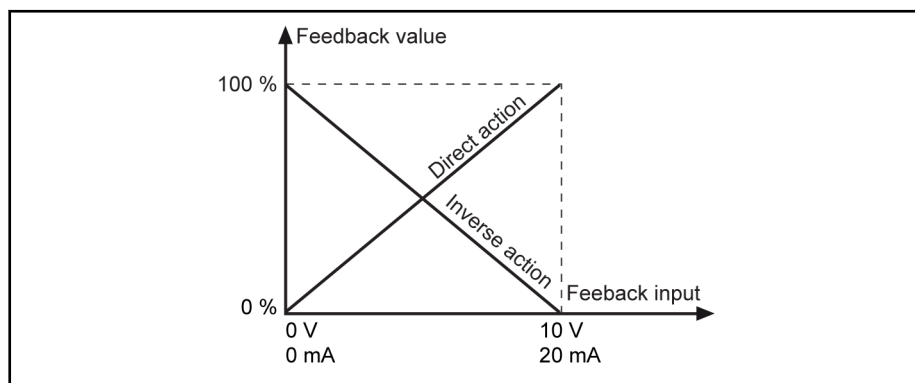
Fig. 7-42:   Feedback modes

E3.04	P: Proportional gain		Factory default	1.500
	Setting range	0.000...10.000	Minimum unit	0.001
E3.05	Ti: Integral time		Factory default	0.00
	Setting range	0....00...100.00 s (0.00 represents no integral)	Minimum unit	0.01

Parameter Settings

E3.06	Td: Derivative time		Factory default	0.00
	Setting range	0.00...100.00 s (0.00 represents no derivative)	Minimum unit	0.01
E3.07	T: Sampling period		Factory default	0.50
	Setting range	0.01...100.00 s	Minimum unit	0.01

Used to set PID control parameters.

- P: Proportional gain

  Used to eliminate deviation

  - Larger P means larger scale and faster response, but too large P leads to oscillation.

  - P cannot eliminate deviation completely.

- Ti: Integral time

  Used to eliminate remained deviation

  - Smaller Ti means faster response of frequency converter to deviation changes, but too mall Ti leads to oscillation.

- Td: Derivative time

  Used to respond fast to changes of deviation between reference and feedback exists in the system.

  - Larger Td means faster response, but too large Td leads to oscillation.

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

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

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

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

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

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

- 0: Stop integral adjustment

  The integral value remains unchanged.

  - When the difference between reference value and feedback value changes, the integral value will change immediately with the changing trend.

- 1: Continue integral adjustment

  The integral value responds simultaneously to the difference change between the reference value and the feedback value.

Parameter Settings

– When the difference between the reference values and the feed-back value changes, more time is needed to compensate the impact of continuous integral adjustment for the integral value to follow the changing trend.

E3.10	PID output action		Factory default	0
	Setting range	0, 1	Minimum unit	1

- 0: Direct action
- 1: Inverse action
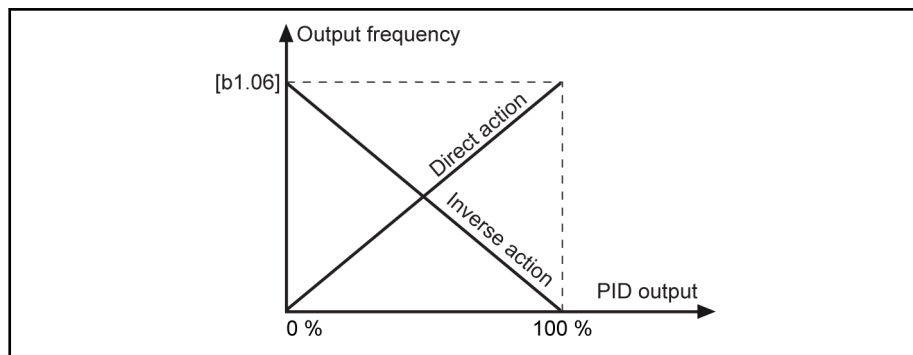
Fig. 7-43: PID adjustment

E3.11	PID feedforward activation		Factory default	0
	Setting range	0, 1	Minimum unit	1
E3.12	PID feedforward limit		Factory default	1.00
	Setting range	0.00...5.00 Hz	Minimum unit	0.01

Used to set the frequency / speed input by adding the fine tuning signal of PID output and the main frequency setting.

- 0: PID feedforward deactivated. If "PID control mode" [E3.00] ≠ 0, the given frequency is set by PID output; if [E3.00] = 0, the given frequency is set by parameter "Frequency setting mode" b1.00.

- 1: PID feedforward activated. If "PID control mode" [E3.00] ≠ 0, the given frequency is set by the result of PID output plus the main frequency setting; if [E3.00] = 0, the given frequency is set by parameter "Frequency setting mode" b1.00.
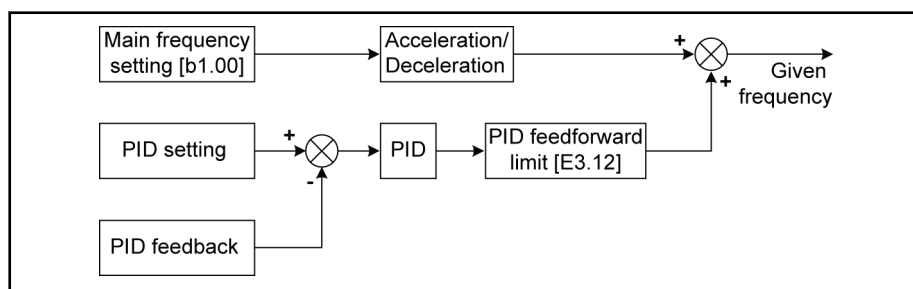
Fig. 7-44: PID feedforward

E3.13	PID analog signal setting channel		Factory default	0
	Setting range	0...3	Minimum unit	1

Used to select the analog signal setting channel when E3.00 is set as 1 or 3:

- 0: the PID given value is from terminal +I

Parameter Settings

- 1: the PID given value is from terminal VR1
- 2: the PID given value is from terminal VR2
- 3: the PID given value is from terminal VR3

Group E4: Protection parameters

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

- Parameter 'Stall over voltage function' E4.01 is used to activate or deactivate stall over voltage function.
  - 0: Deactivated
  - 1: Activated

- In stall over voltage protection, frequency converter detects the bus voltage during deceleration and compares it with 'Stall over voltage protection level' [E4.02].

- If bus voltage exceeds stall over voltage protection level, the frequency converter output frequency stops decrease.

- Only if bus voltage is lower than the stall over voltage protection level, will the frequency converter resume deceleration, as shown in figure below:
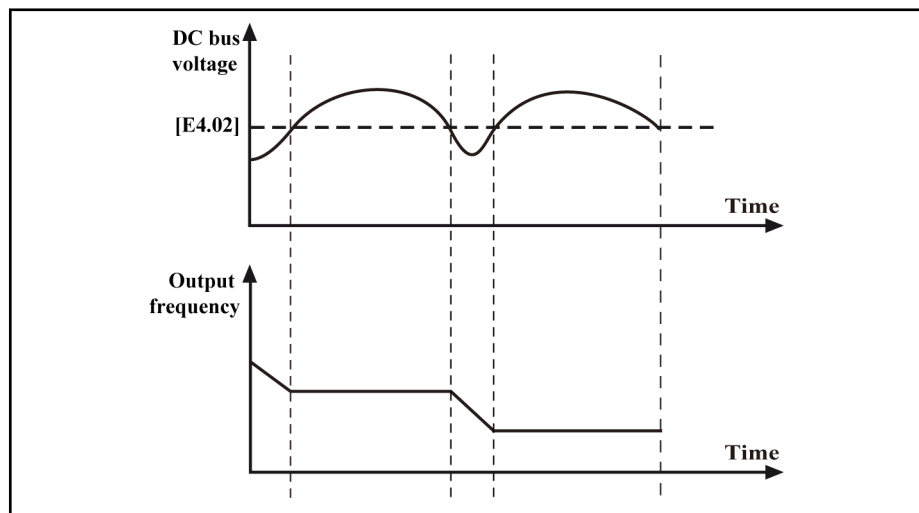
Fig. 7-45:   Stall over voltage protection level

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

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

During acceleration:

- If the frequency converter output current exceeds 'Stall over current protection level' [E4.03], the frequency converter output frequency will stop increase.

- Only if the frequency converter output current is lower than 'Stall over current protection level' [E4.03], will the frequency converter resume acceleration, to avoid stall over current.
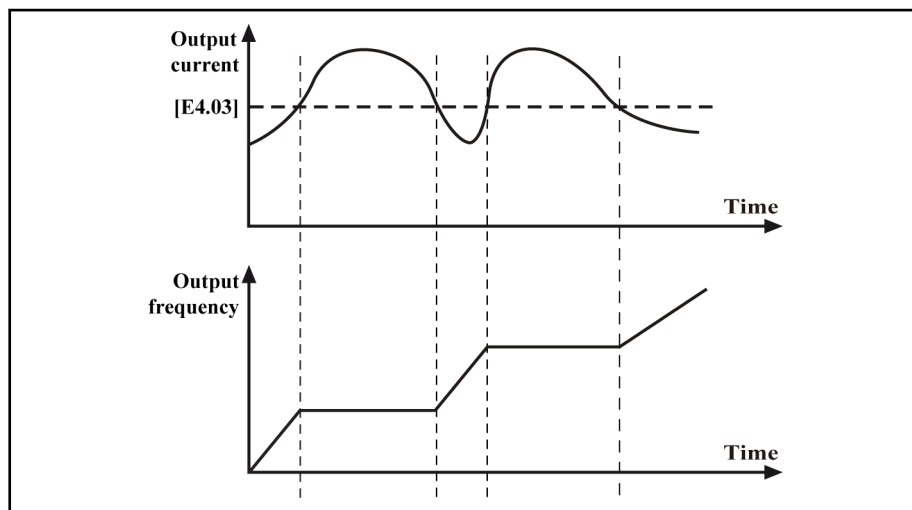

Fig. 7-46:   Stall over current protection level

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

- 0: Inactive

- 1: Heat protection active at low-speed

  With a normal asynchronous motor, heat dissipation is insufficient at low-speed running, the electronic heat protection value will be compensated automatically.

- 2: Heat protection inactive at low-speed

  With a special motor for frequency conversion, heat dissipation will not be deteriorated at low-speed running, the electronic heat protection value automatic compensation is unnecessary.

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

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

  Motor over load protection factor (%) = (Rated motor current / Rated frequency converter current) × 100 %

- The inverse time characteristic of over load protection is shown figure below.
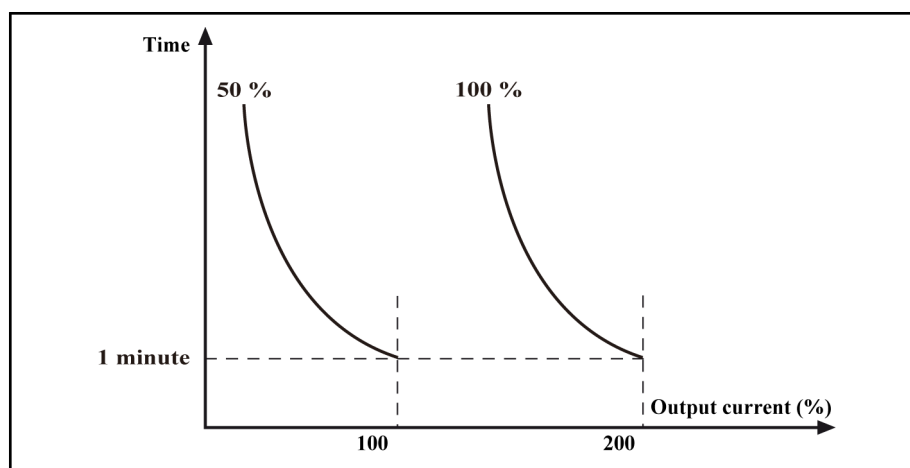
Parameter Settings

Fig. 7-47:   Over load protection curve

E4.06	Type of temperature sensor for motor over heat protection		Factory default	0
	Setting range	0: PTC temperature sensor	Minimum unit	1
		1: NTC temperature sensor		

☞ To activate this function, PTC/NTC temperature sensors need be mounted in the motor with the outputs connected to the respective frequency converter analog input terminals VR1 or VR2, see parameter E4.07.

E4.07	Input channel options of motor over heat protection		Factory default	0
	Setting range	0: Deactivated	Minimum unit	1
		1: VR1		
		2: VR2		
		3: VR3		

● The input of PTC/NTC shares the same channel with VR1 or VR2. Therefore the settings of E4.07 should avoid mutually exclusive settings as shown below:

– When [E4.07] = 1, if settings are as below,

– [E3.00] = 1 / 3 or [E3.13] = 1

– [E3.00]=1 / 2 or [E3.03] = 2 / 3

– [E0.01]...[E0.08] = 18 / 23 / 28

– [b1.00] = 2 or [E0.09] = 0 / 3 / 4 / 6

– [b1.03] = 2 or [S1.05] = 1

Fv will report error message "PRSE" after start.

– When [E4.07] = 2, if settings are as below,

– [E3.00] = 1 / 3 or [E3.13] = 2

– [E3.00] = 1 / 2 or [E3.03] = 4 / 5

– [E0.01] to [E0.08] = 24 / 29

– [b1.00] = 2 or [E0.09] = 1 / 3 / 5

Fv will report error message "PRSE" after start.

Parameter Settings

    –   When [E4.07] = 3, if settings are as below,

       –   [E3.00] = 1 / 3 or [E3.13] = 3

       –   [E3.00] = 1 / 2 or [E3.03] = 6 / 7

       –   [b1.00] = 2 or [E0.09] = 7

- Motor overheat protection input channel shares the same filter time constant E0.14 with the analog input channel.

E4.08	Motor over heat reference		Factory default	2.0
	Setting range	0.0...10.0 V	Minimum unit	0.1

- When the temperature arrives at the set value of E4.08 (motor overheat reference), the motor will freewheel stop with error message "M.O.H." displayed on the operating panel.

- To activate this function, the corresponding motor over heat reference based on temperature sensor type needs to be calculated. If [E4.06] = 0, [E4.07] = 1, digital inputs +10 V, VR1 and GND are used.

  The calculation formula is shown as below:

  [E4.08] = 10 V × R_{PTC}//100 k) / [R + (R_{PTC}//100 k)

  The wiring diagram of PTC temperature detection is shown as below:
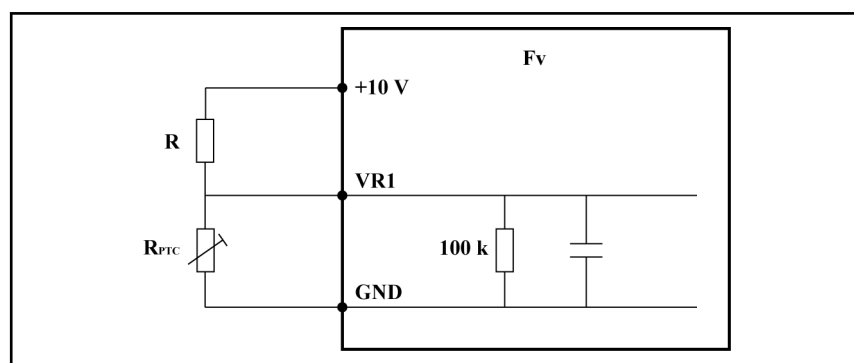
Fig. 7-48:   *Wiring diagram of PTC temperature detection*

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

Motor overheat protection reference [E4.08] [V]	Resistance divider R [kΩ]
1.16	10.0
2.01	5.1
2.18	4.7
2.85	3.3

Tab. 7-17:   *Motor protection reference for general resistor*

E4.09	Phase loss protection		Factory default	0
	Setting range	0...3	Minimum unit	1

- 0: Both input and output phase loss protection active

  –   Frequency converter input phase loss protection is active, and operating panel displays IPH.L.

Parameter Settings

Group E5: Extended parameters

E5.00	VR3 channel amplification factor k4		Factory default	1.00
	Setting range	0.00...10.00	Minimum unit	0.01
E5.01	Pulse input filtering time		Factory default	0
	Setting range	0...9	Minimum unit	1
E5.02	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
E5.03	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1

- E5.01 is used to define the pulse channel filter time constant for processing of input signals. Longer filtering time means stronger anti-interference capability and slower response; shorter filtering time means weaker anti-interference capability and faster response.

E5.04	Relay outputs Ta, Tb and Tc		Factory default	12
	Setting range	0...14	Minimum unit	1

See descriptions of parameters E1.00...E1.02.

E5.05	FM1 output lower limit		Factory default	0.0
	Setting range	0.0 %...[E5.07]	Minimum unit	0.1
E5.06	Output corresponding to [E5.05]		Factory default	0.00
	Setting range	0.00...10.00 V	Minimum unit	0.01
E5.07	FM1 output upper limit		Factory default	100.0
	Setting range	[E5.05]...100.0 %	Minimum unit	0.1
E5.08	Output corresponding to [E5.07]		Factory default	10.00
	Setting range	0.00...10.00 V	Minimum unit	0.01
E5.09	FM2 output lower limit		Factory default	0.0
	Setting range	0.0 %...[E5.11]	Minimum unit	0.1
E5.10	Output corresponding to [E5.09]		Factory default	0.00
	Setting range	0.00...10.00 V	Minimum unit	0.01
E5.11	FM2 output upper limit		Factory default	100.0
	Setting range	[E5.09]...100.0 %	Minimum unit	0.1
E5.12	Output corresponding to [E5.11]		Factory default	10.00
	Setting range	0.00...10.00 V	Minimum unit	0.01

Used to define the relationship between the outputs set by E1.10 and E1.13, and the corresponding analog outputs.

- When the outputs exceed the upper or lower limit, the frequency converter will output the voltage corresponding to the upper or lower limit.

- When output current signals are activated, 1 mA represents 0.5 V.

Parameter Settings
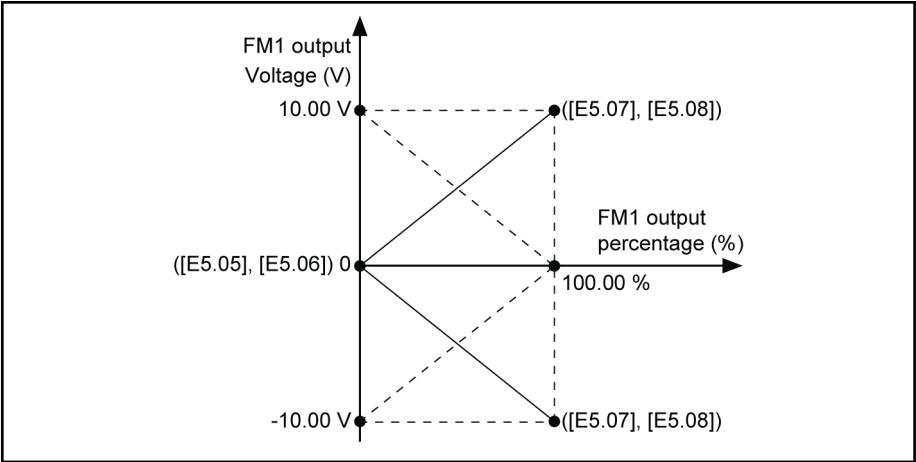
Fig. 7-49:   FM1 voltage output
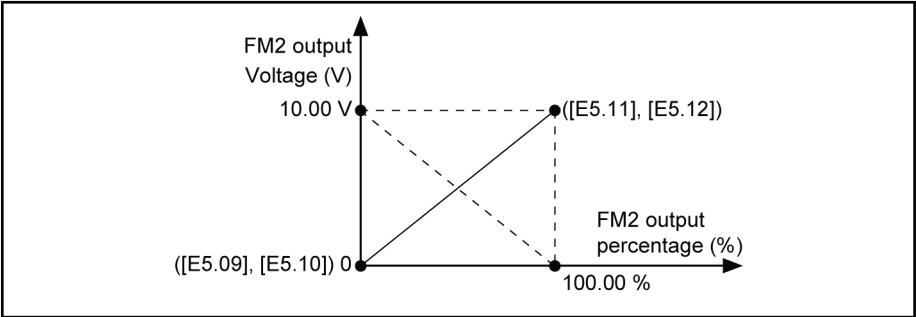
Fig. 7-50:   FM2 voltage output

7.4.4   Category H: Advanced Parameters

Group H0: Communication parameters

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

- 0: ModBus

  Factory default is ModBus protocol and interface. See .

