The Drive & Control Company

Rexroth
Bosch Group

Rexroth Frequency Converter

Fv for Sytronix Series

Operating Instructions
R912004739

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DOK-RCON02-FV-P002****-IT03-EN-P	07. 2014	Software upgrade
DOK-RCON02-FV-P002****-IT04-EN-P	01. 2015	Software upgrade

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.

Deutsch

Nehmen Sie die Produkte erst dann in Betrieb, nachdem Sie die mit dem Produkt gelieferten Unterlagen und Sicherheitshinweise vollständig durchgelesen, verstanden und beachtet haben.

Sollten Ihnen keine Unterlagen in Ihrer Landessprache vorliegen, wenden Sie sich an Ihren zuständigen Bosch Rexroth Vertriebspartner.

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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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Mettere in funzione i prodotti solo dopo aver letto, compreso e osservato per intero la documentazione e le indicazioni di sicurezza fornite con il prodotto.

Se non dovesse essere presente la documentazione nella vostra lingua, siete pregati di rivolgervi al rivenditore Bosch Rexroth competente.

Español

Los productos no se pueden poner en servicio hasta después de haber leído por completo, comprendido y tenido en cuenta la documentación y las advertencias de seguridad que se incluyen en la entrega.

Si no dispusiera de documentación en el idioma de su país, diríjase a su distribuidor competente de Bosch Rexroth.

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Utilize apenas os produtos depois de ter lido, compreendido e tomado em consideração a documentação e as instruções de segurança fornecidas juntamente com o produto.

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Stel de producten pas in bedrijf nadat u de met het product geleverde documenten en de veiligheidsinformatie volledig gelezen, begrepen en in acht genomen heeft.

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

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.

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

Română **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.

Türkçe **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 **请在完全通读、理解和遵守随同产品提供的资料和安全提示后才使用这些产品。**

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

日本語 **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 Introduction

1.1 Introduction to the Documentation

⚠ WARNING **Personal injury and property damage caused by incorrect project planning for applications, machines and installations!**

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

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

Chapters and Contents

Chapter	Title	Description
1	Introduction	Overview
2	Safety Instructions for Electric Drives and Controls	Safety cautions
3	Important Directions for Use	
4	Fv for Sytronix Mounting	Product information (project specific)
5	Installation	
6	Commissioning	Actual applications (for operators and repairers)
7	Parameter Settings	
8	Error Types and Solutions	
9	Technical Data	
10	Accessories	
11	Additional Information	
12	Serial Communication	
13	Service and Support	Service information
14	Environmental Protection and Disposal	Environmental information
15	Appendix	Appendix infomation
–	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

1.2 Definition

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

- Fv for Sytronix: Bosch Rexroth Frequency Converter Fv for Sytronix
- FSWA: Engineering software
- FVAA: PROFIBUS adapter
- FELR: Brake resistor
- FELB: External brake chopper
- FENF: EMC filter
- FRKB: Master/slave pump communication cable
- FVAM: Cable shielding kit

1.3 Type Coding

1.3.1 Type Coding of Fv for Sytronix

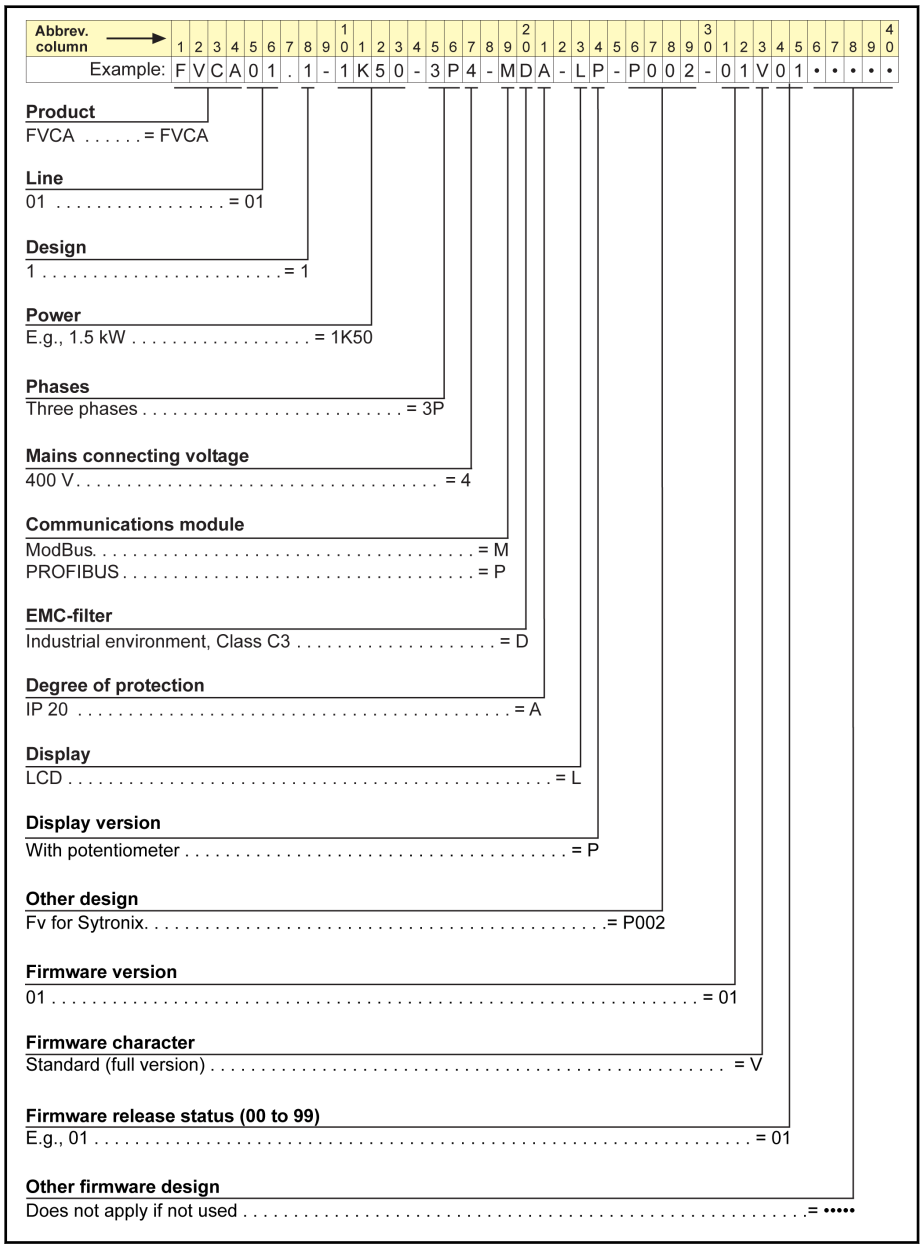


Fig. 1-1: Type coding of Fv for Sytronix

Introduction

1.3.2 Type Coding of Fv for Sytronix Accessories

Engineering software (ConverterPC Sytronix) type coding

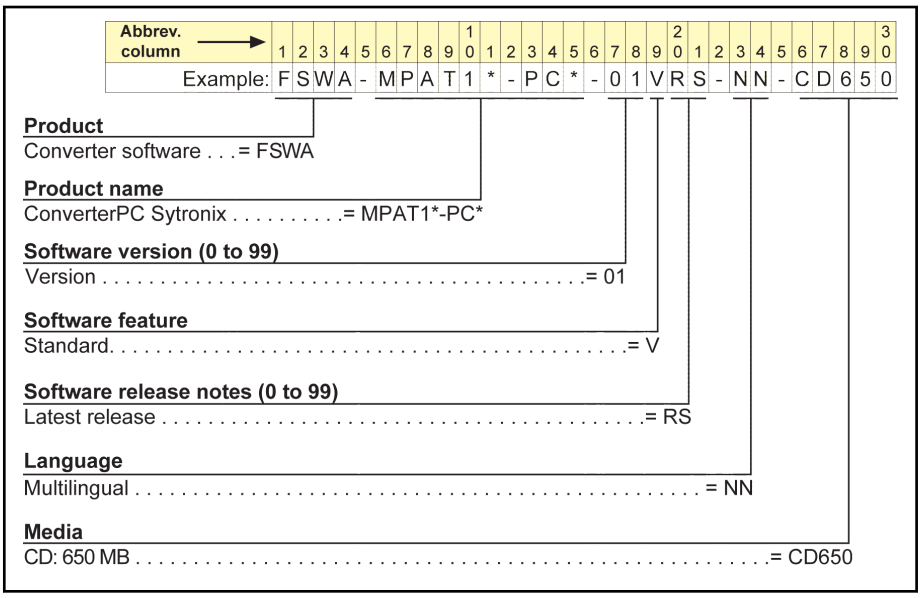


Fig. 1-2: Engineering software type coding

PROFIBUS adapter type coding

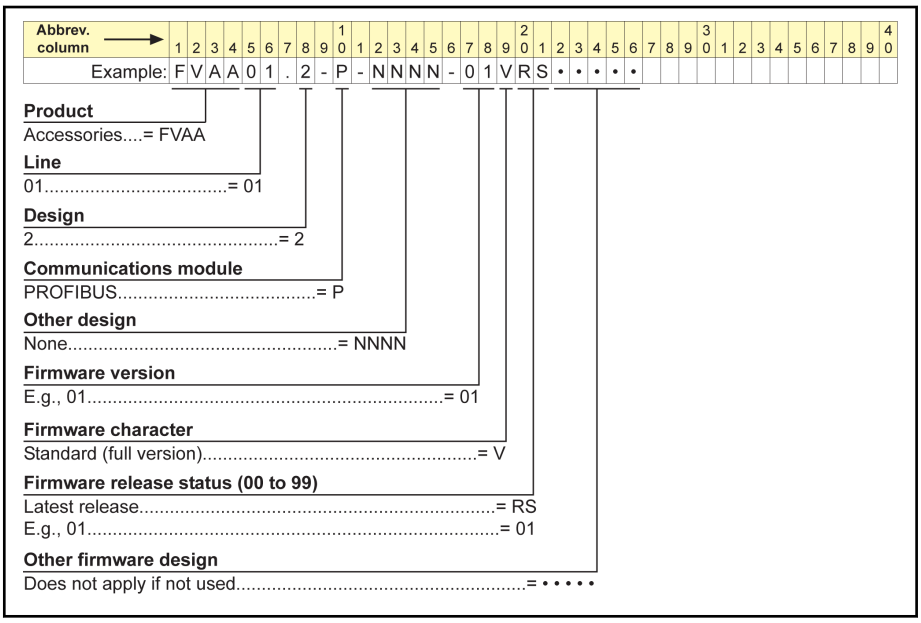


Fig. 1-3: PROFIBUS adapter type coding

Brake resistor type coding

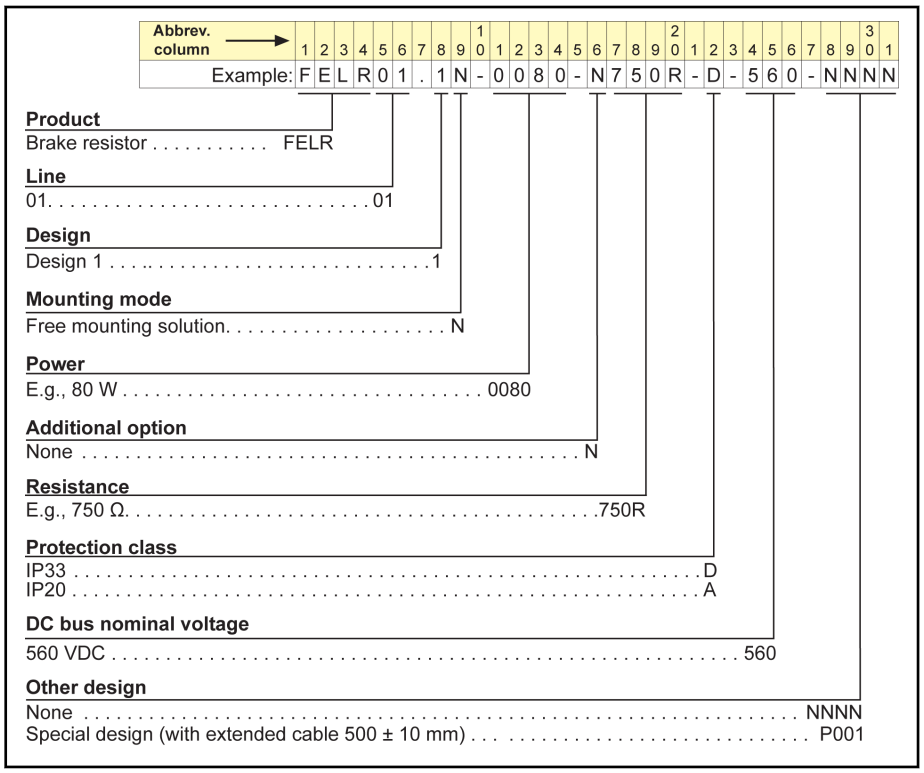


Fig. 1-4: Brake resistor type coding

External brake chopper type coding

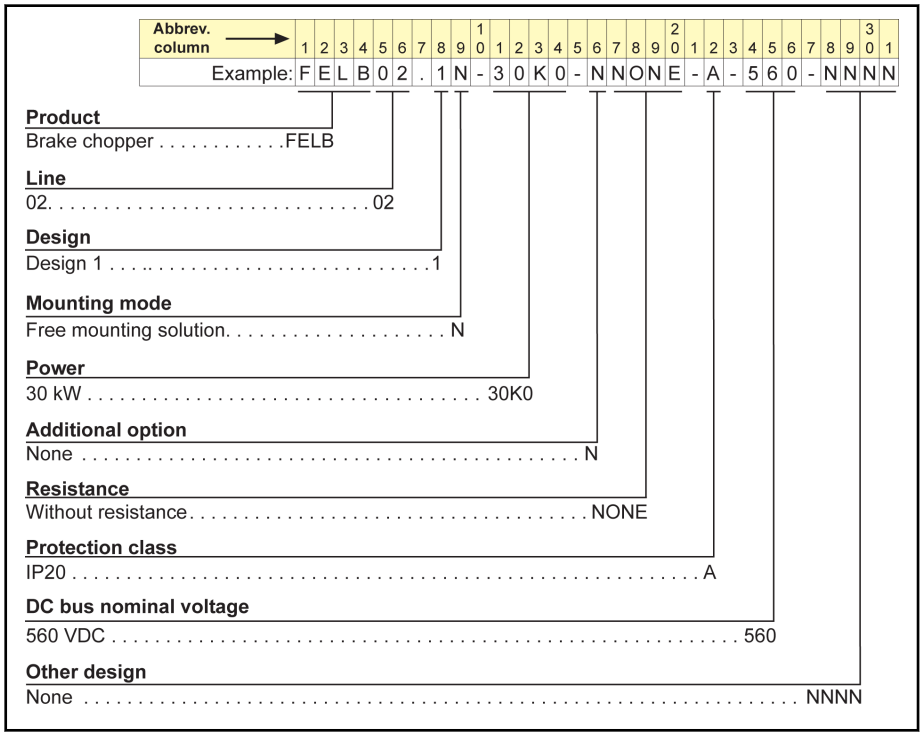


Fig. 1-5: External brake chopper type coding

Introduction

EMC filter type coding

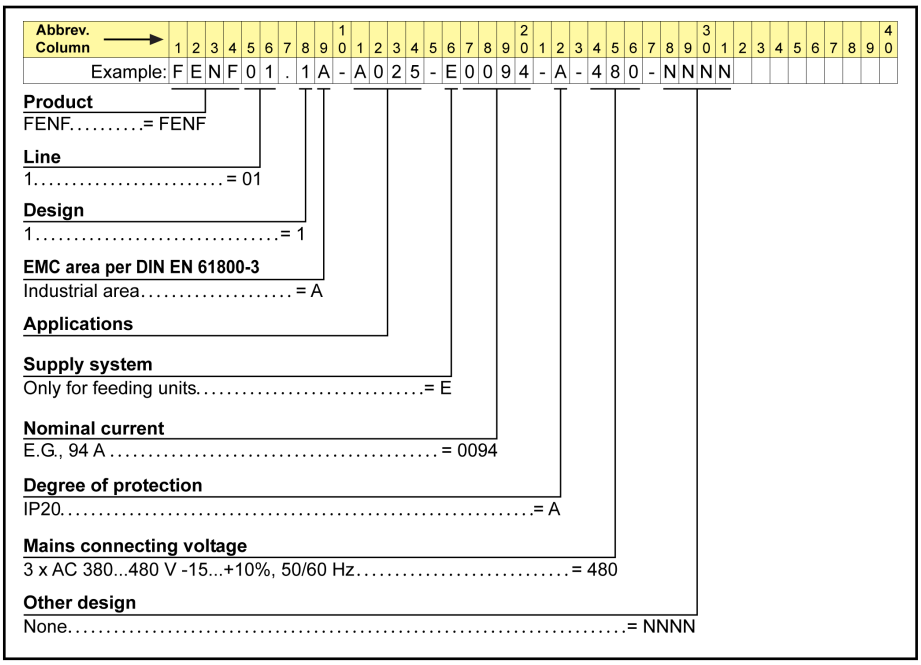


Fig. 1-6: EMC filter type coding

Master/slave pump communication cable type coding

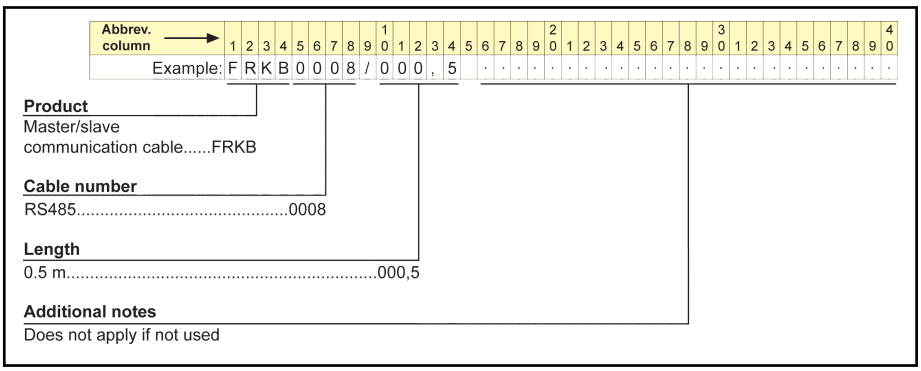


Fig. 1-7: Master/slave pump communication cable type coding

Cable shielding kit type coding

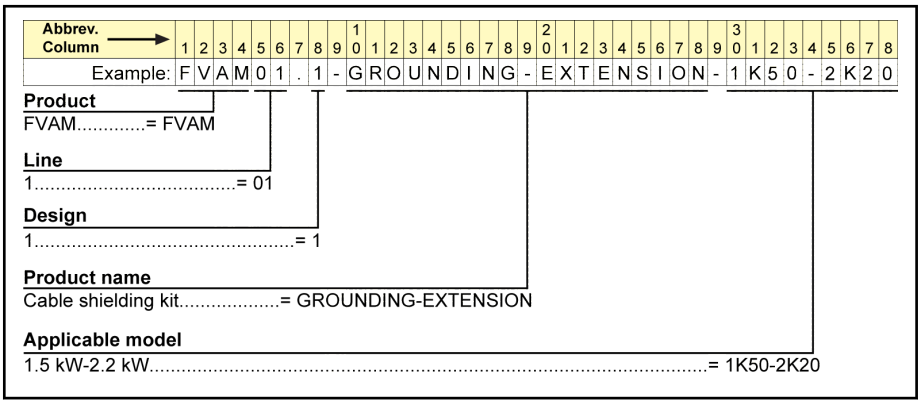


Fig. 1-8: Cable shielding kit type coding

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 model

- Fv for Sytronix, protection class of IP 20 (Control cabinet mounting)
- Internal brake chopper (15K0 and below)
- Safety notes
- Instruction manual (UL)
- EMC filter (EN 61800-3 Environment 2)

Optional accessories

- Operating instructions (Available on Rexroth website)
- PROFIBUS adapter
- RS232/485 adapter
- Engineering software
- Motor filter (dV/dt filter)
- Mains choke
- Brake resistor
- External brake chopper (18K5 to 90K0)
- Master/slave pump communication connector
- Master/slave pump communication cable
- Cable shielding kit

1.4.3 Transport of the Components

Ambient and operating conditions-Transport

Description	Symbol	Unit	Value
Temperature range	T_{a_tran}	°C	-25 to 70
Relative humidity	–	%	5 to 95
Absolute humidity	–	g/m^3	1 to 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 for Sytronix 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 to 55
Relative humidity	–	%	5 to 95
Absolute humidity	–	g/m^3	1 to 29
Climate category (IEC 721)	–	–	1K3
Moisture condensation	–	–	not allowed
Icing	–	–	not allowed

Tab. 1-3: Storage conditions

1.5 Fv for Sytronix Description

1.5.1 Certification

CE certification

Declaration of conformity

For Fv for Sytronix, 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.

EU directives	Standard
Low-Voltage Directive 2006/95/EC	EN 61800-5-1 (IEC 61800-5-1: 2007)
EMC Directive 2004/108/EC	EN 61800-3 (IEC 61800-3: 2004)

Tab. 1-4: EU directives and standards

CE label

Fig. 1-9: CE label

High-voltage test

According to standard EN 61800-5-1, all Fv for Sytronix components are tested with high voltage.

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. 1-10: 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 (1K50 to 37K0: 5,000Arms; 45K0 to 90K0: 42,000Arms), e.g. by appropriate fuses in the mains supply of the supply unit.

Wiring material UL In the scope of UL, use only copper conductors rated 75 °C and above.

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. 1-11: 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.

1.5.2 Properties of the Basic Device Fv for Sytronix

- Allowed ambient temperature: -10 to 40 ℃;
- Protection class: IP 20 (Control cabinet mounting)
- Power range: 1.5 to 90 kW
- Power supply voltage: 3P 380 to 480 VAC (-15 % / +10 %)
- High start-up torque and precise motor speed control
- Overload capability:
  - 150 % of rated current for 60s, and then 540s with rated current for recovery from the overload influence, after this comes next overload period.
  - 200 % of rated current for 1.0s, and then 19.5s with rated current for recovery from the overload influence, after this comes next overload period.
- Output frequency: 0 to 400 Hz
- Pulse width modulation (PWM):

Model	Default value of PWM frequency [kHz]	Effective adjustable range of PWM frequency [kHz]
1K50 to 7K50	8.0	1.0 to 15.0
11K0 to 22K0	6.0	1.0 to 12.0
30K0 to 90K0	4.0	1.0 to 8.0

- Internal brake chopper (15K0 and below) (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 AC 250 V, 3 A / DC 30 V, 3 A
- 2 analog outputs
- 1 RS485 communication port (Supports Modbus protocol by factory default, also supports PROFIBUS protocol via optional adapter)

1.5.4 Cooling Types

- Air cooling
- Forced, temperature-controlled air cooling

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,

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

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

3) to attend a course of instruction in first aid

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

2.2 Explanation of signal words and the Safety alert symbol

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

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

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

⚠ DANGER

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

⚠ WARNING

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

⚠ CAUTION

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

NOTICE

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

2.3 General Information

2.3.1 Using the Safety Instructions and Passing Them on to Others

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

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

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

2.3.2 Requirements for Safe Use

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

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

  The machine and installation manufacturers must

  – make sure that the delivered components are suited for their individual application and check the information given in this application documentation with regard to the use of the components,
  – make sure that their individual application complies with the applicable safety regulations and standards and carry out the required measures, modifications and complements.
- Commissioning of the delivered components is only allowed once it is sure that the machine or installation in which the components are installed complies with the national regulations, safety specifications and standards of the application.
- Operation is only allowed if the national EMC regulations for the application are met.

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

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

National regulations which the user must take into account

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

2.3.3 Hazards by Improper Use

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

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 equip-

ment works. Do not operate the machine if the emergency stopping switch is not working.

- Prevent unintended start-up. Isolate the drive power connection by means of OFF switches / OFF buttons or use a safe starting lockout.
- Make sure that the drives are brought to safe standstill before accessing or entering the danger zone.
- Disconnect electrical power to the components of the electric drive and control system using the master switch and secure them from reconnection ("lock out") for:
  - Maintenance and repair work
  - Cleaning of equipment
  - Long periods of discontinued equipment use
- Prevent the operation of high-frequency, remote control and radio equipment near components of the electric drive and control system and their supply leads. If the use of these devices cannot be avoided, check the machine or installation, at initial commissioning of the electric drive and control system, for possible malfunctions when operating such high-frequency, remote control and radio equipment in its possible positions of normal use. It might possibly be necessary to perform a special electromagnetic compatibility (EMC) test.

2.4.4 Protection Against Magnetic and Electromagnetic Fields During Operation and Mounting

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

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

- Persons with heart pacemakers and metal implants are not allowed to enter the following areas:
  - Areas in which components of the electric drive and control systems are mounted, commissioned and operated.
  - Areas in which parts of motors with permanent magnets are stored, repaired or mounted.
- If it is necessary for somebody with a heart pacemaker to enter such an area, a doctor must be consulted prior to doing so. The noise immunity of implanted heart pacemakers differs so greatly that no general rules can be given.
- Those with metal implants or metal pieces, as well as with hearing aids, must consult a doctor before they enter the areas described above.

2.4.5 Protection against contact with hot parts

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

- Do not touch hot surfaces of, for example, braking resistors, heat sinks, supply units and drive controllers, motors, windings and laminated cores!
- According to the operating conditions, temperatures of the surfaces can be **higher than 60 °C** (140 °F) during or after operation.

- Before touching motors after having switched them off, let them cool down for a sufficient period of time. Cooling down can require **up to 140 minutes**! The time required for cooling down is approximately five times the thermal time constant specified in the technical data.
- After switching chokes, supply units and drive controllers off, wait **15 minutes** to allow them to cool down before touching them.
- Wear safety gloves or do not work at hot surfaces.
- For certain applications, and in accordance with the respective safety regulations, the manufacturer of the machine or installation must take measures to avoid injuries caused by burns in the final application. These measures can be, for example: Warnings at the machine or installation, guards (shieldings or barriers) or safety instructions in the application documentation.

2.4.6 Protection during handling and mounting

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

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

3 Important Directions for Use

3.1 Appropriate Use

Bosch Rexroth products represent state-of-the-art developments and manufacturing. They are tested prior to delivery to ensure operating safety and reliability.

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

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

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

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

3.2 Inappropriate Use

Using the frequency converters outside of the operating conditions described in this documentation 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 for Sytronix Mounting

4.1 Mounting

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

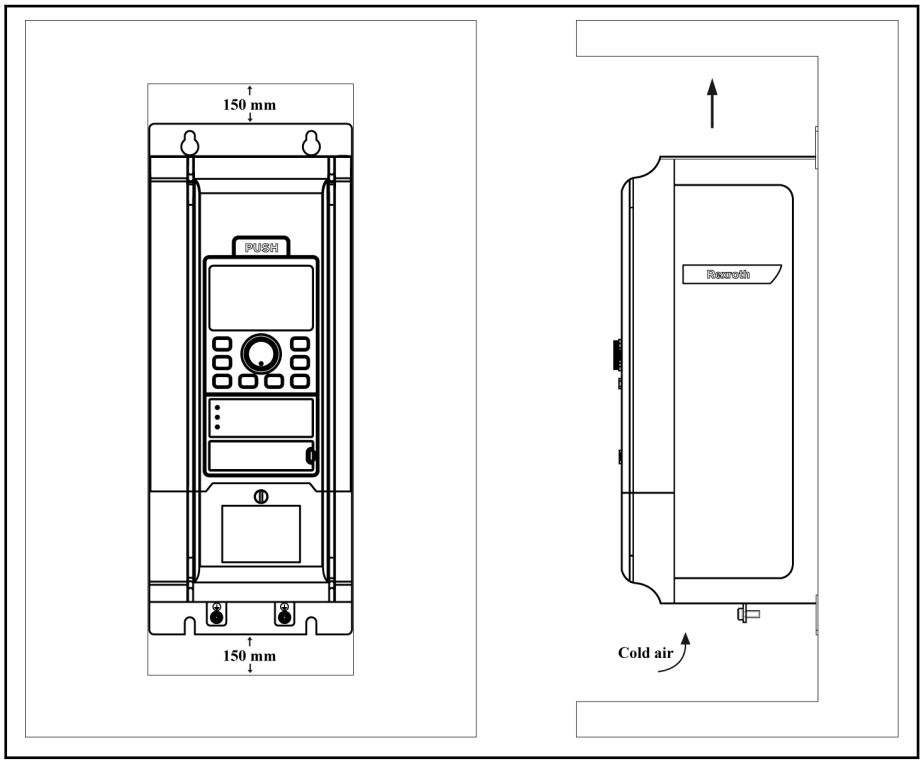


Fig. 4-1: Fv for Sytronix mounting

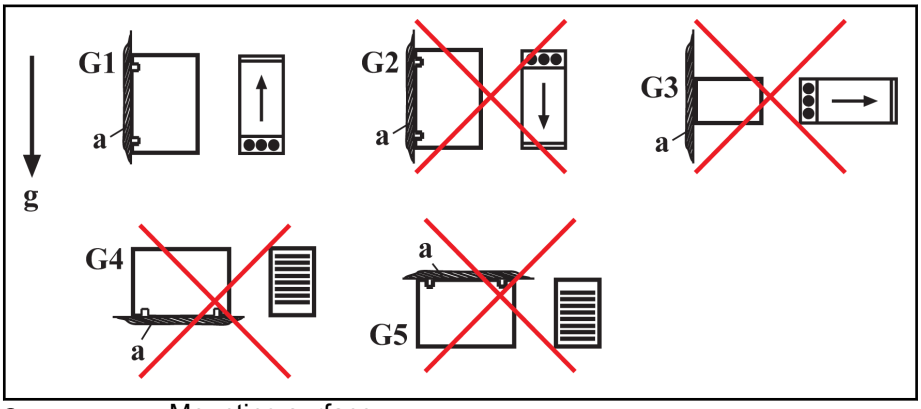
- Fv for Sytronix must be vertically mounted.
- Fv for Sytronix has no side ventilation hole, which enables parallel mounting of Fv for Sytronix with zero distance.
- If one frequency converter is arranged above another, make sure that the upper limit of air temperature into the inlet is not exceeded (See tab. 9-1 "General technical data" on page 177).
- A baffle plate is recommended between the frequency converters to prevent the rising hot air being drawn into the upper frequency converter.

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

Only operate the components in their allowed mounting modes.

Allowed mounting mode of the components:

Only mounting mode G1 is allowed for Fv for Sytronix.



a	Mounting surface
g	Direction of gravitational force
G1	Normal mounting positions. 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 position
G3	Turned by 90° from vertical to horizontal mounting position
G4	Bottom mounting; mounting surface on bottom of control cabinet
G5	Top mounting; mounting surface at top of control cabinet

Fig. 4-2: Allowed mounting mode

4.2 Fv for Sytronix Dimensions and Figure

4.2.1 Fv for Sytronix Dimensions

Frame size	Model	Dimensions [mm]										Screw size	Net weight [kg]
		B	b	T	t	H	h	h1	d	D	L1		
A	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												4.9
	7K50												
C	11K0	175	100	199	2	398	432	448	6.5	204	6.5	M6	8.8
	15K0												9.0
D	18K5	225	125	227	3.5	440	482	500	9	232	9	M8	16.5
	22K0												
E	30K0	250	150	251.5	3.5	525	567	585	9	256.5	9	M8	22.0
	37K0												
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 for Sytronix dimensions

Fv for Sytronix Mounting

4.2.2 Fv for Sytronix Figure

Please refer to chapter 4.2.1 "Fv for Sytronix Dimensions" on page 31 to select four screws for the frequency converter mounting.

1K50 to 15K0

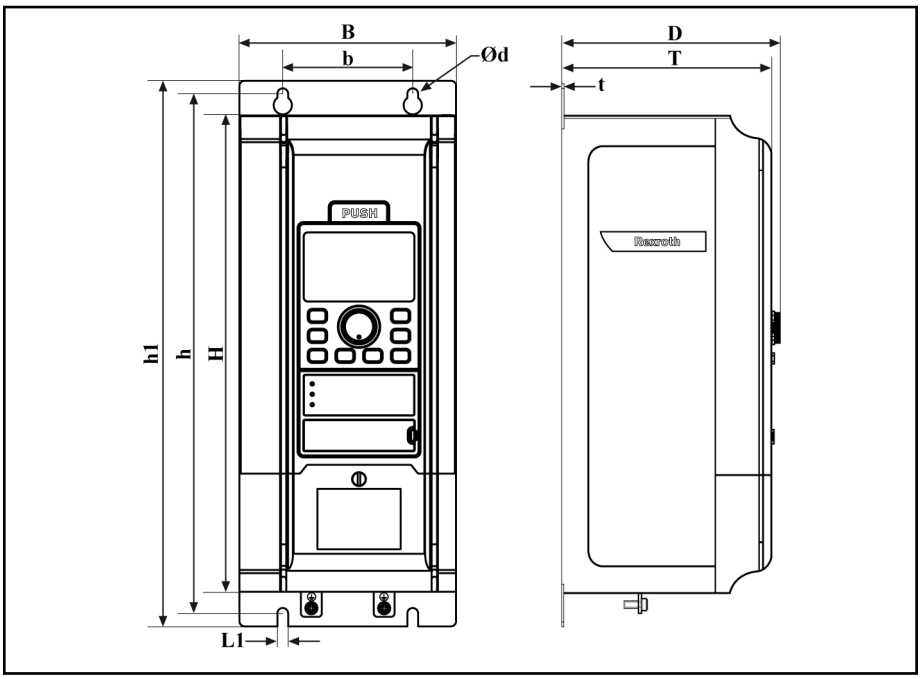


Fig. 4-3: 1K50 to 15K0 figure

18K5 to 37K0

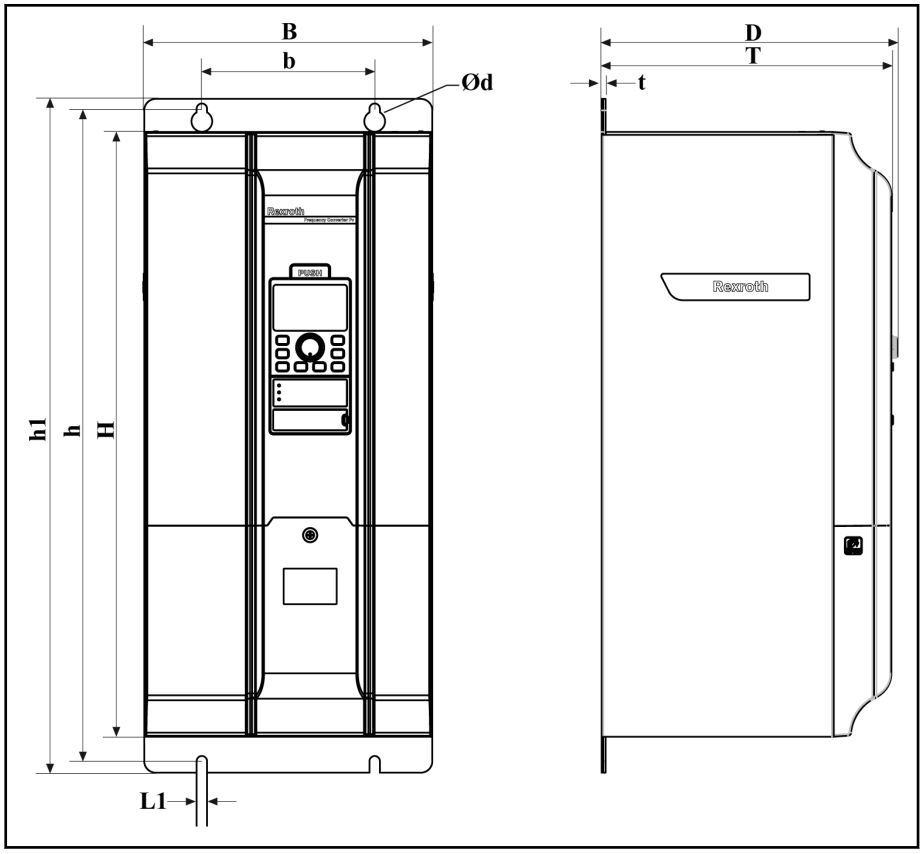


Fig. 4-4: 18K5 to 37K0 figure

45K0 to 90K0

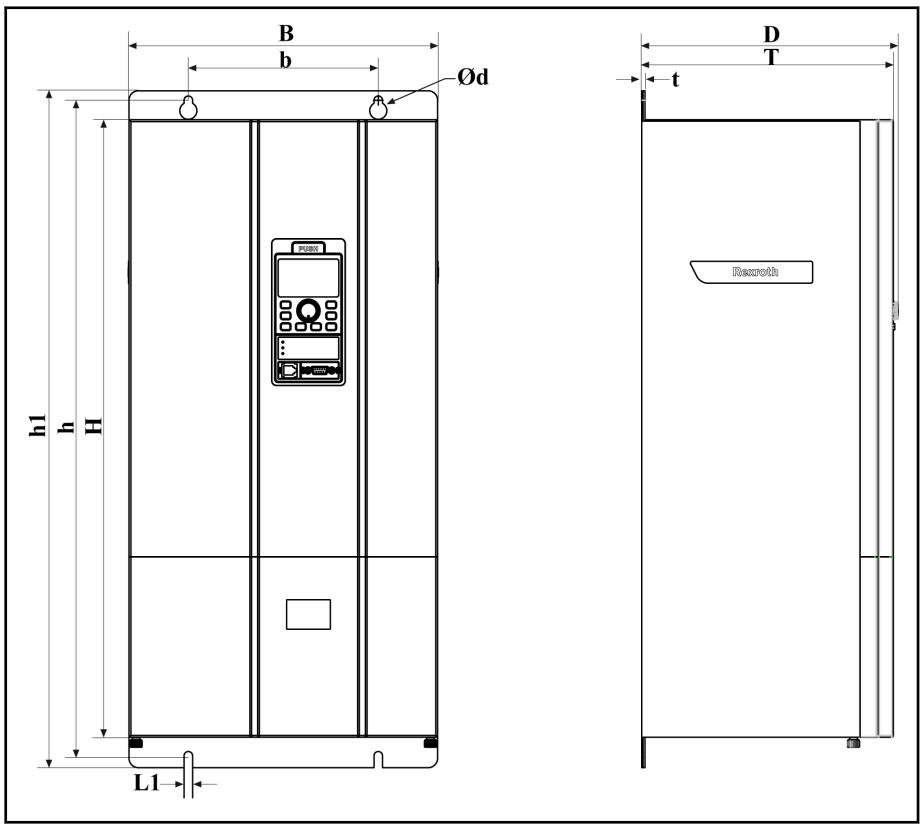


Fig. 4-5: 45K0 to 90K0 figure

5 Installation

5.1 Fv for Sytronix Disassembly and Assembly

5.1.1 Removal and Mounting of the Operating Panel

Removal of the operating panel

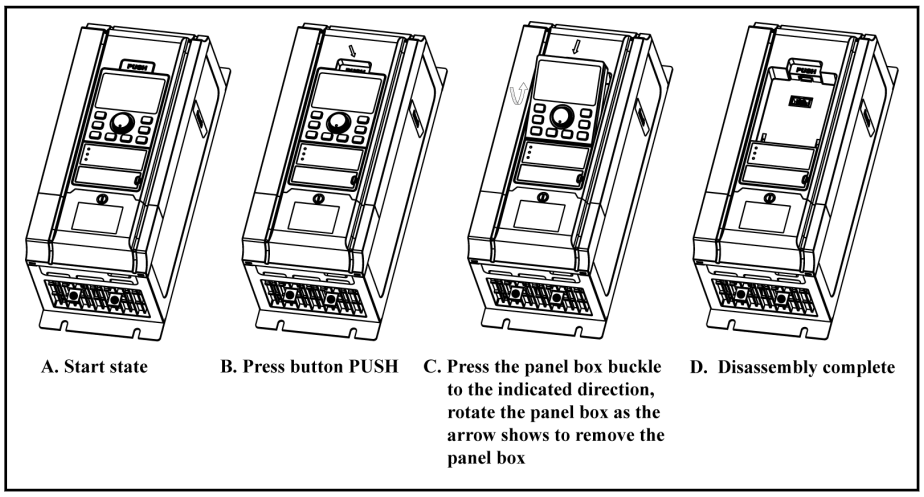


Fig. 5-1: Removal of the operating panel

Mounting of the operating panel

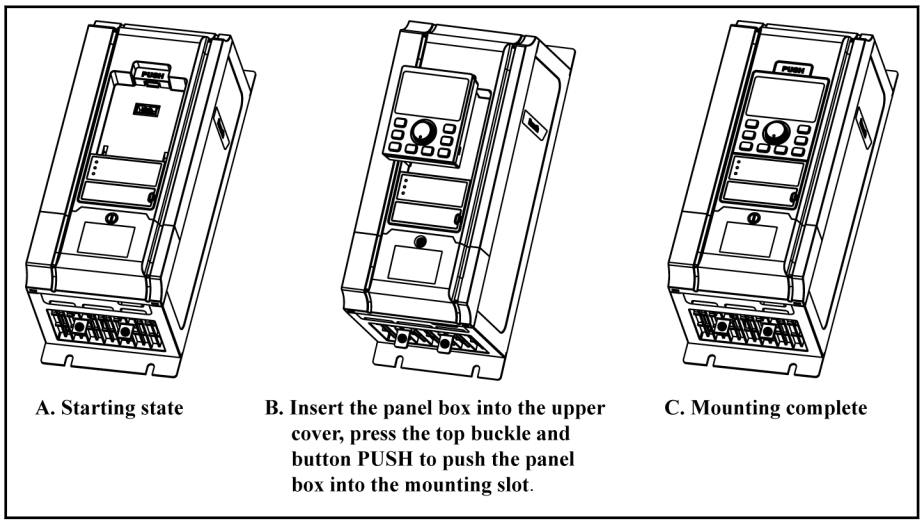


Fig. 5-2: Mounting of the operating panel

5.1.2 Removal and Mounting of the Adapter

Removal of the adapter

To remove the adapter, the operating panel needs to be removed first according to chapter 5.1.1 "Removal and Mounting of the Operating Panel" on page 35.

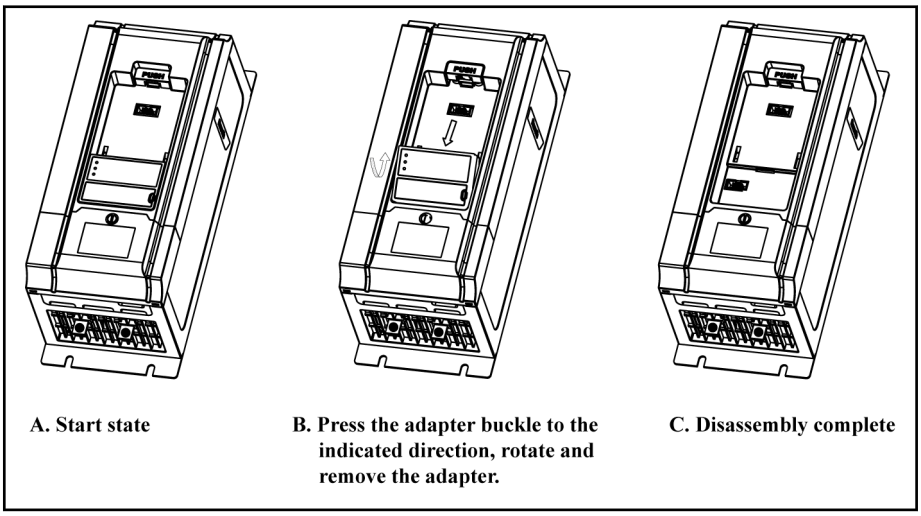


Fig. 5-3: Removal of the adapter

Mounting of the adapter

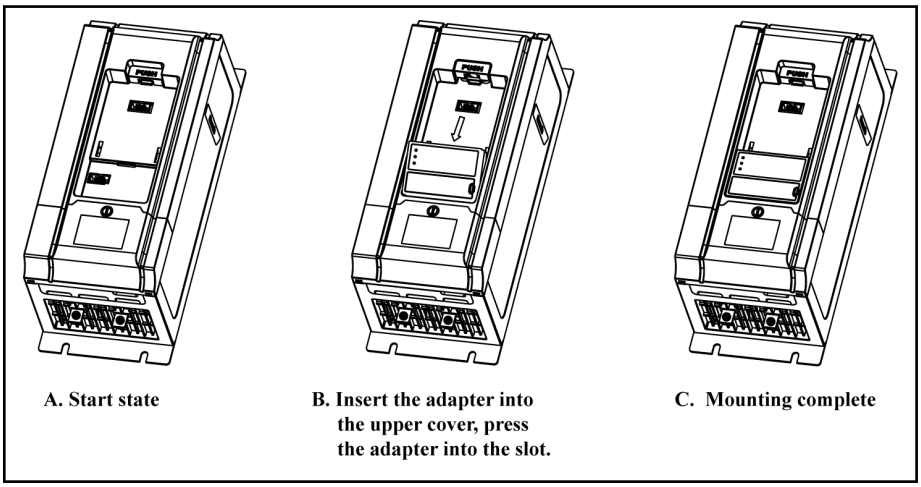


Fig. 5-4: Mounting of the adapter

5.2 Drive System Wiring

5.2.1 Block Diagram

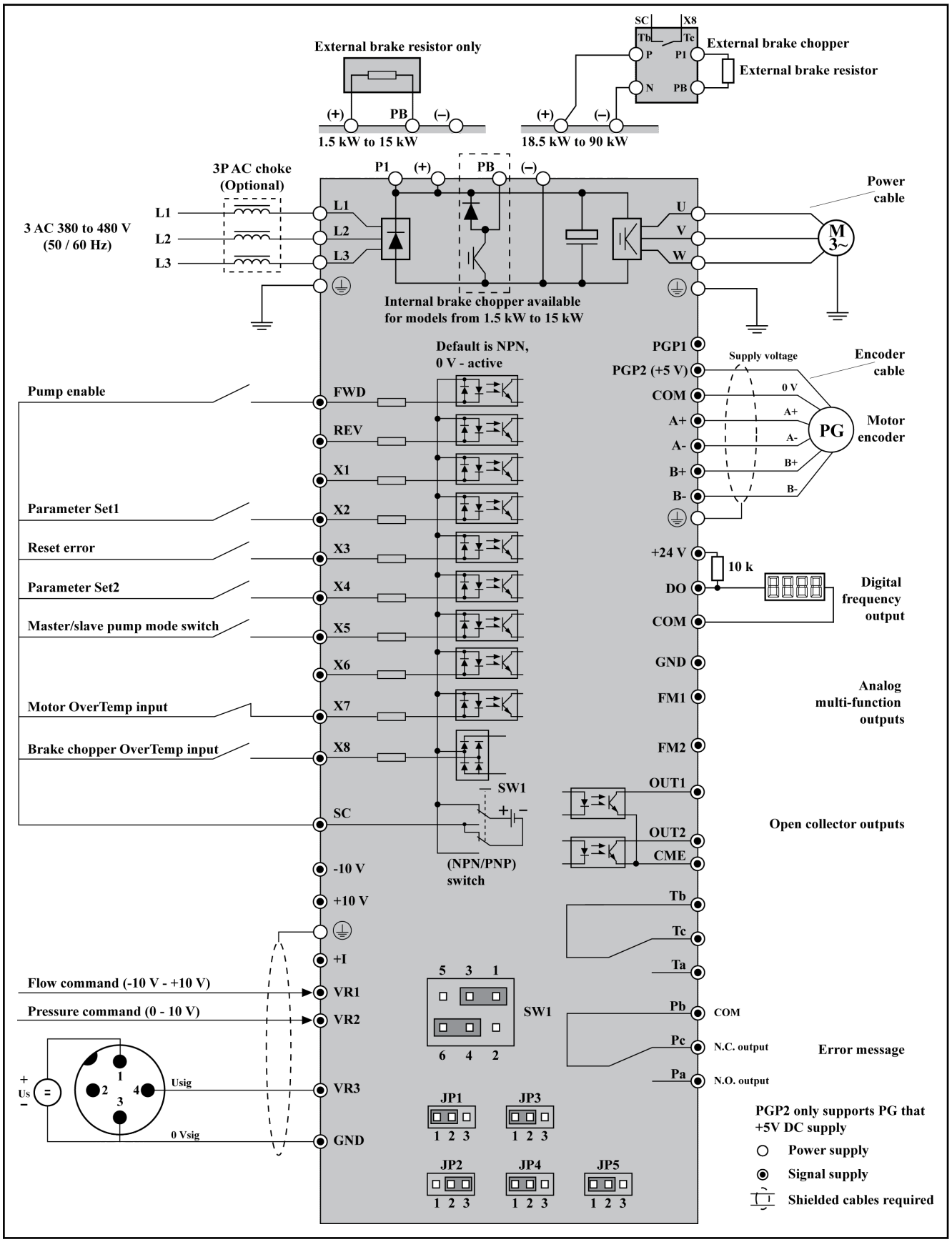


Fig. 5-5: Block diagram_SvP

Installation

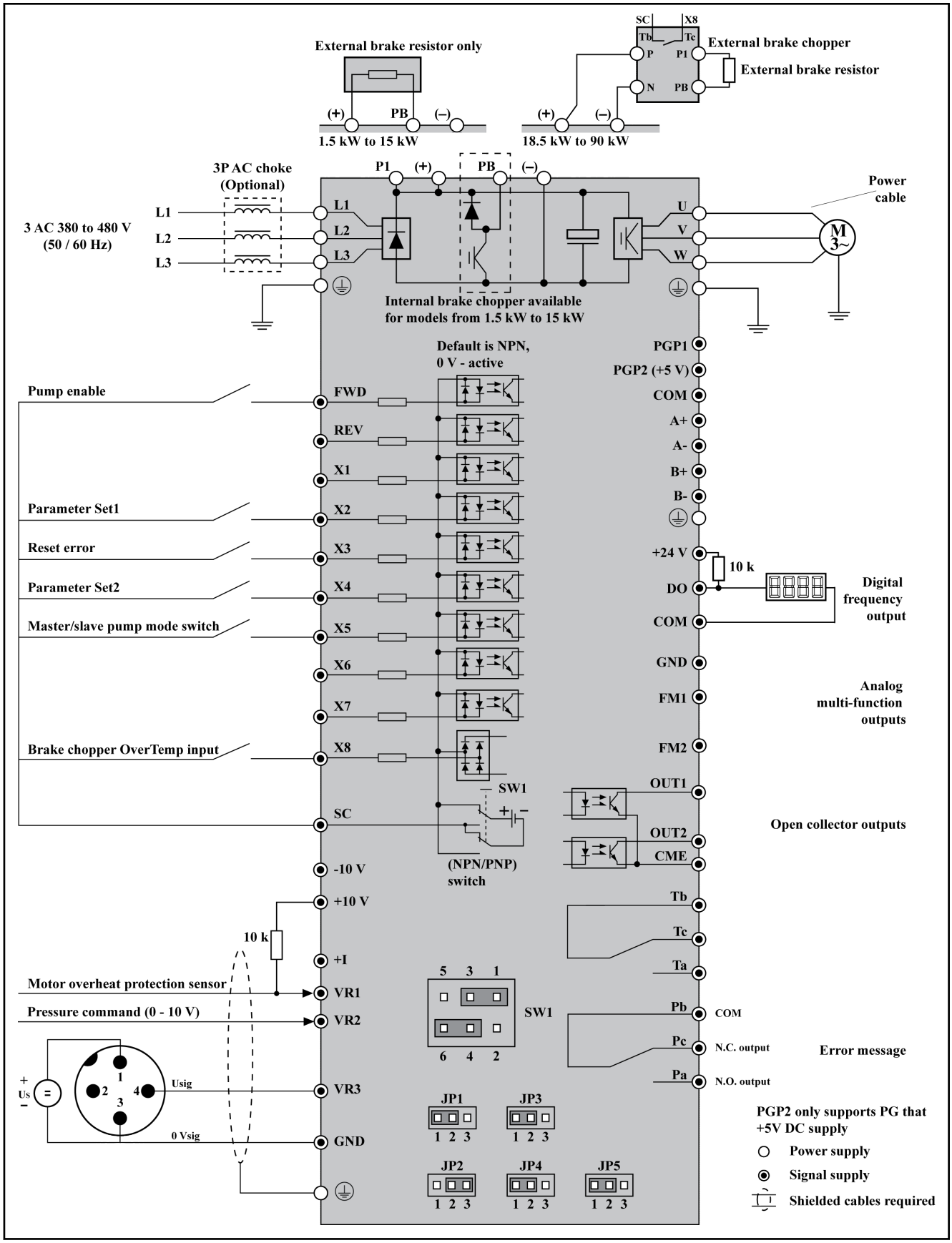


Fig. 5-6: Block diagram_FcP

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 and fire and reduce interference noise.
- Insulated crimp terminals must be used to connect terminals and conductors to ensure the reliability of connection.
- After wiring connection, remove all residual loose wires which may fall into the frequency converter and cause a failure. Be careful not to allow swarf from drilling entering the frequency converter. Check the following points after the circuit connection is completed.
  1. Are all connections correct?
  2. Are there any missing connections?
  3. Do short circuits exist between terminals and wires or ground?
- To make changes in wiring, disconnect the power and wait for 30 minutes to allow the capacitor of the DC circuit to discharge.
- Wiring shall be carried out with wire sizes in accordance with relevant electrical codes.
- A fuse must be provided between the main 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 power, the voltage drop may lead to a reduced torque output by the motor.
- Nothing other than the brake resistor may be connected between the terminal (+) and PB. Do not short circuit!
- Electromagnetic interference: The 3-phase inputs/outputs of a 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 a frequency converter. This may cause frequency converter failure or damage the capacitor or suppressor. Immediately remove any such device which has been installed.
- Integral solid state short circuit protection does not provide branch circuit protection. Branch circuit protection must be provided in accordance with the National Electrical Code and any additional local codes.
- After connecting the main circuit terminals, the motor and the control terminals, reinstall the protection cover before switching on the power. Take account of the following instructions:
  1. Ensure that the power supply can provide appropriate voltage and current. Ensure that the rated current range is within that of the converter and power supply.

Installation

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 the control cabinet.

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

Main circuit wiring diagram

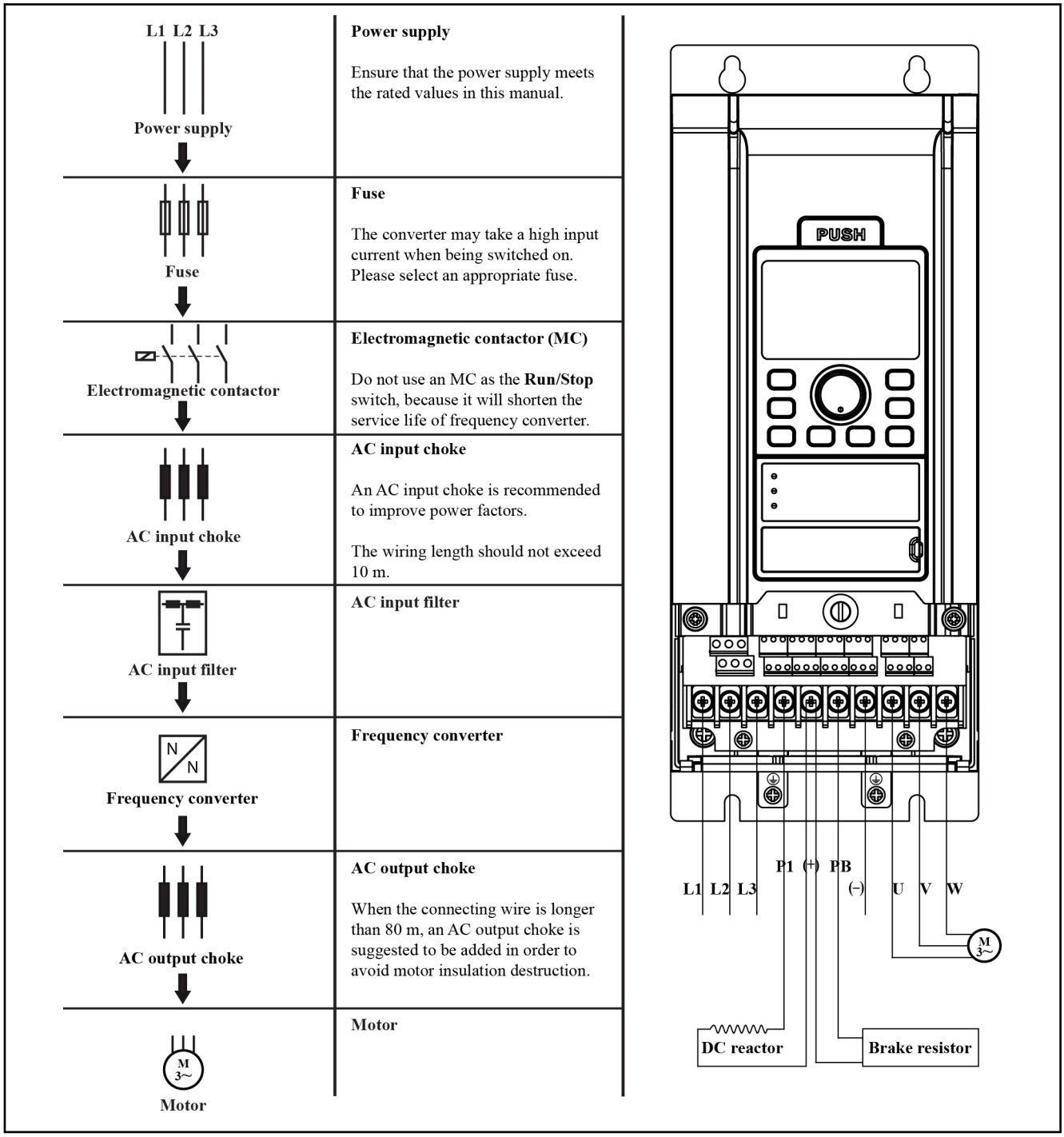


Fig. 5-7: Main circuit wiring diagram

To select an appropriate fuse, please refer to chapter 5.2.4 "Cable and Fuse Dimensions" on page 44.

