MOELLER

Hardware and Engineering

DV5-...

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Warning!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (AWA) of the device concerned.
- Only suitably qualified personnel in accordance with EN 50 110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE) must be connected to the protective earth (PE) or to the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60 364-4-41 (VDE 0100 Part 410) or HD 384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60 204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).
- According to their degree of protection frequency inverters may feature during operation live, bright metal, or possibly moving, rotating parts or hot surfaces.
- The impermissible removal of the necessary covers, improper installation or incorrect operation of motor or frequency inverter may cause the failure of the device and may lead to serious injury or damage.
- The relevant national regulations apply to all work carried on live frequency inverters.
- The electrical installation must be carried out in accordance with the relevant regulations (e. g. with regard to cable cross sections, fuses, PE).
- All work relating to transport, installation, commissioning and maintenance must only be carried out by qualified personnel. (IEC 60 364 and HD 384 and national work safety regulations).
- Installations fitted with frequency inverters must be provided with additional monitoring and protective devices in accordance with the relevant safety regulations etc. Modifications to the frequency inverters using the operating software are permitted.

- All shrouds and doors must be kept closed during operation.
- In order to reduce hazards to persons or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the drive (increased motor speed or sudden standstill of motor). These measures include:
  – Other independent devices for monitoring safety-related variables (speed, travel, end positions etc.).
  – Electrical or non-electrical system related measures (interlocks or mechanical interlocks).
  – Live parts or cable connections of the frequency inverter must not be touched after it has been disconnected from the power supply due to the charge in capacitors. Appropriate warning signs must be provided.

Contents

About this Manual

This manual describes the frequency inverters of the DV5 series.

This manual contains special information which is required for engineering, installation and operation of the DV5 series frequency inverters. The features, parameters and functions are described in detail and illustrated by the use of examples for the most important applications. All the details stated relate to the hardware and software versions specified.

Abbreviations and symbols

Abbreviations and symbols with the following meanings are described in this manual:

EMC: **E**lectro **M**agnetic **C**ompatibility

ESD: Electro static discharge (**E**lectro **S**tatic **D**ischarge)

HF: **H**igh **F**requency

IGBT: **I**nsulated **G**ate **B**ipolar **T**ransistor

PES: **PE** – connection (earth) of the **s**creen (cable)

PNU: **P**arameter **Nu**mber

WE: Factory default setting

All measurements are in millimeters unless otherwise stated.

In some of the illustrations, the enclosure of the frequency inverter as well as other safety relevant parts may be omitted for the purpose of improved visualization. However, the frequency inverter must always be operated in the enclosure with all necessary safety relevant parts and components.

Read the manual carefully before you install and operate the frequency inverter. We assume that you have a good knowledge of engineering fundamentals and that you are familiar with the electrical systems and the principles which apply, and are able to read, understand and apply information contained in technical drawings.

▶ indicates instructions to be followed

→ Makes you aware of interesting tips and additional information

▽ **Caution!**
warns about the possibility of minor material damage.

⚠ **Warning!**
warns about the possibility of major material damage and minor injury.

⚠ **Warning!**
warns about the possibility of major material damage and severe injury or death.

In order to improve the readability, the title of the chapter is indicated on the top of the left-hand page and the current section is indicated on the top of the right-hand page. Pages where chapters commence and blank pages at the end of the chapter are an exception.

1 About DV5 series frequency inverters

System overview

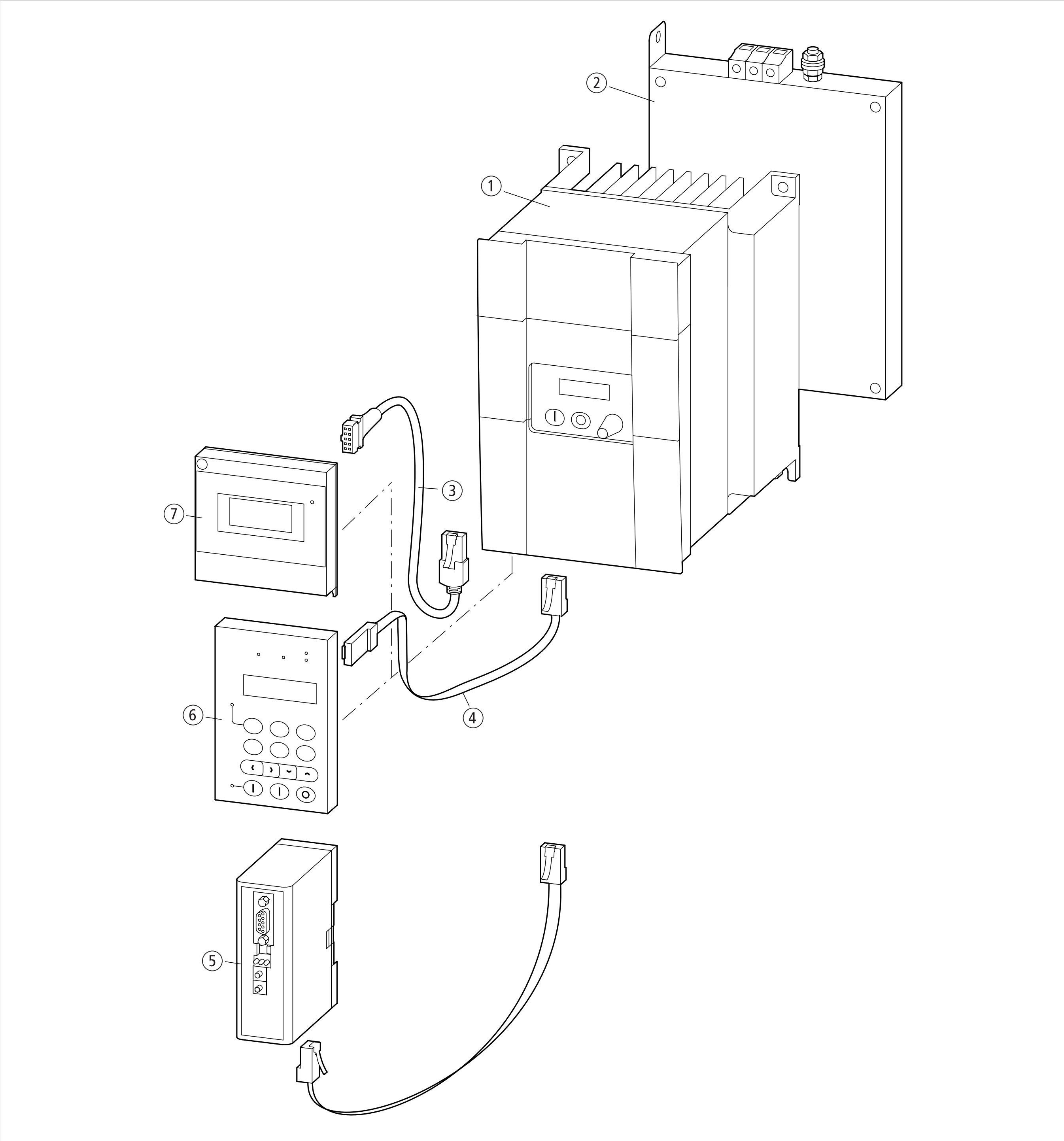


Figure 1: System overview

① DV5 series frequency inverters-...
② DE5-LZ... RFI filter
③ DE5-CBL-...-ICL connection cable
④ DEX-CBL-...-ICS connection cable
⑤ DE5-NET-DP interface module for PROFIBUS-DP
⑥ DEX-DEY-10 external keypad
⑦ DE5-KEY-RO3 external display module

Type code

Type code and type designation of the DV5 series frequency inverter:

DV5 - x x x - yyy

- yyy: Motor rating code
  Incoming supply: EU rated voltage (230 V/400 V)
- x (third): Version and model number
  0 = basic version
  1 = system devices
  2 = voltage code suffix
- x (second): Supply connection, voltage code (EU rated value)
  2 = 230 V (180 V – 0 % to 252 V + 0 %)
  4 = 400 V (342 V – 0 % to 506 V + 0 %)
- x (first): Supply connection, phase code
  1 = single-phase
  3 = three-phase
- DV5: Family name:
  Drives **V**ector Frequency Inverter, Generation **5**

Figure 2: Type code DV5 series frequency inverters

Examples:

DV5-322-075	Frequency inverters of the DV5 series
	Single-phase or three-phase supply: 230 V
	Assigned motor rating: 0.75 kW at 230 V
DV5-340-5K5	Frequency inverters of the DV5 series
	Three-phase mains supply voltage: 400 V
	Assigned motor rating: 5.5 kW at 400 V

Inspecting the items supplied

Frequency inverters of the DV5 series frequency inverters are carefully packed before delivery. The device may be transported only in its original packaging with a suitable transport system (see weight details). Observe the instructions and the warnings on the side of the packaging. This also applies after the device is removed from the package.

Open the packaging with suitable tools and inspect the contents immediately after delivery to ensure that they are complete and undamaged. The package must contain the following items:

- a DV5 series frequency inverter,
- the installation instructions AWA8230-1935,
- a CD with:
  - this manual in PDF format as well as in further languages
  - the parameter definition software;
    the requirements are: A PC with Windows 95, 98, ME, 2000, NT and the DEX-CBL-2M0-PC connection cable

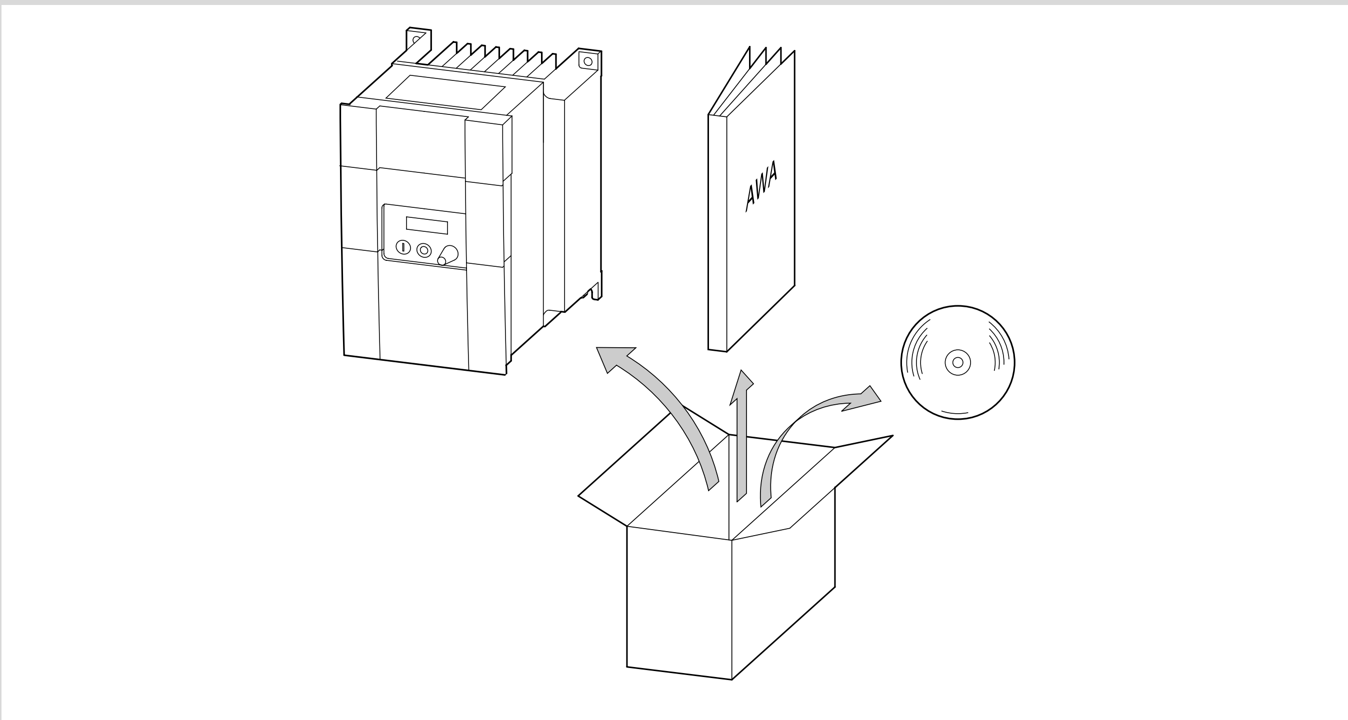


Figure 3: Equipment supplied

→ Using the nameplate attached to the frequency inverter, check to ensure that the frequency inverter is the type which you have ordered.

Layout of the DV5

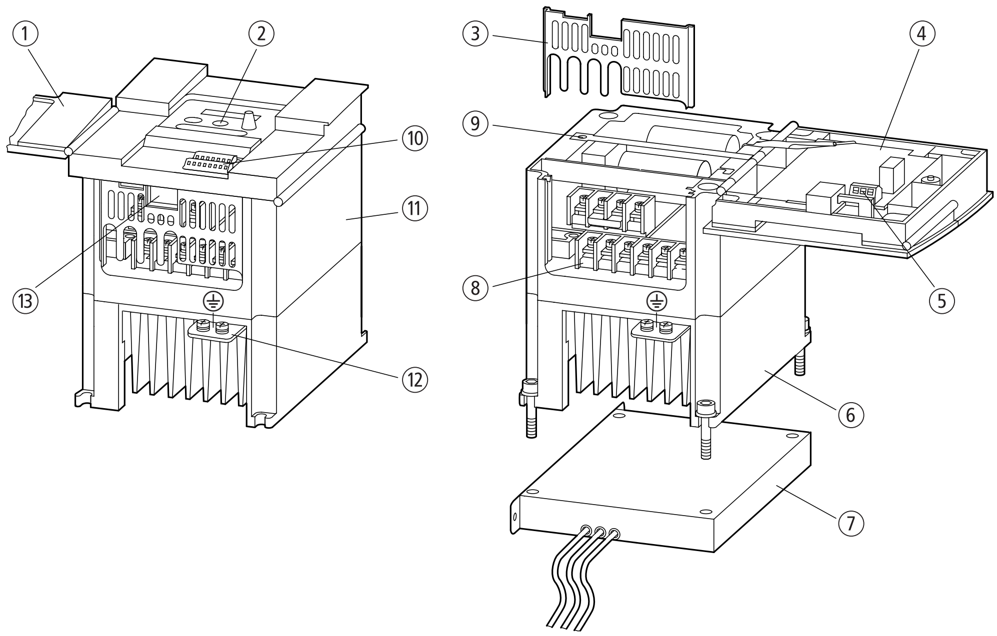


Figure 4: Designations of the DV5

① Front cover, can be opened without tools
② Integrated keypad
③ Terminal shroud
④ Front cover flap with keypad
⑤ Signalling relay terminals
⑥ Heat sink
⑦ Optional radio interference filter
⑧ Power terminals
⑨ Screw for opening the front enclosure
⑩ Control signal terminals
⑪ Enclosure
⑫ Earth connection (PE)
⑬ Interface connection

Frequency inverter characteristics

The DV5 series convert the voltage and frequency of an existing three-phase supply to a DC voltage and use this voltage to generate a three-phase supply with adjustable voltage and frequency. This variable three-phase supply allows stepless variability of three-phase asynchronous motors.

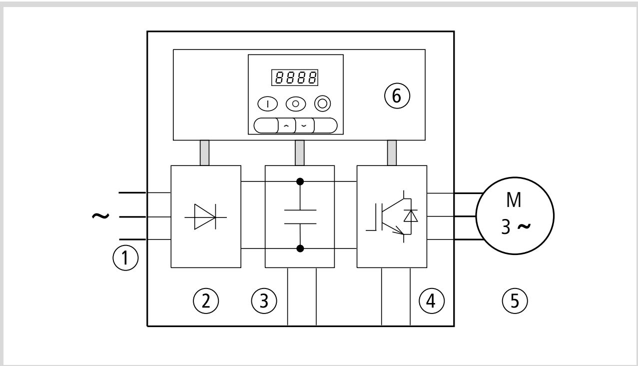


Figure 5: Functional diagram of the frequency inverter

① Supply via an interference suppressor
Mains voltage U_{LN} (EU-rated voltage):
DV5-322 1/3 AC 230 V, 50/60 Hz
DV5-340 3 AC 400 V, 50/60 Hz

② The bridge rectifiers convert the AC voltage of the electrical supply to a DC voltage.

③ The DC link contains a charging resistor, smoothing capacitor and switched-mode power supply unit. It enables coupling of the DC bus voltage and the DC current supply:
DC bus voltage (U_{ZK}) = $\sqrt{2} \times$ mains voltage (U_{LN})

④ IGBT power inverter:
The power inverter converts the DC voltage of the DC link to a variable three-phase alternating voltage with variable frequency. The braking transistor allows braking of motors with a high moment of inertia in conjunction with the external braking resistor or during extended regenerative operation.

⑤ Output voltage (U_2), motor connection:
three-phase, variable AC voltage, 0 to 100 % of the input voltage (U_{LN})
Output frequency (f_2):
Variable frequency, 0.5 to 360 Hz
Output rated current (I_{2N}):
1.8 to 22.5 A with about 1.5 times the starting current for 60 s, with a switching frequency of 5 kHz and with an ambient temperature of 40 °C
Motor connection, assigned shaft output (P_2):
0.18 to 2.2 kW at 230 V
0.37 to 7.5 kW at 400 V

⑥ Programmable control section with keypad and interface.

Selection criteria

The frequency inverter is selected to suit the rated motor current. The output rated current of the frequency inverter must however, be greater than or equal to the rated motor current.

The following drive data is assumed to be known:

- type of motor (three-phase asynchronous motor),
- mains voltage = supply voltage of the motor (e.g. 3 ~ 400 V),
- rated motor current (guide value, dependent on the circuit type and the supply voltage),
- load torque (quadratic, constant, with 1.5-times the starting torque),
- ambient temperature (maximum temperature 40 °C).

→ With the parallel connection of multiple motors to the output of a frequency inverter, the motor currents are subject to vector addition, i.e. the active in-phase current and reactive current components are added separately. Select the frequency inverter rating to ensure that the total current can be supplied by the frequency inverter.

→ If a motor switches during operation on the output of a frequency inverter, the motor draws a multiple of its rated current. Select the rating of the frequency inverter to ensure that the starting current plus the sum of the currents of the running motors does not exceed the rated output current of the frequency inverter.

The rated output current of the frequency inverter can be found in the technical data in the Appendix from Page 115.

Intended use

The DV5 series frequency inverters are not domestic appliances. They are designed only for industrial use as system components.

The DV5 series frequency inverters are electrical apparatus for controlling variable speed drives with three-phase motors. They are designed for installation in machines or for use in combination with other components within a machine or system.

After installation in a machine, the frequency inverters must not be taken into operation until the associated machine has been confirmed to comply with the safety requirements of Machinery Safety Directive (MSD) 89/392/EEC and meets the requirements of EN 60204. The user of the equipment is responsible for ensuring that the machine use complies with the relevant EU Directives.

The CE-mark attached to the DV5 series frequency inverters confirm that, when used in a typical drive configuration, the apparatus complies with the European Low Voltage Directive (LVD) and the EMC Directives (Directive 73/23/EEC, as amended by 93/68/EEC and Directive 89/336/EEC, as amended by 93/68/EEC).

Frequency inverters of the DV5 series are suitable for use in public and non-public networks in the described system configuration. Depending on their location of use, external filtering may be necessary.

Connection to IT networks (networks without a ground potential reference point) is not permitted as the devices internal filter capacitors connect the network to the ground potential (enclosure). On earth free networks, this can lead to dangerous situations or damage to the device (isolation monitoring required).

On the output of the frequency inverter (terminals U, V, W) you may not:

- connect a voltage or capacitive loads (e.g. phase compensation capacitor),
- connect multiple frequency inverters in parallel,
- make a direct connection to the input (bypass).

Observe the technical data and terminal requirements. Refer to the equipment nameplate or label and the documentation for more details.

Any other usage constitutes improper use.

Service and guarantee

In the unlikely event that you have a problem with your Moeller frequency inverter, please contact your local sales office.

Please have the following data and information concerning the to hand:

- exact frequency inverter type designation (→ nameplate)
- date of purchase
- exact description of the problem which has occurred with the frequency inverter.

If some of the information printed on the nameplate is not legible, please state only the information which is clearly legible.

Information concerning the guarantee can be found in the Moeller General Terms and Conditions of Sale.

2 Engineering

This chapter describes the "Features of the DV5" as well as guidelines and regulations concerning the following subjects:

- Connection to the mains
- EMC guidelines

Features of the DV5

Ambient temperatures	
Operation[1)]	Ta = –10 to +40 °C with rated current I_e without derating, up to +50 °C with reduced carrier frequency of 2 kHz and reduced output current to 80 % I_e
Storage	Ta = –25 to +70 °C
Transport	Ta = –25 to +70 °C
Permissible ambient influences	
Resistance to vibration	Vibrations and shaking: maximum 5.9 m/s^2 (0.6 g) at 10 to 55 Hz
Pollution degree	VDE 0110 Part 2, pollution degree 2
Packaging	Dust proof packaging (DIN 4180)
Climatic conditions	Class 3K3 according to EN 50178 (non-condensing, average relative humidity 20 to 90 %)
Installation altitude	Up to 1000 m above sea level
Mounting position	Vertically suspended
Free surrounding areas	100 mm above and below device
Electrical data	
Emitted interference	IEC/EN 61800-3 (EN 55011 group 1, class B)
Noise immunity	IEC/EN 61800-3, industrial environment
Insulation resistance	Overvoltage category III according to VDE 0110
Leakage current to PE	Greater than 3.5 mA according to EN 50178
Degree of protection	IP20
Protection against direct contact	Finger and back-of-hand proof (VBG 4)
Protective isolation against switching circuitry	Safe isolation from the mains. Double basic isolation according to EN 50178
Protective measures	Overcurrent, earth fault, overvoltage, undervoltage, overload, overtemperature, electronic motor protection: I^2t monitoring and PTC input (thermistor or temperature contacts)
Control/regulation	
Modulation method	Pulse width modulation (PWM), V/*f*-predetermined control (linear,quadratic)
Switching frequency	5 kHz (WE), can be selected between 0.5 and 16 kHz
Torque	At start 1.5 × M_N for 60 s with assigned motor rating, every 600 s
Output frequency	
Range	0.5 to 360 Hz
Frequency resolution	0.1 Hz, at digital setpoint, maximum frequency/1000 with analog setpoint
Error limit at 25 °C ±10 °C	Digital setpoint definition ±0.01 % of the maximum frequency
	Analog setpoint definition ±0.2 % of the maximum frequency
Relay	
Changeover contact	• AC 250 V, 2.5 A (resistive load) • AC 250 V, 0.2 A (inductive load, cos φ = 0.4) • AC 100 V, minimum 10 mA
	• DC 30 V, 3 A (resistive load) • DC 30 V, 0.7 A (inductive load, cos φ = 0.4) • DC 5 V, minimum 100 mA

Internal voltages	
Control	24 V DC, maximum 30 mA
Setpoint value definition	10 V DC, maximum 10 mA
Analog and digital actuation	
Analog inputs	• 1 input, 0 to 10 V, input impedance 10 kΩ • 1 input, 4 to 20 mA, load impedance 250 Ω
Digital inputs/outputs	6 Freely programmable inputs
	2 Outputs, open collector (maximum 27 V DC, 50 mA)
Monitor output	1 output for frequency or current, 10 V, maximum 1 mA
Keypad (integrated)	
Operation	6 function keys for control and parameter definition of the DV5
Display	Four character 7 segment display and seven LEDs (status messages)
Potentiometer	Setpoint definition (0 to 270°)

1) If the frequency inverter is to be installed in a control panel, enclosure or similar installation, the prevalent ambient temperature within these enclosures or control panels is considered to be the ambient temperature T_a. The use of fans should be considered to ensure that the ambient temperature remains within permissible limits.

Connection to the mains

The DV5 series frequency inverters can be used without limitation with every type of electrical grid (Electrical grids according to IEC 364-3).

Electrical grid types

Electrical grids with a direct earthing point (TT/TN-systems):

- Operation of the frequency inverters of the DV5 series with TT-/TN-systems is possible without limitation. Adhere to the rated data of the DV5 series frequency inverters.

→ If many frequency inverters with a single-phase supply are connected to the mains, the symmetric distribution on all three mains poles should be considered as well as the loading of the common neutral pole (mains r.m.s current). If necessary, the cross-section of the neutral pole must be increased, if it conducts the total current of all single-phase devices.

Grids with isolated centre point (IT-systems):

- Operation of the frequency inverters of the DV5 series with IT-systems is only conditionally possible. A prerequisite is a suitable device (isolation monitoring), which monitors earth faults and isolates the frequency inverter from the mains.

Caution!
With an earth fault in an IT-system, the capacitors of the frequency inverter which are switched to earth are subject to a very high voltage. Therefore, safe operation of the frequency inverter cannot be guaranteed. The situation can be remedied with an additional isolating transformer with an earthed centre point on its secondary, which is then used to supply the input of the frequency inverter. This constitutes an individual TN-system for the frequency inverter.

Mains voltage, Mains frequency

The rated data for the frequency inverters of the DV5 take the European and American standard voltages into account:

- 230 V, 50 Hz (EU) and 240 V, 60 Hz (USA) with DV5-322,
- 400 V, 50 Hz (EU) und 460 V, 60 Hz (USA) with the DV5-340

The permitted mains voltage range is:

- 230/240 V: 180 V – 0 % to 252 V + 0 %
- 400/460 V: 342 V – 0 % to 506 V + 0 %

The permissible frequency range is 47 Hz – 0 % to 63 Hz + 0 %.

The device assignment of the motor rating to the mains voltage is listed in Section ”Technical Data”, Page 115 in the Appendix.

Interaction with compensation devices

The DV5 series frequency inverters only accept a minimal fundamental reactive power from the AC voltage supply. Compensation is therefore unnecessary.

Caution!
Operation of the frequency inverters of the DV5 series on the mains with p.f. correction equipment is only permitted when this equipment is dampened with chokes.

Fuses and cable cross-sections

When the devices are connected to the mains, the fuses and cable cross-sections which are required are dependent on the rating of the frequency inverter and the operation mode of the drive.

Caution!
The voltage drop under load conditions should be considered when selecting the cable cross-section. Compliance to further standards (e.g. VDE 0113, VDE 0289) is the responsibility of the user.