- 1: PROFIBUS

  An optional Rexroth PROFIBUS adapter is needed. See .

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

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

- 0: 1,200 bps
- 1: 2,400 bps
- 2: 4,800 bps
- 3: 9,600 bps
- 4: 19,200 bps
- 5: 38,400 bps

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

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

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

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

H0.03	Local address		Factory default	0
	Setting range	ModBus	0...247	Minimum unit	1
		PROFIBUS	0...126		

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

- In PROFIBUS communication, the maximum number of frequency converters in the network is 126; 0 is invalid address.

Parameter Settings

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

H0.04	PZD4, PZD3 setting		Factory default	0
	Setting range	0...255	Minimum unit	1
H0.05	PZD6, PZD5 setting		Factory default	0
	Setting range	0...255	Minimum unit	1
H0.06	PZD8, PZD7 setting		Factory default	0
	Setting range	0...255	Minimum unit	1
H0.07	PZD10, PZD9 setting		Factory default	0
	Setting range	0...255	Minimum unit	1

In PROFIBUS communication, parameters H0.04...H0.07 are used to set status variables of PZD area. See .

H0.08	Communication disconnection detection time		Factory default	10.0
	Setting range	0.0...60.0 s (0.0 s: deactivated)	Minimum unit	0.1

- 0.0: communication disconnection detection is deactivated.

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

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

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

- 0: If communication is timeout, the motor freewheels to stop.

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

H0.10	Reserved		Factory default	0
	Setting range	0...65,535	Minimum unit	1

8 Error Types and Solutions

Error No.	Error name and code	Possible reason	Solution
1	Over current at constant speed (O.C.-1)	1. Discontinuous or abnormal load in run mode	1. Check load
		2. Low mains voltage	2. Check voltage of input power supply: 3P 380...480 VAC (-15 % / +10 %)
		3. Motor power and converter power do not match	3. Motor power has to match with converter power
		4. Too large inertia or load	4. Check motor power, converter power, load
		5. Pulse encoder error	5. Check pulse encoder and its connection
2	Over current during acceleration (O.C.-2)	1. Too large start frequency	1. Reduce start frequency
		2. Too large load rotation inertia, too large impact load	2. Increase acceleration time, reduce sudden load change
		3. Improper motor parameter setting	3. Set motor parameters properly or auto tune motor parameters (group S2)
		4. Direct start during motor running	4. Restart after motor stop, or start with rotation speed capture (group b1)
		5. Too short acceleration time	5. Increase acceleration time
		6. Motor power and converter power do not match	6. Motor power has to match with converter power
		7. Pulse encoder error	7. Check pulse encoder and its connection
		8. Improper V/f curve	8. Adjust V/f curve setting and torque increase
3	Over current during deceleration (O.C.-3)	1. Improper motor parameter setting	1. Set motor parameters properly or auto tune motor parameters (group S2)
		2. Too large load rotation inertia	2. Use suitable brake components
		3. Too short deceleration time	3. Increase deceleration time
		4. Motor power and converter power do not match	4. Motor power has to match with converter power
		5. Pulse encoder error	5. Check pulse encoder and its connection
4	Over voltage at constant speed (O.E.-1)	1. Acceleration / deceleration time is too short	1. Increase acceleration/ deceleration time
		2. Abnormal input power supply	2. Check input power supply
		3. Too much load change	3. Use suitable brake components
		4. Improper speed loop parameter setting in vector control	4. Adjust PI parameters of speed loop (group S1)
5	Over voltage during acceleration (O.E.-2)	1. Acceleration time is too short	1. Increase acceleration time
		2. Abnormal input power supply	2. Check input power supply
		3. Direct start during motor running	3. Restart after motor stop, or start with rotation speed capture (group b1)

Error Types and Solutions

Error No.	Error name and code	Possible reason	Solution
6	Over voltage during deceleration (O.E.-3)	1. Too large load rotation inertia	1. Use suitable brake components
		2. Too short deceleration time	2. Increase deceleration time
7	Converter over load (O.L.-1)	1. Long time over load	1. Reduce over load time, reduce load Overload capability: 150 % of rated current for 60 s 180 % of rated current for 10 s
		2. Improper V/f curve settings	2. Adjust V/f curve settings
		3. Motor power and converter power do not match	3. Motor power has to match with converter power
		4. Improper motor parameters setting	4. Set motor parameters properly or auto tune motor parameters (group S2)
		5. Direct start during motor running	5. Restart after motor stop, or start with rotation speed capture (group b1)
		6. Low mains voltage	6. Check input power supply
		7. Too short acceleration time	7. Increase acceleration time
8	Motor over load (O.L.-2)	1. Motor locked	1. Prevent motor lock
		2 Normal motor runs long time with heavy load at low speed	2. Use variable frequency motor or increase converter output frequency
		3. Low voltage of input power supply	3. Check input power supply
		4. Improper V/f curve settings	4. Adjust V/f curve setting and torque increase
		5. Locked-rotor or sudden load increase	5. Check load
		6. Improper setting of motor over load protection factor	6. Adjust setting of motor over load protection factor (group E4)
9	CPU read/ write error (R.E.)	Error or illegal data in control board read/write	Contact with technical service
10	Operating panel read/write error (KEY-)	Error or illegal data in operating panel read/write	Contact with technical service
11	External device error (E.-St)	External error caused by input signals via external terminals	Check external terminals status, check respective reason to error

Error Types and Solutions

Error No.	Error name and code	Possible reason	Solution
12	Communication error (R.S.)	1. Device connection problem	1. Check device communication connection
		2. Improper baud rate setting	2. Set proper baud rate
13	Circuit disconnection (C.F.)	Current detection channel abnormal	Contact with technical service
14	Pulse encoder speed detection error (PULS)	1. Pulse encoder error	1. Check operations of mechanical part and electrical part of encoder, power supply and connections
		2. Pulse encoder connection problem	2. Replace encoder connection cable
		3. Improper setting of pulse encoder	3. Set parameters related to pulse encoder properly
15	Motor overheat (M.O.H.)	1. Continuous low speed running for a long time	1. Use a special motor
		2. Over load	2. Reduce over load time, reduce load
		3. Temperature sensor error	3. Replace the temperature sensor or contact with technical service
16	EMI error (CPU-)	CPU malfunction due to external interference	Remove environmental interference or EMI
17	Short circuit (S.C.)	1. Too large output current	1. Check if motor short circuit, motor to earth short circuit, over load exists
		2. Power component error	2. Contact with technical service
18		Reserved	
19	L1, L2, L3 input phase loss (IPH.L)	1. Abnormal, omitted or broken connection of converter power supply	1. Follow operating procedures to check power supply connections, remove omitted or broken connections
		2. Broken fuse	2. Check fuse
		3. Imbalance in the three phases of input power supply	3. Check installation wiring and input voltage
20	U, V, W output phase loss (OPH.L)	1. Abnormal, omitted or broken connection of converter outputs	1. Check connections of frequency converter outputs, remove omitted or broken connections
		2. Imbalance in the three phases of outputs	2. Check motor
21	Fv over heat (C.O.H.)	1. Converter over heat	1. Reduce ambient temperature, improve ventilation and heat dissipation; clear dust, cotton wadding in air ducts; check fan and its power supply connection
		2. Temperature detection circuit error	2. Contact with technical service

Error Types and Solutions

Error No.	Error name and code	Possible reason	Solution
22	Parameter setting error (PRSE)	Improper setting of parameters	Check set values of parameters
23	Parameter auto-tuning error (TUNE)	1. Power of special or normal motor does not match with converter power	1. Check if the motor is special motor, check if the motor power matches with converter power
		2. Improper setting of motor parameters	2. Set parameters according to motor nameplate
		3. No connection of converter with motor	3. Check motor cable connections
24	Frequency converter over load pre-warning 2	See descriptions of option 14 of parameters E1.00...E1.02	Reduce over load time, reduce load

Tab. 8-1: Error types and solutions

9 Technical Data

9.1 Electrical Data

400 V series

Fv type code	0K40	0K75	1K50	2K20	4K00	5K50	7K50
Output power [kW]	0.4	0.75	1.5	2.2	4.0	5.5	7.5
Rated input current [A]	1.6	3.7	5.1	7.6	16.0	16.5	23.5
Rated output current [A]	1.3	2.5	4.0	5.5	10.0	13.0	17.0
Apparent power [kVA]	0.8	1.6	2.6	3.6	6.5	8.5	11.0
Fv type code	**11K0**	**15K0**	**18K5**	**22K0**	**30K0**	**37K0**	**45K0**
Output power [kW]	11.0	15.0	18.5	22.0	30.0	37.0	45.0
Rated input current [A]	36.0	46.0	48.0	53.0	73.0	88.0	104.0
Rated output current [A]	24.0	33.0	39.0	44.0	60.0	75.0	95.0
Apparent power [kVA]	15.0	21.0	24.0	30.0	40.0	50.0	62.0
Fv type code	**55K0**	**75K0**	**90K0**				
Output power [kW]	55.0	75.0	90.0				
Rated input current [A]	119.0	157.0	184.0				
Rated output current [A]	110.0	152.0	176.0				
Apparent power [kVA]	75.0	100.0	116.0				

Tab. 9-1:   *Fv electrical data*

☞   The complete Fv type code is:

FVCA01.2-xxxx-3P4-MDA-LN-NNNN-01VRS

Technical Data

9.2   General Technical Data

Input	Power supply voltage	3P 380...480 VAC (-15 % / +10 %) (TN-Net)
	Power supply frequency	50...60 Hz (±5 %)
Output	Rated output voltage	Corresponding to input voltage
	Output frequency	0.00...400.00 Hz
	Overload capability	150 % of rated current for 60 s 180 % of rated current for 10 s
Main Functions	Control mode	V/f control (V/f) Sensorless vector control (SVC) Field oriented vector control (FOC)
	Speed regulation range	SVC: 100:1; FOC: 1000:1
	Start-up torque	SVC: 150 % × rated torque at 0.50 Hz FOC: 200 % × rated torque at 0.00 Hz
	Frequency resolution	Analog setting: 1 / 2048 × maximum frequency Digital setting: 0.01 Hz
	Frequency setting accuracy	Analog setting: 0.05 %; digital setting: 0.01 %
	Frequency control accuracy	SVC: 0.5 % × maximum frequency FOC: 0.05 % × maximum frequency
	Multiple speed control	Via integrated logic control or digital inputs
	Status messages via multi-function output signal	Outputs of Run, frequency level detection signal, frequency arrival signal, errors, etc.
	Automatic PWM frequency adaptation	Load-dependent adaptation of PWM frequency
Customized functions	Control commands	Set by operating panel, analog and digital inputs, serial port
	Frequency setting	Set by digital operating panel, analog voltage, analog current and serial port, which can be switched at any time
	Auxiliary frequency setting	Flexible frequency fine tuning and frequency source combination (see parameter E0.09)
	Analog outputs	Analog signal output, 0...20 mA or 0...10 V or -10...0 V, to output physical values, such as output frequency
Operating panel	LCD display	Easy commissioning, display Run status, parameter values and operating indications
	LED indicator	Showing set direction, Run status
Protection	Input phase failure protection, output phase failure protection, output short circuit protection, grounding protection, over current protection, over voltage protection, under voltage protection, overload protection, frequency converter overheat protection, motor overheat protection	
Optional parts	Brake chopper, brake resistor, remote operation adapter, communication cable for cabinet control, ModBus/PROFIBUS adapter	

Technical Data

Environment	Power reduction / altitude	Up...1000 m above sea level: none
		1000…4000 m above sea level: 1 % / 100 m
	Ambient temperature	-10...40 °C (without condensation and frost)
		derating between 40...50 °C, see fig. 9-1 "Derating and ambient temperature" on page 162
	Relative humidity	< 90 % RH (without condensation)
	Shocking	< 5.9 m/s^2 (0.6 g)
	Allowed pollution degree	2 (EN 50178)
Construction	Degrees of protection	IP 20 (control cabinet mounting)
	Cooling type	Enforced, air cooling
Mounting mode	Hanging on the wall	

Tab. 9-2:   General technical data

Technical Data

9.3   Derating of Electrical Data
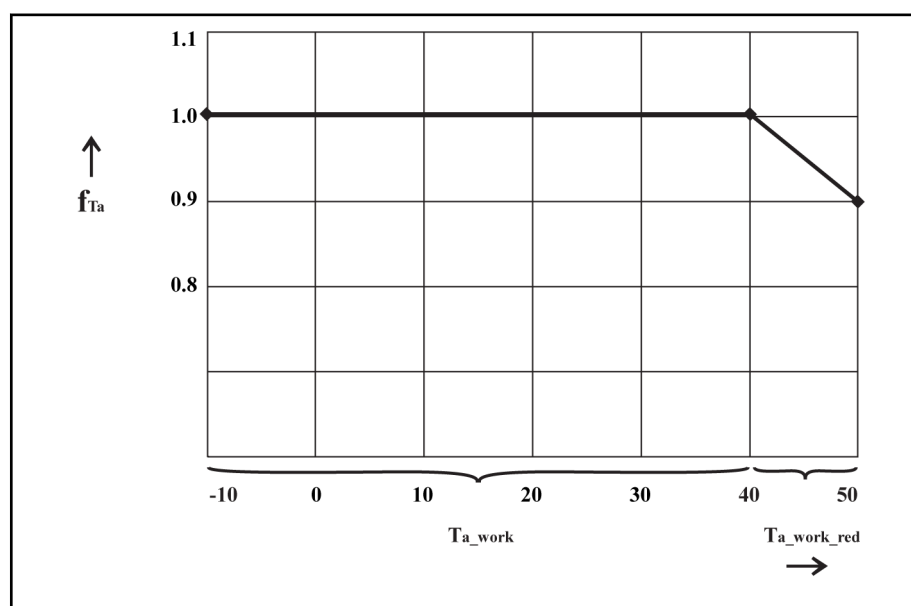
9.3.1   Derating and Ambient Temperature

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

- Frequency converter continuous power output
- Frequency converter continuous current output

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

As the ambient temperature increases, the capacity utilization of the frequency converter is reduced according to the figure below.

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

Fig. 9-1:   *Derating and ambient temperature*

Technical Data

9.3.2   Derating and Mains Voltage

Reduced over current capability based on mains voltage

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

- $U_{mains} < U_{rated}$: With mains voltages below the rated voltage, no higher currents may be withdrawn to keep the same dissipated power.

- $U_{mains} > U_{rated}$: With mains voltages greater than the rated voltage, a reduction of the continuous output current in the permissible range takes place to compensate for the increased switching losses.
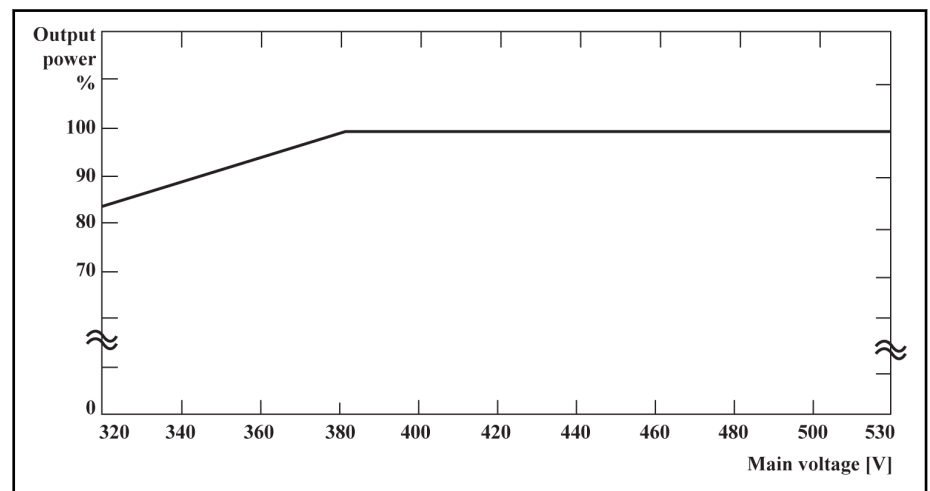

Fig. 9-2:   Derating and mains voltage

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

Technical Data

9.3.3 Derating of the Output Current Depending on the Pulse Frequency

In case of higher pulse frequency, the current is reduced insofar that the power dissipation in power section remains more or less constant. The figure below shows the current reduction based on the pulse frequency for the different frequency converters.
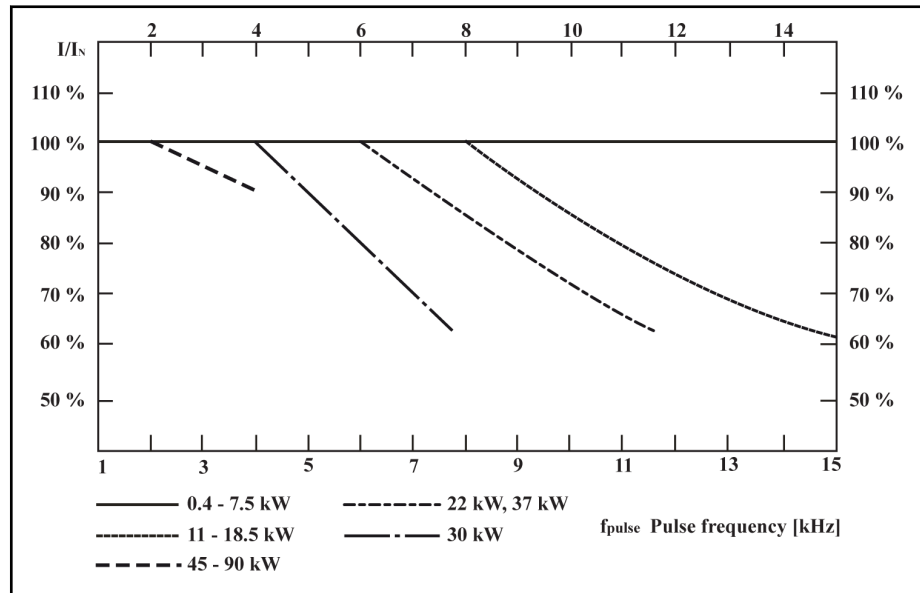
| I | permissible overcurrent |
| $I_{N:}$ | rated current |

Fig. 9-3:   *Derating and output current*

☞
- with 0K40...7K50, the current does not need derating
- with 11K0...18K5 at 8.0 kHz, in 0.1 kHz steps
- with 22K0 and 37K0 at 6.0 kHz, in 0.1 kHz steps
- with 30K0 at 4.0 kHz, in 0.1 kHz steps
- with 45K0...90K0 at 2.0 kHz, in 0.1 kHz steps

Technical Data

9.4 Electromagnetic Compatibility (EMC)

9.4.1 EMC Requirements

General information

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

- Sufficient noise immunity of an electric installation or an electric device against external electric, magnetic or electromagnetic interference via lines or through air.