Main circuit wiring steps

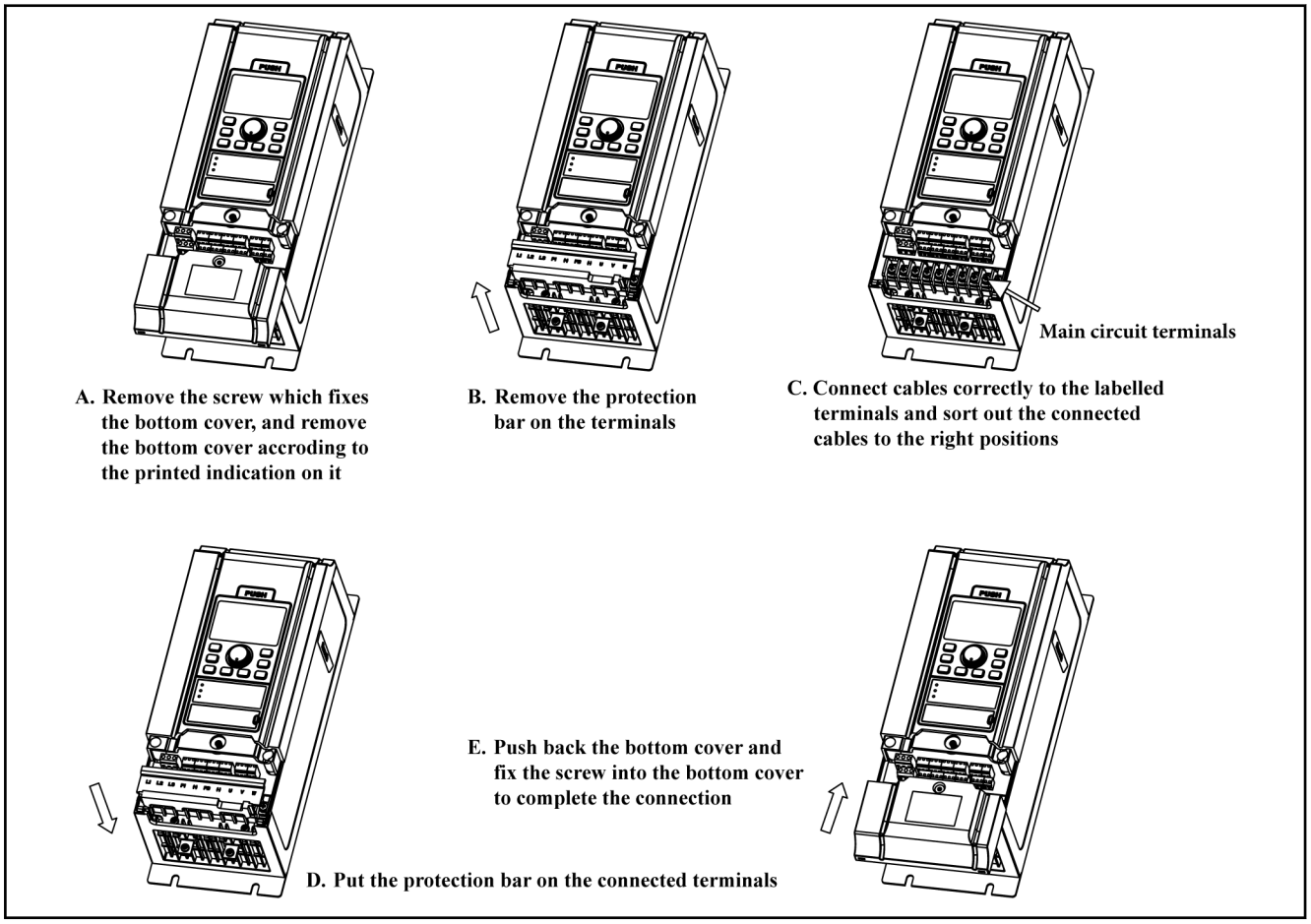


Fig. 5-8: 1K50 to 15K0 main circuit wiring steps

Installation

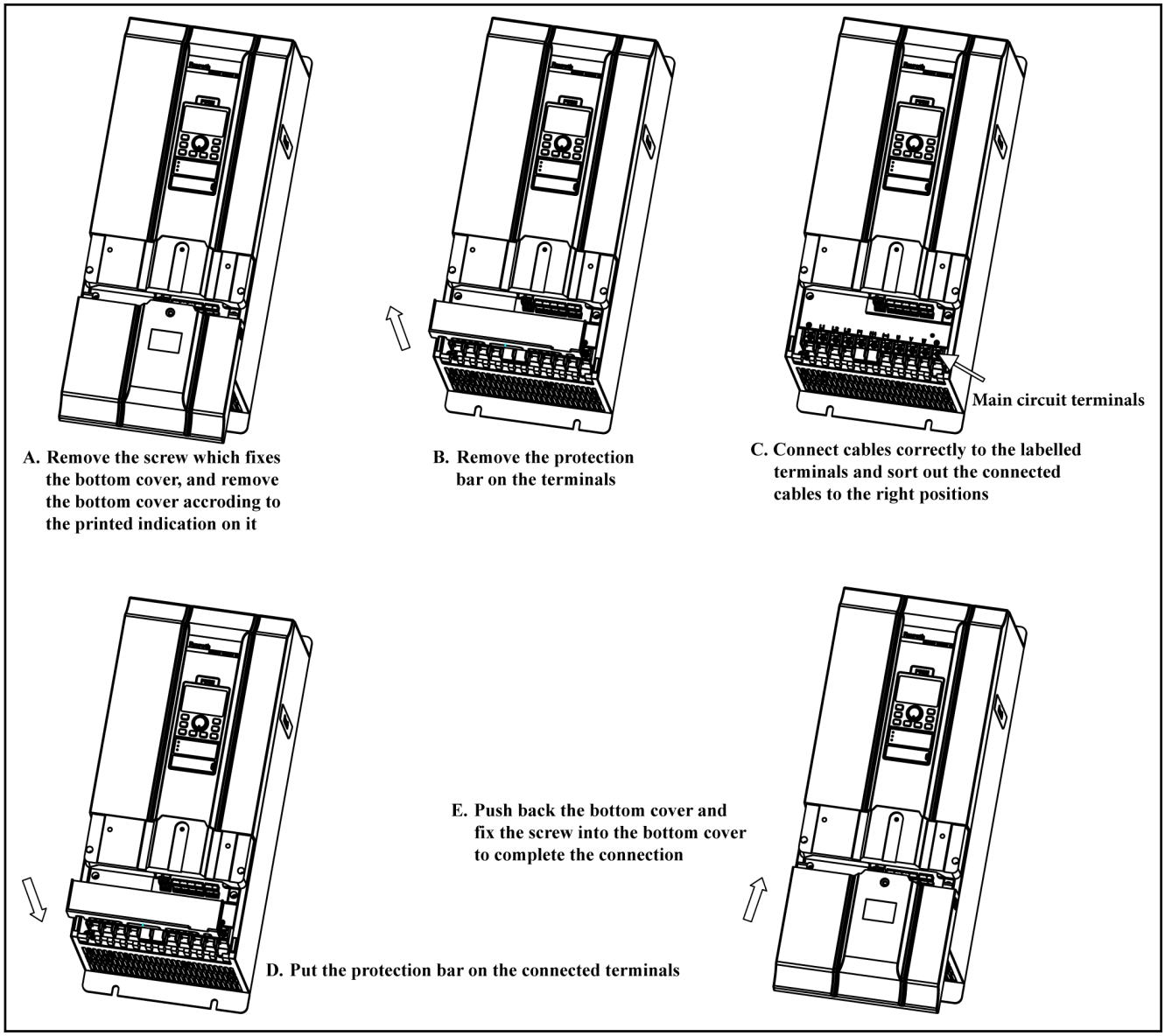


Fig. 5-9: 18K5 to 37K0 main circuit wiring steps

Fig. 5-10: 45K0 to 90K0 main circuit wiring steps

5.2.3 Control Circuit Wiring

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

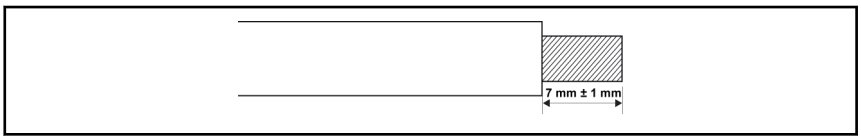


Fig. 5-11: Wire stripping length

- If a post terminal or single-conductor wire is used, the diameter should be less than 0.9 mm. If the diameter 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 °C).

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

☞ 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.

Cable specification for international without USA / Canada

- **ONLY USE** copper wires of 90 °C or above with XLPE or EPR insulation according to IEC 60364-5-52.
- It is recommended to use shielded cables to connect the motor.
- The specification is based on the supply voltage of 3P 380 VAC.
- For "Installation mode", see fig. 5-12 "Cable installation types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)" on page 47.

Model	Fuse	Power cables installation mode				PE	
		B1	B2	E	Torque / Screw	Cable size	Torque /Screw
	[A]	[mm²]	[mm²]	[mm²]	[Nm / lb-in] (Mx)	[mm²]	[Nm / lb-in] (Mx)
1K50	10	1.5	1.5	1.5	1.7 / 15 (M4)	10	1.7 / 15 (M4)
2K20	16	1.5	1.5	1.5	1.7 / 15 (M4)	10	1.7 / 15 (M4)
4K00	20	2.5	2.5	2.5	1.7 / 15 (M4)	10	1.7 / 15 (M4)
5K50	25	4	4	2.5	1.7 / 15 (M4)	10	1.7 / 15 (M4)
7K50	25	4	4	2.5	1.7 / 15 (M4)	10	1.7 / 15 (M4)
11K0	40	6	6	6	2.7 / 24 (M5)	10	2.0 / 18 (M5)
15K0	50	10	10	10	2.7 / 24 (M5)	10	2.0 / 18 (M5)
18K5	63	25	25	16	2.5 / 22 (M6)	16	2.5 / 22 (M6)
22K0	80	25	25	16	2.5 / 22 (M6)	16	2.5 / 22 (M6)
30K0	100	25	–	25	2.5 / 22 (M6)	16	2.5 / 22 (M6)
37K0	125	25	–	25	2.5 / 22 (M6)	16	2.5 / 22 (M6)
45K0	160	50	–	50	8 / 71 (M8)	25	8 / 71 (M8)
55K0	160	50	–	50	8 / 71 (M8)	25	8 / 71 (M8)
75K0	200	95 / 2*50	–	70 / 2*35	15-20 / 133-177 (M10)	50	15-20 / 133-177 (M10)
90K0	250	95 / 2*50	–	95 / 2*50	15-20 / 133-177 (M10)	50	15-20 / 133-177 (M10)

Tab. 5-1: Cable specification for international without USA / Canada

"–" indicates using cables of 105 °C or above with the same dimensions as those of installation mode B1.

Installation

Cable specification for USA / Canada

- **ONLY USE** copper wires of 75 °C or above according to UL 508C.
- It is recommended to use shielded cables to connect the motor.
- The specification is based on the supply voltage of 3P 380 VAC.
- The cables connecting to PE terminal should assemble the UL certificated wire connector which has suitable rating for wire gauge!

Model	Fuse	Power cables		PE	
		Cable size	Torque / Screw	Cable size	Torque / Screw
	[A]	[AWG]	[Nm / lb-in] (Mx)	[AWG]	[Nm / lb-in] (Mx)
1K50	10	14	1.7 / 15 (M4)	8	1.7 / 15 (M4)
2K20	15	14	1.7 / 15 (M4)	8	1.7 / 15 (M4)
4K00	20	12	1.7 / 15 (M4)	8	1.7 / 15 (M4)
5K50	30	10	1.7 / 15 (M4)	8	1.7 / 15 (M4)
7K50	40	10	1.7 / 15 (M4)	8	1.7 / 15 (M4)
11K0	50	6	2.7 / 24 (M5)	8	2.0 / 18 (M5)
15K0	60	4	2.7 / 24 (M5)	8	2.0 / 18 (M5)
18K5	80	4	2.5 / 22 (M6)	8	2.5 / 22 (M6)
22K0	80	4	2.5 / 22 (M6)	8	2.5 / 22 (M6)
30K0	100	2	2.5 / 22 (M6)	8	2.5 / 22 (M6)
37K0	125	2	2.5 / 22 (M6)	6	2.5 / 22 (M6)
45K0	150	1/0	8 / 71 (M8)	6	8 / 71 (M8)
55K0	175	1/0	8 / 71 (M8)	6	8 / 71 (M8)
75K0	225	4/0	15-20 / 133-177 (M10)	4	15-20 / 133-177 (M10)
90K0	250	4/0	15-20 / 133-177 (M10)	4	15-20 / 133-177 (M10)

Tab. 5-2: Cable specification for USA / Canada

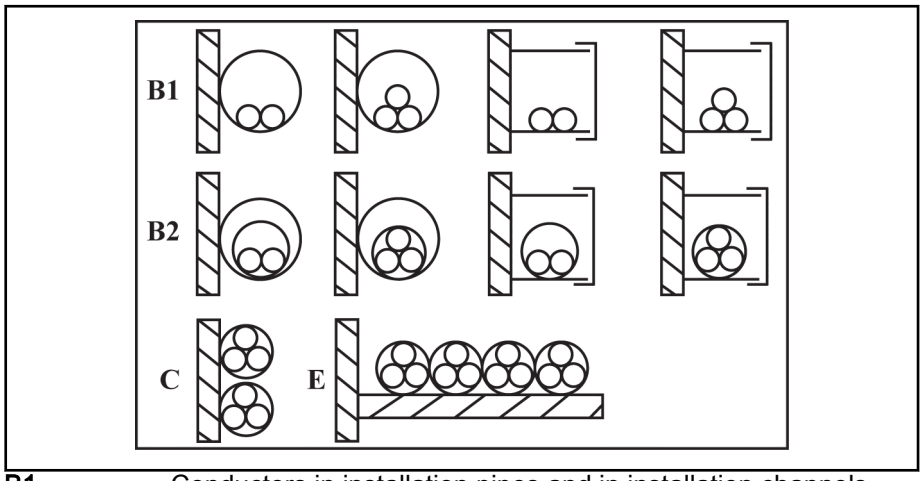
Dimensioning variables of the table values

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. 5-12: Cable installation types (cf. IEC 60364-5-52; DIN VDE 0298-4; EN 60204-1)

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

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

- **USA/Canada:** Class J; 600 V

Installation

Wiring dimensions for terminals

Model	Frame	Terminal type	Wiring size [AWG]
1K50	A	Main circuit terminals are shown as chapter "Main circuit terminals" on page 49	10 to 20
2K20 4K00 5K50 7K50	A B B B	Control circuit terminals are shown as chapter "Control circuit terminals" on page 53	16 to 26
11K0 15K0	C	Main circuit terminals are shown as chapter "Main circuit terminals" on page 49	4 to 10
		Control circuit terminals are shown as chapter "Control circuit terminals" on page 53	16 to 26
18K5	D	Main circuit terminals are shown as chapter "Main circuit terminals" on page 49	2 to 12
22K0 30K0 37K0	D E E	Control circuit terminals are shown as chapter "Control circuit terminals" on page 53	16 to 26
45K0 55K0	F	Main circuit terminals are shown as chapter "Main circuit terminals" on page 49	1 / 0 to 8
		Control circuit terminals are shown as chapter "Control circuit terminals" on page 53	16 to 26
75K0 90K0	G	Main circuit terminals are shown as chapter "Main circuit terminals" on page 49	4 to 4 / 0
		Control circuit terminals are shown as chapter "Control circuit terminals" on page 53	16 to 26

Tab. 5-3: 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 power supply inputs
U, V, W	Frequency converter outputs (to be connected to the motor)
PB	Reserved terminal for external brake resistor
P1, (+)	DC choke inputs or DC positive bus outputs
(-)	DC negative bus output
⏚	Grounding

Tab. 5-4: Main circuit terminals description

Main circuit terminals

1K50 to 15K0

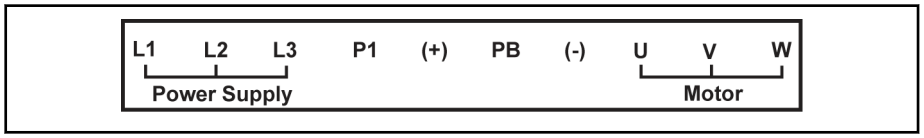


Fig. 5-13: Main circuit terminals illustration_1K50 to 15K0

18K5 and above

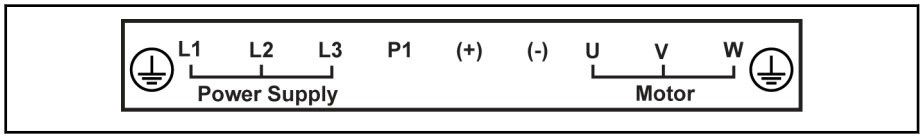


Fig. 5-14: Main circuit terminals illustration_18K5 and above

5.3.2 Control Circuit Terminals

Control circuit terminals description

Terminal	Signal function	Description	Signal requirement
Digital inputs			
FWD	Pump enable	Enabled: the pump can be driven by the frequency converter Disabled: the pump has no action	24 VDC 8 mA inputs via opto-electric couplers; Depends on the position of NPN/PNP jumper SW1
REV	Reserved	–	
X2, X4	Four pressure control data sets (set[0] to set[3]) selection	Multi-function selection according to E0.01 to E0.08	
X3	Error reset		
X5	Master/slave pump mode switch		
X7	Motor overheat (only for SvP 5010)		
X8	Brake chopper overheat		
X1, X6	Multi-function selection		
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)
VR1	Analog commands and feedback	For SvP 5010: Flow command input For FcP 5010: Motor overheat protection sensor or flow command input	Input voltage range: -10 to 10 V Input resistance: 100 kΩ Resolution: 1 /2,000
VR2		For SvP 5010: Pressure command input For FcP 5010: Pressure command or flow command input	Input voltage range: 0 to 10 V Input resistance: 100 kΩ Resolution: 1 /2,000
VR3		Analog pressure feedback input	
+I		Analog current frequency input	Input current range: 0 to 20 mA Input resistance:165 Ω Resolution: 1 /1,000
GND	Frame potential (0 V)	Isolated from COM	–
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		

Terminal	Signal function	Description	Signal requirement
DO-COM	Digital frequency output	Can be programmed as multiple function pulse outputs, see parameter E1.17	Open collector outputs via opto-couplers: Max. output frequency 50 kHz (set by E1.18); Max. output voltage: 24 VDC
Ta	Relay 1 changeover contacts	Programmable multi-function relay outputs, see parameter E4.11 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 2 changeover 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	Shared +24 VDC connection for digital output signals	–	Max. output current: 80 mA①
PGP1-COM	General DC +24 V supply	–	Max. output current: 100 mA (PGP2 is not used)
PGP2-COM (Switch JP5 to position 2-3)	General DC +12 V supply	–	Max. output current: 200 mA (PGP1 is not used)
Analog outputs			
FM1-GND	Analog multi-function output 1	Programmable analog output with multiple functions. See parameters E1.10 to E1.16	Output voltage / current can be set via JP3 for FM1and JP4 for FM2: Output voltage for FM1: -10 to 10 V Output voltage for FM2: 0 to 10 V Output current: 0 to 20 mA
FM2-GND	Analog multi-function output 2		
Encoder signals			
PGP2-COM Switch JP5 to position 1-2 (Factory default)	Supply voltage +5 V	Voltage supply for the encoder	Max. output current: 200 mA (PGP1 is not used)
A+	Encoder signal A	See chapter 5.3.5 "Encoder Signal Selection" on page 56	Encoder supply voltage of differential inputs: 5 V Max. input frequency: 200 kHz
A-			
B+	Encoder signal B		
B-			

Tab. 5-5: Control circuit terminals description

Installation

① indicates:

1. If digital inputs FWD, REV, X1 to X8 are used with internal power supply of +24 V, the maximum output current of the power supply is calculated as follows:

   I_{max} = 80 mA - 8 mA * N

   N: Number of used digital inputs

2. If neither of PGP1 and PGP2 are used, such as in FcP 5010 application, +24 V power supply can get an extra current output ability of 100 mA.

Control circuit terminals

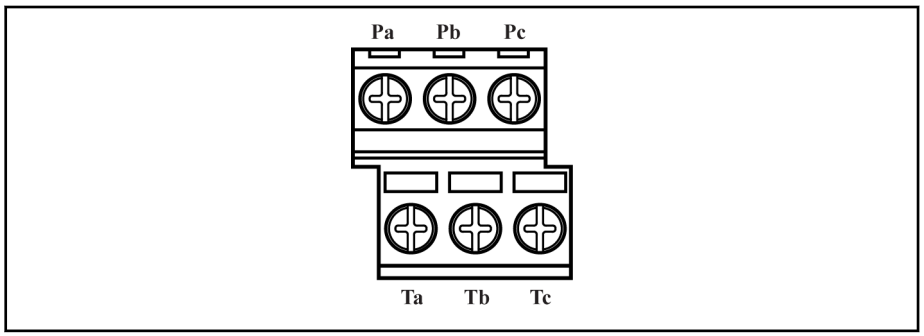


Fig. 5-15: Control circuit terminals_1

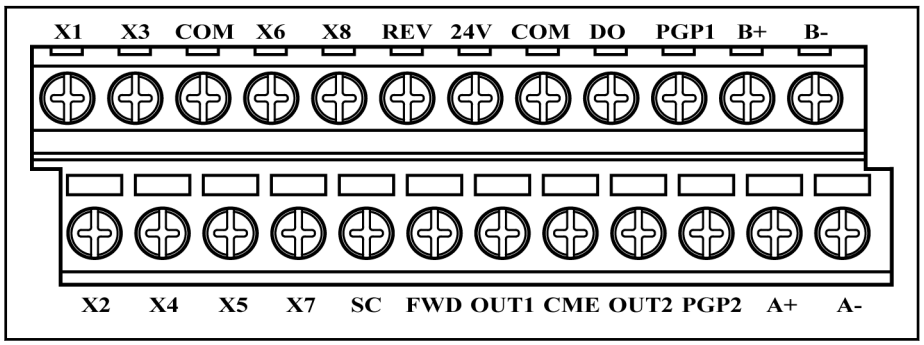


Fig. 5-16: Control circuit terminals_2

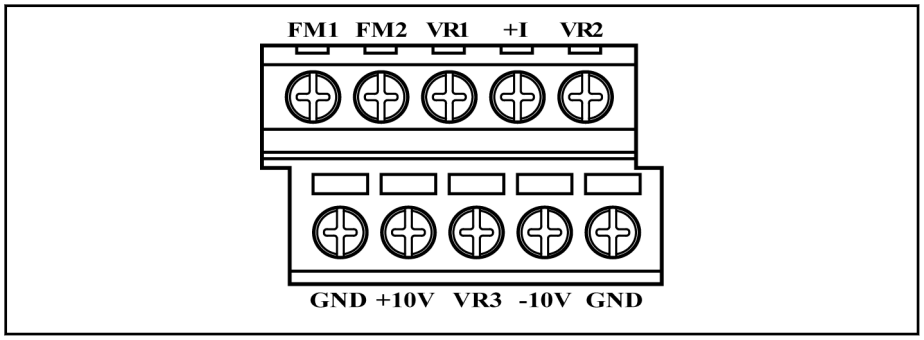


Fig. 5-17: Control circuit terminals_3

Installation

Analog input terminals (±10 V, VR1, VR2, VR3, GND, +I)

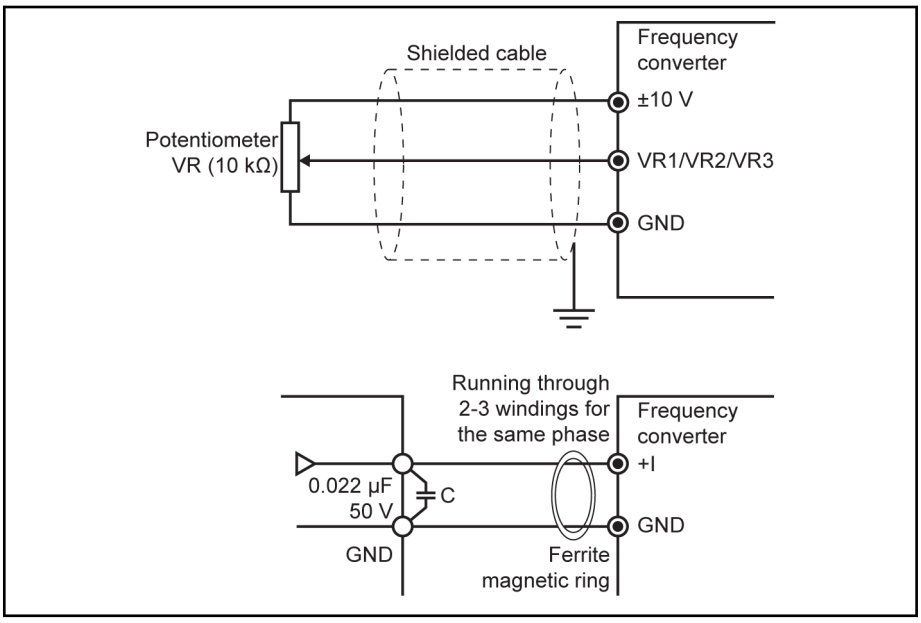


Fig. 5-18: Analog input terminals (±10 V, VR1, VR2, VR3, GND, +I)

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) and shielded cables must be used.
2. Incorrect operation may occur due to interference from the external analog signals output device or from the frequency converter. In such cases, connect a capacitor and ferrite core at the side of the external analog signals output device, as shown above.

5.3.3 Jumper Wiring

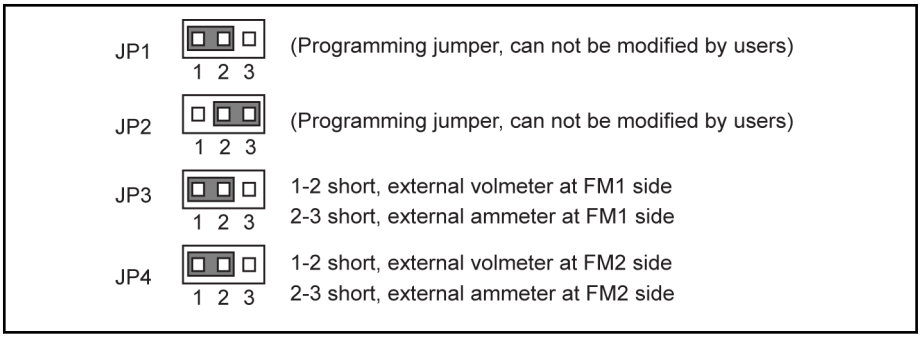


Fig. 5-19: Jumper description

Shown above are factory defaults.

5.3.4 NPN/PNP Jumper SW1

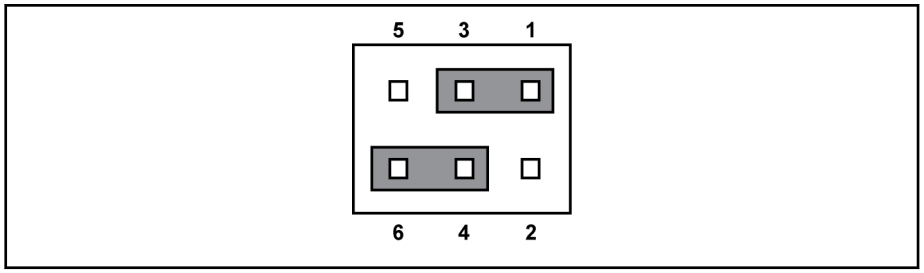


Fig. 5-20: NPN/PNP jumper SW1

The factory default is NPN (Jumper contact at 1-3, 4-6).

The jumper SW1 determines:

1. An internal or 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).

NPN/PNP 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.

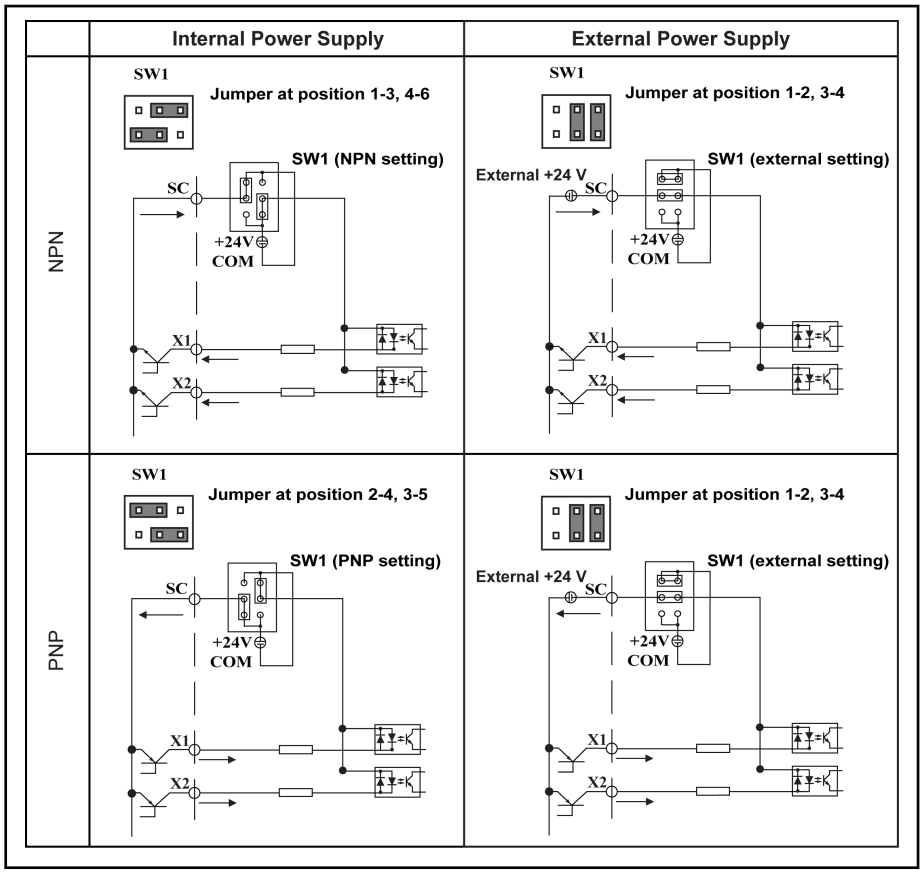


Fig. 5-21: NPN/PNP modes and signal inputs

Installation

5.3.5 Encoder Signal Selection

Fig. 5-22: Encoder jumper JP5

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

Encoder supply (+5 VDC) are set by jumper JP5:

Position 1-2: 5 V/200 mA encoder power supply is provided by PGP2-COM;

Position 2-3: 12 V/200 mA DC general power supply is provided by PGP2-COM.

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

Encoder power supply		Encoder signal	Fv for Sytronix terminal wiring		Reference
Supply option	Voltage		Encoder signal wire	Other connection	
Internal	PGP2 (5 V)	A, B	A-, B-	A+, B+ connected to PGP2	Wiring 1
		A+, A-, B+, B-	A+, A-, B+, B-	–	Wiring 2
External	5 V	A, B	A-, B-	A+, B+ connected to external power supply	Wiring 3
		A+, A-, B+, B-	A+, A-, B+, B-	–	Wiring 4

Tab. 5-6: Encoder wiring description

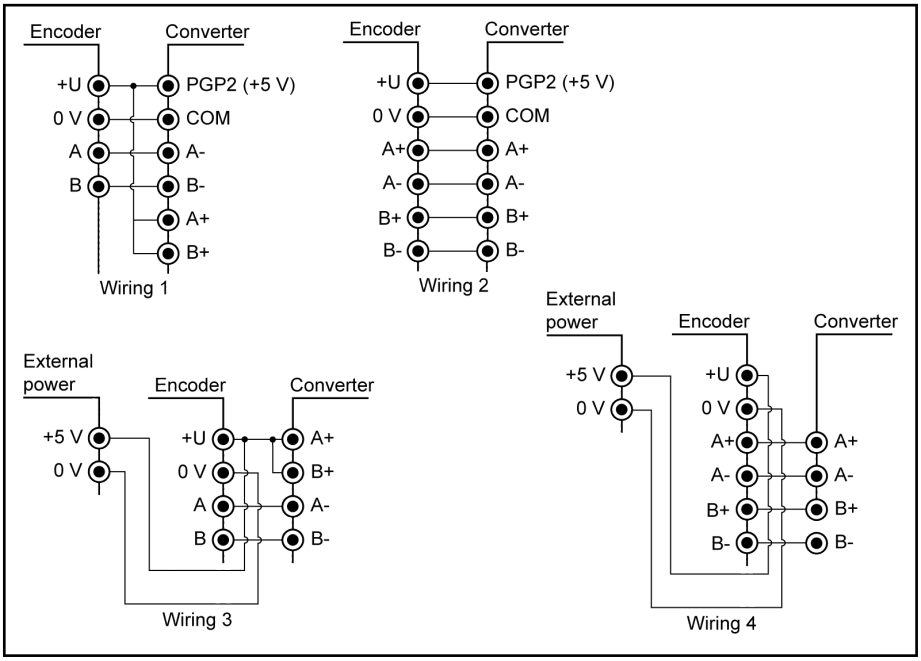


Fig. 5-23: Encoder wiring figure

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.

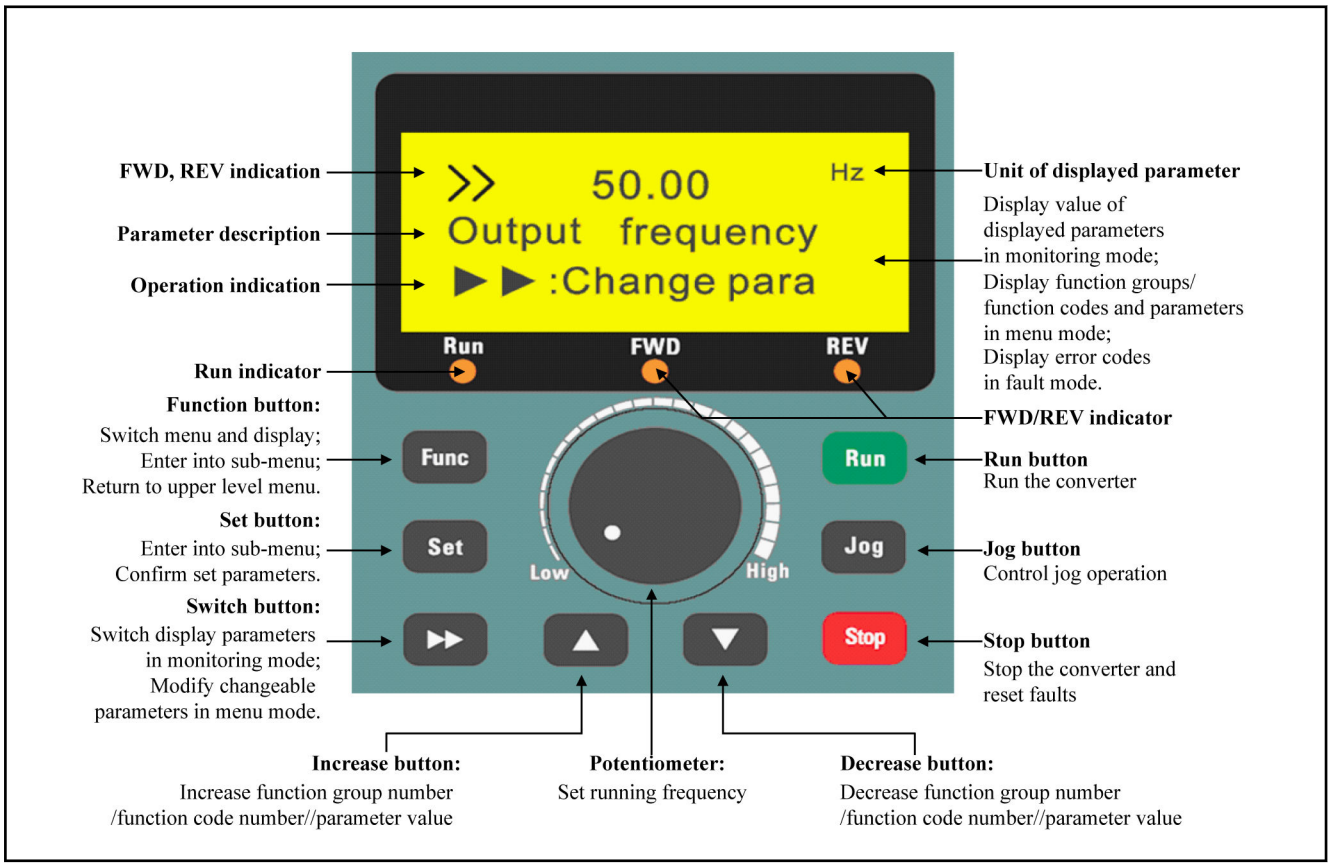


Fig. 6-1: Fv for Sytronix operating panel

Commissioning

6.1.2 3-Level Menu Structure

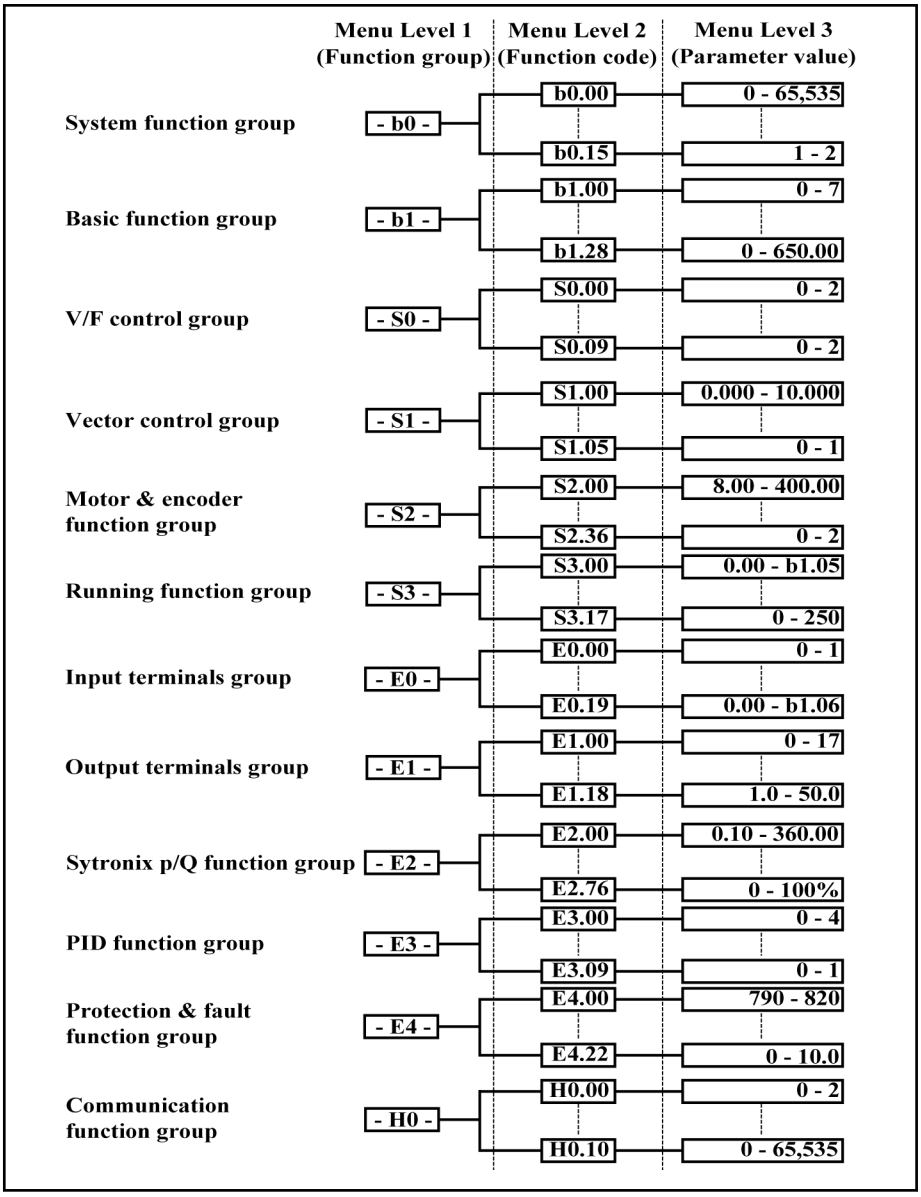


Fig. 6-2: 3-level menu structure

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

6.1.3 Operation Mode Description

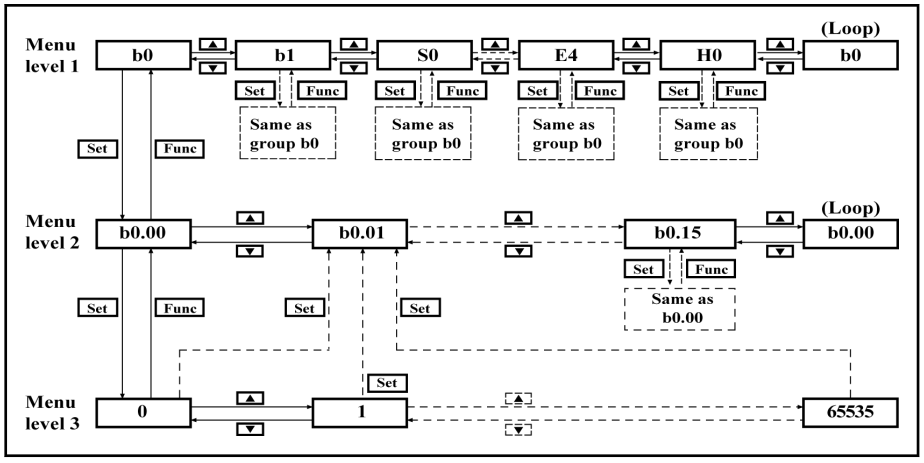


Fig. 6-3: Operation mode description

6.1.4 Example of Operating Panel Operation

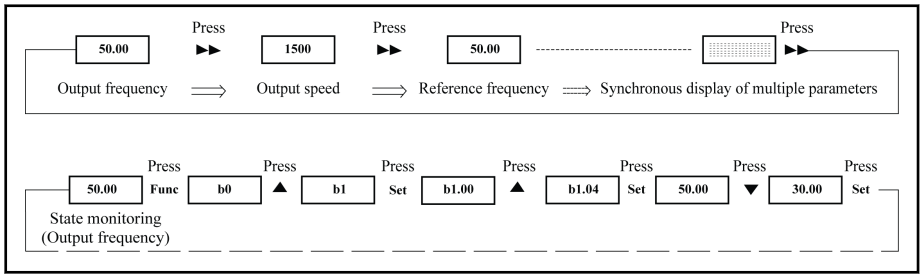


Fig. 6-4: Example of operating panel operation

6.2 Motor Commission

6.2.1 Check, Preparation and Commissioning

1. Ensure that the motor is not connected to any load.
2. Check if the wiring is correct, which includes the power supply (L1, L2, L3), the motor (U, V, W), the encoder (only for SvP 5010), brake chopper(s) and brake resistor(s). Particularly, ensure that the motor terminals U, V and W are not connected to the power supply, and ensure the ground terminal is well grounded.
3. Ensure that there are no short circuits between terminals, live terminals or short circuit to ground.
4. Ensure that terminal connections, connectors and screws are secure.
5. Check whether the motor overheat protection sensor is well connected. In SvP 5010 application, it should be connected to X7 terminal. While in FcP 5010, it should be connected to VR1 terminal.
6. 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.
7. Make the following checks after powering on:
   - Multiple parameters interface displays on panel without error indication. If "software doesn't match" is displayed, it indicates the software version of the operating panel does not match with that of the control board, for which you need consult the service.
   - The settings of the displayed parameters match with the field application.
8. The frequency converter is controlled by digital inputs by defaults. So in motor commission, one function code should be changed:

Code	Name	Factory default	New value
b1.02	Frequency converter control commands	1: Set control commands by digital inputs	0: Set control commands by operating panel

Please change b1.02 according to chapter 6.1.3 "Operation Mode Description" on page 59.

6.2.2 Notes on Commissioning

1. For SvP 5010 application, factory defaults of S2.00 to S2.09 (motor parameters) and S2.12 (pulses per revolution of pulse encoder) have been well set, so users do not need modify them again.
2. A frequency converter has no internal contactor for SvP system, and will be energized once the mains supply is connected. When the **<Run>** key is pressed down (or 'control by terminals' is activated), the frequency converter will generate output.
3. For FcP 5010 application, the default rotation direction of motor has been set to reverse ([3.14]=1:Reverse direction) in order to adapt to the pump's forward direction. Then the REV indicator on panel lights up to show the reverse direction of motor and forward direction of pump.

6.3 System Commission

For SvP 5010, after the successful motor commissioning, please perform the following operations in sequence:

<table>
<tr><th>SN.</th><th>Operation</th><th colspan="4">Note</th></tr>
<tr><td>1</td><td>Couple the motor with pump appropriately</td><td colspan="4">Ensure that the power is switched off</td></tr>
<tr><td>2</td><td>Connect control and feedback signals with frequency converter correctly①</td><td colspan="4">Key signals/terminals include Pump enable / FWD, Parameter Set1 / X2, Parameter Set2 / X4, Reset error / X3, Motor overheat input / X7, Brake chopper overheat input / X8, Flow command / VR1, Pressure command / VR2, Pressure feedback / VR3</td></tr>
<tr><td>3</td><td>Power on and restore parameters to SvP default setting</td><td colspan="4">To prevent the parameters are modified artificially before system's first operation, b0.02 should be set to '1: Restore SvP parameters to factory default'</td></tr>
<tr><td rowspan="7">4</td><td rowspan="7">Run the system</td><td colspan="4">4 sets of p/Q PID parameters are available in group E2. The activation of these parameters are decided by the binary logic of two-digital-input group (X2 and X4 by default) or by communication.② The activation of the p/Q PID parameters should be based on machine sizes and/or axes:</td></tr>
<tr><td>Digital input X2</td><td>Digital input X4</td><td>Data set</td><td>System volume</td></tr>
<tr><td>Inactive</td><td>Inactive</td><td>Set[0]</td><td><2L</td></tr>
<tr><td>Active</td><td>Inactive</td><td>Set[1]</td><td>2L to 4L</td></tr>
<tr><td>Inactive</td><td>Active</td><td>Set[2]</td><td>4L to 6L</td></tr>
<tr><td>Active</td><td>Active</td><td>Set[3]</td><td>>6L</td></tr>
<tr><td colspan="4">Active: switch on; Inactive: switch off</td></tr>
<tr><td>5</td><td>System optimization</td><td colspan="4">Adjust the parameters in group E2 properly to optimize the system operating performance</td></tr>
</table>

For FcP 5010, after the successful motor commissioning, please perform the following operations in sequence:

SN.	Operation	Note
1	Couple the motor with pump appropriately	Ensure that the power is switched off
2	Connect control and feedback signals with frequency converter correctly③	Key signals/terminals include Pump enable / FWD, Parameter Set1 / X2, Parameter Set2 / X4, Reset error / X3, Motor overheat input / VR1, Brake chopper overheat input / X8, Pressure or flow command / VR2, Pressure feedback / VR3
3	Power on and restore parameters to FcP default setting	To prevent parameters being modified artificially before system's first operation, b0.02 should be set to '2: Restore FcP parameters to factory default'. The parameters of MOT-FC motor which matches the frequency converter on power have been well set. To be safe, the defaults of pressure control parameters such as setting pressure, setting flow, p/Q PID parameters and deceleration time are set conservatively. So users need to optimize the pressure control parameters
4	Run the system	Check the motor rotation direction and pressure response
5	System optimization	Adjust the parameter values of b1, E0 and E2 group to optimize the system operating performance

Commissioning

①: See fig. 5-5 "Block diagram_SvP" on page 37.

②: For two-point pump ([S2.31]=1) or double pump ([S2.31]=2), p/Q PID parameters can not be selected artificially. The frequency converter can choose set 1 or set 2 as the p/Q PID parameters automatically according to pump control logic.

③: See fig. 5-6 "Block diagram_FcP" on page 38.

6.4 Master/Slave Pump Application Commission

6.4.1 Overview of Master/Slave Pump Function

Master/Slave pump function is designed for multi-pumps working as a group to achieve a larger flow. In this application, a master pump is needed to control the speed/flow, startup, stop and errors of slave pumps.

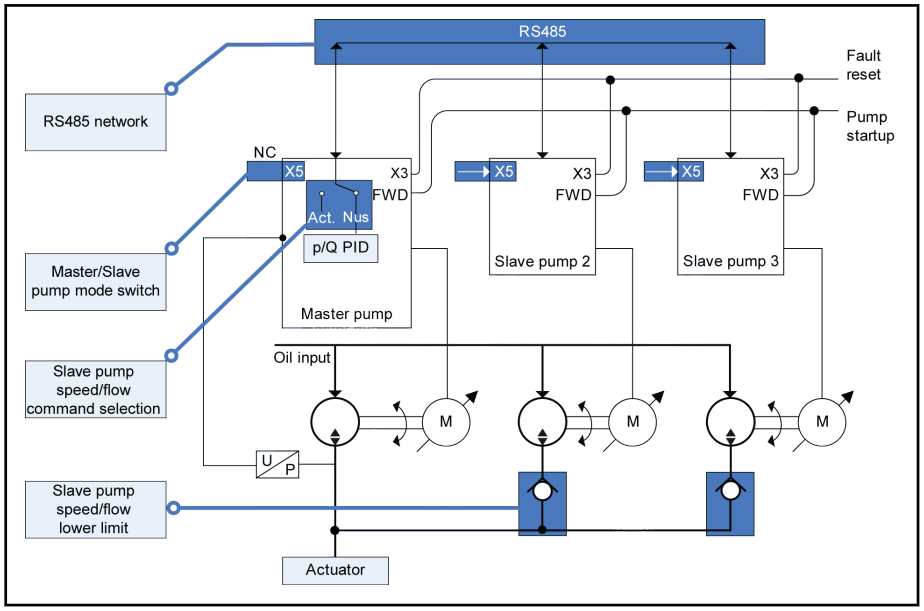


Fig. 6-5: Master/slave function

RS485 network

Used to transfer data between the master and slave pumps. Only one master pump and at most 19 slave pumps are supported.

Master/Slave pump mode switch

This function is only active for slave pumps. In master pump mode, slave pumps work independently. In slave pump mode, slave pumps follow the speed/flow command from master pump. Master/salve pump mode can be switched by digital inputs (X5 by default). When switching occurs, parameter E2.65 'M/S switch delay' is used to configure the waiting time of reversing action of valve.

Slave pump speed/flow command selection

Whether the actual speed/flow or p/Q speed/flow reference of the master pump is selected as the speed/flow command for slave pumps depends on parameter E2.63 'Slave speed/flow command selection'.

Slave pump speed/flow lower limit

If a check valve is used for slave pumps, parameter E2.64 'speed/flow command lower limit' needs to be set properly to avoid reversing action of pumps and low speed/flow.

Error process

If error occurs in one pump no matter master or slave, other pumps normally working will stop running automatically.

If b1.02 Frequency converter control commands of one slave pump is set to '0: Set control commands by operating panel', then when other pumps get errors, this pump can not stop automatically but continues to run mistakenly. In order to avoid this situation, make sure that b1.02 of all slave pumps are set to '1: Set control commands by digital inputs' before running.

6.4.2 Wiring of Master/Slave Pump Application

Example: 1 master pump and 2 slave pumps are connected in the Master/Slave application. Slave pump 1 always works in slave pump mode, so it is unnecessary to connect digital input X5 (NPN mode). While for slave pump 2, when the activation relay for digital input X5 is switched off, it works in slave pump mode; when the relay is switched on, it works in master pump mode.

The wiring figure is shown as below:

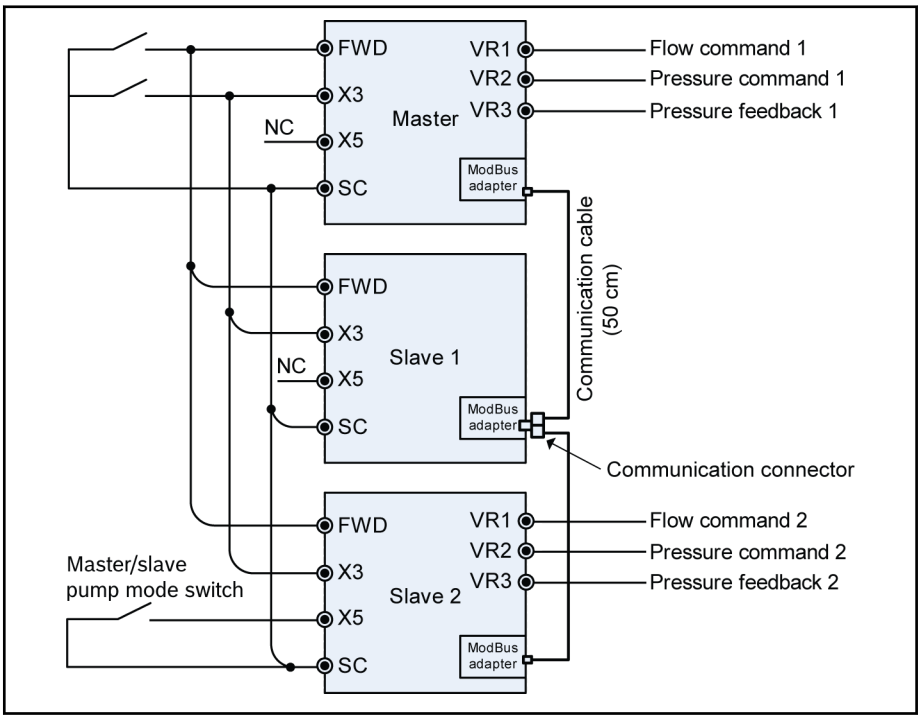


Fig. 6-6: Wiring of Master/slave pump application

6.4.3 Commissioning

For a master/slave pump application, the system commission should be conducted firstly, then the master/slave commission, as shown below:

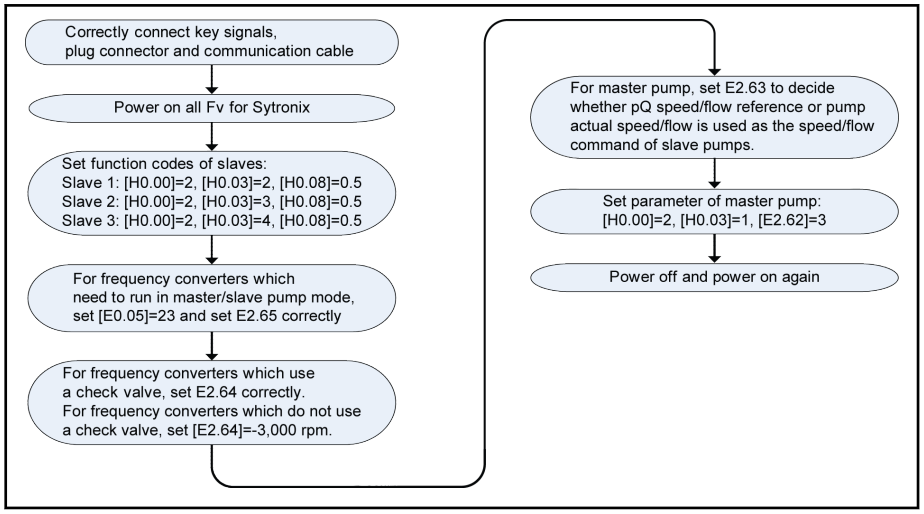


Fig. 6-7: Master/Slave commissioning

6.5 Restore Parameters to Factory Defaults

If the frequency converter fails to run the motor due to wrong parameter settings, a simple solution is to initialize the parameters to factory defaults. For SvP 5010, set [b0.02]='1:Restore SvP parameters to factory default'. For FcP 5010, set [b0.02]='2:Restore FcP parameters to factory default'.