The recommended fuses and the assignment of the DV5 series frequency inverters are listed in Section ”Cables and fuses”, Page 121 in the Appendix.

The national and regional standards (e.g. VDE 0113, EN 60204) must be observed and the necessary approvals (e.g. UL) at the site of installation must be fulfilled.

When the device is operated in a UL-approved system, only UL-approved fuses, fuse bases and cables can be used.

The leakage currents to ground (according to EN 50178) are greater than 3.5 mA. The PE terminal and the enclosure must be connected to the earth-current circuit.

Caution!
The prescribed minimum cross-sections of PE-conductors (EN 50178, VDE 0160) must be observed. Select the cross-section of the PE-conductor as least as large as the terminal capacity of the power terminals.

Protection of persons and domestic animals with residual-current protective devices

Residual-current circuit-breakers RCCB (according to VDE 0100, also referred to as ELCBs). Universal current sensitive ELCBs according to EN 50178 and IEC 755.

	Identification on the residual-current circuit-breakers		
Logo			
Type	alternating current sensitive (RCCB, Type AC)	pulse current sensitive (RCCB, Type A)	universal current sensitive (RCCB, Type B)

The frequency inverter is internally equipped with a mains rectifier. With a short circuit to an exposed conductive part, a fault DC current can block the trip of the alternating current sensitive or pulse current sensitive residual-current circuit-breaker and thus eliminate the protective function. We therefore recommend the use of:

- ”Pulse current sensitive residual-current circuit-breakers” with a rated current ≧ 30 mA with frequency inverters with a single-phase supply (.
- ”Universal current sensitive residual-current circuit-breakers” with a rated current ≧ 300 mA with frequency inverters with a single-phase supply on frequency inverters with three-phase supply .

The fault current recommended values of the DV5 series frequency inverters and the assigned radio interference filter are listed in Section ”Radio interference filter”, Page 124 in the Appendix.

Spurios tripping of a residual-current circuit-breaker can be activated by the following:

- by capacitive compensation currents of the cable screens, particularly with long screened motor cables,
- by simultaneous connection of multiple frequency inverters to the mains supply,
- with the use of additional chokes and filters (radio interference filter, line filter).

Caution!
Residual-current circuit-breakers may only be installed on the primary side between the incoming supply and the frequency inverter.

Warning!
Only use cables, residual-current circuit-breakers and contactors which have a suitable rating. Otherwise there is a danger of fire.

Mains contactor

The mains contactor is connected to the mains side input cables L1, L2, L3 (type dependant). It allows the operational switch on and off of the DV5 series frequency inverters from the mains supply as well as shutdown during a fault.

Mains contactors and the assignment with the DV5 series frequency inverters are listed in Section ”Mains contactors”, Page 122 in the Appendix.

Current peaks

In the following cases, a relatively high peak current can occur on the primary side of the frequency inverter (i.e. on the supply voltage side), which under certain conditions, can destroy the input rectifier of the frequency inverter:

- Imbalance of the voltage supply greater than 3 %.
- The maximum power output of the supply point must be at least 10 times greater than the maximum frequency inverter rating (approx 500 kVA).
- If sudden voltage dips in the supply voltage are to be expected, e.g. :
  - a number of frequency inverters are operated on a common supply voltage.
  - a Thyristor system and a frequency inverter or operated on a common supply voltage.
  - power factor correction devices are switched on or off.

In the cases mentioned, a mains choke with approx. 3 % voltage drop at rated operation should be installed.

Mains choke

The mains choke (also referred to as a commutating choke or line reactor) is connected to the mains side input cables L1, L2, L3 (type dependent). It reduces the harmonics and leads to a reduction of the apparent mains current by up to 30 %.

A mains choke also limits current peaks which occur, caused by potential dips (e.g. caused by p.f. correction equipment or earth faults) or switching operations on the mains.

The mains choke increases the lifespan of the DC link capacitors and consequently the lifespan of the frequency inverter. Its use is also recommended:

- with a single-phase supply (DV5-322),
- with derating (temperatures above +40 °C, sites of installation which are more than 1 000 m above sea level),
- with parallel operation of multiple frequency inverters on a single mains supply point,
- with DC link coupling of multiple frequency inverters (interconnected operation).

Mains chokes and the assignment to DV5 series frequency inverters are listed in Section ”Mains choke”, Page 125 in the Appendix.

Line filter, Radio interference filter

Line filters are a combination of mains chokes and radio interference filters in a single enclosure. They reduce the current harmonics and dampen high frequency radio interference levels.

Radio interference filters only dampen high frequency radio interference levels.

> **Caution!**
> When line filters or radio interference filters are used, the leakage current to earth increases. Observe this point when residual-current circuit-breakers are used.

EMC guidelines

The limit values for emitted interference and immunity with variable speed drives are described in the **IEC/EN 61800-3** product standard.

When operating the frequency inverters of the DV5 series in countries which are part of the European Union (EU), the EMC guideline 89/336/EEC must be observed. The following conditions described must be observed in order to comply with this guideline:

Supply voltage (mains voltage) for the frequency inverter:

- voltage fluctuation ±10 % or less
- voltage imbalance ±3 % or less
- frequency variation ±4 % or less

If the above mentioned conditions are not fulfilled, the respective mains choke must be installed (→ Section "Mains choke" in the Appendix, Page 125).

EMC interference class

When installation is completed according to the Section "Installation", described in "EMC guidelines" Page 17 and with the use of a radio interference filter, the frequency inverters of the DV5 series comply to the following standards:

- Emitted interference:
  IEC/EN 61800-3 (EN 55011 group 1, class B)
- Noise immunity:
  EN 61800-3, industrial environment

With frequency inverters, performance related and emitted interference increase with the switching frequency. The frequency of occurrence of performance related interference also increase with longer motor cables. When the respective radio interference filter is used, the EN 61800-3 standard is complied to as follows:

	Conformity	
	General	**Limited**
First environment (Public power grid)	Up to 10 m motor cable lengths with 16 kHz (maximum switching frequency)	Up to 50 m1)
	Up to 20 m motor cable lengths with maximum 5 kHz switching frequency	
Second environment (Industrial)	Up to 50 m	Up to 50 m

1) This is a product with limited conformity according to IEC/EN 61800-3. This product can cause radio frequency interference in domestic environments. In this case, it is necessary that the user undertakes the required protection measures.

Noise immunity
DV5 series frequency inverters conform with the requirements of the EC/EN 61800-3 EMC-product standard for industrial use (second environment), and the higher interference immunity values in domestic environments (first environment) with the assigned radio interference filters.

A domestic environment can be understood to be a connection point (transformer feeder) to which domestic households are also connected.

The EMC-guideline for an industrial system requires electromagnetic compatibility with the environment as a whole. The product standard examines a typical drive system in principle as a complete system, i.e. the combination of frequency inverter, cables and motor.

Emitted interference and radio interference suppression
DV5 series frequency inverters conform with the requirements of the EC/EN 61800-3 EMC-product standard for domestic use (first environment), and therefore also with the higher interference immunity values in industrial environments (second environment) with the assigned radio interference filters.

Ensure compliance to the limit values with the following points:

- reduction of performance related interference with line filters and/or radio interference filters including mains chokes.
- reduction of the electromagnetic emission interference by screening motor cables and signal cables.
- compliance with installation guidelines (EMC compliant installation).

3 Installation

The DV5 series frequency inverters should be installed in a control panel or in a metal enclosure (e.g. IP54).

→ During installation or assembly operations on the frequency inverter, all ventilation slots and openings should be covered to ensure that foreign bodies and objects do not penetrate the device.

DV5 Installation

The DV5 series frequency inverters must be installed vertically on a non-flammable base.

Mounting position

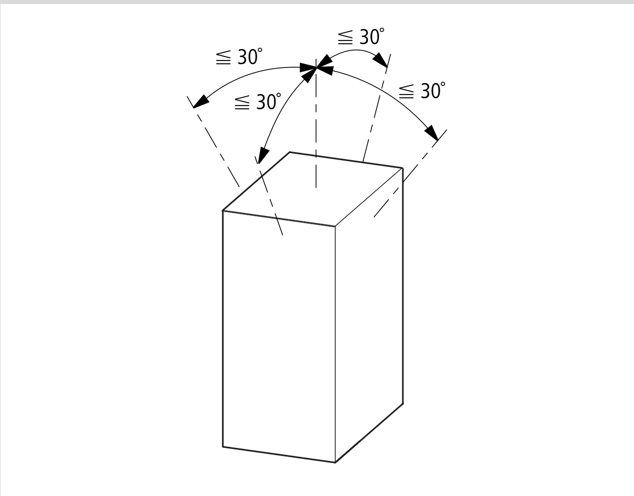


Figure 6: Mounting position

Installation dimensions

A free space of 100 mm minimum is required above and below the device (thermal air circulation).

Please ensure that the front cover of the enclosure can always be opened and closed without impediment to ensure that the control terminals can be connected.

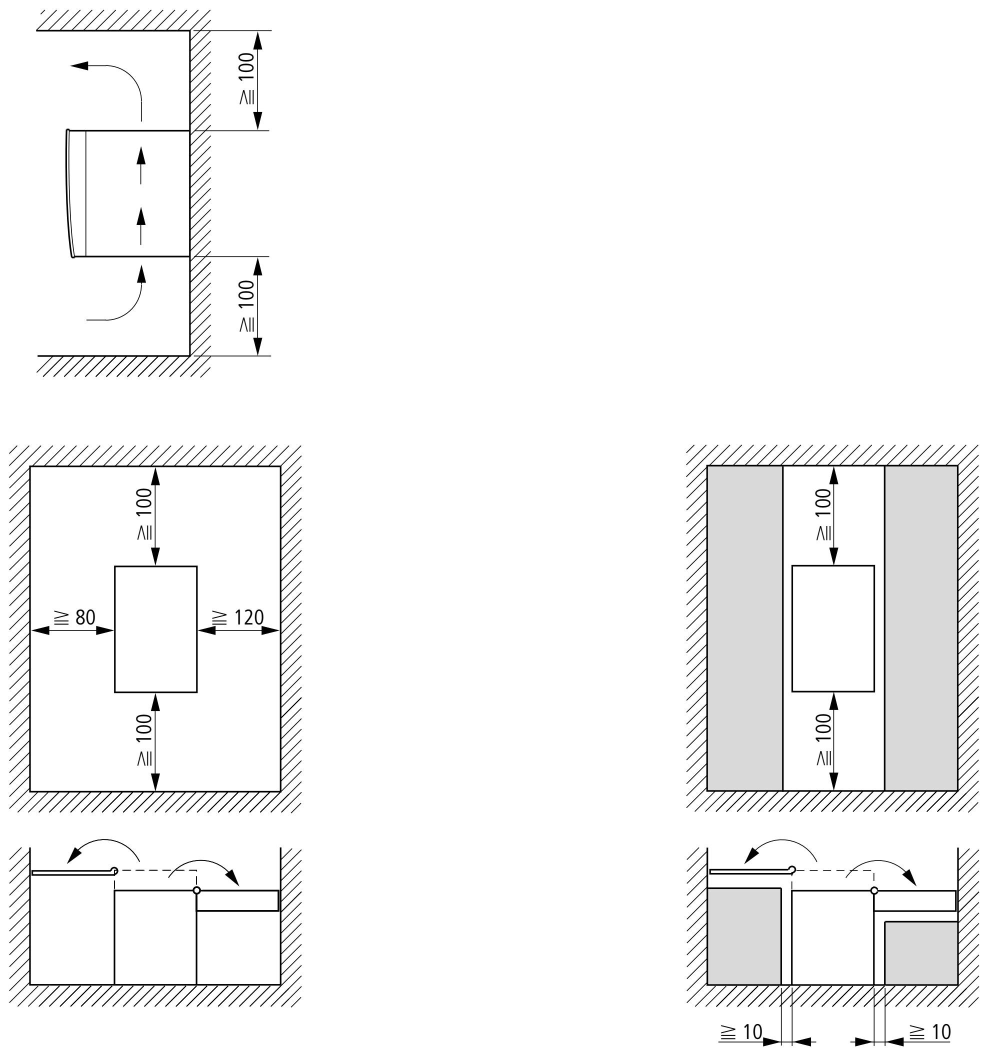


Figure 7: Installation dimensions

Dimensions and weights of the DV5 can be found in the Appendix Section ”Dimensions and weights”, Page 120.

DV5 attachment

Install the DV5 series frequency inverter according to Fig. 8 and tighten the screws with the following torques (→ Table 1):

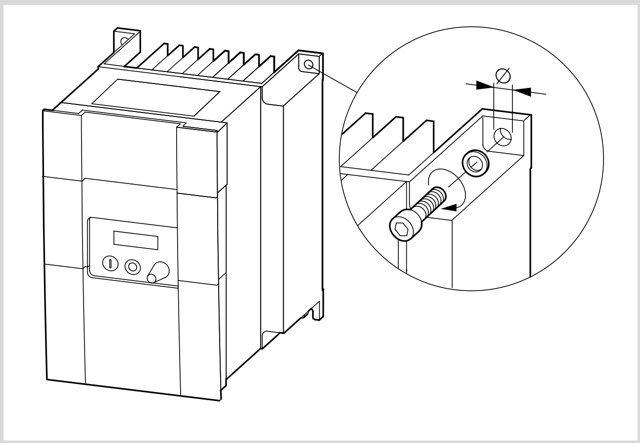
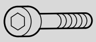


Figure 8: DV5 attachment

Table 1: Tightening torque's of the attachment screws

∅ **[mm]**			
5	M4	3 Nm	26 lbin
7	M6	4 Nm	35 lbin

EMC compliance

EMC compliant installation

The frequency inverter operates with fast electronic switching devices e.g. transistors (IGBT). For this reason, radio interference can occur on the output of the frequency inverter, which may effect other electronic devices located in the direct vicinity such as radio receivers or measurement instruments. In order to offer protection against this radio frequency interference (RFI), the devices should be screened and installed as far away as possible from the frequency inverters.

We recommend the following measures for EMC compliant installation:

- installation of the frequency inverter in a metallic, electrically conducting enclosure with a good connection to earth.
- installation of a radio interference filter on the input of the frequency inverter in its direct vicinity
- screened motor cables (short cable lengths).

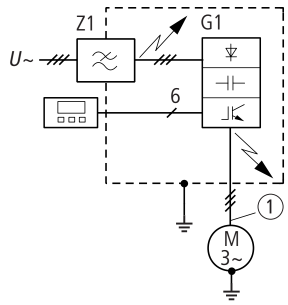


Figure 9: DV5 and radio interference filter in a sealed enclosure

Z1: RFI filter

G1: frequency inverter

① Screened motor cable

▶ Ground the metallic enclosure via a cable which should be as short as possible (→ Fig. 9).

Radio interference filter usage

The RFI filter should be installed in the direct vicinity of the frequency inverter. The connection cable between the frequency inverter and filter should be as short as possible. Screened cables are required if the length exceeds 30 cm.

The radio interference filters assigned for the DE5-LZ... series (→ Section "Radio interference filter" in the Appendix, Page 124) enable the installation below (foot-print) or on the side (book-type) of the DV5series frequency inverters.

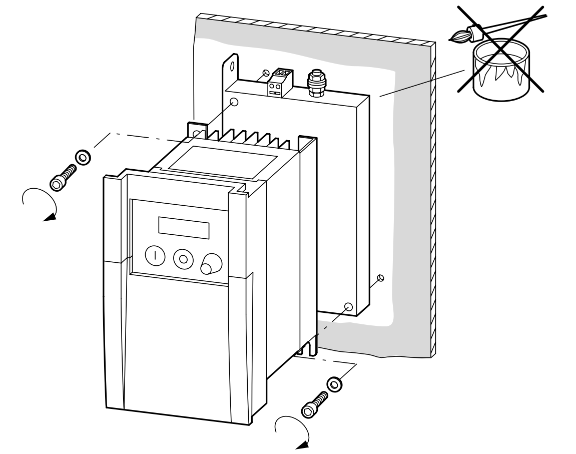


Figure 10: foot-print-Aufbau

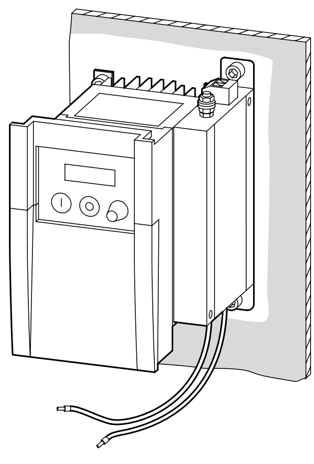


Figure 11: Seitlicher Anbau

Radio interference filters produce leakage currents which can be significantly larger than the rated values in the event of a fault (phase failure, load unbalance). The filters must be earthed before use in order to avoid dangerous voltages. As the leakage currents are high frequency interference sources, the earthing measures must be undertaken with low resistance's on surfaces which as large as possible.

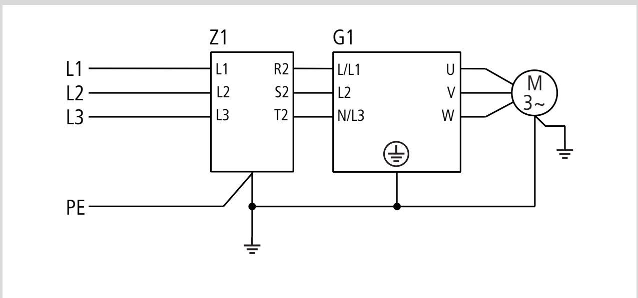


Figure 12: Earthing measures

Z1: EMC filter

G1: frequency inverter

With leakage currents ≧ 3.5 mA, the VDE 0160 and EN 60335 stipulate that either:

- the protective conductor must have a cross-section ≧ 10 mm^2,
- the protective conductor is monitored to ensure continuity or
- an additional protective conductor is also installed.

For the frequency inverters of the DV5 series use the assigned filter DE5-LZ....

EMC measures in the control panel

To ensure EMC-compliant setup, connect all metallic components of the devices and of the control cabinet with each other using a large cross-section conductor with good HF conducting properties. Do not make connections to painted surfaces (Eloxal, yellow chromated). If there is no alternative, use contact and scraper washers to ensure contact with the base metal. Connect mounting plates to each other, and the cabinet doors with the cabinet using contacts with large surface areas and short HF wires.

An overview or all EMC measures can be seen in the following figure.

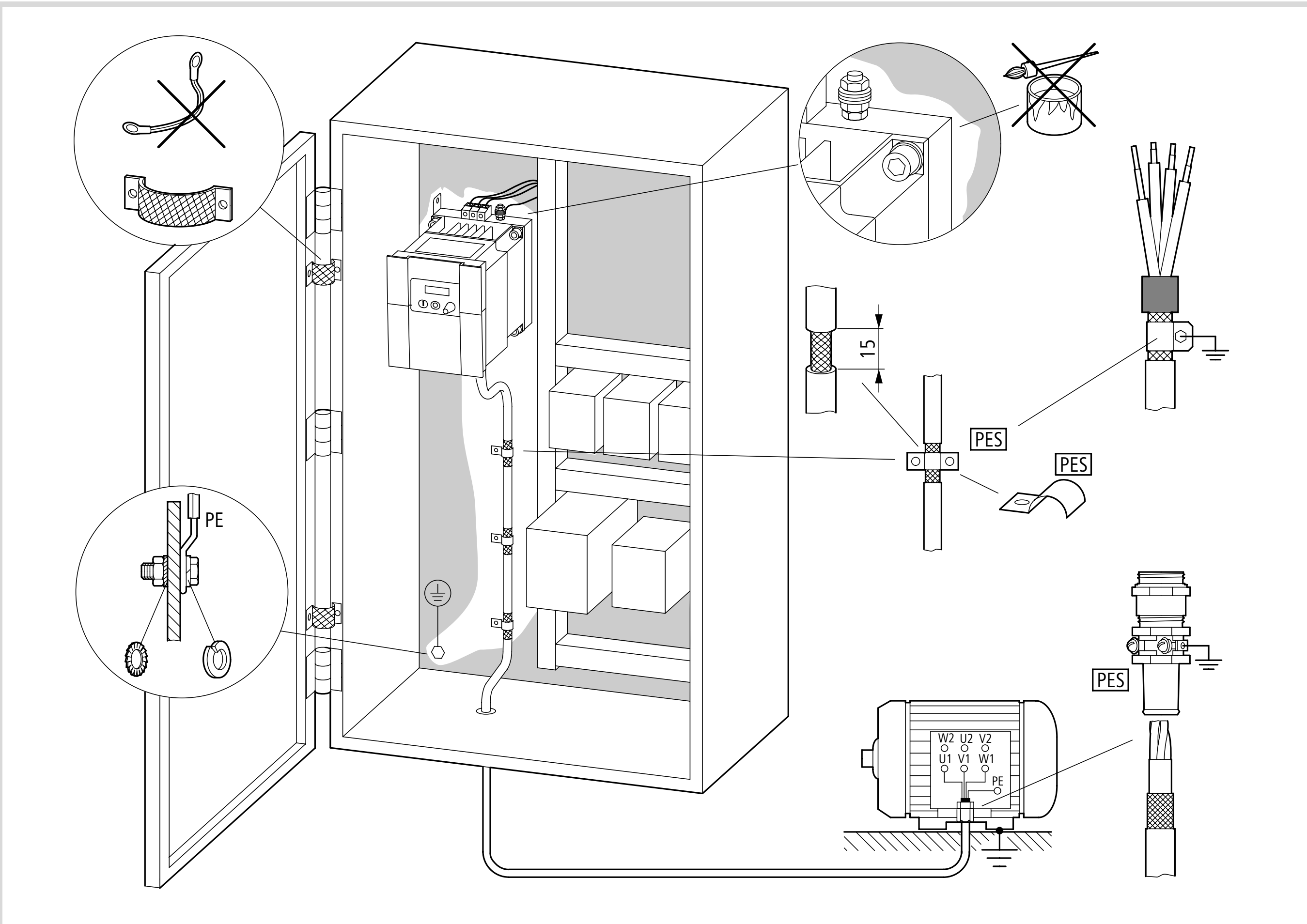


Figure 13: EMC-compliant setup

Fit additional RFI filters or mains filters and frequency inverters as closely as possible to each other and on a single metal plate (mounting plate).

Lay cables in the control cabinet as near as possible to the ground potential. Cables that hang freely act as antennae.

To prevent transfer of electromagnetic energy, lay interference-suppressed cables (e.g. mains supply before the filter) and signal lines as far away as possible (at least 10 cm) from HF-conducting cables (e.g. mains supply cable after a filter, motor power cable). This applies especially where cables are routed in parallel. Never use the same cable duct for interference-suppressed and HF cables. Where unavoidable, cables should always cross over at right angles to each other.

Never lay control or signal cables in the same duct as power cables. Analog signal cables (measured values, setpoints and correction values) must be screened.

Grounding

Connect the ground plate (mounting plate) with the protective earth using a short cable. To achieve the best results, all conducting components (frequency inverter, mains filter, motor filter, mains choke) should be connected by an HF wire, and the protective conductor should be laid in a star configuration from a central earthing point. This produces the best results.

Ensure that the earthing measures have been correctly implemented (→ Fig. 14). No other device which has to be earthed should be connected to the earthing terminal of the frequency inverter. If more than one frequency inverter is to be used, the earthing cables should not form a closed loop.

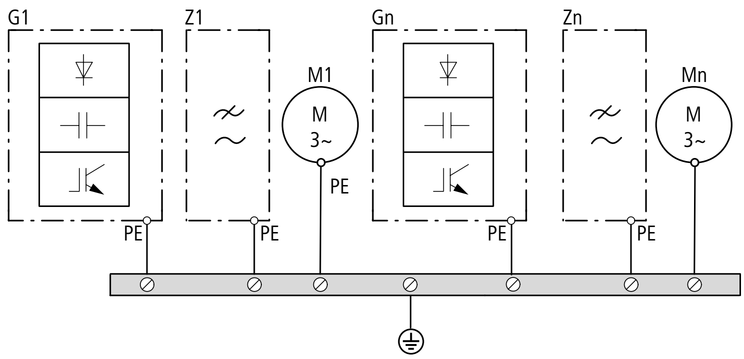


Figure 14: Star-type point to point earthing

Screening

Unscreened cables behave like antennae, i.e. they act as transmitters and receivers. To ensure EMC-compliant connection, screen all interference-emitting cables (frequency inverter/motor output) and interference-sensitive cables (analog setpoint and measured value cables).

The effectiveness of the cable screen depends on a good screen connection and a low screen impedance. Use only screens with tinned or nickel plated copper braiding, braided steel screens are unsuitable. The screen braid must have an overlap ratio of at least 85 percent and an overlap angle of 90°.

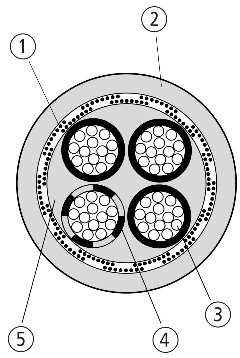


Figure 15: Sample motor cable

① CU screen braid
② PVC outer sheath
③ Strands (CU-strands)
④ PVC core insulation
3 × black, 1 × green/yellow
⑤ Textile braid and PVC inner material

The screened cable between frequency inverter and motor should be as short as possible. Connect the screen to earth at both ends of the cable using a large contact surface connection.

Lay the cables for the supply voltage separately from the signal cables and control cables.

Never unravel the screening or use pigtails to make a connection.

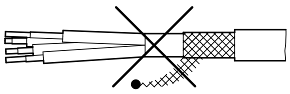


Figure 16: Inadmissible screen grounding (pigtails)

If contactors, maintenance switches, motor protection relays, motor reactors, filters or terminals are installed in the motor cabling, interrupt the screen near these components and connect it to the mounting plate (PES) using a large contact surface connection. The free, unscreened connecting cables should not be longer then about 100 mm.

Example: Maintenance switch

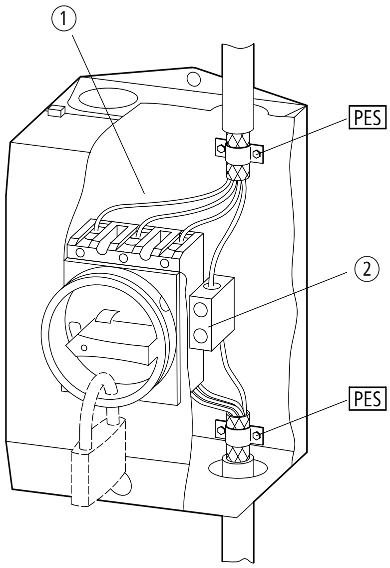


Figure 17: Maintenance switch, e.g. **T… in an enclosure**

① Metal plate

② Insulated PE-terminal

In an EMC-compliant control cabinet (metal-enclosed, damped to about 10 dB), the motor cables do not need to be screened provided that the frequency inverter and motor cables are spatially separated from each other and arranged in a separate partition from the other control system components. The motor cable screening must then be connected via a large surface area connection at the control cabinet (PES).