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

Noise immunity in the drive system

Basic structure for noise immunity

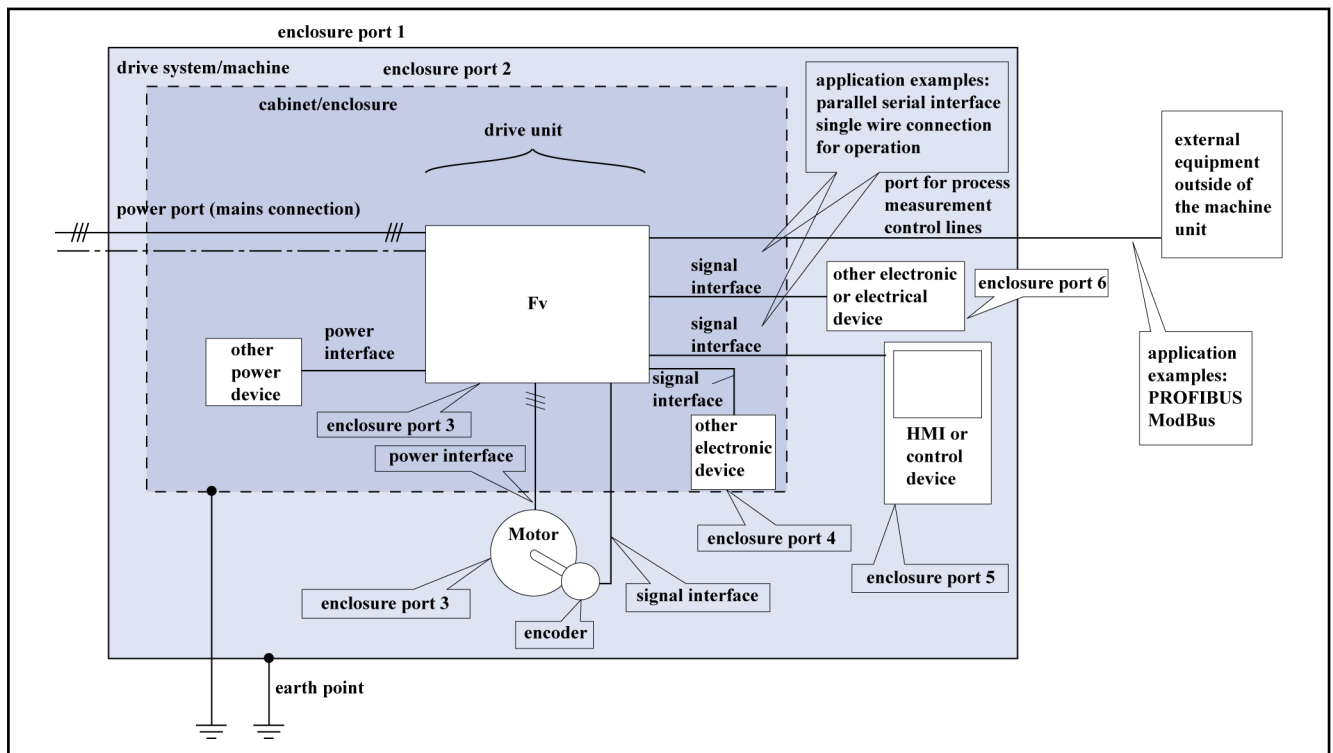The figure below illustrates the interference for definition of noise immunity requirements in the drive system.

Fig. 9-4:   Noise immunity in the drive system

Technical Data

Noise immunity limit values

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

CD   contact discharge
AD   air discharge
CDN   coupling and decoupling network
CN   coupling network

Tab. 9-3:   Noise immunity limit values

Evaluation criterion

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

Tab. 9-4:   Evaluation criterion

Noise emission of the drive system

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

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

The propagation of this interference strongly depends on:

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

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

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

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

Tab. 9-5:   Limit values for line-based disturbances

Technical Data
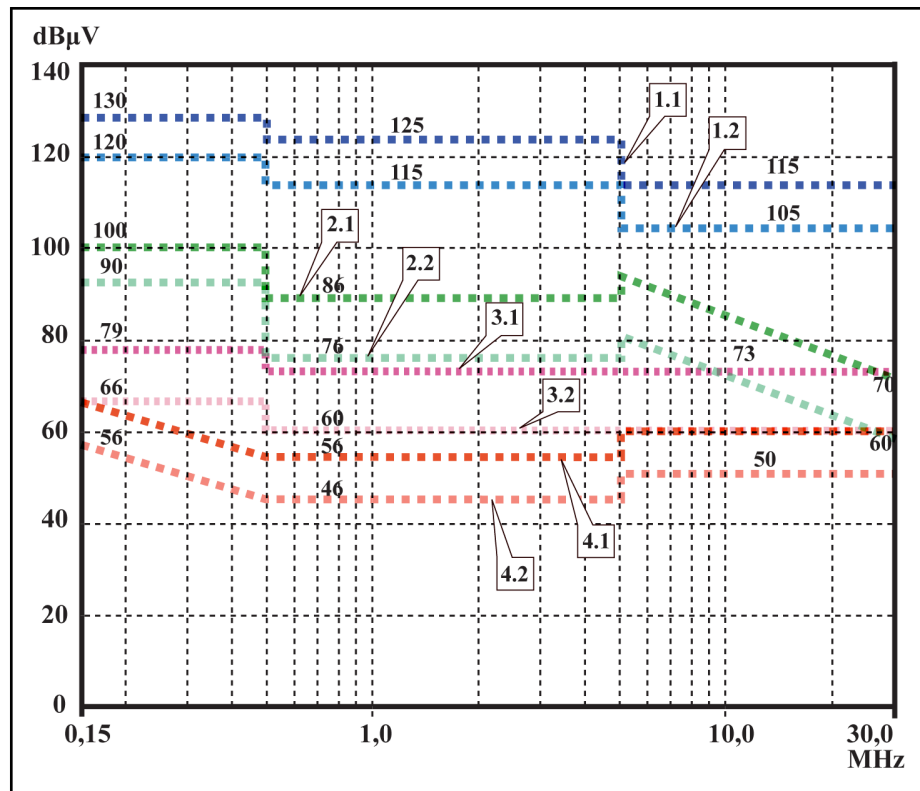
1.1 C3	2nd environment, QP, I>100 A (class A, group 2, I>100 A)
1.2 C3	2nd environment, AV, I>100 A (class A, group 2, I>100 A)
2.1 C3	2nd environment, QP, I≤100 A (class A, group 2, I≤100 A)
2.2 C3	2nd environment, AV, I≤100 A (class A, group 2, I≤100 A)
3.1 C2	1st environment, QP (1st environment, 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. 9-5:   *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.

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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.

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

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

Technical Data

9.4.2   Ensuring the EMC Requirements

Standards and laws

On the European level there are the EU Directives. In the EU states these Directives are transformed into laws valid on a national level. The relevant directive for EMC is EU Directive 2004/108/EC which was transformed on the national level in Germany into the law EMVG ("Law concerning electromagnetic compatibility of devices") of 2008-02-26.

EMC Properties of Components

Drive and control components by Rexroth are designed and built, in accordance with the present state-of-the-art of standardization, according to legal regulations of the EU Directive EMC 2004/108/EC and the German law.

The compliance with EMC standards was tested by means of a typical arrangement with a test setup conforming to standard with the indicated external mains filters. The category C3 requirements according to product standard EN 61800-3 have been complied with.

Applicability for End Product

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

- configuration of the connected drives
- number of the connected drives
- conditions of mounting
- site of installation
- 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, Rexroth drive systems are complied with product standard EN 61800-3 C3. The drive system is listed in the declaration of EMC conformity. This fulfills the legal requirements according to EMC directive.

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

  The product standard for the respective type of machine/installation, if existing, applies to the acceptance test of the machine or installation. In 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.

Technical Data

9.4.3   EMC Measures for Design and Installation

Rules for design of installations with drive controllers in compliance with EMC

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

Mains Filter

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

Control Cabinet Grounding

Connect all metal parts of the cabinet with one another over the largest possible surface area to establish a good electrical connection. This, too applies to the mounting of the 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 separating sheets between power and signal lines. Ground separating sheets several times.

The lines with high potential of noise include:

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

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

Interference Suppression Elements

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

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

Connect these combinations directly at each coil.

Twisted Wires

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

Lines of Measuring Systems

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

Digital Signal Lines

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

Analog Signal Lines

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

Connection of Mains Choke

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

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Installation of Motor Power Cable

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

EMC-optimal installation in facility and control cabinet

General Information

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

☞
- For EMC-optimal installation in the control cabinet, use a separate control cabinet panel for the drive components.
- Frequency converters need to be mounted in metal cabinet and connected to power supply with grounding.
- For frequency converters with internal filter, the maximum length of shielded cable between the motor and frequency converter is 5 m.
- 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. 9-6 "Control Cabinet Mounting According to Interference Areas – Exemplary Arrangements" on page 174.

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.

Technical Data

Control cabinet mounting according to interference areas – exemplary arrangements
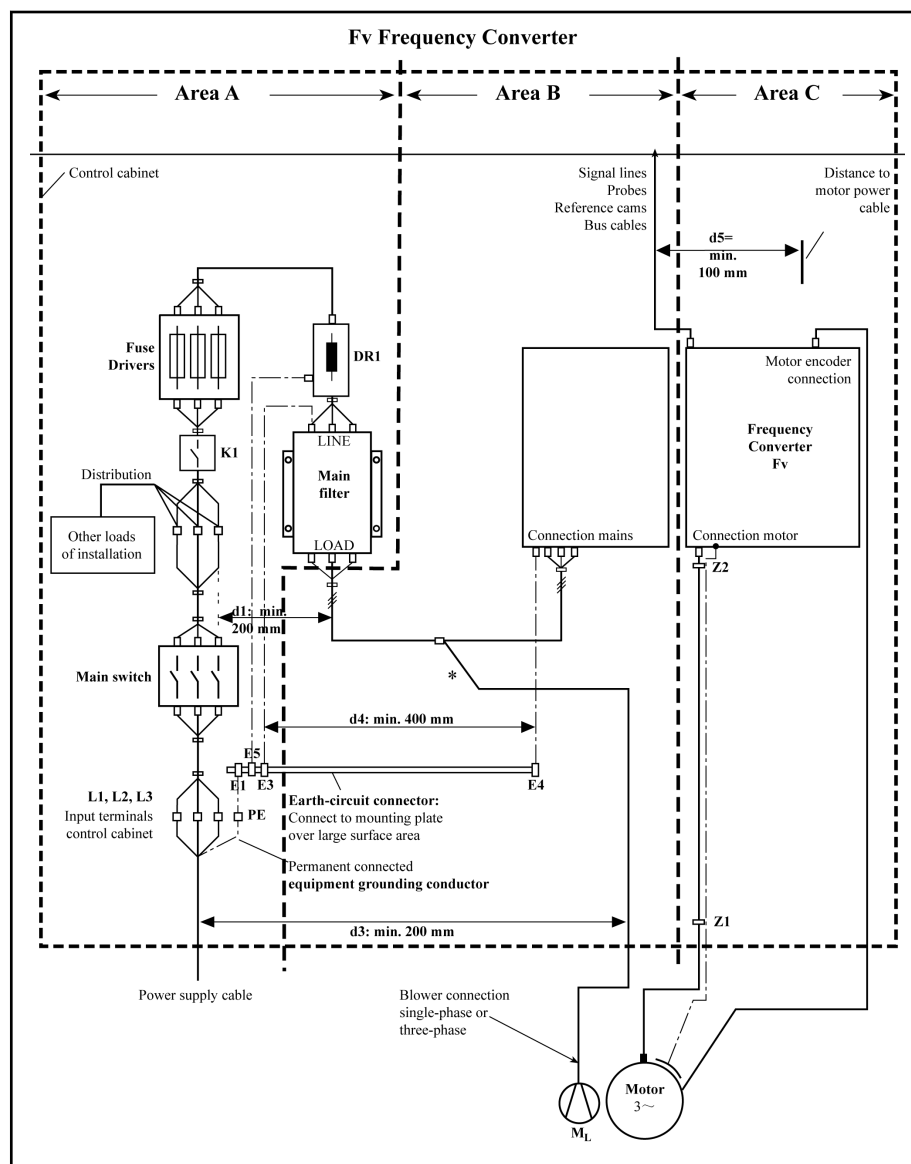
DR1	Mains choke (optional)
E1...E5	Equipment grounding conductor or the components
K1	External mains contactor
M_L	Motor blower
Z1, Z2	Shield connection points for cables

Fig. 9-6:   *Control Cabinet Mounting According to Interference Areas – Exemplary Arrangements*

Technical Data

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

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

Loads at Mains Filter of Drive System

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

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:

Technical Data

- 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.

Grounding

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

See also .

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.

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

Arranging Components and Lines

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

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

Only connect power supply units for auxiliary or control voltage connections in the drive system to the mains via a mains filter. See "Division into Areas (zones)" on page 173.

Install the shortest possible lines between drive controller and filter.

Control Voltage or Auxiliary Voltage Connection

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

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

Line Routing

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

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

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

Influence of the Motor Power Cable

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

- Run the shortest possible motor power cables.

Routing the Motor Power Cables and Motor Encoder Cables

Route the motor power cables and motor encoder cables along grounded metal surfaces, both inside the control cabinet and outside of it, in order to 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.

Technical Data

Ground connections

Housing and Mounting Plate

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

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

Connection Elements

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

Metal Surfaces

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

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

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

Ground Wires and Shield Connections

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

Technical Data

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 173) 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.

Technical Data

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.

10 Accessories

10.1 EMC Filter

10.1.1 The Function of EMC Filter

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

☞ Fv has an optional internal EMC filter. If higher EMC class is required, please use an external EMC filter.

10.1.2 External EMC Filter Type

Fv model	External EMC filter type code
0K40	FENF01.1B-A030-E0008-A-480-NNNN (E0008)
0K75	
1K50	
2K20	
4K00	FENF01.1A-A075-E0025-A-480-NNNN (E0025)
5K50	
7K50	
11K0	FENF01.1A-A075-E0050-A-480-NNNN (E0050)
15K0	
18K5	FENF01.1A-A075-E0066-A-480-NNNN (E0066)
22K0	
30K0	FENF01.1A-A075-E0090-A-480-NNNN (E0090)
37K0	
45K0	FENF01.1A-A075-E0120-A-480-NNNN (E0120)
55K0	
75K0	FENF01.1A-A075-E0250-A-480-NNNN (E0250)
90K0	

Tab. 10-1: External EMC filter type

☞ The EMC filters listed above are recommended based on tests with 10 m motor cables. If longer motor cables are needed, please use appropriate EMC filters.

Accessories

10.1.3   Technical Data

Mechanical data

Figure

☞   **Mounting position and distances**

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

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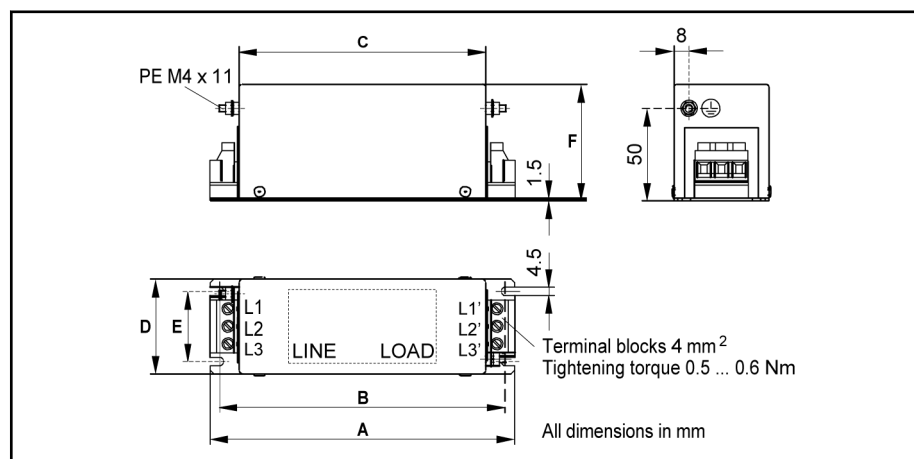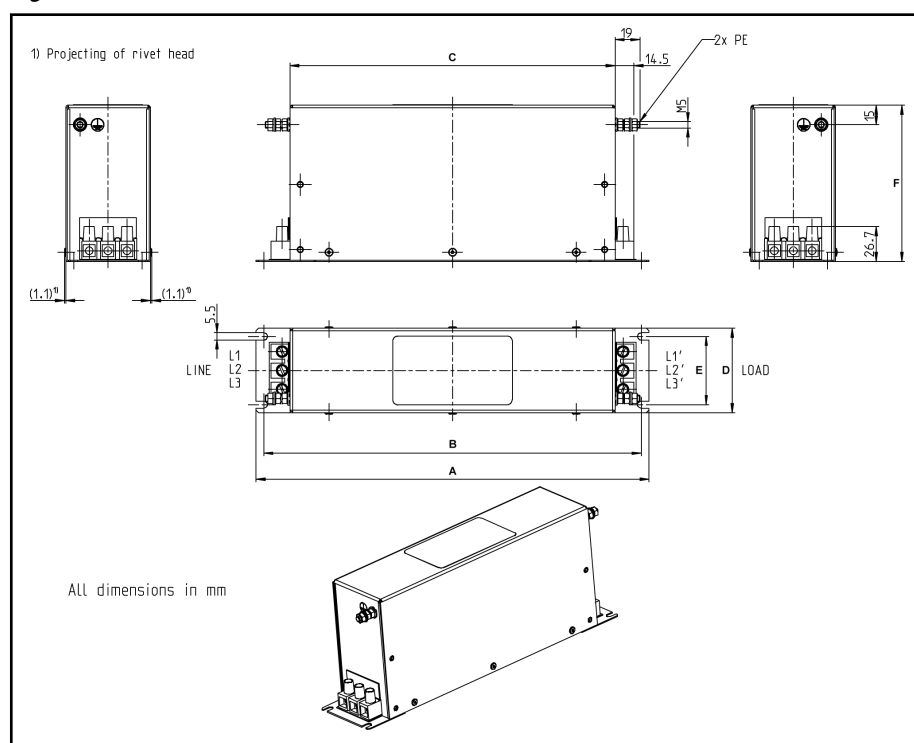