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

6.6 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
Pressure sensor error (P.S.F.)	• Check the pressure sensor and signal interference on sensor lines. • Check the rotation direction of motor. If it's not expected, adjust S3.14 or change the sequence of any two phases of U, V and W to change motor direction. • Adjust E4.07 to E4.10 according to specific application.
The motor vibrates and runs in uncertain directions after each starting	One phase of U, V and W is disconnected (output phase loss)
Master/slave pump communication error (M/S C.)	• Check if [E2.62] is bigger than the actual slave pump number • Check if two or more frequency converters have the same address (H0.03) • Check if the communication cables are well connected • Reset master/slave pump system by digital inputs (X3 by default)

Tab. 6-1: Simple errors and respective solutions

6.7 Notes on Frequent Start and Stop

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

7 Parameter Settings

7.1 Main Functions

7.1.1 Control Command

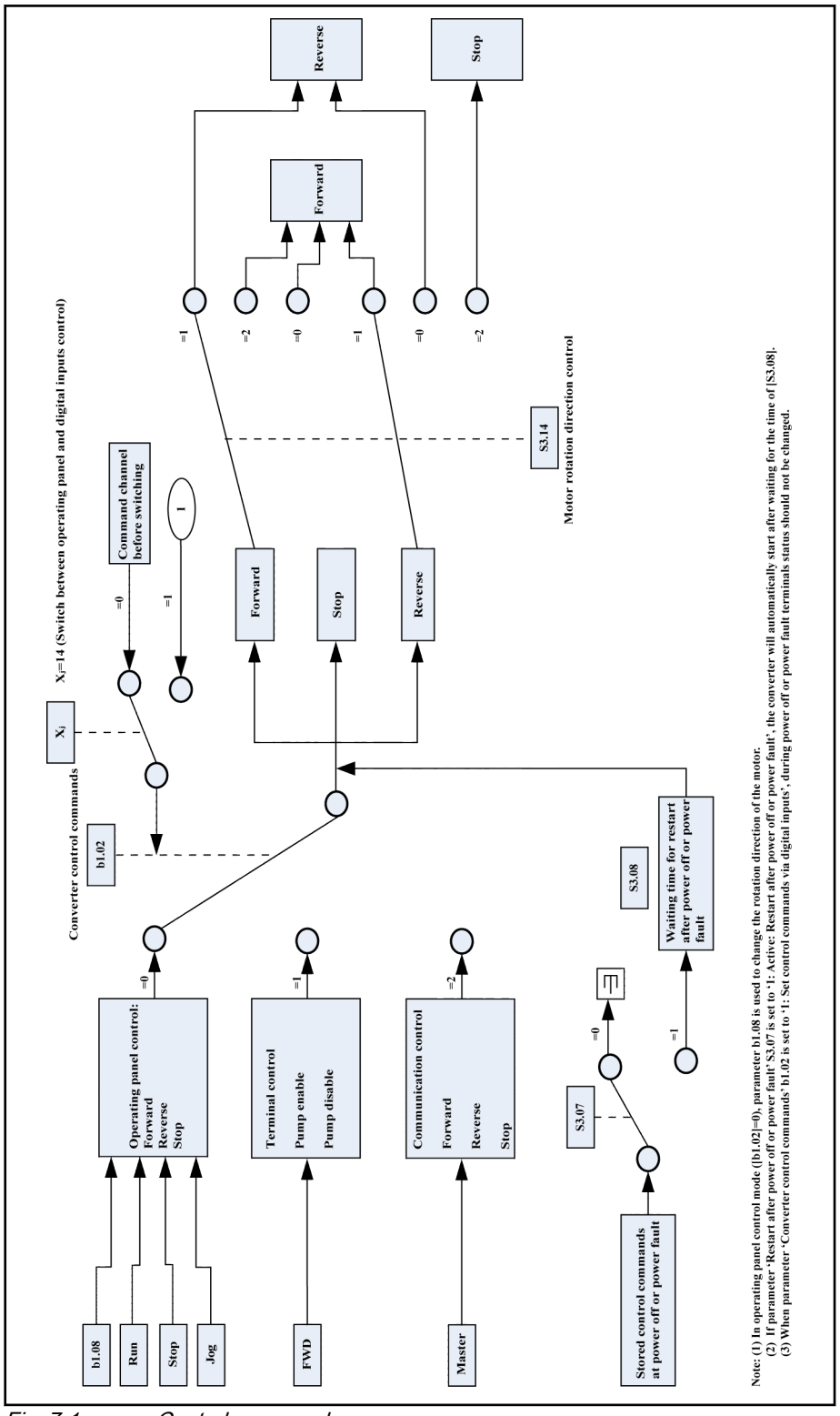


Fig. 7-1: Control command

Parameter Settings

7.1.2 Frequency Setting

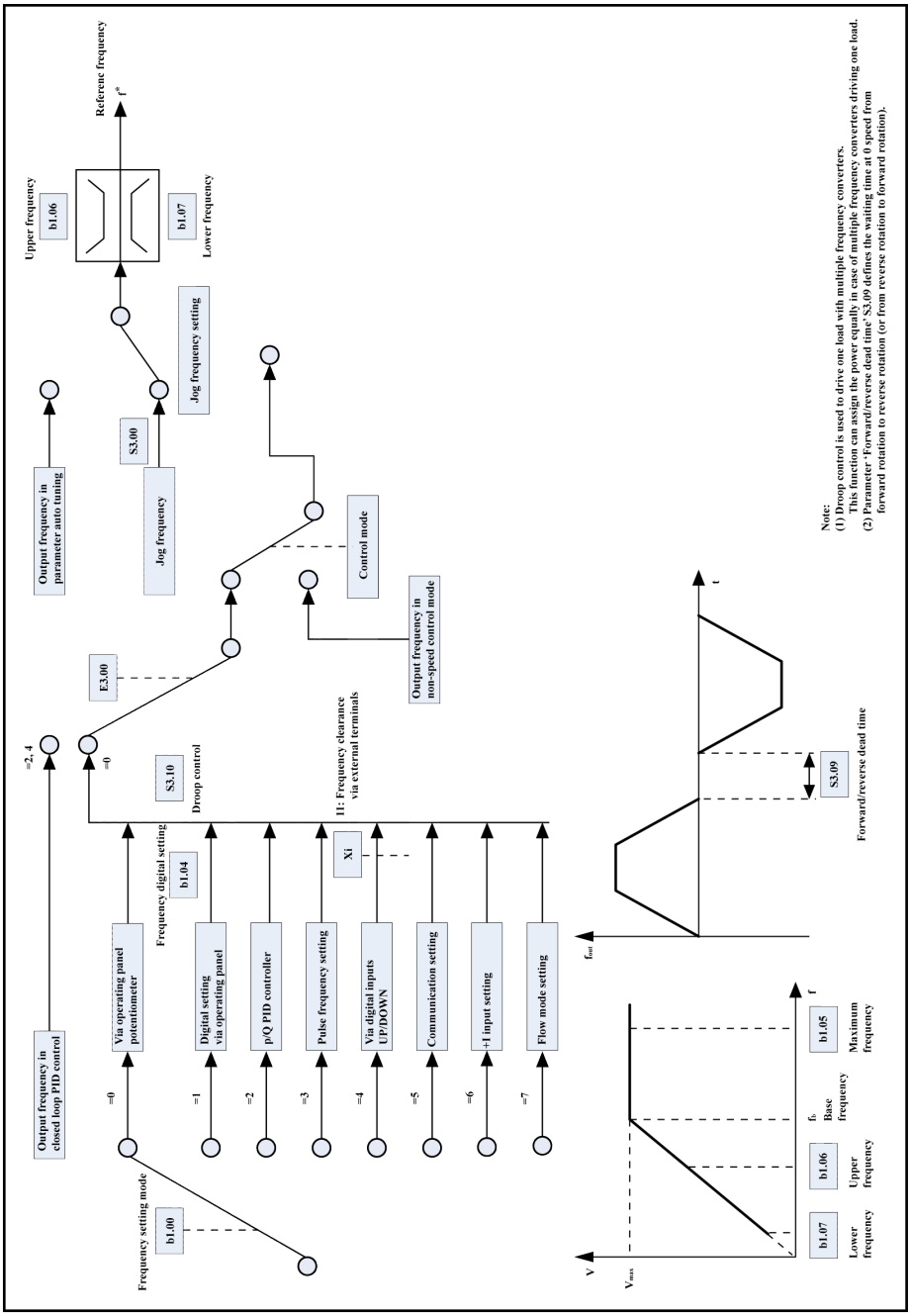


Fig. 7-2: Frequency setting

7.1.3 p/Q PID Control

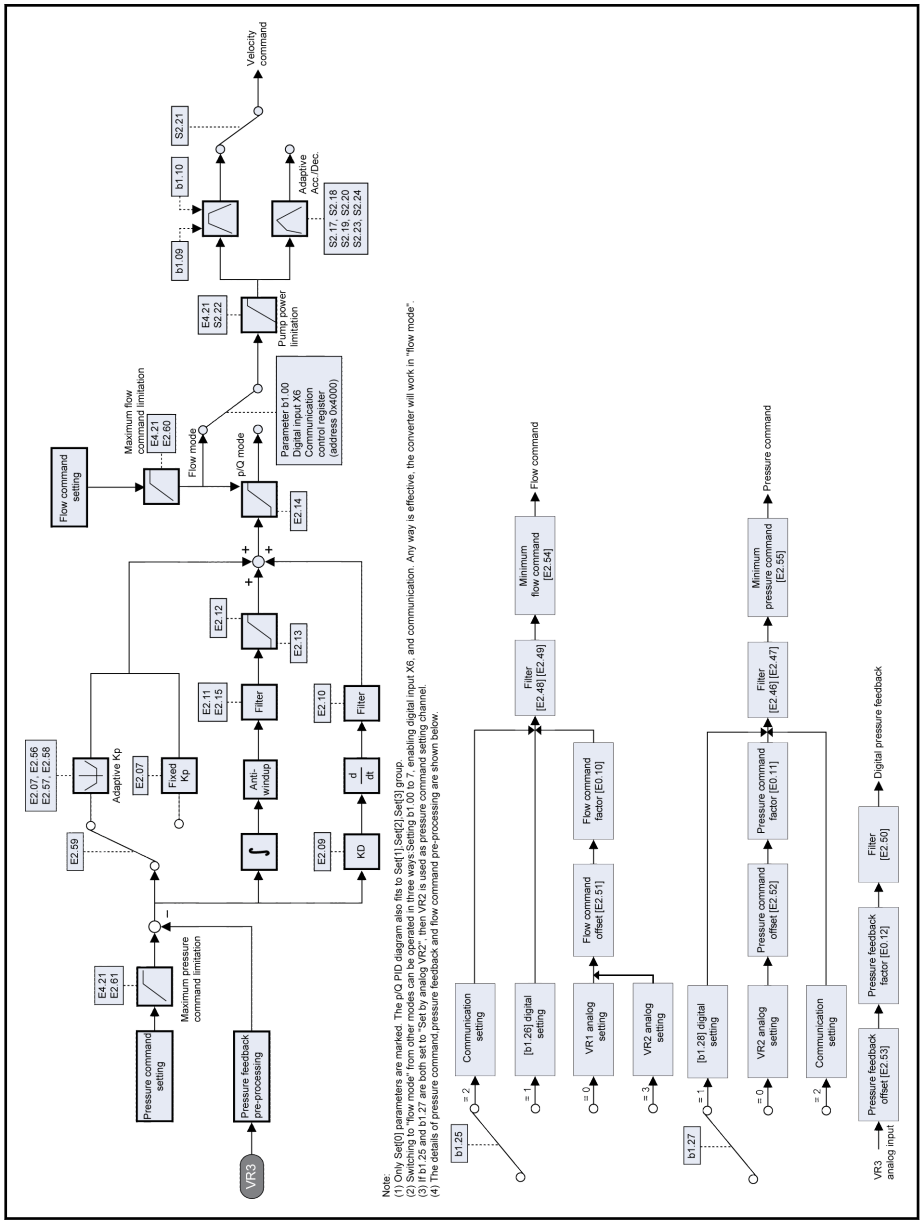


Fig. 7-3: p/Q PID control

Parameter Settings

7.1.4 Start Control

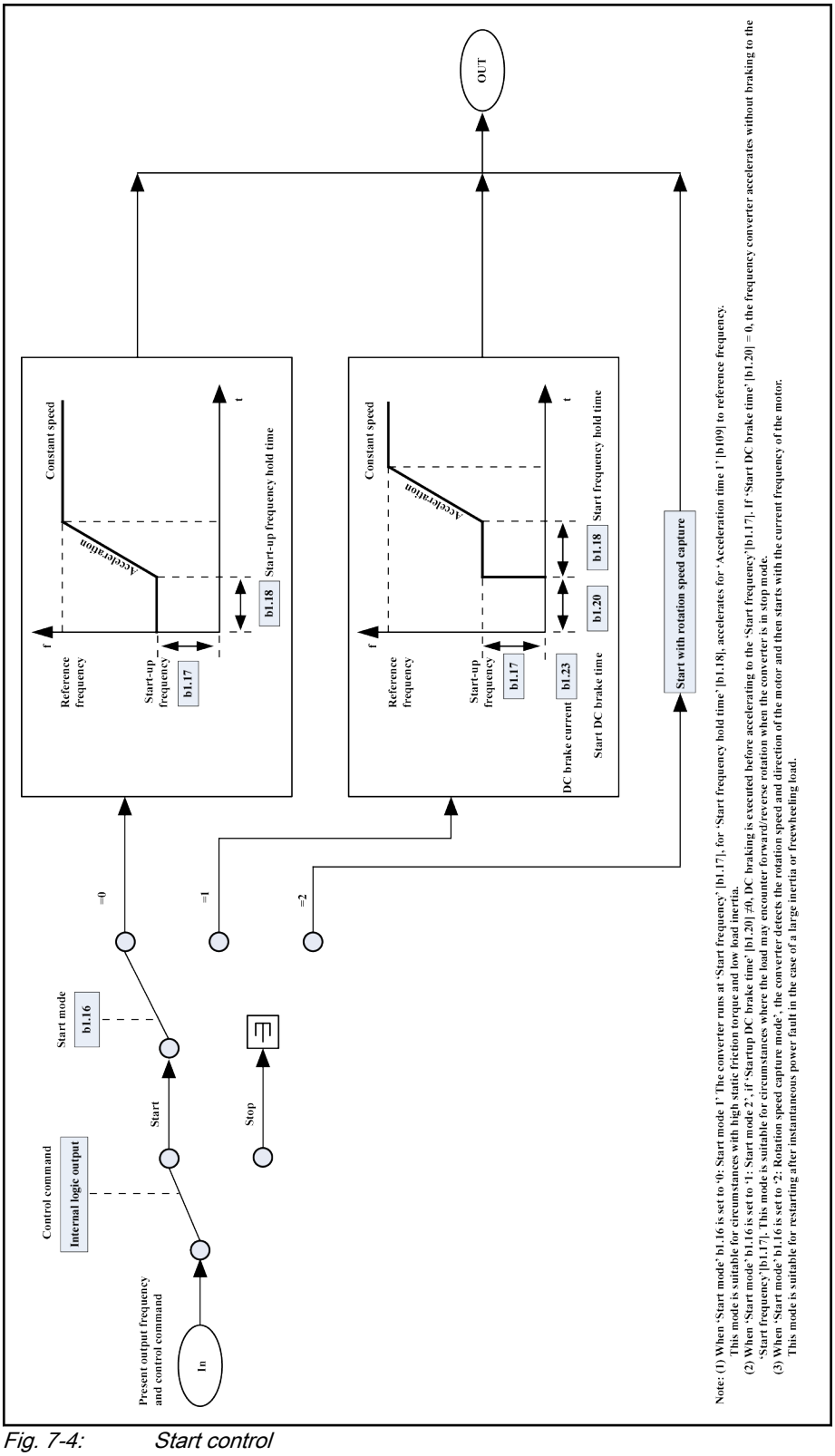


Fig. 7-4: Start control

7.1.5 Stop Control

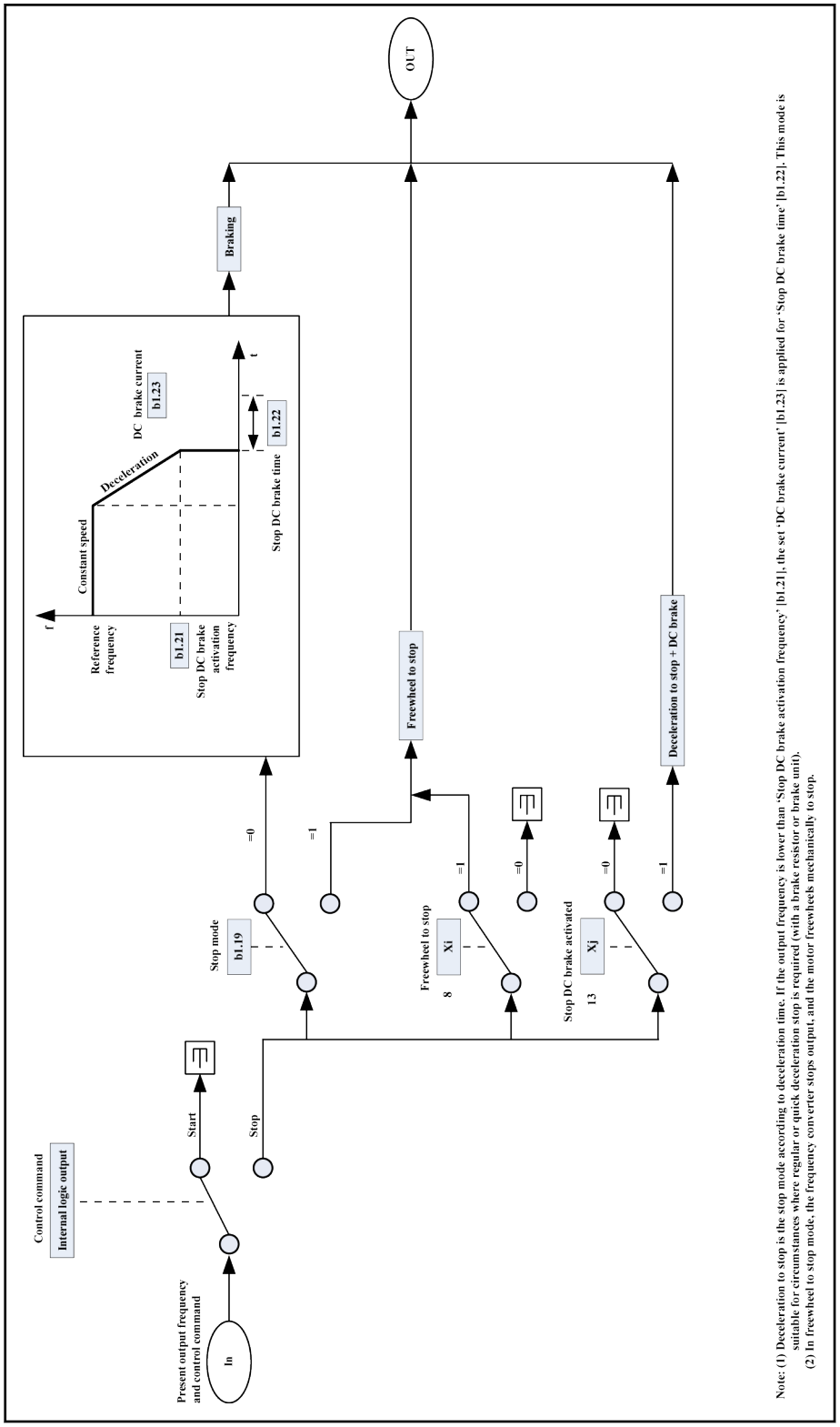


Fig. 7-5: Stop control

Parameter Settings

7.1.6 Linear/S-curve Acceleration/Deceleration

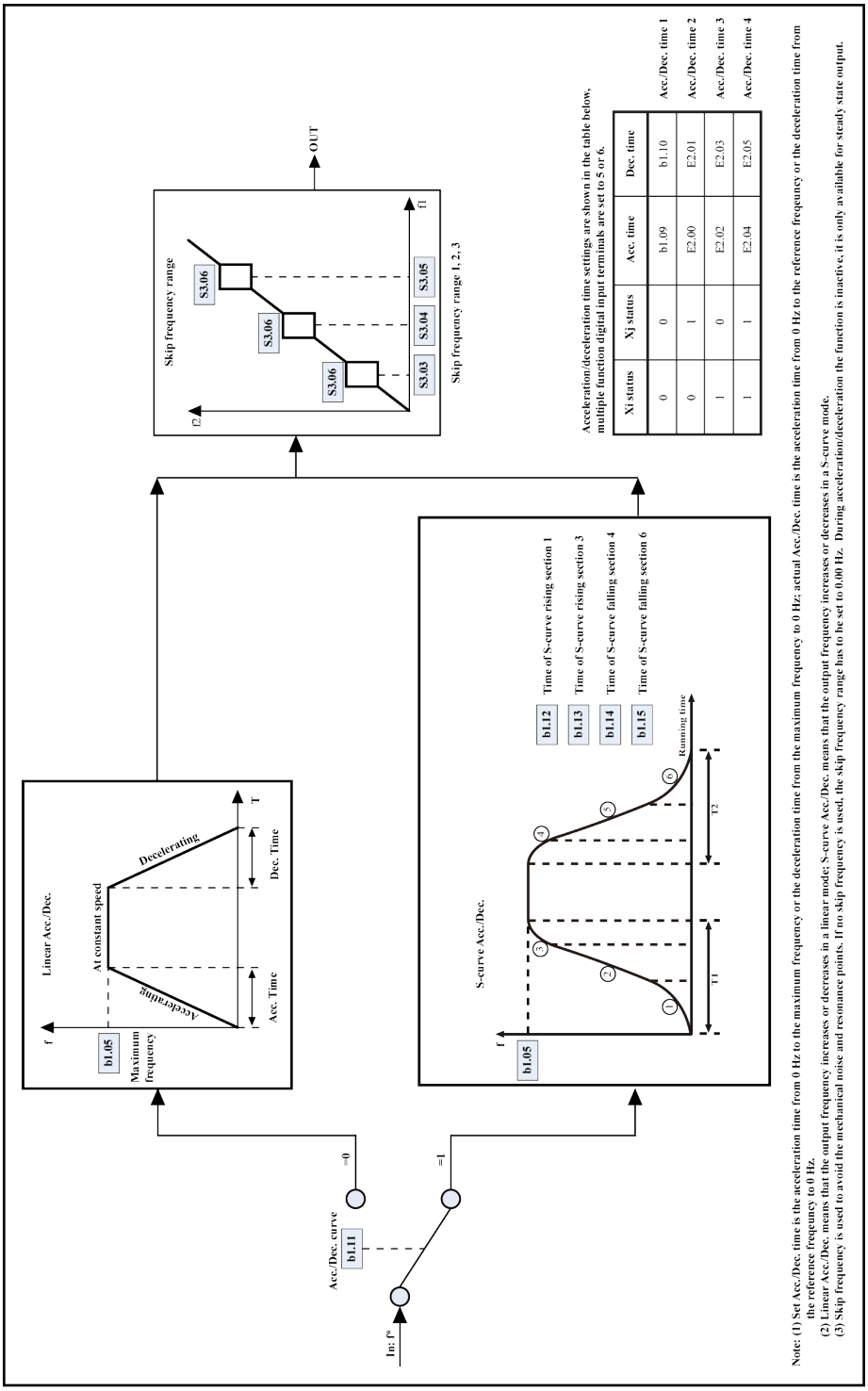


Fig. 7-6: Linear/S-curve acceleration/deceleration

7.1.7 PID Control

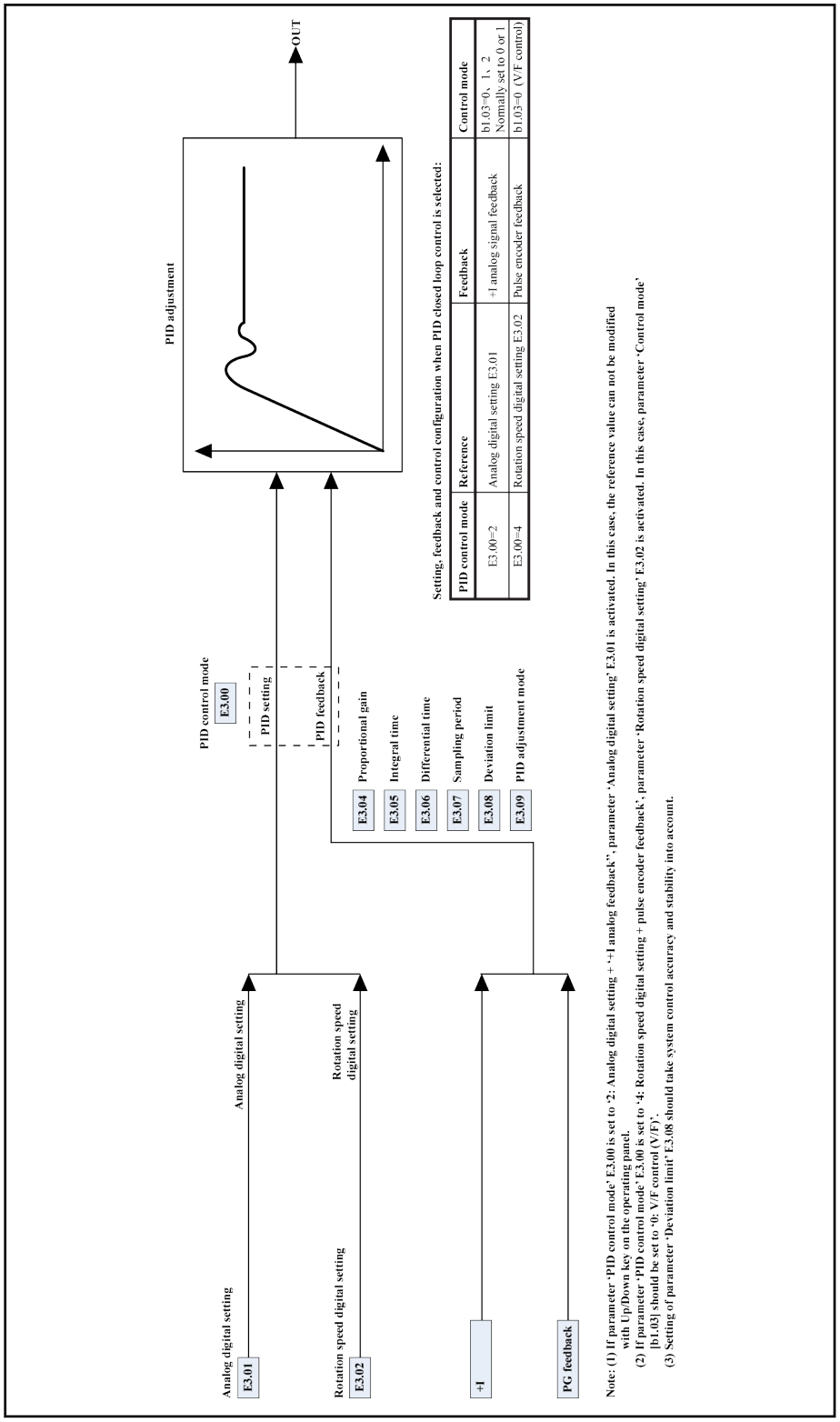


Fig. 7-7: PID control

Parameter Settings

7.1.8 Frequency Setting by +I and Pulse Inputs

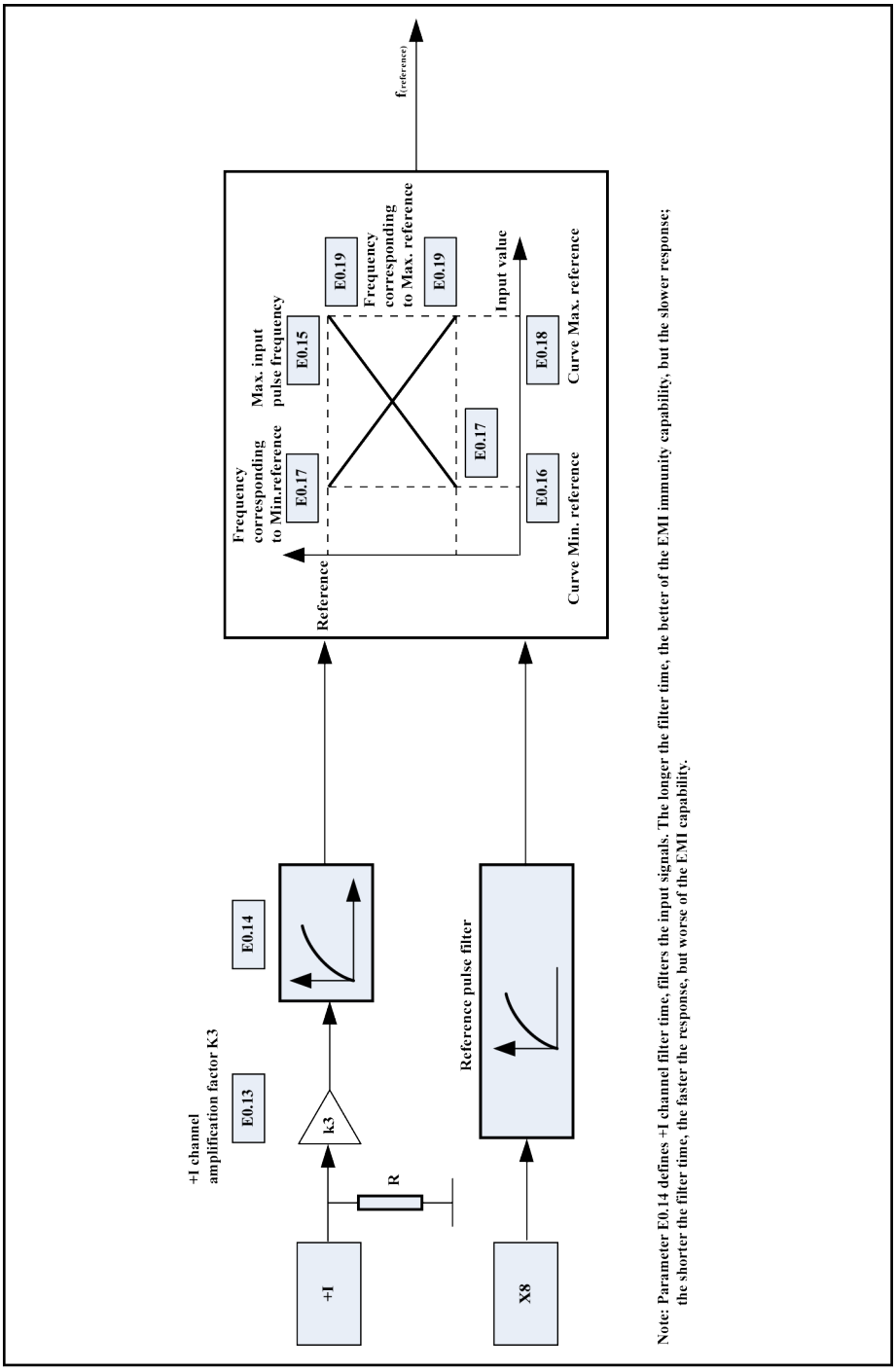
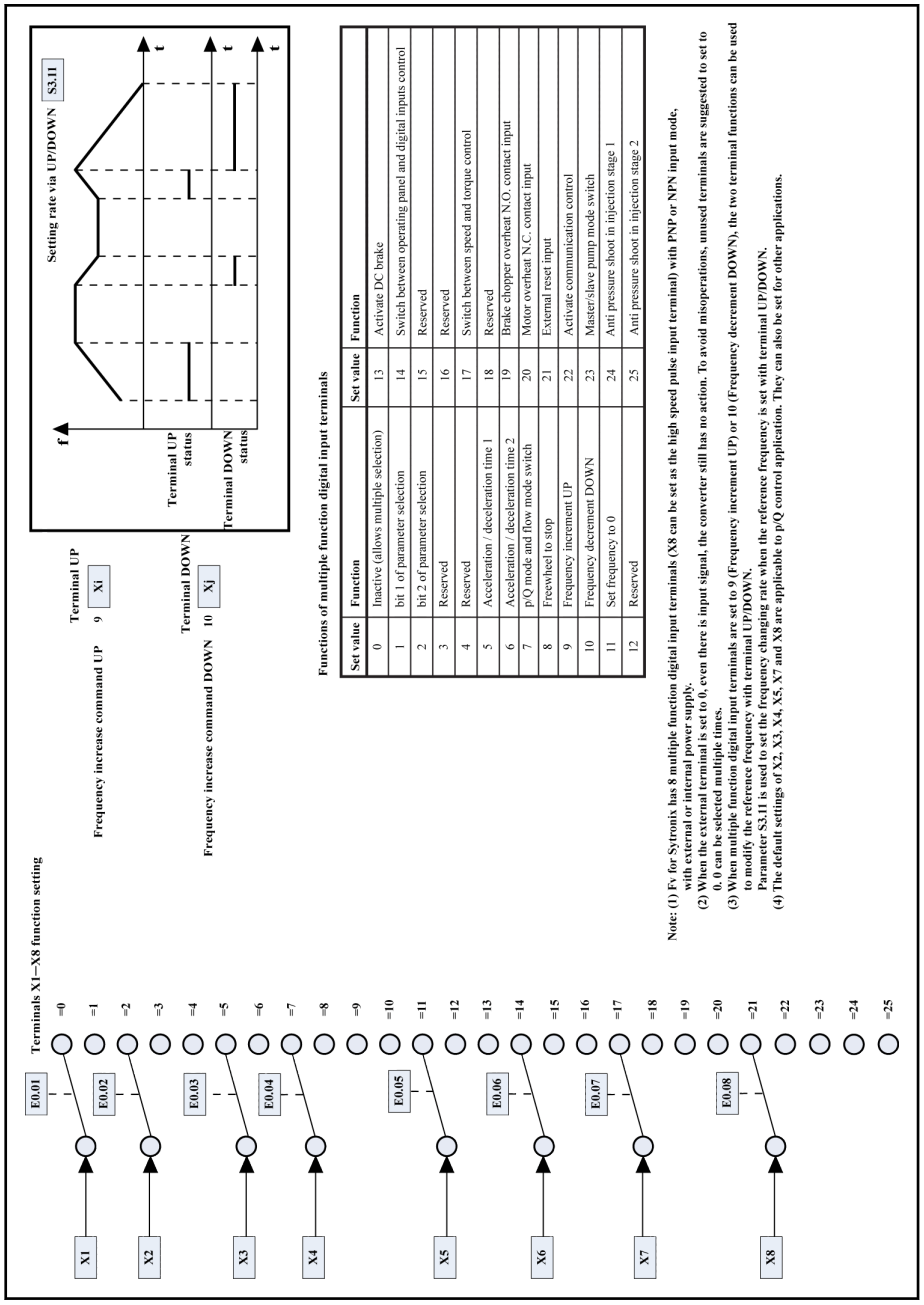


Fig. 7-8: Frequency setting by +I and pulse inputs

7.1.9 Multiple Function Digital Inputs



Functions of multiple function digital input terminals

Set value	Function
0	Inactive (allows multiple selection)
1	bit 1 of parameter selection
2	bit 2 of parameter selection
3	Reserved
4	Reserved
5	Acceleration / deceleration time 1
6	Acceleration / deceleration time 2
7	p/Q mode and flow mode switch
8	Freewheel to stop
9	Frequency increment UP
10	Frequency decrement DOWN
11	Set frequency to 0
12	Reserved
13	Activate DC brake
14	Switch between operating panel and digital inputs control
15	Reserved
16	Reserved
17	Switch between speed and torque control
18	Reserved
19	Brake chopper overheat N.O. contact input
20	Motor overheat N.C. contact input
21	External reset input
22	Activate communication control
23	Master/slave pump mode switch
24	Anti pressure shoot in injection stage 1
25	Anti pressure shoot in injection stage 2

Note: (1) Fv for Sytronix has 8 multiple function digital input terminals (X8 can be set as the high speed pulse input terminal) with PNP or NPN input mode, with external or internal power supply.
(2) When the external terminal is set to 0, even there is input signal, the converter still has no action. To avoid misoperations, unused terminals are suggested to set to 0. 0 can be selected multiple times.
(3) When multiple function digital input terminals are set to 9 (Frequency increment UP) or 10 (Frequency decrement DOWN), the two terminal functions can be used to modify the reference frequency with terminal UP/DOWN.
Parameter S3.11 is used to set the frequency changing rate when the reference frequency is set with terminal UP/DOWN.
(4) The default settings of X2, X3, X4, X5, X7 and X8 are applicable to p/Q control application. They can also be set for other applications.

Fig. 7-9: Multiple function digital inputs

Parameter Settings

7.1.10 Analog Outputs

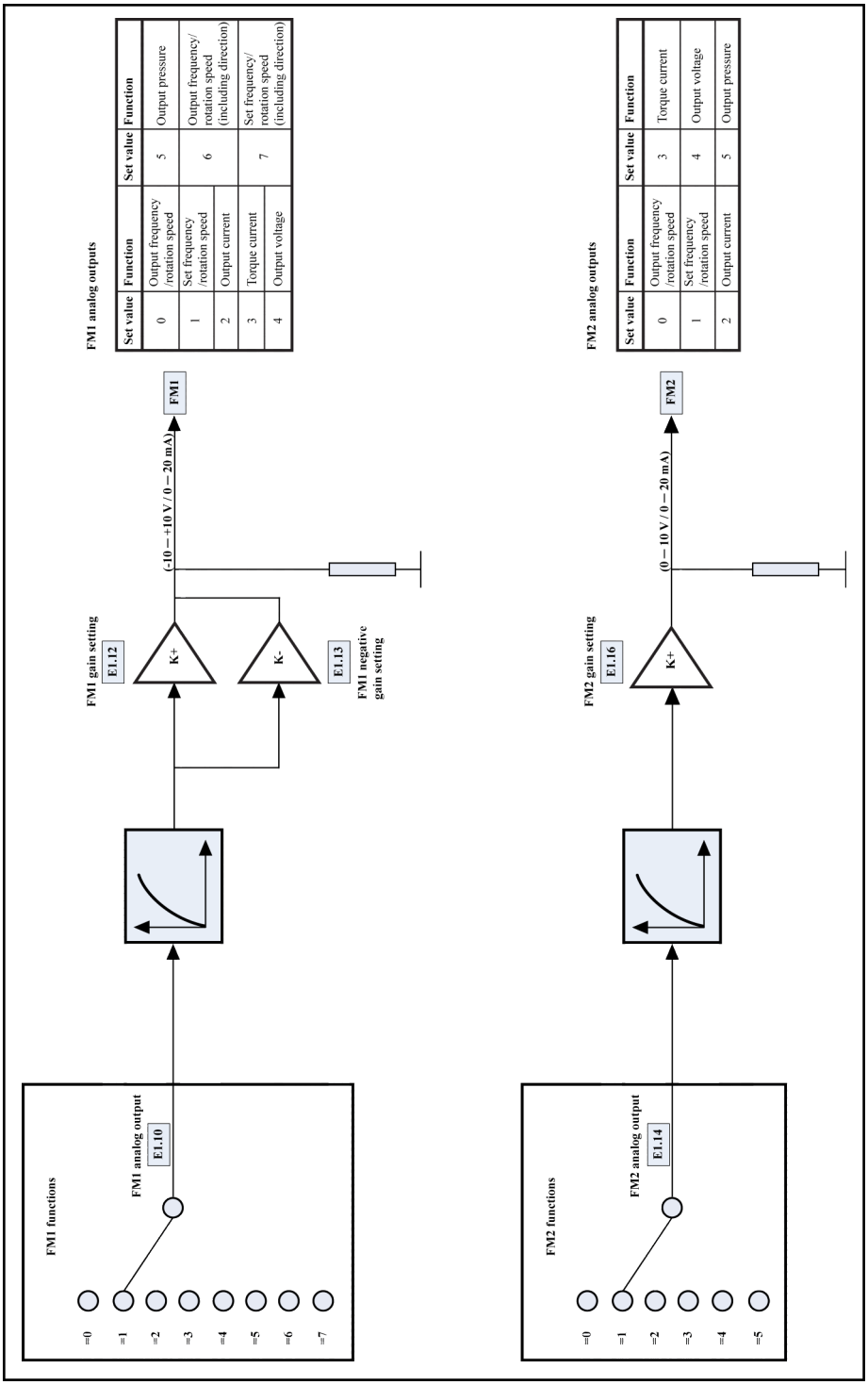


Fig. 7-10: Analog outputs

7.1.11 Digital Outputs

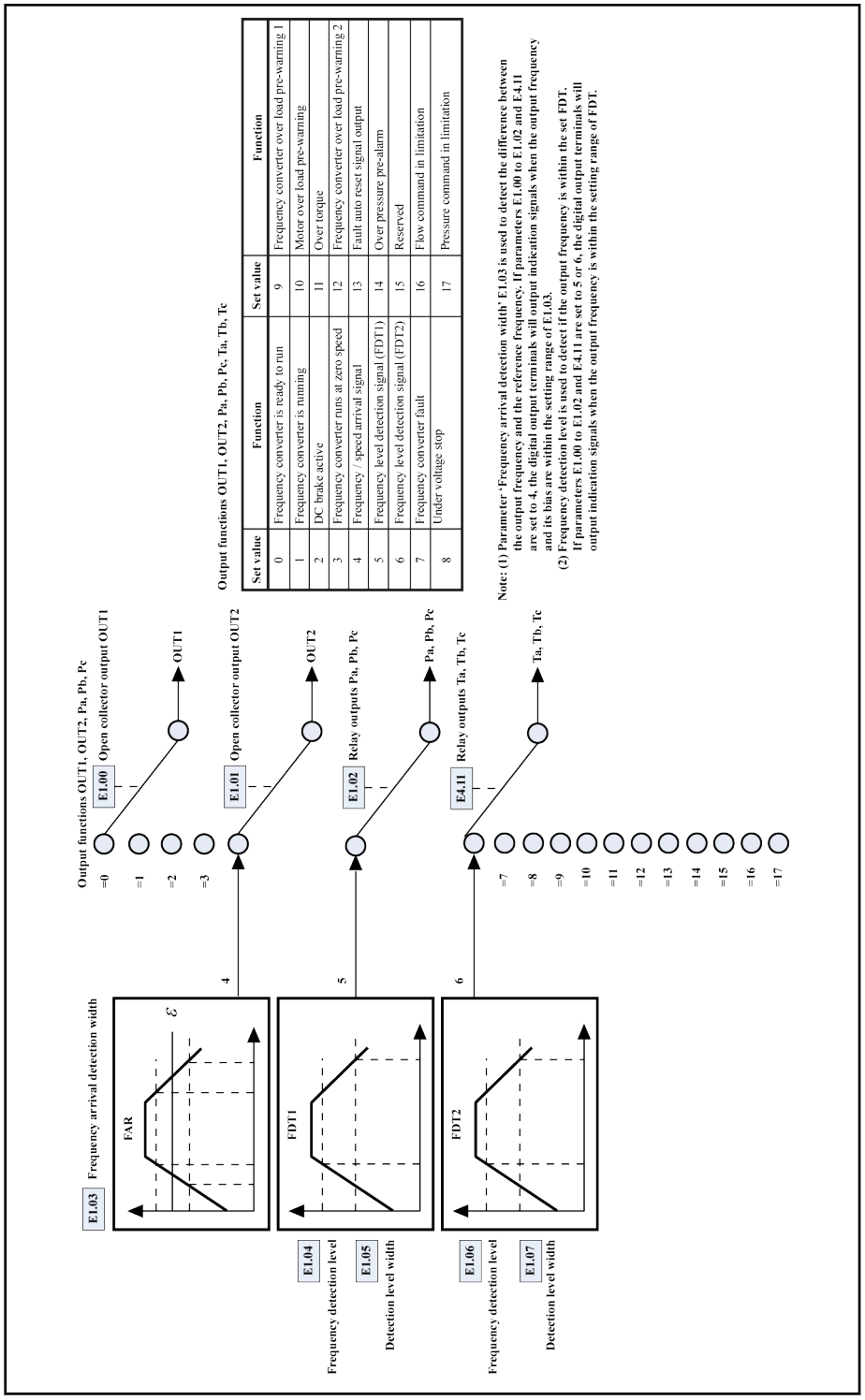


Fig. 7-11: Digital outputs

Parameter Settings

7.1.12 Master/Slave Pump Function

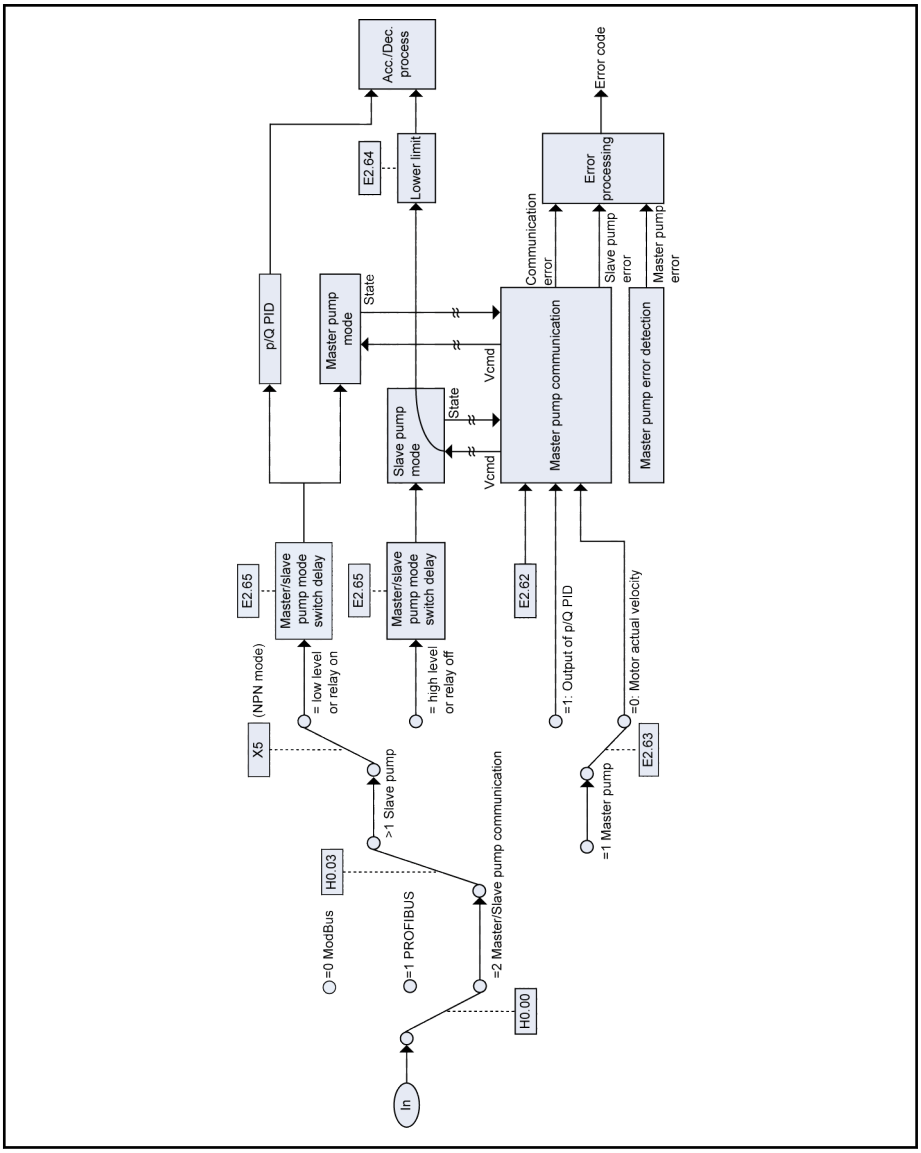


Fig. 7-12: Master/slave pump function

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 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].

Model: set the parameter value based on the model of frequency converter.

Pump type: set the parameter value based on pump type.

7.3 Parameters Functions

7.3.1 Category b: Basic Parameters

Group b0: System parameters

Code	Name	Setting range	Unit	Default	Attrib.
b0.00	User password	0 to 65,535	1	0	◇
b0.01	LCD language	0: Chinese; 1: English	1	SvP: 0 FcP: 1	◇
b0.02	Restore factory default	0: No action 1: Restore SvP parameters to factory default 2: Restore FcP parameters to factory default Note: The value is automatically set to 0 after restoring factory to defaults.	1	0	◆
b0.03	Reserved	0, 1	1	0	◎
b0.04	Mains voltage	380 to 480 V	1	SvP: 380 FcP: 400	◆
b0.05	PWM frequency	1.0 to 15.0 kHz	0.1	Model	◇
b0.06	Automatic adjustment of PWM frequency	0: Disabled; 1: Enabled	1	1	◆
b0.07	LCD backlight mode	0: Energy saving; 1: Always on	1	0	◇
b0.08	LCD display in run mode	0 to 23	1	23	◇
b0.09	LCD display in stop mode		1	23	◇
b0.10	Scale factor of user-defined value	0.1 % to 1,000.0 %	0.1	100.0	◇
b0.11	Set authority	0: b parameters; 1: b, S parameters 2: b, S, E parameters; 3: b, S, E, H parameters	1	3	◇
b0.12	Heat sink temperature	25 to 100 °C	1	Measured	◎
b0.13	Total running time	0 to 65,535 hours	1	0	◎
b0.14	Firmware version	Read-only	–	–	◎
b0.15	SvP/FcP parameter status	1: SvP parameter setting; 2: FcP parameter setting	1	–	◎

Setting range of b0.08 and b0.09:

0: Output frequency; 1: Output rotation speed; 2: Set output frequency
3: Set rotation speed; 4: Output voltage; 5: Output current
6: Output power; 7: DC bus voltage; 8: Torque current
9: Exciting current; 10: User-defined reference value
11: User-defined output value; 12: Reference torque; 13: Digital input
14: Pressure command; 15: p/Q speed/flow reference
16: Speed/flow command; 17: Pressure feedback
18 to 20: Reserved; 21: Heat sink temperature
22: Encoder feedback; 23: Multi-parameters monitor

Group b1: Basic parameters

Basic parameters

Code	Name	Setting range	Unit	Default	Attrib.
b1.00	Frequency setting mode	0: Set by operating panel potentiometer 1: Set by operating panel 2: Set by p/Q PID controller 3: Set by pulse frequency 4: Set by digital inputs **Up / Down** 5: Set by communication 6: Set by +I input 7: Set by flow mode	1	2	◆
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	1	◆
b1.03	Control mode	0: V/f control (V/f) 1: Senseless vector control (SVC) 2: Field oriented vector control (FOC)	1	SvP: 2 FcP: 1	◆
b1.04	Digital set frequency	[b1.07] to [b1.06] Hz	0.01	50.00	◇
b1.05	Maximum frequency	50.00 to 400.00 Hz	0.01	SvP: 85.00 FcP: 100.00	◆
b1.06	Upper frequency	[b1.07] to [b1.05] Hz	0.01	SvP: 85.00 FcP: 100.00	◇
b1.07	Lower frequency	0.00 to [b1.06] Hz	0.01	0.00	◇
b1.08	Operating panel controlled direction	0: Forward rotation; 1: Reverse rotation	1	0	◇

Parameter Settings

Acceleration / Deceleration time and modes

Code	Name	Setting range	Unit	Default	Attrib.
b1.09	Acceleration time 1	0.10 to 360.00 s	0.01	SvP: 0.18 FcP: 0.20	◇
b1.10	Deceleration time 1	0.10 to 360.00 s	0.01	SvP: 0.20 FcP: 2.00	◇
b1.11	Acceleration/deceleration curve	0: Linear mode; 1: S-curve mode	1	0	◆
b1.12	Time of S-curve rising section 1	0.0 % to 40.0 % (of ‘Acceleration time 1’ [b1.09])	0.1	0.0	◆
b1.13	Time of S-curve rising section 3	0.0 % to 40.0 % (of ‘Acceleration time 1’ [b1.09])	0.1	40.0	◆
b1.14	Time of S-curve falling section 4	0.0 % to 40.0 % (of ‘Deceleration time 1’ [b1.10])	0.1	0.0	◆
b1.15	Time of S-curve falling section 6	0.0 % to 40.0 % (of ‘Deceleration time 1’ [b1.10])	0.1	40.0	◆

Start or stop parameters

Code	Name	Setting range	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 to 15.00 Hz	0.01	0.00	◆
b1.18	Start frequency hold time	0.0 to 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	Unit	Default	Attrib.
b1.20	Startup DC brake time	0.0 to 20.0 s (0.0 deactivates DC braking)	0.1	0.0	◆
b1.21	Stop DC brake activation frequency	0.00 to 10.00 Hz	0.01	0.00	◆
b1.22	Stop DC brake time	0.0 to 20.0 s (0.0 deactivates DC braking)	0.1	0.0	◆
b1.23	DC brake current	0.0 % to 150.0 % (of rated frequency converter current)	0.1	0.0	◆
b1.24	Over excitation braking factor	1.000 to 1.500	0.001	1.000	◆

Pressure / Flow command selection

Code	Name	Setting range	Unit	Default	Attrib.
b1.25	Flow command selection	0: Set by analog VR1 1: Set by b1.26 2: Set by communication 3: Set by analog VR2	1	SvP: 0 FcP: 1	◆
b1.26	Flow command digital setting	0 to 3,000 rpm	1	SvP: 0 FcP: 200	◇
b1.27	Pressure command selection	0: Set by analog VR2 1: Set by b1.28 2: Set by communication	1	SvP: 0 FcP: 1	◆
b1.28	Pressure command digital setting	0 to 650.00 bar	0.01	SvP: 0.00 FcP: 10.00	◇

Parameter Settings

7.3.2 Category S: Standard Parameters

Group S0: V/f control

Code	Name	Setting range	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 to [S0.03] Hz	0.01	0.00	◆
S0.02	V/f voltage 1	0.0 % to 120.0 % (of 'Rated motor voltage' [S2.03])	0.1	0.0	◆
S0.03	V/f frequency 2	[S0.01] to [S0.05] Hz	0.01	0.00	◆
S0.04	V/f voltage 2	0.0 % to 120.0 % (of 'Rated motor voltage' [S2.03])	0.1	0.0	◆
S0.05	V/f frequency 3	[S0.03] to [b1.05] Hz	0.01	0.00	◆
S0.06	V/f voltage 3	0.0 % to 120.0 % (of 'Rated motor voltage' [S2.03])	0.1	0.0	◆
S0.07	Slip compensation	0.00 to 10.00 Hz	0.01	0.00	◆
S0.08	Torque increase	0.0 % to 20.0 % (of rated frequency converter voltage) • 0.0 %: Automatic increase • 0.1 % to 20.0 %: Manual increase	0.1	0.1	◆
S0.09	Automatic voltage stabilization	0: Inactive; 1: Always active 2: Inactive during deceleration and braking	1	0	◆

Group S1: Vector control

Code	Name	Setting range	Unit	Default	Attrib.
S1.00	Speed loop proportional gain	0.000 to 10.000	0.001	SvP: 1.450 FcP: 1.000	◆
S1.01	Speed loop integral time	0.000 to 10.000 s (0.000 means inactive)	0.001	0.300	◆
S1.02	Torque limit	0.0 % to 200.0 %	0.1	SvP: 200.0 FcP: 150.0	◆
S1.03	Slip compensation gain	50.0 % to 250.0 %	0.1	85.0	◆
S1.04	Torque control selection	0: By digital input; 1: Always active	1	0	◆
S1.05	Torque control reference	0: Input +I; 1: Reserved	1	0	◆

Group S2: Motor and encoder parameters

Motor nameplate parameters

Code	Name	Setting range	Unit	Default	Attrib.
S2.00	Rated motor frequency	8.00 to 400.00 Hz	0.01	Model	◆
S2.01	Rated motor rotation speed	1 to 30,000 rpm	1		◆
S2.02	Rated motor power	0.4 to 1,000.0 kW	0.1		◆
S2.03	Rated motor voltage	0 to 480 V	1		◆
S2.04	Rated motor current	0.1 to 1,000.0 A	0.1		◆

Motor parameters and adjustment

Code	Name	Setting range	Unit	Default	Attrib.
S2.05	Stator resistance factor	0.00 % to 50.00 %	0.01	Model	◆
S2.06	Rotator resistance factor	0.00 % to 50.00 %	0.01		◆
S2.07	Leakage inductance factor	0.00 % to 50.00 %	0.01		◆
S2.08	Mutual inductance factor	0.0 % to 2,000.0 %	0.1		◆
S2.09	No-load current	0.0 to 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	Unit	Default	Attrib.
S2.12	Pulses per revolution of pulse encoder	1 to 20,000	1	1,024	◆
S2.13	Pulse encoder direction reverse	0: No reverse; 1: Reverse	1	1	◆
S2.14	Pulse encoder fault detection threshold	0.0 to 1,000.0 rpm (0.0: No break protection)	0.1	0.0	◆
S2.15	Pulse encoder fault detection time	0.1 to 10.0 s	0.1	1.0	◆

Parameter Settings

Motor parameters

Code	Name	Setting range	Unit	Default	Attrib.
S2.16	Motor thermal time constant	1.0 to 1000.0 min (Used together with E4.19)	0.1	SvP: 60.0 FcP: Model	◆
S2.17	Motor inertia	0.0000 to 0.5000 kgm^2	0.0001	Model	◆
S2.18	Motor Max. torque1	0 to 1,000 Nm	1	SvP: Model FcP: 0	◆
S2.19	Motor Max. torque2	0 to 1,000 Nm	1	SvP: Model FcP: 0	◆

Acceleration / Deceleration adaptive

Code	Name	Setting range	Unit	Default	Attrib.
S2.20	Lowpass filter time for Acc./Dec. adaptive	0 to 999 ms	1	SvP: 20 FcP: 0	◆
S2.21	Adaptive Acc./Dec. time enable	0: Disabled; 1: Enabled	1	0	◆