The control cable and signal (analog setpoint and measured value) cable screens must be connected only at one cable end. Connect the screen to ground using a large-area contact surface; ensure that the connection has a low impedance. Digital signal cable screens must be connected at both cable ends with large-surface, low-resistance connections.

Electrical connection

In this section, you will find information for connection of the motor and the supply voltage to the power terminals, and the signal cables to the control terminals and signalling relay.

Warning!
The wiring stages may only commence after the frequency inverters have been correctly installed and attached. Otherwise, there is a danger of electrical shock or injury.

Warning!
Wiring may only be carried out under no voltage conditions.

Warning!
Only use cables, residual-current circuit-breakers and contactors which have a suitable rating. Otherwise there is a danger of fire.

An overview of the connections can be found in the following illustration.

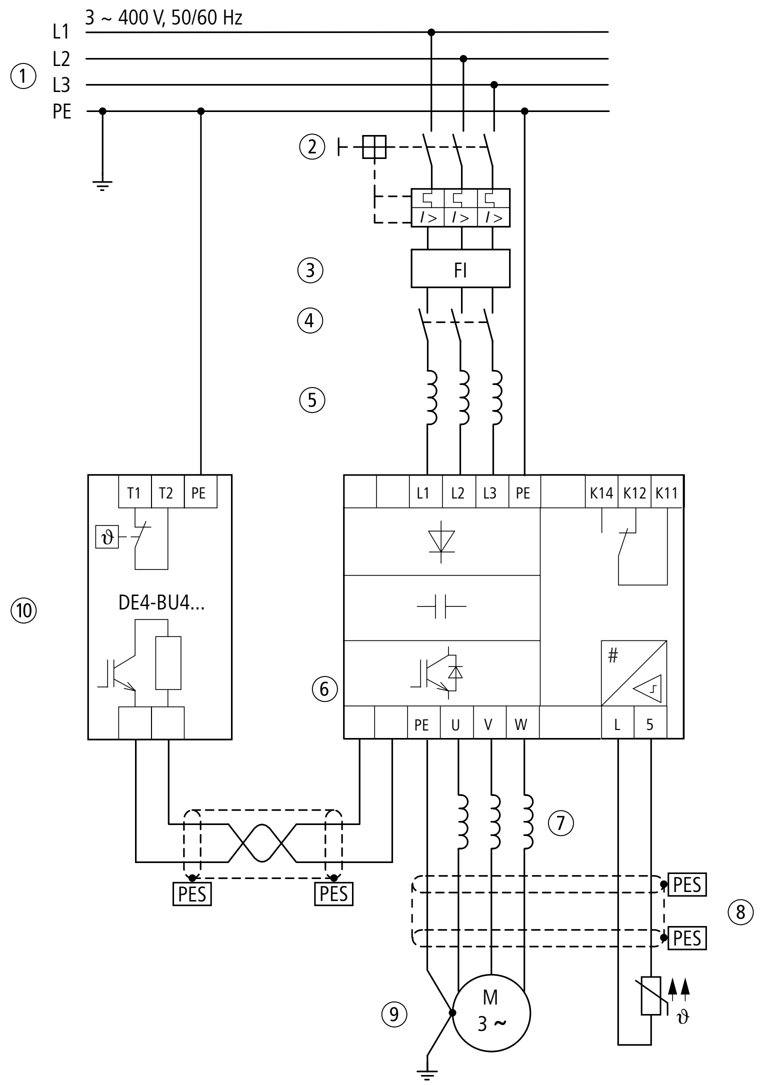


Figure 18: Power connection, example with 400 V

① Network configuration, mains voltage, mains frequency interaction with p.f. compensation systems

② Fuses and cable cross-sections

③ Protection of persons and domestic animals with residual-current protective devices

④ Mains contactor

⑤ Mains choke, radio interference filter, line filter

⑥ Mounting, installation
power connection
EMC measures
example of circuits

⑦ Motor filter
dv/dt filter
sinusoidal filter

⑧ Motor cables, cable length

⑨ Motor connection
parallel operation of multiple motors on an single frequency inverter

⑩ Braking resistors, braking units
DC link coupling
DC supply

Connecting the power section

The flap on the front enclosure must be opened in order to connect the cables to the supply voltage and signal relay terminals.

→ Complete the following steps with the tools stated and without the use of force.

Open the front cover and the front of the enclosure

▶ First of all open the front cover

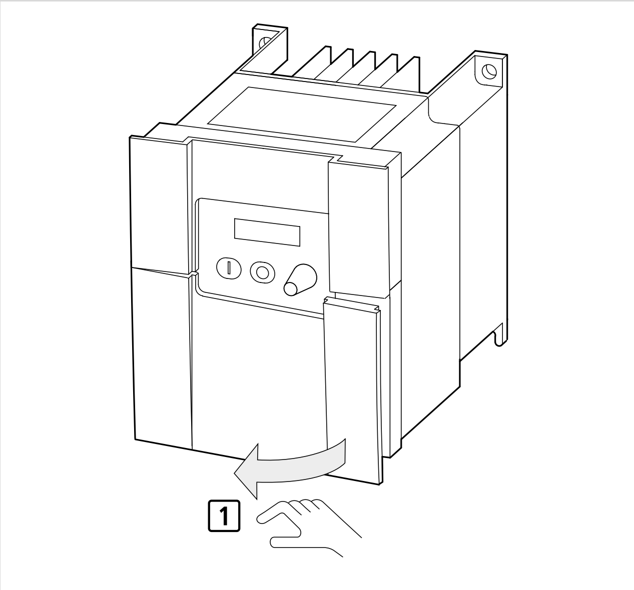


Figure 19: Opening the front cover

▶ Loosen the screw

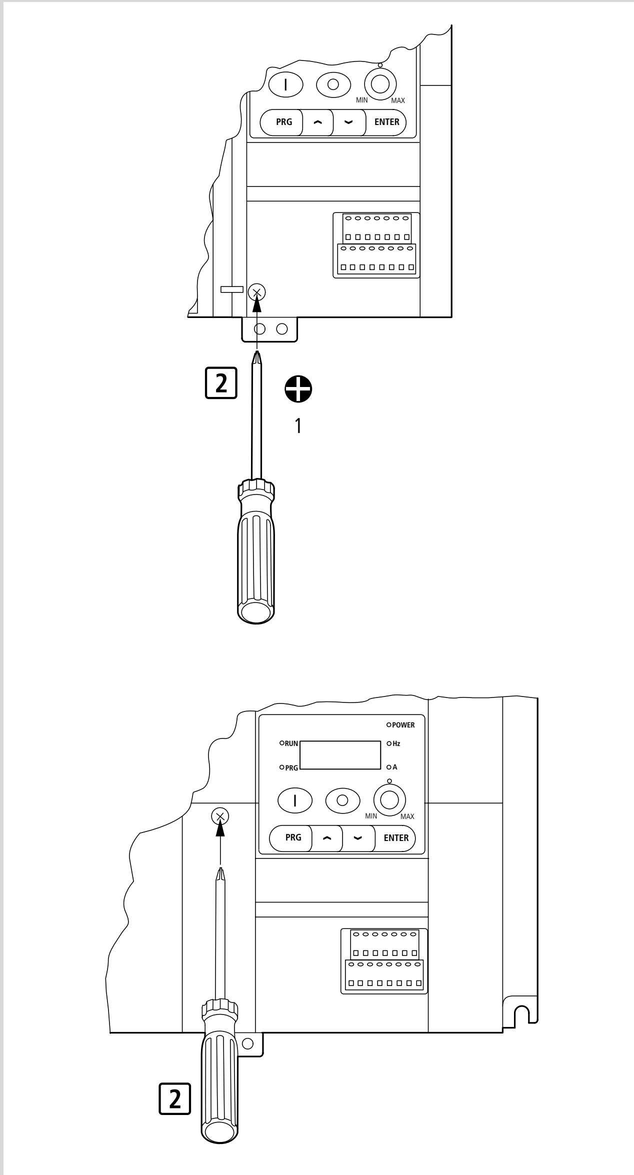


Figure 20: Loosen the screw

▶ Flap open the front cover and remove the terminal shroud.

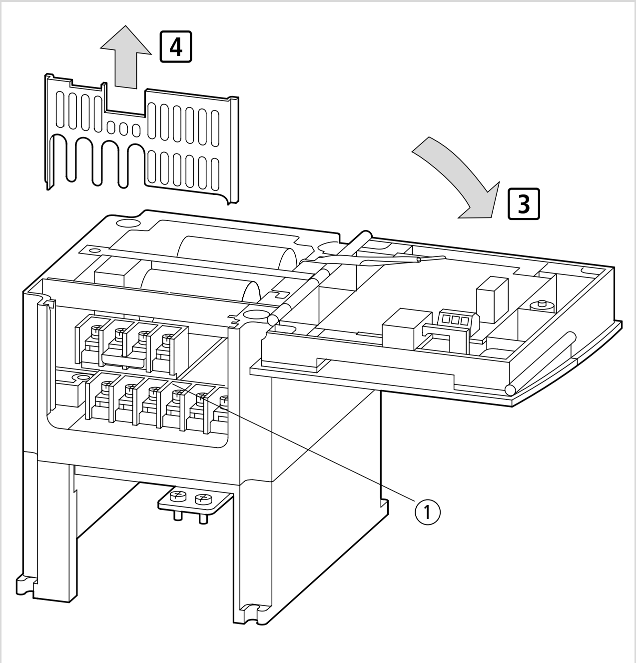


Figure 21: Open the front cover and remove the terminal shroud

① Power terminals

Power terminal arrangement

The arrangement of the power terminals can be seen in the following figure.

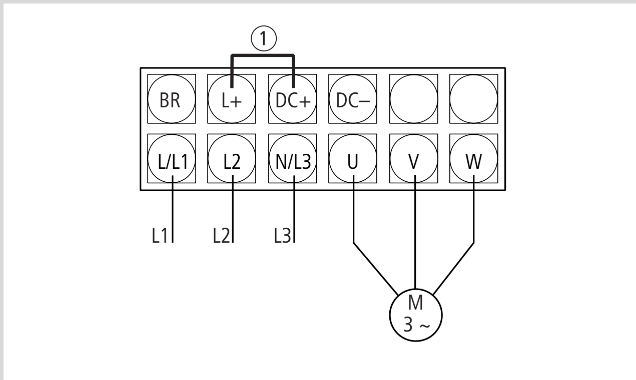
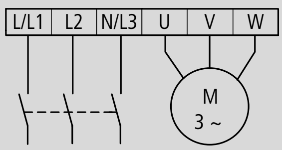


Figure 22: Arrangement of the power terminals

① Internal connection. Remove if a d.c.-link choke is used.

Table 2: Description of the power terminals

Terminal designation	Function	Description
L, L1, L2, L3, N	Supply voltage (mains voltage)	• Single-phase mains voltage: Connection to L and N • Three-phase mains voltage: Connection to L1, L2, L3
U, V, W	Frequency inverter output	Connection of a three-phase motor
L+, DC+	External DC choke	Normally, the terminals L+ and DC+ are assigned with a jumper. If a d.c.-link choke is used, the jumper must be removed.
DC+, DC–	DC link	These terminals are used for the connection of an optional braking resistor as well as for DC linking and DC feed of multiple frequency inverters.
BR, DC+	External braking resistance	These terminals are used for the connection of an optional external braking resistor.
⏚, PE	Earthing	Enclosure earthing (prevents the presence of dangerous voltages on the enclosure with a malfunction)



Power terminal connection

Warning!
The supply voltage must suit the frequency inverter which is selected (→ Section "Appendix", Page 115):

- DV5-322: Single-phase or three-phase: 230 V (180 to 264 V ± 0 %)
- DV5-340: three-phase 400 V (342 to 506 V ± 0 %)

Warning!
The mains voltage may not be connected for any reason to the output terminals U, V and W. Danger of electrical shock or fire.

Warning!
Each phase of the supply voltage for the frequency inverter must be protected by a fuse (danger of fire).

Warning!
Ensure that all power cables are correctly tightened on the power section.

Warning!
The frequency inverter must be earthed. Danger of electrical shock or fire.

Laying the cables

Lay the cables for the power section separately from the signal cables and control cables.

The motor cables which are to be connected must be screened. The maximum cable length must not exceed 50 m. With larger cable lengths, a motor choke is required for dv/d*t*-limitation

If the cable leading from the frequency inverter to motor is longer than approx. 10 m, it is possible that the available thermal relays (bimetallic relays) will malfunction due to high frequency harmonics. Install a motor filter on the output of the frequency inverter in this case.

Warning!
Do not connect cables to the terminals in the power section which are not designated. These terminals are partially without function (dangerous voltages) or are reserved for DV5 internal purposes.

Tightening torques and conductor cross-sections

Warning!
Tighten the screws on the terminals correctly (→ Table 3), so that they do not come loose unintentionally.

▶ Screw on the cables tightly according to Table 3.

Table 3: Tightening torque's and conductor cross-sections for the power terminals

L, L1, L2, L3, N L+, DC+, DC–, BR U, V, W, PE DV5-	mm²	AWG	mm	mm		Nm	⊕
322-018 322-037 322-055	1.5	16	6 to 8	7.1	M3.5 M4 (PE)	0.8 to 0.9	1
340-037 340-075 340-1K5 340-2K2	1.5	16	8 to 10	9	M4	1.2 to 1.3	1
322-075 322-1K1 340-3K0 340-4K0	2.5	14	8 to 10	9	M4	1.2 to 1.3	1
322-1K5 322-2K2 340-5K5 340-7K5	4	12	12 to 14	13	M5	2 to 2.2	2

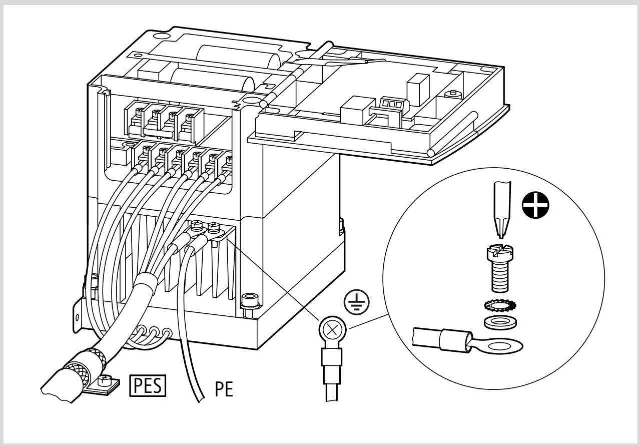


Figure 23: Cable connection to the power terminals

Connecting the supply voltage

▶ Connect the supply voltage to the power terminals:
- Single-phase supply voltage: L, N and PE
- Three-phase supply voltage: L1, L2, L3 and PE

Connecting the motor cable

▶ Connect the motor cable to the U, V, W and PE terminals:

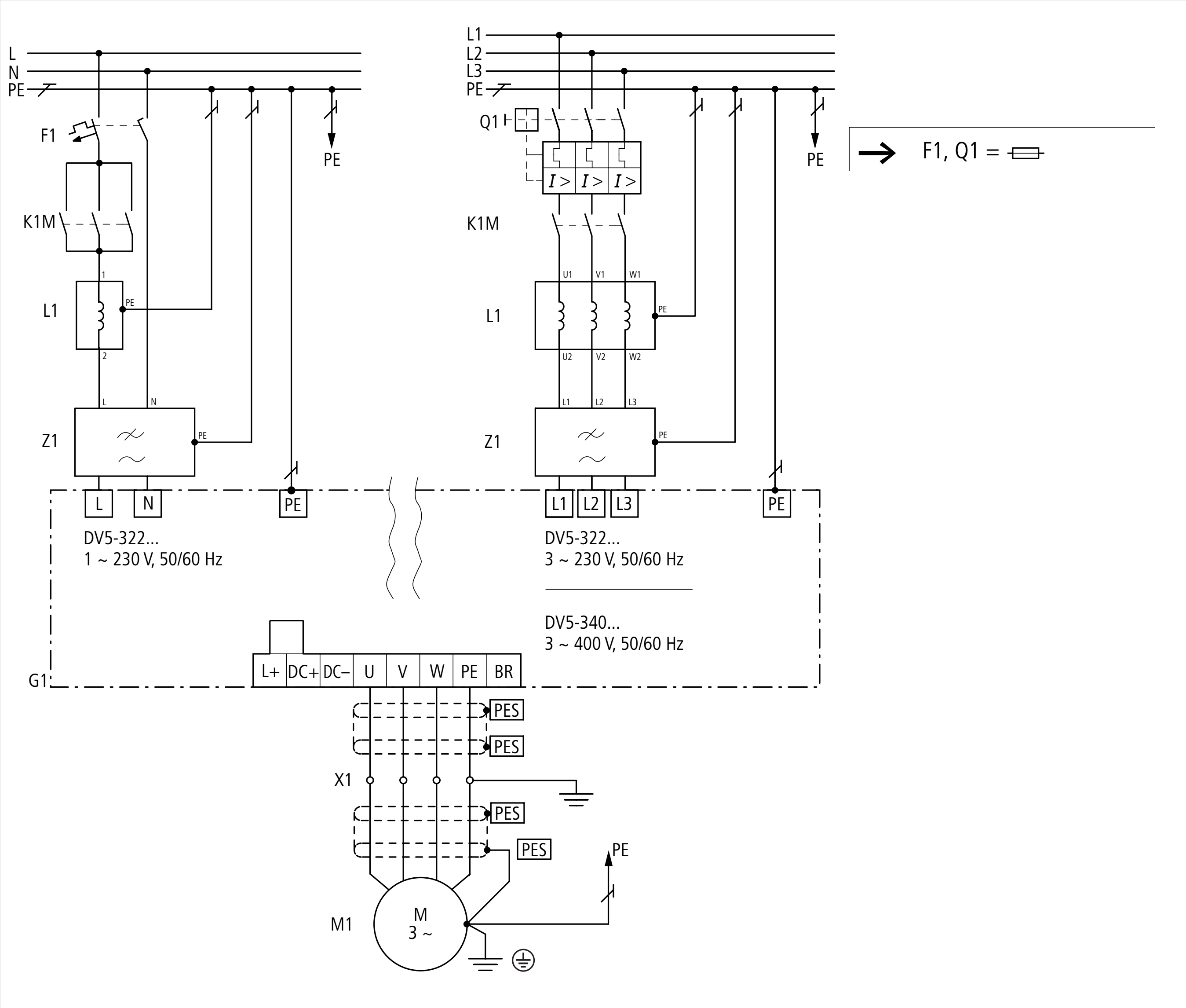


Figure 24: Power terminal connection example

F1, Q1: Line protection

K1M: Mains contactor

L1: Mains choke

Z1: RFI filter

→ Observe the electrical connection data (rating data) on the rating label (nameplate) of the motor.

The stator winding of the motor can be connected as a star or delta configuration in accordance with the rating data on the name-plate.

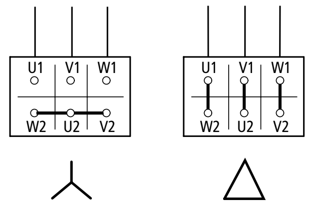


Figure 25: Connection types

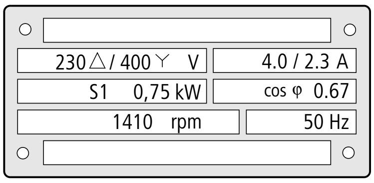


Figure 26: Example of a motor nameplate

Frequency inverter	**DV5**322--**075**	**DV5**340--**075**
Mains voltage	Single-phase 230 V	3-phase 400 V
Mains current	9 A	3.3 A
Motor circuit	Delta	Star
Motor current	4 A	2.3 A
Motor voltage	3 AC 0 to 230 V	3 AC 0 to 400 V

Warning!
If motors whose insulation is not suitable for operation with frequency inverters are used, the motor may be destroyed.

If you use a motor filter or a sinusoidal filter here, the rate of voltage rise can be limited to values of approx. 500 V/µs (DIN VDE 0530, IEC 2566).

In the factory default setting, frequency inverters of the DV5 series have a clockwise rotating field. Rotation of the motor shaft to the right is achieved by connecting the motor and frequency inverter terminals as follows:

Motor	**DV5**
U1	U
V1	V
W1	W

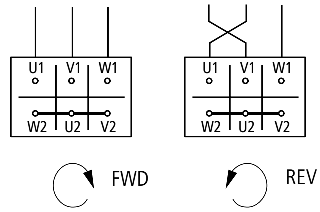


Figure 27: Direction of rotation, change of rotation direction

You reverse the direction of rotation of the motor shaft with frequency inverter operation on the DV5 by:

- exchanging two of the phases connected to the motor.
- triggering terminal 1 (FWD = clockwise) or 2 (REV = anticlockwise).
- applying a control command via the interface or fieldbus interface connection.

The speed of a three-phase motor is determined by the number of pole pairs and the frequency. The output frequency of the DV5 series frequency inverter can be varied infinitely in the range from 0.5 to 360 Hz.

Connection of pole-changing three-phase motors (Dahlander changing pole motors), rotor-fed three-phase commutator shunt motors (slipring rotor) or reluctance motors, synchronous motors and servo motors is possible, when they are approved for use with frequency inverters by the motor manufacturer.

Warning!
The operation of a motor with speeds higher than the rated speed (nameplate) can cause mechanical damage to the motor (bearings, unbalance) and the machinery to which it is connected and can lead to dangerous operating conditions!

Caution!
Uninterrupted operation in the lower frequency range (less than approx. 25 Hz) can lead to thermal damage (overheating) with self-ventilated motors. Possible counter-measures include: Over-dimensioning or external cooling independant of motor speed.

Observe the manufacturers recommendations for operation of the motor.

Parallel connection of motors on a frequency inverter

The DV5 series frequency inverters can control multiple motors connected in parallel. If differing motor speeds are required, they must be selected via the number of pole pairs and/or the gear transmission ratio.

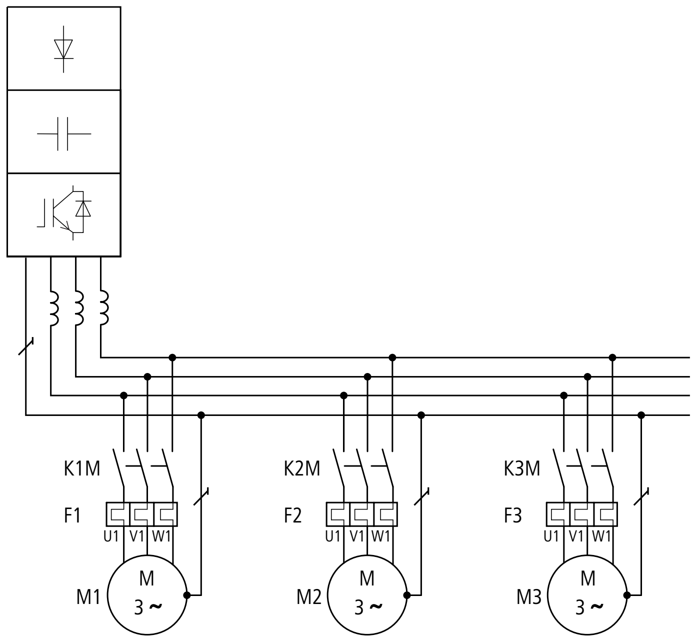


Figure 28: Parallel connection of multiple motors

Caution!
If a frequency inverter controls a number of motors in parallel, the contactors for the individual motors must be designed for AC-3 operation. You may not use the mains contactors from the table in the Appendix Section "Mains contactors", Page 122. These mains contactors are only designed for the mains (primary) currents of the frequency inverter. If they are used in the motor circuit, the contacts could weld.

The load resistance on the output of the frequency inverter is reduced by parallel connection of the motors. The total stator inductivity is reduced and the leakage capacitance increases. As a result, the current distortion is larger when compared to operation with a single motor load. In order to reduce the current distortion, chokes or sinusoidal filters can be used on the frequency inverter output.

→ The current consumption of all the connected motors may not exceed the rated output current I_{2N} of the frequency inverter.

→ It is not possible to use electronic motor protection when operating the frequency inverter with a number of connected motors. You must however, protect each motor with Thermistors and/or overload relays.

If motors with large differences in output power (e.g. 0.37 kW and 2.2 kW) are connected in parallel to the output of a frequency inverter, problems can occur during the start phase and at low speeds. It is possible, that motors with a low motor rating are unable to develop the required torque. This is due to the relatively high ohmic resistance's in the stators of these motors. They require a higher voltage during the start phase and at low speeds.

Motor cable

Only screened motor cables may be used for EMC related compatability. The length of the motor cable and the associated use of further components has an influence on the operating mode and the operational behaviour. With parallel operation (multiple motors connected to the frequency inverter output) the resulting cable lengths l_{res} must be calculated:

$$l_{res} = \Sigma l_M \times \sqrt{n}_M$$

Σl_M: Sum of all motor cable lengths

n_M: Number of motor circuits

→ With long motor cables, the leakage currents can cause the "earth fault" fault indication due to parasitic cable capacities. In this case, motor filters must be used.

Keep the motor cables as short as possible as it will positively influence the drive behaviour.

Motor filters, dv/d*t*-filters, sinusoidal filters
Motor filters (chokes) compensate for capacitive currents with long motor cables and with grouped drives (multiple connection of parallel drives to a single inverter).

The use of motor filters is recommended (observe the manufacturers instructions):

- with grouped drives
- with the operation of three-phase current asynchronous motors with maximum frequencies greater than 200 Hz,
- with the operation of reluctance motors or permanently-excited synchronous motors with maximum frequencies greater than 120 Hz.

With dv/d*t* filters, the voltage on the motor terminals are limited to values less than 500 V/µs. They should be applied with motors with unknown or insufficient withstand voltage for the insulation.

Caution!
During the engineering phase, the voltage drop associated with motor filters and dv/d*t* filters must be considered as it can be up to 4 % of the frequency inverter output voltage.