Fig. 10-1:   E0008
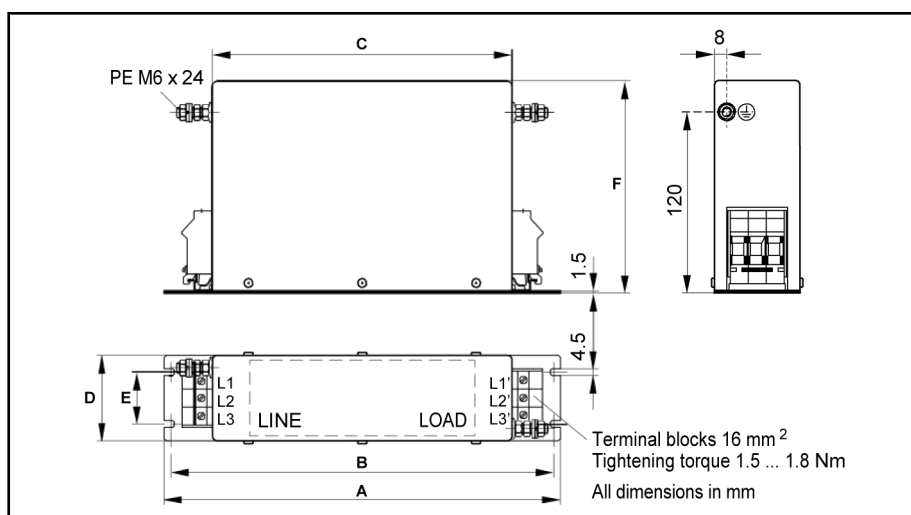

Fig. 10-2:   E0025 and E0050
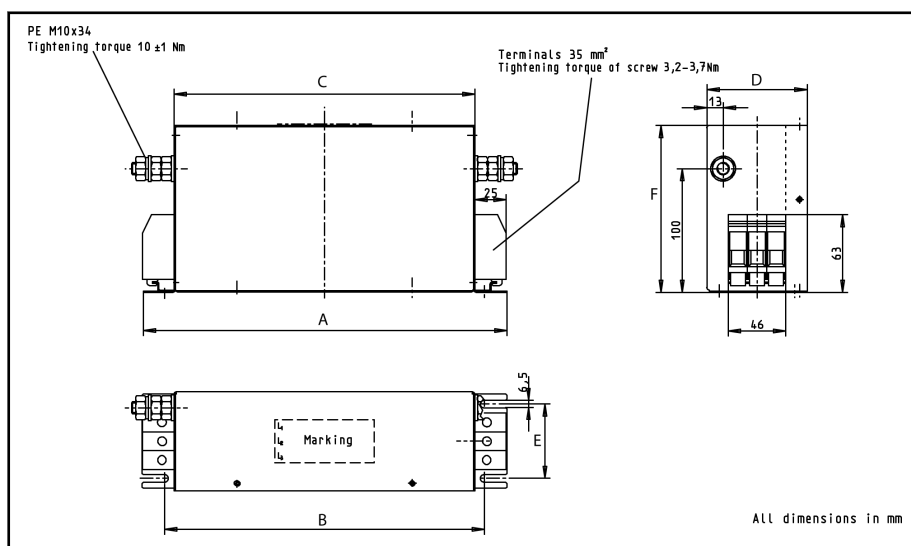
Accessories

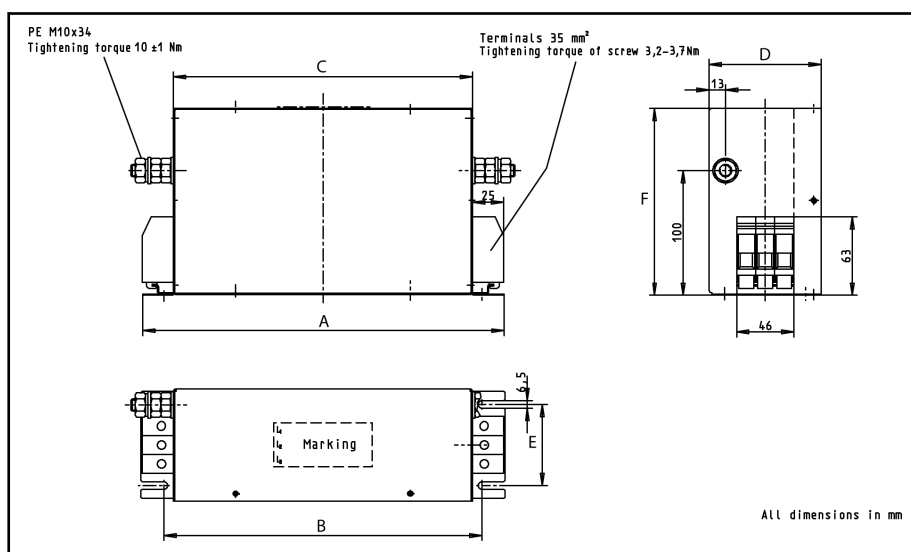Fig. 10-3:   E0066

Fig. 10-4:   E0090
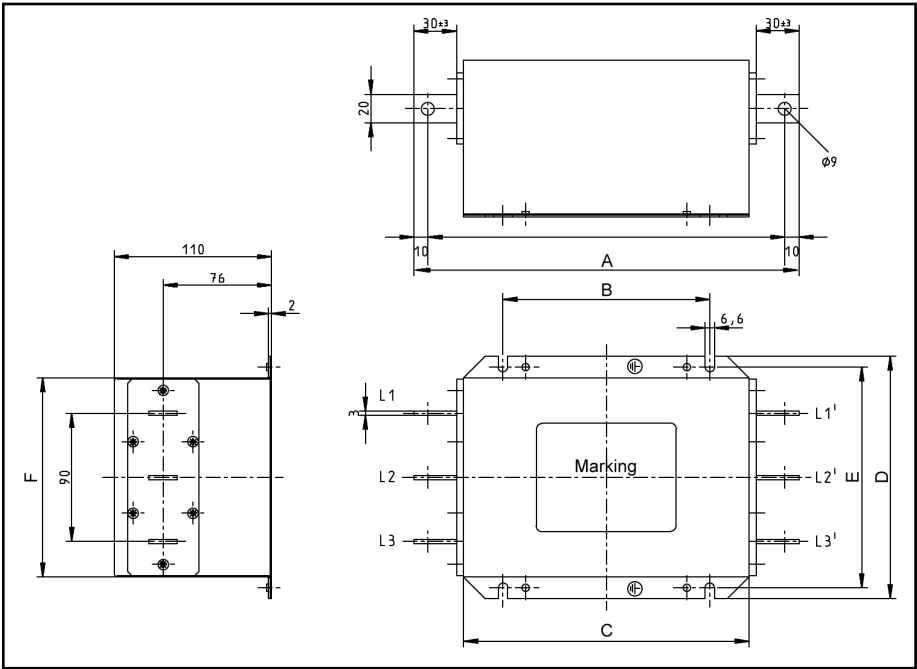

Fig. 10-5:   E0120

Accessories

Fig. 10-6:   E0250

Dimensions

EMC filter	A [mm]	B [mm]	C [mm]	D [mm]	E [mm]	F [mm]	PE size	PE tightening torque [Nm]	Terminal wire size [mm²]	Terminal tightening torque [Nm]
E0008	165	155	134	51.5	38	63	M4	1.2	4	0.5...0.6
E0025	231	221	200	46	38	83	M5	2	4	0.5...0.6
E0050	265	255	200	58	35	90	M6	3	10	1.2...1.5
E0066	265	255	200	58	35	142	M6	3	16	1.5...1.8
E0090	290	255	240	80	60	135	M10	10	35	3.2...3.7
E0120	290	255	240	90	65	150	M10	10	35	3.2...3.7
E0250	250	145	200	170	155	110	Ø6.6	6...9	Ø9	6...9

Tab. 10-2:   Dimensions

Accessories

Electrical data

☞ **Using EMC filters in mains grounded via outer conductor**

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

Description	Symbol	Unit	E0008	E0025	E0050	E0066	E0090	E0120	E0250
Degree of protection according to IEC60529	–	–	IP 20						
Listing according to UL standard (UL)	–	–	UL 1283						
Listing according to CSA standard (UL)	–	–	C22.2 No. 8						
Mass (weight)	m	kg	0.6	1.1	1.8	2.7	4.2	4.9	5.0
Mains voltage three-phase at TNS, TN-C, TT mains	U_{LN}	V	380…480						
Mains voltage three-phase at Corner- grounded-Delta mains	U_{LN}	V	Not allowed						
Mains voltage three-phase at IT mains	U_{LN}	V	Not allowed						
Tolerance U_{LN} (UL)	–	%	+10 %...-15 %						
Input frequency (UL)	f_{LN}	Hz	50...60						
Nominal current	I_{L_cont}	A	8	25	50	66	90	120	250
Calculation of leakage current	I_{leak}	mA	13	15	15	16	18	18	<21
DC resistance typical value	R_{typ}	–	16 mΩ	5 mΩ	2 mΩ	1.5 mΩ	1.1 mΩ	0.9 mΩ	110 µΩ
Required wire size according to IEC 60364-5-52; at I_{L_cont}	A_{LN}	mm²	4	4	10	16	35	35	120 /2×70
Required wire size according to UL 508 A (internal wiring); at I_{L_cont} (UL)	A_{LN}	AWG	10	10	6	6 (2)	1	3/0	3/0 (2)

Tab. 10-3:   Electrical data

Accessories

10.2   Brake Components

10.2.1   Brake Chopper

The function of brake chopper

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

Internal brake chopper

Fv 0K40...15K0 have internal brake choppers. External brake resistors are needed to activate the braking function.

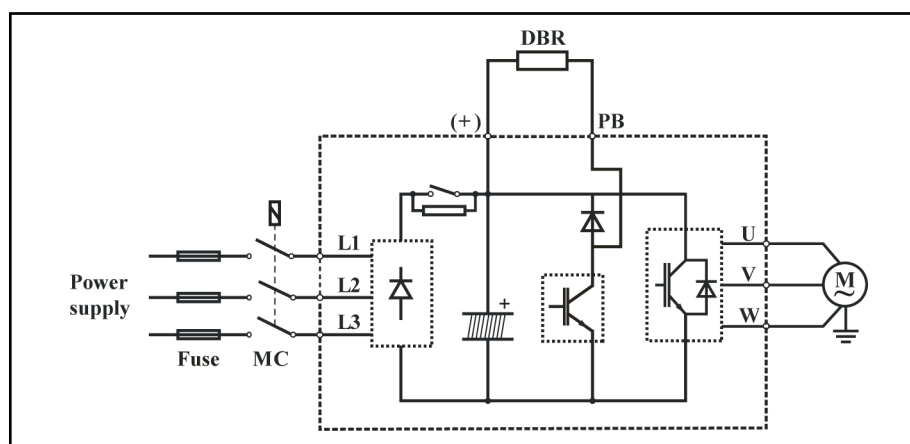The working principle of the brake chopper is shown in figure below.

Fig. 10-7:   Working principle of internal brake chopper

External brake chopper (18K5 and above models)

Technical data

Voltage class		3P 380 V -15 %...480 V +10 % power supply; 50 / 60 Hz ±5 %	
Brake chopper model-FELB		FELB02.1N-30K0-NNONE-A-560-NNNN (30K0)	FELB02.1N-45K0-NNONE-A-560-NNNN (45K0)
Input and output specifications	Peak current [A]	50	75
	Rated current [A]	15	25
	Braking start-up voltage	630 / 660 / 690 / 730 / 760 V ± 16 V	
	Maximum hysteresis	About 16 V	
	Synchronous signal	Coupled input, coupled output, up to 3 brake choppers at most can be set to operate in parallel	
Power supply	DC BUS voltage range	460...800 VDC	
Protection	Overheat of heat sink	It is active when the temperature exceeds +85 °C	
	Error output	RELAY junction 0.6 A 125 VAC / 2 A 30 VDC (T1, T2)	
Indication functions	Power ON	When voltage (more than 100 V), on the PCB DC mains lead terminal flows in the red "POWER" indicator lights on	
	Braking ON	When brake chopper works, the green "BRAKING" indicator lights on	

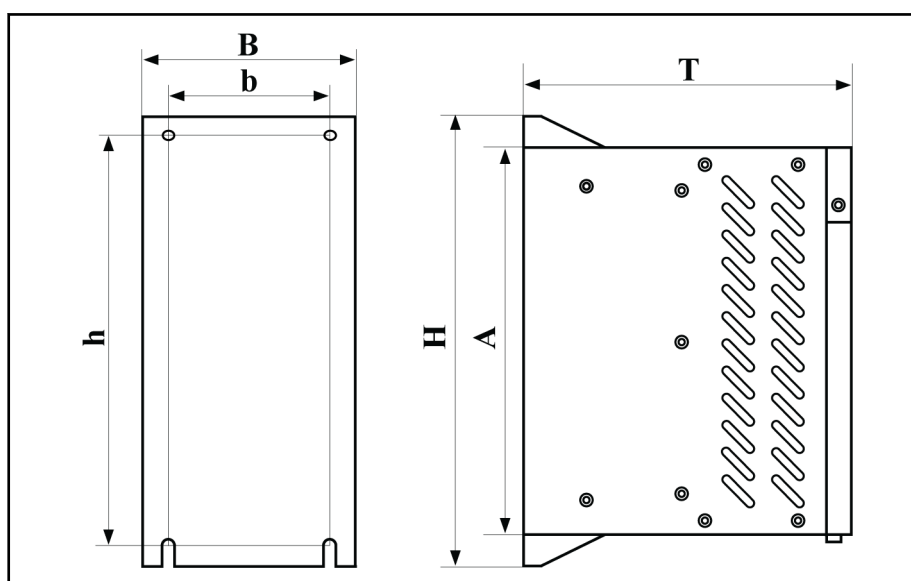*Tab. 10-4:   Technical specifications*

Dimensions and weight

Fig. 10-8:   Dimensions diagram

Brake chopper typecode	Dimensions [mm]						Weight [kg]
	B	H	T	b	h	A	
30K0	103	215	158	78	200	185	2.5
45K0							

Tab. 10-5:   Dimensions and weight

Accessories
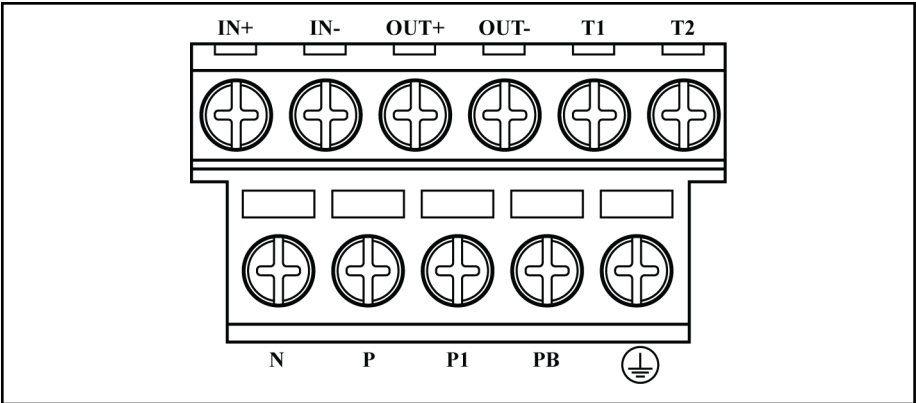
Brake chopper terminals

Fig. 10-9:   Brake chopper terminals

Wiring on each terminal of brake choppers

Name of terminal	Sign of terminal		Cable size [AWG]	Screw size	Torque
Input power supply	N, P		10...12	M4	18 kgf–cm (15.6 in–ibf)
Brake resistor	P1, PB				
Multiple units in parallel	input	IN+, IN-	18...20		
	output	OUT+, OUT-			
Error output	T1, T2				
Grounding	⏚		10...12		

Tab. 10-6:   Wiring on each terminal of brake choppers

Basic wiring diagram

To avoid brake chopper damage or break down in case of overload or error conditions, please refer to the following wiring diagram. The brake chopper FELB error switch should be connected to Xi of Fv. The temperature switch of the brake resistor should be in series with the line contactor coil circuit.
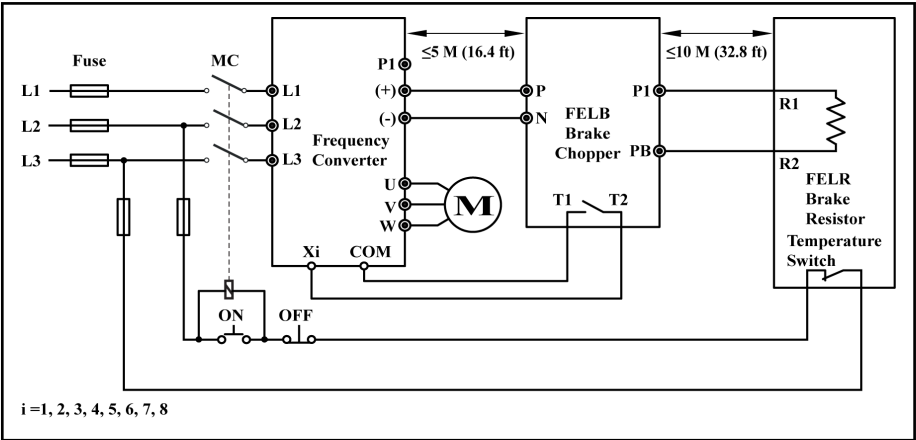

Fig. 10-10:   Basic wiring diagram

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

| ⚠ WARNING | The brake resistor connections at the brake chopper (terminals P1 and PB) have no short circuit protection! Wrong wiring will cause damage to the components! |

Please ensure the reliable grounding of the brake chopper.

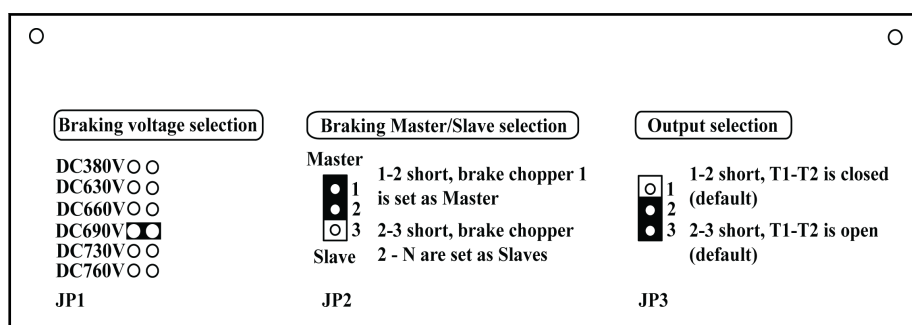## The settings of the brake chopper

Fig. 10-11:   Brake chopper settings

Selection of braking voltage

The 400 V class brake chopper has 5 operating voltages (630 V, 660 V, 690 V, 730 V, 760 V), and power supply of the brake chopper is from +(P), -(N) of the frequency converter. This setting will influence the level of the operating voltage of the brake chopper, which is an important procedure. Please switch the jumpers to the needed operating voltage position, the factory default value of JP1 is 690 V.