Pump parameters

Code	Name	Setting range	Unit	Default	Attrib.
S2.22	Pump type	0 to 12	1	SvP: Depends on model and S2.36 FcP: 0	◆
S2.23	Pump displacement 1	0 to 250 ccm	1	SvP: Pump type FcP: 0	◆
S2.24	Pump inertia	0.0000 to 0.1000 kgm^2	0.0001	SvP: Pump type FcP: 0	◆
S2.25	Pump maximum critical pressure	0.00 to 650.00 bar	0.01	SvP: Pump type FcP: 0	◆
S2.26	Pump maximum continuous pressure	0.00 to 350.00 bar	0.01	SvP: Pump type FcP: 0	◆
S2.27	Pump displacement 2	0 to 250 ccm	1	0	◆
S2.28	Maximum pressure error upper limitation	0 to 350.00 bar	0.01	15.00	◆
S2.29	Maximum pressure error lower limitation	0 to 350.00 bar	0.01	10.00	◆

User input parameters

Code	Name	Setting range	Unit	Default	Attrib.
S2.30	User input Max. pressure monitoring	0.00 to 350.00 bar	0.01	200.00	◆
S2.31	Pump control mode	0: Constant pump 1: Two-point pump 2: Double pump	1	0	◆
S2.32	Pump logic selection	0: Positive 1: Negative	1	0	◆
S2.33	Speed switching threshold adjustment	0.1 to 1.0	0.1	0.9	◆
S2.34	Pump power	0.00 to 300.00 kW	0.01	SvP: Model FcP: 0.00	◆
S2.35	Reserved	0, 1	1	0	◎

System type

Code	Name	Setting range	Unit	Default	Attrib.
S2.36	System type	0: SvP S series 1: SvP E series 2: Other series	1	SvP: 0 FcP: 2	◆

Parameter Settings

Group S3: Control parameters

Jog

Code	Name	Setting range	Unit	Default	Attrib.
S3.00	Jog frequency	0.00 to [b1.05] Hz	0.01	5.00	◆
S3.01	Jog acceleration time	0.10 to 360.00 s	0.01	0.50	◇
S3.02	Jog deceleration time	0.10 to 360.00 s	0.01	0.10	◇

Skip frequency

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

Restart after power off or power fault

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

Other parameters in Group S3

Code	Name	Setting range	Unit	Default	Attrib.
S3.09	Forward/reverse dead time	0.0 to 3,600.0 s	0.1	0.0	◆
S3.10	Droop control	0.00 to 10.00 Hz	0.01	0.00	◆
S3.11	Setting rate via **Up/Down**	0.10 to 100.00 Hz/s	0.01	1.00	◇
S3.12	Brake chopper threshold	600 to 785 V	1	660	◆
S3.13	Braking duty cycle	0 % to 100 %	1	100	◆
S3.14	Motor rotation direction control	0: Forward direction 1: Reverse direction 2: Reverse direction disabled	1	SvP: 0 FcP: 1	◆
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	◇
S3.17	Brake chopper protect threshold	0 to 250 V	1	50	◆

7.3.3 Category E - Extended Parameters

Group E0: Analog and digital inputs

Multi- function digital inputs

Code	Name	Setting range	Unit	Default	Attrib.
E0.00	Reserved	0, 1	1	0	◎
E0.01	Digital input X1	0: Inactive (allows multiple selection) 1: bit 1 of parameter selection 2: bit 2 of parameter selection 5: Acceleration/deceleration time 1 6: Acceleration/deceleration time 2 7: p/Q mode and flow mode switch 8: Freewheel to stop 9: Frequency increment **Up** 10: Frequency decrement **Down** 11: Set frequency to 0 13: Activate DC brake 14: Switch between operating panel and digital inputs control 17: Switch between speed and torque control 19: Brake chopper overheat N.O. contact input 20: Motor overheat N.C. contact input 21: External reset input 22: Activate communication control 23: Master/Slave pump mode switch 24: Anti pressure shoot in injection stage 1 25: Anti pressure shoot in injection stage 2 3, 4, 12, 15, 16, 18: Reserved	1	0	◆
E0.02	Digital input X2		1	1	◆
E0.03	Digital input X3		1	21	◆
E0.04	Digital input X4		1	2	◆
E0.05	Digital input X5		1	23	◆
E0.06	Digital input X6		1	0	◆
E0.07	Digital input X7		1	SvP: 20 FcP: 0	◆
E0.08	Digital input X8		1	19	◆

Parameter Settings

Analog inputs

Code	Name	Setting range	Unit	Default	Attrib.
E0.09	Reserved	0, 1	1	0	◎
E0.10	Flow command factor	0.0 to 1,000.0 rpm/V	0.1	SvP: Model; FcP: 240	◆
E0.11	Pressure command factor	0.00 to 65.00 bar/V	0.01	SvP: 17.50; FcP: 10.00	◆
E0.12	Pressure feedback factor	0.00 to 65.00 bar/V	0.01	25.25	◆
E0.13	+I channel amplification factor k3	0.00 to 10.00	0.01	1.00	◆
E0.14	+I channel filter time	0.000 to 2.000 s	0.001	0.100	◆
E0.15	Maximum input pulse frequency	1.0 to 50.0 kHz	0.1	20.0	◆
E0.16	Characteristic curve minimum reference	0.0 % to [E0.18]	0.1	0.0	◆
E0.17	Frequency corresponding to characteristic curve minimum reference	0.00 to [b1.06] Hz	0.01	0.00	◆
E0.18	Characteristic curve maximum reference	[E0.16] to 100.0 %	0.1	100.0	◆
E0.19	Frequency corresponding to characteristic curve maximum reference	0.00 to [b1.06] Hz	0.01	50.00	◆

Group E1: Analog and digital outputs

Multi-function digital outputs

Code	Name	Setting range	Unit	Default	Attrib.
E1.00	Open collector output OUT1	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: Frequency converter fault 8: Under voltage stop 9: Frequency converter over load pre-warning 1 10: Motor over load pre-warning 11: Over torque 12: Frequency converter over load pre-warning 2 13: Fault auto reset signal output 14: Over pressure pre-alarm 15: Reserved 16: Flow command in limitation 17: Pressure command in limitation	1	1	◆
E1.01	Open collector output OUT2		1	9	◆
E1.02	Relay outputs Pa, Pb and Pc (If [S2.31]=1 or 2, the function of relay outputs is inactive)		1	7	◆
E1.03	Frequency arrival detection width	0.0 % to 20.0 % (of maximum frequency [b1.05])	0.1	5.0	◇
E1.04	Frequency detection level FDT1	0.0 % to 100.0 % (of maximum frequency [b1.05])	0.1	90.0	◇
E1.05	Frequency detection level FDT1 width	0.0 % to 100.0 % (of maximum frequency [b1.05])	0.1	5.0	◇
E1.06	Frequency detection level FDT2	0.0 % to 100.0% (of maximum frequency [b1.05])	0.1	50.0	◇
E1.07	Frequency detection level FDT2 width	0.0 % to 100.0 % (of maximum frequency [b1.05])	0.1	5.0	◇
E1.08	Frequency converter over load pre-warning 1 level setting	20.0 % to 100.0 % (of rated frequency converter current)	0.1	95.0	◇
E1.09	Motor over load pre-warning level setting	100.0 % to 250.0 % (of rated motor current)	0.1	100.0	◇

Parameter Settings

Analog outputs

Code	Name	Setting range	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 pressure 6: Output frequency / rotation speed (including direction) 7: Set frequency / rotation speed (including direction)	1	SvP: 6 FcP: 0	◇
E1.11	Reserved	0, 1	1	0	◎
E1.12	FM1 gain setting	0.00 to 10.00	0.01	0.92	◇
E1.13	FM1 negative gain setting	0.00 to 10.00	0.01	0.92	◇
E1.14	FM2 analog output	0: Output frequency / rotation speed 1: Set frequency / rotation speed 2: Output current 3: Torque current 4: Output voltage 5: Output pressure	1	5	◇
E1.15	Reserved	0, 1	1	0	◎
E1.16	FM2 gain setting	0.00 to 10.00	0.01	0.92	◇

DO pulse outputs

Code	Name	Setting range	Unit	Default	Attrib.
E1.17	Pulse outputs	0: Output frequency 1: Output voltage 2: Output current	1	0	◇
E1.18	Maximum output pulse frequency	1.0 to 50.0 kHz	0.1	20.0	◇

Group E2: Sytronix p/Q Functions

Acceleration / deceleration time

Code	Name	Setting range	Unit	Default	Attrib.
E2.00	Acceleration time 2	0.10 to 360.00 s	0.01	0.20	◇
E2.01	Deceleration time 2	0.10 to 360.00 s	0.01	SvP: 0.10 FcP: 0.30	◇
E2.02	Acceleration time 3	0.10 to 360.00 s	0.01	SvP: 0.30 FcP: 0.50	◇
E2.03	Deceleration time 3	0.10 to 360.00 s	0.01	SvP: 0.10 FcP: 0.50	◇
E2.04	Acceleration time 4	0.10 to 360.00 s	0.01	SvP: 0.50 FcP: 1.00	◇
E2.05	Deceleration time 4	0.10 to 360.00 s	0.01	SvP: 0.10 FcP: 1.00	◇

p/Q PID

Code	Name	Setting range	Unit	Default	Attrib.
E2.06	Lowpass Filter time for adaptive Kp [0]	0 to 999 ms	1	10	◆
E2.07	Proportional gain [0]	0.00 to 500.00 rpm/bar	0.01	SvP: Model FcP: 8.00	◆
E2.08	Pressure deviation for TI switch [0]	0.00 to 150.00 bar	0.01	SvP: 10.00 FcP: 0.00	◆
E2.09	Differential gain [0]	0.000 to 10.000 (rpm/bar)*s	0.001	SvP: Model FcP: 1.000	◆
E2.10	Lowpass Filter time for Kd [0]	0 to 999 ms	1	35	◆
E2.11	Intergal time [0]	0 to 999 ms	1	SvP: 80 FcP: Model	◆
E2.12	Upper limiation of I+D [0]	-10,000 to 10,000 rpm	1	SvP: Model FcP: 2,800	◆
E2.13	Lower limiation of I+D [0]	-10,000 to 10,000 rpm	1	0	◆
E2.14	System minimal speed [0]	-10,000 to 10,000 rpm	1	SvP: -1,500 FcP: 0	◆
E2.15	Intergal time 2 [0]	0 to 999 ms	1	0	◆
E2.16	Lowpass Filter time for adaptive Kp [1]	0 to 999 ms	1	10	◆
E2.17	Proportional gain [1]	0.00 to 500.00 rpm/bar	0.01	SvP: Model FcP: 8.00	◆
E2.18	Pressure deviation for TI switch [1]	0.00 to 150.00 bar	0.01	SvP: 10.00 FcP: 0.00	◆

Parameter Settings

Code	Name	Setting range	Unit	Default	Attrib.
E2.19	Differential gain [1]	0.000 to 10.000 (rpm/bar)*s	0.001	SvP: Model FcP: 1.000	◆
E2.20	Lowpass Filter time for Kd [1]	0 to 999 ms	1	35	◆
E2.21	Intergal time [1]	0 to 999 ms	1	SvP: 80 FcP: Model	◆
E2.22	Upper limiation of I+D [1]	-10,000 to 10,000 rpm	1	SvP: Model FcP: 2,800	◆
E2.23	Lower limiation of I+D [1]	-10,000 to 10,000 rpm	1	0	◆
E2.24	System minimal speed [1]	-10,000 to 10,000 rpm	1	SvP: -1,500 FcP: 0	◆
E2.25	Intergal time 2 [1]	0 to 999 ms	1	0	◆
E2.26	Lowpass Filter time for adaptive Kp [2]	0 to 999ms	1	10	◆
E2.27	Proportional gain [2]	0.00 to 500.00 rpm/bar	0.01	SvP:Model FcP: 8.00	◆
E2.28	Pressure deviation for TI switch [2]	0.00 to 150.00 bar	0.01	SvP: 10.00 FcP: 0.00	◆
E2.29	Differential gain [2]	0.000 to 10.000 (rpm/bar)*s	0.001	SvP: Model FcP: 1.000	◆
E2.30	Lowpass Filter time for Kd [2]	0 to 999 ms	1	35	◆
E2.31	Intergal time [2]	0 to 999 ms	1	SvP: 80 FcP: Model	◆
E2.32	Upper limiation of I+D [2]	-10,000 to 10,000 rpm	1	SvP: Model FcP: 2,800	◆
E2.33	Lower limiation of I+D [2]	-10,000 to 10,000 rpm	1	0	◆
E2.34	System minimal speed [2]	-10,000 to 10,000 rpm	1	SvP: -1,500 FcP: 0	◆
E2.35	Intergal time 2 [2]	0 to 999 ms	1	0	◆
E2.36	Lowpass Filter time for adaptive Kp [3]	0 to 999 ms	1	10	◆
E2.37	Proportional gain [3]	0.00 to 500.00 rpm/bar	0.01	SvP: Model FcP: 8.00	◆
E2.38	Pressure deviation for TI switch [3]	0.00 to 150.00 bar	0.01	SvP: 10.00 FcP: 0.00	◆
E2.39	Differential gain [3]	0.000 to 10.000 (rpm/bar)*s	0.001	SvP: Model FcP: 0.000	◆
E2.40	Lowpass Filter time for Kd [3]	0 to 999 ms	1	35	◆
E2.41	Intergal time [3]	0 to 999 ms	1	SvP: 80 FcP: 0	◆

Code	Name	Setting range	Unit	Default	Attrib.
E2.42	Upper limiation of I+D [3]	-10,000 to 10,000 rpm	1	SvP: Model FcP: 2,800	◆
E2.43	Lower limiation of I+D [3]	-10,000 to 10,000 rpm	1	0	◆
E2.44	System minimal speed [3]	-10,000 to 10,000 rpm	1	SvP: -1,500 FcP: 0	◆
E2.45	Intergal time 2 [3]	0 to 999 ms	1	0	◆
E2.46	Lowpass filter time pressure rising up [0]	0 to 999 ms	1	SvP: 120 FcP: 80	◆
E2.47	Lowpass filter time pressure dropping down [0]	0 to 999 ms	1	40	◆
E2.48	Lowpass filter time flow rising up	0 to 999 ms	1	2	◆
E2.49	Lowpass filter time flow dropping down	0 to 999 ms	1	2	◆
E2.50	Lowpass filter time pressure feedback	0 to 999 ms	1	4	◆
E2.51	Flow command offset	0.00 to 9.00 V	0.01	0.00	◆
E2.52	Pressure command offset	0.00 to 9.00 V	0.01	0.00	◆
E2.53	Pressure feedback offset	0.00 to 9.00 V	0.01	0.10	◆
E2.54	Minimum flow command	0 to 1,000 rpm	1	40	◆
E2.55	Minimum pressure command	0.00 to 100.00 bar	0.01	5.00	◆
E2.56	Kp gain upper limit	0.00 to 500.00 rpm/bar	0.01	SvP: 8.20 FcP: 10.00	◆
E2.57	Pressure deviation lower for adaptive Kp	0.00 to [E2.58] bar	0.01	60.00	◆
E2.58	Pressure deviation upper for adaptive Kp	[E2.57] to 650.00 bar	0.01	120.00	◆
E2.59	Kp adaptive enable	0: Disabled; 1: Enabled	1	0	◆
E2.60	Maximum flow command limitation	0 to 3,000 rpm	1	SvP: 2,500 FcP: 2,800	◆
E2.61	Maximum pressure command limitation	0.00 to 650.00 bar	0.01	SvP: 175.00 FcP: 250	◆
E2.62	Slave pump number	0 to 19	1	0	◆
E2.63	Slave speed/flow command selection	0, 1	1	1	◆
E2.64	Slave speed/flow command lower limit	-3,000 to 3,000 rpm	1	0	◆
E2.65	Master/Slave pump mode switch delay	0 to 500 ms	1	100	◆
E2.66	Reserved	0, 1	1	1	◎
E2.67	Lowpass filter time pressure rising up [1]	0 to 999 ms	1	SvP: 140 FcP: 80	◆
E2.68	Lowpass filter time pressure dropping down [1]	0 to 999ms	1	SvP: 60 FcP: 40	◆

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Code	Name	Setting range	Unit	Default	Attrib.
E2.69	Lowpass filter time pressure rising up [2]	0 to 999 ms	1	SvP: 160 FcP: 80	◆
E2.70	Lowpass filter time pressure dropping down [2]	0 to 999 ms	1	SvP: 80 FcP: 40	◆
E2.71	Lowpass filter time pressure rising up [3]	0 to 999 ms	1	SvP: 180 FcP: 100	◆
E2.72	Lowpass filter time pressure dropping down [3]	0 to 999 ms	1	100	◆
E2.73	p/Q command start delay	0.0 to 1,000.0 s	0.1	0.0	◆
E2.74	Flow leakage	-10,000 to 10,000 rpm	1	100	◆
E2.75	Pressure rise ratio 1	0 to 100 %	1	40	◆
E2.76	Pressure rise ratio 2	0 to 100 %	1	95	◆

Group E3: PID control

Code	Name	Setting range	Unit	Default	Attrib.
E3.00	PID control mode	0: PID control inactive 1: Reserved 2: Analog digital setting + "+I analog feedback" 3: Reserved 4: Rotation speed digital setting + pulse encoder feedback	1	0	◆
E3.01	Analog digital setting	0.00 to 10.00 V	0.01	0.00	◇
E3.02	Rotation speed digital setting	0 to 30,000 rpm	1	0	◇
E3.03	Reserved	0, 1	1	0	◎
E3.04	P: Proportional gain	0.000 to 10.000	0.001	1.500	◇
E3.05	Ti: Integral time	0.00 to 100.00 s (0.00 represents no integral)	0.01	0.00	◇
E3.06	Td: Differential time	0.00 to 100.00 s (0.00 represents no derivative)	0.01	0.00	◇
E3.07	T: Sampling period	0.01 to 100.00 s	0.01	0.50	◇
E3.08	Deviation limit	0.0 % to 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	◇

Parameter Settings

Group E4: Protection and fault parameters

Protection parameters

Code	Name	Setting range	Unit	Default	Attrib.
E4.00	Software over voltage protection threshold	790 to 820 V	1	810	◆
E4.01	Stall over voltage function	0: Inactive; 1: Active	1	0	◆
E4.02	Stall over voltage protection level	120.0 % to 150.0 % (of rated frequency converter peak voltage)	0.1	130.0	◆
E4.03	Stall over current protection level	20.0 % to 200.0 % (of rated frequency converter output current)	0.1	200.0	◆
E4.04	Motor over load protection	0: Inactive 1: Heat protection active at low-speed 2: Heat protection inactive at low-speed	1	0	◇
E4.05	Motor over load protection factor	50.0 % to 110.0 %	0.1	100.0	◇
E4.06	Phase loss protection	0: Both input and output phase loss protection active 1: Only input phase loss protection active 2: Only output phase loss protection active 3: Both input and output phase loss protection inactive	1	0	◇
E4.07	Pressure sensor fault detection threshold	0 to 3,000 rpm	1	SvP: 1 FcP: 50	◆
E4.08	Pressure sensor fault detection time	0.1 to 100.0 s	0.1	10.0	◆
E4.09	Pressure detection threshold	1.00 to 650.00 bar	0.01	5.00	◆
E4.10	Pressure detection period	0.1 to 100.0 s	0.1	1.0	◆
E4.18	Reserved	0, 1	1	0	◎
E4.19	Type of temperature sensor for motor over heat protection	0: Other temperature sensor type 1: PTC temperature sensor 2: With motor temperature model 3: NTC temperature sensor	1	SvP: 0 FcP: 1	◆
E4.22	Motor overheat voltage level setting	0 to 10.0 V	0.1	SvP: 0.0 FcP: 2.8	◆

Pump protection

Code	Name	Setting range	Unit	Default	Attrib.
E4.20	Over Max. pressure limitation time	0.1 to 100.0 s	0.1	5.0	◆
E4.21	Pump protection selection	0 to 15	1	0	◆

Fault parameters

Code	Name	Setting range	Unit	Default	Attrib.
E4.11	Relay Ta, Tb and Tc output	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: Frequency converter fault 8: Under voltage / frequency converter stop warning 9: Frequency converter over load pre-warning 1 10: Motor over load pre-warning 11: Over torque 12: Frequency converter over load pre-warning 2 13: Fault auto reset signal output 14: Over pressure pre-alarm 15: Reserved 16: Flow command in limitation 17: Pressure command in limitation	1	7	◆
E4.12	Number of fault reset attempts	0 to 3 (0: Inactive for auto reset)	1	0	◆
E4.13	Interval between reset attempts	2 to 60 s	1	10	◆
E4.14	Last fault	0 to 33	1	0	◎
E4.15	2nd last fault		1	0	◎
E4.16	3rd last fault		1	0	◎
E4.17	Delete fault record	0: No action; 1: Active Note: The value is automatically set to 0 after the operation.	1	0	◆

Setting range of E4.14 to E4.16:

0: No fault record
1: Over current at constant speed (O.C.-1)
2: Over current during acceleration (O.C.-2)
3: Over current during deceleration (O.C.-3)
4: Over voltage at constant speed (O.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 fault (R.E.)
10: Operating panel read/write fault (KEY-)

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11: Motor overheat (M.O.H.)
12: Communication fault (R.S.)
13: Circuit disconnection (C.F.)
14: Pulse encoder speed detection fault (PULS)
15: Brake chopper over heat (B.O.H.)
16: EMI fault (CPU-)
17: Short circuit (S.C.)
18: Pressure sensor fault (P.S.F.)
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 fault (PRSE)
23: Parameter auto-tuning fault (TUNE)
24: Frequency converter over load pre-warning 2 (O.L.-3)
25: Over pressure pre-alarm (O.P.W.)
26: Over pressure fault (O.P.F.)
27: Braking threshold low (B.T.L.)
28: Reserved
29: Reserved
30: Flow command in limitation (F.C.LI)
31: Pressure command in limitation (P.C.LI)
32: Slave pump fault (M/S S.)
33: Master/Slave pump communication fault (M/S C.)

7.3.4 Category H: Advanced Parameters

Group H0: Communication parameters

Code	Name	Setting range	Unit	Default	Attrib.
H0.00	Communication protocol	0: Modbus; 1: PROFIBUS 2: Master/Slave pump control communication	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 6: Reserved 7: Data acquisition (Only for internal)	1	3	◆
H0.02	Data format	0: N, 8, 2 (1 start bit, 8 data bits, 2 stop bits, without check) 1: E, 8, 1 (1 start bit, 8 data bits, 1 stop bit, even) 2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd)	1	0	◆
H0.03	Local address	Modbus: 1 to 247 PROFIBUS: 1 to 126 Master/Slave pump communication: 1 to 20 (1 means master pump)	1	1	◆
H0.04	PZD4, PZD3 setting	0 to 238	1	0	◆
H0.05	PZD6, PZD5 setting	0 to 238	1	0	◆
H0.06	PZD8, PZD7 setting	0 to 238	1	0	◆
H0.07	PZD10, PZD9 setting	0 to 238	1	0	◆
H0.08	Communication disconnection detection time	0.0 to 60.0 s (0.0s: deactivated)	0.1	0.0	◆
H0.09	Communication disconnection action	0: Stop; 1: Keep running	1	0	◆
H0.10	Reserved	0 to 65,535	1	0	◆

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 to 65,535	Minimum unit	1

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

- Set password: Set a number between 1 to 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 to 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 forgot the set password.

b0.01	LCD language		Factory default	SvP: 0 FcP: 1
	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 SvP parameters to factory default
  - Restore parameters to the ones suitable for SvP application.
- 2: Restore FcP parameters to factory default
  - Restore parameters to the ones suitable for FcP application.

☞
1. All parameters (except E4.14 to E4.16 and b0.01) will be restored to factory defaults.
2. b0.02 is automatically set to 0 after the parameters have been set to factory default. Users can check parameter status (SvP or FcP) after restoring through b0.15.

b0.03	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1

b0.04	Mains voltage		Factory default	SvP: 380 FcP: 400
	Setting range	380 to 480 V	Minimum unit	1

b0.05	PWM frequency		Factory default	Model
	Setting range	1.0 to 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 interferences caused by the frequency converter.
    - increase the higher harmonic component of output current, motor power loss and motor temperature.
- The factory default values and valid adjustable ranges of Fv for Sytronix PWM frequency are shown in the table below.

Model	Default value of PWM frequency [kHz]	Effective adjustable range of PWM frequency [kHz]
1K50 to 7K50	8.0	1.0 to 15.0
11K0 to 22K0	6.0	1.0 to 12.0
30K0 to 90K0	4.0	1.0 to 8.0

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

For the temperature, voltage and current derating figures related to PWM frequency, refer to chapter 9.3 "Derating of Electrical Data" on page 179.

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

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

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

- 0: Energy saving

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

  The LCD backlight will be always active.

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

b0.08	LCD display value in run mode		Factory default	23
	Setting range	0 to 23	Minimum unit	1
b0.09	LCD display value in stop mode		Factory default	23
	Setting range	0 to 23	Minimum unit	1

- 0: Output frequency
- 1: Output rotation speed

  The output rotation speed has different meanings under different control mode. The details are shown below.

Control mode	The meaning of output rotation
V/f	Output synchronous speed
SVC	Estimated value of motor rotation speed
FOC	Feedback speed of PG

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

  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 to X8, FWD and REV. The value of "Digital inputs status" is 0 to 3,377.

  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.

Decimal	Displayed value	1234									
	bit	4th number (x 1000 +)		3rd number (x 100 +)		2nd number (x 10 +)			1st number (x 1)		
	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

- 14: Pressure command
- 15: p/Q speed/flow reference
- 16: Speed/flow command
- 17: Pressure feedback
- 18 to 20: Reserved
- 21: Heat sink temperature
- 22: Encoder feedback
- 23: Multi-parameters monitor

p/Q speed/flow reference is the output of p/Q PID.

When [b0.08] or [b0.09] = 23, the monitoring values displayed on the LCD panel from top to bottom are: pressure command, output current, pressure feedback, output power, speed/flow command and output rotation speed.

☞ There are totally 23 status parameters, all of which can be displayed by switching between ►► in either running or stopping mode.

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

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

b0.11	Set authority		Factory default	3
	Setting range	0 to 3	Minimum unit	1

- Only parameters of the selected groups are visible.

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

Tab. 7-4: Parameter filter range

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

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

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

- Displays the total running time of the frequency converter.

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

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

b0.15	SvP/FcP parameter status		Factory default	–
	Setting range	1: SvP parameter setting 2: FcP parameter setting	Minimum unit	1

- Read only. To show whether SvP or FcP parameter is selected for converter operation.

Group b1: Basic parameters

b1.00	Frequency setting mode		Factory default	2
	Setting range	0: Set by operating panel potentiometer 1: Set by operating panel 2: Set by p/Q PID controller 3: Set by pulse frequency 4: Set by digital inputs **Up/Down** 5: Set by communication 6: Set by +I input 7: Set by flow mode	Minimum unit	1

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

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

- 2: Set by p/Q PID controller
  - Set the frequency by p/Q PID controller output. This mode is set as default setting in Sytronix application.
- 3: Set by pulse frequency
  - Set output frequency by external pulse frequency signals using digital input X8 (signal range is 9 to 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 to 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: Zeroing of output frequency setting
  - Step 2

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

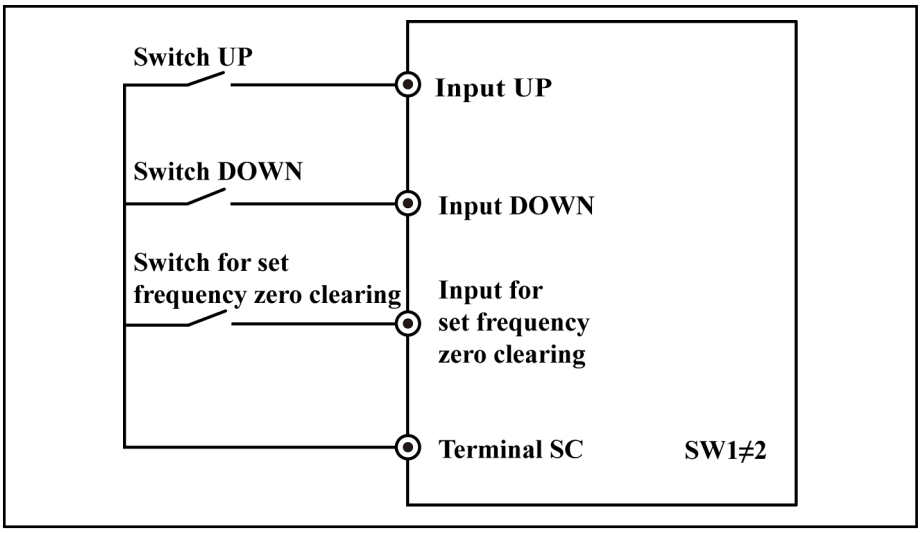


Fig. 7-13: Frequency setting via digital inputs

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).
- 6: Set by input +I

  +I is for 0 to 20 mA (with channel input resistance of 165 Ω).
- 7: Set by flow mode

  Set output frequency by speed/flow command. The converter works in flow mode.

☞ The converter can also be configurated to flow mode through digital input or communication.

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

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

b1.02	Frequency converter control commands		Factory default	1
	Setting range	0, 1, 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**) to control run, stop, etc.
- 1: Set control commands by digital inputs
  - Use digital inputs **FWD**, **REV** to control run, stop, forward or reverse, etc. See parameters also in group E0.
- 2: Set control commands by communication
  - Use communication to control run, stop, forward or reverse, etc. See chapter 12 "Serial Communication" on page 225.

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

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

- 0: V/f control (V/f)
  - Select this mode if it is impossible to conduct auto-tuning or obtain accurate motor parameters.

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

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

1. Accurate motor parameters are required for vector control. The matched motor parameters have been stored in parameters S2.00 to S2.09 as factory defaults. For third party motors, parameters can be obtained by auto-tuning function. If auto-tuning is impossible and the accurate motor parameters are known, first set parameters S2.00 to S2.04, 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, please refer to parameters in group S for related settings.

b1.04	Digital set frequency		Factory default	50.00
	Setting range	[b1.07] to [b1.06] Hz	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	SvP: 85.00 FcP: 100.00
	Setting range	50.00 to 400.00 Hz	Minimum unit	0.01
b1.06	Upper frequency		Factory default	SvP: 85.00 FcP: 100.00
	Setting range	[b1.07] to [b1.05] Hz	Minimum unit	0.01
b1.07	Lower frequency		Factory default	0.00
	Setting range	0.00 to [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.

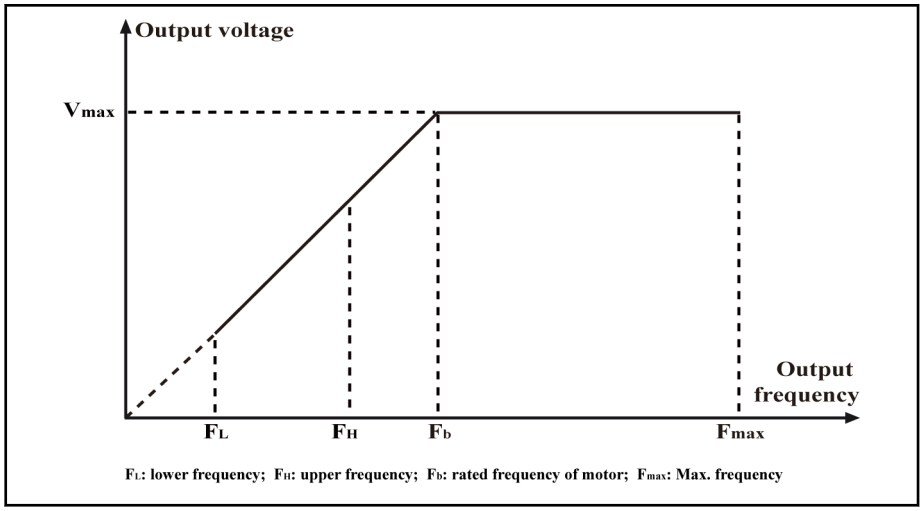


Fig. 7-14: Maximum frequency_upper frequency − UF_lower frequency − LF

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.

- 0: Forward rotation
- 1: Reverse rotation

b1.09	Acceleration time 1		Factory default	SvP: 0.18 FcP: 0.20
	Setting range	0.10 to 360.00 s	Minimum unit	0.01
b1.10	Deceleration time 1		Factory default	SvP: 0.20 FcP: 2.00
	Setting range	0.10 to 360.00 s	Minimum unit	0.01

- The acceleration time is the duration, in which the frequency converter changes the output frequency from 0 Hz to ‘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] to 0 Hz. Shown as T2 in figure below.

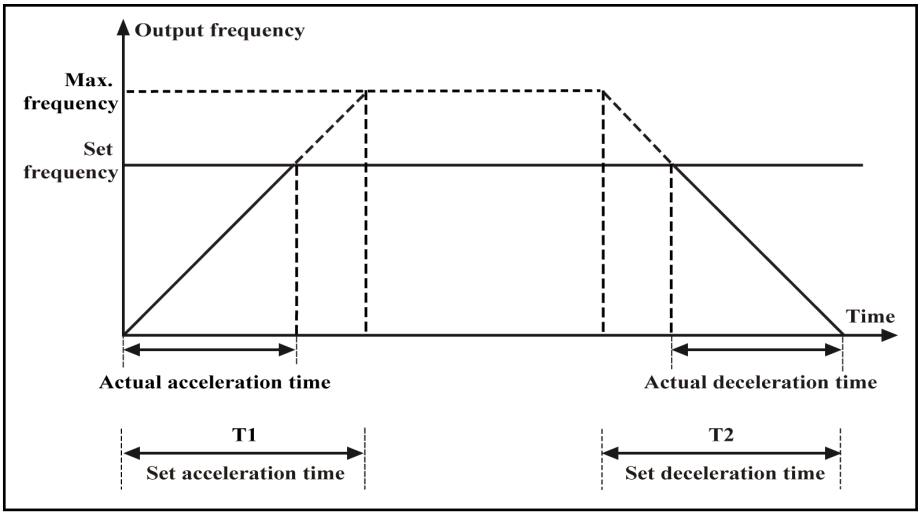


Fig. 7-15: Acceleration time1 & Deceleration time 1

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

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

This parameter sets the acceleration/deceleration curve 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 linear as shown in figure below.

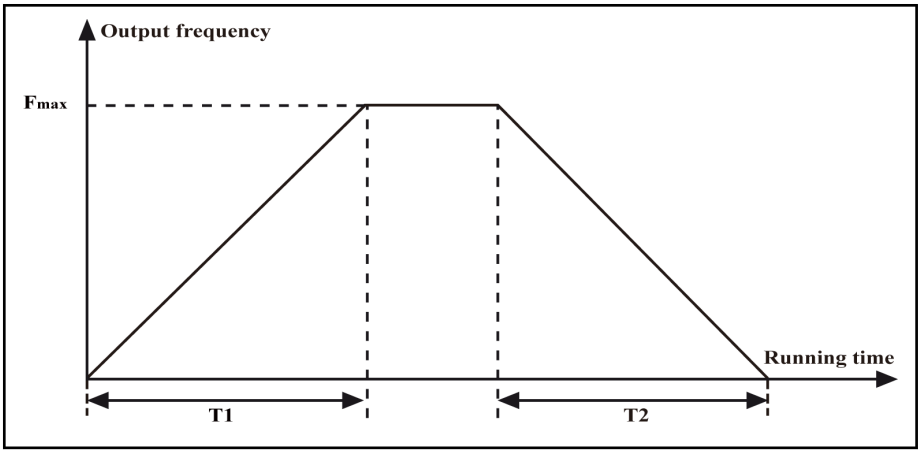


Fig. 7-16: Linear acceleration/deceleration mode

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

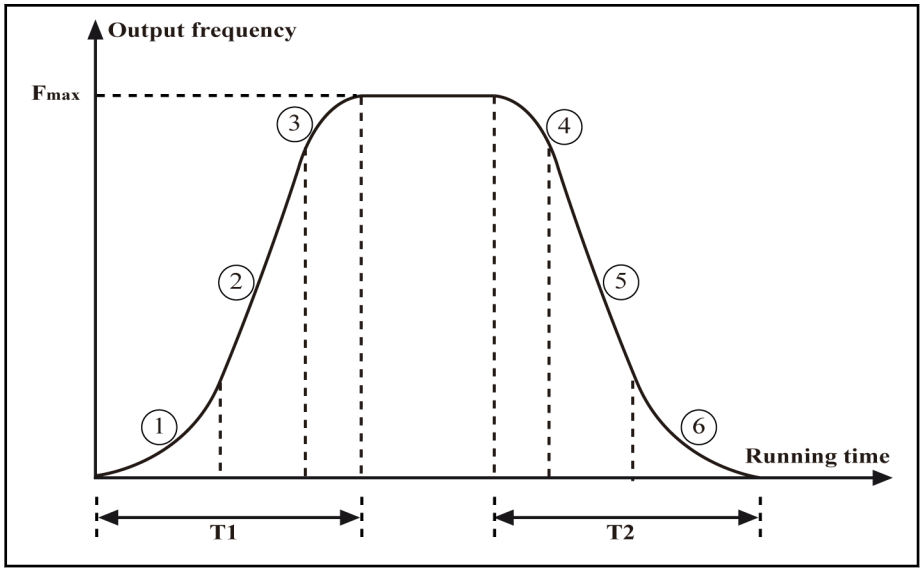


Fig. 7-17: S-curve acceleration/deceleration mode

b1.12	Time of S-curve rising section 1		Factory default	0.0
	Setting range	0.0 % to 40.0 % (of 'Acceleration time 1' [b1.09])	Minimum unit	0.1
b1.13	Time of S-curve rising section 3		Factory default	40.0
	Setting range	0.0 % to 40.0 % (of 'Acceleration time 1' [b1.09])	Minimum unit	0.1
b1.14	Time of S-curve falling section 4		Factory default	0.0
	Setting range	0.0 % to 40.0 % (of 'Deceleration time 1' [b1.10])	Minimum unit	0.1
b1.15	Time of S-curve falling section 6		Factory default	40.0
	Setting range	0.0 % to 40.0 % (of 'Deceleration time 1' [b1.10])	Minimum unit	0.1

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

- 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.

☞ 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
  - The frequency converter decelerates to stop according the deceleration time.

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

- 1: Freewheel to stop
  - Once the stop command is activated, the 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 to 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, the frequency converter starts directly without DC brake. The larger the DC brake current, the larger the braking force is. Take the withstanding capability of the motor into account.

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

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

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

b1.23	DC brake current		Factory default	0.0
	Setting range	0.0 % to 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.

b1.24	Over excitation braking factor		Factory default	1.000
	Setting range	1.000 to 1.500	Minimum unit	0.001

- The overexcitation braking function is only active in SVC and FOC control mode. In V/f control mode, it’s inactive.
- When [b1.24]=1.00, ‘overexcitation braking’ is inactive.
- A higher factor brings a higher braking force. However, an excessive high factor may trigger error of overcurrent (O.C.-1, O.C.-2, O.C.-3), converter overload (O.L.-1) or motor overload (O.L.-2). Reduce the setting of the factor in such cases.

b1.25	Flow command selection		Factory default	SvP: 0 FcP: 1
	Setting range	0 to 3	Minimum unit	1

To select the source of flow command.

- 0: Set by analog VR1

  Setting flow command by analog channel VR1.
- 1: Set by b1.26

  Setting flow command by parameter b1.26.
- 2: Set by communication

  Setting flow command through PC or PLC devices. Details refer to chapter 12 "Serial Communication" on page 225.
- 3: Set by analog VR2

  Setting flow command by analog channel VR2.

b1.26	Flow command digital setting		Factory default	SvP: 0 FcP: 200
	Setting range	0 to 3,000 rpm	Minimum unit	1

When [b1.25]=1, b1.26 is used to set the flow command value.

Parameter Settings

b1.27	Pressure command selection		Factory default	SvP: 0 FcP: 1
	Setting range	0 to 2	Minimum unit	1

To select the source of pressure command.

- 0: Set by analog VR2

  Setting pressure command by analog channel VR2.
- 1: Set by b1.28

  Setting pressure command by parameter b1.28.
- 2: Set by communication

  Setting pressure command through PC or PLC devices. Details refer to chapter 12 "Serial Communication" on page 225.

☞ If b1.25 and b1.27 are both set to "Set by analog VR2", then VR2 is used as pressure command setting channel.

b1.28	Pressure command digital setting		Factory default	SvP: 0.00 FcP: 10.00
	Setting range	0 to 650.00 bar	Minimum unit	0.01

When [b1.27]=1, b1.28 is used to setting the pressure command value.

7.4.2 Category S: Standard Parameters

Group S0: V/f control

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

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

- 0: Linear mode
  - Suitable for constant torque load (shown as 0 in figure below).
- 1: Square mode
  - Suitable for variable torque loads (shown as 1 in figure below).

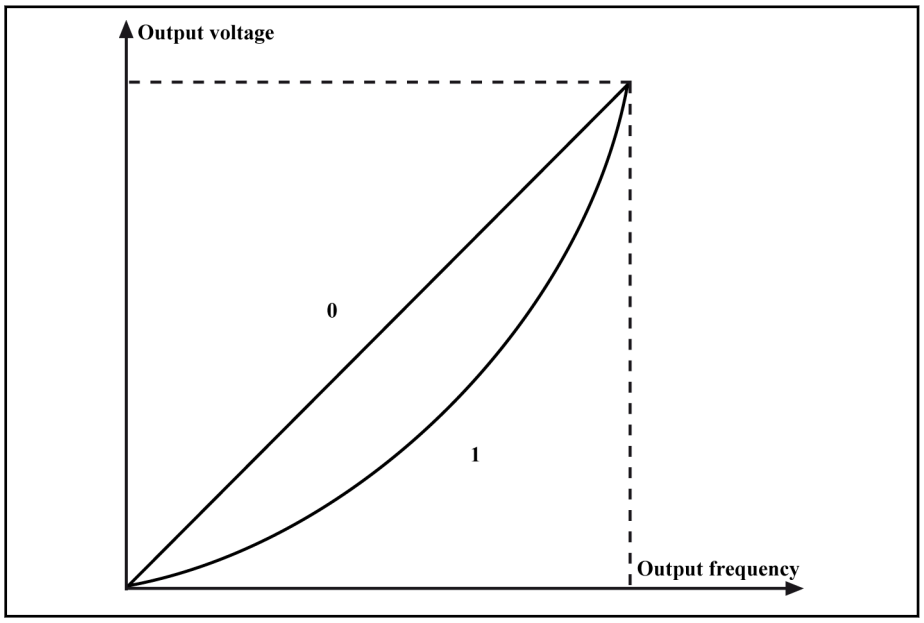


Fig. 7-18: Linear and square V/f curves

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

Parameter Settings

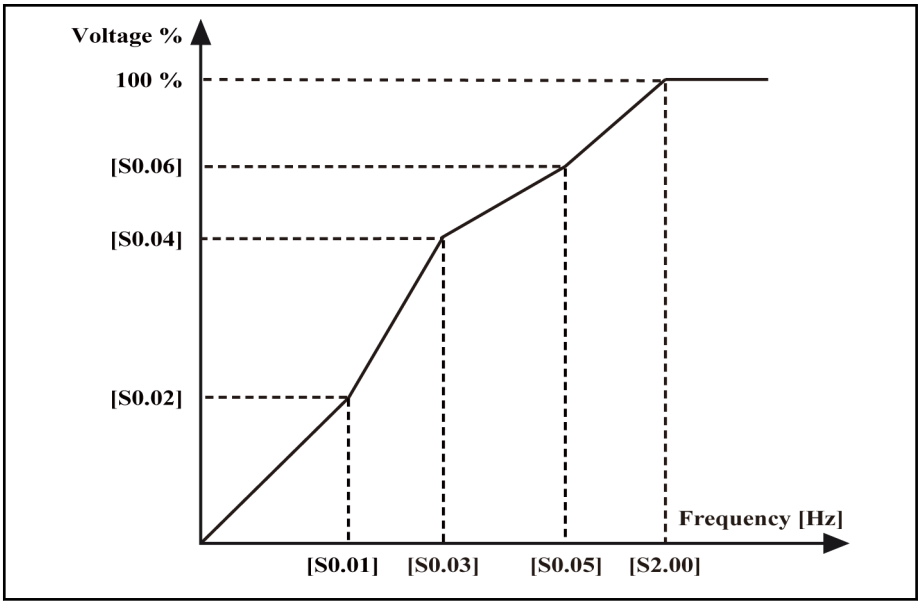


Fig. 7-19: User defined V/f curve

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

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

S0.07	Slip compensation		Factory default	0.00
	Setting range	0.00 to 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.
- 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 % to 20.0 % (of rated frequency converter voltage): 0.0 %: Automatic increase 0.1 % to 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 is shown in figures below.

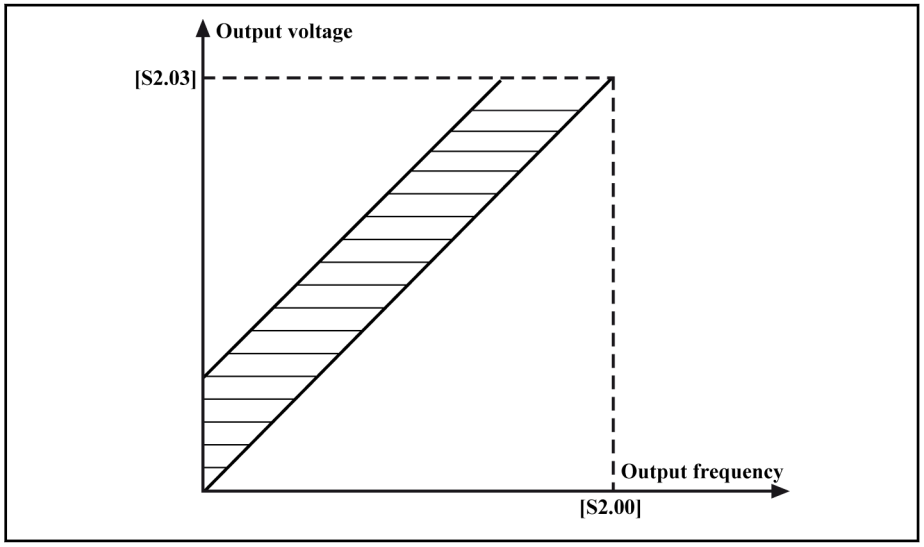


Fig. 7-20: Linear V/f curve automatic torque increase

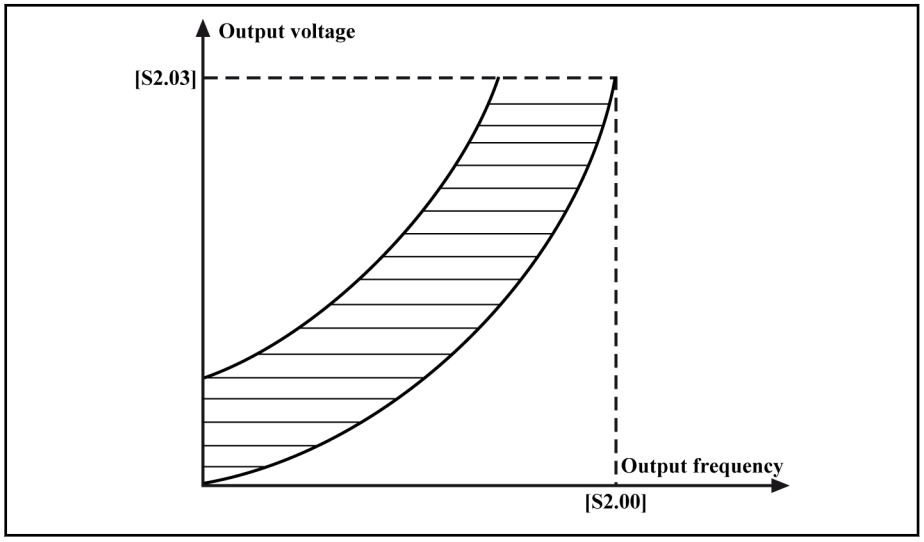


Fig. 7-21: Square V/f curve automatic torque increase

- 0.1 % to 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 characteristics of V/f control.

  Large increase may cause high current leading to motor over heat and may result in motor damage. Linear and square V/f curve manual torque increase is shown in figures below.

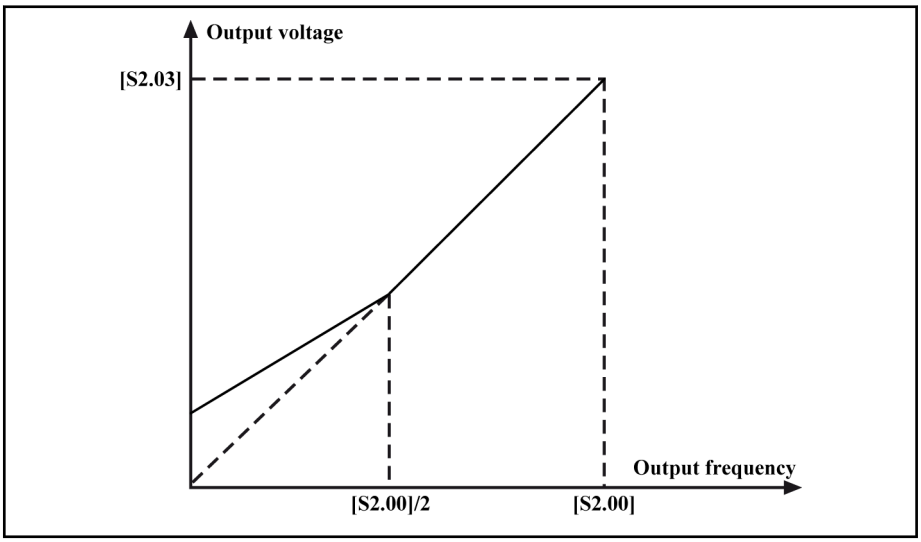


Fig. 7-22: Linear V/f curve manual torque increase

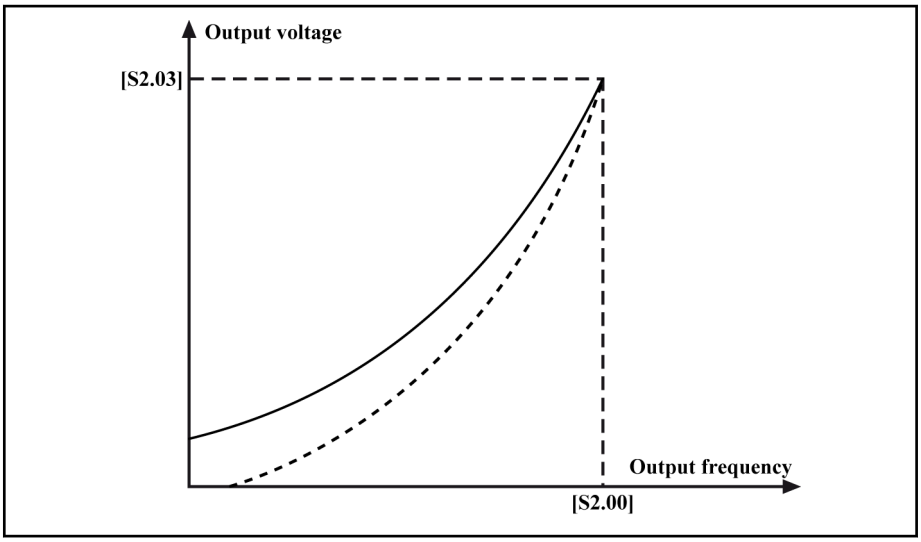


Fig. 7-23: Square V/f curve manual torque increase

S0.09	Automatic voltage stabilization		Factory default	0
	Setting range	0: Inactive 1: Always active 2: Inactive during deceleration and braking	Minimum unit	1

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

- 0: Inactive
- 1: Always active

  - Select if brake resistor is in place or no quick deceleration is necessary.
- 2: Inactive during deceleration and braking
  - Select if quick deceleration is necessary and no brake resistor is in place to reduce significantly the possibility of over voltage warnings.

Parameter Settings

Group S1: Vector control

S1.00	Speed loop proportional gain		Factory default	SvP: 1.450 FcP: 1.000
	Setting range	0.000 to 10.000	Minimum unit	0.001
S1.01	Speed loop integral time		Factory default	0.300
	Setting range	0.000 to 10.000 s (0.000 means inactive)	Minimum unit	0.001

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

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

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

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

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

S1.02	Torque limit		Factory default	SvP: 200.0 FcP: 150.0
	Setting range	0.0 % to 200.0 % (Motor rated current)	Minimum unit	0.1

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

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

S1.03	Slip compensation gain		Factory default	85.0
	Setting range	50.0 % to 250.0 %	Minimum unit	0.1

Used to maintain constant motor speeds with load changes.

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

S1.04	Torque control selection		Factory default	0
	Setting range	0: By digital input 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.
  – Torque control
    – Speed controller is inactive and the output torque changes according to the set torque.
    – Output frequency changes with the load speed.
    – The output speed is limited by ‘Upper frequency’ b1.06. If the load speed is larger than ‘Upper frequency’ [b1.06], the output torque will be different from the set torque because of speed limitation.

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

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

S1.05	Torque control reference		Factory default	0
	Setting range	0: Input +I 1: Reserved	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: Reserved

Parameter Settings

Group S2: Motor, encoder, pump and system parameters

For SvP 5010 application, most parameters of S2 group is dependent. The relationship is shown as below:

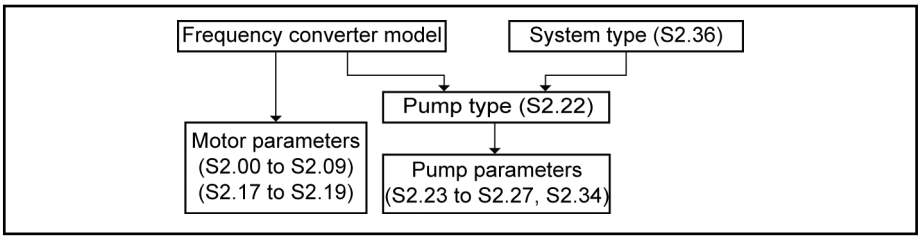


Fig. 7-24: Relationship of S2 group parameters

☞ The arrow shows the interdependent relationship of different parameters. For example, when S2.36 changes, S2.22 changes with it. Then S2.23 to S2.27, S2.34 changes with S2.22.

S2.00	Rated motor frequency		Factory default	Model
	Setting range	8.00 to 400.00 Hz	Minimum unit	0.01
S2.01	Rated motor rotation speed		Factory default	Model
	Setting range	1 to 30,000 rpm	Minimum unit	1
S2.02	Rated motor power		Factory default	Model
	Setting range	0.4 to 1,000.0 kW	Minimum unit	0.1
S2.03	Rated motor voltage		Factory default	Model
	Setting range	0 to 480 V	Minimum unit	1
S2.04	Rated motor current		Factory default	Model
	Setting range	0.1 to 1,000.0 A	Minimum unit	0.1

Set parameters S2.00 to 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	Model
	Setting range	0.00 % to 50.00 %	Minimum unit	0.01
S2.06	Rotator resistance factor		Factory default	Model
	Setting range	0.00 % to 50.00 %	Minimum unit	0.01
S2.07	Leakage inductance factor		Factory default	Model
	Setting range	0.00 % to 50.00 %	Minimum unit	0.01
S2.08	Mutual inductance factor		Factory default	Model
	Setting range	0.0 % to 2,000.0 %	Minimum unit	0.1
S2.09	No-load current		Factory default	Model
	Setting range	0.0 to 1,000.0 A	Minimum unit	0.1
S2.10	Parameter auto-tuning		Factory default	0
	Setting range	0, 1, 2	Minimum unit	1

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

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

☞

1. In SvP 5010 application, the accurate motor parameters have been stored in parameters S2.00 to S2.09 as factory defaults, which do not need modification or update.

   In FcP 5010 application, S2.00 to S2.09 has been well set to exact parameter value of MOT-FC motor which has the same power as frequency converter. So if frequency converter and MOT-FC motor with the same power are used together, there's no need to set S2.00 to S2.09 again. But If other motor is used, S2.00 to S2.09 should be set exactly.
2. ‘Parameter auto-tuning’ S2.10 is ‘1: Auto tuning with running motor’ and over current or over voltage occurs, increase the value of parameters ‘Acceleration time 1’ b1.09 and ‘Deceleration time 1’ b1.10.
3. Ensure the motor is stopped before starting auto-tuning; otherwise auto-tuning may end in abnormal results.
4. In some cases, it is not possible to use auto-tuning. In such cases, accurate motor parameter values must be entered, to parameters S2.00 to S2.09.

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 to 20,000	Minimum unit	1
S2.13	Pulse encoder direction reverse		Factory default	1
	Setting range	0, 1	Minimum unit	1
S2.14	Pulse encoder fault detection threshold		Factory default	0.0
	Setting range	0.0 to 1,000.0 rpm (0.0 rpm: No break protection)	Minimum unit	0.1
S2.15	Pulse encoder fault detection time		Factory default	1.0
	Setting range	0.1 to 10.0 s	Minimum unit	0.1

Set parameters S2.12 to 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 speed command is larger than ‘Pulse encoder fault detection threshold’ [S2.14] and the actual speed is smaller than ‘Pulse encoder fault detection threshold’ [S2.14] and lasts for ‘ Pulse encoder fault detection time’ [S2.15], pulse encoder speed detection error (PULS) will occur on panel.
- This function is only active when converter is running in speed control or pressure control status, and inactive in torque control status.