When sinusoidal filters are used, the motors are supplied with voltage and current which is almost sinusoidal.

Caution!
During the engineering phase, it is necessary to consider that the sinusoidal filter on the output voltage and the switching frequency of the frequency inverter must be adapted to suit each other.

The voltage drop on the sinusoidal filter can be up to 15 % of the frequency inverter output voltage.

Bypass operation
If you want to have the option of operating the motor with the frequency inverter or directly from the mains supply, the incoming supplies must be locked mechanically:

Caution!
Switch-over between the frequency inverter and the mains supply must be undertaken in a no voltage state.

Warning!
The frequency inverter outputs (U, V, W) may not be connected to the mains voltage (destruction of the device, danger of fire).

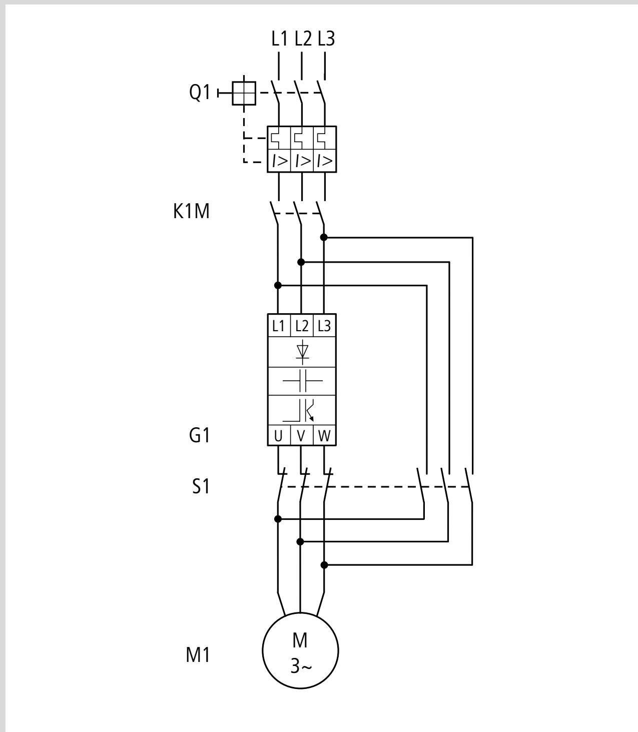


Figure 29: Bypass motor control

Connecting the signalling relay

The following figure indicates the position of the signalling relay.

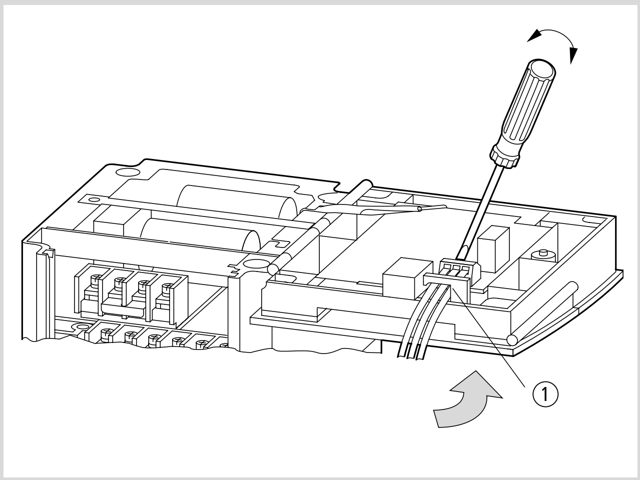
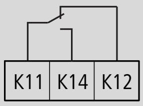


Figure 30: Connecting the signalling relay

① Signalling relay terminals

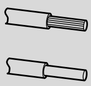
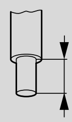
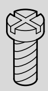
→ When connecting the signalling relay, support the open enclosure front.

Table 4: Description of the signalling relay terminals

Terminal designation	Description1)
K11 K12 K14	Default settings: • Operating signal: K11-K14 closed. • Fault message or power supply off: K11-K12 closed Characteristics of the relay contacts: • Maximum 250 V AC/2.5 A (resistive) or 0.2 A (inductive, power factor = 0.4); Minimum 100 V AC/10 mA • Maximum 30 V DC/3.0 A (resistive) or 0.7 A (inductive, power factor = 0.4); Minimum 5 V DC/100 mA 

1) You can also configure the signalling relay terminals as digital outputs.

Table 5: Signalling relay conductor cross-sections and tightening torques

					 M3
n	mm2	mm	AWG	mm	Nm
1 ×	0.14 to 1.5	6	6 to 16	0.4 × 2.5	0.5 to 0.6
2 ×	0.14 to 0.75	6	–	0.4 × 2.5	0.5 to 0.6

► Fit the terminal shroud to the enclosure again and close the enclosure front.

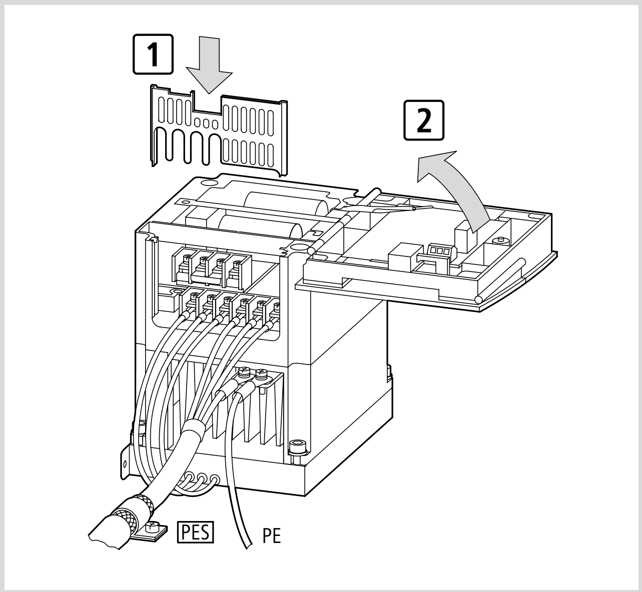


Figure 31: Close the power section

Connecting the control signal terminals

The following figure shows the arrangement of the individual control signal terminals.

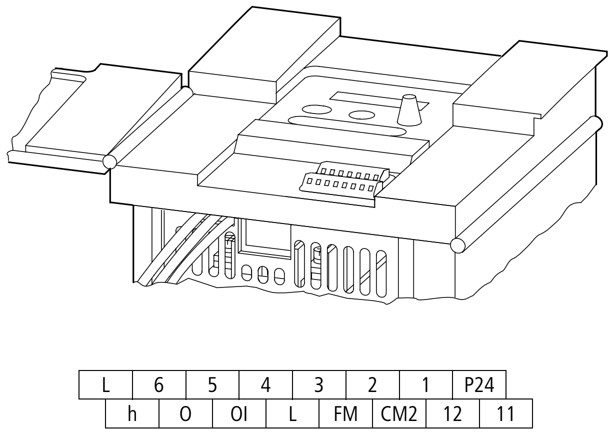


Figure 32: Location of the control signal terminals

ESD measures
Discharge yourself on an earthed surface before touching the frequency inverter and its accessories.
This prevents damage to the devices through electrostatic discharge.

Function of the control signal terminals

Table 6: Meaning of the control signal terminals

No.	Function	Level	Default setting	Technical data, description
L	Common reference potential	0 V	–	Reference potential for the internal voltage sources P24 and H
6	Digital input	HIGH = +12 to +27 V LOW = 0 to +3 V	2CH = second parameter set	PNP logic, configurable, R_i = 5 kΩ Reference potential: Terminal L
5	Digital input		Reset	PNP logic, configurable, R_i = 33 kΩ Reference potential: Terminal L
4	Digital input		FF2 (FF3) = fixed frequency 1 (3)	PNP logic, configurable, R_i = 5 kΩ Reference potential: Terminal L
3	Digital input		FF1 (FF3) = fixed frequency 2 (3)	
2	Digital input		REV = anticlockwise rotation	
1	Digital input		FWD = clockwise rotation	
P24	Control voltage output	+24 V	–	Supply voltage for actuation of digital inputs 1 to 6. Load carrying capacity: 30 mA Reference potential: Terminal L
h	Setpoint voltage output	+10 V ⎓	–	Supply voltage for external setpoint potentiometer. Load carrying capacity: 10 mA Reference potential: Terminal L
O	Analog input	0 to +10 V ⎓	Frequency setpoint value (0 to 50 Hz)	R_i = 10 kΩ Reference potential: Terminal L
OI	Analog input	4 to 20 mA	Frequency setpoint value (0 to 50 Hz)	R_B = 250 Ω Output: Terminal L
L	Common reference potential	0 V	–	Reference potential for the internal voltage sources P24 and H

No.	Function	Level	Default setting	Technical data, description
FM	Analog output	0 to +10 V ⎓	Frequency actual value (0 to 50 Hz)	Configurable, monitored DC voltage; 10 V corresponds to set final frequency (50 Hz). Accuracy: ±5 % from final value Load carrying capacity: 1 mA Reference potential: Terminal L
CM2	External control voltage input	Up to 27 V ⎓	–	Connection: Reference potential (0 V) of the external voltage source for the transistor outputs, terminals 11 and 12. Load carrying capacity: Up to 100 mA (sum of terminals 11 + 12)
12	Transistor output	Up to 27 V = CM2	RUN (operation)	Configurable, open collector Load carrying capacity: Up to 50 mA
11	Transistor output		Frequency setpoint reached	

Control signal terminal wiring

Wire the control signal terminals to suit their application. For a description of how to change the functions of the control signal terminals, see Section "Programming the control signal terminals", Page 49.

Caution!
Never connect terminal P24 with terminals L, H, OI or FM.

Caution!
Never connect terminal H with terminal L.

Use twisted or screened cables for connecting to the control signal terminals. Earth the screen on one side with a large contact area near the frequency inverter. The cable length should not exceed 20 m. For longer cables, use a suitable signal amplifier.

The following figure shows a sample protective circuit for the control signal terminals

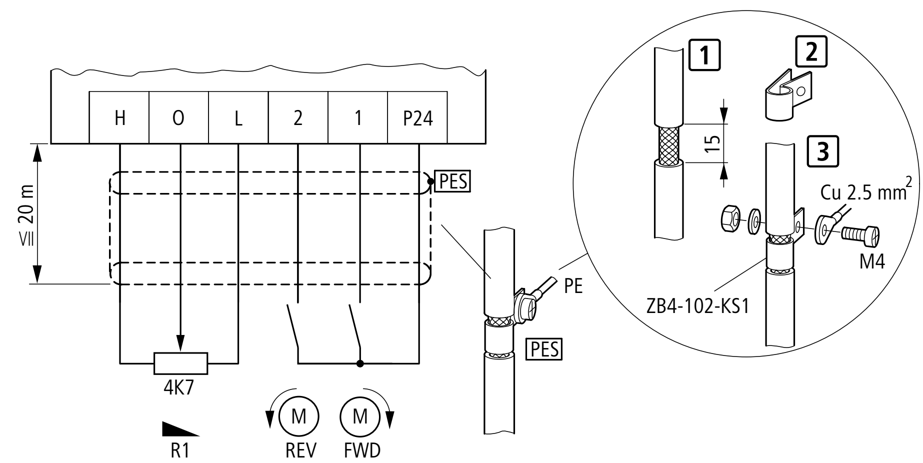


Figure 33: Control terminal connection (factory setting)

When connecting a relay to one of the digital outputs 11 or 12, connect a free-wheel diode in parallel with the relay, so that the self-induction voltage generated when the relay is switched off cannot destroy the digital outputs.

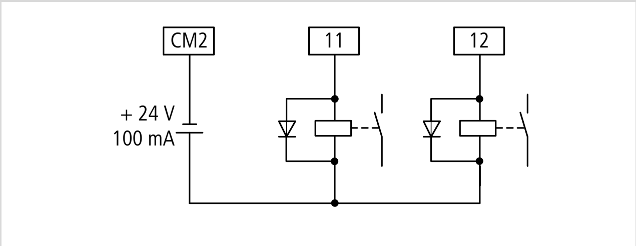


Figure 34: Relay with free-wheel diode

→ Use relays that switch reliably at 24 V ⎓ and a current of about 3 mA.

→ Lay the control and signal cables separately from the mains and motor cables.

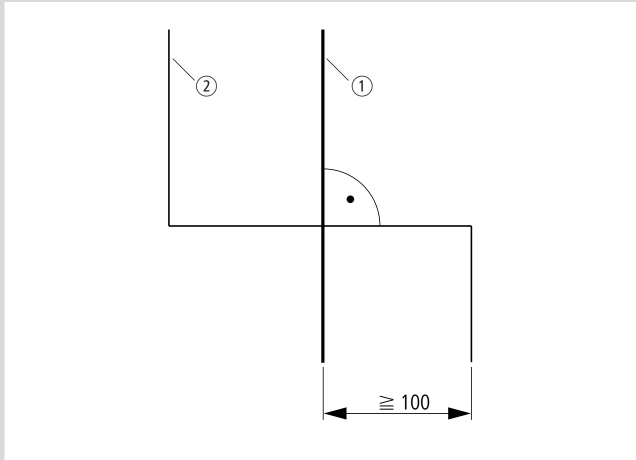


Figure 35: Crossover of signal and power cables

① Power cable: L1, L2, L3 or L and N, U, V, W, L+, DC+, DC–, BR

② Signal cables: H, O, OI, L, FM, 1 to 6, 11 and 12, CM2, P24

Example for the protective circuit of the digital inputs when the internal P24 supply voltage is used, or when a separate external 24 V power supply is used:

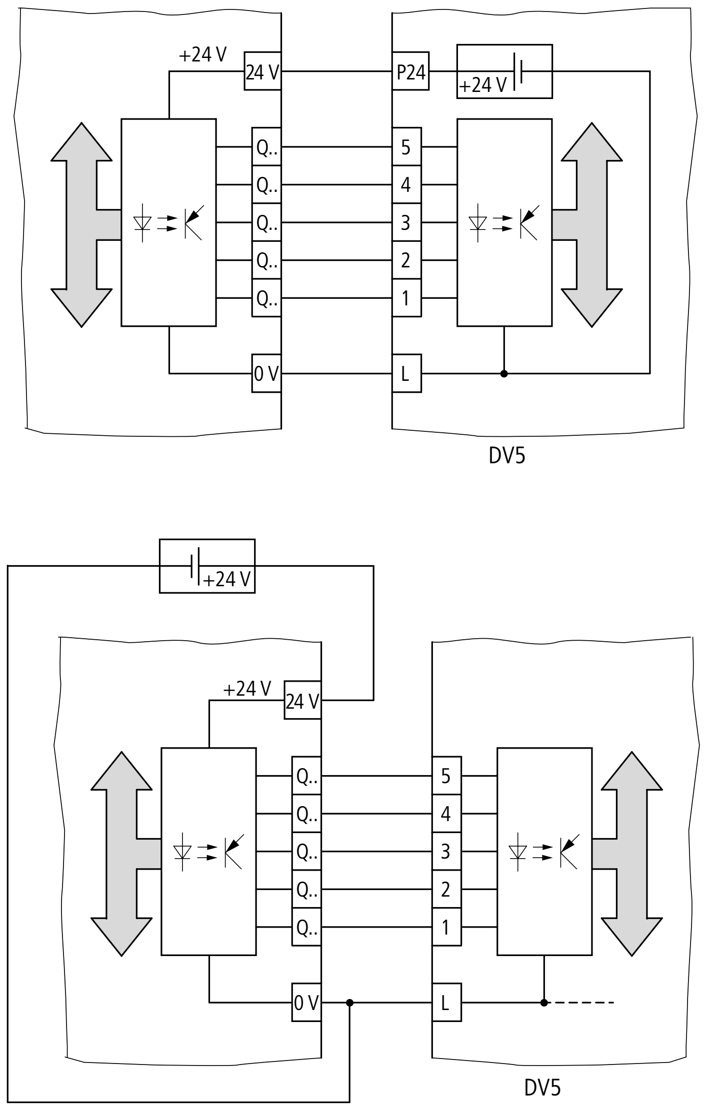


Figure 36: Triggering of the digital inputs

Caution!
Before commissioning, remove the covering on the upper ventilation slots and openings, as the frequency inverter will otherwise overheat → Fig. 37.

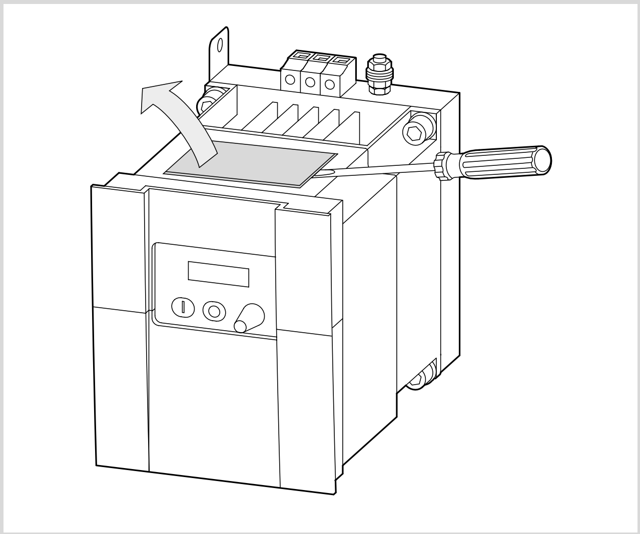


Figure 37: Removing the upper cover

4 DV5 Operation

This section describes how to commission the DV5 series frequency inverters and deals with issues that need to be observed during its operation.

Initial startup

Observe the following points before you take the frequency inverter into operation:

- Ensure that the power cables L and N or L1, L2 and L3 as well as the frequency inverter outputs U, V and W are correctly connected.
- The control lines must be connected correctly.
- The earth terminal must be connected correctly.
- Only the terminals marked as earthing terminals must be earthed.
- The frequency inverter must be installed vertically on a non-flammable surface (e.g. a metal surface).
- Remove any residue from wiring operations – such as pieces of wire – and all tools from the vicinity of the frequency inverter.
- Make sure that the cables connected to the output terminals are not short-circuited or connected to earth.
- Ensure that all terminal screws have been tightened sufficiently.
- Make sure that the frequency inverter and the motor are correct for the mains voltage.
- The configured maximum frequency must match the maximum operating frequency of the connected motor.
- Never operate the frequency inverter with opened power section covers. The front enclosure must be closed and secured with the screw provided.

Caution!
Do not carry out h.v. tests. Built-in overvoltage filters are fitted between the mains voltage terminals and earth, which could be destroyed.

→ Sparkover voltage and insulation resistance tests (megger tests) have been carried out by the manufacturer.

The control signal terminals are wired as follows.

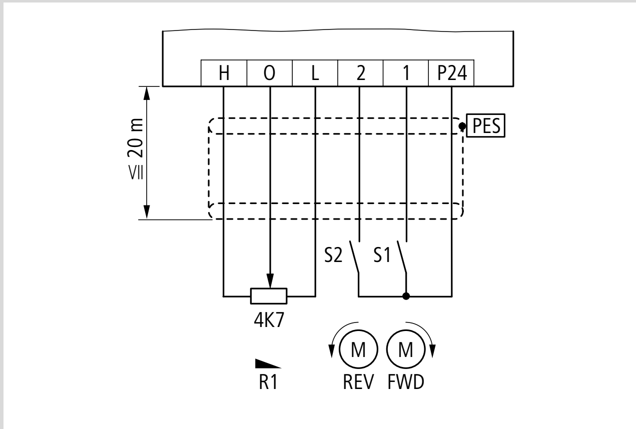


Figure 38: Connecting control signal terminals (default settings)

▶ Switch on the supply voltage.

The POWER and Hz LEDs light up (keypad). The display should indicate 0.0.

▶ Close switch S1 (FWD = clockwise rotation).
▶ With potentiometer R1, you can set the frequency and therefore the motor speed.

The motor turns clockwise and the display indicates the set frequency.

▶ Open switch S1.

The motor speed is reduced to zero (Display: 0.0).

▶ Close switch S2 (REV = anticlockwise rotation).
▶ With potentiometer R1, you can set the frequency and therefore the motor speed.

The motor turns anticlockwise and the display indicates the set frequency.

▶ Open switch S2.

The motor speed is reduced to zero (Display: 0.0).

If both switches S1 and S2 are closed, the motor will not start. The motor speed reduces to zero during operation if you close both switches.

Caution!
Check the following points during or after the ”initial operation” so that damage to the motor does not occur:

- Was the direction of rotation correct?
- Has a fault occurred during acceleration or deceleration?
- Was the frequency display correct?
- Did any unusual motor noises or vibrations occur?

If a fault has occurred due to overcurrent or overvoltage, increase the acceleration or deceleration time (→ Section ”Acceleration time 1”, Page 80 and Section ”Deceleration time 1” Page 81).

By default, the ON key and the potentiometer on the keypad (→ Fig. 39 and → Table 7) have no functions assigned to them. For details about activating these operator controls, see Section ”Setting the frequency and start command parameters”, Page 82.

LCD keypad

The following illustration shows the LCD keypad of the DV5.

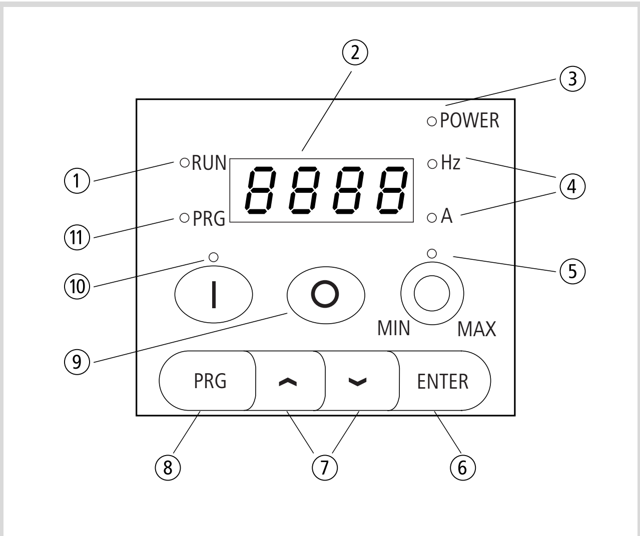


Figure 39: Keypad view

For an explanation of the elements, see Table 7.

Table 7: Explanation of the operating and indication elements

Number	Name	Explanation
①	RUN LED	LED lights up in **RUN mode**, if the frequency inverter is ready for operation or operational.
②	7 segment display	Display for frequency, motor current, error messages, etc.
③	POWER LED	LED is lit when the frequency inverter has power.
④	Hz or A LED	Indication in ②: output frequency (Hz) or output current (A)
⑤	Potentio-meter and LED	Frequency setpoint setting LED is lit when the potentiometer is activated.
⑥	ENTER key ENTER	The key is used for saving entered or changed parameters.
⑦	Arrow keys ⌃ ⌄	Selecting functions, changing numeric values ⌃ Increase ⌄ Reduce
⑧	PRG key PRG	For selecting and exiting the program-ming mode.
⑨	OFF key O	Stop the running motor and acknow-ledge a fault message. Active by default, also for actuation through terminals.
⑩	On key and LED I	Starts the motor in the specified direc-tion (not active by default).
⑪	PRG LED	LED is lit during parameterization.

Operation with LCD keypad

The functions of the DV5 are organized in parameter groups. The following sections describe how to set the parameter values and how the setting menu is structured.

For a detailed description of the parameters, see Section ”Setting Parameters”, Page 79.

Menu overview

The following figure shows the sequence in which the parameters appear on the display. Table 8 provides a brief description of the parameters.

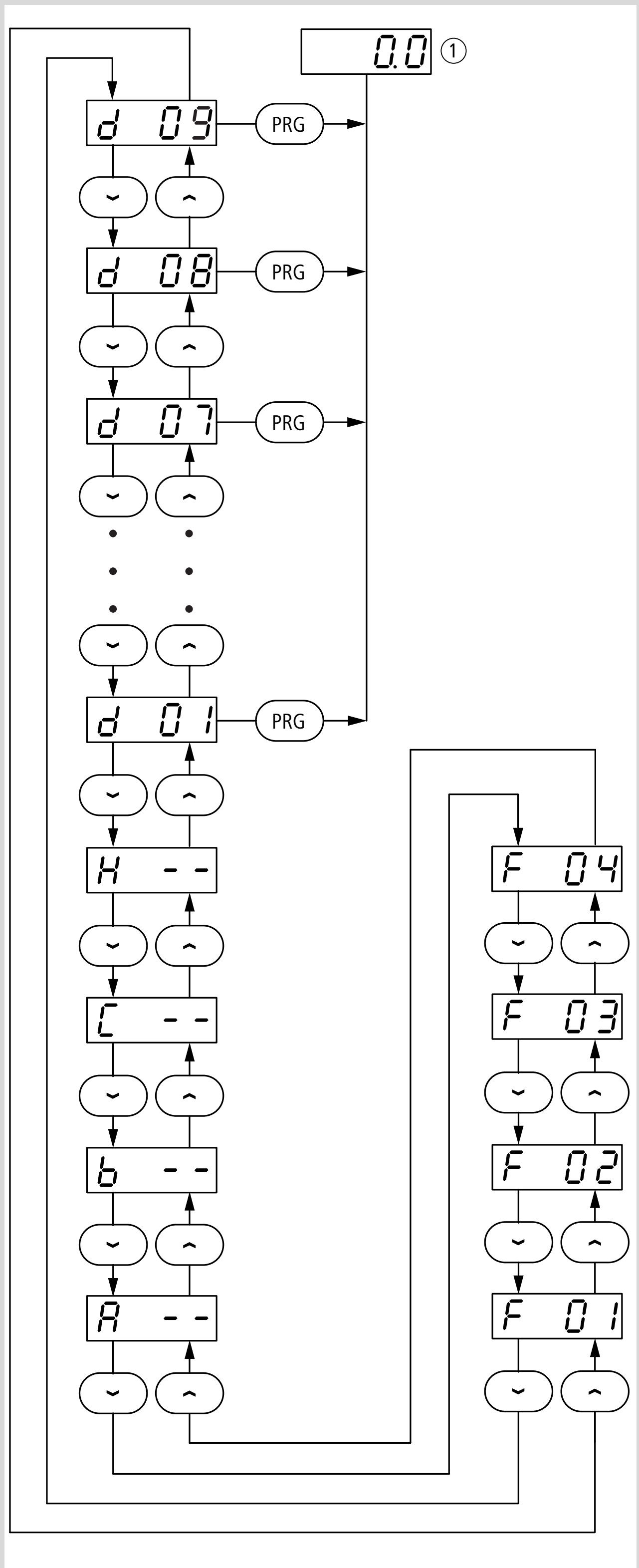


Figure 40: Menu structure of the DV5 keypad

① The display is dependant on the display parameter (PNU d01 to d09) from which you return.