The input voltage of the power supply to the frequency converter [V]	380	400	415	440
Braking startup voltage [V]	660	690	730	760

Tab. 10-7:   Recommended startup braking voltage

- Master/Slave setting:

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

- Error output selection:

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

Accessories

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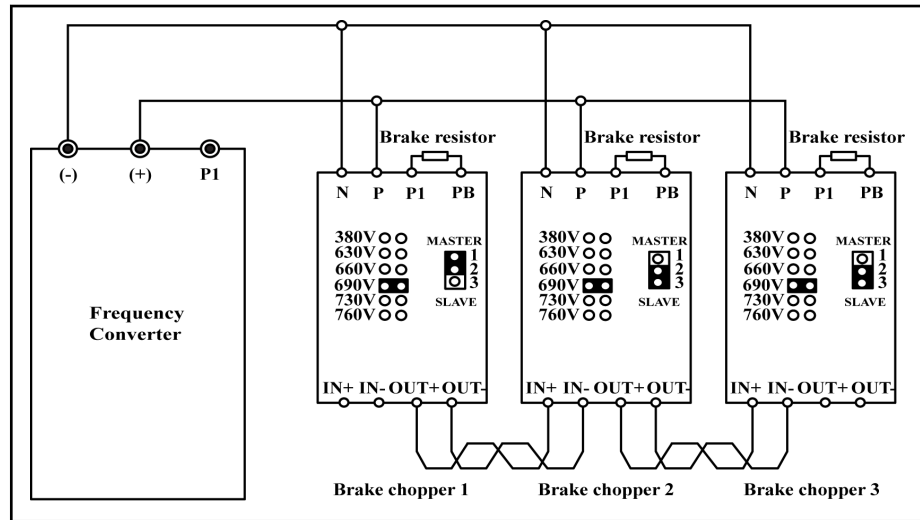

Fig. 10-12:   Brake chopper wiring

Definition for braking ratio OT %

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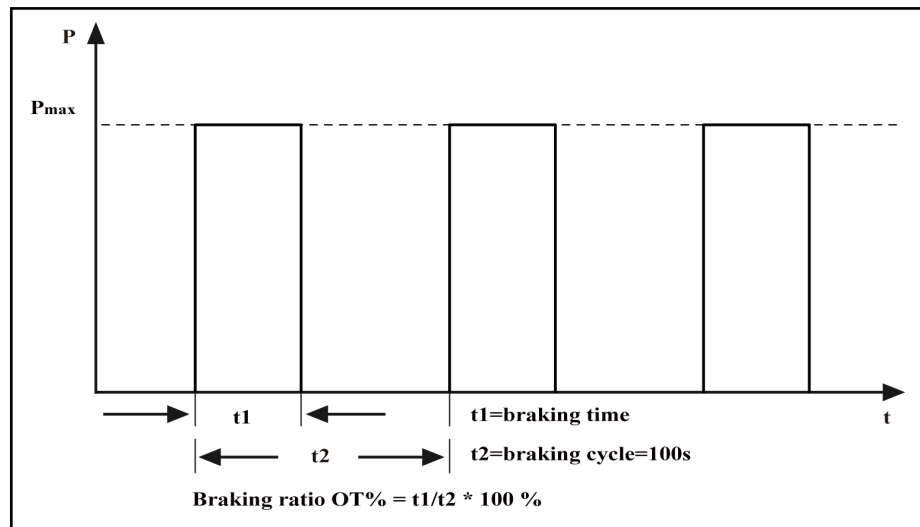

Fig. 10-13:   Braking ratio

Error analysis and countermeasures

When there is abnormality with the brake chopper, the thermal protection of the brake chopper will be activated. A failure signal will be sent by the brake chopper to the frequency converter. The abnormality of the brake chopper may result in the failure and warning of the frequency. Make sure to find the cause of failure and run it after the failure is removed.

Item	Error conditions	Failure cause	Countermeasures
1	The "POWER" light of brake chopper off	Wrong connection	Check if "MASTER" is selected and check wire connection
2	The "BRAKING" light of brake chopper off	Breakdown of brake chopper IGBT	Replace brake chopper
		Open circuit with brake resistor	Check brake resistor and its wiring
3	"Overvoltage" warning with the of frequency converter	Wrongly connected wires	Check wires
		Inadequate capacity of brake resistor and brake chopper	Check design and recalculate
		Inappropriate brake chopper voltage selection	Set again
4	Thermal protection device of brake chopper acts caused by overheated radiator	High braking ratio	Check design and recalculate
		Environmental temperature > 40 ℃	Reduce environmental temperature with cooling fans

Tab. 10-8:   Error analysis and countermeasures

10.2.2   Brake Resistor

Brief introduction

Energy regenerated when a 3-phase AC motor is decelerated (the frequency is reduced) is recovered and fed into the frequency converter. To prevent over voltage of the frequency converter, an external brake resistor may be used. A power transistor discharges the DC bus voltage energy (braking voltage threshold at approx. 770 VDC) to the brake resistor, and the energy is lost as heat.

☞
- If a resistance lower than the recommended value (and no less than the minimum resistance) is used, contact the agent or manufacturer for calculation of resistance power.
- Safety and flammability of surrounding conditions shall be considered. Keep all 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 electric performance of the brake resistor.

Accessories

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 chopper 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 (On Time percentage) Braking ratio
Tb   Braking time
Tc   Engineering cycle time in application

Fig. 10-14:   Braking ratio

☞   The frequency converter models, brake chopper types and the brake resistor types listed in the tables are abbreviations. For definition of type codes, see chapter 1.3 "Type Coding" on page 9.

Model	FELB Typecode	FELB Quantity	FELR Typecode	FELR Type	FELR Quantity
0K40	Internal	–	0080-N750R-D	750Ω/80W	1
0K75	Internal	–	0080-N750R-D	750Ω/80W	1
1K50	Internal	–	0260-N400R-D	400Ω/260W	1
2K20	Internal	–	0260-N250R-D	250Ω/260W	1
4K00	Internal	–	0390-N150R-D	150Ω/390W	1
5K50	Internal	–	0520-N100R-D	100Ω/520W	1
7K50	Internal	–	0780-N075R-D	75Ω/780W	1
11K0	Internal	–	1K04-N050R-D	50Ω/1040W	1
15K0	Internal	–	1K56-N040R-D	40Ω/1560W	1
18K5	FELB02.1N-30K0	1	04K8-N032R-A	32Ω/4.8kW	1
22K0	FELB02.1N-30K0	1	04K8-N27R2-A	27.2Ω/4.8kW	1
30K0	FELB02.1N-30K0	1	06K0-N020R-A	20Ω/6.0kW	1
37K0	FELB02.1N-45K0	1	09K6-N016R-A	16Ω/9.6kW	1
45K0	FELB02.1N-45K0	1	09K6-N13R6-A	13.6Ω/9.6kW	1
55K0	FELB02.1N-30K0	2	06K0-N020R-A	20Ω/6.0kW	2
75K0	FELB02.1N-45K0	2	09K6-N13R6-A	13.6Ω/9.6kW	2
90K0	FELB02.1N-45K0	3	06K0-N020R-A	20Ω/6.0kW	3

Tab. 10-9:   Brake resistor selection_OT = 10 %

Model	FELB Typecode	FELB Quantity	FELR Typecode	FELR Type	FELR Quantity
0K40	Internal	–	0150-N750R-D	750Ω/150W	1
0K75	Internal	–	0150-N700R-D	700Ω/150W	1
1K50	Internal	–	0520-N350R-D	350Ω/520W	1
2K20	Internal	–	0520-N230R-D	230Ω/520W	1
4K00	Internal	–	0780-N140R-D	140Ω/780W	1
5K50	Internal	–	1K04-N090R-D	90Ω/1040W	1
7K50	Internal	–	1K56-N070R-D	70Ω/1560W	1
11K0	Internal	–	02K0-N047R-D	47Ω/2.0kW	1
15K0	Internal	–	01K5-N068R-D	68Ω/1.5kW	2
18K5	FELB02.1N-30K0	1	10K0-N028R-A	28Ω/10.0kW	1
22K0	FELB02.1N-30K0	1	10K0-N022R-A	22Ω/10.0kW	1
30K0	FELB02.1N-45K0	1	12K5-N017R-A	17Ω/12.5kW	1
37K0	FELB02.1N-45K0	1	10K0-N032R-A	32Ω/10.0kW	2
45K0	FELB02.1N-30K0	2	10K0-N024R-A	24Ω/10.0kW	2
55K0	FELB02.1N-45K0	2	12K5-N018R-A	18Ω/12.5kW	2
75K0	FELB02.1N-45K0	3	12K5-N020R-A	20Ω/12.5kW	3
90K0	FELB02.1N-45K0	3	12K5-N020R-A	20Ω/12.5kW	3

Tab. 10-10:   Brake resistor selection_OT = 20 %

Accessories

Model	FELB Typecode	FELB Quantity	FELR Typecode	FELR Type	FELR Quantity
0K40	Internal	–	0240-N750R-D	750Ω/240W	1
0K75	Internal	–	0500-N550R-D	550Ω/500W	1
1K50	Internal	–	0800-N275R-D	275Ω/800W	1
2K20	Internal	–	01K2-N180R-D	180Ω/1.2kW	1
4K00	Internal	–	02K0-N110R-D	110Ω/2.0kW	1
5K50	Internal	–	01K5-N150R-D	150Ω/1.5kW	2
7K50	Internal	–	04K5-N055R-A	55Ω/4.5kW	1
11K0	Internal	–	06K0-N040R-A	40Ω/6.0kW	1
15K0	Internal	–	08K0-N027R-A	27Ω/8.0kW	1
18K5	FELB02.1N-45K0	1	10K0-N022R-A	22Ω/10.0kW	1
22K0	FELB02.1N-45K0	1	12K5-N018R-A	18Ω/12.5kW	1
30K0	FELB02.1N-30K0	2	10K0-N27R2-A	27.2Ω/10.0kW	2
37K0	FELB02.1N-45K0	2	10K0-N022R-A	22Ω/10.0kW	2
45K0	FELB02.1N-45K0	2	12K5-N018R-A	18Ω/12.5kW	2
55K0	FELB02.1N-30K0	3	12K5-N022R-A	22Ω/12.5kW	3
75K0	FELB02.1N-45K0	4	10K0-N022R-A	22Ω/10.0kW	4
90K0	FELB02.1N-45K0	4	10K0-N022R-A	22Ω/10.0kW	4

Tab. 10-11:   Brake resistor selection_OT = 40 %

☞
- In the table in the manual, the recommended resistance of the brake resistor is 100 % braking torque, selected according to necessity. If the 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 chopper. The current I_c through the brake resistor can be calculated by formula $I_c = U_d/R_b$, in which U_d is the braking operating voltage of brake chopper.

- After the adjustment of the resistance of brake resistor, the power of brake resistor should be also adjusted appropriately. The power can be calculated by formula $P_{max} = U_d^2 / R_b$. According to the actual working condition, the braking ratio OT % can be selected to reduce the power of brake resistor reasonably for intermittent braking load. The power of brake resistor can be calculated by formula $P_R = K \times P_{max} \times OT \%$, in which K is the derating coefficient of brake resistor. The selection of the brake torque should be in general smaller than 150 % of the rated motor torque, or consulting the technical support for more information.
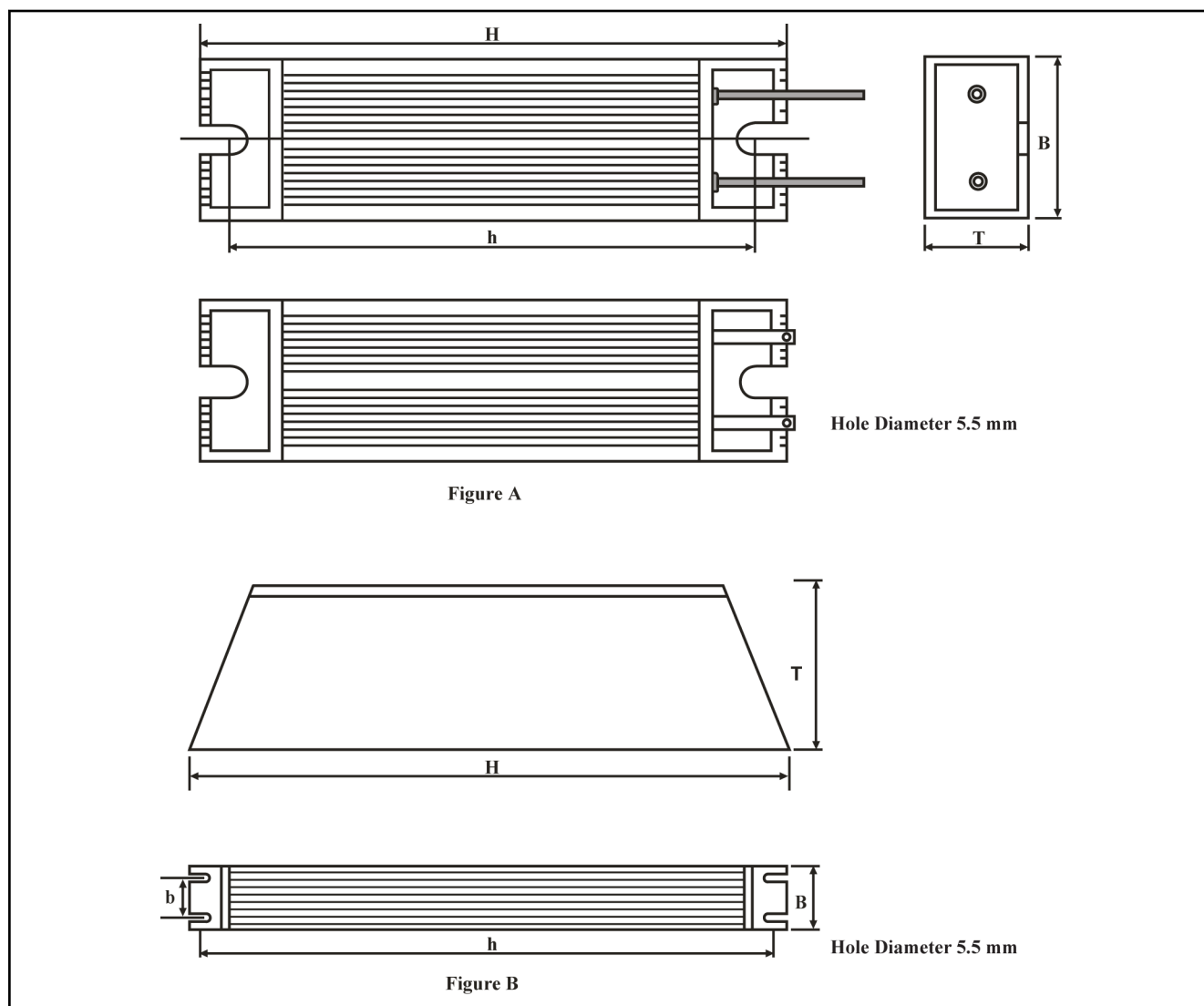
Accessories

Brake resistor in aluminum housing

Hole Diameter 5.5 mm

Figure A

Hole Diameter 5.5 mm

Figure B

Fig. 10-15:   Brake resistor in aluminum housing

Accessories

Brake resistor typecode	Impe-dance [Ω]	Power [W]	Fig.	Dimensions [mm]					Wiring [mm²]	Terminal [mm]	Cable length [mm]	Net weight [kg]	Type
				H	h	B	b	T					
0520-N100R-D	100	520	A	335	317	60	–	30	2.5	–	500	1.03	Alumi.
0390-N150R-D	150	390		265	247	60	–	30	2.5	–	500	0.80	Alumi.
0520-N230R-D	230	520		335	317	60	–	30	2.5	–	500	1.03	Alumi.
0260-N250R-D	250	260		215	197	60	–	30	2.5	–	500	0.62	Alumi.
0520-N350R-D	350	520		335	317	60	–	30	2.5	–	500	1.03	Alumi.
0260-N400R-D	400	260		215	197	60	–	30	2.5	–	500	0.62	Alumi.
0500-N550R-D	550	500		335	317	60	–	30	2.5	–	500	1.03	Alumi.
0150-N700R-D	700	150		215	197	40	–	20	2.5	–	500	0.32	Alumi.
0080-N750R-D	750	80		140	123	40	–	20	2.5	–	500	0.20	Alumi.
1K56-N040R-D	40	1560	B	485	470	50	30	107	2.5	M6	–	4.35	Alumi.
02K0-N047R-D	47	2000		550	534	50	30	107	4.0	M6	–	4.90	Alumi.
1K04-N050R-D	50	1040		400	384	50	30	107	2.5	M6	–	4.35	Alumi.
01K5-N068R-D	68	1500		485	470	50	30	107	2.5	M6	–	3.60	Alumi.
1K56-N070R-D	70	1560		485	470	50	30	107	2.5	M6	–	2.20	Alumi.
0780-N075R-D	75	780		400	382	61	40.5	59	2.5	M6	–	4.35	Alumi.
1K04-N090R-D	90	1040		400	384	50	30	107	2.5	M6	–	3.60	Alumi.
02K0-N110R-D	110	2000		550	534	50	30	107	4.0	M6	–	2.20	Alumi.
0780-N140R-D	140	780		400	382	61	40.5	59	2.5	M6	–	4.35	Alumi.
01K5-N150R-D	150	1500		485	470	50	30	107	2.5	M6	–	4.90	Alumi.
01K2-N180R-D	180	1200		450	434	50	30	107	2.5	M6	–	4.00	Alumi.
0800-N275R-D	275	800		400	382	61	40.5	59	2.5	M6	–	2.20	Alumi.

Tab. 10-12:   Aluminum brake resistor dimensions

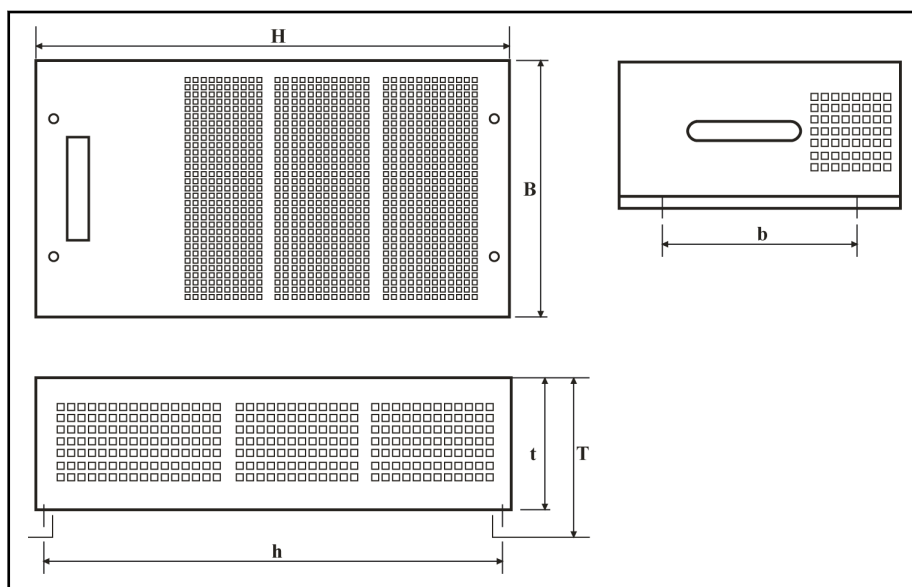☞   Alumi.: Brake resistor in aluminum housing.

Accessories

Brake resistor box
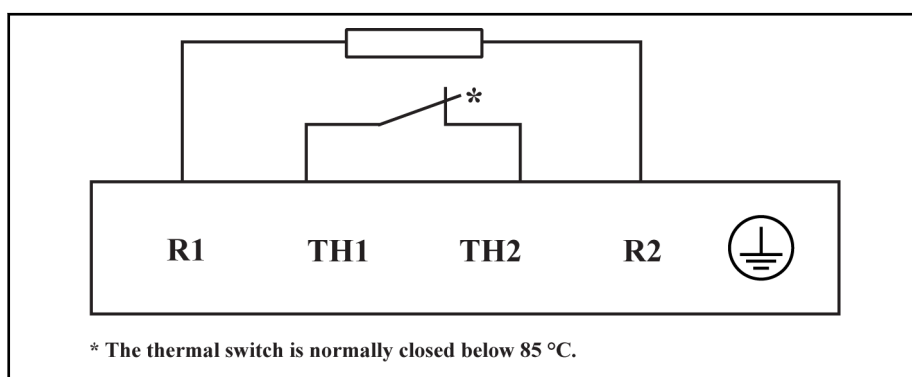

Fig. 10-16:   Brake resistor box dimensions drawing

* The thermal switch is normally closed below 85 °C.