S2.16	Motor thermal time constant		Factory default	SvP: 60.0 FcP: Model
	Setting range	1.0 to 1000.0 min Used together with E4.19	Minimum unit	0.1

- S2.16 is used to protect the motor against overheat with motor temperature model ([E4.19]=2).

  In FcP 5010 application, the default value restored in S2.16 is the MOT-FC motor thermal time constant with 100K temperature rise. If motor thermal model is used for overheat protection instead of temperature sensor, S2.16 should be set according to motor type, environmental temperature, cooling condition and other related conditions.

☞ When the motor overheating fault occurs, it is recommended to wait at least 30 minutes before running.

S2.17	Motor inertia		Factory default	Model
	Setting range	0.0000 to 0.5000 kgm^2	Minimum unit	0.0001
S2.18	Motor max. torque 1		Factory default	SvP: Model FcP: 0
	Setting range	0 to 1,000 Nm	Minimum unit	1
S2.19	Motor max. torque 2		Factory default	SvP: Model FcP: 0
	Setting range	0 to 1,000 Nm	Minimum unit	1
S2.20	Lowpass filter time for Acc./Dec. adaptive		Factory default	SvP: 20 FcP: 0
	Setting range	0 to 999 ms	Minimum unit	1
S2.21	Adaptive Acc./Dec. time enable		Factory default	0
	Setting range	0, 1	Minimum unit	1

Parameters S2.17 to S2.21 are used to configure the function of adaptive acceleration/deceleration.

S2.17 is used to set the rotational inertia value of motor.

S2.18 is used to set the max. output torque of motor when it runs with the base frequency [S2.00].

S2.19 is used to set the max. output torque of motor when it runs with the maximum frequency [b1.05].

In Sytronix application, the relationship between the max. motor output torque and running frequency are simplified into linearity, as shown below:

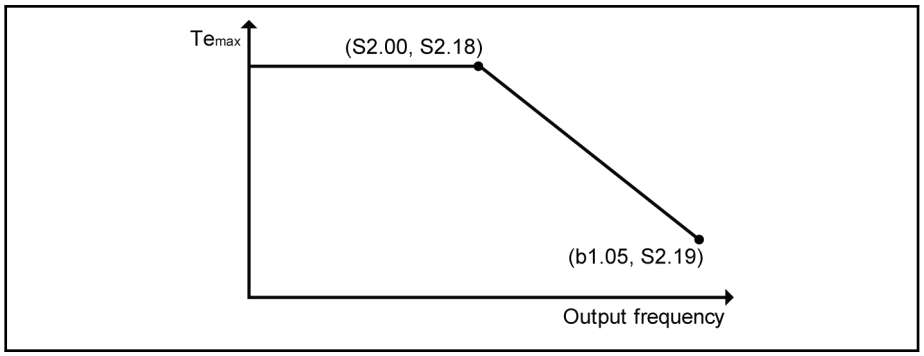


Fig. 7-25: Relationship of motor Max. output torque and running frequency

In the figure above, the horizontal axis indicated the frequency converter output frequency, and the vertical axis indicates the max. motor output torque. When the motor runs with the base frequency, the torque is a constant value; When the output frequency is higher than the base frequency, the max. motor torque will reduce linearly.

S2.21 is used to enable or disable the adaptive Acc./Dec. function, aiming to improve the motor speed response and decrease the pressure overshoot in sytronix application.

[S2.21]	Acc./Dec. Time
0	[b1.09]/[b1.10]
1	Adaptive Acc./Dec. time

Adaptive Acc./Dec. time=f(P_act, S2.17, S2.18, S2.19, S2.23, S2.24)

P_act: Actual pressure value filtered by S2.20.

In SvP 5010 application, default values of S2.17 to S2.21 have been well set, so there's no need to adjust them again. In FcP 5010 application, adaptive Acc./Dec. function is not recommended.

S2.22	Pump type		Factory default	SvP: Depends on model and S2.36 FcP: 0
	Setting range	0 to 12	Minimum unit	1
S2.23	Pump Vg1		Factory default	SvP: Pump type FcP: 0
	Setting range	0 to 250 ccm	Minimum unit	1
S2.24	Pump inertia		Factory default	SvP: Pump type FcP: 0
	Setting range	0.0000 to 0.1000 kgm^2	Minimum unit	0.0001
S2.25	Pump maximum critical pressure		Factory default	SvP: Pump type FcP: 0
	Setting range	0.00 to 650.00 bar	Minimum unit	0.01

Parameter Settings

S2.26	Pump maximum continuous pressure		Factory default	SvP: Pump type FcP: 0
	Setting range	0.00 to 350.00 bar	Minimum unit	0.01
S2.27	Pump Vg2		Factory default	0
	Setting range	0 to 250 ccm	Minimum unit	1
S2.34	Pump power		Factory default	SvP: Model FcP: 0.00
	Setting range	0.00 to 300.00 kW	Minimum unit	0.01

In Sytronix SvP application, altogether twelve types of Rexroth constant pump parameters (PGM4, PGM5 series) have been stored in parameters S2.23 to S2.27, and S3.34 which change with S2.22. If other type pump is used, set S2.22 to 0 and S2.36 to 2 firstly, then input pump parameters to S2.23-S2.27, S2.34.

For constant pump, S2.23 is used to set the pump displacement. For two-point pump, S2.23 is to set the maximum pump displacement while S2.27 is to set the minimum displacement. For double pump, S2.23 is to set the displacement of the first pump while S2.27, the second.

S2.25 is used to set the maximum instantaneous outlet pressure of the pump.

S2.26 is used to set the maximum outlet pressure when pump works continuously.

S2.34 is used to set the pump rated power.

S2.30	User input Max. pressure monitoring		Factory default	200.00
	Setting range	0.00 to 350.00 bar	Minimum unit	0.01

Parameter S2.30 is to limit the maximum pressure command user inputs. The smaller value between [S2.26] 'Pump maximum continuous pressure' and [S2.30] 'User input Max. pressure monitoring' is considered as the maximum permissible pressure for the system.

S2.28	Maximum pressure error upper limitation		Factory default	15.00
	Setting range	0 to 350.00 bar	Minimum unit	0.01
S2.29	Maximum pressure error lower limitation		Factory default	10.00
	Setting range	0 to 350.00 bar	Minimum unit	0.01
S2.31	Pump control mode		Factory default	0
	Setting range	0 to 2	Minimum unit	1
S2.32	Pump logic selection		Factory default	0
	Setting range	0, 1	Minimum unit	1
S2.33	Speed switching threshold adjustment		Factory default	0.9
	Setting range	0.1 to 1.0	Minimum unit	0.1

Choose different control mode and logic according to the type of pump.

- S2.31=0 Constant pump

When[S2.31]=0, relay Pa,Pb,Pc can be used as multi-function output.

- S2.31=1 two-point pump or S2.31=2 double pump

  When[S2.31]=1 or 2, relay Pa, Pb, Pc can only be used for switching displacement of two-point pump or double pump. Multi-function output is inactive.

If [S2.32]='0:Positive', action logic of relay is shown in the figure below. When relay Pa, Pb, Pc acts, data set[2] is selected as p/Q PID parameters instead of data set[1]. If [S2.32]='1:Negative', action logic of relay is contrary to that in the figure shown below. When relay Pa, Pb, Pc acts, data set[1] is selected as p/Q PID parameters instead of data set[2].

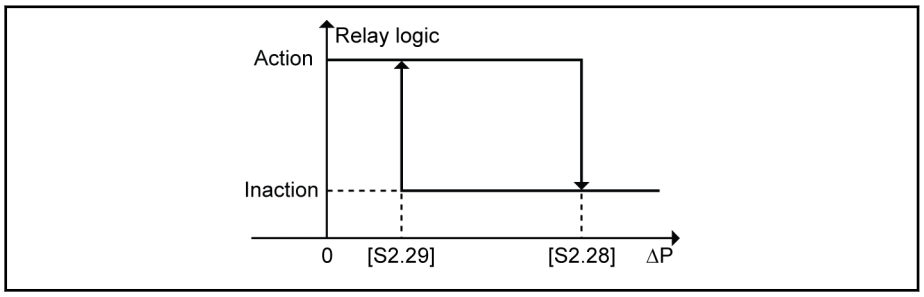


Fig. 7-26: Action logic of relay when pump actual speed is less than nth

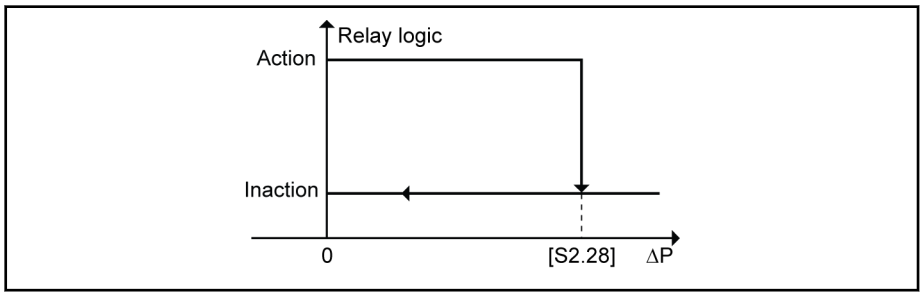


Fig. 7-27: Action logic of relay when pump actual speed is bigger than nth

ΔP=pressure command – pressure feedback

nth=[S2.33] * [E2.60]* V_{gmin} / V_{gmax}

For two-point pump: V_{gmax}=[S2.23], V_{gmin}=[S2.27]

For double pump: V_{gmax}=[S2.23] + [S2.27], V_{gmin}=[S2.23]

Application example:

24V power supply, normal open relay terminal Pa, Pb and Rexroth two-point pump controller is connected in series, [S2.31] is set to '1: two-point pump' and [S2.32] is set to '0: Positive', when ΔP and nth satisfy the condition of relay action, pump switches to the minimum displacement.

S2.35	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
S2.36	System type		Factory default	SvP: 0 FcP: 2
	Setting range	0, 1, 2	Minimum unit	1

- [S2.36]=0: SvP S series; [S2.36]=1: SvP E series; [S2.36]=2: Other series

When [S2.36]=2, parameters S2.22 to S2.27, and S2.34 will be set to 0 automatically, for users to input the third party pump parameters.

Parameter Settings

Group S3: Control parameters

S3.00	Jog frequency		Factory default	5.00
	Setting range	0.00 to [b1.05] Hz	Minimum unit	0.01
S3.01	Jog acceleration time		Factory default	0.50
	Setting range	0.10 to 360.00 s	Minimum unit	0.01
S3.02	Jog deceleration time		Factory default	0.10
	Setting range	0.10 to 360.00 s	Minimum unit	0.01

- 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.

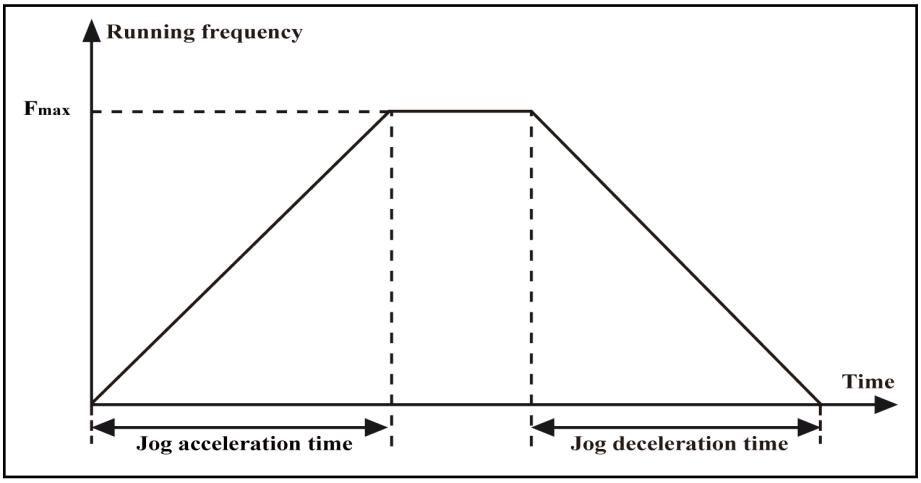


Fig. 7-28: Jog frequency setting

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

Jog is inactive in torque control mode.

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

- During acceleration/deceleration the function is inactive (only available for steady state output).
- Do not make the three skip frequency ranges overlap or nest in each other.

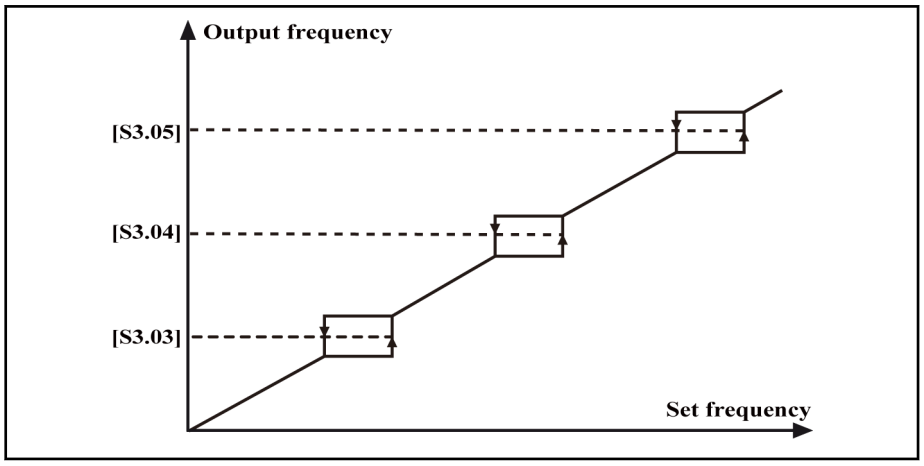


Fig. 7-29: Skip frequencies and ranges

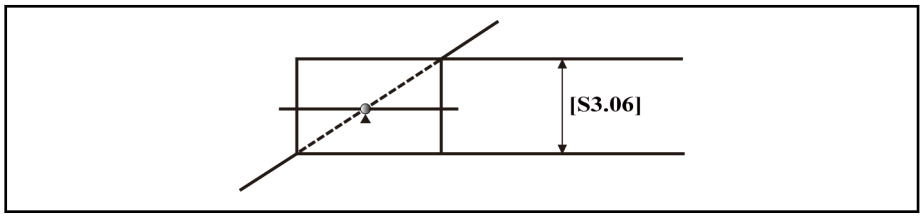


Fig. 7-30: Frequency output forbidden point

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 to 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: Inactive

  No restart after power off or power fault.

- 1: Active

  Restart after power off or power fault.

  – For a running frequency converter, when ‘frequency converter control commands’ b1.02 is ‘0: Set control commands via operating panel’ and no stop signal input:
    – If parameter [S3.07]=1, the frequency converter will automatically start.
    – 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 via digital inputs’ or ‘2: Set control commands via 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].
– 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 via digital inputs’, do not change the state of digital inputs during power off or power fault.

⚠ WARNING **Ensure running safety!**

S3.09	Forward/reserve dead time		Factory default	0.0
	Setting range	0.0 to 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.

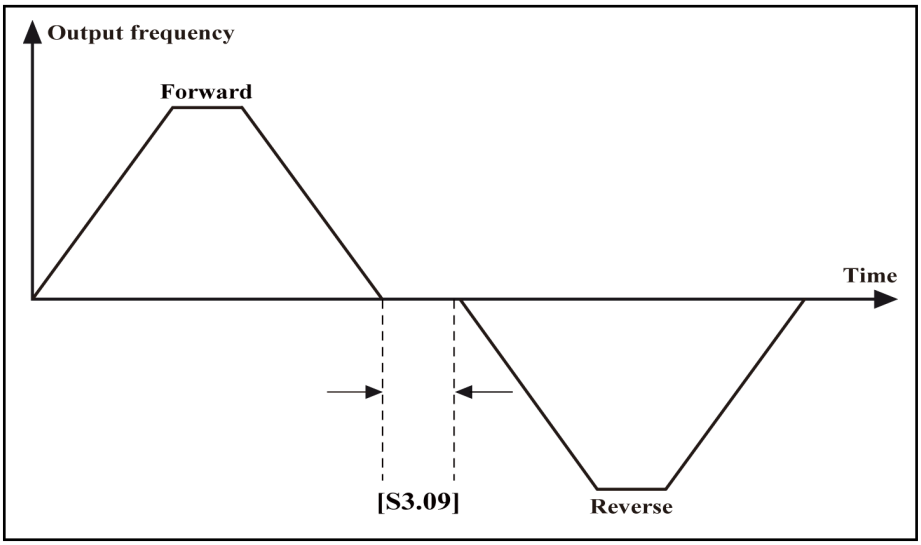


Fig. 7-31: Forward/reserve dead time

S3.10	Droop control		Factory default	0.00
	Setting range	0.00 to 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 of output power distribution.

- When a frequency converter is subject to a too high 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.

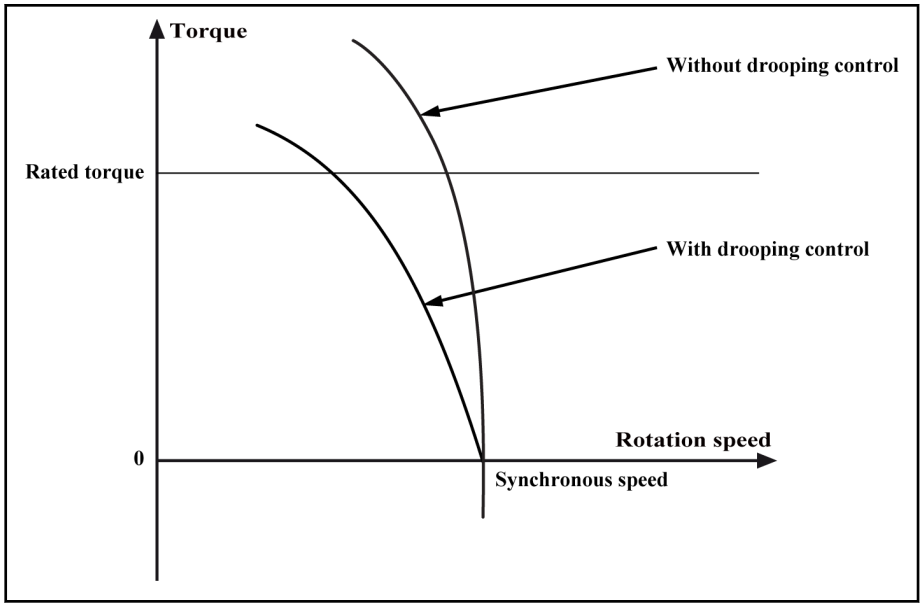


Fig. 7-32: Droop control

S3.11	Setting rate via **Up/Down**		Factory default	1.00
	Setting range	0.10 to 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	660
	Setting range	600 to 785 V	Minimum unit	1
S3.13	Braking duty cycle		Factory default	100
	Setting range	0 % to 100 %	Minimum unit	1

- Only for models with an internal brake chopper.
- 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 rotation direction control		Factory default	SvP: 0 FcP: 1
	Setting range	0, 1, 2	Minimum unit	1

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

- 0: Forward direction
- 1: Reverse direction
- 2: Reverse direction disabled

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

- 0: Valid only for operating panel control

– **Stop** key is only valid when ‘frequency converter control commands’ b1.02 is set to ‘0: Set control commands via operating panel’.

- 1: Valid for all control means
  – **Stop** key is valid for all settings of ‘frequency converter control commands’ b1.02.

- **Stop** key as a fault 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, in order to restart the frequency converter, the external commands have to be disabled first.

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

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

S3.17	Brake chopper protect threshold		Factory default	50
	Setting range	0 to 250 V	Minimum unit	1

When actual mains voltage is bigger than the rated, and S3.12 Brake chopper threshold is set too low, the brake chopper will action wrongly even in stop state.

S3.17 is used to solve this problem. In stop state, when the condition 'V_{dc} + [S3.17] > [S3.12]' (V_{dc} is the DC bus voltage) is met and lasts for 3 seconds, a fault of B.T.L. will occur on panel. That means S3.12 Brake chopper threshold is set too low. Increase [S3.12] or decrease [S3.17] to remove the fault. When [S3.17] is set to 0, this function is inactive.

This function is only active for 15.0 kW and the below models with internal brake chopper.

7.4.3 Category E: Extended Parameters

Group E0: Analog and digital inputs

E0.00	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
E0.01	Digital input X1		Factory default	0
	Setting range	0 to 25	Minimum unit	1
E0.02	Digital input X2		Factory default	1
	Setting range	0 to 25	Minimum unit	1
E0.03	Digital input X3		Factory default	21
	Setting range	0 to 25	Minimum unit	1
E0.04	Digital input X4		Factory default	2
	Setting range	0 to 25	Minimum unit	1
E0.05	Digital input X5		Factory default	23
	Setting range	0 to 25	Minimum unit	1
E0.06	Digital input X6		Factory default	0
	Setting range	0 to 25	Minimum unit	1
E0.07	Digital input X7		Factory default	SvP: 20 FcP: 0
	Setting range	0 to 25	Minimum unit	1
E0.08	Digital input X8		Factory default	19
	Setting range	0 to 25	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 (no active) to avoid malfunction.
- 1: bit 1 of parameter selection
- 2: bit 2 of parameter selection

  See details in chapter 6.3 "System Commission" on page 61.
- 3: Reserved
- 4: Reserved
- 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. 7-6: Multi-speed acceleration/deceleration time

- 7: p/Q mode and flow mode switch

  If digital input is active, frequency converter works in flow mode, then flow command is used as setting speed.

- 8: Freewheel to stop activated
  - 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 command
- 10: Frequency decrement Down command
  - These two inputs are used to change the set frequency with digital inputs Up/Down. See parameters b1.00 and S3.11.
- 11: Zeroing of set frequency via digital inputs
  - Used to clear the set frequency with digital inputs Up/Down and change the set frequency to 0.
- 12: Reserved
- 13: Activate DC brake
  - When the output frequency reaches the stop DC brake activation frequency, the frequency converter decelerate to stop, this input is active and the frequency converter directly switches to the stop DC brake status. See parameters b1.21 and b1.23. Parameter b1.22 is inactive in this case.
- 14: Switch between control with operating panel and with digital inputs
  - Used to switch between control with operating panel and with digital inputs, when [b1.02]=0 or [b1.02]=1.
- 15: Reserved
- 16: Reserved
- 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 [S1.04]= 0, the digital input is disconnected to activate speed control; and when the digital input is connected to activate torque control.

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

- 18: Reserved
- 19: Brake chopper overheat N.O. contact input
  – Once receiving the fault signal of "Bake chopper overheat", the frequency converter responses with ‘B.O.H.’ alarm and stops.
- 20: Motor overheat N.C. contact input
  – Once receiving the fault signal of "Motor overheat", the frequency converter responses with ‘M.O.H’ alarm and stops.
- 21: External reset input
  – Same like reset with operating panel.
  – Allows remote fault reset.
- 22: Activate communication control
  – Used to switch between control with operating panel and with communication, when [b1.02]=0.
  – Used to switch between control with digital inputs and with communication, when [b1.02]=1.
- 23: Master/slave pump mode switch

  In master/slave pump application, a slave pump can switch dynamically between master pump and slave pump mode, controlled by digital terminals(X5 default).

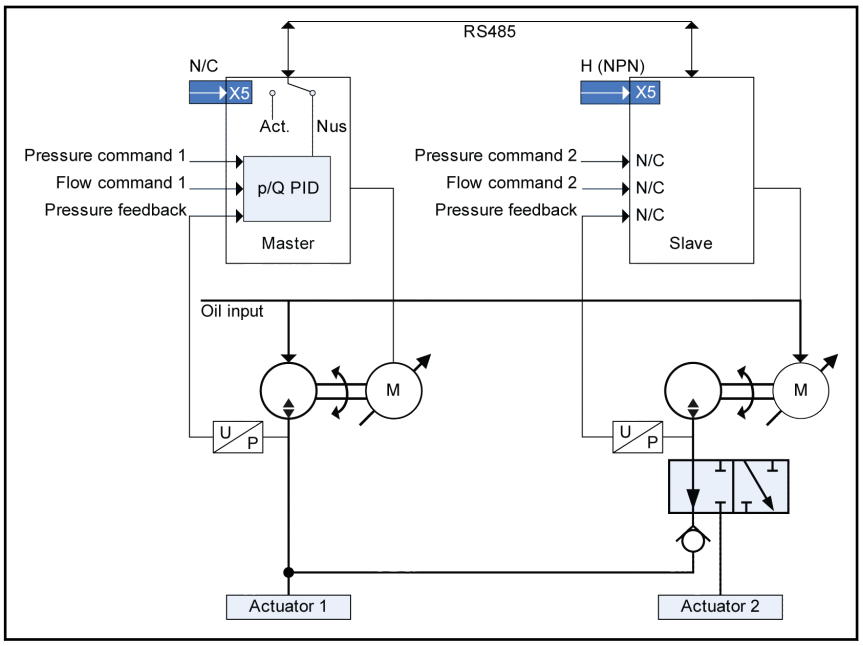


Fig. 7-33: Slave flow mode application

As shown in figure above, X5 relay is off or in high level (NPN mode), then slave pump works in slave pump mode, following master pump's speed/flow command and acting on actuator1. Pressure command, flow command and pressure feedback signals for slave pump are not used. The check valve is used, so E2.64 must be set to 0 or higher.

Parameter Settings

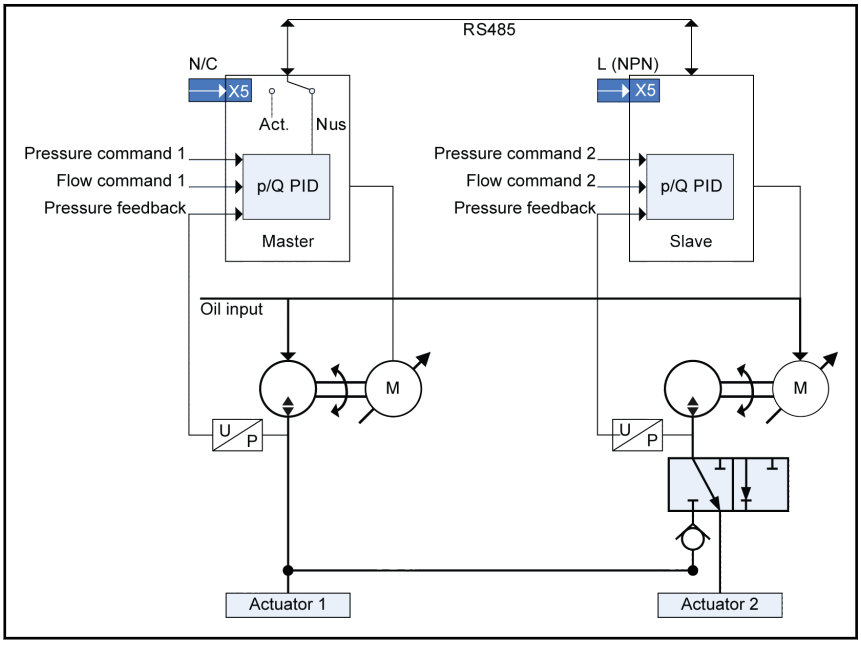


Fig. 7-34: Master flow mode application

As shown in figure above, X5 relay is on or in low level (NPN mode), then slave pump works in master pump mode, an independent hydraulic system acting on actuator 2 can be supplied. Pressure command, flow command, and pressure feedback signals are used for p/Q PID controller, E2.64 is also invalid. For master pump, of which the local address H0.03 is set to 1, X5 is invalid. When slave pump is in switch pump mode, E2.65 should be properly set to wait for reversing valve's action.

- 24: Anti pressure shoot in injection stage 1
- 25: Anti pressure shoot in injection stage 2

  For SvP 5010 application, in injection stage easy to cause pressure overshoot, enable the anti pressure shoot function through digital input to reduce the overshoot. And in other phases, disable this function to prevent its impact on pressure dynamic response.

E0.09	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
E0.10	Flow command factor		Factory default	SvP: Model FcP: 240
	Setting range	0.0 to 1,000.0 rpm/V	Minimum unit	0.1
E0.11	Pressure command factor		Factory default	SvP: 17.50 FcP: 10.00
	Setting range	0.00 to 65.00 bar/V	Minimum unit	0.01
E0.12	Pressure feedback factor		Factory default	25.25
	Setting range	0.00 to 65.00 bar/V	Minimum unit	0.01

- E0.10 is used to set the factor that converts the analog signal of VR1 to the flow (speed) command value.
  - Flow command value = VR1 × [E0.10]
- E0.11 is used to set the factor that converts the analog signal of VR2 to the pressure command value.

– Pressure command value = VR2 × [E0.11]

- E0.12 is used to set the factor that converts the analog signal of VR3 to the pressure feedback value.
  – Pressure feedback value = VR3 × [E0.12]

E0.13	Channel +I amplification factor K3		Factory default	1.00
	Setting range	0.00 to 10.00	Minimum unit	0.01
E0.14	Channel +I filter time		Factory default	0.100
	Setting range	0.000 to 2.000 s	Minimum unit	0.001
E0.15	Maximum input pulse frequency		Factory default	20.0
	Setting range	1.0 to 50.0 kHz	Minimum unit	0.1
E0.16	Characteristic curve minimum reference		Factory default	0.0
	Setting range	0.0 % to [E0.18]	Minimum unit	0.1
E0.17	Frequency corresponding to characteristic curve minimum reference		Factory default	0.00
	Setting range	0.00 to [b1.06] Hz	Minimum unit	0.01
E0.18	Characteristic curve maximum reference		Factory default	100.0
	Setting range	[E0.16] to 100.0 %	Minimum unit	0.1
E0.19	Frequency corresponding to characteristic curve maximum reference		Factory default	50.00
	Setting range	0.00 to [b1.06] Hz	Minimum unit	0.01

- When +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.

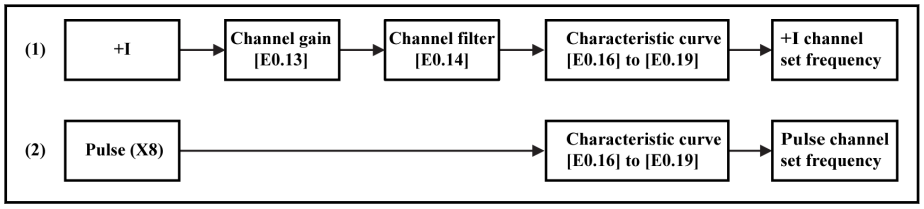


Fig. 7-35: Reference frequency channel and reference frequency

- For reference frequency signals of after gain and filter processing, their relationship with the set frequencies is determined by characteristic curve which is defined with E0.16 to E0.19. The characteristic curve can independently realize positive and negative actions, as shown in figure below.

Parameter Settings

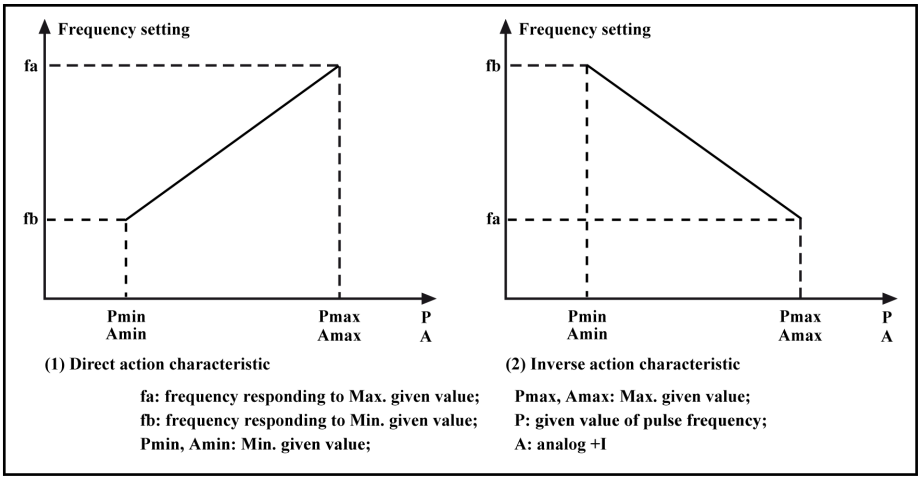


Fig. 7-36: Output frequency characteristics curves

- Analog input A being 100 % corresponds to 20 mA, and pulse frequency P being 100 % corresponds to the maximum input pulse frequency defined with E0.15.
- Parameter E0.14 is used to define the channel +I filter time constant for processing of input signals. Longer filter time means stronger anti-interference capability and slower response; shorter filtering time means weaker anti-interference capability and faster response.

Group E1: Analog and digital outputs

E1.00	Open collector output OUT1		Factory default	1
	Setting range	0 to 17	Minimum unit	1
E1.01	Open collector output OUT2		Factory default	9
	Setting range	0 to 17	Minimum unit	1
E1.02	Relay outputs Pa, Pb and Pc		Factory default	7
	Setting range	0 to 17	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 fault 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.
- 5: Frequency level detection signal (FDT1)
  - See related parameters E1.04 to E1.05.
- 6: Frequency level detection signal (FDT2)
  - See related parameters E1.06 to E1.07.
- 7: Frequency converter fault
  - Output indicating signal when the frequency converter is in fault.
- 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.
- 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 over load pre-warning 2

Output indicating signal when a load with K1 times of rated current is applied to the frequency converter for T1 seconds long. Fault O.L.-3 occurs on the display at the same time. Fault O.L.-1 will occur if this load keeps for another T2 seconds long. The relationship of K1 and T1, T2 is shown below:

Load K1 (%)	T1/s	T2/s
110 to 115	3,600	360
116 to 120	1,800	180
121 to 130	600	60
131 to 140	300	30
141 to 150	60	6
151 to 160	30	3
161 to 170	20	2
171 to 180	10	1
181 to 190	5	0.5
191 to 200	1	0.1

Tab. 7-7: Relationship of K1 and T1, T2

- 13: Fault auto reset signal output
  - Output indicating signal when the frequency converter attempts to auto reset.
- 14: Over pressure pre-alarm
- 15: Reserved
- 16: Flow command in limitation
- 17: Pressure command in limitation

For details on setting value of 14,16 and 17, please see E4.21 description.

If [S2.31]=1 or 2, relay Pa, Pb, Pc are used for two-point pump or double pump control. The function of relay outputs is inactive.

E1.03	Frequency arrival detection width		Factory default	5.0
	Setting range	0.0 % to 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 to E1.02 are set to ‘4: Frequency/speed arrival signal’, the difference between the output frequency and the set frequency is within the setting range, and the output indicating signals are shown in figure below.

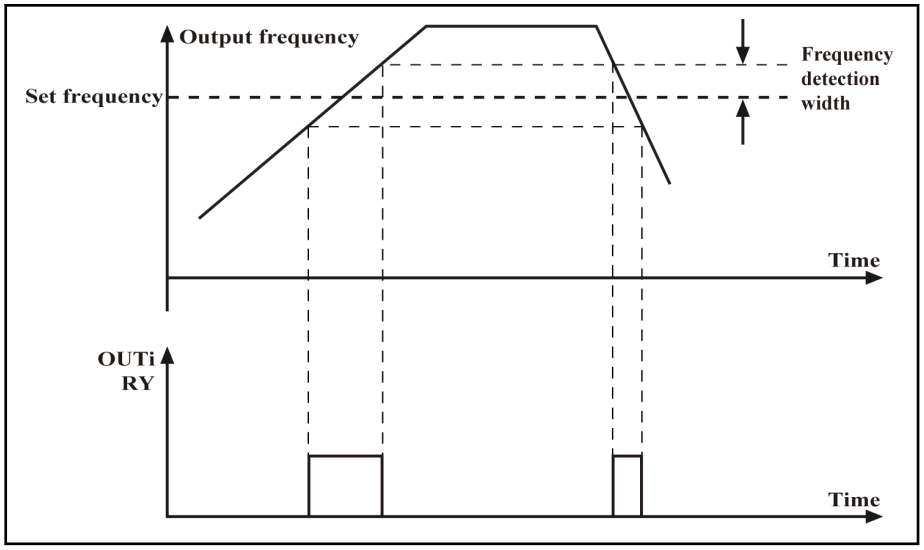


Fig. 7-37: Frequency arrival signal

E1.04	Frequency detection level FDT1		Factory default	90.0
	Setting range	0.0 % to 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 % to 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 % to 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 % to 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 to 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

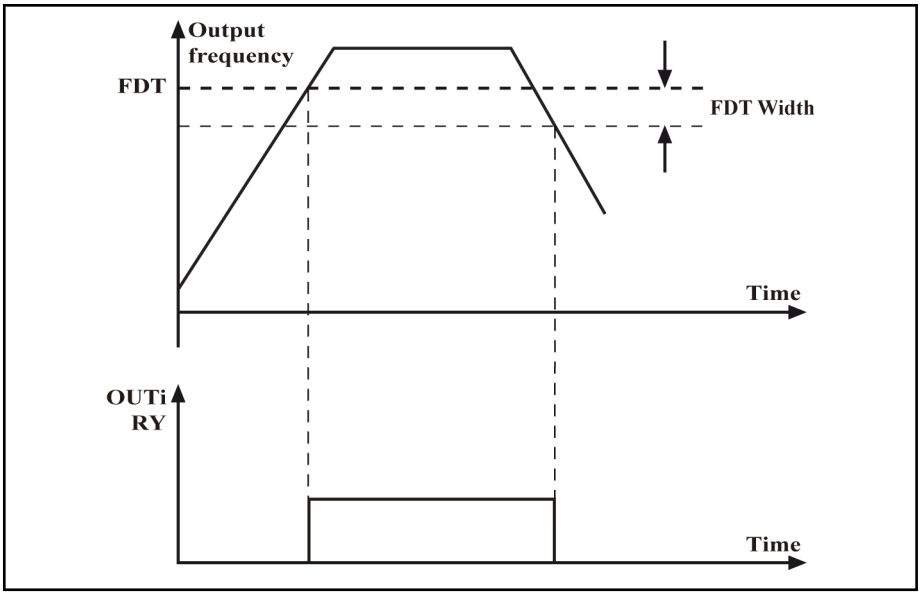


Fig. 7-38: Frequency level detection signal

E1.08	Frequency converter over load pre-warning 1 level setting		Factory default	95.0
	Setting range	20.0 % to 100.0 % (of rated frequency converter current)	Minimum unit	0.1

Output indicating signal when parameters E1.00 to E1.02 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'.

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

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

E1.10	FM1 analog outputs		Factory default	SvP: 6 FcP: 0
	Setting range	0 to 7	Minimum unit	1
E1.11	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
E1.12	FM1 gain setting		Factory default	0.92
	Setting range	0.00 to 10.00	Minimum unit	0.01
E1.13	FM1 negative gain setting		Factory default	0.92
	Setting range	0.00 to 10.00	Minimum unit	0.01

- Output voltage signal: -10 to 10 V
- Output current signal: 0 to 20 mA

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

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

[E1.10]	Outputs	Range
0	Output frequency/ rotation speed	0 to maximum output frequency/rotation speed, corresponding to 0 to 10 V / 0 to 20 mA analog outputs
1	Reference frequency/ rotation speed	0 to maximum reference frequency/rotation speed, corresponding to 0 to 10 V / 0 to 20 mA analog outputs
2	Output current	0 to 2 times of rated current, corresponding to 0 to 10 V / 0 to 20 mA analog outputs
3	Torque current	0 % to 200 % of rated torque current, corresponding to 0 to 10 V / 0 to 20 mA analog outputs
4	Output voltage	0 to 1.2 times of rated voltage, corresponding to 0 to 10 V / 0 to 20 mA analog outputs
5	Output pressure	0 to maximum output pressure ([E0.12] × 10 V) corresponding to 0 to 10 V / 0 to 20 mA analog outputs.
6	Output frequency/ rotation speed (including direction)	Maximum output frequency/rotation speed (reverse direction) to 0 to maximum output frequency/ rotation speed (forward direction) corresponding to -10 V to10 V analog outputs.
7	Set frequency/rotation speed (including direction)	Maximum reference frequency/rotation speed (reverse direction) to 0 to maximum reference frequency/rotation speed (forward direction) corresponding to -10 V to10 V analog outputs.

Tab. 7-8: Meanings of analog outputs

In different control mode, output frequency/rotation speed has different meanings.

Control mode	The meaning of output frequency/rotation speed
V/f	Converter output frequency (Hz) / synchronous speed (rpm)
SVC	Estimated value of motor rotation speed (rpm)
FOC	Feedback speed of PG (rpm)

- Parameter ‘FM1 gain setting’ E1.12 is used to set the gain of FM1 positive output voltage.
- Parameter ‘FM1 negative gain setting’ E1.13 is used to set the gain of FM1 negative output voltage.

E1.14	FM2 analog outputs		Factory default	5
	Setting range	0 to 5	Minimum unit	1

Parameter Settings

E1.15	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1
E1.16	FM2 gain setting		Factory default	0.92
	Setting range	0.00 to 10.00	Minimum unit	0.01

For details of E1.14 and E1.16, refer to descriptions of parameters E1.10 and E1.12.

E1.17	Pulse outputs		Factory default	0
	Setting range	0 to 2	Minimum unit	1
E1.18	Maximum output pulse frequency		Factory default	20.0
	Setting range	1.0 to 50.0 kHz	Minimum unit	0.1

DO pulse frequency output range: 0 to [E1.18] kHz.

- If parameter ‘Pulse outputs’ E1.17 is set to ‘0: Output frequency’, when the output frequency reaches the maximum frequency, the corresponding set value of parameter ‘Maximum output pulse frequency’ E1.18 is output via output DO.
- If parameter ‘Pulse outputs’ E1.17 is set to ‘1: Output voltage’, when the output voltage reaches 500 V, the corresponding set value of parameter ‘Maximum output pulse frequency’ E1.18 is output via output DO.
- If parameter ‘Pulse outputs’ E1.17 is set to ‘2: Output current’, when the output current reaches the rated current, the corresponding set value of parameter ‘Maximum output pulse frequency’ E1.18 is output via output DO.

Group E2: Sytronix p/Q functions

E2.00	Acceleration time 2		Factory default	0.20
	Setting range	0.10 to 360.00 s	Minimum unit	0.01
E2.01	Deceleration time 2		Factory default	SvP: 0.10 FcP: 0.30
	Setting range	0.10 to 360.00 s	Minimum unit	0.01
E2.02	Acceleration time 3		Factory default	SvP: 0.30 FcP: 0.50
	Setting range	0.10 to 360.00 s	Minimum unit	0.01
E2.03	Deceleration time 3		Factory default	SvP: 0.10 FcP: 0.50
	Setting range	0.10 to 360.00 s	Minimum unit	0.01
E2.04	Acceleration time 4		Factory default	SvP: 0.50 FcP: 1.00
	Setting range	0.10 to 360.00 s	Minimum unit	0.01
E2.05	Deceleration time 4		Factory default	SvP: 0.10 FcP: 1.00
	Setting range	0.10 to 360.00 s	Minimum unit	0.01

- 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 parameters E0.01 to E0.08.

Group E2 offers 40 parameters (E2.06 to E2.45) to store 4 data sets of individual settings for p/Q PID controller . Each of them can be selected via X2 and X4 inputs.

4 sets of p/Q PID control parameters (E2.06 to E2.45) are available in group E2. The activation of these parameters are decided by the binary logic of digital inputs X2 (Parameter Set1) and X4 (Parameter Set2). The table below shows the parameters assigned to each data set.

Data set	Parameters
Set[0]	E2.06 to E2.15
Set[1]	E2.16 to E2.25
Set[2]	E2.26 to E2.35
Set[3]	E2.36 to E2.45

Tab. 7-9: p/Q PID controller data sets

The activation of the p/Q PID parameters should be based on machine sizes and/or axes, see chapter 6.3 "System Commission" on page 61.

In E2 group, if parameters of filter time constant are set to 0 ms, the corresponding filter will be inactive.

Parameter Settings

E2.06	Lowpass Filter time for adaptive Kp [0]		Factory default	10
	Setting range	0 to 999 ms	Minimum unit	1
E2.16	Lowpass Filter time for adaptive Kp [1]		Factory default	10
	Setting range	0 to 999 ms	Minimum unit	1
E2.26	Lowpass Filter time for adaptive Kp [2]		Factory default	10
	Setting range	0 to 999 ms	Minimum unit	1
E2.36	Lowpass Filter time for adaptive Kp [3]		Factory default	10
	Setting range	0 to 999 ms	Minimum unit	1

Used to set the filter time for the output of proportional element if adaptive Kp function is enabled.

When the pressure command suddenly changes, proper LPF_Time can smooth the output of proportional element, to prevent pressure vibration. While larger value of the filter time may result in pressure control lag.

E2.07	Proportional gain [0]		Factory default	SvP: Model FcP: 8.00
	Setting range	0.00 to 500.00 rpm/bar	Minimum unit	0.01
E2.17	Proportional gain [1]		Factory default	SvP: Model FcP: 8.00
	Setting range	0.00 to 500.00 rpm/bar	Minimum unit	0.01
E2.27	Proportional gain [2]		Factory default	SvP: Model FcP: 8.00
	Setting range	0.00 to 500.00 rpm/bar	Minimum unit	0.01
E2.37	Proportional gain [3]		Factory default	SvP: Model FcP: 8.00
	Setting range	0.00 to 500.00 rpm/bar	Minimum unit	0.01

Used to set the proportional gain of p/Q PID controller. The larger of proportional gain, the faster of pressure response; but too large of proportional gain leads to pressure overshot and oscillation.

E2.08	Pressure deviation for TI switch [0]		Factory default	SvP: 10.00 FcP: 0.00
	Setting range	0.00 to 150.00 bar	Minimum unit	0.01
E2.18	Pressure deviation for TI switch [1]		Factory default	SvP: 10.00 FcP: 0.00
	Setting range	0.00 to 150.00 bar	Minimum unit	0.01
E2.28	Pressure deviation for TI switch [2]		Factory default	SvP: 10.00 FcP: 0.00
	Setting range	0.00 to 150.00 bar	Minimum unit	0.01

E2.38	Pressure deviation for TI switch [3]		Factory default	SvP: 10.00 FcP: 0.00
	Setting range	0.00 to 150.00 bar	Minimum unit	0.01
E2.11	Intergal time [0]		Factory default	SvP: 80 FcP: Model
	Setting range	0 to 999 ms	Minimum unit	1
E2.21	Intergal time [1]		Factory default	SvP: 80 FcP: Model
	Setting range	0 to 999 ms	Minimum unit	1
E2.31	Intergal time [2]		Factory default	SvP: 80 FcP: Model
	Setting range	0 to 999 ms	Minimum unit	1
E2.41	Intergal time [3]		Factory default	SvP: 80 FcP: 0
	Setting range	0 to 999 ms	Minimum unit	1
E2.15	Intergal time 2 [0]		Factory default	0
	Setting range	0 to 999 ms	Minimum unit	1
E2.25	Intergal time 2 [1]		Factory default	0
	Setting range	0 to 999 ms	Minimum unit	1
E2.35	Intergal time 2 [2]		Factory default	0
	Setting range	0 to 999 ms	Minimum unit	1
E2.45	Intergal time 2 [3]		Factory default	0
	Setting range	0 to 999 ms	Minimum unit	1

Intergal time and Intergal time 2 are both time constant for integration of p/Q PID controller. They are selected according to the pressure deviation (pressure command-pressure feedback).

The logic is shown as below:

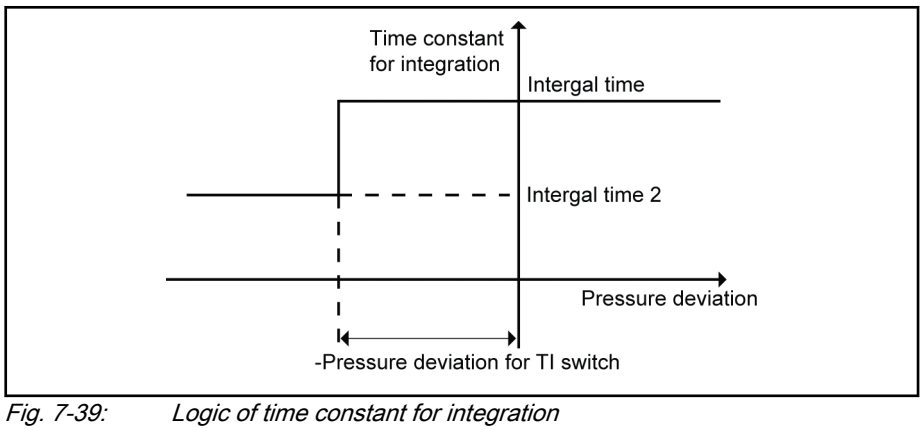


Fig. 7-39: Logic of time constant for integration

If TI_2 is set to 0 ms, integral time constant is fixed at TI. If TI is set to 0 ms, the integrator with TI is inactive. Then TI_2 is used as the only integral time constant if it is not 0 ms.

Parameter Settings

E2.09	Differential gain [0]		Factory default	SvP: Model FcP: 1.000
	Setting range	0.000 to 1.000 (rpm/bar)*s	Minimum unit	0.001
E2.19	Differential gain [1]		Factory default	SvP: Model FcP: 1.000
	Setting range	0.000 to 1.000 (rpm/bar)*s	Minimum unit	0.001
E2.29	Differential gain [2]		Factory default	SvP: Model FcP: 1.000
	Setting range	0.000 to 1.000 (rpm/bar)*s	Minimum unit	0.001
E2.39	Differential gain [3]		Factory default	SvP: Model FcP: 0.000
	Setting range	0.000 to 1.000 (rpm/bar)*s	Minimum unit	0.001

Used to set differential gain of p/Q PID controller. The larger of differential gain, the smaller pressure overshoot, but the slower of the pressure response. Too larger differential gain will cause the system to destabilize.

If there is large pressure overshoot, increasing lowpass filter time for Kd, decreasing proportional gain or increasing lowpass filter time of pressure rising up (E2.46, E2.67, E2.69, E2.71) can reduce the overshoot.

E2.10	Lowpass Filter time for Kd [0]		Factory default	35
	Setting range	0 to 999 ms	Minimum unit	1
E2.20	Lowpass Filter time for Kd [1]		Factory default	35
	Setting range	0 to 999 ms	Minimum unit	1
E2.30	Lowpass Filter time for Kd [2]		Factory default	35
	Setting range	0 to 999 ms	Minimum unit	1
E2.40	Lowpass Filter time for Kd [3]		Factory default	35
	Setting range	0 to 999 ms	Minimum unit	1

Used to set the filter time for differential element of the p/Q PID controller. Proper Lowpass Filter time for Kd [2] can suppress the high frequency oscillations of differential element, while larger value of the filter time may cause pressure control lag.

E2.12	Upper limiation of I+D [0]		Factory default	SvP: Model FcP: 2,800
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1

E2.22	Upper limiation of I+D [1]		Factory default	SvP: Model FcP: 2,800
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.32	Upper limiation of I+D [2]		Factory default	SvP: Model FcP: 2,800
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.42	Upper limiation of I+D [3]		Factory default	SvP: Model FcP: 2,800
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.13	Lower limiation of I+D [0]		Factory default	0
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.23	Lower limiation of I+D [1]		Factory default	0
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.33	Lower limiation of I+D [2]		Factory default	0
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.43	Lower limiation of I+D [3]		Factory default	0
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1

Used to set the maximum and minimum speeds of integral outputs to prevent from integral saturation.

E2.14	System minimal speed [0]		Factory default	SvP: -1,500 FcP: 0
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.24	System minimal speed [1]		Factory default	SvP: -1,500 FcP: 0
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.34	System minimal speed [2]		Factory default	SvP: -1,500 FcP: 0
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1
E2.44	System minimal speed [3]		Factory default	SvP: -1,500 FcP: 0
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1

Used to set minimum speed limit of p/Q PID controller output.

E2.51	Flow command offset		Factory default	0.00
	Setting range	0.00 to 9.00 V	Minimum unit	0.01
E2.52	Pressure command offset		Factory default	0.00
	Setting range	0.00 to 9.00 V	Minimum unit	0.01

Parameter Settings

E2.53	Pressure feedback offset		Factory default	0.10
	Setting range	0.00 to 9.00 V	Minimum unit	0.01

Used to perform a zero compensation for the analog inputs VR1,VR2 and VR3.

E2.46	Lowpass filter time pressure rising up [0]		Factory default	SvP: 120 FcP: 80
	Setting range	0 to 999 ms	Minimum unit	1
E2.67	Lowpass filter time pressure rising up [1]		Factory default	SvP: 140 FcP: 80
	Setting range	0 to 999 ms	Minimum unit	1
E2.69	Lowpass filter time pressure rising up [2]		Factory default	SvP: 160 FcP: 80
	Setting range	0 to 999 ms	Minimum unit	1
E2.71	Lowpass filter time pressure rising up [3]		Factory default	SvP: 180 FcP: 100
	Setting range	0 to 999 ms	Minimum unit	1

These parameters are used to set filter time constant for pressure command rising up stage.

E2.47	Lowpass filter time pressure dropping down [0]		Factory default	40
	Setting range	0 to 999 ms	Minimum unit	1
E2.68	Lowpass filter time pressure dropping down [1]		Factory default	SvP: 60 FcP: 40
	Setting range	0 to 999 ms	Minimum unit	1
E2.70	Lowpass filter time pressure dropping down [2]		Factory default	SvP: 80 FcP: 40
	Setting range	0 to 999 ms	Minimum unit	1
E2.72	Lowpass filter time pressure dropping down [3]		Factory default	100
	Setting range	0 to 999 ms	Minimum unit	1

These parameters are used to set filter time constant for pressure command dropping down stage.

E2.48	Lowpass filter time flow rising up		Factory default	2
	Setting range	0 to 999 ms	Minimum unit	1
E2.49	Lowpass filter time flow dropping down		Factory default	2
	Setting range	0 to 999 ms	Minimum unit	1
E2.50	Lowpass filter time pressure feedback		Factory default	4
	Setting range	0 to 999 ms	Minimum unit	1

Used to set the analog channel filter time constant for processing of input signals. A longer filter time means stronger anti-interference capability and slower response; a shorter filtering time means weaker anti-interference capability and faster response.

- E2.48: Filter time constant for flow command rising up stage.
- E2.49: Filter time constant for flow command dropping down stage.
- E2.50: Filter time constant for pressure feedback both rising up and dropping down stage.

E2.54	Minimum flow command		Factory default	40
	Setting range	0 to 1,000 rpm	Minimum unit	1
E2.55	Minimum pressure command		Factory default	5.00
	Setting range	0.00 to 100.00 bar	Minimum unit	0.01

- E2.54 is used to set the minimum limit of flow command.

  When the converter is running in flow mode or slave pump mode, E2.54 is inactive.
- E2.55 is used to set the minimum limit of pressure command.

E2.56	Kp gain upper limit		Factory default	SvP: 8.20 FcP: 10.00
	Setting range	0.00 to 500.00 rpm/bar	Minimum unit	0.01
E2.57	Pressure deviation lower for adaptive Kp		Factory default	60.00
	Setting range	0.00 to [E2.58] bar	Minimum unit	0.01
E2.58	Pressure deviation upper for adaptive Kp		Factory default	120.00
	Setting range	[E2.57] to 650.00 bar	Minimum unit	0.01
E2.59	Kp adaptive enable		Factory default	0
	Setting range	0, 1	Minimum unit	1

Adaptive Kp function is designed to improve the dynamic performance of pressure control and decrease the overshoot.

Taking set[0] for example: when E2.59 is set to 0, Kp parameter is fixed as E2.07. When E2.59 is set to 1, the Kp value variational curve is as shown in the figure below.

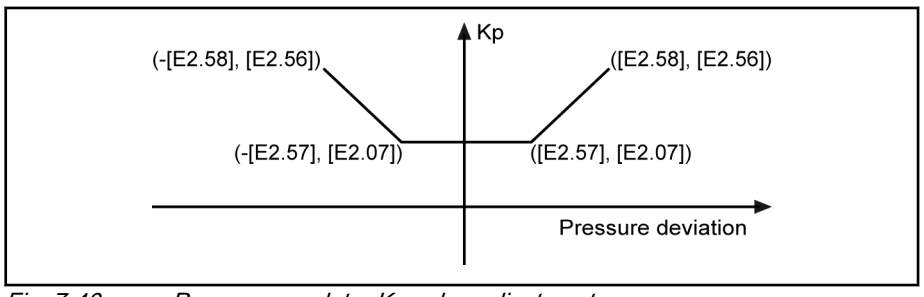


Fig. 7-40: Pressure regulator Kp value adjustment

Here, the horizontal axis is the deviation between pressure command and actual pressure, vertical axis is the Kp value relative to pressure deviation. The slope of Kp curve can be set by two group parameters, when the pressure deviation is less than [E2.57], the Kp will be limited to a constant value ([E2.07]), otherwise, it can be calculated with the formula: Kp=(Pressure deviation-[E2.57])*([E2.56]-[E2.07])/([E2.58]-[E2.57])+[E2.07].

Parameter Settings

E2.60	Maximum flow command limitation		Factory default	SvP: 2,500 FcP: 2,800
	Setting range	0 to 3,000 rpm	Minimum unit	1
E2.61	Maximum pressure command limitation		Factory default	SvP: 175.00 FcP: 250
	Setting range	0.00 to 650.00 bar	Minimum unit	0.01

These two parameters are used to limit the flow command and pressure command that user inputs. For details, please see E4.21 description.