Table 8: Explanation of the parameters

Display	Explanation
Display parameter	
d 01	Output frequency display
d 02	Output current display
d 03	Direction of rotation display
d 04	PID feedback display
d 05	Digital inputs 1 to 6 status
d 06	Status of digital outputs 11 and 12
d 07	Scaled output frequency
d 08	Display of last alarm
d 09	Display of second and third to last alarm
Basic parameters	
F 01	Frequency setpoint adjustment
F 02	Set acceleration time 1
F 03	Set deceleration time 1
F 04	Direction of rotation adjustment
Extended parameter groups	
A --	Extended functions group A
b --	Extended functions, group B
C --	Extended functions, group C
H --	Extended functions, group H

For a detailed explanation of the parameters, see Section ”Setting Parameters”, Page 79.

Changing display and basic parameters

Press the PRG key to switch from display or RUN mode to programming mode. The PRG lamp lights up in this mode.

You can access the individual parameters or parameter groups with the UP and DOWN arrow keys (→ Fig. 40).

To access the programming mode, press the PRG key. You can modify the parameter values with the arrow keys.
Exceptions are the display parameters PNU d01 to d09. These parameters have no values. After you have selected a display parameter with the arrow keys, you can return to the display mode with the PRG key. The display reflects the selected display parameter (→ Section “Setting the display parameters”, Page 79).

Parameter values can be accepted with the ENTER key or rejected with the PRG key.

By pressing the PRG key in the range of the display parameters PNU d01 to d09, you return to the display mode.

Example for changing acceleration time 1: PNU F02
The frequency inverter is in the display mode and the RUN lamp is lit.

▶ Press the PRG key.

The frequency inverter changes to the programming mode, the PRG lamp lights up and d 01 or the most recently modified parameter appears on the display.

▶ Press the DOWN key seven times until F 02 appears on the display.
▶ Press the PRG key.

The set acceleration time 1 in seconds appears on the display (WE = 10.0).

▶ The set value is changed with the UP and DOWN arrow keys.

There are now two possibilities:

▶ Accept the displayed value by pressing the ENTER key.
▶ Reject the displayed value by pressing the PRG key.

The display responds with F 02.

▶ Press the DOWN key seven times until d 01 appears on the display.
▶ Press the PRG key.

The frequency inverter changes over to the display mode and displays the set frequency.

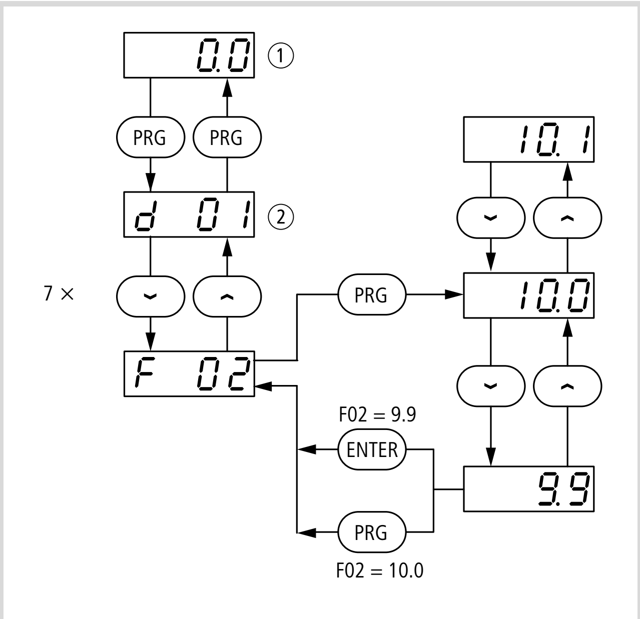


Figure 41: Change acceleration time 1

① Display dependent on the selected display parameter PNU d01 to d09

② Display of the most recently changed parameter

Changing the parameters of the extended parameter groups

The following example illustrates how to change PNU A03 of the extended parameter group A. You can change the parameter values of groups B, C and H exactly as described in the example. For a detailed description of the extended parameter groups, see from Section ”Setting the frequency and start command parameters”, Page 82.

An example of how to change the base frequency PNU A03
▶ Press the PRG key to change over to the programing mode.

The most recently modified parameter appears on the display and the PRG lamp lights up.

▶ Press the UP or DOWN key until the extended parameter group A -- appears on the display.
▶ Press the PRG key.

The display indicates A 01.

▶ Press the UP key twice until A 03 appears on the display.
▶ Press the PRG key.

The value set under PNU A03 (WE = 50.0) appears.

▶ You can change the value with the UP and DOWN arrow keys.

There are now two possibilities:

▶ Accept the displayed value by pressing the ENTER key.
▶ Reject the displayed value by pressing the PRG key.

The display indicates A 03.

▶ Press the PRG key.

The display indicates A --.

▶ Press the DOWN key four times until d 01 appears.
▶ Press the PRG key.

The frequency inverter changes over to the display mode and displays the current frequency.

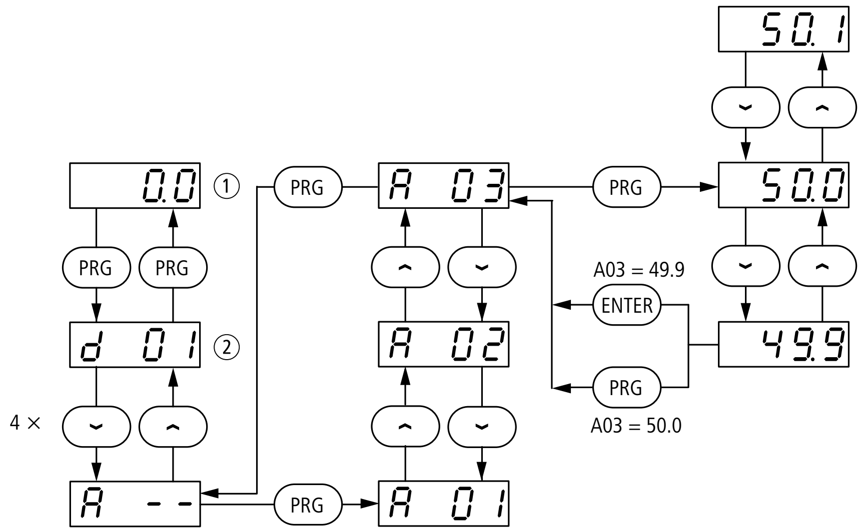


Figure 42: Change the base frequency (example with default setting)

① Display dependent on the selected display parameter PNU d01 to d09

② Display of the most recently changed parameter

Display after the supply voltage is applied

After the supply voltage is switched on, the last screen which was visible before switch off will reappear (not, however, within the extended parameter groups).

Operational warning message

Warning!
If the supply voltage recovers after a brief failure, the motor may restart automatically if a start signal is still present. If personnel are endangered as a result, an external circuit must be provided which excludes a restart after voltage recovery.

Warning!
If the frequency inverter has been configured so that the stop command is not issued via the OFF key on the LCD keypad, pressing the OFF key will not switch off the motor. A separate Emergency-Stop switch must be provided in the case.

Warning!
Maintenance and inspection of the frequency inverter may only be undertaken at least 5 minutes after the supply voltage has been switched off. Failure to observe this point can result in electric shock as a result of the high voltages involved.

Warning!
Never pull on the cable to unplug connectors (e.g. for fan or circuit boards).

Warning!
If a malfunction is responded to by a reset, the motor will start automatically if a start signal is applied at the same time. To avoid the risk of serious or fatal injury to personnel, you must ensure that the start signal is not present before acknowledging an error message with a reset.

Warning!
When the supply voltage for the frequency inverter is applied when the start signal is active, the motor will start immediately. Make sure that the start signal is not active before the supply voltage is switched on.

Warning!
Cables or plug connectors may not be connected or disconnected during operation when the supply voltage is switched on.

Caution!
To prevent a risk of serious or fatal injury to personnel, never interrupt the operation of the motor by opening the contactors installed on the primary or secondary side.

→ The ON key is functional only if the corresponding parameters of the frequency inverter have been configured accordingly (Section "Setting the frequency and start command parameters", Page 82).

→ Before operating motors at frequencies above the standard 50 or 60 Hz, contact their manufacturers to verify that the motors are suitable for operation at higher frequencies. The motors could otherwise incur damage.

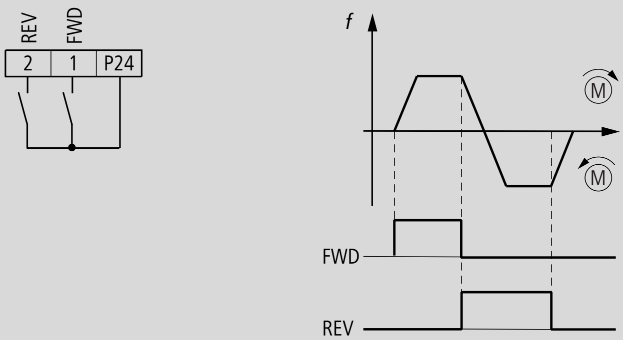
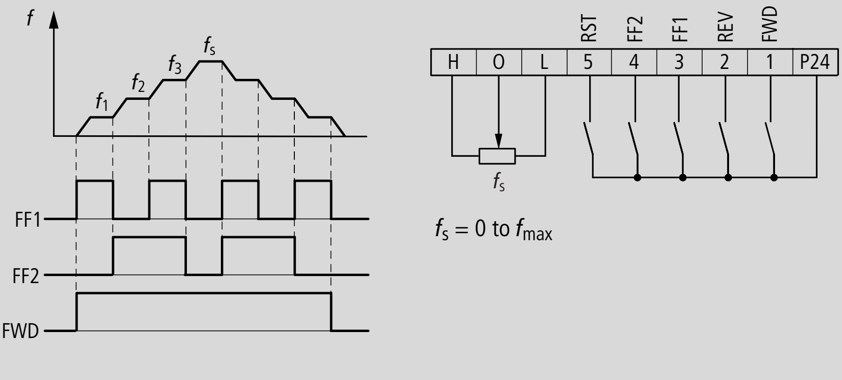
5 Programming the control signal terminals

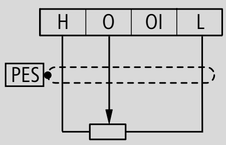
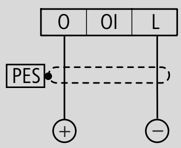
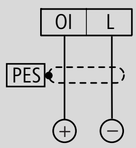
This section describes how to assign various functions to the control signal terminals.

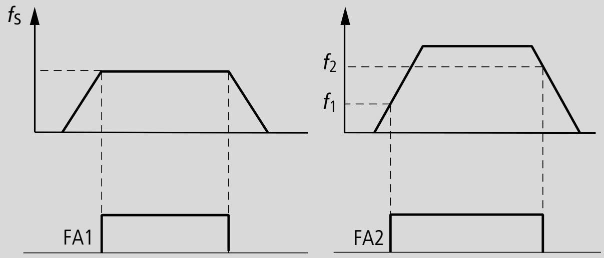
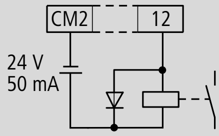
Overview

Table 9 provides an overview of the control signal terminals and a brief description of the functions which you can assign to the programmable digital inputs and outputs. For a detailed description of the individual functions, see from Page 52.

Table 9: Function description

Name	Value[1)]	Function	Description
Programmable digital inputs 1 to 6			Parameter definition under PNU C01 to C06
FWD	00	Clockwise (start/stop)	
REV	01	Anticlockwise (start/stop)	FWD input closed: motor starts up in a clockwise direction. FWD input open: motor coasts to a stop (clockwise rotation). REV input: same case for anticlockwise rotation as with FWD FWD and REV inputs closed simultaneously: motor coasts to a stop.
FF1	02	Programmable fixed frequencies 1 to 4	Example: Four fixed frequencies 
FF2	03		
FF3	04		
FF4	05		For four fixed frequency stages (three programmable fixed frequencies and a setpoint value), two fixed frequency inputs (3 = FF1 and 4 = FF2) are required ($2^2 = 4$).
JOG	06	Jog mode	The jogging mode, which is activated by switching on the JOG input, is used, for example, for setting up a machine in manual mode. When a start signal is received, the frequency programmed under PNU A38 is applied to the motor. Under PNU A39, you can select one of three different operating modes for stopping the motor.
DB	07	External brake	Once the DB input is switched on, DC braking can be carried out.
SET	08	Selection of the second parameter set	Switching on SET allows you to select the second parameter set for setpoint frequency, torque boost, first and second acceleration/deceleration ramp and other functions. Parameters in the second parameter set are identified by a leading “2”, e.g. : PNU A**2**01

Name	Value[1)]	Function	Description
2CH	09	Second time ramp	Activates the second acceleration and deceleration time with PNU A92 and PNU A93 respectively
FRS	11	Controller inhibit (free run stop)	When FRS is switched on, the motor is immediately switched off and coasts to a stop.
EXT	12	External fault	When the EXT input is switched on, the fault signal activates PNU E12 and the motor switches off. The fault signal can be acknowledged, for example, with the RST input.
USP	13	Restart inhibit	When the USP input is switched on, the restart inhibit is active. This prevents a motor restart when the voltage recovers after a mains failure while a start signal is present.
SFT	15	Parameter protection	Switching on the SFT input to activate the parameter protection prevents loss of the entered parameters by inhibiting write operations to these parameters.
AT	16	Setpoint input OI (4 to 20 mA) active	When the AT input is switched on, only the setpoint value input OI (4 to 20 mA) is processed.
RST	18	Reset	To acknowledge an error message, switch on the RST input. If a reset is initiated during operation, the motor will coast to a stop. The RST input is a make (NO) contact; it cannot be programmed as a break contact (NC).
PTC	19	Connection for a PTC thermistor	You can only program digital input 5 with PNU C05 as an input for a PTC thermistor. Use terminal L as the reference potential.
UP	27	Acceleration (motor potentiometer)	When input UP is switched on, the motor accelerates (available only if you have specified the frequency setpoint with PNU F01 or A20).
DWN	28	Deceleration (motor potentiometer)	When input DWN is switched on, the motor decelerates (available only if you have specified the frequency setpoint with PNU F01 or A20).
P24	–	+24 V ⎓ for digital inputs	24 V ⎓ potential for digital inputs 1 to 6
Frequency setpoint definition			
h	–	+10 V setpoint voltage for external potentiometer	Setpoint value can be set with potentiometer:  *R*: 1 to 10 kΩ Setpoint value through voltage input:  0 to 10 V ⎓ Input impedance: 10 kΩ Setpoint value through current input:  4 to 20 mA ⎓ Load resistor: 250 Ω
O	–	Analog input for frequency setpoint (0 to 10 V)	
OI	–	Analog input for frequency setpoint (4 to 20 mA)	
L	–	0 V reference potential for setpoint inputs	The OI input for a setpoint value from 4 to 20 mA is only used when the digital input configured as the AT input is closed.
Analog output			
FM	–	Frequency monitor	The frequency can be output via a connected analog or digital measurement device via this input. As an option, the motor current can be displayed.
L	–	0 V	0 V reference potential for the FM output

Name	Value[1]	Function	Description
Digital outputs 11 and 12			Parameter definition under PNU C21 and C22
FA1	01	Signal when frequency is reached or exceeded	 f_S = setpoint frequency Connection of a signal relay to digital output 11 or 12:  Transistor output (open collector) (maximum 27 V ⎓, 50 mA)
FA2	02		If a digital signal is configured as FA1, a signal is issued as long as the setpoint value is achieved. If a digital signal is configured as FA2, a signal is output as long as the frequencies defined under PNU C42 and PNU C43 are exceeded.
RUN	00	RUN signal	The RUN signal is output during operation of the motor.
OL	03	Signal on overload	The OL signal is output when the overload alarm threshold (adjustable under PNU C41) is exceeded.
OD	04	Signal on PID control deviation	The OD signal is output when the PID control deviation set under PNU C44 is exceeded.
AL	05	Signal (alarm) on fault	The AL signal is issued when a fault occurs.
CM2	–	0 V	0 V reference potential for the programmable digital outputs 11 and 12. These transistor outputs (open collector) are controlled through optocouplers, whose reference potential is CM2. CM2 is isolated from L.
Signalling relay[2]			Parameter definition under PNU C24
K11 K12 K14	–	Signalling relay contacts	During normal, healthy operation, terminals K11-K14 are closed. If a malfunction occurs or the supply voltage is switched off, the terminals K11-K12 are closed. Maximum permissible values: • 250 V ~; maximum load 2.5 A (purely resistive) or 0.2 A (with a power factor of 0.4) • 30 V ⎓; maximum load 3.0 A (purely resistive) or 0.7 A (with a power factor of 0.4) • Minimum values necessary: 100 V ~ with a load of 10 mA or 5 V ⎓ with a load of 100 mA

1) To activate the function, enter this value in the corresponding parameter.

2) This output can be used as both a signal output and a normal digital output.

Frequency display FM

The FM terminal provides the output frequency or the motor current as a frequency signal.

The selection between the frequency display and display of the motor current is made under PNU C23.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
C23	Display via FM output	–	00	Indication of the output frequency (analog 0 to 10 V ⎓ signal)	00
			01	Indication of motor current (analog 0 to 10 V ⎓ signal; 100 % rated current corresponds to 5 V ⎓)	
			02	Display of the output frequency (digital impulse signal)	

Analog frequency display

The signal output (PNU C23 = 00 or 01) is a square-wave, with a constant period of oscillation. Its pulse width is proportional to the current frequency value (0 to 10 V correspond to 0 Hz to the end frequency).

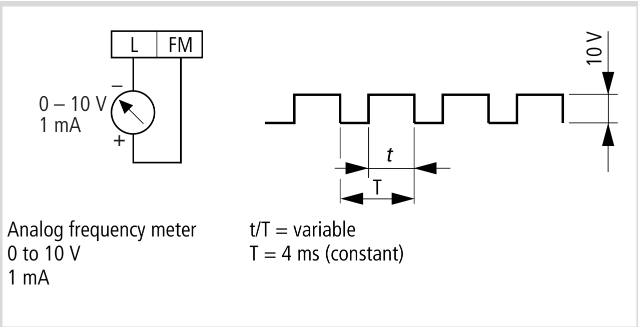


Figure 43: Connection of an analog frequency meter

Signal compensation takes place in PNU b81. The signal accuracy after compensation is ±5 %.

If for example, a higher level of smoothing of the FM signal is required for a motor current display, an external low-pass filter circuit is required. The accuracy is approx. ±10 %.

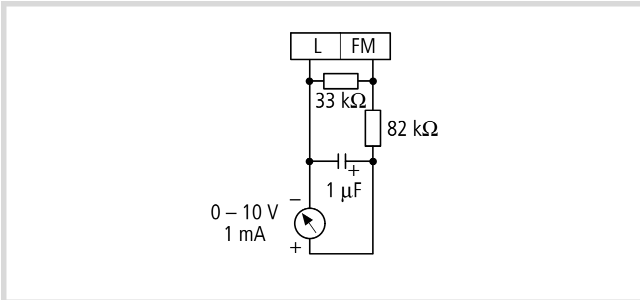


Figure 44: Example for a low-pass circuit

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b81	Adjustment value for analog signal on FM terminal	✓	0 to 255	The analog signal issued on the FM terminal (frequency actual value or output current) can be adjusted here. The impulse signal (digital frequency actual value) cannot be compensated.	80

Digital frequency display

The frequency of this signal (PNU C23 = 02) changes proportionally to the output frequency. The pulse duty factor remains constant at about 50 %.

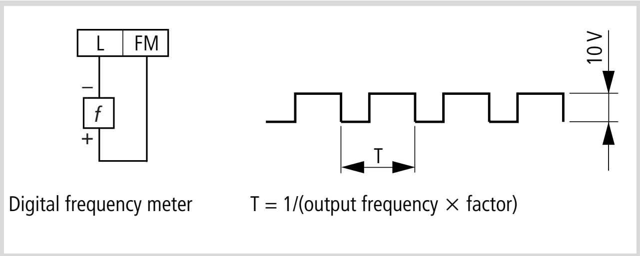


Figure 45: Digital frequency meter connection

The signal frequency results from the product of the current output frequency and an adjustable factor at PNU b86.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b86	Frequency factor	✓	0.1 to 99.9	The product of the value displayed under PNU d01 and this factor is displayed at PNU d07. This value is also available at the FM terminal.	1.0

Matching terminals O and OI

With PNU C81 and C82, you can match the analog setpoint signals at terminals O (0 to 10 V) and OI (4 to 20 mA) to your requirements.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
C81	Matching the setpoint signal at terminal O	✓	0 to 255	Here, you can match the setpoint signal (0 to 10 V) supplied at analog input O with reference to the output frequency.	Depending on inverter
C82	Matching the setpoint signal at terminal OI	✓	0 to 255	Here, you can match the setpoint signal (4 to 20 mA) supplied at analog input OI with reference to the output frequency.	

Programmable digital inputs 1 to 6

You can assign various functions to terminals 1 to 6. Depending on your requirements, these terminals can be configured as follows:

- clockwise start signal (FWD),
- anticlockwise start signal (REV),
- selection inputs for various fixed frequencies (FF1 to FF4),
- reset input (RST),
- etc.

The terminal function for each of the programmable digital inputs 1 to 6 occurs via PNU C01 to C06, i.e. you use PNU C01 to specify the function of digital input 1, PNU C02 to specify the function of digital input 2, etc. You cannot, however, assign the same function to two inputs.

Programmable digital inputs 1 to 6 are configured as make contacts by default. If, therefore, the function of an input terminal is to be activated, the corresponding input must be closed (i.e. the input terminal is connected to terminal P24). Conversely, to deactivate the input terminal, the input must be opened.

Caution!
If an EEPROM error occurs (fault message E 08), all parameters must be checked to ensure that they are correct (particularly the RST input).

Table 10: Digital inputs 1 to 6

PNU	Terminal	Adjustable in RUN mode	Value	WE
C01	1	–	→ Table 11	00
C02	2			01
C03	3			02
C04	4			03
C05	5			18
C06	6			09

A detailed description of the input functions can be found on the pages listed in Table 11.

Table 11: Functions of the digital inputs

Value	Function	Description	→ Page
00	FWD	Start/stop clockwise	55
01	REV	Start/stop anticlockwise	55
02	FF1	First fixed frequency input	56
03	FF2	Second fixed frequency input	
04	FF3	Third fixed frequency input	
05	FF4	Fourth fixed frequency input	
06	JOG	Jog mode	64
07	DB	DC brake	70
08	SET	Selection of the second parameter set	68
09	2CH	Second acceleration and deceleration time	59
11	FRS	Motor shutdown and free run stop	60
12	EXT	External fault	61
13	USP	Restart inhibit	62
15	SFT	Parameter protection	66
16	AT	Setpoint input through current	58
18	RST	Reset	63
19	PTC	PTC thermistor input (digital input 5 only)	65
27	UP	Acceleration (motor potentiometer)	67
28	DWN	Deceleration (motor potentiometer)	67

If required, the digital inputs can be configured as break (NC) contacts. For this purpose, under PNU C11 to C16 (corresponding to digital inputs 1 to 6), 01 is to be input. An exception exists only for inputs which you configure as RST (reset) or as PTC (PTC thermistor input). These inputs can only be operated as make (NO) contacts.

Caution!
If you reconfigure digital inputs configured as FWD or REV as break contacts (the default setting is as a make contact), the motor starts immediately. They should only be reconfigured as break contacts when it is absolutely essential.

Table 12: Configuring digital inputs as break contacts

PNU	Terminal	Value	Adjustable in RUN mode	Function	WE
C11	1	00 or 01	–	00: Make contact 01: Break contact	00
C12	2				
C13	3				
C14	4				
C15	5				
C16	6				

Start/Stop

Clockwise rotation FWD

If you activate a digital input which has been configured as a FWD input, the motor starts to run in a clockwise direction. If you deactivate the input, the motor coasts to a stop.

If the FWD and the REV inputs are activated simultaneously, the motor coasts to a stop.

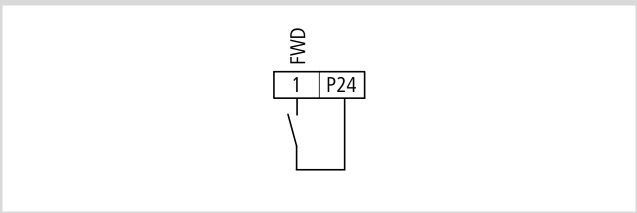


Figure 46: Digital input 1 configured as FWD „Start/Stop clockwise rotation"

Anticlockwise operation: REV

If you activate a digital input which has been configured as an REV input, the motor starts to run in an anticlockwise direction. If you deactivate the input, the motor coasts to a stop.

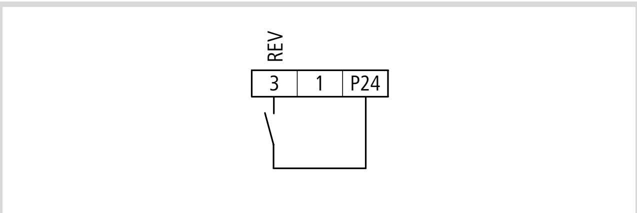


Figure 47: Digital input 2 configured as REV "Start/Stop anticlockwise"

Issue start command

By default, the start command is issued through the inputs configured as FWD or REV. If however, the start command is currently issued via the ON key on the keypad, set under PNU A02 the value 01 (start command via FWD/REV input) (→ Section "Start command", Page 82).

- ▶ Program one of the digital inputs 1 to 6 as FWD by setting the corresponding PNU (C01 to C06) to 00.
- ▶ Program one of the digital inputs 1 to 6 as REV by setting the corresponding PNU (C01 to C06) to 01.

Warning!
If the supply voltage for the frequency inverter is applied when the start signal is activated, the motor will start immediately. Make sure, therefore, that the start signal is not active before the supply voltage is switched on.

Warning!
If the FWD/REV input is opened (inactive state if FWD/REV is configured as a make contact) and then it is reconfigured as a break contact, it must be noted that the motor will start immediately after the reconfiguration.