Fig. 10-17:   Brake resistor box terminals

Accessories

Brake resistor typecode	Impedance [Ω]	Power [kW]	Dimensions						Wiring [mm²]	Terminal [mm]	Weight [kg]	Type
			B	H	t	T	h	b				
09K6-N13R6-A	13.6	9.6	410	685	145	170	642	340	6.0	M6	18.5	box
09K6-N016R-A	16	9.6	410	685	145	170	642	340	6.0	M6	18.5	box
12K5-N017R-A	17	12.5	410	685	145	170	642	340	6.0	M6	20.5	box
12K5-N018R-A	18	12.5	410	685	145	170	642	340	6.0	M6	20.5	box
12K5-N020R-A	20	12.5	410	685	145	170	642	340	6.0	M6	20.5	box
06K0-N020R-A	20	6.0	340	600	145	170	580	291	4.0	M6	14.0	box
10K0-N022R-A	22	10.0	410	685	145	170	642	340	6.0	M6	18.5	box
12K5-N022R-A	22	12.5	410	685	145	170	642	340	6.0	M6	20.5	box
10K0-N024R-A	24	10.0	410	685	145	170	642	340	6.0	M6	18.5	box
08K0-N027R-A	27	8.0	410	685	145	170	642	340	6.0	M6	16.5	box
10K0-N27R2-A	27.2	10.0	410	685	145	170	642	340	6.0	M6	18.5	box
04K8-N27R2-A	27.2	4.8	340	600	145	170	580	291	4.0	M6	12.0	box
10K0-N028R-A	28	10.0	410	685	145	170	642	340	6.0	M6	18.5	box
10K0-N032R-A	32	10.0	410	685	145	170	642	340	6.0	M6	18.5	box
04K8-N032R-A	32	4.8	340	600	145	170	580	291	4.0	M6	12.0	box
06K0-N040R-A	40	6.0	340	600	145	170	580	291	4.0	M6	14.0	box
04K5-N055R-A	55	4.5	340	600	145	170	580	291	4.0	M6	12.0	box

Tab. 10-13:   Brake resistor box dimensions

☞   box: Brake resistor box.

10.3   Encoder Adapter

10.3.1   The Function of Encoder Adapter

The encoder adapter is used to improve the precision of speed sampling when +12 V or +24 V supply voltage is used for the encoder, no matter internal or external supply.

10.3.2   Encoder Adapter Dimensions
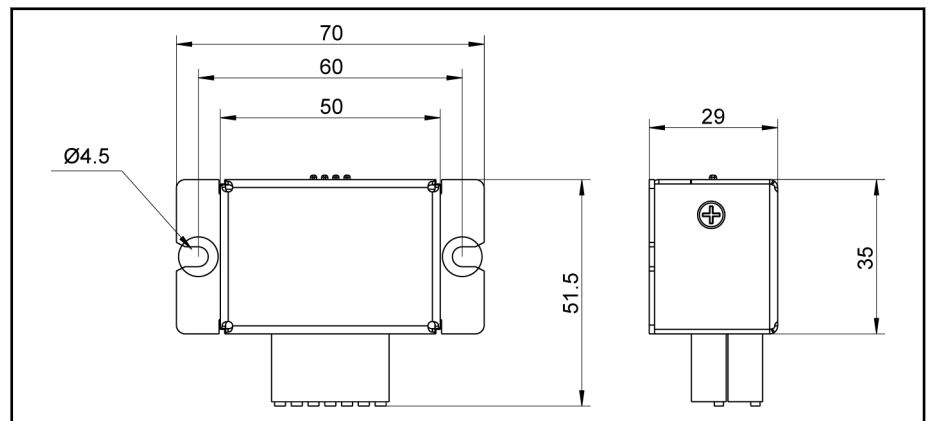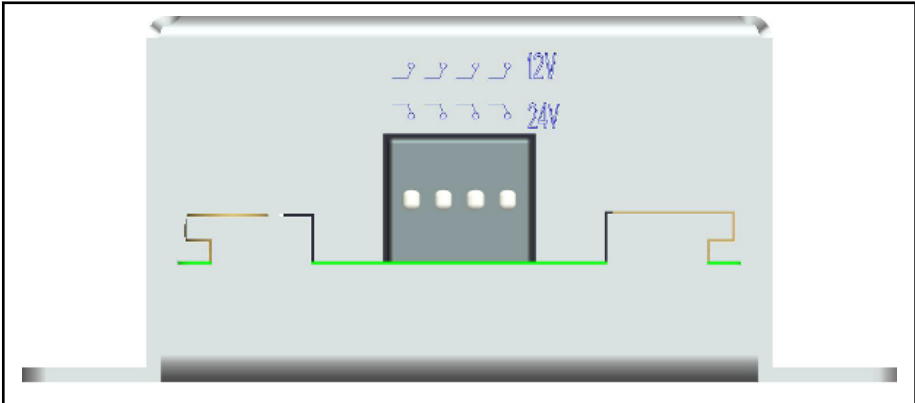

Fig. 10-18:   Encoder adapter dimensions

Accessories

10.3.3   Encoder Adapter Terminals
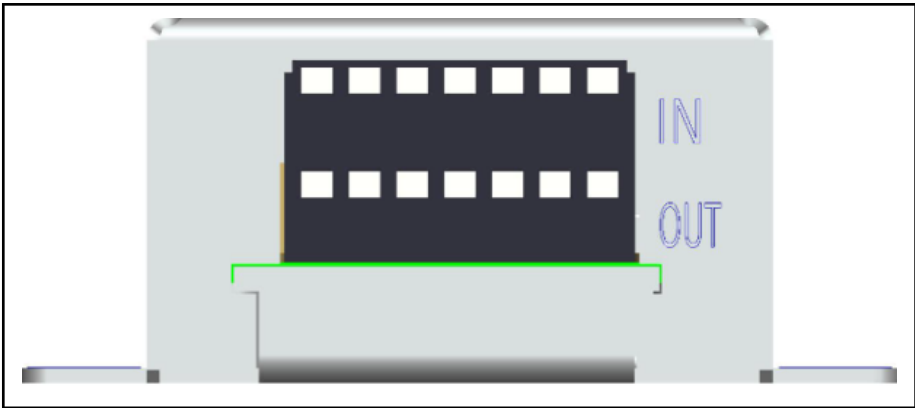
Fig. 10-19:   Encoder adapter IN and OUT terminals

IN (Used to connect with motor encoder signals)						
PGP2	A	$\overline{A}$	COM	B	$\overline{B}$	PGP1
OUT (Used to connect with CPU board of the frequency converter)						
PGP2	A+	A-	COM	B+	B-	PGP1

Tab. 10-14:   Encoder adapter IN and OUT terminals description

Switches down (by default) Supports 24 V power supply, corresponding to
                              PGP1-COM
Switches up   Supports 12 V power supply, corresponding to
                              PGP2-COM

Fig. 10-20:   Encoder adapter DIP terminals

☞   For encoder wiring information, see
.

10.4   Communication Interface

10.4.1   PROFIBUS Adapter

The PROFIBUS adapter (FVAA01.2-P-NNNN-01VRS) is used to convert Fv serial RS485 interface (ModBus) to PROFIBUS DP standard.

Please refer to chapter 12 "Communication Protocols" on page 207.

10.4.2   ModBus Adapter

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

10.5   Accessories for Control Cabinet Mounting

10.5.1   Remote Operation

The operating panel is mounted at the control cabinet. The user can operate the frequency converter from the outside of the control cabinet conveniently. To realize this function, the user needs order the remote operation adapter (FVAM) and its accessories additionally.

Replace the operating panel with the remote operation adapter

Remove operating panel from the frequency converter and place the remote operation adapter instead.

Recommended opening dimensions at control cabinet
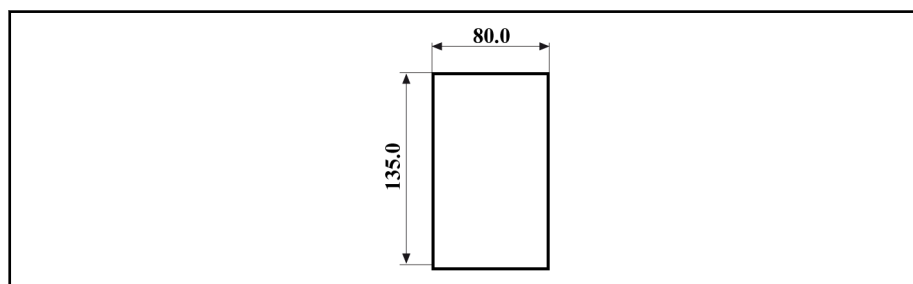
Fig. 10-21:   Recommended opening dimensions at control cabinet

Direct mounting of operating panel at the control cabinet with mounting plate

• When the opening dimensions at the control cabinet are in compliance with the recommendation, the operating panel can be mounted directly at the control cabinet with the mounting plate buckles.
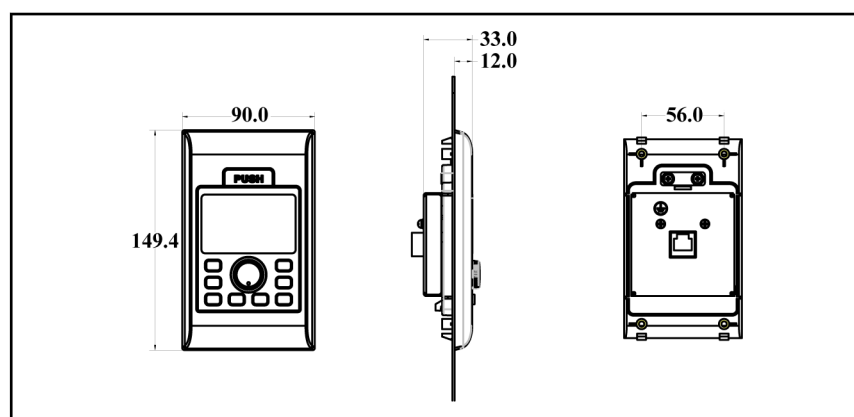
Fig. 10-22:   Direct mounting of operating panel at the control cabinet with mounting plate

Mounting of operating panel at the control cabinet with mounting plate and fixing metal strips

• When the opening dimensions are larger than the recommendations, 2 fixing metal strips and 4 M4x10 screws are necessary to fix the mounting plate. Please refer to figures below for detailed information.

Accessories
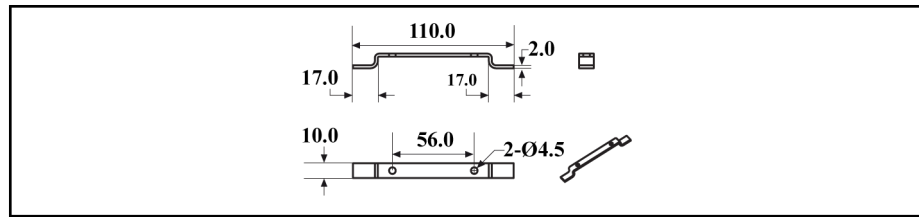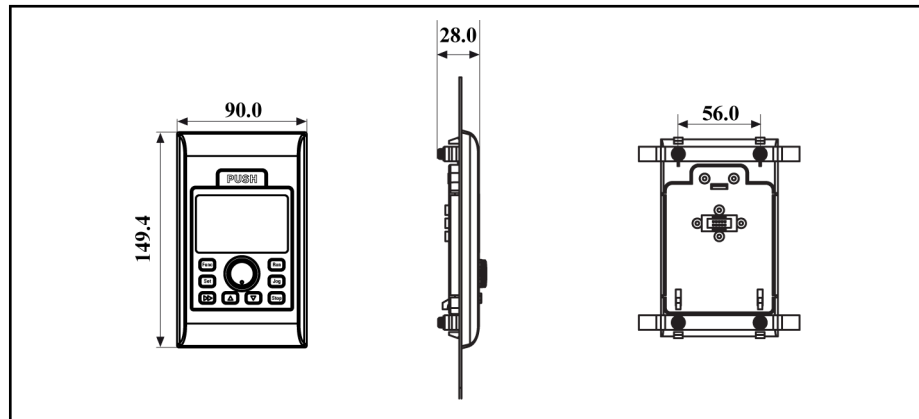

Fig. 10-23:   Fixing metal strip

Fig. 10-24:   Mounting of operating panel at the control cabinet with mounting plate and fixing metal strips

Connecting the remote operation adapter and the mounting plate with remote connection cable

The remote connection cable needs to be grounded.

- Stripping the cable insulation.
- Connecting the shielding layer with the metal buckle tightly (as close as possible to the frequency converter to achieve good grounding effect).
- Fixing the metal buckle on the inner wall of the control cabinet.

10.5.2   Operating Panel Cable for Control Cabinet Mounting

Please use shielded twisted pair cables with the length within 15 m. If you need cables from Bosch Rexroth, please order it with the type code of FRKS0003/015,0.

10.6   Engineering Software

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

11 Additional Information

11.1 Simple Applications of Process Control

11.1.1 Automatic Constant Pressure Water Control System
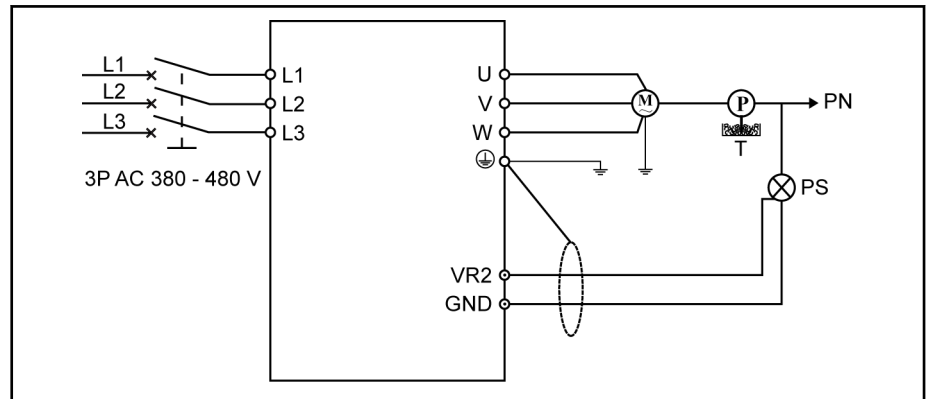
M	Motor
P	Pump
PN	Pipe network
PS	Pressure sensor

Fig. 11-1:   Automatic constant pressure water control system

- The set value of pressure is set by analog value digital setting E3.01. The pressure feedback from output VR2 corresponds to a value of 0...10 V.

- [E3.00] = 2, [E3.03] = 4. E3.04, E3.05, E3.06, and E3.07 are set depending on actual conditions.

11.1.2 Closed-loop Speed Control System
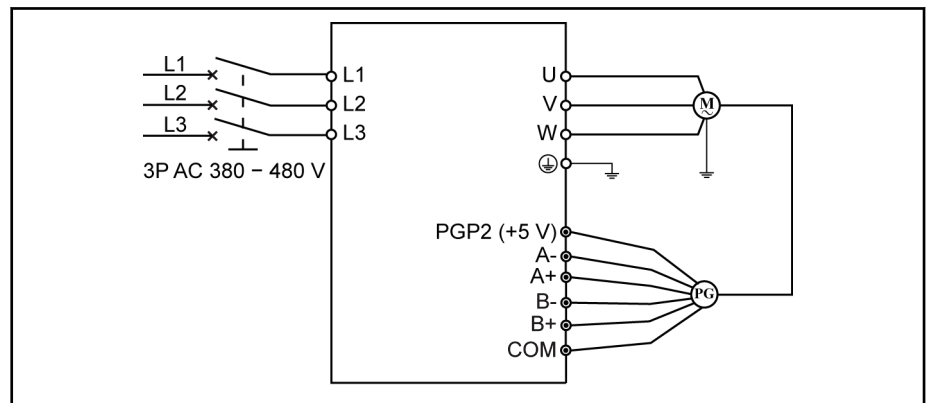
Fig. 11-2:   Closed-loop speed control system

- Conditions and requirements:

PGP2 is connected to the operational power supply of pulse encoder, and the set value of speed is set by rotation speed digital setting E3.02. [E3.00] = 4, S2.12 is set according to the specification of the feedback encoder.

Additional Information

11.2   Discharging of Capacitors

11.2.1   Discharging of DC Bus Capacitors

In the frequency converters, capacitors are used in the DC bus as energy stores. Energy stores maintain their energy even when the supply voltage has been cut off and have to be discharged before somebody gets in contact with them. Discharging devices have been integrated in the frequency converters; within the indicated discharging time, these devices discharge the voltage below the allowed 50 V.

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

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

11.2.2   Discharging Device

Operating principle

A contactor is installed to switch a resistor to the terminals L+ and L- of the DC bus connection to discharge the capacitors. The contactor is activated via a control input which is supplied with appropriate control voltage.
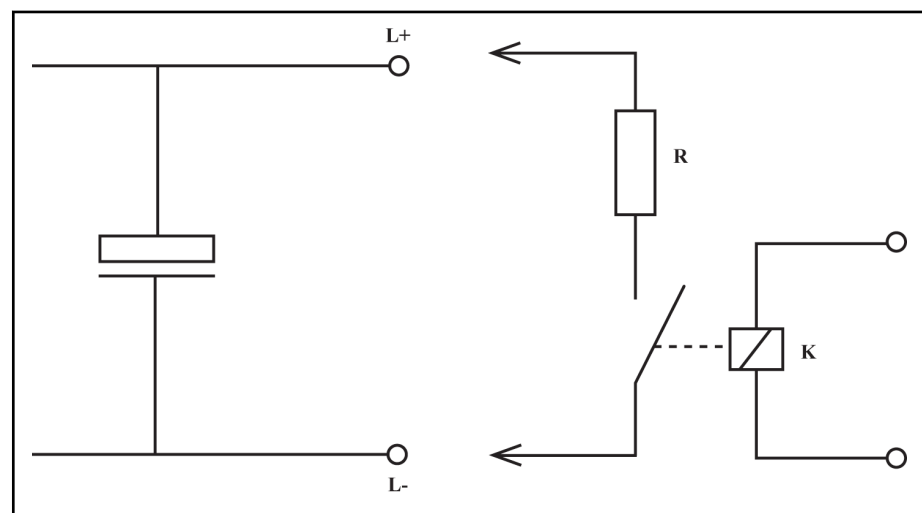
R	Discharging resistor
K	Contactor contact

Fig. 11-3:   *Operating principle of discharging device*

Dimensioning

The individual components have to be sufficiently dimensioned:

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

Installation

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

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

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

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

⚠ CAUTION	Risk of damage by intense heat!

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

How to install the discharging device

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

   If you install discharging device after having switched on supply voltage for the first time, wait 30 minutes to allow discharging. Check whether voltage has fallen below 50 V before touching live parts!

2. Place discharging resistor as far as possible from heat-sensitive components.

Activation

Observe the following order for activating the discharge device:

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

2. Activate discharging device.

12 Communication Protocols

12.1 Introduction

Fv provides standard RS485 communication port to realize the communication between the master station and the slave station via ModBus or PROFIBUS protocols. With the help of a PC, an SPS 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 parameters, monitoring of frequency converter running status and error messages) to address the specific requirements of applications.