E2.62	Slave pump number		Factory default	0
	Setting range	0 to 19	Minimum unit	1

In master/slave pump application, if [E2.62] > the actual slave pump number, master/slave pump communication fault (M/S C.) will be reported. If [E2.62] < the actual slave pump number, slave pumps with higher address will be out of control.

E2.63	Slave speed/flow command selection		Factory default	1
	Setting range	0, 1	Minimum unit	1

- [E2.63]=0: Feedback speed
  - When [b1.03]=0: V/f control, output synchronous speed of master pump frequency converter is selected as speed/flow command of slave pumps.
  - When [b1.03]=1: SVC control, master pump's estimated speed is selected as speed/flow command of slave pumps.
  - When [b1.03]=2: FOC control, master pump's PG feedback is selected as speed/flow command of slave pumps.
- [E2.63]=1: Command speed

  Master pump's p/Q speed/flow reference is selected as speed/flow command of slave pumps.

E2.64	Slave speed/flow command lower limit		Factory default	0
	Setting range	-3,000 to 3,000 rpm	Minimum unit	1

A check valve is suggested for slave pump to to avoid cavitation of the hydraulic replacer. As is shown in the figure below, for slave pump 3, E2.64 should be set to 0 rpm or slightly greater. If one pump, no matter master or slave, has fault, the whole system can stop running automatically, then the check valve is not needed for slave pump, such as slave pump 2 in the figure below. So for slave pump 2, E2.64 can be set to -3,000 rpm. E2.64 is inactive for master pump.

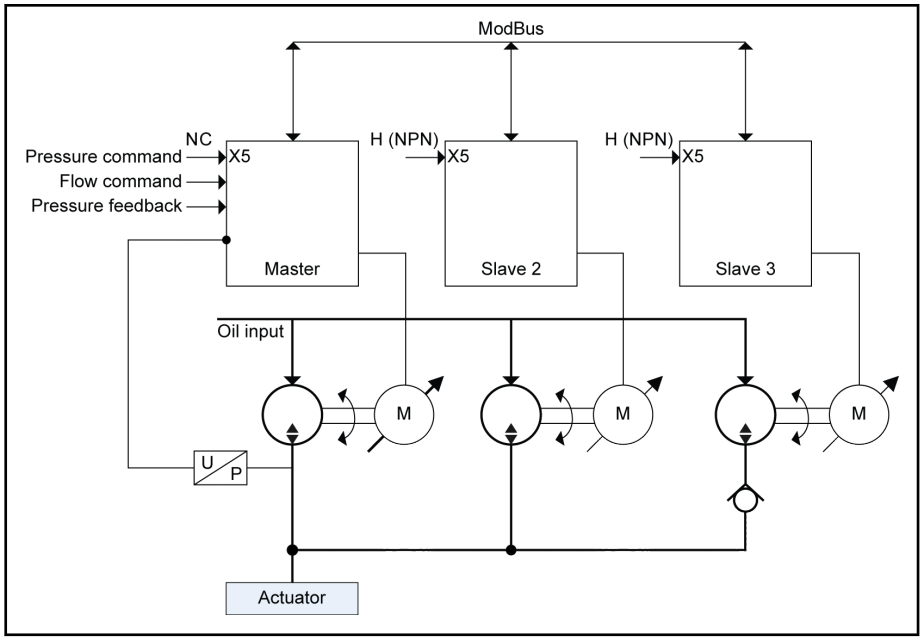


Fig. 7-41: Master/slave pump application for slave speed/flow command lower limit

E2.65	Master/Slave pump switch delay		Factory default	100
	Setting range	0 to 500 ms	Minimum unit	1

When slave pump switches working mode, a certain time delay configured by E2.65 is needed to wait for reversing valve's action.

E2.73	p/Q command start delay		Factory default	0.0
	Setting range	0.0 to 1,000.0 s	Minimum unit	0.1

From the moment that 'run' command is given to the converter, pressure and flow command will act after [E2.73] seconds. In the delaying period, pressure and flow command is clamped by E2.55 Minimum pressure command and E2.54 Minimum flow command respectively.

Parameter Settings

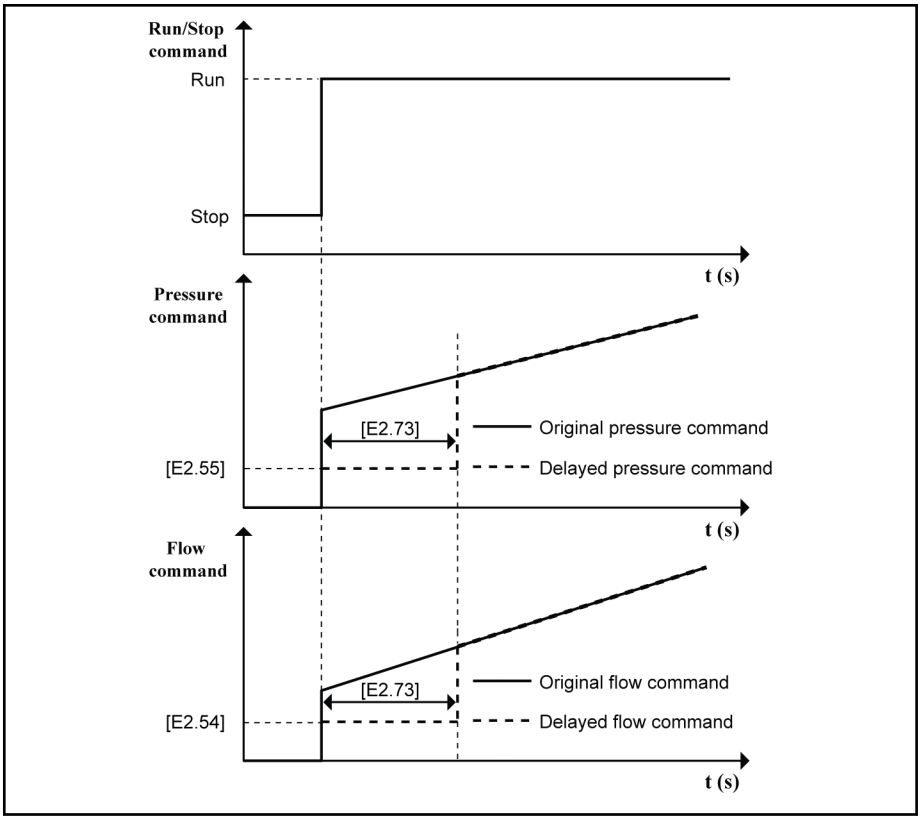


Fig. 7-42: Diagram of pressure and flow command delay

E2.74	Flow leakage		Factory default	100
	Setting range	-10,000 to 10,000 rpm	Minimum unit	1

E2.74 is to set the flow leakage in injection stage. If overshoot occurs, output of I element of p/Q PID is only to compensate the system flow leakage, not to adjust the pressure loop anymore.

E2.75	Pressure rise ratio 1		Factory default	40
	Setting range	0 to 100 %	Minimum unit	1
E2.76	Pressure rise ratio 2		Factory default	95
	Setting range	0 to 100 %	Minimum unit	1

E2.75 and E2.76 define two ratios of pressure feedback and pressure command. In injection stage, when ratio of pressure feedback and pressure command rises to [E2.75], pump flow command start to decrease. And when the ratio rises to [E2.76], pump flow command stops to decrease and holds the new flow command value until overshoot disappears. Decrease E2.75 and E2.76 can reduce pressure overshoot. [E2.75] should always be set less than [E2.76].

- E2.74 to E2.76 should be used together with digital inputs which are set to '24: Anti pressure shoot in injection stage 1' or '25: Anti pressure shoot in injection stage 2'.
- In FcP application, the function of anti pressure overshoot is not needed.

Group E3: PID control

PID control is a common used process control approach suitable for process control, but p/Q control function is not available, so the PID in group E3 can be used in SvP 5010 and FcP 5010 application.

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.

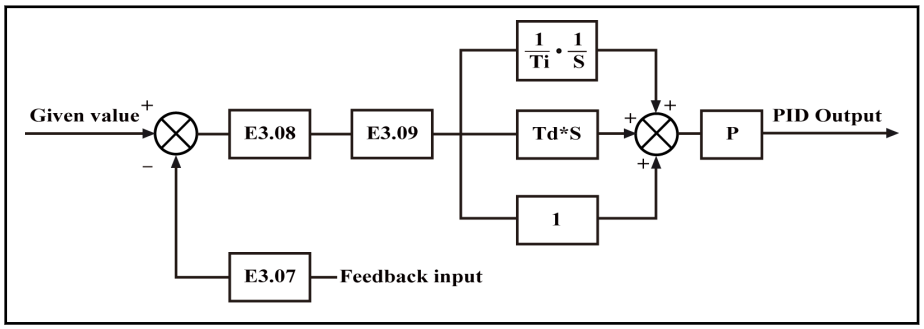


Fig. 7-43: Process PID control

☞ 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 to 4	Minimum unit	1

- 0: PID control inactive
- 1: Reserved
- 2: Analog digital setting + "+I analog feedback"
- 3: Reserved
- 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 to 10.00 V	Minimum unit	0.01

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

E3.02	Rotation speed digital setting		Factory default	0
	Setting range	0 to 30,000 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.

Parameter Settings

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

Tab. 7-10: Configuration in closed loop PID control

E3.03	Reserved		Factory default	0
	Setting range	0, 1	Minimum unit	1

E3.04	P: Proportional gain		Factory default	1.500
	Setting range	0.000 to 10.000	Minimum unit	0.001
E3.05	Ti: Integral time		Factory default	0.00
	Setting range	0.00 to 100.00 s (0.00 represents no integral)	Minimum unit	0.01
E3.06	Td: Differential time		Factory default	0.00
	Setting range	0.00 to 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 to 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.
- Ti: Integral time
  - Used to eliminate deviation
    - Smaller Ti means faster response of frequency converter to deviation changes, but too mall Ti leads to oscillation.
- Td: Differential 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 % to 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.
    - When the difference between the reference values and the feedback value changes, more time is needed to compensate the impact of continuous integral adjustment for the integral value to follow the changing trend.

Parameter Settings

Group E4: Protection and fault parameters

E4.00	Software over voltage protection threshold		Factory default	810
	Setting range	790 to 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 % to 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: Inactive
  - 1: Active
- 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:

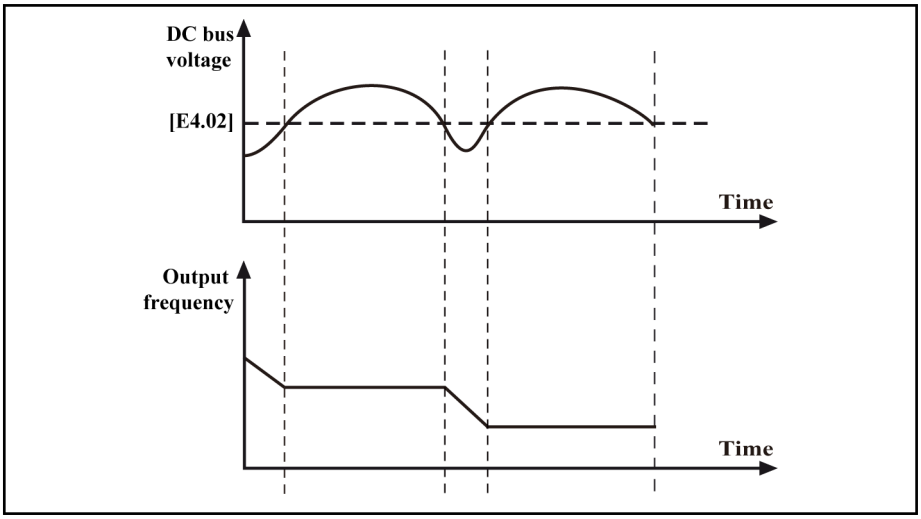


Fig. 7-44: Stall over voltage protection level

E4.03	Stall over current protection level		Factory default	200.0
	Setting range	20.0 % to 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’, 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.

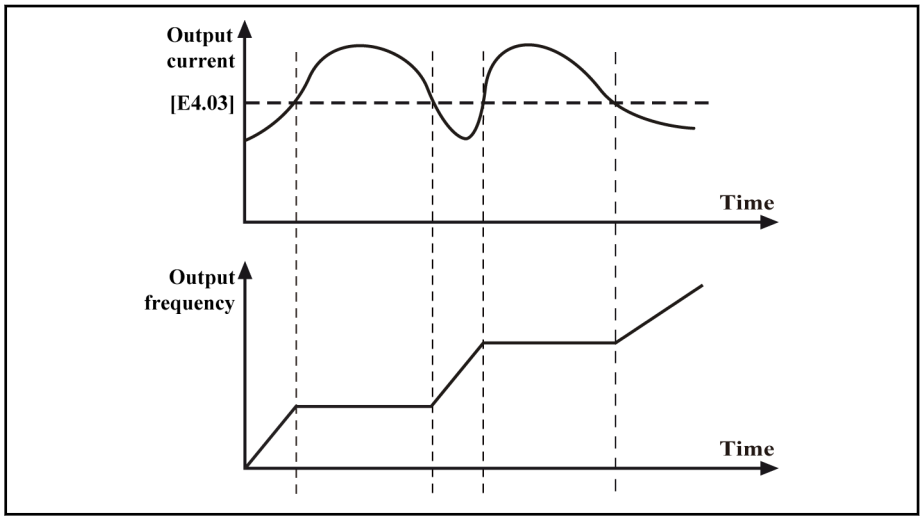


Fig. 7-45: Stall over current protection level

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

- 0: Inactive
- 1: Compensation of motor temperature protection value 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: Compensation of motor temperature protection value inactive at low-speed
  - With a special motor for frequency conversion, head dissipation will not be deteriorated at low-speed running, the electronic heat protection value automatic compensation is unnecessary.

E4.05	Motor over load protection factor		Factory default	100.0
	Setting range	50.0 % to 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) x 100 %
- The inverse time characteristic of over load protection is shown figure below.

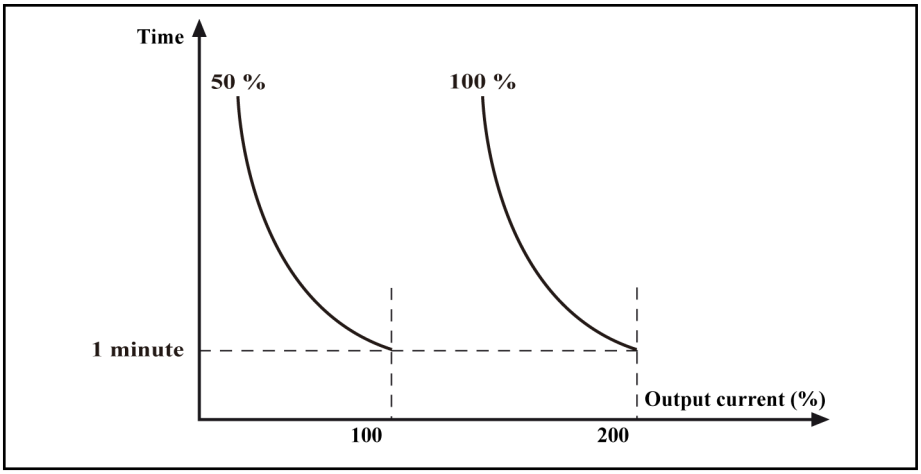


Fig. 7-46: Over load protection curve

E4.06	Phase loss protection		Factory default	0
	Setting range	0 to 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.
  - Frequency converter output phase loss protection is active, and operating panel displays OPH.L.
- 1: Only input phase loss protection active
- 2: Only output phase loss protection active
- 3: Both input and output phase loss protection inactive

E4.07	Pressure sensor fault detection threshold		Factory default	SvP: 1 FcP: 50
	Setting range	0 to 3,000 rpm	Minimum unit	1
E4.08	Pressure sensor fault detection time		Factory default	10.0
	Setting range	0.1 to 100.0 s	Minimum unit	0.1
E4.09	Pressure detection threshold		Factory default	5.00
	Setting range	1.00 to 650.00 bar	Minimum unit	0.01
E4.10	Pressure detection period		Factory default	1.0
	Setting range	0.1 to 100.0 s	Minimum unit	0.1

Used to detect pressure sensor fault (P.S.F.). P.S.F. occurs in two cases:

- Motor reverse speed exceeds [E4.07] for time longer than [E4.08].
- When frequency converter receives a 'stop' command, it begins to detect the trend of pressure feedback, and stops to detect when pressure feedback fall to less than [E4.09]. During the detection, if the decreasing rate of pressure feedback is less than 1bar/[E4.10]s, P.S.F fault will occur on panel.

☞ When converter is running in flow mode or slave pump mode, the function of pressure sensor detection is inactive.

E4.11	Relay Ta, Tb and Tc output		Factory default	7
	Setting range	0 to 17	Minimum unit	1

- 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: Frequency converter fault
- 8: Under voltage stop
- 9: Frequency converter over load prewarning1
- 10: Motor over load pre-warning
- 11: Over torque
- 12: Frequency converter over load pre-warning 2
- 13: Fault auto reset signal output
- 14: Over pressure pre-alarm
- 15: Reserved
- 16: Flow command in limitation
- 17: Pressure command in limitation

For details of E4.11, refer to E1.02 descriptions.

E4.12	Number of fault reset attempts		Factory default	0
	Setting range	0 to 3	Minimum unit	1
E4.13	Interval between reset attempts		Factory default	10
	Setting range	2 to 60 s	Minimum unit	1

- Automatic fault reset function can be used to ensure continuous running without human intervention in the case of occasional faults, such as over current and over voltage during start or running.
- If parameter ‘Number of fault reset attempts’ E4.12 is not set to ‘0: Auto reset deactivated’, the frequency converter is automatically reset and re-starts after the interval of ‘Interval between reset attempts’ [E4.13].
  - ‘Number of fault reset attempts’ E4.12 is used to set the allowed maximum times of attempts for automatic reset in case of fault.
  - ‘Interval between reset attempts’ E4.13 is used to set interval time between reset attempts.
- If fault still exists after ‘Number of fault reset attempts’ [E4.12], the frequency converter will send an alarm and stop.
- Automatic fault reset is valid to the following fault types: O.C.-1, O.C.-2, O.C.-3, O.E.-1, O.E.-2, O.E.-3, O.L.-1, O.L.-2, E.-St, CPU-, C.O.H, M.O.H and B.O.H.

Parameter Settings

E4.14	Last fault		Factory default	0
	Setting range	0 to 33	Minimum unit	1
E4.15	2nd last fault		Factory default	0
	Setting range	0 to 33	Minimum unit	1
E4.16	3rd last fault		Factory default	0
	Setting range	0 to 33	Minimum unit	1

Used to record the recent three faults, and can be viewed after reset. For fault types, please refer to chapter 8 "Error Types and Solutions" on page 171.

E4.17	Delete fault record		Factory default	0
	Setting range	0, 1	Minimum unit	1

- 0: No action
- 1: Active
  - Delete fault records stored in parameters E4.14 to E4.16.

E4.18	**Reserved**		Factory default	0
	Setting range	0, 1	Minimum unit	1
E4.19	**Type of temperature sensor for motor over heat protection**		Factory default	SvP: 0 FcP: 1
	Setting range	0: Other temperature sensor type 1: PTC temperature sensor 2: With motor temperature model 3: NTC temperature sensor	Minimum unit	1

- [E4.19]=0: When temperature sensor type is not included in E4.19, such as SvP 5010 system, a switching mode temperature sensor is used for motor overheat protection, please set E4.19 to '0: Other temperature sensor type'.
- [E4.19]=1 or 3: To activate this function, PTC/NTC temperature sensors in the motor need be mounted with VR1. Then VR1 can not be used as flow command setting channel anymore. This function is suitable for FcP 5010 application which uses PTC temperature sensor for motor overheat protection. Refer to note of E4.22 for detail connection method of PTC/NTC.
- [E4.19]=2: Protect the motor against overheat with motor temperature model if there's no temperature sensor. Refer to S2.16 for detail description about this function.

E4.20	Over max. pressure limitation time		Factory default	5.0
	Setting range	0.1 to 100.0 s	Minimum unit	0.1

E4.21	Pump protection selection		Factory default	0
	Setting range	0 to 15	Minimum unit	1

0 to 15(0FH)

bit0

- 0: Deactivate the pump power limitation
- 1: Activate the pump power limitation

When the pump's drive power extends to its maximum permissible value, an upper limit is taken to the pump speed command to ensure that the drive power no longer increases.

bit1

- 0: Deactivate the pressure monitoring
- 1: Activate the pressure monitoring

If this function is activated, the logic of pressure monitoring and protection is shown as below:

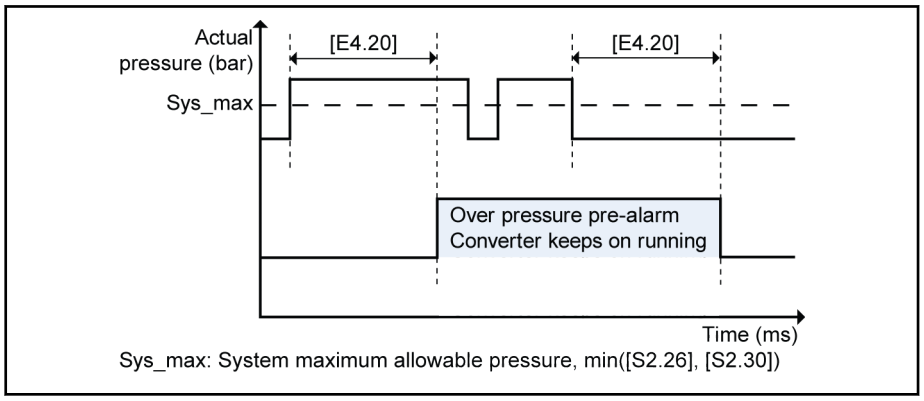


Fig. 7-47: Protection logic of over pressure pre-alarm

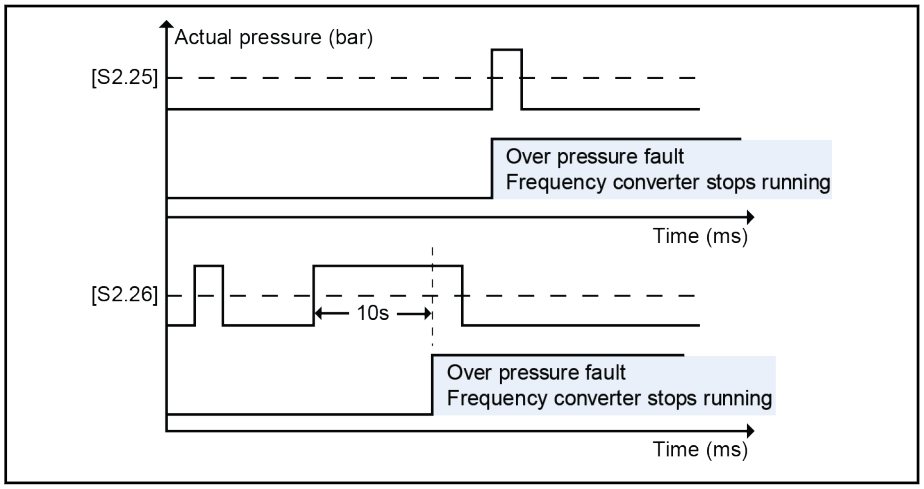


Fig. 7-48: Protection logic of over pressure fault

bit2

- 0: Deactivate the max. flow command limitation
- 1: Activate the max. flow command limitation

bit3

- 0: Deactivate the max. pressure command limitation
- 1: Activate the max. pressure command limitation

These two functions aim to limit the pressure command and flow command that user inputs will not extend to the maximal pressure command and the

maximal flow command of the Sytronix system. The protection logic of the pressure command limitation is shown as below:

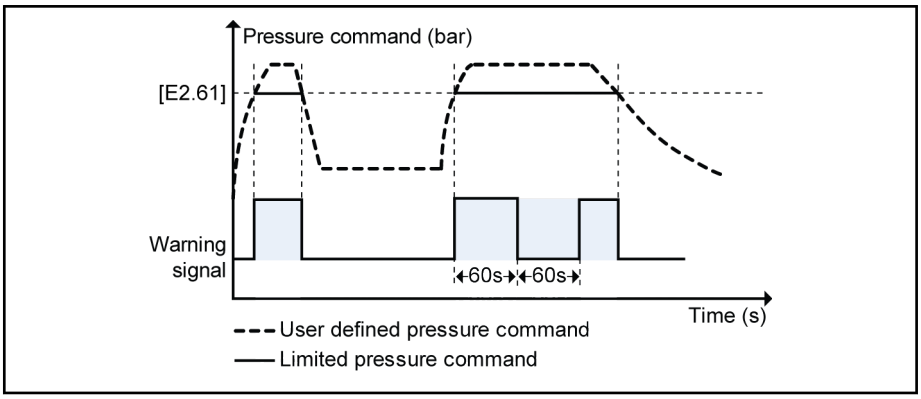


Fig. 7-49: Pressure command limitation

When the pressure command user inputs is bigger than [E2.61]:

- The pressure command is limited to [E2.61].
- The output signal (OUT1, OUT2, relays) becomes valid if E1.00, E1.01, E1.02 or E4.11 is set to 17.
- The warning of "Pressure command in limitation" appears on LCD.
- The frequency converter outputs warning signal every 30 seconds, with each lasting 30 seconds. Once the limitation disappears, the warning signal disappears also.

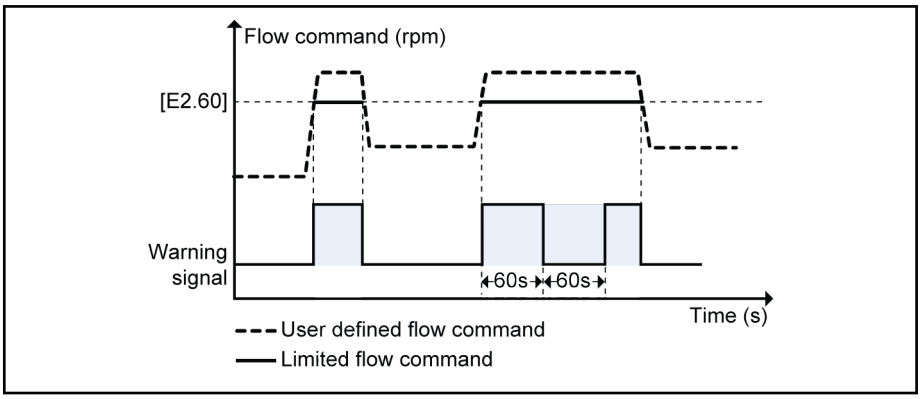


Fig. 7-50: Flow command limitation

When the flow command user inputs is bigger than [E2.60]:

- The flow command is limited to [E2.60].
- The output signal (OUT1, OUT2, relays) becomes valid if E1.00, E1.01, E1.02 or E4.11 is set to 16.
- The warning of "Flow command in limitation" appears on LCD.
- The frequency converter outputs warning signal every 60 seconds. Once the limitation disappears, the warning signal disappears also.

1. When the converter is running in flow mode or slave pump mode, the protect functions of pump power limitation, pressure monitoring and max. pressure command limitation are inactive.
2. When the converter is running in slave pump mode, the function of max. flow command limitation is inactive. But in flow mode, this function is active.

E4.22	Motor overheat voltage level setting		Factory default	SvP: 0.0 FcP: 2.8
	Setting range	0 to 10.0 V	Minimum unit	0.1

- When the temperature arrives at [E4.22], the motor will freewheel stop with fault message "M.O.H." displayed on panel.
- To activate this function, [E4.22] needs to be calculated according to temperature sensor type. For example, If [E4.19] =1, the calculation formula is shown as below:

  [E4.22] = 10 V * (R_{PTC} //100 k) / [R + (R_{PTC}//100 k)]

The wiring diagram of PTC temperature detection is shown as below:

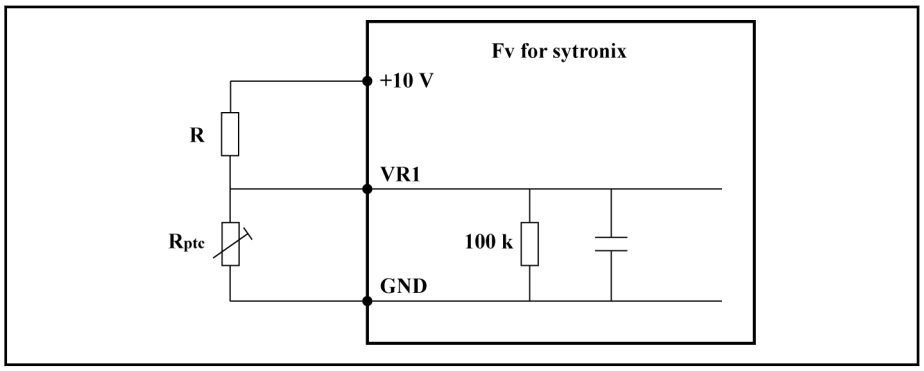


Fig. 7-51: Wiring diagram of PTC temperature detection

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 voltage level setting [E4.22] [V]	Resistance divider R [kΩ]
1.16	10.0
2.01	5.1
2.18	4.7
2.85	3.3

Tab. 7-11: Motor protection reference for general resistor

Parameter Settings

7.4.4 Category H: Advanced Parameters

Group H0: Communication parameters

H0.00	Communication protocol		Factory default	0
	Setting range	0 to 2	Minimum unit	1

- 0: Modbus
  - Modbus protocol and interface are factory default settings. See chapter 12.2 "Modbus Communication Function" on page 225.
- 1: PROFIBUS
  - An optional Rexroth PROFIBUS adapter is needed. See chapter 12.3 "PROFIBUS Communication Function" on page 244.
- 2: Master/slave pump control communication
  - If H0.00 is set to 2, master/slave pump function is enabled.

H0.01	Baud rate		Factory default	3
	Setting range	0 to 7	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
- 6: Reserved; 7: Data acquisition (Only for internal)

☞ 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 to 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)
- 2: O, 8, 1 (1 start bit, 8 data bits, 1 stop bit, odd)

☞ 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	1
	Setting range	Modbus	1 to 247	Minimum unit	1
		PROFIBUS	1 to 126		
		Master/slave pump	1 to 20		

- 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.

- In Master/slave pump communication, only one master pump (address 1) and max.19 slave pumps (address 2 to 20) are supported.

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

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

In PROFIBUS communication, parameters H0.04 to H0.07 are used to set status variables of PZD area. See chapter 12.3.4 "Periodical Data Communication" on page 248.

H0.08	Communication disconnection detection time		Factory default	0.0
	Setting range	0.0 to 60.0 s (0.0: deactivated)	Minimum unit	0.1

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

☞ Normally, this parameter is deactivated. It 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 to 65,535	Minimum unit	1

8 Error Types and Solutions

Possible reason	Solution
Error 01 (O.C.-1): Over current at constant speed	
1. Discontinuous or abnormal load in Run mode	1. Check load
2. Low mains voltage	2. Check voltage of input power supply: 3P 380 to 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
Error 02 (O.C.-2): Over current during acceleration	
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
Error 03 (O.C.-3): Over current during deceleration	
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
Error 04 (O.E.-1): Over voltage at constant speed	
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 of speed loop (group S1)
Error 05 (O.E.-2): Over voltage during acceleration	
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

Possible reason	Solution
Error 06 (O.E.-3): Over voltage during deceleration	
1. Too large load rotation inertia	1. Use suitable brake components
2. Too short deceleration time	2. Increase deceleration time
Error 07 (O.L.-1): Converter over load	
1. Long time over load	1. Reduce over load time, reduce load Overload capability: 150 % of rated current for 60s, and then 540s with rated current for recovery from overload influence, after this comes next over-load period 200 % of rated current for 1.0s, and then 19.5s with rated cur-rent for recovery from overload influence, after this comes next overload period
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 parameter setting	4. Set motor parameters properly or auto tune motor parameters (group S2)
5. Direct start during motor running	5. Restart after motor stop, or start with rotation speed capture (group b1)
6. Low mains voltage	6. Check input power supply
7. Too short acceleration time	7. Increase acceleration time
Error 08 (O.L.-2): Motor over load	
1. Motor locked	1. Prevent motor lock
2 Normal motor runs long time with large load at low speed	2. Use variable frequency motor or increase converter output frequency
3. Low voltage of input power supply	3. Check input power supply
4. Improper V/f curve settings	4. Adjust V/f curve settings
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)
Error 09 (R.E.): CPU read/ write error	
Error or illegal data in control board read/write	Contact with technical service
Error 10 (KEY-): Operating panel read/write error	
Error or illegal data in operating panel read/write	Contact with technical service
Error 11 (M.O.H.): Motor overheat	
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
Error 12 (R.S.): Communication error	
1. Device connection problem	1. Check device communication connection

Possible reason	Solution
2. Improper baud rate setting	2. Set proper baud rate
Error 13 (C.F.): Circuit disconnection	
Current detection channel abnormal	Contact with technical service
Error 14 (PULS): Pulse encoder speed detection error	
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
Error 15 (B.O.H.): Brake chopper overheat	
1. Too high brake ratio S3.13	1.Decrease brake ratio
2. Signal missing	2. Check the validity of overheat signal from brake chopper
3. Connection error	3. Check the connection between brake chopper and digital input X8
Error 16 (CPU-): EMI error	
CPU malfunction due to external interference	Remove environmental interference or EMI
Error 17 (S.C.): Short circuit	
1. Too large output current	1. Check if motor short circuit, motor to earth short circuit, earth short circuit, over load exist
2. Power component error	2. Contact with technical service for maintenance
Error 18 (P.S.F.): Pressure sensor error	
1. Motor reverse speed exceeds the setting of E4.07 for time longer than [E4.08]	1. Check if the pressure sensor is normal Increase [E4.07] and [E4.08]
2. When converter stops running, pressure feedback falls slowly.	2. Check if the pressure sensor is normal Increase [E4.09] and [E4.10]
Error 19 (IPH.L): L1, L2, L3 input phase loss	
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
Error 20 (OPH.L): U, V, W output phase loss	
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
Error 21 (C.O.H.): Converter over heat	
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 22 (PRSE): Parameter setting error	

Error Types and Solutions

Possible reason	Solution
Improper setting of parameters	Check set values of parameters
Error 23 (TUNE): Parameter auto-tuning error	
1. Power of special or normal motor does not match with converter power	1. Check if the motor is special motor, check if the motor power matches with converter power
2. Improper setting of parameters on motor nameplates	2. Set parameters according to motor nameplate
3. No connection of converter and motor	3. Check motor cable connections
Error 24 (O.L.-3): Frequency converter overload pre-alarm 2	
Over load for a period of time, see descriptions of E1.00 to E1.02 "12: Frequency converter over load pre-warning 2"	Reduce over load time, reduce load
Error 25 (O.P.W.): Over pressure pre-alarm	
Actual pressure exceeds Max. pressure command for time longer than [E4.20]	Check if pressure feedback signal (VR3) is well connected
	Increase [E4.20]
	Decrease the Max. pressure command user input
Error 26 (O.P.F.): Over pressure error	
Actual pressure exceeds [S2.25] (Pump maximum critical pressure)	Check if pressure feedback signal (VR3) is well connected
	Increase [S2.25] slightly or decrease pressure command
Actual pressure exceeds [S2.26] (Pump maximum cont pressure) for time longer than 10s	Increase [S2.26] slightly or decrease pressure command
Error 27 (B.T.L.): Braking threshold low	
Mains voltage is too high or [S3.12] is set too low.	• Check whether the mains voltage of the converter is beyond the scope allowed. • Increase [S3.12] or decrease [S3.17] appropriately.
Error 28, 29: Reserved	
Error 30 (F.C.LI): Flow command in limitation	
Flow command user input exceeds [E2.60] (Maximum flow command)	Check if flow command signal (VR1) are well connected
	Increase [E2.60] slightly or decrease flow command user input
Error 31 (P.C.LI): Pressure command in limitation	
Pressure command user input exceeds [E2.61] (Maximum pressure command)	Check if flow command signal (VR2) are well connected
	Increase [E2.61] slightly or decrease pressure command user input
Error 32 (M/S S.): Slave pump fault	
In master/salve application, one or more slave pumps have stop fault and stop	Find out the fault slave pumps and clear their faults
Error 33 (M/S C.): Master/slave pump communication error	
In master/salve pump application, master pump fails to communicate with slave pumps	Check if [E2.62] is bigger than the actual slave pump number
	Check if two or more pumps have the same address
	Check if the communication cables are well connected
	Reset maser/slave pump system by digital inputs (X3 by default)

Possible reason	Solution
Parameter write-protection (S.ERR)	
1. Password protection	Input the correct password first, then modify the parameter
2. When frequency converter is running, users attempt to modify parameters that can only be modified in Stop mode	Stop the frequency converter first, then modify the parameters
3. Pressing the keys with too short interval	Press the keys with a longer interval

Tab. 8-1: Error types and solutions

9 Technical Data

9.1 Fv for Sytronix General Technical Data

Input	Power supply voltage	3P 380 to 480 VAC (-15 % / +10 %) (TN - Net)
	Power supply frequency	50 to 60 Hz (±5 %)
Output	Rated output voltage	Corresponding to input voltage
	Output frequency	0 to 400 Hz
	Overload capability	Overload with 150 % of rated current for 60s, and then 540s with rated current, after this comes the next overload period. Overload with 200 % of rated current for 1.0s, and then 19.5s with rated current, after this comes the next overload period.
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: 1,000:1
	Start-up torque	SVC: 150 % × rated torque at 0.5 Hz FOC: 200 % × rated torque at 0 Hz
	Frequency resolution	Analog setting: Maximum frequency × 1 / 2,048 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
	Status messages via multi-function output signal	Outputs of Run, frequency level detection signal, frequency arrival signal, faults, 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, p/Q PID control, pulse frequency, analog current, serial port and digital inputs Up/Down, which can be switched at any time
	Four sets of p/Q PID control parameters selection for different machine sizes and/or axes	The defaults of each set have been optimized for different machine sizes and / or axes, and also can be selected via digital input terminals of X2 and X4.
	Analog outputs	Analog signal output, 0 to 20 mA, -10 to 10 V or 0 to 10 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, pump protection	

Technical Data

Optional parts	Brake chopper, braking resistor, operating panel for cabinet control, communication cable for cabinet control, PROFIBUS adapter, master/slave pump communication connector, master/salve pump communication cable, cable shielding kit	
Environment	Power reduction/altitude	Up to 1,000 m above sea level: none; 1,000 to 4,000 m above sea level: 1 % / 100 m
	Ambient temperature	-10 °C to 40 °C (without condensation and frost); derating between 40 °C and 50 °C, see chapter 9.3.1 "Derating and Ambient Temperature" on page 179
	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. 9-1: General technical data

9.2 Electrical Data

400 V series

Fv for Sytronix model	**1K50**	**2K20**	**4K00**	**5K50**	**7K50**	**11K0**	**15K0**	**18K5**
Power class [kW]	1.5	2.2	4.0	5.5	7.5	11.0	15.0	18.5
Rated input current [A]	5.1	7.6	16.0	16.5	23.5	36.0	46.0	48.0
Rated output current [A]	4.0	5.5	10.0	13.0	17.0	24.0	33.0	39.0
Apparent power [kVA]	2.6	3.6	6.5	8.5	11.0	15.0	21.0	24.0
Fv for Sytronix model	**22K0**	**30K0**	**37K0**	**45K0**	**55K0**	**75K0**	**90K0**	**–**
Power class [kW]	22.0	30.0	37.0	45.0	55.0	75.0	90.0	–
Rated input current [A]	53.0	73.0	88.0	104.0	119.0	157.0	185.0	–
Rated output current [A]	44.0	60.0	75.0	95.0	110.0	152.0	176.0	–
Apparent power [kVA]	30.0	40.0	50.0	62.0	75.0	100.0	116.0	–

Tab. 9-2: Fv for Sytronix electrical data

The complete type code of Fv for Sytronix is:
FVCA01.1-xxxx-3P4-MDA-LP-P002-01V01

9.3 Derating of Electrical Data

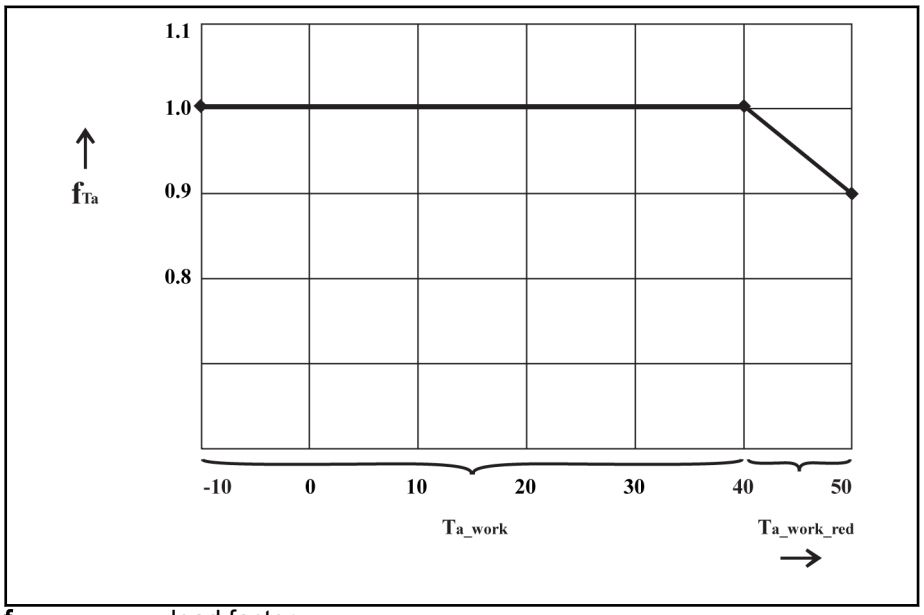
9.3.1 Derating and Ambient Temperature

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 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

9.3.2 Derating and Mains Voltage

Reduced over current based on mains voltage

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

- Umains<Urated: With mains voltages below the rated voltage, no higher currents may be withdrawn to keep the same dissipated power.
- Umains>Urated: 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.

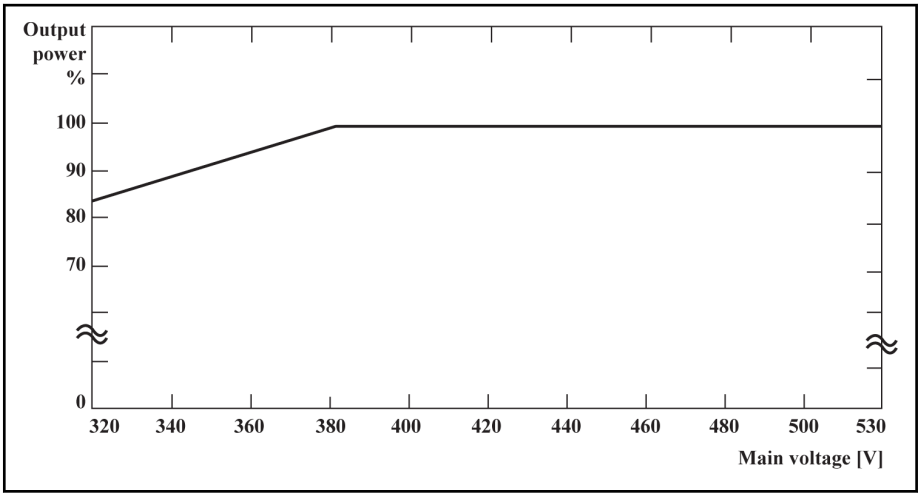


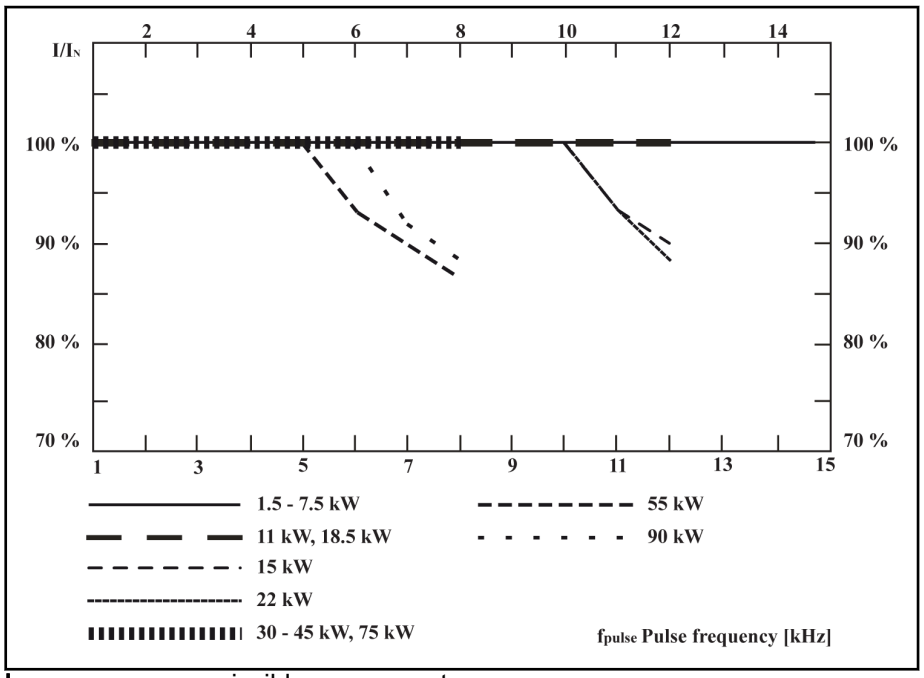
Fig. 9-2: Derating and mains voltage

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

9.3.3 Derating of the Output Current Depending on the Pulse Frequency

The figure below shows the current reduction based on the pulse frequency for the different frequency converters. In case of higher pulse frequency, the current is reduced insofar that the power dissipation in power section remains more or less constant.

For frequency converters:



I permissible overcurrent
$I_{N:}$ rated current

Fig. 9-3: Derating and output current

Model	1K50 to 7K50	11K0, 18K5	15K0			22K0		
Pulse frequency range [kHz]	1.0 to 15.0	1.0 to 12.0	1.0 to 10.0	11.0	12.0	1.0 to 10.0	11.0	12.0
Percentage of rated current	No derating	No derating	No derating	93 %	90 %	No derating	93%	88 %
Model	**30K0, 37K0 45K0, 75K0**	**55K0**				**90K0**		
Pulse frequency range [kHz]	1.0 to 8.0	1.0 to 5.0	6.0	7.0	8.0	1.0 to 6.0	7.0	8.0
Percentage of rated current	No derating	No derating	93 %	90 %	87 %	No derating	92 %	88 %

Tab. 9-3: Current derating list

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.

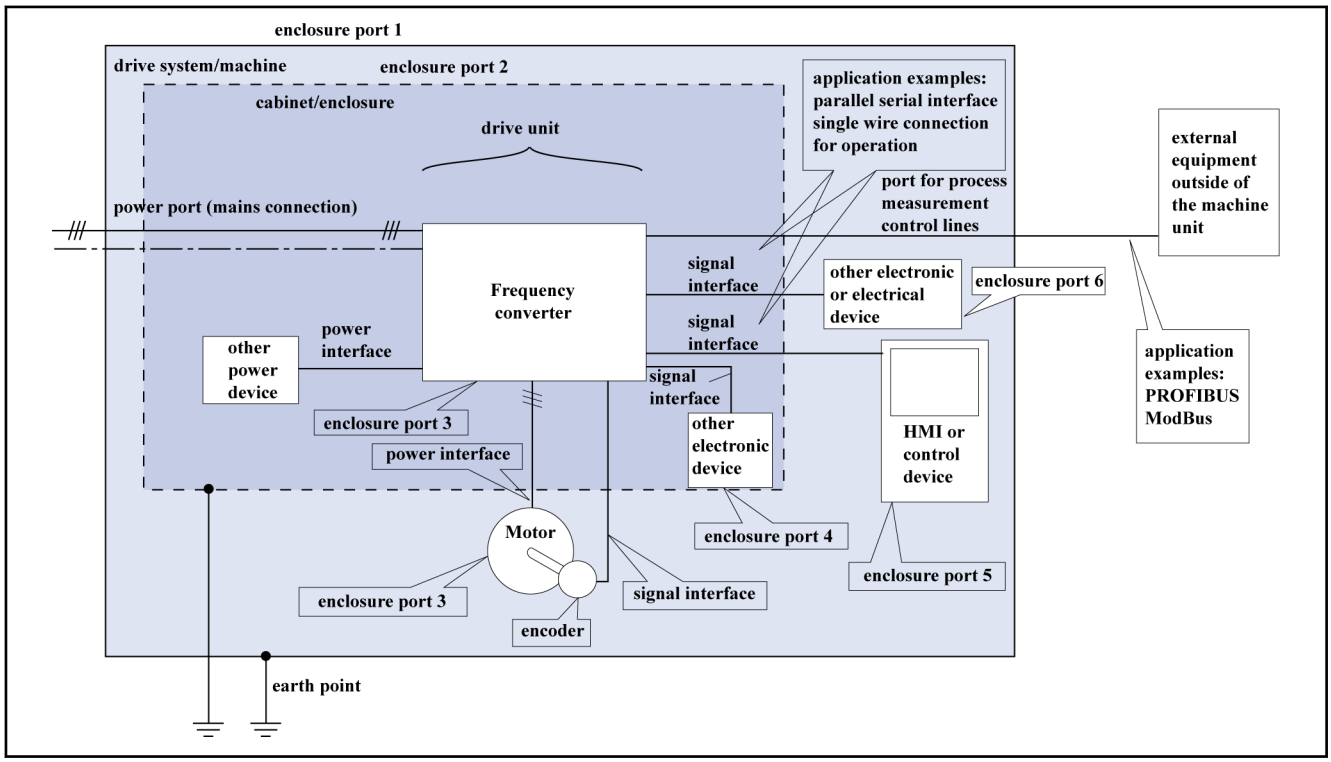


Fig. 9-4: Noise immunity in the drive system

Noise immunity limit values

Place of effect	Phenomenon	Standard	Conditions	Coupling	Test values according to standard EN 61800-3	Performance level
Enclosure port	ESD	IEC 61000-4-2	–	CD, AD	4 kV CD, 8 kV AD	B
	RF field	IEC 61000-4-3	–	Via antenna on EUT	10 V/m, 80 – 1,000 MHz 3 V/m, 1,400 – 2,000 MHz 1 V/m, 2,000 – 2,700 MHz	A
Power port	Burst	IEC 61000-4-4	–	mains connection I<100 A: discoupling network I≥100 A: clamp or CN	2 kV / 5 kHz (CN or CDN) 4 kV / 2.5 kHz (clamp)	B
	Surge	IEC 61000-4-5	only mains connection; I<63 A, light load test	–	line-line 1 kV line-earth 2 kV	B
	Conducted radio-frequency common mode	IEC 61000-4-6	Length>3 m	clamp	10 V, 0.15 – 80 MHz	A
Power interface	Burst	IEC 61000-4-4	Length>3 m	clamp	2 kV / 5 kHz	B
Signal interface	Burst	IEC 61000-4-4	Length>3 m	clamp	1 kV / 5 kHz	B
	Conducted radio-frequency common mode	IEC 61000-4-6	Length>3 m	clamp or CDN	10 V, 0.15 – 80 MHz	A
Ports of process; measurement control lines	Burst	IEC 61000-4-4	Length>3 m	clamp	2 kV / 5 kHz	B
	Conducted radio-frequency common mode	IEC 61000-4-6	length>3 m	clamp or CDN	10 V, 0.15 – 80 MHz	A

CD contact discharge
AD air discharge
CDN coupling and decoupling network
CN coupling network

Tab. 9-4: 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. 9-5: Evaluation criterion

Technical Data

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

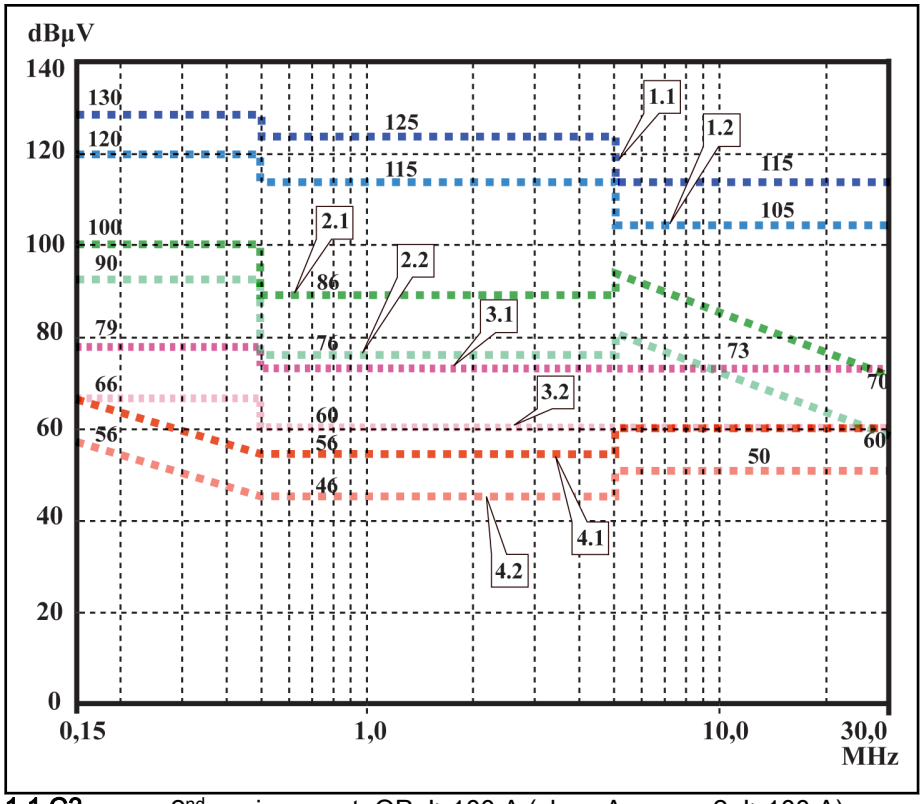
If the interference gets from the device to the connected lines in unfiltered form, these lines can radiate the interference into the air (antenna effect). This applies to power lines, too.

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. 9-6: Limit values for line-based disturbances



1.1 C3	2nd environment, QP, I>100 A (class A, group 2, I>100 A)
1.2 C3	2nd environment, AV, I>100 A (class A, group 2, I>100 A)
2.1 C3	2nd environment, QP, I≤100 A (class A, group 2, I≤100 A)
2.2 C3	2nd environment, AV, I≤100 A (class A, group 2, I≤100 A)
3.1 C2	1st environment, QP (1st environment, even if source of interference in 2nd environment) (class A, group 1)
3.2 C2	1st environment, AV (1st environment, even if source of interference in 2nd environment) (class A, group 1)
4.1 C1	1st environment, QP (1st environment, even if source of interference in 2nd environment) (class B, group 1)
4.2 C1	1st environment, AV (1st environment, even if source of interference in 2nd environment) (class B, group 1)

Fig. 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.

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 for Sytronix 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 for Sytronix.

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.

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.

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 chapter "Control cabinet mounting according to interference areas – exemplary arrangements" on page 190.

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

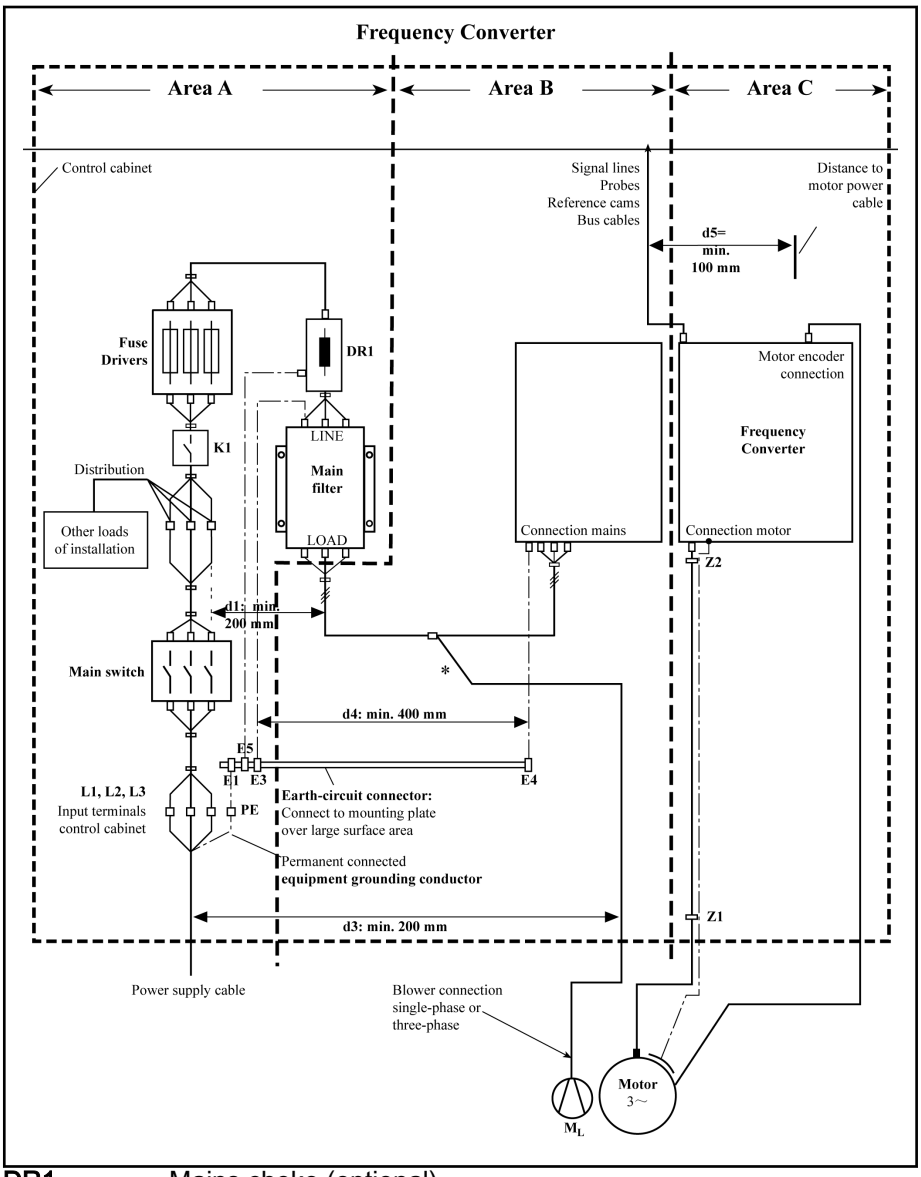
Never run lines of one of these areas in parallel with lines of another area so that there is not any unwanted interference injection from one area to the other and that the filter is jumped with regard to high frequency. Use the shortest possible connecting lines.