Fixed frequency FF1 to FF4 selection

With the digital inputs configured as FF1 to FF4 you can select up to 16 user-definable fixed frequencies (including frequency setpoints), depending on which of the inputs is active or inactive (→ Table 13). It is not necessary to use all the fixed frequency selection inputs at the same time. Using only three inputs, for example, allows you to choose between eight fixed frequencies; with two fixed frequency selection inputs, four fixed frequencies are available for selection.

The fixed frequencies have a higher priority than all other setpoint values and can be accessed at any time through inputs FF1 to FF4 without needing to be enabled separately. Jog mode, to which the highest priority is assigned, is the only operation with a higher priority than the fixed frequencies.

Table 13: Fixed frequencies

Fixed frequency stage	PNU	Input FF4	FF3	FF2	FF1
$0 = f_s$	Frequency setpoint value	0	0	0	0
f_1	a21	0	0	0	1
f_2	a22	0	0	1	0
f_3	a23	0	0	1	1
f_4	a24	0	1	0	0
f_5	a25	0	1	0	1
f_6	a26	0	1	1	0
f_7	a27	0	1	1	1
f_8	a28	1	0	0	0
f_9	a29	1	0	0	1
f_{10}	a30	1	0	1	0
f_{11}	a31	1	0	1	1
f_{12}	a32	1	1	0	0
f_{13}	a33	1	1	0	1
f_{14}	a34	1	1	1	0
f_{15}	a35	1	1	1	1

0 = input deactivated
1 = input activated

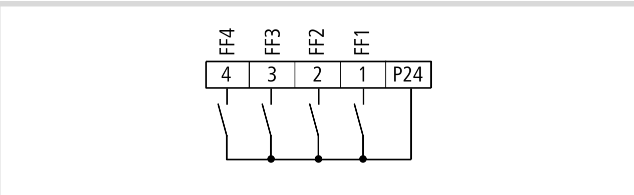


Figure 48: Digital inputs 1 to 4 configured as FF1 to FF4 (fixed frequency)

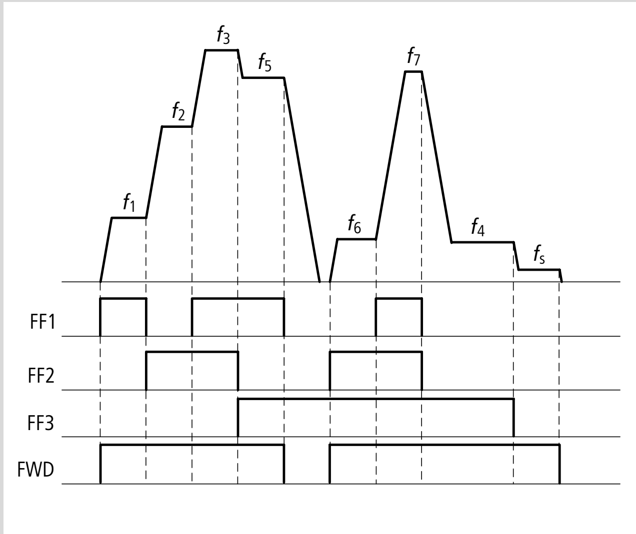


Figure 49: Function chart of "Fixed frequency" control FF1 to FF3

▶ Program one or more of the digital inputs 1 to 6 as FF1 to FF4, by entering the values 02 (FF1) to 05 (FF4) under the corresponding PNU (C01 to C06).

The fixed frequencies can be programmed in two ways:

- input of the fixed frequencies under PNU A21 to A35,
- input of the fixed frequencies under PNU F01.

With PNU F01, it is possible to modify the parameter even though the parameter protection PNU b31 is set (→ Page 66).

Input of the fixed frequencies under PNU A21 to 35

▶ Goto PNU A21 and press the PRG key.
▶ Use the arrow keys to enter the fixed frequency and confirm with the ENTER key.
▶ Repeat these steps for PNU A22 to A35 to suit your required frequencies.

Input of the fixed frequency under PNU F01

For frequency input under PNU F01, the value 02 must be set beforehand in PNU A01.

▶ To select a fixed frequency stage, activate the digital inputs as listed in Table 13.
▶ Goto PNU F01.

The current frequency appears on the display.

▶ Use the arrow keys to enter the fixed frequency and confirm with the ENTER key.

The entered value is saved in the parameter which you have selected with the digital inputs (→ Table 13).

▶ Repeat these steps for your additional fixed frequencies.

Specifying frequency setpoints

The frequency setpoint value can be assigned in one of three ways, dependent on PNU A01:

- via the installed potentiometer on the keypad, PNU A01 = 00;
- via analog input O (0 to 10 V) or OI (4 to 20 mA), PNU A01 = 01 (WE);
- via PNU F01 or PNU A20, PNU A01 = 02.

Selecting fixed frequencies

▶ The set fixed frequency values are selected by activating the respective digital inputs (→ Table 13).

Table 14: Fixed frequency parameters

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A01	Defined frequency setpoint	–	00	Definition with the potentiometer on the keypad	01
			01	Definition via analog input O (0 to 10 V) or OI (4 to 20 mA)	
			02	Definition under PNU F01 and/or PNU A20	
A20 A220	Frequency setpoint value	✓	0.5 to 360 Hz	You can input a frequency setpoint value. You must input 02 under PNU A01 for this purpose.	0.0
A21	Fixed frequency			You can assign a frequency to each of the 15 fixed frequency parameters from PNU A21 to A35.	
A22					
A23					
...					
A35					
F01	Display/input of frequency value			Display of the current frequency setpoint value or the current fixed frequency. Modified values are saved with the ENTER key according to the selection of the digital inputs configured as FF1 to FF4. Resolution ±0.1 Hz	

→ If one or more of the fixed frequencies exceeds 50 Hz, you must first increase the end frequency accordingly with PNU A (04 (→ Section "Maximum end frequency", Page 83).

→ Fixed frequency stage 0 (none of the inputs FF1 to FF4 are activated) corresponds to the frequency setpoint value. Depending on the configuration PNU A01 it is possible to implement via the integrated potentiometer, the setpoint input values O or OI, or via PNU F01 and PNU A20.

Current setpoint value AT (4 to 20 mA)

When the digital input which has been configured as AT is active, the setpoint value is defined by the current flow (4 to 20 mA) on terminal OI. If however the AT input is inactive, the setpoint value is defined by the voltage present (0 to 10 V) at terminal O.

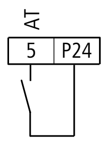


Figure 50: Digital input 5 configured as AT (setpoint value via current)

Under PNU A01, enter the type of frequency setpoint definition. With a default setting of 01, the voltage 0 to 10 V present on terminal O or the current of 4 to 20 mA flowing into terminal OI is interpreted as the setpoint value. Depending on whether the AT input is active or not. If it has not yet been correctly configured, set the parameter to 01.

▶ Program one of the digital inputs 1 to 6 as AT, by inputting the value 16 under the respective PNU (C01 to C06) to 16.

Second time ramp 2CH

If the digital input which has been configured as 2CH is active, the motor will be accelerated or braked with the second acceleration or deceleration time. If the 2CH input is again deactivated, a changeover to the first acceleration/deceleration time takes place.

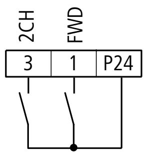


Figure 51: Digital input 3 configured as the "second time ramp" 2CH

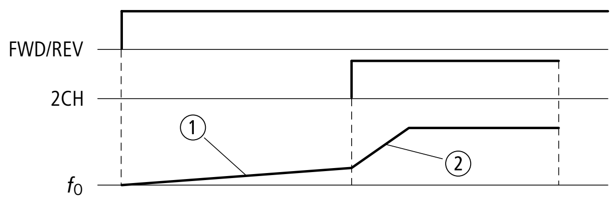


Figure 52: Function chart for 2CH (second acceleration time)

f_0: output frequency

① First acceleration time

② Second acceleration time

- ▶ Set under PNU A92 and PNU A93, the required value for the second acceleration and delay time.
- ▶ Then set under PNU A94, the value 00 so that the changeover to the second acceleration and delay time via the 2CH input is enabled (this is the default setting).
- ▶ Program one of the digital inputs 1 to 6 as 2CH, by setting the value 09 under the respective PNU (C01 to C06).

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A92 A292	Second acceleration time	✓	0.1 to 3000 s	Setting times for the second acceleration and deceleration time 0.1 to 999.9 s; resolution: 0.1 s 1000 to 3000 s; resolution: 1 s	15
A93 A293	Second deceleration time				
A94 A294	Changeover from the first to the second time ramp	–	00	Changeover to the second time ramp if an active signal is present on a 2CH digital input.	00
			01	Changeover to the second time ramp when the frequencies entered under PNU A95 and/or A96 are achieved	

→ If you set PNU A94 to 01, the changeover to the second acceleration or deceleration time can take place automatically at the frequency set under PNU A95 or A96 (→ Section "Time ramps", Page 100).

→ The value for the first acceleration and deceleration time is defined in PNU F01 and F02 (→ Section "Acceleration time 1", Page 80).

Controller inhibit and coasting of the motor FRS (free run stop)

If you activate the digital input configured as FRS, the motor is switched off and coasts to a stop (for example if an Emergency-Stop is made). If you deactivate the FRS input, then, depending on the converter's configuration, frequency output is either synchronized to the current speed of the coasting motor or restarts at 0 Hz.

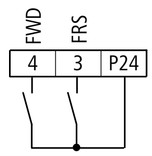


Figure 53: Configuration of digital input 3 as "controller inhibit" FRS (free run stop) and 4 as FWD (start/stop clockwise rotation)

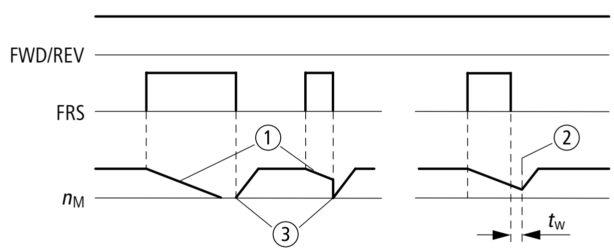


Figure 54: Function chart "control inhibit and free run stop" FRS

n_M: motor speed

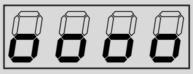
t_W: delay time (setting under PNU b03)

① Motor coasts to a stop

② Synchronization to the current motor speed

③ Restart from 0 Hz

- ▶ Set under PNU b88, if the motor is to restart with 0 Hz after deactivation of the FRS input, or if a synchrinization to the current motor speed after a waiting time (PNU b03) is to occur.
- ▶ Program one of the digital inputs 1 to 6 as FRS, by inputting the value 11 under the respective PNU (C01 to C06).

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b03	Delay time until restart	–	0.3 to 100 s	Here, set a time which is to expire before an automatic restart is initiated after a fault signal. This time can also be used in conjunction with the FRS function. During the delay, the following message appears on the LED display: 	1.0
b88	Motor restart after removal of the FRS signal	–	00	0 Hz restart after deactivation of the FRS input	00
			01	Synchronization of the motor to the current motor speed after the delay time entered under PNU b03.	

External fault message EXT

If the digital input configured as EXT is activated, the fault message E12 is initiated (e.g. an input used for the bimetal contacts). The fault message remains active even if the EXT input is deactivated again and must be acknowledged with a reset.

A reset can be carried out with:

- the RST input or
- the OFF key.
- Alternatively, the supply voltage can be switched off and on again.

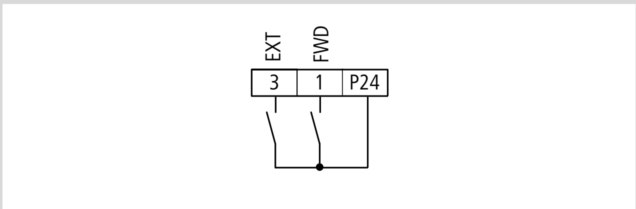


Figure 55: Digital input 1 configured as FWD "start/stop clockwise rotation" and digital input 3 as EXT "external fault"

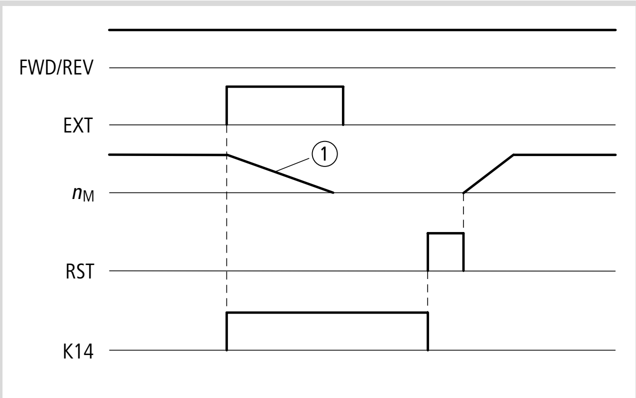


Figure 56: Function chart for EXT (external fault message)

n_M: motor speed

K14: signalling relay contact K14

① Motor coasts to a stop

▶ Program one of the digital inputs 1 to 6 as EXT, by inputting the value 12 under the respective PNU (C01 to C06).

Warning!
After a reset, the motor restarts immediately if a start command (FWD or REV) is present.

Restart inhibit USP

If the digital input configured as USP is activated, the restart inhibit is also activated. This prevents restart of the motor, when the voltage recovers after a mains fault if a simultaneous start command (active signal on FWD or REV) is present. Fault message E13 is issued. By pressing the OFF key or by an active signal on the RST input, E13 is erased. Alternatively, the start command can be revoked.

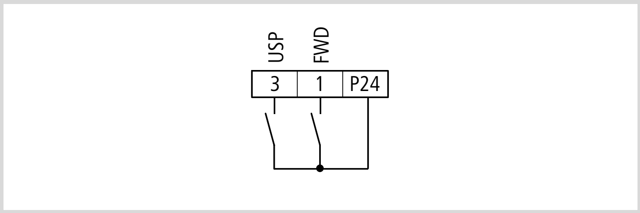


Figure 57: Digital input 1 configured as FWD (start/stop clockwise rotation) and digital input 3 as USP (restart inhibit).

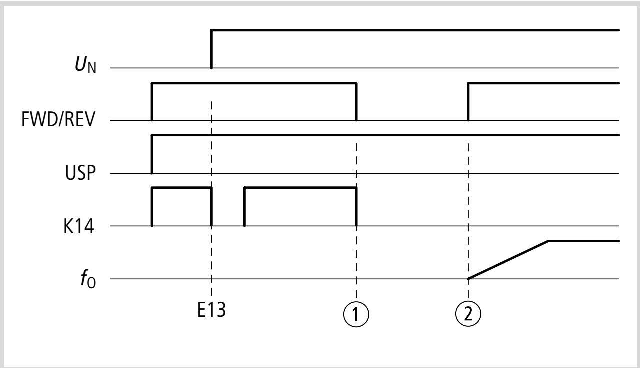


Figure 58: Function chart for USP (restart inhibit)

U_N: supply voltage

K14: signalling relay contact K14

f_O: output frequency

① Revoke start command (alarm no longer present)

② Start command

▶ Program one of the digital inputs 1 to 6 as USP, by inputting the value 13 under the respective PNU (C01 to C06).

Warning!
If the restart inhibit has activated (fault message E13) and this fault message is acknowledged with a reset command when the start command (input FWD or REV active) is still active, it is important to note that the motor will start to run immediately.

→ If you issue a start signal within three seconds of reestablishing the power supply and the restart inhibit is active, the restart inhibit is also triggered and issues fault message E13. When the restart inhibit is used, you should therefore wait for at least 3 seconds before issuing a start command to the frequency inverter.

→ The restart inhibit can still be executed, after an undervoltage fault message (E09) when a reset command is issued via the RST input.

Reset: RST

A fault message can be acknowledged by activating and subsequently deactivating (i.e. resetting) the digital input configured as RST.

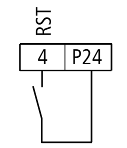


Figure 59: Digital input 4 configured as RST (reset)

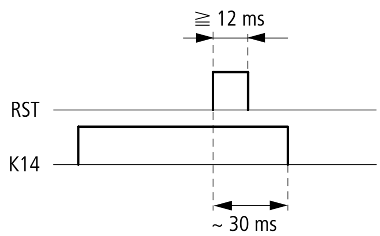


Figure 60: Function chart for RST (reset)

K14: signalling relay contact K14

▶ Program one of the digital inputs 1 to 6 as RST, by inputting the value 18 under the respective PNU (C01 to C06).

Warning!
If a malfunction is responded to by a reset, the motor will start immediately if a start signal is applied simultaneously. To avoid the risk of serious or fatal injury to personnel, you must ensure that the start signal is not present before acknowledging an error message with a reset.

→ When a fault condition has occurred, the OFF key on the keypad acts as a RESET key, and can be used instead of the RST input to reset the fault.

→ If the RST input is active for more than 4 seconds, it can cause a false trip.

→ The RST input is always a make (NO) contact and cannot be programmed as a break contact (NC).

→ Alternatively, you can acknowledge a fault message by briefly switching the supply voltage off and on again.

→ If a reset is initiated during operation, the motor will coast to a stop.

Jog mode (JOG)

When the digital input configured as JOG is activated, the motor can be operated in jog mode. This mode is used, e.g. for manual setting actions on machinery by issuing a start command on the FWD or REV input with a relatively low frequency without applying an acceleration ramp to the motor.

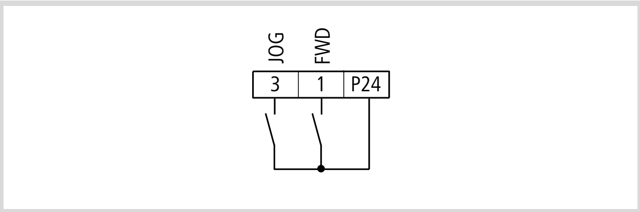


Figure 61: Digital input 1 configured as FWD (start/stop clockwise rotation) and 3 as JOG (jog mode).

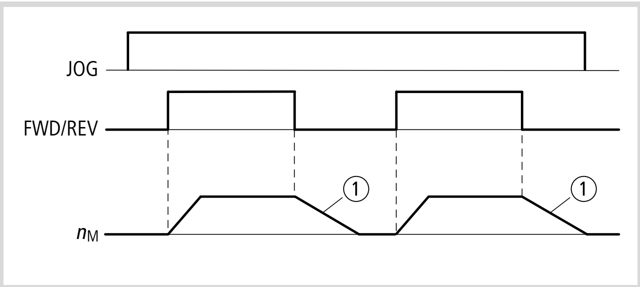


Figure 62: Function chart for JOG (jog mode)

n_M: motor speed

① Depending on the setting of PNU A39
00: free run (coast)
01: deceleration ramp
02: DC braking

▶ Input under PNU A38 the frequency which is to be applied to the motor when jog mode is active.

Make sure that the frequency is not too high, as it is applied directly to the motor without an acceleration ramp. This could cause a fault message to occur. Set a frequency below about 5 Hz.

▶ As the start command in jog mode is to be set via the FWD or REV input, set under PNU A02 the value 01.
▶ Under PNU A39, you determine how the motor is to be braked.
▶ Program one of the digital inputs 1 to 6 as JOG, set the value 06 under the respective PNU (C01 to C06).

Caution!
Make sure that the motor has stopped before using jog mode.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A02	Start command	–	01	The start command for starting the motor is issued by the digital inputs configured as FWD or REV.	01
			02	The start command for starting the motor is issued by the ON key on the keypad.	
A38	Frequency in jog mode	✓	0.5 to 9.99 Hz	The frequency to be applied to the motor in jog mode.	1.0
A39	Type of motor stop in jog mode	–	00	Stop command on: the motor coasts to halt	00
			01	Stop command on: the motor is braked to standstill using a deceleration ramp	
			02	Stop command on: the motor is braked to standstill using DC braking	

→ Jog mode cannot be applied if the value set for the jog mode frequency under PNU A38 is less than the start frequency set under PNU b82 (→ Section "RUN operational", Page 74)

→ Jog mode can only be activated when the frequency inverter is in the Stop state.

PTC thermistor input: PTC

If programmable digital input 5 is configured as PTC, the motor temperature can be monitored with a thermistor with a positive temperature coefficient (PTC) connected to terminals 5 and L. If the resistance of the thermistor rises above 3000 Ω (±10 %), the motor is stopped and fault message E35 is displayed.

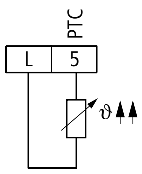


Figure 63: Digital input 5 configured as PTC (thermistor input)

▶ Program digital input 5 as PTC by setting PNU C05 to 19.

→ The PTC thermistor can be connected only to digital input 5, not to digital inputs 1 to 4 and 6 .

→ If digital input 5 is configured as PTC, but no thermistor is connected, fault message E35 is displayed.

→ The PTC input is always a make contact; it cannot be configured as a break contact.

Software protection SFT

If you activate the digital input configured as SFT, the configured parameters cannot be overwritten unintentionally.

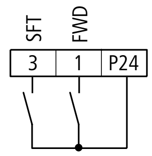


Figure 64: Digital input 3 configured as "Software protection" SFT

- ▶ First of all set under PNU b31 if the software protection should also apply for the frequency setting under PNU F01.
- ▶ Then, program one or more of the digital inputs 1 to 6 as SFT, set the value 15 under PNU (C01 to C06).

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b31	Software dependent parameter protection	–	00	Software protection through SFT input; all functions inhibited	01
			01	Software protection through SFT input; input via PNU F01 possible	
			02	Software protection without SFT input; all functions inhibited	
			03	Software protection without SFT input; input via PNU F01 possible	

→ There is however, an alternative method of software protection available which does not require an SFT input. For this purpose, set under PNU b31 the value 02 or 03, depending on whether or not the software protection should also apply for the frequency setting made with PNU F01.

Acceleration/Deceleration (motor potentiometer) UP/DWN

If you configure one of the programmable digital inputs as UP or DWN (or two programmable digital inputs as UP and DWN), an additional acceleration (with the UP input active) or deceleration (with the DWN input active) can be carried out, starting with the set frequency setpoint.

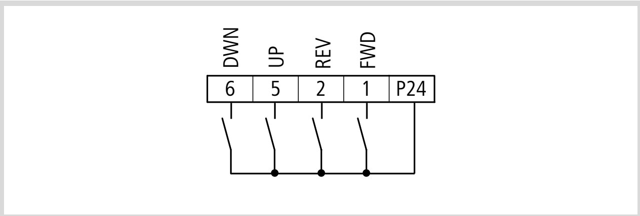


Figure 65: Digital input 1 configured as FWD (start/stop clockwise rotation), 2 as REV (start/stop anticlockwise rotation), 5 as UP (acceleration) and 6 as DWN (deceleration)

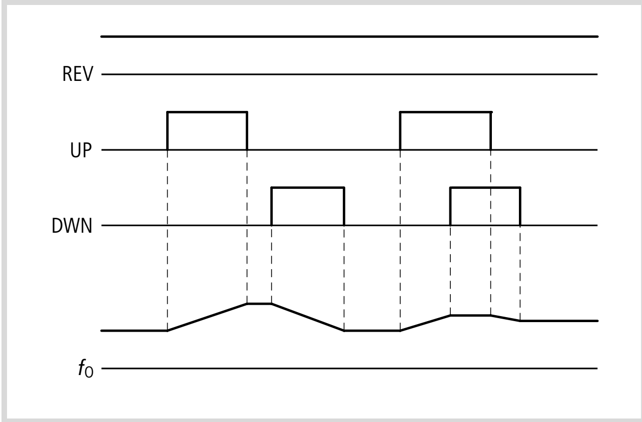


Figure 66: Function chart for UP/DOWN (acceleration/deceleration – motor potentiometer)

f_O: output frequency

- ▶ Since the terminal functions UP and DWN can be used only when the frequency setpoint has been specified with PNU F01 or A20, make sure that PNU A01 contains the value 02.
- ▶ Then, program one or two of the digital inputs 1 to 6 as UP or DWN by setting the corresponding PNU (C01 to C06) to 27 or 28.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A01	Defined frequency setpoint	–	00	Definition with the potentiometer on the keypad	01
			01	Definition via analog input O (0 to 10 V) or OI (4 to 20 mA)	
			02	Definition under PNU F01 and/or PNU A20	

The UP/DWN function is not available when jog mode has been activated (with active JOG input) or when the frequency setpoint input is made through the analog input terminals.

The output frequency ranges from 0 Hz to the end frequency specified under PNU A04 (→ Section ”Endfrequenz”, Page 83).

The shortest permissible duration during which an UP or DWN input must be active is 50 ms.

Through the use of the input configured as UP, the frequency setpoint in PNU A01 is also increased (→ Fig. 69).

Using the second parameter set SET

When the digital input configured as SET is active, the parameters from the second parameter set are used. This allows you to operate a second motor with the same frequency inverter (albeit not at the same time) without having to reprogram the frequency inverter. The functions available in the second parameter set are listed in Table 15.

As soon as the SET input is deactivated, the normal parameters of the default parameter set are used.

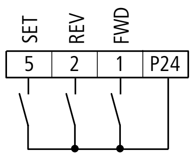


Figure 67: Digital input 1 configured as FWD (start/stop clockwise rotation), 2 as REV (start/stop anticlockwise rotation), and 5 as SET (use second parameter set)

- ▶ Program one or two of the digital inputs 1 to 6 as SET by setting the corresponding PNU (C01 to C06) to 08.

The motor must have come to a standstill before the SET input is activated.

If the SET input is deactivated while the motor is in operation, the parameters of the second parameter set are used until the motor is stationary again.

Table 15: Functions with second parameter set

Description of the function	Parameter number (PNU)	
	Default	Second parameter set
First acceleration time	F02	F202
First deceleration time	F03	F203
Base frequency	A03	A203
Maximum end frequency	A04	A204
Frequency setpoint (PNU A01 must be 02 for this)	A20	A220
Boost characteristics	A41	A241
Percentage voltage increase with manual boost	A42	A242
Maximum boost relative to the base frequency	A43	A243
V/F characteristic	A44	A244
Second acceleration time	A92	A292
Second deceleration time	A93	A293
Type of changeover from first to second time ramp	A94	A294
Changeover frequency for changeover from first to second acceleration time	A95	A295
Changeover frequency for changeover from first to second deceleration time	A96	A296
Tripping current for electronic motor protection device	b12	b212
Characteristic for electronic motor protection device	b13	b213

Description of the function	Parameter number (PNU)	
	Default	Second parameter set
Motor data, standard/auto	H02	H202
Motor rating	H03	H203
Number of motor poles	H04	H204
Motor constant K_p	H05	H205
Motor stabilization constant	H06	H206
Motor constant R_1 (standard/autotuning)	H20/H30	H220/H230
Motor constant R_2 (standard/autotuning)	H21/H31	H221/H231
Motor constant L (standard/autotuning)	H22/H32	H222/H232
Motor constant I_0 (standard/autotuning)	H23/H33	H223/H233
Motor constant J (standard/autotuning)	H24/H34	H224/H234

Activate DC braking DB

When you activate the digital input configured as DB, DC braking is carried out.