12.2 ModBus Protocol

12.2.1 Protocol Descriptions

Introduction

ModBus is a master/slave protocol. Only one device may send commands in the network at a particular time.

The master station manages message exchange by polling the slave stations. Unless being approved by the master station, no station may send message.

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

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

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

There are two types of dialogs between the master station and the slave stations:

- The master station sends a request to a slave station and waits for its response.

- The master station sends a request to all slave stations and does not wait for their response (broadcasting).

Communication Protocols

Transmission

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

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

Tab. 12-1:   Typical RTU frame format

☞   Data are transmitted in binary codes.

If an interval is 3.5 characters or longer, it is taken as the end of the frame. Therefore, all information in a frame must be transmitted in a continuous data flow. If an interval of 3.5 characters or longer occurs before a complete frame is sent out, the receiving device will consider the information has ended and start processing it, and mistake following bytes for a new frame's address. Similarly, if the interval between a new frame and the previous one is less than 3.5 characters, the receiving device will consider it as a part of the previous frame. Due to confusion of the frames, the CRC check will fail and lead to a communication error.

Data format and sending sequence of one byte:

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

CRC (Cyclic redundancy check):

- CRC16, lower bytes first and higher bytes later

Slave address:

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

12.2.2   Interface

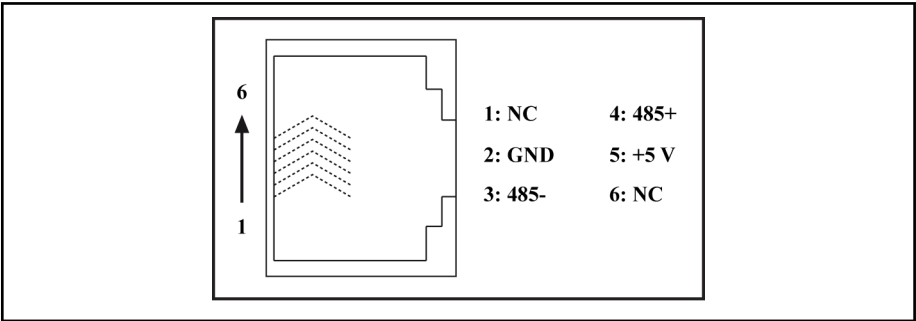The RJ11 communication interface of Fv is shown in figure below.

Fig. 12-1:   Fv RJ11 communication interface

12.2.3   Protocol Functions

Supported functions

The main function of ModBus is to read and to write parameters. Different function codes decide different operation requests. ModBus functions managed by Fv and their limits are shown in table below.

Function code	Meaning	Broadcast	Maximum value of N
3=0x03	Read N register parameters	NO	16 characters in maximum
6=0x06	Rewrite a register with information stored even after power off	YES	–
8=0x08	Loop test	NO	–
16=0x10	Rewrite N registers with information stored even after power off	YES	16 characters in maximum
23=0x17	Read from and write to N registers	NO	16 characters in maximum

Tab. 12-2:   *ModBus functions managed by Fv and their limits*

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

If the device fails to act upon the request, it responds with an error code and exception code. The error code is the function code plus 0x80. An example of exception code is shown in table below.

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

Tab. 12-3:   *Error codes_meanings_reasons*

Communication Protocols

Function descriptions

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

For example, it is necessary to read 2 continuous words starting from communication register 0100H of a slave frequency converter addressed at 01H. The frame structure is described in tables below.

Message start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	03H
Higher byte of start address	01H
Lower byte of start address	00H
Higher byte of data	00H
Lower byte of data	02H
CRC lower byte	C5H
CRC higher byte	F7H
Message end	Transmission time for 3.5 bytes

Tab. 12-4:   Function 0x03_master request

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

Tab. 12-5:   Function 0x03_slave response

Function 0x06: Write a word.

Example: Write 0000H to communication register address 0006H of a slave frequency converter addressed at 01H. The frame structure is described in tables below.

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

Tab. 12-6:   Function 0x06_master request

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

Tab. 12-7:   Function 0x06_slave response

Communication Protocols

Function 0x08: Loop test. The same message is returned.

To test the communication loop of 2 continuous words 1234H and 5678H with a frequency converter addressed at 01H, the frame structure is described in tables below.

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

Tab. 12-8:   Function 0x08_master request

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

Tab. 12-9:   Function 0x08_slave response

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

Example: To modify 2 continuous resisters start from 0109H with words 003CH and 0050H with a slave frequency converter addressed at 01H. The frame structure is described in tables below.

Message start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	10H
Higher byte of write register start address	01H
Lower byte of write register start address	09H
Higher byte of register number	00H
Lower byte of register number	02H
Bytes of data	04H
Higher byte of data in register 0109H	00H
Lower byte of data in register 0109H	3CH
Higher byte of data in register 010AH	00H
Lower byte of data in register 010AH	50H
CRC lower byte	FEH
CRC higher byte	65H
Message end	Transmission time for 3.5 bytes

Tab. 12-10:   Function 0x10_master request

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

Tab. 12-11:   Function 0x10_slave response

Communication Protocols

Function 0x17: Read/write N words, range: 1...16

Example: To read data in 2 continuous registers starting from address 0100H, write 0064H and 00C8H to 2 continuous registers starting from address 0109H with a slave frequency converter addressed at 01H. The frame structure is described in tables below.

Message start	Transmission time for 3.5 bytes
Slave address	01H
ModBus function code	17H
Higher byte of read register start address	01H
Lower byte of read register start address	00H
Higher byte of read register number	00H
Lower byte of read register number	02H
Higher byte of write register start address	01H
Lower byte of write register start address	09H
Higher byte of write register number	00H
Lower byte of write register number	02H
Bytes of data for writing	04H
Higher byte of data in address 0109H	00H
Lower byte of data in address 0109H	64H
Higher byte of data in address 010AH	00H
Lower byte of data in address 010AH	C8H
CRC lower byte	48H
CRC higher byte	72H
Message end	Transmission time for 3.5 bytes

Tab. 12-12:   Function 0x17_master request

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

Tab. 12-13:   Function 0x17_slave response

Communication Protocols

12.2.4   Communication Mapping Register Address Distribution

Introduction

The communication mapping registers of ModBus are in four types, frequency converter parameter registers, communication control registers, communication state feedback register and communication monitor 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 consists of one word. The higher byte 0x00...0x0C represents the function code group, and the relationship is shown in table below; the lower byte represents the function code within the code group.

Function group	Mapping address	Function group	Mapping address
b0	0x00	b1	0x01
S0	0x02	S1	0x03
S2	0x04	S3	0x05
E0	0x06	E1	0x07
E2	0x08	E3	0x09
E4	0x0A	E5	0x0B
H0	0x0C		

Tab. 12-14:   *Relationship between frequency converter parameter register addresses and corresponding function codes*

Example: Parameter register 0x0103, the higher byte 0x01 represents group b1, the lower byte 0x03 represents the 4th function code.

Communication Protocols

Communication control registers (0x4000, 0x4001, 0x4002)

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	Inactive
	0	Active
6	1	Stop acceleration/deceleration active
	0	Inactive
5	1	Reset active
	0	Inactive
4	1	E-Stop active
	0	Inactive
3	1	Stop according to parameter setting
	0	Inactive
2	1	Reverse
	0	Forward
1	1	Jog active
	0	Inactive
0	1	General control active
	0	Inactive

Tab. 12-15:   Communication control registers (0x4000, 0x4001, 0x4002)_bit definition

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

The address of torque setting register for communication control is 0x4002. This register is write-only. When 'Torque control reference' S1.05 is set to '3: Set by communication', the torque command can be set with writing data to this address.

Communication state feedback register (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 table below.

bit	Value	Description
15...11	–	Error code
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	In run
	0	In stop
0	1	Reverse
	0	Forward

Tab. 12-16:   Communication state word register (0x5000)_bit definition

The meanings of error codes are described in table below.

No.	Error code name
0	No error record
1	Over current at constant speed (O.C.-1)
2	Over current in acceleration (O.C.-2)
3	Over current in deceleration (O.C.-3)
4	Over voltage at constant speed (O.E.-1)
5	Over voltage in acceleration (O.E.-2)
6	Over voltage in deceleration (O.E.-3)
7	Frequency converter overload (O.L.-1)
8	Motor overload (O.L.-2)
9	CPU read/write error (R.E.)
10	Operating panel read/write error (KEY-)
11	External error (E.-St)

Communication Protocols

No.	Error code name
12	Communication error (R.S.)
13	Circuit disconnection (C.F.)
14	Encoder speed detection error (PULS)
15	Motor overheat (M.O.H.)
16	EMI (CPU-)
17	Short circuit (S.C.)
18	Reserved
19	L1, L2, L3 phase failure (IPH.L)
20	U, V, W phase failure (OPH.L)
21	Frequency converter overheat (C.O.H.)
22	Parameter setting error (PRSE)
23	Parameter auto-tuning error (TUNE)
24	Frequency converter over load pre-warning 2 (O.L.-3)

Tab. 12-17:   Error codes and meanings_ModBus

Communication monitor registers (0x5001...0x5013)

Communication monitor registers are read-only. The relationship between the register addresses and monitored values are shown in table below.

Register address	Monitored value
0x5001	Output frequency
0x5002	Reference frequency
0x5003	Output current
0x5004	DC bus voltage
0x5005	Heat sink temperature
0x5006	Output voltage
0x5007	Output power
0x5008	Torque current
0x5009	Exciting current
0x500A	Output speed
0x500B	Reference speed
0x500C	User-defined reference value
0x500D	User-defined output value
0x500E	Reference torque
0x500F	Digital inputs status
0x5010	Encoder speed feedback
0x5011	Torque limit setting

Register address	Monitored value
0x5012	Speed limit setting
0x5013	Multi-monitoring display

Tab. 12-18:   Addresses of monitor registers and monitored values

- "0" is returned when the communication address is 0x5013.

12.2.5   ModBus Communication Example

One slave address is 01H. The frequency setting of the frequency converter has been set to "external computer frequency setting" and the source of running commands is "external computer control". It is required for the motor connected to the frequency converter to run with 50 Hz (forward rotation). The operation can be achieved with function 0x10 of the ModBus protocol. The messages of the requests from the master and responses from the slave are shown in table below.

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

Tab. 12-19:   Example of ModBus communication

Communication Protocols

12.2.6   Special Notes

1. The external computer can not write to function codes b0.03, b0.08, b0.09 and S2.10.

2. b0.00 and b0.02 do not support multiple write including single write in multiple write; parameters of motor name plate and motor can not be written at the same time; Terminals X1 to X8 can not be rewritten if they are not 0.

3. If the communication protocol is changed, baud rate, data frame and local address will be restore to factory default.

4. The read response of user password and factory password is '0000' in case of external computer reading.

5. External computer can not set, modify or cancel user password; external computer can only write 0 in case of no password or write correct password in case of with password; if a password is active, the external computer only has the access to modify the parameters after input of the correct password; After the external has the access to modify the parameters, if the previous password is input again, the modification access is disabled.

6. The access to control registers and state registers is not limited by user password.

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

12.2.7   Communication Networking

Networking

The communication network is shown in figure below. Network terminal slaves at both ends need external resistance with a recommended value of 120 Ω, 0.25 W.
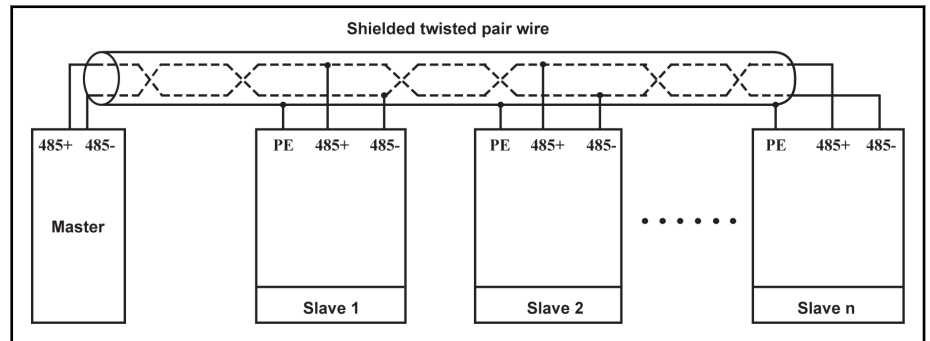
Fig. 12-2:   ModBus networking

⚠ WARNING	Cables may only be connected when drive is turned off!

Recommendations on networking

- Use shielded twisted pair cable to connect RS485 links.
- ModBus cable should be adequately away from power cables (30 cm in minimum).
- Avoid crossing of ModBus cables and power cables and use orthogonal crossing if crossing must be used.
- The shield layer of cables should be connected to protected ground or to equipment ground if the equipment ground has already been connected to protected ground. Do not directly ground any point of the RS485 network.
- In no circumstance should ground cables constitute a loop.

Communication Protocols

12.3   PROFIBUS Protocol

12.3.1   Protocol Description

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

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

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

Tab. 12-20:   PROFIBUS Frame format

Physical transmission medium for PROFIBUS is twisted-pair cable (RS-485 standard). Maximum length of bus cable is within the scope of 100...1,200 m, depending on the set transmission rate. When no repeater is used, 32 nodes at maximum can be connected to the same PROFIBUS network; if a repeater is used, nodes connected to the network may be increased to 126. In PROFIBUS communication, the master is usually a programmable logic controller, which is able to select the nodes responsive to commands from the master. In PROFIBUS network, no communication can be achieved among nodes.

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

12.3.2   PROFIBUS-Adapter

Technical data

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

Tab. 12-21:   PROFIBUS-Adapter technical parameters and performance

Functions

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

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

● Sending frequency setting signal to frequency converter.

● Reading working status information from frequency converter (such as run, rotation direction, rotation speed, error message, etc.).

● Reading or modifying frequency converter parameters.

- Resetting frequency converter in case of error.

Network structure

Fv PROFIBUS network connection via PROFIBUS-Adapter is shown in figure below.
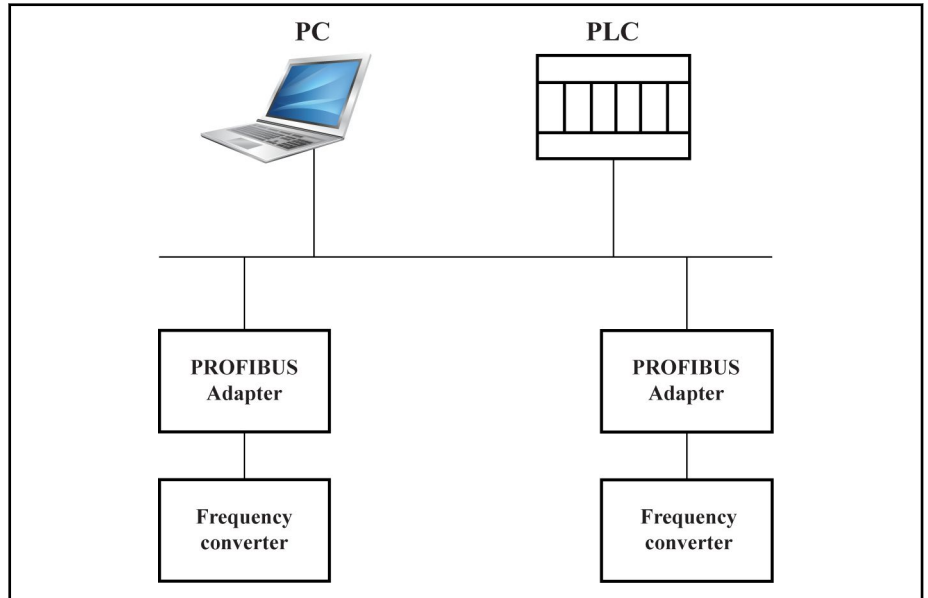
Fig. 12-3:   Fv PROFIBUS network

12.3.3   Electrical Installations

Outline structure
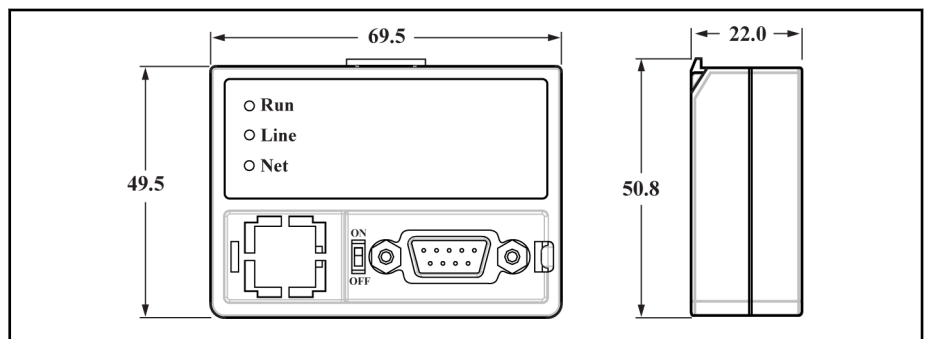
Fig. 12-4:   PROFIBUS adapter dimensions

Adapter terminal configuration
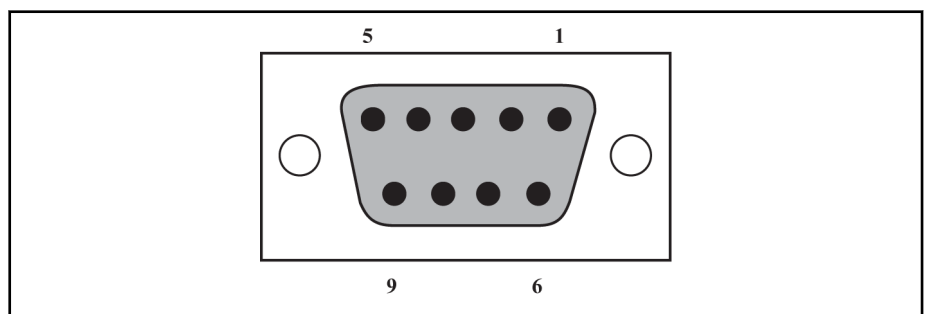
Fig. 12-5:   Bus connection terminal PROFIBUS DB9

Communication Protocols

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

Tab. 12-22:   Definition of PROFIBUS DB9 Pins

Requirements for PROFIBUS link

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

Impedance of the cable should be within 100...200 Ω. Cable capacity (among conductors) should be < 60 pF/m, and conductor cross section should be ≥ 0.22 (24 AWG). Two kinds of cables are used for PROFIBUS with detail definitions stated in table below.

Cable parameters	Type A	Type B
Impedance	135...165 Ω (f = 3...20 MHz)	100...130 Ω (f > 100 kHz)
Capacity	< 30 pF/m	< 60 pF/m
Resistance	≤ 110 Ω/km	≤ 110 Ω/km
Conductor cross section	≥ 0.34 (22 AWG)	≥ 0.22 (24 AWG)

Tab. 12-23:   Type of PROFIBUS-adapter cable

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

Relationship between communication rate and cables

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

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

Tab. 12-24:   Relationship between communication rate and cable length

EMC measures

- Conductor of bus cable (signal cable) must be twisted, and shielded and installed separately with electrical power cable with a distance of at least 20 cm. Bus cable shielding layer should be grounded at one end. Terminal PE at terminal block X2 is taken as connecting terminal of the shielding layer. The terminal PE is only valid at the 1st pin of DB9 socket or when DB9 metal cover is connected with the shielding layer of bus cable.