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 to 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

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 connec-

tions 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:

- 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 "Division into areas (zones)" on page 189.

Point of connection for equipment 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 189.

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.

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.

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 189) 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.

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 for Sytronix 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 for Sytronix model	External EMC filter type code
1K50	FENF01.1A-A075-E0008-A-480-NNNN (E0008)
2K20	
4K00	FENF01.1A-A075-E0022-A-480-NNNN (E0022)
5K50	
7K50	
11K0	FENF01.1A-A075-E0030-A-480-NNNN (E0030)
15K0	FENF01.1A-A075-E0051-A-480-NNNN (E0051)
18K5	
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.

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.

Accessories

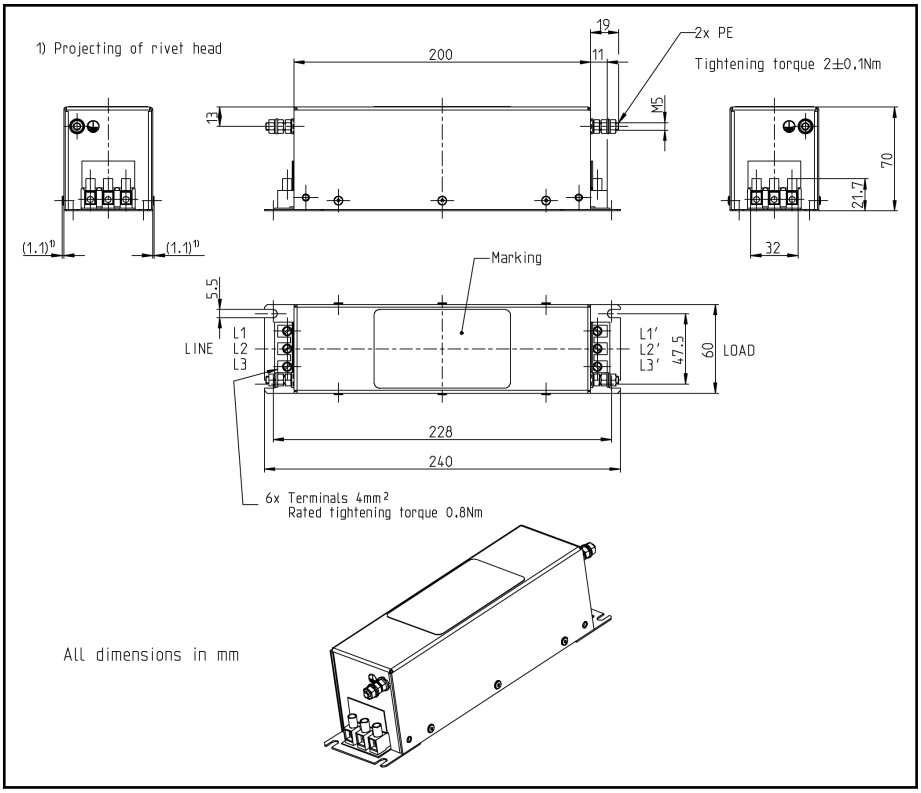


Fig. 10-1: E0008

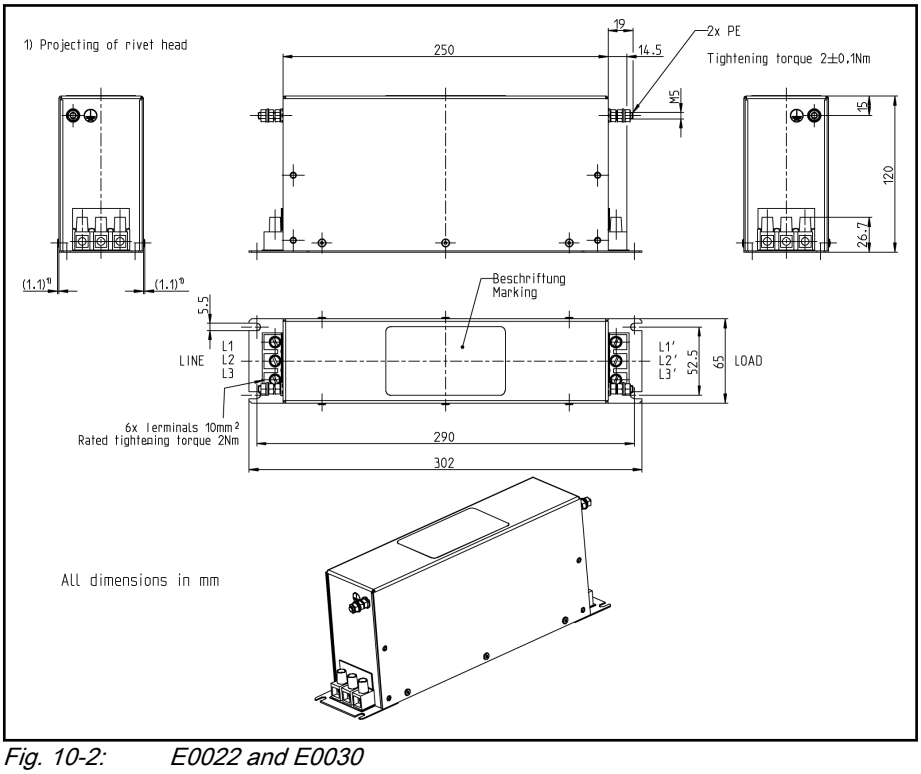


Fig. 10-2: E0022 and E0030

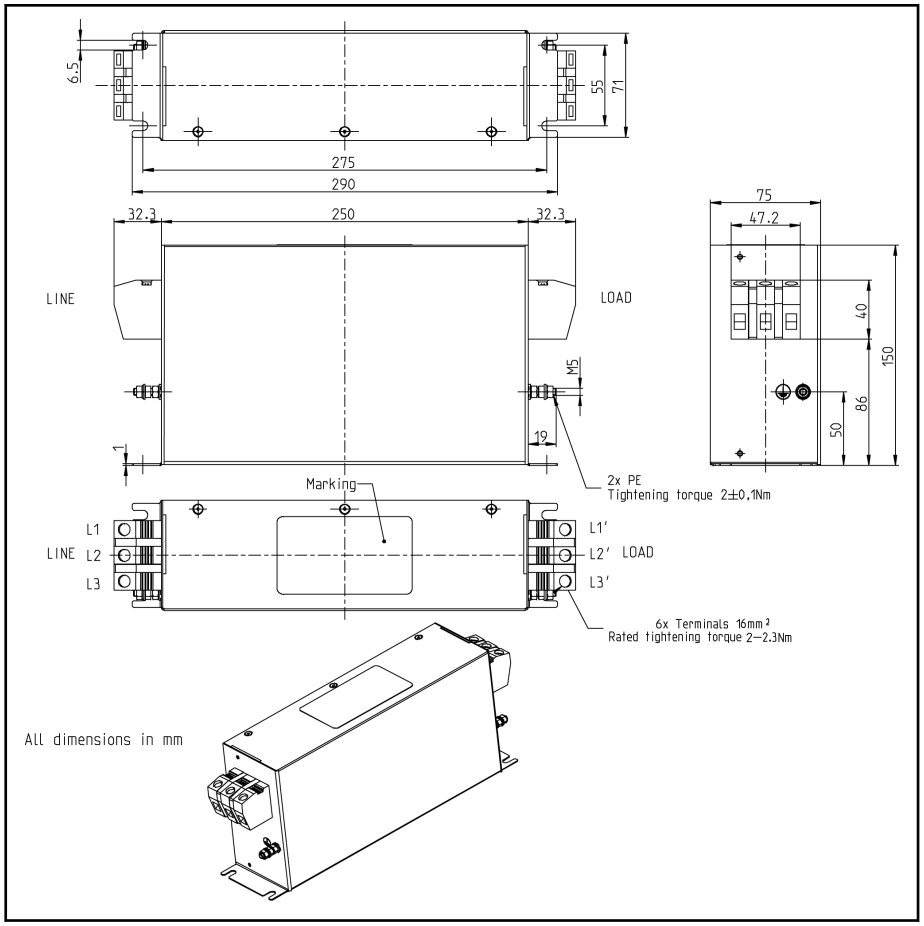


Fig. 10-3: E0051

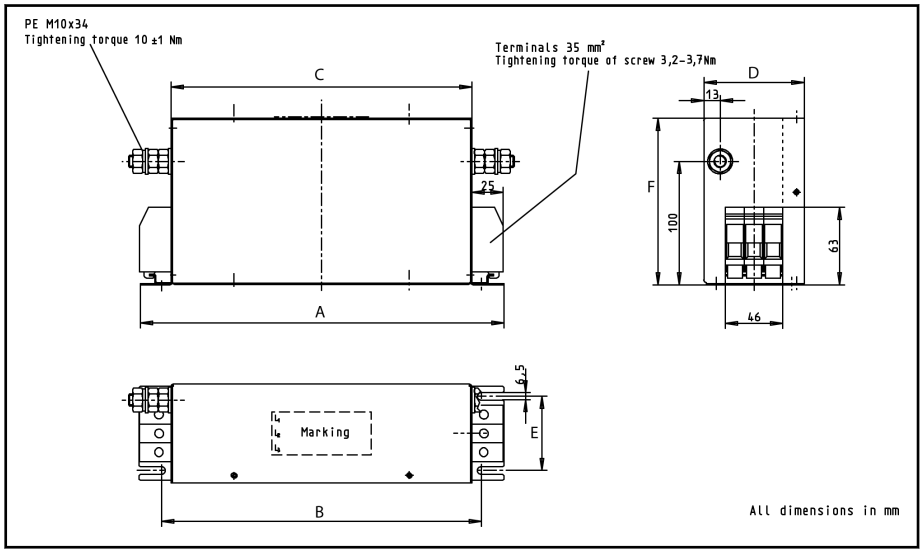


Fig. 10-4: E0090

Accessories

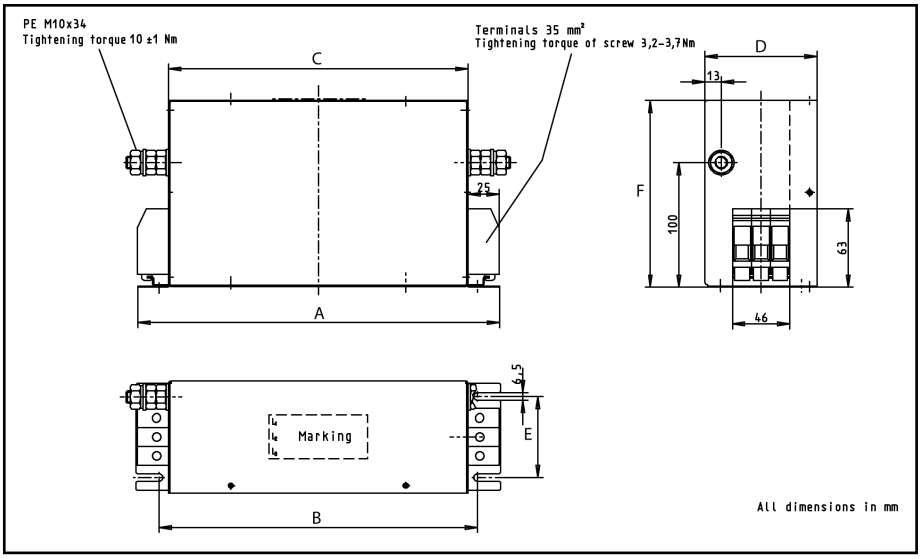


Fig. 10-5: E0120

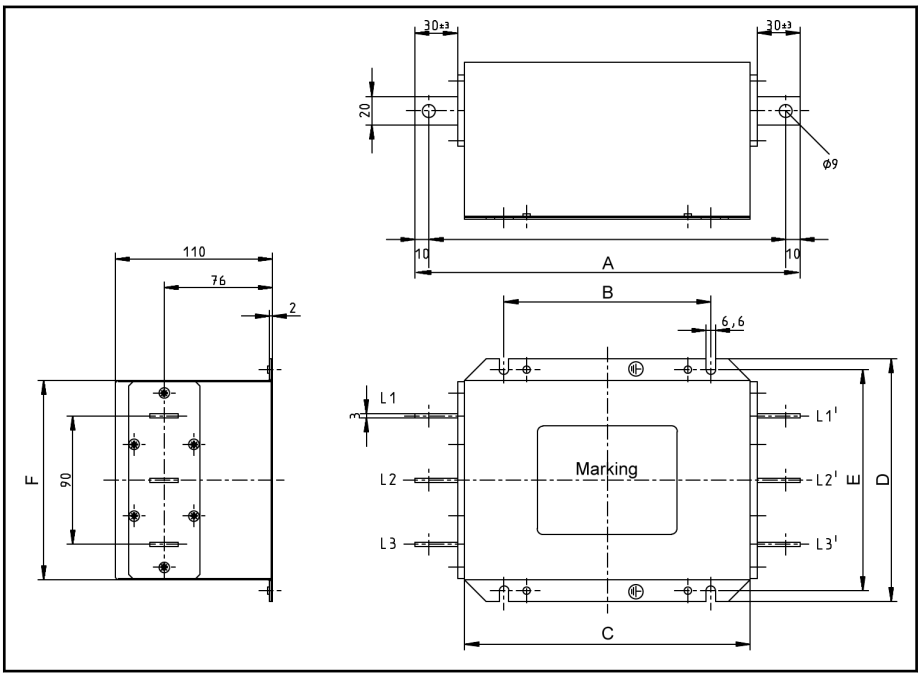


Fig. 10-6: E0250

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	240	228	200	60	47.5	70	M5	2	4	0.8
E0022	302	290	250	65	52.5	120	M5	2	10	2
E0030										
E0051	314.6	275	250	75	55	150	M5	2	16	2 to 2.3
E0090	290	255	240	80	60	135	M10	10	35	3.2 to 3.7
E0120	290	255	240	90	65	150	M10	10	35	3.2 to 3.7
E0250	250	145	200	170	155	110	Ø6.6	6 to 9	Ø9	6 to 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	E0022	E0030	E0051	E0090	E0120	E0250
Degree of protection according to IEC60529			IP20						
Listing according to UL standard (UL)			UL 1283						
Listing according to CSA standard (UL)			C22.2 No. 8						
Mass (weight)	m	kg	1.4	3.0	3.3	4.4	4.2	4.9	5.0
Mains voltage three-phase at TNS, TN-C, TT mains	U_{LN}	V	380 to 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 % to -15 %						
Input frequency (UL)	f_{LN}	Hz	50 to 60						
Nominal current	I_{L_cont}	A	8	22	30	51	90	120	250
Calculation of leakage current	I_{leak}	mA	27	19	27	67	18	18	<21
DC resistance typical value	R_{typ}		15 mΩ	8 mΩ	4 mΩ	2.8 mΩ	1.1 mΩ	0.9 mΩ	110 µΩ
Required wire size according to IEC 60364-5-52; at I_{L_cont}	A_{LN}	mm^2	4	10	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	8	6	6 (2)	1	3/0	3/0 (2)

Tab. 10-3: Electrical data

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 for Sytronix 1K50 to 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.

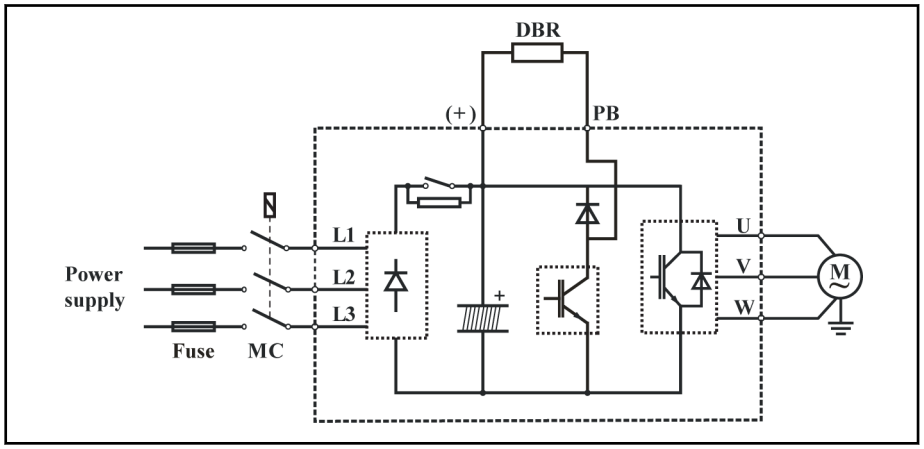


Fig. 10-7: Working principle of internal brake chopper

Accessories

External brake chopper (18K5 kW and above models)

Technical data

Voltage class		AC power supply 380 V -15 % to 480 V +10 %; 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	DC 460 to 800 V	
Protection	Overheat of heat sink	It is active when the temperature exceeds +85 °C	
	Failure output	RELAY junction 0.6 A 125 VAC / 2 A 30 VDC (Tb, Tc)	
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

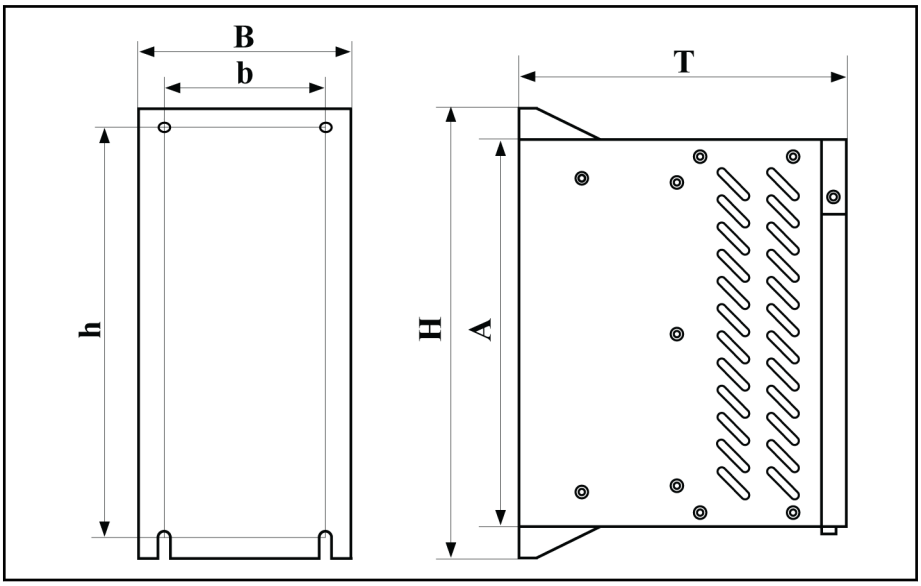


Fig. 10-8: Dimensions diagram

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

Brake chopper terminals

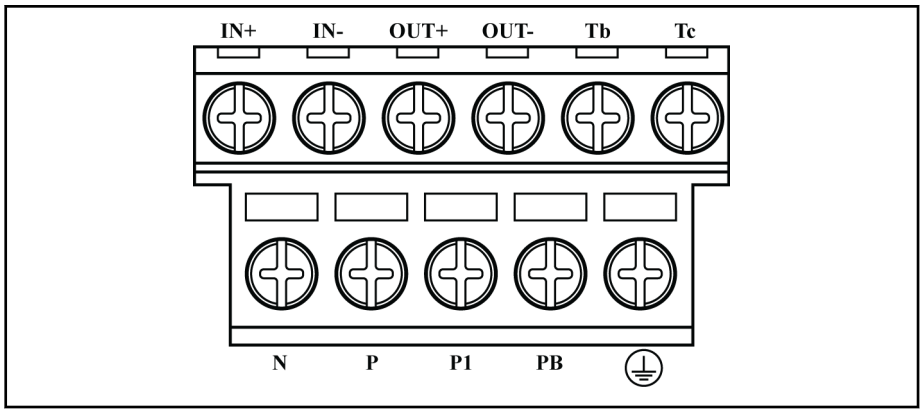


Fig. 10-9: Brake chopper terminals

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 to 12	M4	18 kgf–cm (15.6 in–ibf)
Brake resistor	P1, PB				
Multiple units in parallel	input	IN+, IN-	18 to 20		
	output	OUT+, OUT-			
Failure output	Tb, Tc				
Grounding	⏚		10 to 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 fault conditions, please refer to the following wiring diagram. The brake chopper FELB fault switch should be connected to Xi of the frequency converter. The temperature switch of the braking resistor should be in series with the line contactor coil circuit.

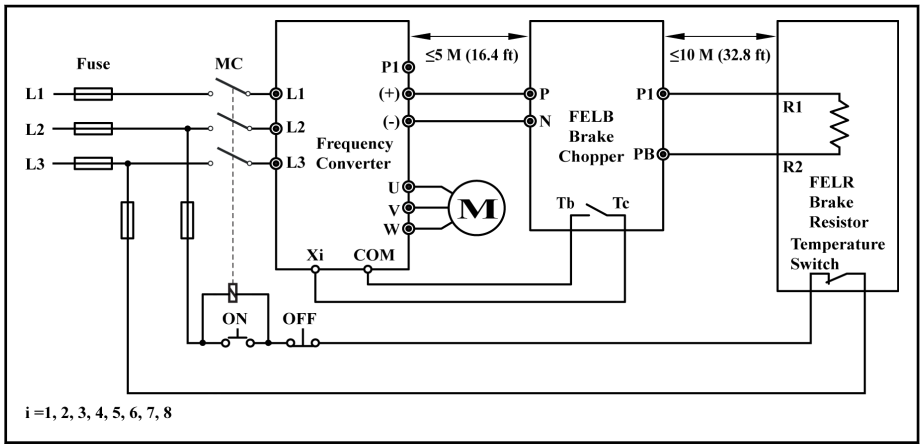


Fig. 10-10: Basic wiring diagram

- 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 braking resistor should be not more than 10 M (32.8 ft).

⚠ WARNING **The braking 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

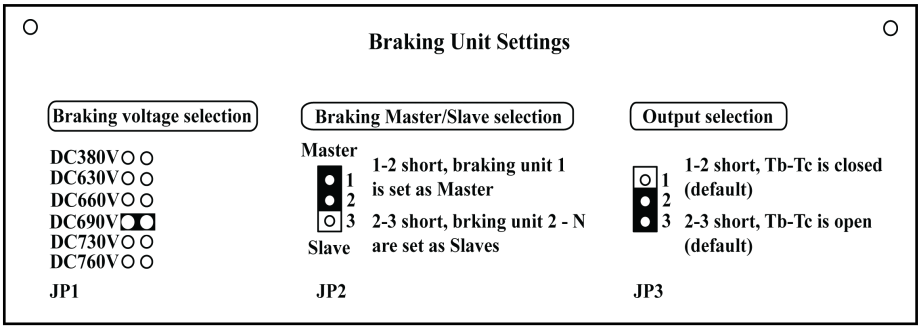


Fig. 10-11: Brake chopper settings

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.

- Fault output selection:

  The temperature failure output of the brake chopper is Tb-Tc; operating temperature is +85 °C. Tb-Tc is set normally open as factory default; if normally closed is required, please set JP3, and short circuit 1-2.

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".

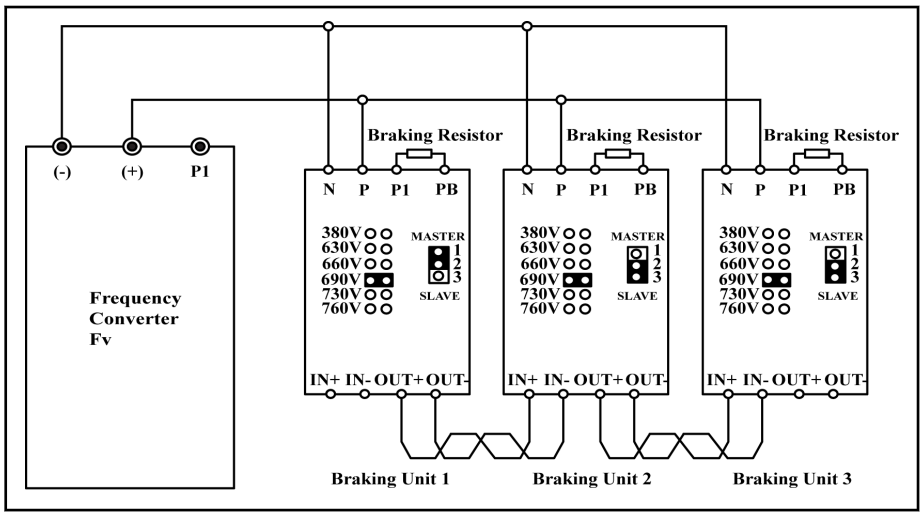


Fig. 10-12: Brake chopper wiring

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 braking resistor must be taken into consideration so that enough time can be ensured for the brake chopper and the braking resistor to release the heat generated in the braking process.

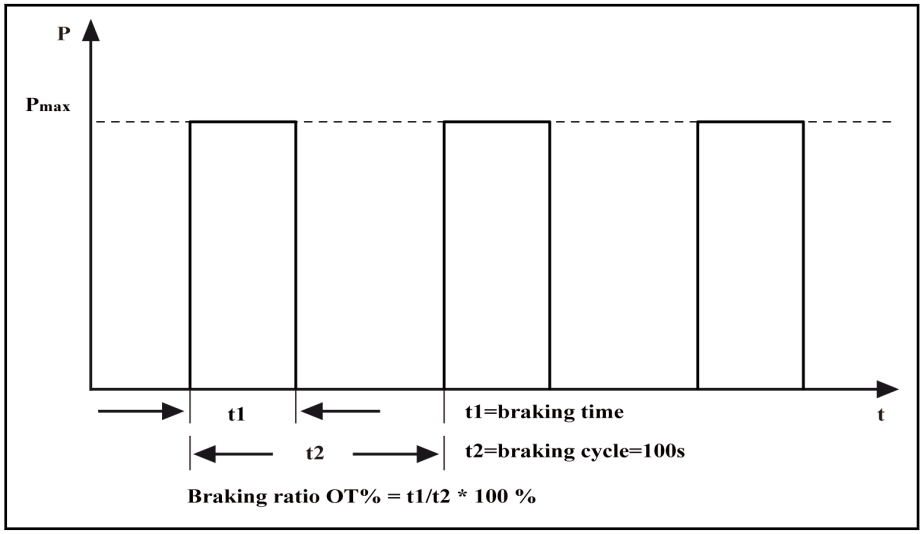


Fig. 10-13: Braking ratio

Fault 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 converter. 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 braking resistor	Check braking resistor and its wiring
3	“Overvoltage” warning with the of frequency converter	Wrongly connected wires	Check wires
		Inadequate capacity of braking 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: Fault 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.

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
Tb Braking time
Tc Cycle time

Fig. 10-14: Braking ratio

Model	FELB typecode	FELB quantity	FELR typecode	FELR type	FELR quantity
1K50	Internal	–	FELR01.1N-0260-N250R-D-560-NNNN	250Ω/260W	1
2K20			FELR01.1N-0260-N250R-D-560-NNNN	250Ω/260W	1
4K00			FELR01.1N-0390-N150R-D-560-NNNN	150Ω/390W	1
5K50			FELR01.1N-0260-N250R-D-560-NNNN	250Ω/260W	2
7K50			FELR01.1N-0390-N150R-D-560-NNNN	150Ω/390W	2
11K0			FELR01.1N-0390-N150R-D-560-NNNN	150Ω/390W	3
15K0			FELR01.1N-02K0-N047R-D-560-P001	47Ω/2.0kW	1
18K5	FELB02.1N-30K0	1			1
22K0		1			2
30K0		1			2
37K0		1			3
45K0		1			3
55K0		1			3
75K0		2			6
90K0		2			6

Tab. 10-9: Brake resistor selection_OT = 5 %

Accessories

Model	FELB typecode	FELB quantity	FELR typecode	FELR type	FELR quantity
1K50	Internal	–	FELR01.1N-0260-N400R-D-560-NNNN	400Ω/260W	1
2K20	Internal	–	FELR01.1N-0260-N250R-D-560-NNNN	250Ω/260W	1
4K00	Internal	–	FELR01.1N-0390-N150R-D-560-NNNN	150Ω/390W	1
5K50	Internal	–	FELR01.1N-0520-N100R-D-560-NNNN	100Ω/520W	1
7K50	Internal	–	FELR01.1N-0780-N075R-D-560-NNNN	75Ω/780W	1
11K0	Internal	–	FELR01.1N-1K04-N050R-D-560-NNNN	50Ω/1040W	1
15K0	Internal	–	FELR01.1N-1K56-N040R-D-560-NNNN	40Ω/1560W	1
18K5	FELB02.1N-30K0	1	FELR01.1N-04K8-N032R-A-560-NNNN	32Ω/4.8kW	1
22K0	FELB02.1N-30K0	1	FELR01.1N-04K8-N27R2-A-560-NNNN	27.2Ω/4.8kW	1
30K0	FELB02.1N-30K0	1	FELR01.1N-06K0-N020R-A-560-NNNN	20Ω/6.0kW	1
37K0	FELB02.1N-45K0	1	FELR01.1N-09K6-N016R-A-560-NNNN	16Ω/9.6kW	1
45K0	FELB02.1N-45K0	1	FELR01.1N-09K6-N13R6-A-560-NNNN	13.6Ω/9.6kW	1
55K0	FELB02.1N-30K0	2	FELR01.1N-06K0-N020R-A-560-NNNN	20Ω/6.0kW	2
75K0	FELB02.1N-45K0	2	FELR01.1N-09K6-N13R6-A-560-NNNN	13.6Ω/9.6kW	2
90K0	FELB02.1N-45K0	3	FELR01.1N-06K0-N020R-A-560-NNNN	20Ω/6.0kW	3

Tab. 10-10: Brake resistor selection_OT = 10 %

Model	FELB typecode	FELB quantity	FELR typecode	FELR type	FELR quantity
1K50	Internal	–	FELR01.1N-0520-N350R-D-560-NNNN	350Ω/520W	1
2K20	Internal	–	FELR01.1N-0520-N230R-D-560-NNNN	230Ω/520W	1
4K00	Internal	–	FELR01.1N-0780-N140R-D-560-NNNN	140Ω/780W	1
5K50	Internal	–	FELR01.1N-1K04-N090R-D-560-NNNN	90Ω/1040W	1
7K50	Internal	–	FELR01.1N-1K56-N070R-D-560-NNNN	70Ω/1560W	1
11K0	Internal	–	FELR01.1N-02K0-N047R-D-560-NNNN	47Ω/2.0kW	1
15K0	Internal	–	FELR01.1N-01K5-N068R-D-560-NNNN	68Ω/1.5kW	2
18K5	FELB02.1N-30K0	1	FELR01.1N-10K0-N028R-A-560-NNNN	28Ω/10.0kW	1
22K0	FELB02.1N-30K0	1	FELR01.1N-10K0-N022R-A-560-NNNN	22Ω/10.0kW	1
30K0	FELB02.1N-45K0	1	FELR01.1N-12K5-N017R-A-560-NNNN	17Ω/12.5kW	1
37K0	FELB02.1N-45K0	1	FELR01.1N-10K0-N032R-A-560-NNNN	32Ω/10.0kW	2
45K0	FELB02.1N-30K0	2	FELR01.1N-10K0-N024R-A-560-NNNN	24Ω/10.0kW	2
55K0	FELB02.1N-45K0	2	FELR01.1N-12K5-N018R-A-560-NNNN	18Ω/12.5kW	2
75K0	FELB02.1N-45K0	3	FELR01.1N-12K5-N020R-A-560-NNNN	20Ω/12.5kW	3
90K0	FELB02.1N-45K0	3	FELR01.1N-12K5-N020R-A-560-NNNN	20Ω/12.5kW	3

Tab. 10-11: Brake resistor selection_OT = 20 %

Model	FELB typecode	FELB quantity	FELR typecode	FELR type	FELR quantity
1K50	Internal	–	FELR01.1N-0800-N275R-D-560-NNNN	275Ω/800W	1
2K20	Internal	–	FELR01.1N-01K2-N180R-D-560-NNNN	180Ω/1.2kW	1
4K00	Internal	–	FELR01.1N-02K0-N110R-D-560-NNNN	110Ω/2.0kW	1
5K50	Internal	–	FELR01.1N-01K5-N150R-D-560-NNNN	150Ω/1.5kW	2
7K50	Internal	–	FELR01.1N-04K5-N055R-A-560-NNNN	55Ω/4.5kW	1
11K0	Internal	–	FELR01.1N-06K0-N040R-A-560-NNNN	40Ω/6.0kW	1
15K0	Internal	–	FELR01.1N-08K0-N027R-A-560-NNNN	27Ω/8.0kW	1
18K5	FELB02.1N-45K0	1	FELR01.1N-10K0-N022R-A-560-NNNN	22Ω/10.0kW	1
22K0	FELB02.1N-45K0	1	FELR01.1N-12K5-N018R-A-560-NNNN	18Ω/12.5kW	1
30K0	FELB02.1N-30K0	2	FELR01.1N-10K0-N27R2-A-560-NNNN	27.2Ω/10.0kW	2
37K0	FELB02.1N-45K0	2	FELR01.1N-10K0-N022R-A-560-NNNN	22Ω/10.0kW	2
45K0	FELB02.1N-45K0	2	FELR01.1N-12K5-N018R-A-560-NNNN	18Ω/12.5kW	2
55K0	FELB02.1N-30K0	3	FELR01.1N-12K5-N022R-A-560-NNNN	22Ω/12.5kW	3
75K0	FELB02.1N-45K0	3	FELR01.1N-12K5-N018R-A-560-NNNN	18Ω/12.5kW	6
90K0	FELB02.1N-45K0	3	FELR01.1N-12K5-N018R-A-560-NNNN	18Ω/12.5kW	6

Tab. 10-12: 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 $P_R=K * P_{max} * OT\%$, in which k is the derating coefficient of brake resistor. The selection of the brake torque should be in general smaller than 150 % of the rated motor torque, or consulting the technical support for more information.
- For 75K0 and 90K0 model, every two brake resistor is connected in parallel to one brake unit.

Accessories

Brake resistor in aluminum housing

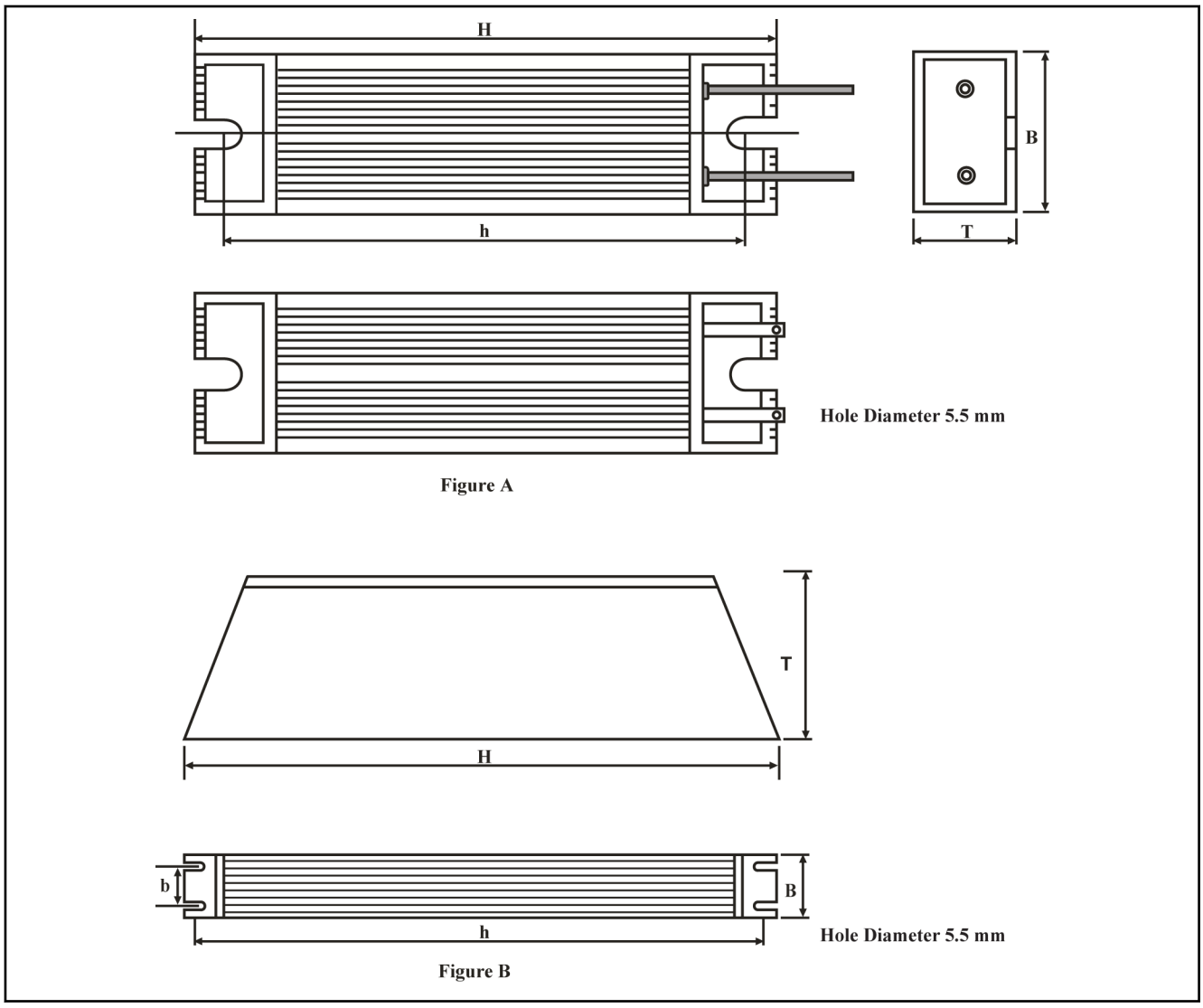


Fig. 10-15: Brake resistor in aluminum housing

Brake resistor typecode	Impedance [Ω]	Power [W]	Fig.	Dimensions [mm]					Wiring [mm²]	Terminal [mm]	Cable length [mm]	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.
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. 10-13: Aluminum brake resistor dimensions

- Alumi.: Brake resistor in aluminum housing.
- The complete type code of brake resistors in the above table is: FELR01.1N-xxxx-NxxxR-x-560-NNNN.
- The dimensions of brake resistor 02K0-N047R-D are applicable to both -NNNN and -P002. For -P002, an additional 500 mm long cable is provided with the delivery.

Accessories

Brake resistor box

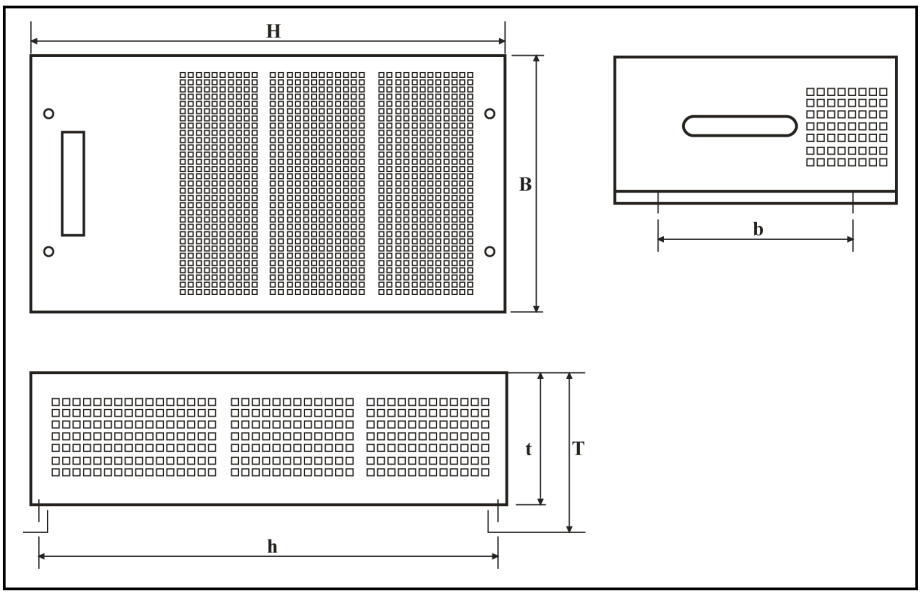


Fig. 10-16: Brake resistor box dimensions drawing

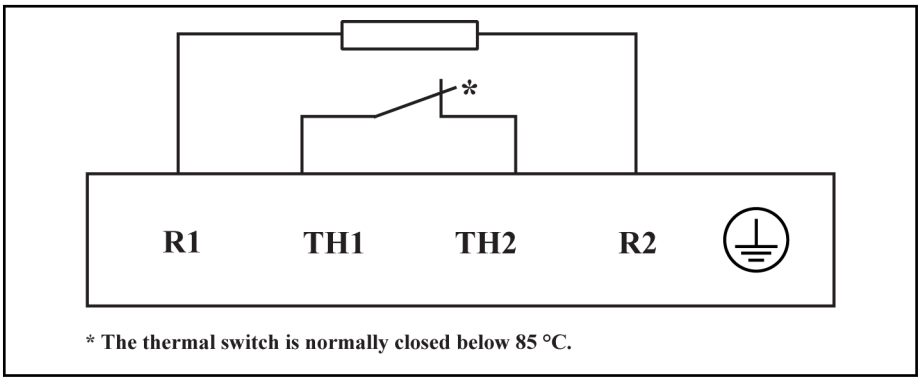


Fig. 10-17: Brake resistor box terminals

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. 10-14: Brake resistor box dimensions

- box: Brake resistor box.
- The complete type code of brake resistors in the above table is: FELR01.1N-xxxx-NxxxR-x-560-NNNN.

10.3 Communication Interface

10.3.1 PROFIBUS Adapter Module

The PROFIBUS adapter (FVAA01.2-P-NNNN-01V01) is used to convert Fv for Sytronix serial RS485 interface (Modbus) to PROFIBUS DP standard.

Please refer to chapter 12 "Serial Communication" on page 225.

10.3.2 Modbus Adapter Module

The Modbus adapter (FVAA01.2-M) is used to connect the RS485 interface (Modbus) with a PC or another control unit.

10.4 Engineering Software

ConverterPC Sytronix 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 Sytronix documentation available.

The latest version of Converter PC is 01V08, which is applicable to firmware with the version of 01V05, 01V06 and 01V08.

10.5 Master/Slave Pump Communication Connector

This special connector is a 6P4C junction box with three interconnected terminals. It is used for setting up RS485 communication network for master/slave pump application.

The type code: PLUG CONNECTOR ZKX-202-6P4C.

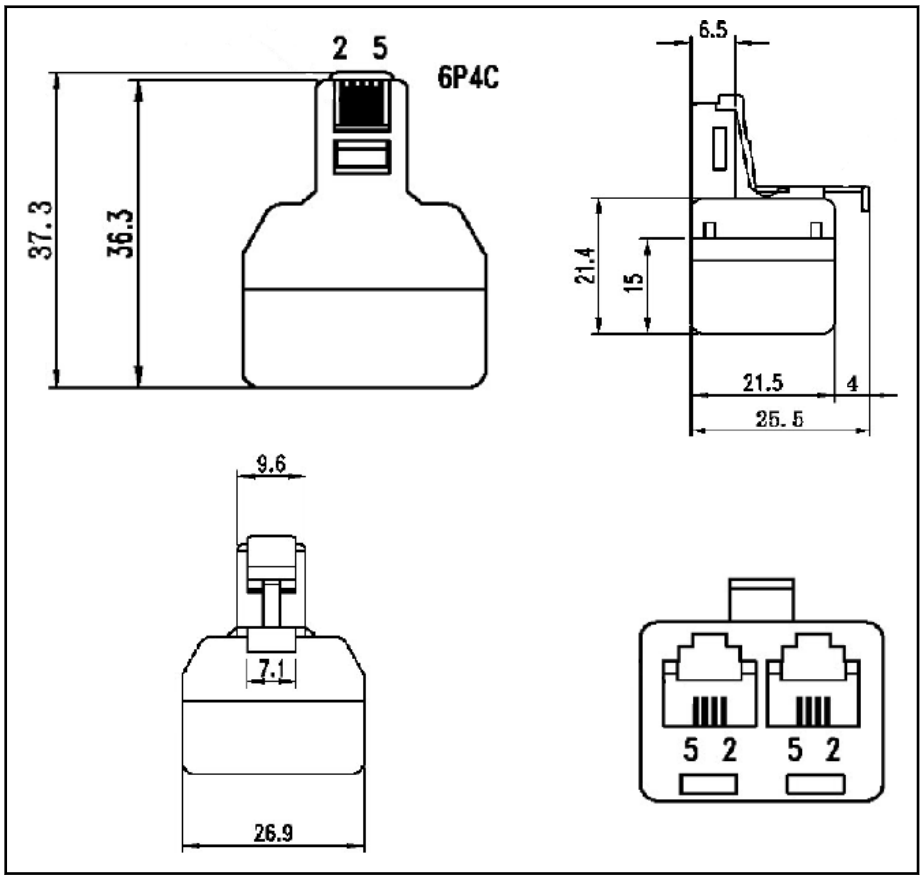


Fig. 10-18: Plug connector for master/slave application

10.6 Master/Slave Pump Communication Cable

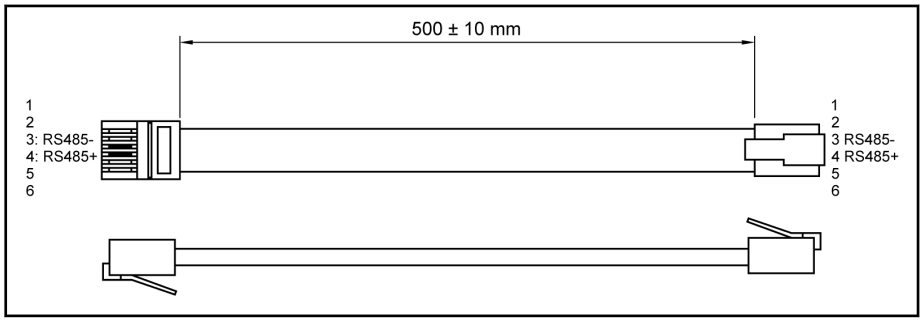


Fig. 10-19: Master/slave communication cable

10.7 Cable Shielding Kit

10.7.1 Brief Introduction to the Accessory

This Cable Shielding Kit is applicable to Frequency Converter Fv for Sytronix. It is used for providing additional contact/fixing/support to the power/control terminals of the frequency converter. With the Cable Shielding Kit, the shielding cable grounding is more stable, the EMC protection of signals is better. In addition, the Cable Shielding Kit can also fix and prevent cables from falling off from the wiring terminals of the frequency converter.

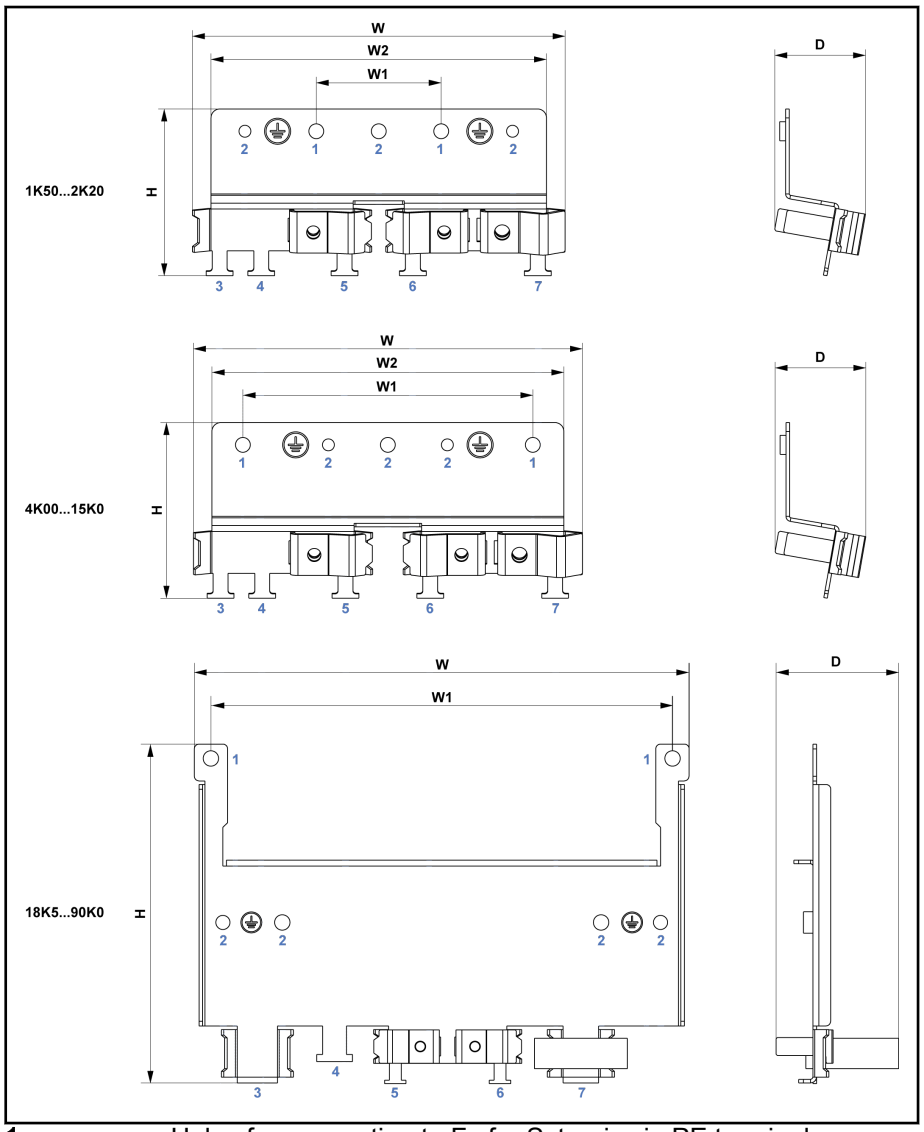
10.7.2 Type of Frequency Converter and Cable Shielding Kit

Fv for Sytronix model	Cable shielding kit type
1K50, 2K20	FVAM01.1-GROUNDING-EXTENSION-1K50-2K20
4K00, 5K50, 7K50	FVAM01.1-GROUNDING-EXTENSION-4K00-7K50
11K0, 15K0	FVAM01.1-GROUNDING-EXTENSION-11K0-15K0
18K5, 22K0	FVAM01.1-GROUNDING-EXTENSION-18K5-22K0
30K0, 37K0	FVAM01.1-GROUNDING-EXTENSION-30K0-37K0
45K0, 55K0	FVAM01.1-GROUNDING-EXTENSION-45K0-55K0
75K0, 90K0	FVAM01.1-GROUNDING-EXTENSION-75K0-90K0

Tab. 10-15: Matching table for frequency converter and cable shielding kit

10.7.3 Figure and Dimensions

Figure and terminals marking



1	Holes for connection to Fv for Sytronix via PE terminals
2	User grounding terminals (e.g., mains or motor grounding cable)
3	Fixing of mains cables
4	Fixing of brake resistor cables
5	Fixing of digital signal lines
6	Fixing of analog signal lines
7	Fixing of motor cables

Fig. 10-20: Figure and terminals marking

For the Cable Shielding Kit of model 1K50 to 2K20, the connection holes 1 are in the middle, the grounding terminals 2 are on two sides.

Accessories

Dimensions

Frame	Model	W	W1	W2	H	D
A	1K50 to 2K20	125	42	113	56	31
B	4K00 to 7K50	131	98	118	59	31
C	11K0 to 15K0	158	118	145	66	31
D	18K5 to 22K0	208	194	–	133	50
E	30K0 to 37K0	208	194	–	143	52
F	45K0 to 55K0	270	250	–	180	58
G	75K0 to 90K0	386	360	–	218	69

Tab. 10-16: Dimensions

10.7.4 Wiring Descriptions

☞ For marking (1 to 7) in the following descriptions, see the above figure **Dimensions and terminals marking**.

- Please ensure that the connection holes 1 of the Cable Shielding Kit are connected to the PE terminals of the frequency converter. Wrong connection might lead to electric shock. Ensure that the screws are well tightened to prevent the Cable Shielding Kit from falling off.
- The grounding terminals 2 are marked with grounding symbols. They are used to connect the grounding cables of the mains and the motor, from which the grounding cables are connected to the PE terminals of Fv for Sytronix via the Cable Shielding Kit.
- 3P mains cables and grounding cables need to be fixed on terminal 3 with cable straps. The T shape of the terminal is used to prevent the cable strap from falling off. Please use suitable cable strap according to the cable dimensions or use several cable straps. Be sure that the cable straps cannot fall off after fixing.
- Terminal 4 is used for fixing the brake resistor cables with cable straps.
- Terminals 5 and 6 are used for fixing signal lines. For digital signal lines without shielding, please remove the clamp, and then fix all the lines on the T shape of the terminal with cable straps. For analog signal lines with shielding, please strip the insulation as shown in the figure below. To provide a better EMC protection, clamp the exposed (exposed over the same length as that of the clamp) shielding layer with clamps to ensure a large contact area of the metal shielding layer and the Cable Shielding Kit of Fv for Sytronix. Use additional cable straps to fix the cable after the clamp on the T shape of the terminal. Ensure that the cable section under the cable strap has insulation, well fixed with enough tensile strength. In addition, prevent the cables from damage by the cable straps.

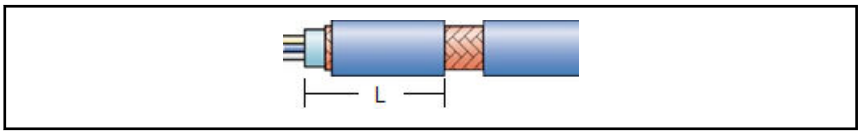


Fig. 10-21: Stripping of analog signal line

- Remove the insulation of the motor cable as shown in the figure below. Fold back the shielding layer over the insulation, and then fix it with a clamp or hose clamp on terminal 7.

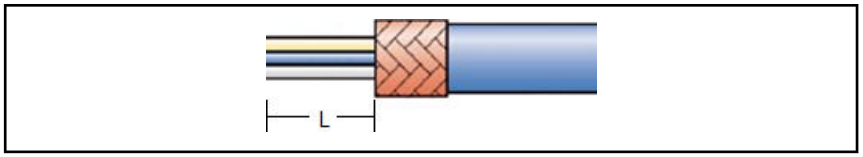


Fig. 10-22: Stripping of motor cable

- Mount Fv for Sytronix on the metal frame of the control cabinet with bolts, washers and toothed washers and ensure the frame coating of Fv for Sytronix has been well cut by the toothed washer so that Fv for Sytronix can form a grounding circuit with the control cabinet.
- The suggested cable stripping length is as shown in the table below:

Fv for Sytronix model	Suggested stripping length L [mm]	
	Analog signal line	Motor cable
1K50 to 2K20	120	90
4K00 to 7K50	150	90
11K0 to 15K0	210	110
18K5 to 22K0	210	140
30K0 to 37K0	230	160
45K0 to 55K0	360	180
75K0 to 90K0	550	220

Tab. 10-17: Suggested stripping length

11 Additional Information

11.1 Closed-loop Speed Control System

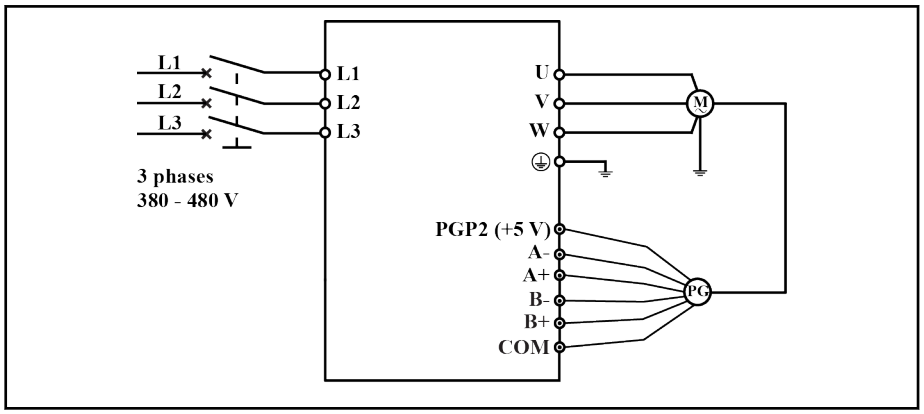


Fig. 11-1: Closed-loop speed control system

- 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.