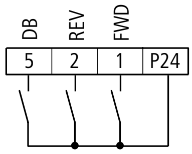


Figure 68: Digital input 1 configured as FWD (start/stop clockwise rotation), 2 as REV (start/stop anticlockwise rotation), and 5 as DB (DC braking)

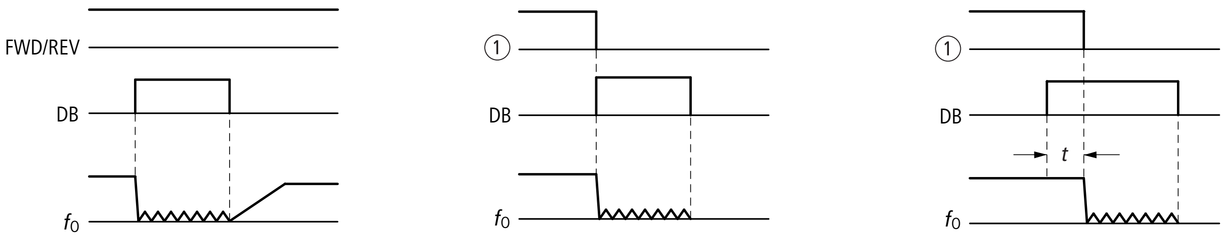


Figure 69: Function chart for DB (DC braking)

f_0: output frequency

① Start signal through keypad

- ▶ Program one of the digital inputs 1 to 6 as DB by setting the corresponding PNU (C01 to C06) to 07.
- ▶ In PNU A53, enter a delay time *t* (→ Fig. 69) from 0 to 5.0 s, which is to expire before DC braking takes effect after activation of the DB input.
- ▶ In PNU A54, set a braking force between 0 % and 100 %.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A53	DC braking waiting time	–	0.0 to 5 s	When the frequency set with PNU A52 is reached, the motor coasts for the time duration entered here before DC braking is activated.	0.0
A54	DC braking torque	–	0 to 100 %	Adjustment range for the level of braking torque.	0
A55	DC braking duration	–	0.0 to 60 s	The time during which DC braking is active.	0.0

→ Keep the duration of DC braking as short as possible, especially when a large braking force is used.

Programmable digital outputs 11 and 12

The programmable digital outputs 11 and 12 are open collector transistor outputs (→ Fig. 70), to which e.g. relays can be connected. These outputs can both be utilized for various functions, for example to signal when a determined frequency setpoint is reached or when a fault occurs.

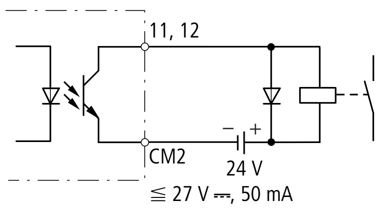


Figure 70: Digital output

Transistor output: maximum 27 V ⎓, 50 mA

The terminal function for each of the programmable digital inputs 11 and 12 is implemented via PNU C21 and C22, i.e. with PNU C21 the function for digital output 11 is determined and with PNU C22 the function for digital output 12 is determined.

Table 16: Digital outputs 11 and 12

PNU	Terminal	Adjustable in RUN mode	Value	WE
C21	11	–	→ Table 17	01
C22	12			00

A detailed description of the output functions can be found on the pages listed in Table 17.

Table 17: Functions of the digital outputs

Value	Function	Description	→ Page
00	RUN	Signal during operation of the motor	74
01	FA1	Frequency setpoint reached	72
02	FA2	Frequency exceeded	
03	OL	Overload	75
04	OD	PID control deviation exceeded	76
05	AL	Fault	77

Programmable digital inputs 11 and 12 are by default configured as break (NC) contacts. If, therefore, you activate the function of an output terminal, the corresponding input opens; if you deactivate it, the output closes.

If required, the digital inputs can be configured as make (NO) contacts. To do this, enter 00 under PNU C31 and C32 (corresponding to digital output 11 and 12) for this purpose.

Table 18: Configuration of digital outputs as make contacts

PNU	Terminal	Value	Adjustable in RUN mode	Function	WE
C31	11	00 or 01	–	00: Make contact 01: Break contact	01
C32	12				

Frequency value messages FA1/FA2

The digital output configured as FA1 will be activated as soon as the setpoint frequency is achieved.

The digital output configured as FA2 is activated as long as the frequencies set under PNU C42 and C43 are exceeded.

To ensure a certain level of hysterysis, the FA1 and FA2 signals are activated 0.5 Hz before the frequency setpoint value or the frequency value set under PNU C42 is achieved and deactivated 1.5 Hz after the frequency setpoint value or the frequency value set under PNU C43 is achieved.

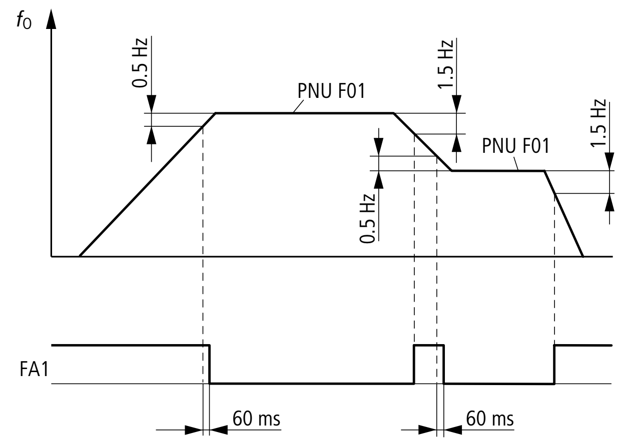


Figure 71: Function chart for FA1 (frequency achieved)

f_0: output frequency

F01: setpoint value

As the digital outputs 11 and 12 are configured as break contacts, FA1 is active with "0".

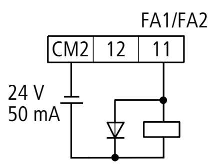


Figure 72: Digital output 11 configured as FA1/FA2 (frequency achieved/exceeded)

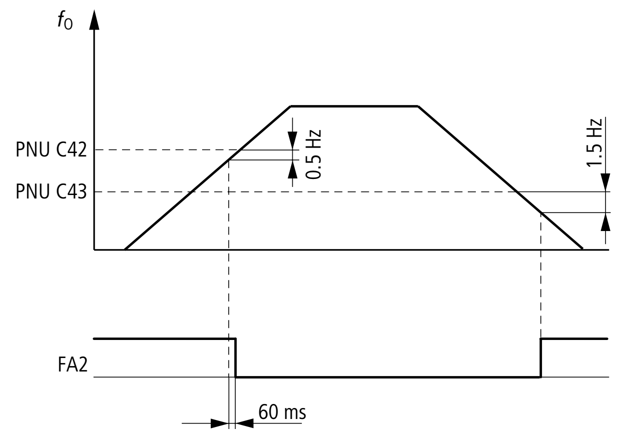


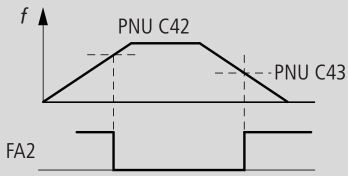
Figure 73: Function chart for FA2 "frequency exceeded"

f_0: output frequency

As the digital outputs 11 and 12 are configured as break contacts, FA2 is active with "0".

- ▶ If you want to configure a programmable output as FA2, you must set the frequency under PNU C42, at which the FA2 signal is to be generated in the acceleration phase.
- ▶ With PNU C43, you set the respective frequency which is to remain active until the FA2 signal is deactivated during deceleration.
- ▶ Program one of the digital outputs 11 or 12 as an FA1 or FA2 output by setting under PNU C21 or C22, the value 01 for FA1 or 02 for FA2.

→ The transition of an FA1 or FA2 signal from the inactive to the active state takes place with a delay of about 60 ms.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
C42	Frequency from which FA2 becomes active during acceleration	–	0 to 360 Hz	 The digital output (11 or 12) configured as FA2 becomes active when the frequency entered here is exceeded during acceleration.	0.0
C43	Frequency at which FA2 becomes inactive during deceleration			The digital output (11 or 12) configured as FA2 remains active as long as the actual frequency remains higher than the frequency entered during deceleration (→ also the illustration for PNU C42).	

RUN operational

The digital output configured as RUN remains activated as long as a frequency not equal to 0 Hz is present, i.e. as long as the motor is driven in a clockwise or anticlockwise direction.

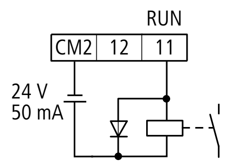


Figure 74: Digital output 11 configured as RUN "operational"

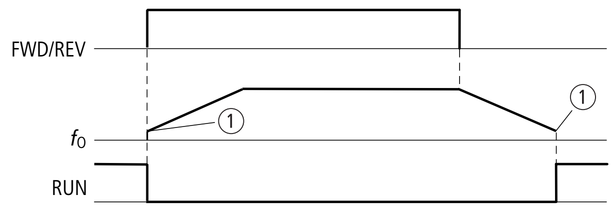


Figure 75: Function chart for RUN "operational"

f_0: output frequency

① At PNU b82 set start frequency

As the digital outputs 11 and 12 are configured as break contacts, RUN is active with "0".

▶ Program one of the digital inputs 11 or 12 as a RUN output by setting the value 00 under PNU C21 or C22.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b82	Increased start frequency	–	0.5 to 9.9 Hz	An increase in the start frequency leads to a corresponding reduction in the acceleration and deceleration times (for example to overcome high frictional resistance). If the frequencies are too high, fault message E02 may be issued. With the set start frequency, the motor starts without a ramp function.	0.5

Overload message OL

The digital output configured as OL is activated when a freely selectable motor current is exceeded. The OL output is active as long as the motor current is higher than this threshold.

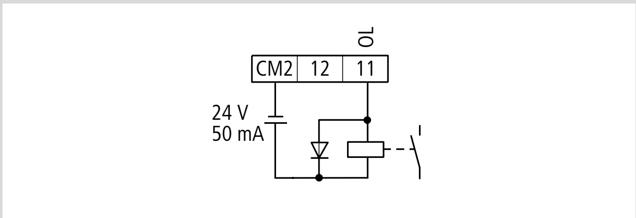


Figure 76: Digital output 11 configured as an OL "overload message"

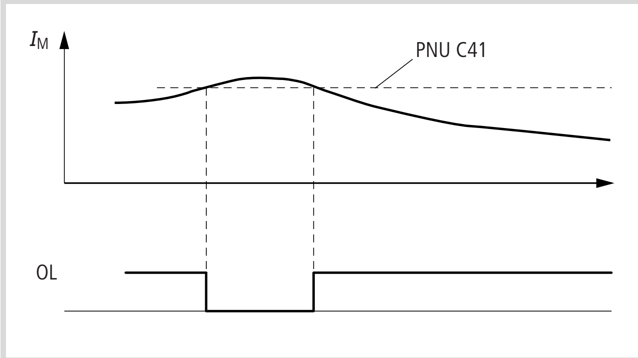


Figure 77: Function chart for OL "Overload message"

As the digital outputs 11 and 12 are configured as break contacts, OL is active with "0".

▶ If you want to configure a programmable digital output as OL, you must set the current under PNU C41, at which the OL signal activates when it has been exceeded.
▶ Then, program one or more of the digital outputs 11 or 12 as the OL output, by setting the value 03 under PNU C21 or C22.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
C41	Overload alarm threshold	–	0 to 2 × I_e1)	The current value entered here determines when the OL overload signal should be activated.	I_e1)

1) Frequency inverter's rated current

PID controller deviation message OD

The digital output configured as OD is activated when a user definable PID deviation (actual value versus setpoint value) is exceeded. The OD output remains active as long as this differential is exceeded.

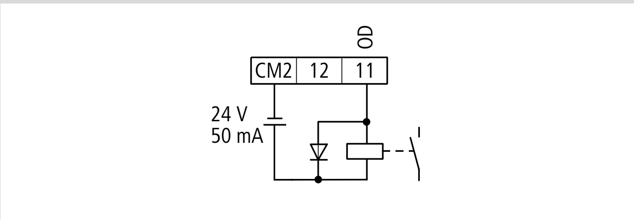


Figure 78: Digital output 11 configured as OD "PID deviation"

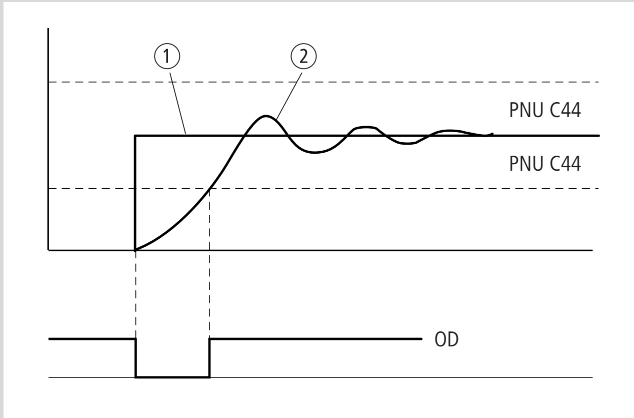


Figure 79: Function chart for OD "PID deviation"

① Setpoint

② Actual value

As the digital outputs 11 and 12 are configured as break contacts, OD is active with "0".

▶ If you want to configure a programmable output as OD, you must set the threshold under PNU C44 at which the OD signal should be activated.

▶ Then, program one or more of the digital outputs 11 or 12 as the OD output, by setting the value 04 under PNU C21 or C22 .

PNU	Name	Adjustable in RUN mode	Value	Function	WE
C44	PID regulator deviation	–	0 to 100%	If the deviation between the setpoint and actual value exceeds the value entered here when the PID controller is active, the OD signal activates.	3.0

Error message AL

The digital output configured as AL activates when a fault has occurred.

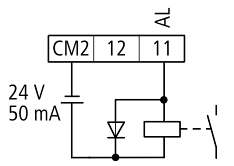


Figure 80: Digital output 11 configured as AL (fault occurrence)

▶ Program one of the digital inputs 11 or 12 as the AL output, by setting the value 05 under PNU C21 or C22.

When the AL output is configured as a break contact (default setting), remember that there is a delay from the time the supply voltage is switched on until the AL output is closed, and a fault message relating to the AL output therefore appears for a short time after the supply is switched on.

Please note that the programmable digital outputs (including the one configured as AL) are open collector types and therefore have different electrical characteristics than the signalling relay outputs (terminals K11, K12 and K14). In particular, the maximum voltage and current carrying capacity ratings are significantly lower than those of the relay outputs.

After the frequency inverter supply voltage has been switched off, the AL output remains active until the DC bus voltage has dropped below a certain level. This time depends, among other factors, on the load applied to the inverter.

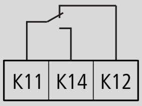
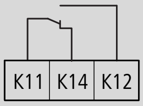
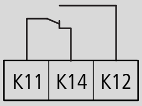
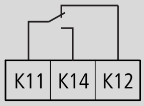
The delay from the time a fault occurs until the AL output is activated is about 300 ms.

Signalling relay terminals K11, K12, K14

If a fault occurs, the signalling relay (changeover) is triggered. The switching conditions can be programmed as required.

By default, the signalling relay output is used for signalling faults, but you can also use it as a normal programmable digital output. To do this, enter the appropriate value in PNU C24 (the default value, 05, means that the output is used for fault signalling).

Table 19: Default setting of the signalling relay

Default setting of the signalling relay				Reconfigured signalling relay terminals (PNU C33 = 00)			
Fault or DV5 switched off 		Operating message 		Fault message 		Operating message or DV5 switched off 	
Voltage	**Operating status**	**K11–K12**	**K11–K14**	**Voltage**	**Operating status**	**K11–K12**	**K11–K14**
On	Normal	Open	Closed	On	Normal	Closed	Open
On	Fault	Closed	Open	On	Fault	Open	Closed
Off	–	Closed	Open	Off	–	Closed	Open

- ▶ Under PNU C24, specify the signalling method.
- ▶ Use the above table to configure contacts K11–K12 or K11–K14 as make or break contacts under PNU C33.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
C24	Signal at signalling relay output	–	00	RUN: Signal during motor operation	05
			01	FA1: Frequency reached	
			02	FA2: Frequency exceeded	
			03	OL: Overload	
			04	OD: PID deviation exceeded	
			05	AL: Fault	
C33	Signalling relay output	–	00	K11-K14 close with a fault message	01
			01	K11-K14 close when the supply voltage is applied	

After a fault has occurred, the associated fault message is retained even after the voltage supply is switched off. The fault message can be displayed again after the voltage has been switched back on. However, the inverter is reset when the device is switched off, i.e. the fault message will not be signalled on the terminals of the signalling relay after the inverter is switched back on.

→ If however, the fault signalling is to be retained even after the inverter is switched back on, a latching (self maintaining) relay should be used.

When the signalling relay output is configured as a break contact (default setting), it is important to remember that there is a delay from the time the supply voltage is switched on until the AL output is closed, and that a fault message for the AL output therefore appears for a short time after the supply is switched on.

6 Setting Parameters

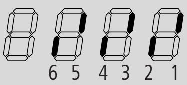
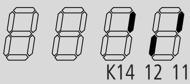
The parameters listed in this section can be set using the keypad.

The adjustment and setting possibilities listed below are thematically arranged according to their function. This provides a clear overview of all parameters assigned to a particular functional area (e.g. Section "DC braking (DC-Break)", PNU A51 to A55).

With the second parameter set, you can assign a second value to some of the parameters. The second value is suffixed with a "2", e.g. F**2**02. For a summary of the parameters in the second parameter set, see Section "Using the second parameter set SET", Page 68.

Setting the display parameters

In this section, you will see which parameters can be set using the display on the keypad.

PNU	Name	Function
d01	Output frequency in Hz	Output frequency display from 0.5 to 360 Hz. The "Hz" lamp on the keypad lights up.
d02	Motor current in A	Display of the output current from 0.01 to 999.9 A (filtered indication with a time constant of 100 ms). The "A" lamp on the keypad lights up.
d03	Direction of rotation	Display: • F for clockwise rotation (forward), • r for anticlockwise rotation (reverse), • 0 for stop
d04	Actual value × factor	Only with active PID closed loop control. The factor is set under PNU A75 and can have a value from 0.01 to 99.99; the default setting is 1.0.
d05	Status of digital inputs 1 to 6	 Example: Digital inputs 1, 3 and 5 are activated. The digital inputs 2, 4 and 6 are deactivated.
d06	Digital outputs 11 and 12 and fault message output	 Example: The digital output 11 and the signal output K14 are activated. Digital output 12 is deactivated.
d07	Output frequency × factor	The display of the product of the factor (PNU b86) and the output frequency in the range 0.01 to 99990. Examples: • Display 11.11 corresponds to 11.11, • 111.1 corresponds to 111.1, • 1111. corresponds to 1111, • 1111 corresponds to 11110.
d08	Last alarm indication	Display of the most recent fault message and (after the PRG key is pressed) the output frequency, motor current and DC bus voltage at the time the fault occurred. If a fault message is not available, the display shows ---
d09	Older fault messages (fault message register)	Display of the second from last and (after the PRG key is pressed) third from last fault message. If neither the second last or third last fault message has been stored, the display shows ---

Basic functions

Input/display frequency value

PNU F01 displays the current frequency setpoint value or the current fixed frequency. You can change the frequencies with the arrow keys and save the settings in accordance with the setting of PNU A01 and the fixed frequency stages FF1 to FF4 (digital inputs) (→ Section "Fixed frequency FF1 to FF4 selection", Page 56).

With PNU F01, you can change parameters even when the parameter protection PNU b31 has been set (→ Page 66).

Display/input frequency setpoint value
If you have not activated any fixed frequencies, PNU F01 displays the frequency setpoint value.

The frequency setpoint value can be assigned in one of three ways, depending on PNU A01:

- via the installed potentiometer on the keypad, PNU A01 = 00;
- via analog input O (0 to 10 V) or OI (4 to 20 mA), PNU A01 = 01 (default setting);
- via PNU F01 or PNU A20, PNU A01 = 02.

If you specify the frequency setpoint value with PNU A20 (→ Page 82), you can enter a new value under PNU F01. This is automatically saved under PNU A20:

▶ Change the current value with the arrow keys.
▶ Save the modified value with the ENTER key.

The saved value is automatically written to PNU A20.

Displaying/entering fixed frequencies
If you have activated the fixed frequencies via the functions FF1 to FF4 of the digital inputs, PNU F01 displays the selected fixed frequencies.

For information about changing the fixed frequencies, see Section "Input of the fixed frequency under PNU F01", Page 56.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
F01	Input/indication of frequency setpoint value	✓	0.5 to 360 Hz	Resolution ±0.1 Hz The setpoint can be defined using various methods: • With PNU F01 or A20: Enter the value 02 under PNU A01. • With the potentiometer on the keypad: Enter the value 00 under PNU A01. • With a 0 to 10 V voltage signal or a 4 to 20 mA current signal at input terminals O or OI: Enter the value 01 under PNU A01. • With the digital inputs configured as FF1 to FF4. After selection of the required fixed frequency stage using FF1 to FF4, the frequency for the respective stage can be entered. The display of the setpoint value is independent of which method was used to set the setpoint value.	0.0

Acceleration time 1

Acceleration time 1 defines the time in which the motor reaches its end frequency after a start command is issued.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
F02 F202	Acceleration time 1	✓	0.1 to 3000 s	Resolution of 0.1 s at an input of 0.1 to 999.9 Resolution of 1 s at an input of 1000 to 3000	10.0

Deceleration time 1

Deceleration time 1 defines the time in which the motor brakes to 0 Hz after a stop command.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
F03 F203	Deceleration time 1	✓	0.1 to 3000 s	Resolution of 0.1 s at an input of 0.1 to 999.9 Resolution of 1 s at an input of 1000 to 3000	10.0

Direction of rotation

The direction of rotation defines the direction in which the motor turns after a start command is issued.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
F04	Direction of rotation	–	00	The motor runs in a clockwise direction.	00
			01	The motor runs in an anticlockwise direction.	

Setting the frequency and start command parameters

This section describes the methods for adjusting and setting the start command and basic frequency-related parameters.

Definition of frequency setpoint value

With PNU A01, you set how the frequency setpoint value is to be defined:

- Via the potentiometer on the keypad
- Via analog input O (0 to 10 V) or OI (4 to 20 mA)
- Definition under PNU F01 and/or PNU A20

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A01	Defined frequency setpoint	–	00	Definition with the potentiometer on the keypad	01
			01	Definition via analog input O (0 to 10 V) or OI (4 to 20 mA)	
			02	Definition under PNU F01 and/or PNU A20	
A20	Frequency setpoint value	✓	0.5 to 360 Hz	You can input a frequency setpoint value. You must assign 02 under PNU A01 for this purpose.	0.0
F01	Display/input of frequency value	✓		Display of the current frequency setpoint value or the current fixed frequency. Modified values are saved with the ENTER key according to the selection of the digital inputs configured as FF1 to FF4 (→ Section "Fixed frequency FF1 to FF4 selection", Page 56). Resolution ±0.1 Hz	

Start command

With PNU A02, you define whether the start command is issued using the ON key of the keypad or through the digital inputs configured as FWD and REV.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A02	Start command	–	01	The start command for starting the motor is issued by the digital inputs configured as FWD or REV.	01
			02	The start command for starting the motor is issued by the ON key on the keypad.	

Base frequency

The base frequency is the frequency at which the output voltage has its maximum value.

PNU	Name	Adjustable in RUN mode	Value	WE
A03 A203	Base frequency	–	50 to 360 Hz	50

Maximum end frequency

If you want to set another frequency range with a constant voltage that lies beyond the base frequency set under PNU A03, this frequency is set with PNU A04. The maximum end frequency may not be smaller than the base frequency.

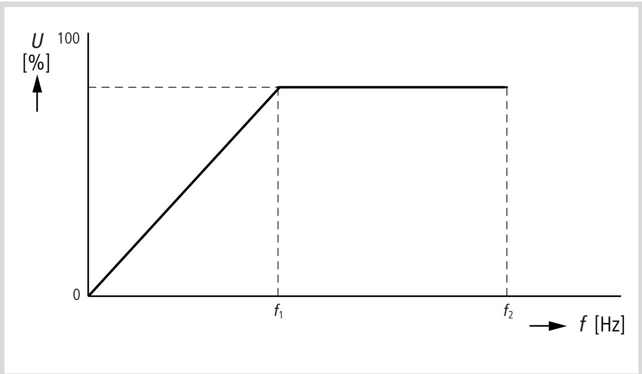


Figure 81: Maximum end frequency

f_1: base frequency

f_2: maximum end frequency

PNU	Name	Adjustable in RUN mode	Value	WE
A04 A204	Maximum end frequency	–	50 to 360 Hz	50

Analog setpoint value matching

The external setpoint signal can be specifically matched with parameters PNU A11 to A16, which are described below. A configurable voltage or current setpoint range can be assigned to a configurable frequency range.

Furthermore, analog setpoint signal filtering can be adjusted using PNU A16.