- Conductors of communication connection cable (signal cable) for adapter and frequency converter must be twisted, and shielded and installed separately at a reasonable distance. Shielding layer for communication cable should be grounded at one end.

- Signal cable and electric power cable should be orthogonal in case of crossing.

- Signal cable should be as short as possible.

- Large area is required for the connection of shielding layer.

12.3.4   Periodical Data Communication

PPO data type

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

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

Process data area (PZD area): including control word and reference frequency (data flow from master to slave), or status word, actual output frequency and other status monitoring values of slave (data flow from slave to master). For detail descriptions of PKW area and PZD area, please refer to chapter "PKW parameter area" on page 226 and chapter "PZD process data area" on page 230.
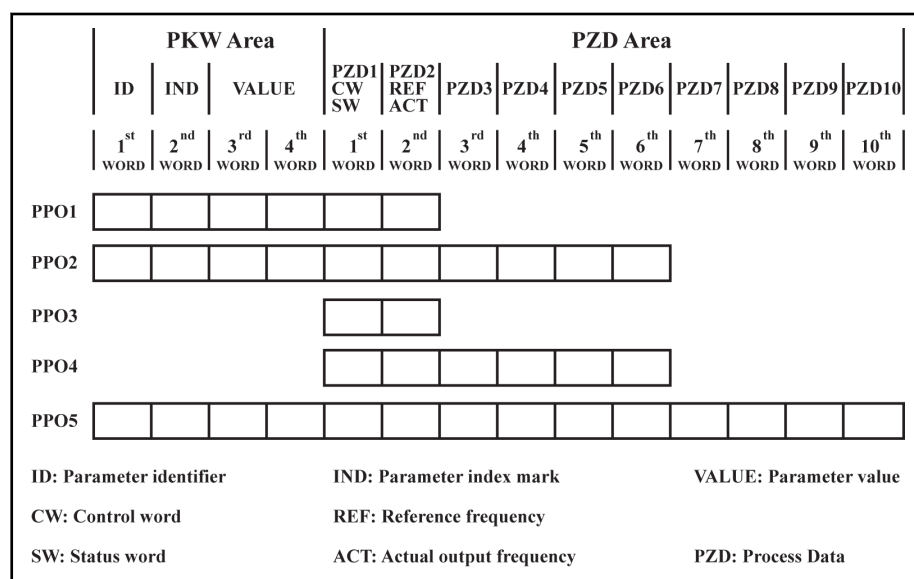
Fig. 12-6:   PPO type

Communication Protocols

PKW parameter area

This data area is composed of ID, IND, VALUE_high and VALUE_low, as shown in figure below. They are used to read or modify the parameter of a certain function code of frequency converter, but only one function code can be read or modified each time. When master gives request and slave makes response, bit definition for each specific word in PKW area is shown in tab. 12-25 "Request data frame in PKW area_from master to slave" on page 226 and tab. 12-26 "Response data frame in PKW area_from slave to master" on page 227. If frequency converter fails to execute PKW area request command, it will return error code to the master in VALUE_low. Refer to tab. 12-27 "PKW area error codes" on page 227 for details.

PKW Area

| ID | IND | VALUE_high | VALUE_low |
| 1st WORD | 2nd WORD | 3rd WORD | 4th WORD |
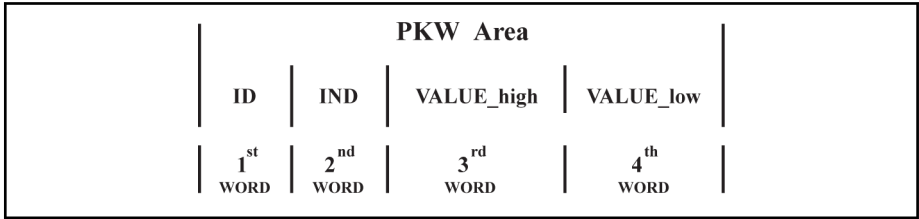
Fig. 12-7:   PKW area data format

- Request data frame in PKW area

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

Tab. 12-25:   Request data frame in PKW area_from master to slave

☞   For addressing of parameter function group and the index serial No. within the group, please refer to chapter "Addressing of communications function code parameter group and index number within the group" on page 235.

- **Response data frame in PKW area**

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

Tab. 12-26:   Response data frame in PKW area_from slave to master

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

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

Tab. 12-27:   PKW area error codes

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

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

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

Communication Protocols

The following examples are based on Fv and PROFIBUS-Adapter.

Example 1   Reading value of parameter 'Skip frequency range' [S3.06]. 0×05 is the function group, 0×06 is the index serial No. of the parameter within the group, then request and response data frames in PKW area are shown in table below:

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

Tab. 12-28:   *Example 1_request and response data frames of PKW area*

☞   ID of request data frame could be 0×1000 or 0×1800, because the 11th digit of ID in tab. 12-25 "Request data frame in PKW area_from master to slave" on page 226 can be 0 or 1. 0 is strongly recommended. In following examples, only ID value of 0with this digit is given.

Example 2   Reading value of parameter 'Skip frequency range' S3.06. 0×05 is the function group, 0×06 is the index serial No. of the parameter within the group. If the index serial No. of group S3 is miswritten as 0×20 (0×20, exceeds specified limit in group S), then request and response data frames in PKW area are shown in table below:

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

Tab. 12-29:   *Example 2_request and response data frames of PKW area*

Example 3   Modifying value of parameter 'Skip frequency range' S3.06. 0×05 is the function group, 0×03 is the index serial No. within the group, 0×0BB8 is the modified value, then request and response data frames in PKW area are shown in table below:

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

Tab. 12-30:   *Example 3_request and response data frames of PKW area*

Example 4   Modifying value of parameter 'Skip frequency range' S3.06. 0×05 is the function group, 0×06 is the index serial No. within the group, and 0×1388 (0×1388 exceeds upper limit of parameter S3.06) is the modified value, then request and response data frames in PKW area are shown in table below:

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

Tab. 12-31:   *Example 4_request and response data frames of PKW area*

Example 5   Modifying value of parameter 'Skip frequency range' S3.06. 0×05 is the function group, 0×06 is the index serial No. within the group, and 0×0BB8 is the modified value. But, PPO command code (bit15...12 of ID) is miswritten as 8 (illegal command code), then request and response data frames in PKW area are shown in table below:

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

Tab. 12-32:   Example 5_request and response data frames of PKW area

Example 6   If the user password is available, to modify the value of parameter 'Skip frequency range' S3.06. 0×05 is the function group, 0×06 is the index serial No. within the group, and 0x0BB8 is the modified value, then the request and response data frames in PKW area are shown in table below:

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

Tab. 12-33:   Example 6_after user password modified_request and response data frames of PKW area

Example 7   Forward run the frequency converter at 50.00 Hz (0x1388) , then modify the value of parameter 'Skip frequency range' S3.06. 0×05 is the function group, 0×06 is the index serial No. within the group, and 0x0BB8 is the modified value, then the request and response data frames in PKW area are shown in table below:

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

Tab. 12-34:   Example 7_request and response data frames of PKW area

Example 8   Modify the value of parameter 'Heat sink temperature' b0.12. 0x00 is the function group, 0x0C is the index serial No. within the group, and 0x0001 is the modified value, then the request and response data frames in PKW area are shown in table below:

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

Tab. 12-35:   Example 8_request and response data frames of PKW area

Example 9   Modify the value of parameter 'LCD display in run mode' b0.08. 0x00 is the function group, 0x08 is the index serial No. within the group, and 0x0BB8 is the modified value, then the request and response data frames in PKW area are shown in table below:

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

Tab. 12-36:   Example 9_request and response data frames of PKW area

Communication Protocols

PZD process data area

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

- Control word (CW)

bit	Value	Description
15...8	–	Reserved
7	0	Control active
	1	Control inactive
6	0	Inactive
	1	SCI stop acceleration/deceleration
5	0	Error reset inactive
	1	Error reset active
4	0	E-Stop inactive
	1	E-Stop active
3	0	Inactive
	1	Stop as parameter setting mode
2	0	Forward
	1	Reverse
1	0	Jog inactive
	1	Jog active
0	0	Run inactive
	1	Run active

Tab. 12-37:   bit definition of control word

☞   When bit7 is 1, command is invalid.

- **Status word (SW)**

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

Tab. 12-38:   bit definition of status word

☞   In case of system errors, error records can be read in parameters E4.13...E4.15.

Communication Protocols

No.	Error code name	No.	Error code name
0	No error record	13	Circuit disconnection (C.F.)
1	Over current at constant speed (O.C.-1)	14	Encoder speed detection error (PULS)
2	Over current in acceleration (O.C.-2)	15	Motor overheat (M.O.H.)
3	Over current in deceleration (O.C.-3)	16	EMI (CPU-)
4	Over voltage at constant speed (O.E.-1)	17	Short circuit (S.C.)
5	Over voltage in acceleration (O.E.-2)	18	Reserved
6	Over voltage during deceleration (O.E.-3)	19	L1, L2, L3 phase failure (IPH.L)
7	Frequency converter overload (O.L.-1)	20	U, V, W phase failure (OPH.L)
8	Motor overload (O.L.-2)	21	Frequency converter overheat (C.O.H.)
9	CPU read/write error (R.E.)	22	Parameter setting error (PRSE)
10	Operating panel read/write error (KEY-)	23	Parameter auto-tuning error (TUNE)
11	External error (E.-St)	24	Frequency converter over load pre-warning 2 (O.L.-3)
12	Communication error (R.S.)	–	–

Tab. 12-39:   Error codes and meanings_PROFIBUS

Example 1   If the Maximum frequency of the frequency converter is set at 100 Hz, to forward run the frequency converter ward run at 200 Hz (0x4E20) (exceeds the maximum frequency), then the PPO request and response messages are shown in table below.

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

Tab. 12-40:   Example 1_PPO request and response messages

☞   In this example, the feedback status word is 0x0180, bit7...bit9 of status word is 011 (PZD area set frequency exceeds limit).

Example 2   The frequency converter is first forward run at 50 Hz (0x1388), the hardware circuit of communication is then disconnected, then the PPO request and response messages are shown in table below.

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

Tab. 12-41:   Example 2_PPO request and response messages

☞ In this example, the feedback status word is 0x0080, bit7...bit9 of status word is 001 (Communication hardware circuit error).

- **Process data PZD3...PZD10**

One of parameters H0.04...H0.07 can set 2 PZDs. For example, H0.04 sets PZD3 and PZD4, with bit0...bit3 setting of PZD3, bit4...bit7 setting of PZD4, then the maximum range of the function code is 00...FFH (hex) or 0...255 (decimal). The corresponding relationship between the set value (4 bits) and monitored value is shown in table below.

00	Output current
01	Reference frequency
02	Output current
03	DC bus voltage
04	Heat sink temperature
05	Output voltage
06	Output power
07	Torque current
08	Exciting current
09	Output speed
0A	Reference speed
0B	User-defined reference value
0C	User-defined output value
0D	Reference torque
0E	Digital inputs status
0F	Encoder speed feedback

Tab. 12-42:   Process data PZD3...PZD 10 values and function code settings

- **Examples for operation of PZD process data area**

Example 1   The master communicates with the slave via PPO4. From fig. 12-6 "PPO type" on page 225 and tab. 12-42 "Process data PZD3...PZD 10 values and function code settings" on page 233, we need to set status monitoring value corresponding to PZD3...PZD6 in parameters of Fv.

If we need to start frequency converter for forward rotation at 50.00 Hz (0×1388), and request PZD3 to reflect output current, PZD4 to reflect output voltage, PZD5 to reflect DC bus voltage, PZD6 to reflect radiator temperature, respective function codes are set as: [H0.04] = 82; [H0.05] = 67. Complete PPO request and response messages are shown in table below.

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

Tab. 12-43:   Example 1 for PZD process data area_request and response messages of PPO

Communication Protocols

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

Example 2   When the frequency converter forward runs at 50 Hz, to stop the frequency
converter as parameter settings, please refer to example 1.

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

Tab. 12-44:   Example 2 for PZD process data area_request and response messages of PPO

Example 3   To reverse start the frequency converter at 50 Hz, please refer to example 1
for parameter settings.

	PZD1	PZD2	PZD3	PZD4	PZD5	PZD6
PPO request message	CW	REF	0x0000	0x0000	0x0000	0x0000
	0x0005	0x1388				
PPO response message	SW	ACT	0x0000	0x0206	0x02DA	0x001A
	0x0003	0x1388				

Tab. 12-45:   Example 3 for PZD process data area_request and response messages of PPO

Example 4   When the frequency converter reverse runs at 50 Hz, to stop the frequency
converter as parameter settings, please refer to example 1.

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

Tab. 12-46:   Example 3 for PZD process data area_request and response messages of PPO

Addressing of communications function code parameter group and index number within the group

The communication function code address of the frequency converter is in strict correspondence with the function code. It consists of parameter group and index number of parameters within the group. Reading and writing function codes are possible through reading and writing contents of function code address of PROFIBUS communication.

According to the data format defined in **'Request data frame in PKW area'** and **'Response data frame in PKW area'**, a complete communication function code address consists of two parts: parameter group and index number of function code within the group.

The parameter group is defined as in the table below:

Parameter group	b0	b1	S0	S1	S2	S3	E0
Mapping address	00H	01H	02H	03H	04H	05H	06H
Parameter group	E1	E2	E3	E4	E5	H0	–
Mapping address	07H	08H	09H	0AH	0BH	0CH	–

Tab. 12-47:   Addressing range of parameter group

The index number of the function code within the parameter group is defined as in the table below:

Function code index number within the parameter group	xx.00	xx.01	...	xx.99
Mapping address	00H	01H	...	63H

Tab. 12-48:   Addressing range of function code index number within the parameter group

xx means a certain parameter group among b0, b1, S0, S1, S2, S3, E0, E1, E2, E3, E4, E5, and H0.

The function code index number within a parameter group is from 00...99 which is corresponding to the function code in the parameter list.

☞   Use the respective mapping addresses of 'Parameter group' and 'Function code index number within the parameter group' to set a communication function code in PROFIBUS communication.

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12.3.5   Communication Parameter Configuration

Communication related parameter settings in Fv

Function code	Function name	Setting range of parameter
b1.00	Frequency setting mode	5: Set via communication
b1.02	Frequency converter control commands	2: Set control commands via communication
H0.00	Communication protocols selection	1: PROFIBUS protocols
H0.03	Local address	1...126
H0.04	PZD4, PZD3 setting	0...255
H0.05	PZD6, PZD5 setting	0...255
H0.06	PZD8, PZD7 setting	0...255
H0.07	PZD10, PZD9 setting	0...255
H0.08	Communication disconnection detection time	0.0...60.0s (0.0s: deactivated)
H0.09	Communication disconnection action	0: Stop 1: Continue running

Tab. 12-49:   Fv PROFIBUS-DP communication parameters

☞   If parameter [S3.15] = 1, when the frequency converter is stopped by the **Stop** key on the operating panel, adapter is isolated from communication software of the frequency converter. If communication is to be re-established, **Stop** and **Reset** commands must be sent to the frequency converter by the adapter.

Parameter configuration of master

Parameter configuration for related master may refer to instructions for the master. The address configured for slave in the master should be consistent with the parameter address configured for the slave. Communication baud rate and PPO type is determined by the master.

GSD file

Users may log on the website of the company at www.boschrexroth.com/fv to download electronic database document (RXFVDP01.gsd) and bit map document (RX_FV*.bmp) pack for fieldbus adapter. For specific operation and PROFIBUS system configuration method, please refer to related system configuration documents.

12.3.6   Errors and Analysis

LED display analysis

Run   This light indicates if PROFIBUS adapter is running normally. If PROFIBUS adapter is correctly connected to the frequency converter, and related parameter configuration for the frequency converter is correct, this light is always on after power is switched on. If this light is flashing, please switch off the power supply first, and then check if PROFIBUS adapter is correctly connected with the frequency converter, if frequency converter parameters are correctly configured, and if PROFIBUS adapter power connection is reliable. After that, switch power on for PROFIBUS adapter. If this problem still exists, please contact your dealer.

Line   This light indicates the status of communication between the PROFIBUS adapter and the frequency converter. It indicates normal communication if this light is always on. If this light is off, it indicates disconnection between the adapter and the frequency converter. Then, please check hardware connection between PROFIBUS adapter and frequency converter. If this light is flashing, it indicates abnormal connection between the adapter and the frequency converter. Then, please check hardware connection between the PROFIBUS adapter and the frequency converter.

Net   This light indicates the status of communication between the PROFIBUS adapter and PROFIBUS master. If this light is always flashing, it indicates normal communication. If this light is off, please check hardware wiring between the PROFIBUS adapter and master, and check if the master configuration is correct.

Diagnosis information of master

From diagnosis of the adapter by master, 6-byte diagnosis information is obtained. Detailed meanings for each byte are as below:

- **First byte (Station_Status_1)**

0	Diag.Station_Non_Existent (set by master, reset by slave) 1: slave does not exist
1	Diag.Station_Non_Ready (set by slave) 1: slave is not ready for data exchange
2	Diag.Cfg_Error (set by slave) 1: Adapter data received does not match with originally configured data
3	Diag.Ext_Diag (set by slave) 1: diagnosis entrance is at undetermined diagnosis area of the slave
4	Diag.Not-Supported (set by slave) 1: service not supported by slave
5	Diag.Invalid_Slave_Response (set by master, reset by slave) 1: invalid response of slave
6	Diag.Prm_Error (set by slave) 1: invalid parameter or parameter value
7	Diag.Master_Lock (set by master, reset by slave) 1: parameters of slave are set by other masters

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- ● **Second byte (Station_Status_2)**

0	Diag.Prm_Req (set by slave) 1: Slave needs to be reconfigured, parameters need to be set again.
1	Diag.Stat_Diag (set by slave) 1: Static diagnosis, slave fails (temporarily) to provide valid data.
2	Always set as 1 by slave
3	Diag.WD_On (set by slave) 1: watchdog is on
4	Diag.Freeze_Mode (set by slave) 1: freezing command received by slave
5	Diag.Sync_Mode (set by slave) 1: synchronizing command received by slave
6	Reserved
7	Diag.Deactivated (set by master, reset by slave) 1: slave inactive

- ● **Third byte (Station_Status_3)**

0 to 6	Reserved
7	Diag.Ext_Diag_Overflow (set by slave) 1: more diagnosis information in Ext_Diag_Date than what specified information

- ● **Fourth byte (Diag.Master_Add)**

Log in address of PROFIBUS master which parameterizes this PROFIBUS slave in this eight-bit set. If there is no such master which parameterizes this PROFIBUS slave, address 255 of this PROFIBUS slave will be logged in this octet.

- ● **Fifth and sixth bytes (Ident_Number)**

    The identifier of the adapter.

13 Service and Support

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

Service Germany

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

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

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

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

Service worldwide

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

Preparing information

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

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

14 Environmental Protection and Disposal

14.1 Environmental Protection

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

No Release of Hazardous Substances Our products do not contain any hazardous substances which may be released in the case of appropriate use. Normally, our products will not have any negativ influences on the environment.

Significant Components Basically, our products contain the following components:

Electronic devices	**Motors**
• steel	• steel
• aluminum	• aluminum
• copper	• copper
• synthetic materials	• brass
• electronic components and modules	• magnetic materials
	• electronic components and modules

14.2 Disposal

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

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

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

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

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

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

Batteries and Accumulators Batteries and accumulators can be labeled with this symbol.

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

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

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

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

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

Environmental Protection and Disposal

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

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

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