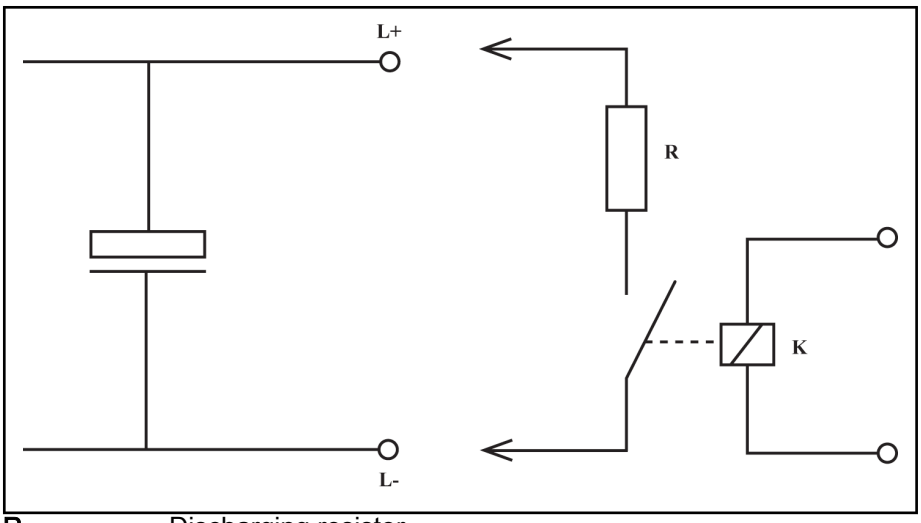
To shorten the waiting time until voltage has fallen below 50 V, you can take the following measure:

- Use the discharging device described below

11.2.2 Discharging Device

Operating principle

A contactor is installed to switch a resistor to the terminals L+ and L- of the DC bus connection to discharge the capacitors. The contactor is activated via a control input which is supplied with appropriate control voltage.



R Discharging resistor
K Contactor contact

Fig. 11-2: Operating principle of discharging device

Dimensioning

The individual components have to be sufficiently dimensioned:

- Value of the discharging resistor: 1,000 ohm and at least 1,000 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 1,000 V;
- The contactor contact has to withstand the occurring discharge current according to the resistance value that is used, i.e. 1 A with 1,000 ohm.

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 Serial Communication

12.1 Introduction

Fv for Sytronix 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 code parameters, monitoring of frequency converter running status and failure messages) to address the specific requirements of applications.

12.2 Modbus Communication Function

12.2.1 Protocol Description

Introduction

Modbus is a master/slave protocol. Only one device may send commands in the network at a particular time.

The master station manages information exchange by polling the slave stations. Unless being approved by the master station, no station may send information.

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

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

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

There are two types of dialogs between the master station and the slave stations:

- The master station sends a request to a slave station and waits for its response.
- The master station sends a request to all slave stations and does not wait for their response (broadcasting).

Serial Communication

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 fault.

Data format and sending sequence of one byte:

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

CRC (Cyclic redundancy check):

- CRC16, lower bytes first and higher bytes later

Slave address:

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

12.2.2 Interface

The RJ11 communication interface of Fv for Sytronix is shown in figure below.

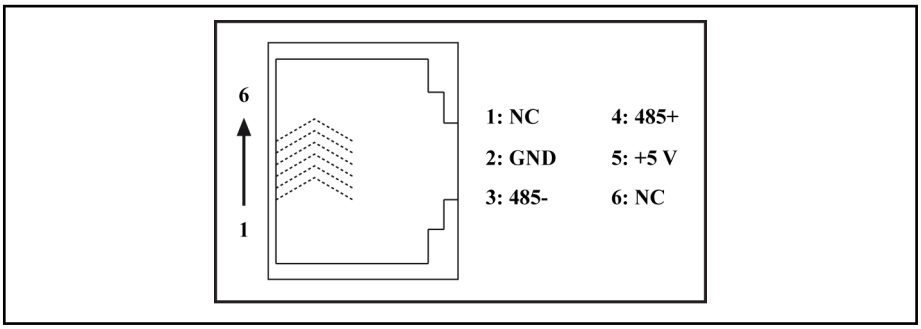


Fig. 12-1: Fv for Sytronix RJ11 communication interface

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 for Sytronix and its limits are shown in table below.

Function code	Description	Broadcast	Maximum value of N
3=0x03	Read N register parameters	NO	16 characters in maximum
6=0x06	Rewrite a register with information stored even after power off	YES	–
8=0x08	Loop test	NO	–
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
65=0x41	Specially used for pressure and flow control	NO	–

Tab. 12-2: Modbus functions managed by Fv for Sytronix and its limits

☞ “Read” and “Write” is considered from the prospect of the master station.

If the device fails to act upon the request, it responds with an error code and exception code. The error code is the function code plus 0x80. An example of exception code is shown in table below.

Error code	Meaning	Reason
1	Password locked	User password locked
2	Function code error	Function code is not 03, 06, 08, 16, 23
3	Invalid address	Undefined address
4	Invalid data	Data exceeds limit
5	Parameters can not be modified in run mode	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

Serial Communication

Function description

Function 0x03: Read N words, range: 1 to 16

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

Start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	03H
Higher byte of start address	01H
Lower byte of start address	00H
Higher byte of data	00H
Lower byte of data	02H
CRC lower byte	C5H
CRC higher byte	F7H
End	Transmission time for 3.5 bytes

Tab. 12-4: Function 0x03_master request

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

Tab. 12-5: Function 0x03_slave response

Function 0x06: Write a word

Example: Write 0000H to communication register address 0006H of the slave frequency converter with address 01H. The frame structure is described in tables below.

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

Tab. 12-6: Function 0x06_master request

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

Tab. 12-7: Function 0x06_slave response

Function 0x08: Loop test

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

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

Tab. 12-8: Function 0x08_master request

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

Tab. 12-9: Function 0x08_slave response

Function 0x10: Write N words, range: 1 to 16

Example: To modify 2 continuous resisters start from 0109H with words 003CH and 0050H with slave frequency converter address 01H. The frame structure is described in tables below.

Start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	10H
Higher byte of write register start address	01H
Lower byte of write register start address	09H
Higher byte of register number	00H
Lower byte of register number	02H
Bytes of data	04H
Higher byte of data in register 0109H	00H
Lower byte of data in register 0109H	3CH
Higher byte of data in register 010AH	00H
Lower byte of data in register 010AH	50H
CRC lower byte	FEH
CRC higher byte	65H
End	Transmission time for 3.5 bytes

Tab. 12-10: Function 0x10_master request

Start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	10H
Higher byte of register start address	01H
Lower byte of register start address	09H
Higher byte of register number	00H
Lower byte of register number	02H
CRC lower byte	90H
CRC higher byte	36H
End	Transmission time for 3.5 bytes

Tab. 12-11: Function 0x10_slave response

Function 0x17: Read/write N words, range: 1 to 16

Example: To read data in 2 continuous registers starting from address 0100H, write 0064H and 00C8H to 2 continuous registers starting from address 0109H. The frame structure is described in tables below.

Start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	17H
Higher byte of read register start address	01H
Lower byte of read register start address	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
End	Transmission time for 3.5 bytes

Tab. 12-12: Function 0x17_master request

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

Tab. 12-13: Function 0x17_slave response

Function code 0x41: Specially used for pressure and flow control

Example: To implement pressure and flow control by writing and reading registers through 0x41 function code. Address of the frequency converter is 01H. In this example, communication control word, pressure command and flow command are sent by master, and communication state feedback word, pressure feedback and ouput speed are replied by slave. The frame structure is described in tables below.

Start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	41H
Higher byte of write register start address	40H
Lower byte of write register start address	00H
Higher byte of register number	00H
Lower byte of register number	04H
Bytes of data	08H
Higher byte of data in register 4000H	04H (Enable flow mode)
Lower byte of data in register 4000H	01H (Start the frequency converter)
Higher byte of data in register 4001H	00H
Lower byte of data in register 4001H	00H (Frequency command is 0 Hz)
Higher byte of data in register 4002H	07H
Lower byte of data in register 4002H	D0H (Pressure command is 20.00 bar)
Higher byte of data in register 4003H	06H
Lower byte of data in register 4003H	40H (Flow command is 1600 rpm)
CRC lower byte	0BH
CRC higher byte	C5H
End	Transmission time for 3.5 bytes

Tab. 12-14: Function 0x41_master request

Start	Transmission time for 3.5 bytes
Slave address	01H
Modbus function code	41H
Bytes of read register	06H
Higher byte of read register 5000H	00H
Lower byte of read register 5000H	02H (Frequency converter state word)
Higher byte of read register 5011H	07H
Lower byte of read register 5011H	D1H (Pressure feedback 20.01 bar)
Higher byte of read register 500AH	06H
Lower byte of read register 500AH	3FH (output speed 1599 rpm)
CRC lower byte	CFH

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CRC higher byte	A1H
End	Transmission time for 3.5 bytes

Tab. 12-15: Function 0x41_slave response

1. To set control word, pressure command and flow command through 0x41 function code, following parameters should be set respectively first.
   - Set b1.02 Frequency converter control commands to '2:Set control commands by communication'.
   - Set b1.25 Flow command selection to '2:Set by communication'.
   - Set b1.27 Pressure command selection to '2: Set by communication'.
2. When [b1.00]='5: Set by communication', then frequency command will be received. When [b1.00]='2: Set by p/Q PID controller' or '7: Set by flow setting', frequency command will not be received though it ‘s sent by master. In this situation, writing 0x0000 to register 0x4001 is recommended.
3. To use 0x41 function code, intervals between master request messages are determined by Modbud baudrate. The relationship is:
   - When baudrate is 9,600 bps, Interval is 40 ms.
   - When baudrate is 19,200 bps, Interval is 20 ms.
   - When baudrate is 38,400 bps, Interval is 10 ms.

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 to 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	H0	0x0B

Tab. 12-16: 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 3rd function code.

Communication control registers (0x4000, 0x4001)

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

bit	Value	Description
15 to 11	-	Reserved
10	1	Enable flow mode
	0	Disable flow mode
9, 8	0, 0	To switch p/Q control parameter set 0
	0, 1	To switch p/Q control parameter set 1
	1, 0	To switch p/Q control parameter set 2
	1, 1	To switch p/Q control parameter set 3
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. 12-17: Communication control register 0x4000_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 pressure command setting register for communication control is 0x4002. This register is write-only. When [b1.27]='2: Set by communication', pressure command can be set with writing data to this address. The range of writing data is from 0 to 65,000, corresponding to pressure command from 0 to 650.00 bar. If the data exceeds the range, pressure command will be limited to 650.00 bar.

The address of flow command setting register for communication control is 0x4003. This register is write-only. When [b1.25]='2: Set by communication', flow command can be set with writing data to this address. The range of writ-

ing data is from 0 to 3,000, corresponding to flow command from 0 to 3,000 rpm. If the data exceeds the range, flow command will be limited to 3,000 rpm.

- Frequency converter can not be set to flow mode through communication if there is fault or warning.
- When [b1.00]='2: Set by p/Q PID controller' or '7: Set by flow mode', forward/reverse control bit (0x4000: bit2) is inactive.

Communication state feedback register (0x5000)

Definition of each bit

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 to 11	–	Error code
10 to 8	–	Reserved
7	1	Fault
	0	No fault
6	1	Stall over current
	0	Normal
5	1	Stall over voltage
	0	Normal
4	1	Decelerating
	0	Not in deceleration
3	1	Accelerating
	0	Not in acceleration
2	1	Jogging
	0	Not in jog
1	1	In run
	0	In stop
0	1	Reverse
	0	Forward

Tab. 12-18: Communication state word register (0x5000) _bit definition

Meanings of error codes

The meanings of error codes are described in table below.

No.	Error code name
0	No fault 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 fault (R.E.)

No.	Error code name
10	Operating panel read/write fault (KEY-)
11	Motor overheat (M.O.H.)
12	Communication fault (R.S.)
13	Circuit disconnection (C.F.)
14	Encoder speed detection fault (PULS)
15	Brake chopper overheat (B.O.H.)
16	EMI (CPU-)
17	Short circuit (S.C.)
18	Pressure sensor fault (P.S.F.)
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 fault (PRSE)
23	Parameter auto-tuning fault (TUNE)
24	Converter overload pre-alarm 2 (O.L.-3)
25	Over pressure pre-warning (O.P.W.)
26	Over pressure error (O.P.F.)
27	Braking threshold low (B.T.L.)
28	Reserved
29	Reserved
30	Flow command limitation (F.C.LI)
31	Pressure command limitation (P.C.LI)
32	Slave pump fault (M/S S.)
33	Master/slave pump communication error (M/S C.)

Tab. 12-19: Error codes and meanings_Modbus

Communication monitor registers (0x5001 to 0x5014)

Communication monitor registers are read-only. The relationship between the addresses of monitor registers 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	Encoder feedback
0x500D	Digital terminals
0x500E	Pressure reference
0x500F	p/Q speed/flow reference
0x5010	Speed/flow command
0x5011	Pressure feedback
0x5012	Reserved
0x5013	Reserved
0x5014	Reserved

Tab. 12-20: Addresses of monitor registers and monitored values

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. 12-21: Example of Modbus communication

12.2.6 Special Notes

1. The external computer can not write to function codes b0.00, b0.07, b0.08, b0.09 and S2.10.
2. b0.02 does not support 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, with a PC, a logic control or an external computer and various frequency converters, which are connected by shielded twisted pair cables via RS232/485 adapter. The maximum length of 232 network cable connection is 15 meters. The slave at the end of the network needs a termination resistor with recommended value of 120 Ω, 0.25 W.

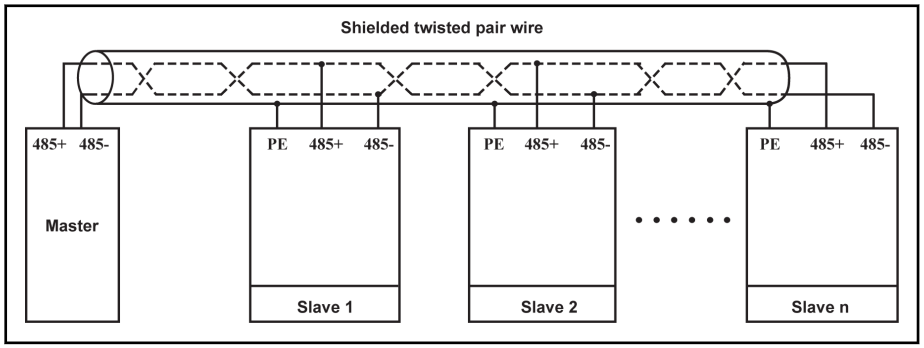

Fig. 12-2: Modbus networking

⚠ 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.

12.3 PROFIBUS Communication Function

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. 12-22: PROFIBUS frame format

Physical transmission medium for PROFIBUS is twisted-pair cable (RS-485 standard). Maximum length of bus cable is within the scope of 100 to 1200 m, depending on the set transmission rate. When no repeater is used, 32 nodes at maximum can be connected to the same PROFIBUS network; if a repeater is used, nodes connected to the network may be increased to 126. In PROFIBUS communication, the master is usually a programmable logic controller, 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 to 12 Mbps
EMC requirement	IEC 1000-4

Tab. 12-23: PROFIBUS-Adapter technical parameters and performance

Functions

PROFIBUS-Adapter is able to control Fv for Sytronix 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 fault.

Network structure

Fv for Sytronix PROFIBUS network connection via PROFIBUS-Adapter is shown in figure below.

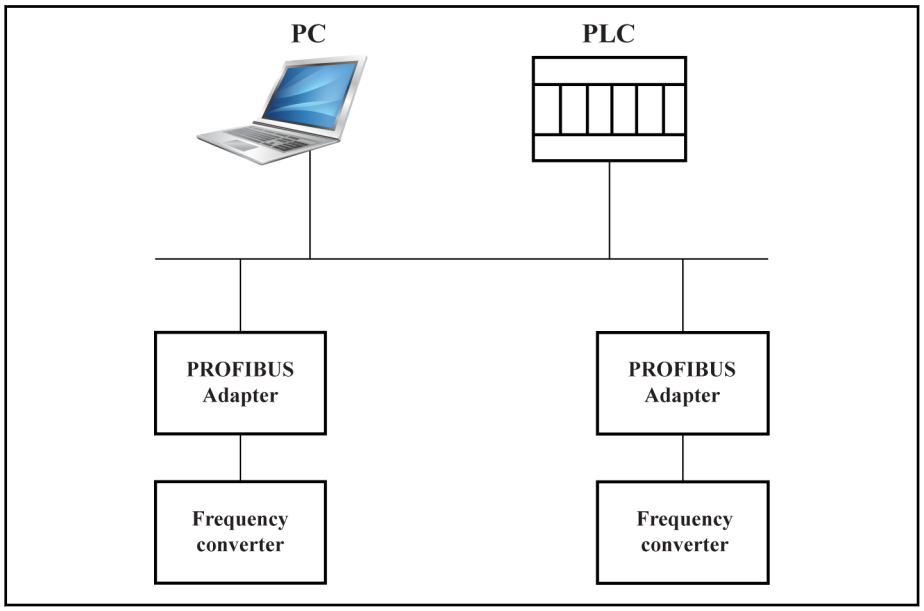

Fig. 12-3: Fv for Sytronix PROFIBUS network

Serial Communication

12.3.3 Electrical Installations

Outline structure

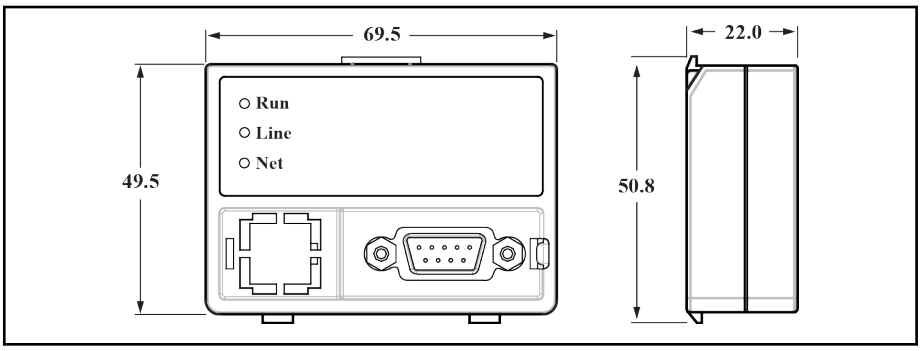

Fig. 12-4: PROFIBUS adapter dimensions

Adapter terminal configuration

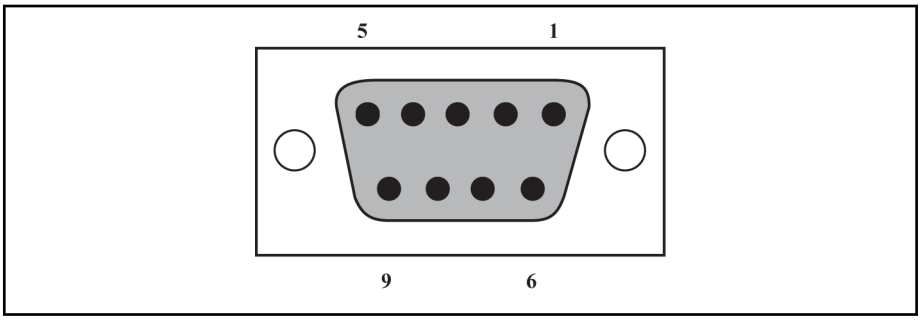

Fig. 12-5: Bus connection terminal PROFIBUS DB9

Pin No.	Terminal sign	Terminal name	Function description
1	NC	–	–
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. 12-24: Pin definition of PROFIBUS DB9 interface

Requirements for PROFIBUS link

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

Impedance of the cable should be within 100 Ω to 200 Ω. Cable capacity (among conductors) should be < 60 pF/m, and conductor cross section should be ≥ 0.22 (24 AWG). Two kinds of cables are used for PROFIBUS with detail definitions stated in table below.

Cable parameters	Type A	Type B
Impedance	135 to 165 Ω (f=3 to 20 MHz)	100 to 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. 12-25: 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 to 93.75 kbps	1000	1000
187.5 kbps	1000	600
500 kbps	400	200
1.5 Mbps	200	200
3 to 12 Mbps	100	100

Tab. 12-26: Relationship between communication rate and cable length

EMC measures

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

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

12.3.4 Periodical Data Communication

PPO 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, or status word, actual output frequency and other status monitoring values of slave.

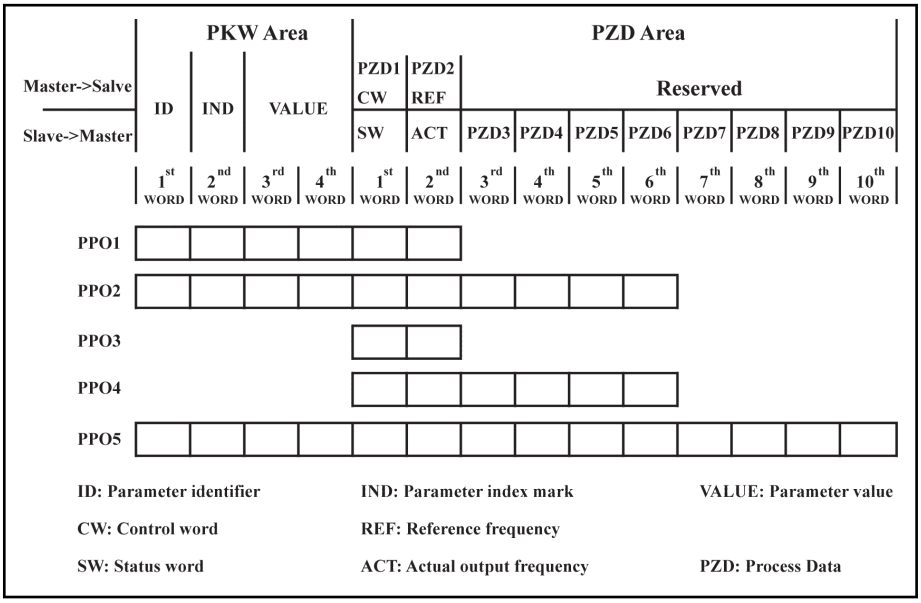

Fig. 12-6: PPO type

PQT type

PQT type is specially used for pressure and flow control in Fv for Sytronix application.

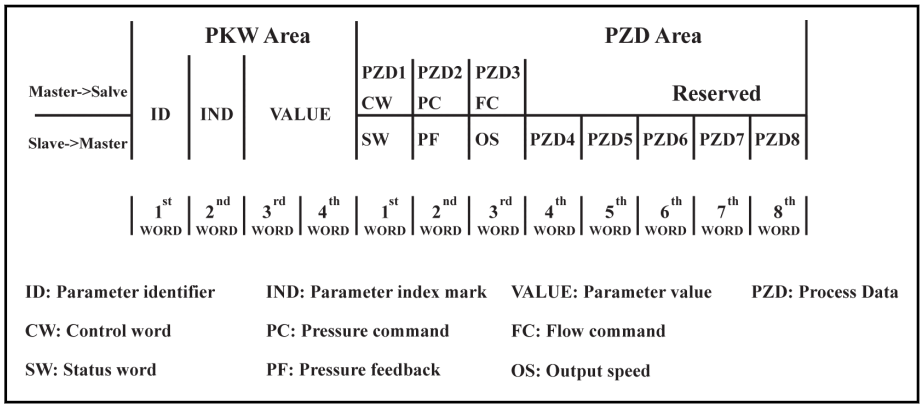

Fig. 12-7: PQT type

- The function of pressure and flow control through communication only exists in Sytronix firmware with the version of 01V08 and the older. The version of adaptor and GSD file should be 01V03 and the older.
- When PQT type is used, low 4 bits of H0.04 PZD4, PZD3 setting which are used for set status variables of PZD3 are inactive.
- Limited by communicating rate between adapter and frequency converter, message sending period of master should be set to more than 6 ms.

For detail descriptions of PKW parameter area and PZD process data area, see the following chapters.

Serial Communication

PKW parameter area

PKW parameter area description

This data area is composed of ID, IND, VALUE_high and VALUE_low, as shown in figure below. They are used to read or modify the parameter of a 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. 12-27 "Request data frame in PKW area_from master to slave" on page 250 and tab. 12-28 "Response data frame in PKW area_from slave to master" on page 251. If frequency converter fails to execute PKW area request command, it will return error code to the master in VALUE_low, see tab. 12-29 "PKW area error codes" on page 251.

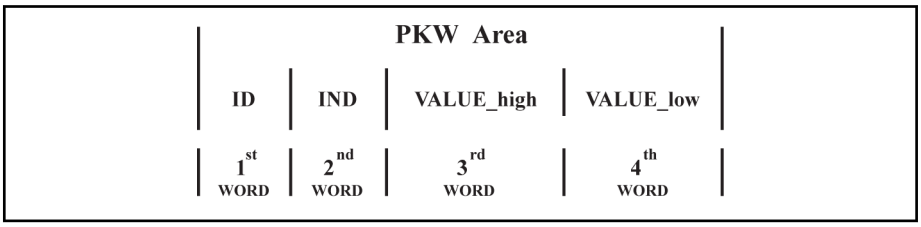

Fig. 12-8: PKW area data format

Request data frame in PKW area

Word	Identifier	bit	Value	Description
1st	ID	15 to 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 to 8	000B	Group No. for function code parameter
		7 to 0	xxH	
2nd	IND	15 to 8	xxH	Index serial number of function code within the group
		7 to 0	0	Reserved, default is 0.
3rd	VALUE_high	15 to 0	0	Reserved, default is 0.
4th	VALUE_low	15 to 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. 12-27: 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 "PPO type" on page 248.

Response data frame in PKW area

Word	Identifier	bit	Value	Description
1st	ID	15 to 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 to 8	000B	Group No. of function code parameter
		7 to 0	xxH	
2nd	IND	15 to 8	xxH	Index serial number of function code parameter within the group
		7 to 0	0	Reserved，default is 0.
3rd	VALUE_high	15 to 0	0	Reserved，default is 0.
4th	VALUE_low	15 to 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. 12-28: 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 to 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 fault in PKW	Conductor interference
9	EEPROM read/write fault	EEPROM write operation is not complete.

Tab. 12-29: PKW area error codes

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

Example of parameter operation in PKW area

Example description

In real application, the PROFIBUS adapter communicates with the master through messages in PPO structure. Among the 5 PPOs stated in fig. 12-6 "PPO type" on page 248, PPO 1, PPO 2 and PPO5 apply both PKW area and PZD area. In following examples, PKW area data frames are taken from complete PPO message to describe its request and response data frames.

The following examples are based on Fv for Sytronix 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. 12-30: 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 can be 0 or 1. 0 is strongly recommended, refer to chapter 12.3.4 "Periodical Data Communication" on page 248. 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. 12-31: 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	0x0BB8
Response data frame of PKW area	0x1005	0x0600	0x0000	0x0BB8

Tab. 12-32: 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. 12-33: 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. 12-34: 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. 12-35: 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. 12-36: 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. 12-37: 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. 12-38: Example 9_request and response data frames of PKW area

PZD process data area

PZD process data area description

For PPO1 to PPO5 type, when the master is sending a request message to the slave, PZD1 and PZD2 in PZD process data area are respectively corresponding to control word (CW) and reference frequency (REF) and PZD3 to PZD10 (number depending on PPO type) are written as 0. When the slave returns a response message to the master, PZD1 and PZD2 in PZD process data area are respectively corresponding to status word (SW) and actual output frequency (ACT), and PZD3-PZD10 are corresponding to status monitoring values (such as output current, output voltage, AC bus voltage, etc.) set by parameters H0.04 to H0.07.

For PQT type, when the master is sending a request message to the slave, PZD1, PZD2 and PZD3 in PZD process data area are respectively corresponding to control word(CW), pressure command(PC) and flow command(FC) and PZD4 to PZD8 are written as 0. When the slave returns a response message to the master, PZD1, PZD2 and PZD3 in PZD process data area are respectively corresponding to status word(SW), pressure feedback(PF) and output speed(OS), and PZD4 to PZD8 are corresponding to status monitoring values set by parameters H0.04 to H0.07.

Control word (CW)

bit	Value	Description
15 to 8	–	Reserved
7	0	Control active
	1	Control inactive
6	0	Inactive
	1	SCI stop acceleration
5	0	Fault reset inactive
	1	Fault 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. 12-39: Bit definition of control word

☞ When bit7 is 1, command is invalid.

Serial Communication

Status word (SW)

bit	Value	Description
11 to 15	–	Frequency converter error codes
10	–	Reserved
7 to 9	000	Normal
	001	Communication hardware circuit fault (SW feedback has no meaning when there is circuit fault in communication hardware.)
	010	Communication data fault in PZD area
	011	Reference frequency exceeds limit in PZD area.
	100 to 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. 12-40: Bit definition of status word

☞ In case of system faults, fault records can be read in parameters E4.14 to E4.16.

Error codes and meanings in PROFIBUS communication

No.	Error code name	No.	Error code name
0	No fault record	17	Short circuit (S.C.)
1	Over current at constant speed (O.C.-1)	18	Pressure sensor fault (P.S.F.)
2	Over current in acceleration (O.C.-2)	19	L1, L2, L3 phase failure (IPH.L)
3	Over current in deceleration (O.C.-3)	20	U, V, W phase failure(OPH.L)
4	Over voltage at constant speed (O.E.-1)	21	Frequency converter overheat (C.O.H.)
5	Over voltage in acceleration (O.E.-2)	22	Parameter setting fault (PRSE)
6	Over voltage during deceleration (O.E.-3)	23	Parameter auto-tuning fault (TUNE)
7	Frequency converter overload (O.L.-1)	24	Frequency converter overload pre-alarm 2 (O.L.-3)
8	Motor overload (O.L.-2)	25	Over pressure pre-alarm (O.P.W.)
9	CPU read/write fault (R.E.)	26	Over pressure error (O.P.F.)
10	Operating panel read/write fault (KEY-)	27	Braking threshold low(B.T.L.)
11	Motor overheat (M.O.H.)	28	Reserved
12	Communication fault (R.S.)	29	Reserved
13	Circuit disconnection (C.F.)	30	Flow command in limiting (F.C.LI)
14	Encoder speed detection fault (PULS)	31	Pressure command in limiting (P.C.LI)
15	Brake chopper overheat (B.O.H.)	32	Slave pump fault (M/S S.)
16	EMI (CPU-)	33	Master/slave pump communication fault (M/S C.)

Tab. 12-41: Error codes and meanings_PROFIBUS

☞ When system is subject to fault, please read value of parameter E4.14 of frequency converter.

Examples

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. 12-42: Example 1_PPO request and response messages

☞ In this example, the feedback status word is 0x0180, bit 7 to 9 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. 12-43: Example 2_PPO request and response messages

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

Process data PZD3 to PZD10

One of parameters H0.04 to H0.07 can set 2 PZDs. For example, H0.04 sets PZD3 and PZD4, with bit0 to bit3 setting of PZD3, bit4 to bit7 setting of PZD4, then the maximum range of the function code is 00 to EEH (hex) or 0 to 238 (decimal). The corresponding relationship between the set value (4 bits) and monitored value is shown in table below.

00	Output frequency
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	Encoder feedback
0C	Digital terminals
0D	Pressure reference
0E	p/Q speed/flow reference

Tab. 12-44: Process data PZD3 to 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 chapter "PPO type" on page 248 and chapter "PZD process data area" on page 255, we need to set status monitoring value corresponding to PZD3 to PZD6 in parameters of Fv for Sytronix.

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. 12-45: Example 1 for PZD process data area_request and response messages of PPO

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

Example 2

When the 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. 12-46: 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.

Serial Communication

	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. 12-47: 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. 12-48: Example 4 for PZD process data area_request and response messages of PPO

Example 5

To run the frequency converter, set pressure command to 40.00 bar, flow command to 1,500 rpm. The control mode is FOC. H0.04-H0.06 are all set to 0, that means the monitored values of PZD4 to PZD8 are all set to output frequency.

	PZD1	PZD2	PZD3	PZD4	PZD5	PZD6	PZD7	PZD8
PQT request message	CW	PC	FC	N/A	N/A	N/A	N/A	N/A
	0x0001	0x0FA0	0x05DC					
PQT response message	SW	PF	OS	0x13D8	0x13D8	0x13D8	0x13D8	0x13D8
	0x0002	0x0FAE	0x05F0					

Tab. 12-49: Example 5 for PZD process data area_request and response messages of PQT

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
Mapping address	0x00	0x01	0x02	0x03	0x04	0x05
Parameter group	E0	E1	E2	E3	E4	H0
Mapping address	0x06	0x07	0x08	0x09	0x0A	0x0B

Tab. 12-50: 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. 12-51: 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 and H0.

The function code index number within a parameter group is from 00 to 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.

Serial Communication

12.3.5 Communication Parameter Configuration

Communication related parameter settings in Fv for Sytronix

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
b1.25	Flow command selection	2: Set by communication
b1.27	Pressure command selection	2: Set by communication
H0.00	Communication protocols	1: PROFIBUS
H0.03	Local address	1 to 126
H0.04	PZD4, PZD3 setting	0 to 238
H0.05	PZD6, PZD5 setting	0 to 238
H0.06	PZD8, PZD7 setting	0 to 238
H0.07	PZD10, PZD9 setting	0 to 238
H0.08	Communication disconnection detection time	0.0 to 60.0s (0.0: deactivated)
H0.09	Communication disconnection action	0: Stop 1: Keep running

Tab. 12-52: Fv for Sytronix 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 Faults 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_Fault (set by slave) 1: Adapter data received does not match with originally configured data
3	Diag.Ext_Diag (set by slave) 1: diagnosis entrance is at undetermined diagnosis area of the slave
4	Diag.Not-Supported (set by slave) 1: service not supported by slave
5	Diag.Invalid_Slave_Response (set by master, reset by slave) 1: invalid response of slave
6	Diag.Prm_Fault (set by 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

- **Second byte (Station_Status_2)**

0	Diag.Prm_Req (set by slave) 1: Slave needs to be reconfigurated, parameters need to be set again.
1	Diag.Stat_Diag (set by slave) 1: Static diagnosis, slave fails (temporarily) to provide valid data.
2	Always set as 1 by slave
3	Diag.WD_On (set by slave) 1: watchdog is on
4	Diag.Freeze_Mode (set by slave) 1: freezing command received by slave
5	Diag.Sync_Mode (set by slave) 1: synchronizing command received by slave
6	Reserved
7	Diag.Deactivated (set by master, reset by slave) 1: slave inactive

- **Third byte (Station_Status_3)**

0 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
- steel
- aluminum
- copper
- synthetic materials
- electronic components and modules

Motors
- steel
- aluminum
- copper
- brass
- 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.

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.

15 Appendix

15.1 Appendix I: Word Abbreviations in This Manual

Abbreviation	Full word	Abbreviation	Full word
Acc.	acceleration	**M.O.L.**	motor over load
Adp.	adaptive	**M/S**	master/slave
Alg.	analog	**Max.**	maximum
Auto.	automatic	**Min.**	minimum
Brak.	braking	**Mul.**	Multi-
C.	converter	**Monit.**	monitoring
C.O.L.	converter over load	**N.C.**	normally closed
C.R.Curr.	converter rated current	**N.O.**	normally open
C.R.V.	converter rated voltage	**No.**	number
C.R.Vp	converter peak voltage	**Neg.**	negative
CMD	command	**O.H.**	overheat
Commu.	communication	**O.P.**	over pressure
Compen.	compensation	**Out.**	output
Const.	constant	**P**	proportional
Cont.	continuous	**Para.**	parameter
Crit.	critical	**PG**	encoder
Ctrl.	control	**Pmax.**	Maximum pressure
Dec.	deceleration	**POFF**	power off
Detc.	detection	**Poten.**	potentiometer
Devia.	deviation	**PPR**	pulses per revolution
Dig.	digital	**Pres.**	pressure
Dir.	direction	**Prot.**	protection
Disconn.	disconnection	**Ref.**	reference
Disp.	diaplay	**Resist.**	resistance
Dispm.	displacement	**Resta.**	restart
Dn	down	**REV**	reverse
Ep	pressure error	**Scmd.**	speed/flow command
Excit.	excitation	**Sel.**	selection
F.	fault	**Set.**	setting
Fact.	factor	**Sp.**	speed
Fdb.	feedback	**St.**	start
Freq.	frequency	**Stab.**	stabilization
Func.	function	**Stc.**	static

Appendix

Abbreviation	Full word	Abbreviation	Full word
FWD	forward	**SW**	software
Hd.	hold	**Swh.**	switch
I	integral	**Sys.**	system
Inact.	inactive	**T.**	time
Induct.	inductance	**Temp.**	temperature
Lim.	limitation	**Thred.**	threshold
LPF_T	Lowpass filter time	**Volt.**	voltage
M.	motor		

15.2 Appendix II: Parameter Names Abbreviated on Panel Display

15.2.1 Menu level 1

Panel display	Full name	Relevant parameter
Alg./Dig. input	Analog and digital input	**Group E0**
Alg./Dig. output	Analog and digital output	**Group E1**
Control Para.	Control parameters	**Group S3**
Commu. parameter	Communication parameters	**Group H0**
Motor & PG Para.	Motor and encoder parameters	**Group S2**
p/Q Functions	Sytronix p/Q Functions	**Group E2**

15.2.2 Menu level 2

Panel display	Full name	Relevant parameter
+I factor K3	+I channel amplification factor k3	**E0.13**
+I filter time	+I channel filter time	**E0.14**
Acc. time 1	Acceleration time 1	**b1.09**
Acc. time 2	Acceleration time 2	**E2.00**
Acc. time 3	Acceleration time 3	**E2.02**
Acc. time 4	Acceleration time 4	**E2.04**
Acc./Dec. curve	Acceleration/deceleration curve	**b1.11**
Adaptive Acc/Dec	Adaptive Acc./Dec. time enable	**S2.21**
Analog Dig. Set.	Analog digital setting	**E3.01**
Auto. PWM Freq.	Automatic adjustment of PWM frequency	**b0.06**
Auto.Volt.Stab.	Automatic voltage stabilization	**S0.09**
Brak. duty cycle	Braking duty cycle	**S3.13**
Brak. threshold	Brake chopper threshold	**S3.12**
Brak.Prot.Thred.	Brake chopper protect threshold	**S3.17**
C.O.L. warn1 set	Frequency converter over load pre-warning 1 level setting	**E1.08**
Commu. protocol	Communication protocol	**H0.00**
Control commands	Frequency converter control commands	**b1.02**
Curve Min.Ref.	Characteristic curve minimum reference	**E0.16**
Curve Min.Freq.	Frequency corresponding to characteristic curve minimum reference	**E0.17**
Curve Max.Ref.	Characteristic curve maximum reference	**E0.18**
Curve Min.Freq.	Frequency corresponding to characteristic curve maximum reference	**E0.19**
Dec. time 1	Deceleration time 1	**b1.10**
Dec. time 2	Deceleration time 2	**E2.01**

Appendix

Panel display	Full name	Relevant parameter
Dec. time 3	Deceleration time 3	**E2.03**
Dec. time 4	Deceleration time 4	**E2.05**
Delete F. record	Delete fault record	**E4.17**
Dig. set Freq.	Digital set frequency	**b1.04**
Disconn. action	Communication disconnection action	**H0.09**
Disconn.Detc.T.	Communication disconnection detection time	**H0.08**
Disp. run mode	LCD display in run mode	**b0.08**
Disp. stop mode	LCD display in stop mode	**b0.09**
F. reset times	Number of fault reset attempts	**E4.12**
Flow CMD factor	Flow command factor	**E0.10**
Flow CMD offset	Flow command offset	**E2.51**
Flow CMD. Sel.	Flow command selection	**b1.25**
Flow CMD.Dlg.set	Flow command digital setting	**b1.26**
FM1 gain Set.	FM1 gain setting	**E1.12**
FM1 Neg.gain set	FM1 negative gain setting	**E1.13**
FM2 gain Set.	FM2 gain setting	**E1.16**
Freq. Set. mode	Frequency setting mode	**b1.00**
Freq.Detc. Width	Frequency arrival detection width	**E1.03**
FWD/REV dead T.	Forward/reserve dead time	**S3.09**
Heat sink Temp.	Heat sink temperature	**b0.12**
Jog Acc.time	Jog acceleration time	**S3.01**
Jog Dec.time	Jog deceleration time	**S3.02**
Kd[0]	Differential gain [0]	**E2.09**
Kd[1]	Differential gain [1]	**E2.19**
Kd[2]	Differential gain [2]	**E2.29**
Kd[3]	Differential gain [3]	**E2.39**
Kp[0]	Proportional gain [0]	**E2.07**
Kp[1]	Proportional gain [1]	**E2.17**
Kp[2]	Proportional gain [2]	**E2.27**
Kp[3]	Proportional gain [3]	**E2.37**
LCD light mode	LCD backlight mode	**b0.07**
Leakage Induct.	Leakage inductance factor	**S2.07**
Lower Lim.I+D[0]	Lower limiation of I+D [0]	**E2.13**
Lower Lim.I+D[1]	Lower limiation of I+D [1]	**E2.23**
Lower Lim.I+D[2]	Lower limiation of I+D [2]	**E2.33**
Lower Lim.I+D[3]	Lower limiation of I+D [3]	**E2.43**

Appendix

Panel display	Full name	Relevant parameter
LPF_T Acc/Dec.	Lowpass filter time for Acc./Dec. adaptive	S2.20
LPF_T Adp.Kp[0]	Lowpass Filter time for adaptive Kp [0]	E2.06
LPF_T Adp.Kp[1]	Lowpass Filter time for adaptive Kp [1]	E2.16
LPF_T Adp.Kp[2]	Lowpass Filter time for adaptive Kp [2]	E2.26
LPF_T Adp.Kp[3]	Lowpass Filter time for adaptive Kp [3]	E2.36
LPF_T flow down	Lowpass filter time flow dropping down	E2.49
LPF_T Pres. Fdb.	Lowpass filter time pressure feedback	E2.50
LPF_T flow up	Lowpass filter time flow rising up	E2.48
LPF_T Kd[0]	Lowpass Filter time for Kd [0]	E2.10
LPF_T Kd[1]	Lowpass Filter time for Kd [1]	E2.20
LPF_T Kd[2]	Lowpass Filter time for Kd [2]	E2.30
LPF_T Kd[3]	Lowpass Filter time for Kd [3]	E2.40
LPF_T Pres.Dn[0]	Lowpass filter time pressure dropping down [0]	E2.47
LPF_T Pres.Dn[1]	Lowpass filter time pressure dropping down [1]	E2.68
LPF_T Pres.Dn[2]	Lowpass filter time pressure dropping down [2]	E2.70
LPF_T Pres.Dn[3]	Lowpass filter time pressure dropping down [3]	E2.72
LPF_T Pres.Up[0]	Lowpass filter time pressure rising up [0]	E2.46
LPF_T Pres.Up[1]	Lowpass filter time pressure rising up [1]	E2.67
LPF_T Pres.Up[2]	Lowpass filter time pressure rising up [2]	E2.69
LPF_T Pres.Up[3]	Lowpass filter time pressure rising up [3]	E2.71
M. Max. torque1	Motor Max. torque1	S2.18
M. Max. torque2	Motor Max. torque2	S2.19
M.O.H. Prot.	Motor overheat protection level	E4.18
M.O.H. sensor	Type of temperature sensor for motor over heat protection	E4.19
M.O.L. Prot.mode	Motor over load protection	E4.04
M.O.L. warn set	Motor over load pre-warning level setting	E1.09
M.O.L.Prot.Fact.	Motor over load protection factor	E4.05
M.thermal Const.	Motor thermal time constant	S2.16
M/S switch delay	Master/slave pump switch delay	E2.65
Max. flow CMD	Maximum flow command limitation	E2.60
Max. input pulse	Maximum input pulse frequency	E0.15
Max. Pres. CMD	Maximum pressure command limitation	E2.61
Max.Ep.Up lim.	Maximum pressure error upper limitation	S2.28
Max.Ep.Low lim.	Maximum pressure error lower limitation	S2.29
Max.Freq.	Maximum frequency	b1.05
Max.output pulse	Maximum output pulse frequency	E1.18

Appendix

Panel display	Full name	Relevant parameter
Min. flow CMD	Minimum flow command	E2.54
Min. Pres. CMD	Minimum pressure command	E2.55
Motor Dir. Ctrl.	Motor rotation direction control	S3.14
M.O.H.Volt.Level	Motor overheat voltage level setting	E4.22
Mutual Induct.	Mutual inductance factor	S2.08
O.P. limit time	Over Max. pressure limitation time	E4.20
Over Excit.Brak.	Over excitation braking factor	b1.24
P.S.F. Detc.time	Pressure sensor fault detection time	E4.08
P.S.F. threshold	Pressure sensor fault detection threshold	E4.07
Panel Ctrl. Dir.	Operating panel control-led direction	b1.08
Para.auto-tuning	Parameter auto-tuning	S2.10
PG Dir. reverse	Pulse encoder direction reverse	S2.13
PG F.threshold	Pulse encoder fault detection threshold	S2.14
PG fault time	Pulse encoder fault detection time	S2.15
PG PPR	Pulses per revolution of pulse encoder	S2.12
Phase loss Prot.	Phase loss protection	E4.06
Power off Resta.	Restart after power off or power fault	S3.07
Pres.CMD factor	Pressure command factor	E0.11
Pres.Detc. time	Activate pressure detection time	E4.10
Pres.threshold	Activate pressure detection value	E4.09
Pres.CMD offset	Pressure command offset	E2.52
Pres.Devia.lower	Pressure deviation lower for adaptive Kp	E2.57
Pres.Devia.upper	Pressure deviation upper for adaptive Kp	E2.58
Pres.Fdb. offset	Pressure feedback offset	E2.53
Pres.Fdb.factor	Pressure feedback factor	E0.12
Pres.CMD. Sel.	Pressure command selection	b1.27
Pres.CMD.Dlg.set	Pressure command digital setting	b1.28
Pres.rise ratio	Pressure rise ratio	E2.75, E2.76
Pres.Detc.period	Pressure detection period	E4.10
Pump Cont. Pmax.	Pump maximum continuous pressure	S2.26
Pump Crit. Pmax.	Pump maximum critical pressure	S2.25
Pump Prot.select	Pump protection selection	E4.21
Pump Dispm.	Pump displacement	S2.23, S2.27
Pump Ctrl. Mode	Pump control mode	S2.31
Pump Logic Sel.	Pump logic selection	S2.32
p/Q CMD St.delay	p/Q command start delay	S2.73

Panel display	Full name	Relevant parameter
Rated M. current	Rated motor current	S2.04
Rated M. power	Rated motor power	S2.02
Rated M. speed	Rated motor rotation speed	S2.01
Rated M. voltage	Rated motor voltage	S2.03
Reset interval	Interval between reset attempts	E4.13
Resta. wait time	Waiting time to restart after power off or power fault	S3.08
Restore default	Restore factory default	b0.02
Rotor Resist.	Rotator resistance factor	S2.06
Save set Freq.	Saving options of digital set frequency	b1.01
Scale user value	Scale factor of user-defined value	b0.10
S-Curve section1	Time of S-curve rising section 1	b1.12
S-Curve section3	Time of S-curve rising section 3	b1.13
S-Curve section4	Time of S-curve falling section 4	b1.14
S-Curve section6	Time of S-curve falling section 6	b1.15
Skip Freq. range	Skip frequency range	S3.06
Slave Scmd.lower	Slave speed/flow command lower limit	E2.64
Slave Scmd.Sel.	Slave speed/flow command selection	E2.63
Slip Compen.	Slip compensation	S0.07
Slip Compen.gain	Slip compensation gain	S1.03
Speed Dig. Set.	Rotation speed digital setting	E3.02
Sp. loop Gain-P	Speed loop proportional gain	S1.00
Sp. loop Time-I	Speed loop integral time	S1.01
St.Freq.Hd. time	Start frequency hold time	b1.18
Stall O.C. level	Stall over current protection level	E4.03
Stall O.E. Func.	Stall over voltage function	E4.01
Stall O.E. level	Stall over voltage protection level	E4.02
Start brake time	Startup DC brake time	b1.20
Stator Resist.	Stator resistance factor	S2.05
Stop brake Freq.	Stop DC brake activation frequency	b1.21
Stop brake time	Stop DC brake time	b1.22
Stop key valid	Stop key validity	S3.15
SW. O.E. Prot.	Software over voltage protection threshold	E4.00
Sys.Min.Speed[0]	System minimal speed [0]	E2.14
Sys.Min.Speed[1]	System minimal speed [1]	E2.24
Sys.Min.Speed[2]	System minimal speed [2]	E2.34
Sys.Min.Speed[3]	System minimal speed [3]	E2.44

Appendix

Panel display	Full name	Relevant parameter
TI switch[0]	Pressure deviation for TI switch [0]	**E2.08**
TI switch[1]	Pressure deviation for TI switch [1]	**E2.18**
TI switch[2]	Pressure deviation for TI switch [2]	**E2.28**
TI switch[3]	Pressure deviation for TI switch [3]	**E2.38**
TI[0]	Intergal time [0]	**E2.11**
TI[1]	Intergal time [1]	**E2.21**
TI[2]	Intergal time [2]	**E2.31**
TI[3]	Intergal time [3]	**E2.41**
TI_2[0]	Intergal time 2 [0]	**E2.15**
TI_2[1]	Intergal time 2 [1]	**E2.25**
TI_2[2]	Intergal time 2 [2]	**E2.35**
TI_2[3]	Intergal time 2 [3]	**E2.45**
Threshold adjust	Speed switching threshold adjustment	**S2.33**
Torque control	Torque control selection	**S1.04**
Torque Ctrl.Ref.	Torque control reference	**S1.05**
Up/Down rate	Setting rate via Up/Down	**S3.11**
Upper Lim.I+D[0]	Upper limiation of I+D [0]	**E2.12**
Upper Lim.I+D[1]	Upper limiation of I+D [1]	**E2.22**
Upper Lim.I+D[2]	Upper limiation of I+D [2]	**E2.32**
Upper Lim.I+D[3]	Upper limiation of I+D [3]	**E2.42**
User Pmax.Monit.	User input Max. pressure monitoring	**S2.30**

15.2.3 Menu level 3

Panel display	Full name	Relevant parameter setting
Acc.Dec. time 1	Acceleration/deceleration time 1	[E0.01] to [E0.08]=5
Acc.Dec. time 2	Acceleration/deceleration time 2	[E0.01] to [E0.08]=6
Active low Sp.	Heat protection active at low-speed	[E4.04]=1
Alg.Dig.set+'+I'	Analog digital setting + "+I analog feedback"	[E3.00]=2
Anti Pre.Shoot	Anti pressure shoot in injection stage	[E0.01] to [E0.08]=24 or 25
b Para.	b parameters	[b0.11]=0
b,S Para.	b, S parameters	[b0.11]=1
b,S,E Para.	b, S, E parameters	[b0.11]=2
b,S,E,H Para.	b, S, E, H parameters	[b0.11]=3
Both active	Both input and output phase loss protection active	[E4.06]=0
Both inactive	Both input and output phase loss protection inactive	[E4.06]=3
Both save	Saved when powered off or stopped	[b1.01]=3
Brak. O.H. N.O.	Brake chopper overheat N.O. contact input	[E0.01] to [E0.08]=19
By Dlg.inputs	Digital inputs control	[S1.04]=0
By temperature	Temperature controlled	[S3.16]=0
C. in running	Frequency converter is running	[E1.00] to [E1.02]=1
C. in zero speed	Frequency converter runs at zero speed	[E1.00] to [E1.02]=3
C. ready to run	Frequency converter is ready to run	[E1.00] to [E1.02]=0
C.O.L. warning1	Frequency converter over load pre-warning 1	[E1.00] to [E1.02]=9
C.O.L. warning2	Frequency converter over load pre-warning 2	[E1.00] to [E1.02]=12
Commu.Ctrl.	Activate communication control	[E0.01] to [E0.08]=22
Converter->Panel	Copy from frequency converter to operating panel	[b0.03]=1
Data acquisition	Data acquisition(Only for internal)	[H0.01]=7
Decelerated stop	Decelerate to stop	[b1.19]=0
FcP Para.default	Restore FcP parameters to factory default	[b0.02]=2
Flow CMD limit	Flow command in limitation	[E1.00] to [E1.02]=16
For all controls	Valid for all control means	[S3.15]=1
Freewheel stop	Freewheel to stop	[b1.19]=1
Freewheel stop	Freewheel to stop	[E0.01] to [E0.08]=8
Freq. decrement	Frequency decrement Down	[E0.01] to [E0.08]=10
Freq. increment	Frequency increment Up	[E0.01] to [E0.08]=9
Full auto-tuning	Auto tuning with running motor	[S2.10]=1
FWD rotation	Forward rotation	[b1.08]=0
Heat sink Temp.	Heat sink temperature	[b0.09]=21
Inact.Dec./Brak.	Inactive during deceleration and braking	[S0.09]=2

Appendix

Panel display	Full name	Relevant parameter setting
Inactive low Sp.	Heat protection inactive at low-speed	[E4.04]=2
Input active	Only input phase loss protection active	[E4.06]=1
Keep integration	Continue integral adjustment, when output fre- quency reaches upper/ lower limit frequency	[E3.09]=1
M.O.H. N.C.Input	Motor overheat N.C. contact input	[E0.01] to [E0.08]=20
M.O.L. warning	Motor over load pre-warning	[E1.00] to [E1.02]=10
M/S pump switch	Master/Slave pump mode switch	[E0.01] to [E0.08]=23
Mul.Para.monitor	Multi-parameters monitor	[b0.09]=23
Neither save	Not saved when powered off or stopped	[b1.01]=0
NTC Temp. Sen- sor	NTC temperature sensor	[E4.19]=3
O.P. warning	Over pressure pre-alarm	[E1.00] to [E1.02]=14
Only for panel	Valid only for operating panel control	[S3.15]=0
Output active	Only output phase loss protection active	[E4.06]=2
Output Dir.Freq.	Output frequency (including direction)	[E1.10]=6
Panel->Converter	Copy from operating panel to frequency converter	[b0.03]=2
Para.select bit1	bit 1 of parameter selection	[E0.01] to [E0.08]=1
Para.select bit2	bit 2 of parameter selection	[E0.01] to [E0.08]=2
p/Q speed Ref.	p/Q speed/flow reference	[b0.09]=15
Pres. CMD limit	Pressure command in limitation	[E1.00] to [E1.02]=17
Pressure CMD	Pressure command	[b0.09]=14
Pressure Fdb.	Pressure feedback	[b0.09]=17
PTC Temp. Sen- sor	PTC temperature sensor	[E4.19]=1
p/Q/flow mode Swh	p/Q mode and flow mode switch	[E0.01] to [E0.08]=7
p/Q Sp./flow Ref.	p/Q speed/flow reference	[b0.08] to [b0.09]=15
Ref. torque	Reference torque	[b0.09]=12
Restore default	Restore parameter to factory default	[b0.02]=1
REV rotation	Reverse rotation	[b1.08]=1
Save when POFF	Saved when powered off; not saved when stopped	[b1.01]=2
Save when stop	Not saved when powered off; saved when stopped	[b1.01]=1
Set by Commu.	Set by communication	[b1.00]=5, [b1.25]=2, [b1.27]=2
Set by Commu.	Set control commands by communication	[b1.02]=2
Set by Dlg.input	Set control commands by digital inputs	[b1.02]=1
Set by p/Q PID	Set by p/Q PID controller	[b1.00]=2
Set by panel	Set control commands by operating panel	[b1.02]=0

Panel display	Full name	Relevant parameter setting
Set by Poten.	Set by operating panel potentiometer	**[b1.00]=0**
Set by pulse	Set by pulse frequency	**[b1.00]=3**
Set by Up/Down	Set by digital inputs Up / Down	**[b1.00]=4**
Set Dir. Freq.	Set frequency (including direction)	**[E1.10]=7**
Set Freq. to 0	Set frequency to 0	**[E0.01] to [E0.08]=11**
Set output Freq.	Set output frequency	**[b0.09]=2**
Sp.Dig.set+PG	Rotation speed digital setting + pulse encoder feedback	**[E3.00]=4**
Sp./flow command	Speed/flow command	**[b0.08] to [b0.09]=16**
Speed arrival	Frequency/speed arrival signal	**[E1.00] to [E1.02]=4**
Speed capture	Rotation speed capture mode	**[b1.16]=2**
Stc.auto-tunning	Auto tuning with static motor	**[S2.10]=2**
Stop integration	Stop integral adjustment, when output frequency reaches upper/lower limit frequency	**[E3.09]=0**
SvP Para.default	Restore SvP parameters to factory default	**[b0.02]=1**
Swh. panel/Dlg.	Switch between operating panel and digital inputs control	**[E0.01] to [E0.08]=14**
Swh. Sp./torque	Switch between speed and torque control	**[E0.01] to [E0.08]=17**
Under Volt.stop	Under voltage stop	**[E1.00] to [E1.02]=8**
User Out. value	User-defined output value	**[b0.09]=11**
User Ref. value	User-defined reference value	**[b0.09]=10**
With Temp. model	With motor temperature model	**[E4.19]=2**

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Notes

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