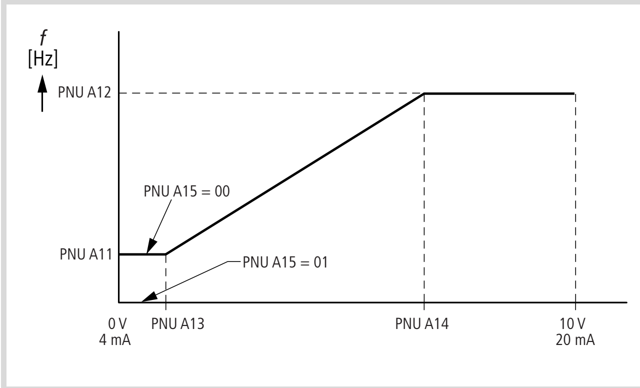


Figure 82: Setpoint value matching

x: Voltage or current setpoint signal on analog input O or OI

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A11	Frequency with minimum setpoint value	–	0 to 360 Hz	Here, the frequency that corresponds to the minimum voltage setpoint value under PNU A13 is set.	0.0
A12	Frequency with maximum setpoint value		0 to 360 Hz	Here, the frequency that corresponds to the maximum voltage setpoint value under PNU A14 is set.	0.0
A13	Minimum setpoint value		0 to 100 %	The minimum setpoint value entered here relates to the maximum possible voltage or current setpoint (10 V or 20 mA).	0
A14	Maximum setpoint value		0 to 100 %	The maximum setpoint value entered here relates to the maximum possible voltage or current setpoint (10 V or 20 mA).	100
A15	Conditions for start frequency		Determines the behaviour at setpoint values below the minimum setpoint value.		01
			00	The frequency defined under PNU A11 is applied to the motor.	
			01	A frequency of 0 Hz is applied to the motor.	
A16	Analog input filter time constant		To reduce the inverter's response time to setpoint changes at the O or OI terminal, and thereby determine the degree to which analog signal harmonics are filtered, you can enter a value between 1 and 8 here.		8
			1	Minimal filtering effect/fast response to setpoint value changes	
			....		
			8	Maximum filtering effect/slow response to setpoint value changes	

Voltage/frequency characteristics and boost

The boost with the V/*f* characteristic has the effect of boosting the voltage (and consequently boosting the torque) in the lower frequency range. The manual boost raises the voltage in the frequency range from the start frequency (standard setting 0.5 Hz) to half the base frequency (25 Hz with the standard setting of 50 Hz) in every operating stage (acceleration, normal operation, deceleration), independently of the motor load. With automatic boost, in contrast, the voltage is boosted according to the motor load. A voltage boost may cause a fault message and trip due to the higher currents involved.

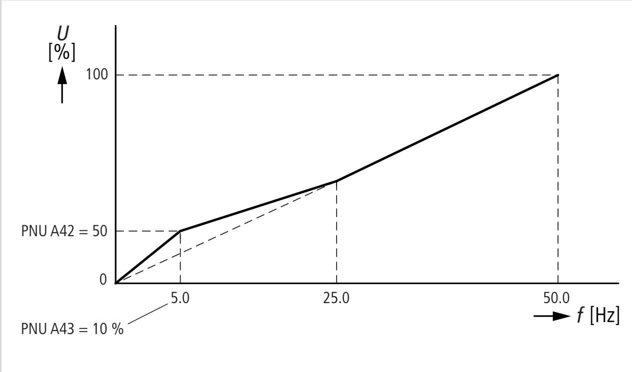
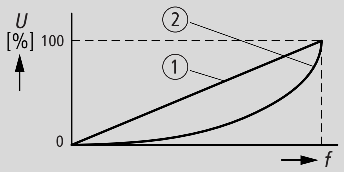
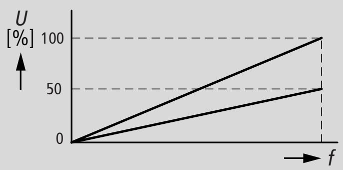


Figure 83: Boost characteristics

Parameter settings:
A41 = 00
A42 = 50
A43 = 10.0
A44 = 00
A45 = 100

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A41 A241	Boost characteristics	–	00	Manual boost	00
			01	Automatic boost	
A42 A242	Manual boost percentage	✓	0 to 99 %	Setting the voltage boost level with manual boost.	11
A43 A243	Maximum boost with a percentage of the base frequency	✓	0 to 50 %	Setting the frequency with the highest voltage boost as a percentage of the base frequency.	10.0
A44 A244	Voltage/frequency characteristic	–	 ① Linear ② Quadratic	You can select a quadratic or a V/*f* characteristic for accelerating or decelerating the motor. If SLV control is active, you should set the pulse frequency to at least 2.1 kHz with PNU b83 (→ Section "Carrier frequency", Page 105).	02
			00	Linear V/*f* characteristic (constant torque).	
			01	Quadratic V/*f* characteristic (reduced torque)	
			02	SLV (**s**ensor**l**ess **v**ector control) is active	
A45	Output voltage	✓	50 to 100 % of the input voltage	 The output voltage can be set from 50 to 100 % of the input voltage.	100

DC braking (DC-Break)

To activate DC braking, apply a stop signal (PNU A51 to A55). By applying a pulsed DC voltage to the motor stator, a braking torque is induced in the rotor and acts against the rotation of the motor. With DC braking, a high level of stopping and positioning accuracy can be achieved.

Caution!
DC braking results in additional heating of the motor. You should therefore configure the braking torque (PNU A54) as low and the braking duration (PNU A55) as short as possible.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A51	DC braking active/ inactive	–	00	DC braking is not used (is inactive)	00
			01	DC braking is used (is active)	
A52	DC braking starting frequency		0.5 to 10 Hz	DC braking is active if the frequency is less than the frequency entered here.	0.5
A53	DC braking waiting time		0.0 to 5 s	When the frequency set with PNU A52 is reached, the motor coasts for the time duration entered here before DC braking is activated.	0.0
A54	DC braking torque		0 to 100 %	Adjustment range for the level of braking torque.	0
A55	DC braking duration		0.0 to 60 s	The time during which DC braking is active.	0.0

Operating frequency range

The frequency range which is determined by the values configured under PNU b82 (start frequency) and PNU A04 (end frequency) can be limited by PNU A61 and A62 (→ Fig. 84). As soon as the frequency inverter receives a start command, it applies the frequency set under PNU A62.

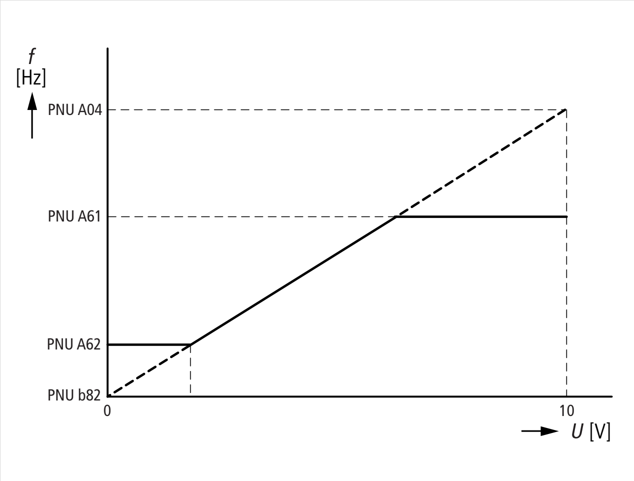


Figure 84: Upper frequency limit (PNU A61) and lower frequency limit (PNU A62)

To avoid resonance within the drive system, it is possible to program three frequency jumps under PNU A63 to A68. In the example (→ Fig. 85), the first frequency jump (PNU A63) is defined as 15 Hz, the second (PNU A65) as 25 Hz and the third (PNU A67) as 35 Hz. In the example, the frequency jump widths (adjustable under PNU A64, A66 and A68) are set to 1 Hz.

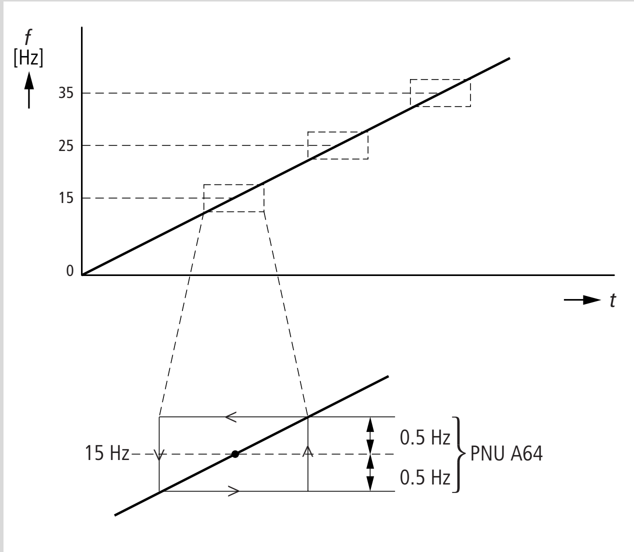


Figure 85: Frequency jumps

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A61	Maximum operating frequency	–	0.5 to 360 Hz	This function can be deactivated by entering 0.0	0.0
A62	Minimum operating frequency		0.5 to 360 Hz		0.0
A63	First frequency jump		0.1 to 360 Hz		0.0
A64	First jump width		0.1 to 10 Hz		0.5
A65	Second frequency jump		0.1 to 360 Hz		0.0
A66	Second jump width		0.1 to 10 Hz		0.5
A67	Third frequency jump		0.1 to 360 Hz		0.0
A68	Third jump width		0.1 to 10 Hz		0.5

PID controller

The DV5 series frequency inverter is a PID controller. This can be used, for example, for flow and throughput controllers with fans and pumps. PID control has the following features:

- The setpoint value can be issued via the frequency inverter keypad or via an external digital signal (fixed frequencies). Sixteen different setpoint values are possible. In addition, the setpoint can be defined with an analog input signal (0 to 10 V or 4 to 20 mA).
- With the DV5, you can implement the actual value signal feedback through an analog input voltage (of up to 10 V) or an analog input current (up to 20 mA).
- The permissible range for the actual value signal feedback can be specifically matched (e.g. 0 to 5 V, 4 to 20 mA, or other ranges).
- With the aid of a scale adjustment, you can match the setpoint signal and/or the actual value signal to the actual physical quantities (such as air or water flow, temperature, etc.) and represent them on the display.

The PID closed-loop control

"P" stands for **P**roportional, "I" stands for **I**ntegral and "D" stands for **D**ifferential. In control engineering, the combination of these three terms is termed PID closed-loop control, PID regulation or PID control. PID closed-loop control is used in numerous types of application, e.g. for controlling air and water flow or for controlling pressure and temperature. The output frequency of the inverter is controlled by a PID control algorithm to ensure that the deviation between the setpoint and actual value is as small as possible. The following figure shows a block diagram representation of a PID closed loop control:

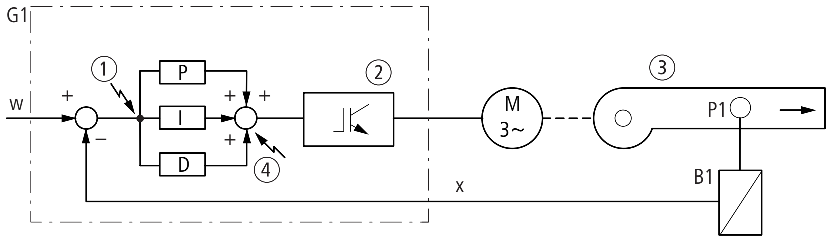


Figure 86: PID closed-loop control block diagram

G1: frequency inverter DV5
w: Setpoint value
x: Actual value
P1: Controlled variable
B1: Measured value converter

① System deviation
② Converter
③ Fans, pumps or similar devices
④ Frequency setpoint value

→ PID closed loop control is only possible after the type of setpoint value and actual value used have been defined.

The example in the following figure shows a fan control:

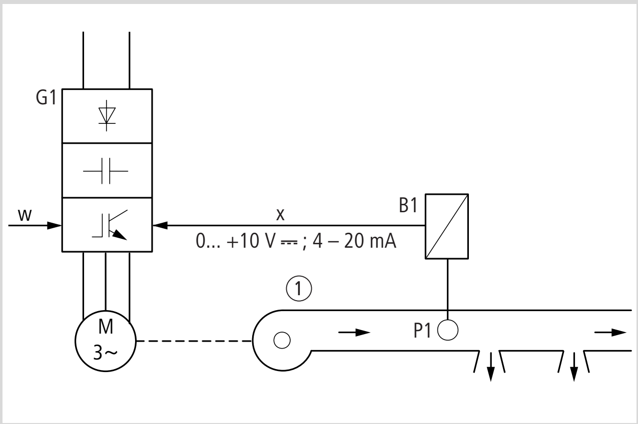


Figure 87: Example of a fan control

G1: Frequency inverter DV5
w: Setpoint value
x: Actual value
P1: Controlled variable
B1: Measured value converter
① Fan

P: Proportional component

This component ensures that the output frequency and the system deviation are subject to a proportional relationship. Using PNU A72, the so-called proportional gain (K_p), expressed in %, can be defined.

The following figure illustrates the relationship between system deviation and output frequency. A large value for K_p results in a quick reaction to a change of the system deviation. If, however, K_p is too large, the system becomes unstable.

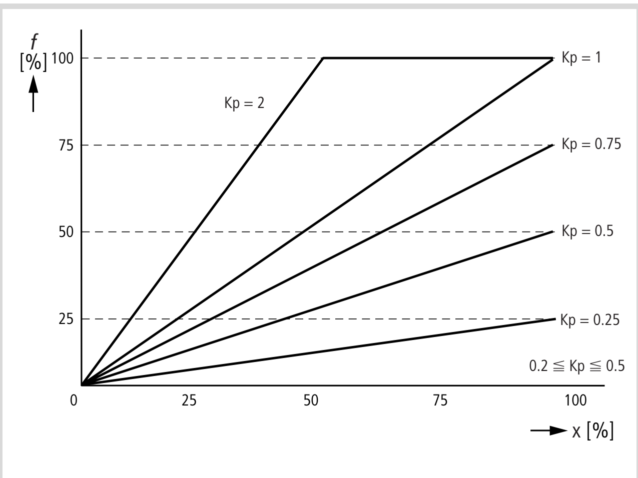


Figure 88: Proportional gain K_p

x: System deviation

The maximum output frequency in the above figure is defined as 100 %. K_p can be set between 0.2 and 5.0 under PNU A72.

I: Integral component

This component results in a correction of the output frequency by integration of the system deviation. In the case of purely proportional control, a large system deviation causes a large change in the output frequency. It follows, then, that if the system deviation is very small, the change in the output frequency is also very small. The problem is that the system deviation cannot be completely eliminated. Hence the need for an integral component.

The integral component causes a continuous adding up of the system deviation so that the deviation can be reduced to zero. The reciprocal value of the integration gain is the integration time $T_i=1/K_i$.

With the DV5 series frequency inverters, set the integration time (T_i). The value may be between 0.5 s and 150 s. To disable the integral component, enter 0.0.

D: Differential component

This component causes a differentiation of the system deviation. As pure proportional control uses the current value of the system deviation and pure integral control values from previous actions, a certain delay in the control process always occurs. The D component compensates for this behaviour.

Differential control corrects the output frequency using the rate of change of the system deviation. The output frequency can therefore be compensated very quickly.

K_d can be set between 0 and 100 s.

The PID controller

A PID controller combines the P, I and D components described in the previous sections. In order to achieve the optimum control characteristics, each of the three PID parameters must be set. Uniform control behaviour without large steps in the output frequency is guaranteed by the proportional component; the integral component minimizes the existing system deviation the steady-state and the differential component ensures a quick response to a rapidly changing actual value signal.

As differential control is based on a differentiation of the system deviation, it is very sensitive and also responds to unwanted signals, such as interference, which can result in system instability. Differential control is normally not required for flow, pressure and temperature control.

Setting the PID parameters

Values for the PID parameters must be chosen depending on the application. and the system's control characteristics. To ensure correct PID closed loop control, the following points should be observed:

- Stable steady-state behaviour,
- Fast reaction
- Small system deviation in the steady state.

Parameters K_p, T_i and K_d must be set within the stable operating range. As a general rule, increasing one of the parameters K_p, K_i (= reduction of T_i) and K_d results in a system with a faster response. A very large increase however, causes system instability, as the returned actual value increases and decreases continuously as if subject to oscillation. In the worst case, divergent behaviour will be result (→ Fig. 89 to Fig. 92):

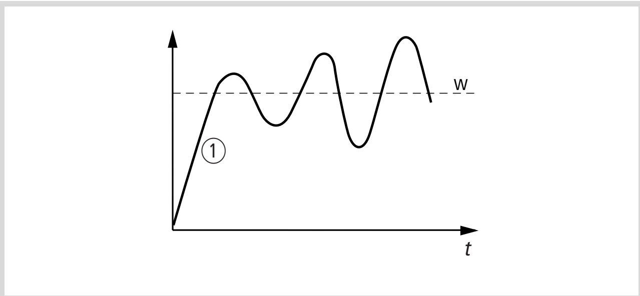


Figure 89: Divergent behaviour

w: Setpoint value

① Output signal

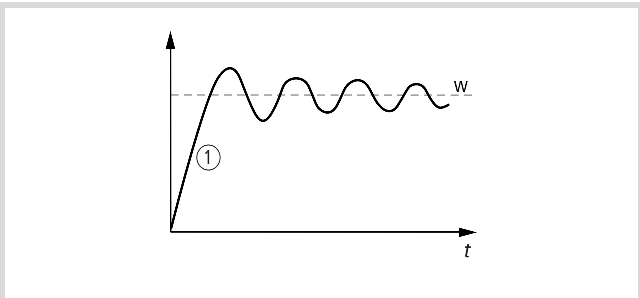


Figure 90: Oscillation, dampened

w: Setpoint value

① Output signal

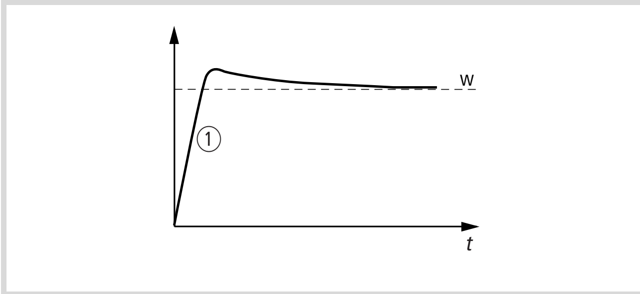


Figure 91: Good regulation behaviour

w: Setpoint value

① Output signal

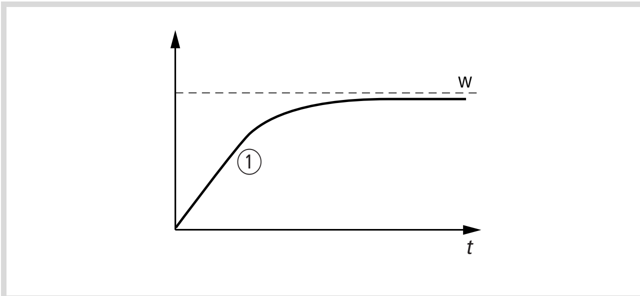


Figure 92: Slow regulation, large static system deviation

w: Setpoint value

① Output signal

The following table provides guidelines for setting each parameter.

Table 20: Setting the controller regulation times

Setpoint change	Causes a slow reaction:	Increase proportional component (K_p)
	Causes a fast but unstable reaction	Set a lower P component
Setpoint and actual value	Differ greatly:	Reduce integral component (T_i)
	Approach each other after oscillation:	Set a higher I component
After increase of K_p	The reaction is still slow:	Increase D component (K_d)
	The reaction is still unstable:	Set a lower D component

Structure and parameters of the PID controller

PID controller active/inactive

DV5 frequency inverters can operate in one of the following two control modes:

- Frequency control active (i.e. PID closed loop control inactive)
- PID closed loop control active

You can switch between both modes with PNU A71 (PID control active/inactive).

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A71	PID control active/inactive	–	00	PID closed loop control is not used (inactive)	00
			01	PID closed loop control is used (active)	

Frequency control is the standard method of control used by many frequency inverters. A setpoint value is defined by a control unit (keypad) as an analog voltage or current signal, or via a 4 bit wide digital command applied to the control signal terminals.

With PID closed loop control, the inverter's output frequency is controlled by a control algorithm to ensure that the deviation between the setpoint and actual value is kept at zero.

Parameter

The following figure illustrates which parameters are effective in different areas of the PID block diagram. The stated parameters (e.g. PNU A72) correspond to those on the integrated frequency inverter keypad:

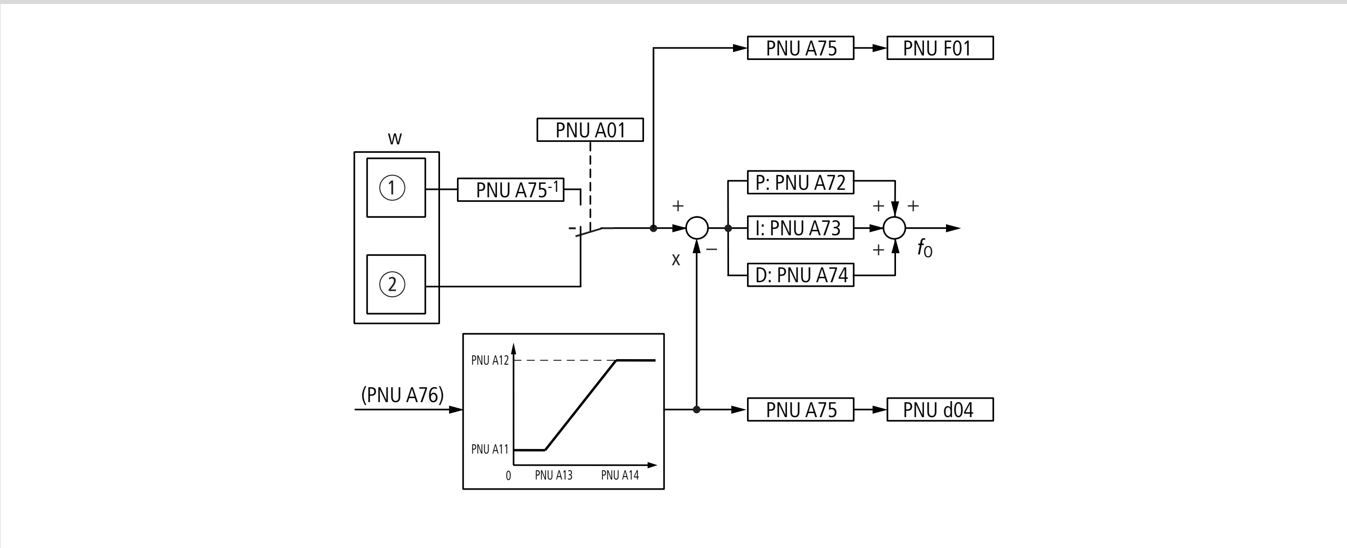


Figure 93: PID closed loop control parameters

w: Setpoint value

x: Actual value

f_0: output frequency

① Frequency definition with keypad, fixed frequency

② Analog definition with potentiometer, analog inputs, current or voltage

PNU	Function	Adjustable in RUN mode	Value	Function	WE
A01	Defined frequency setpoint	–	00	Definition with the potentiometer on the keypad	01
			01	Definition via analog input O (0 to 10 V) or OI (4 to 20 mA)	
			02	Definition under PNU F01 and/or PNU A20	
A11	Frequency with minimum setpoint value	–	0 to 360 Hz	Here, the frequency that corresponds to the minimum voltage setpoint value under PNU A13 is set.	0.0
A12	Frequency with maximum setpoint value	–	0 to 360 Hz	Here, the frequency that corresponds to the maximum voltage setpoint value under PNU A14 is set.	0.0
A13	Minimum setpoint value	–	0 to 100 %	The minimum setpoint value entered here relates to the maximum possible voltage or current setpoint (10 V or 20 mA).	0
A14	Maximum setpoint value	–	0 to 100 %	The maximum setpoint value entered here relates to the maximum possible voltage or current setpoint (10 V or 20 mA).	100
d04	Actual value × factor	✓	–	Only with active PID closed loop control. The factor is set under PNU A75, from 0.01 to 99.99; default setting = 1.0.	–
F01	Input/display frequency value	✓	0.5 to 360 Hz	Resolution ±0.1 Hz The setpoint can be defined using various methods: • With PNU F01 or A20: Enter the value 02 under PNU A01. • With the potentiometer on the keypad: Enter the value 00 under PNU A01. • With a 0 to 10 V voltage signal or a 4 to 20 mA current signal at input terminals O or OI: Enter the value 01 under PNU A01. • With the digital inputs configured as FF1 to FF4. After selection of the required fixed frequency stage using FF1 to FF4, the frequency for the respective stage can be entered. The display of the setpoint value is independent of which method was used to set the setpoint value.	0.0
A72	P component of the PID controller	✓	0.2 to 5.0	Adjustment range of the proportional component of the PID closed loop control	1.0
A73	I component of the PID controller	✓	0.0 to 150 s	Adjustment time T_i of the integral component of the PID closed loop control	1.0
A74	D component of the PID controller	✓	0.0 to 100 s	Adjustment time T_d of the differential component of the PID closed loop control	0.0
A75	Setpoint factor of the PID controller	–	0.01 to 99.99	The display of the frequency setpoint or actual value can be multiplied by a factor, so that process related quantities (e.g. flow or similar) can be displayed instead of the frequency.	1.00
A76	Input actual value signal for PID controller	–	00	Actual value signal present on analog input OI (4 to 20 mA)	00
			01	Actual value signal present on analog input O (0 to 10 V)	

Internal regulator-based calculations
All calculations within the PID algorithm are carried out in percentages, so that different physical units can be used, such as

- Pressure (N/m^2),
- Flow rate (m^3/min),
- Temperature (°C), etc.

The setpoint and returned actual values can, for example, also be compared as percentages.

A useful scaling function (PNU A75) is also available. When these parameters are used, you can define the setpoint directly as the required physical quantity and/or display setpoint and actual values as physical quantities suitable for the process.

Additionally, analog signal matching (PNU A11 to A14) is available, with which a range based on the actual value feedback can be defined. The following graphs illustrate the mode of operation of this function.

Setpoint definition

There are three ways of entering the setpoints:

- Keypad
- Digital control signal terminal input (4 bit)
- Analog input (terminals O-L or OI-L)

If the digital setpoints are defined through the control signal terminals, define the required setpoint value in PNU A21 to A35. The setting procedure is similar to the one which is used in frequency regulation mode (i.e. with a deactivated PID controller) for setting the respective fixed frequencies (→ Section "Fixed frequency FF1 to FF4 selection", Page 56).

Actual value feedback and actual value signal matching

You can specify the actual value signal as follows:

- With an analog voltage on control signal terminal O (maximum 10 V)
- With an analog current on control signal terminal OI (maximum 20 mA)

One of the two methods mentioned is selected via PNU A76.

To adapt the operation of the PID controller to the respective application, the actual value feedback signal can also be matched as shown in Figure 94:

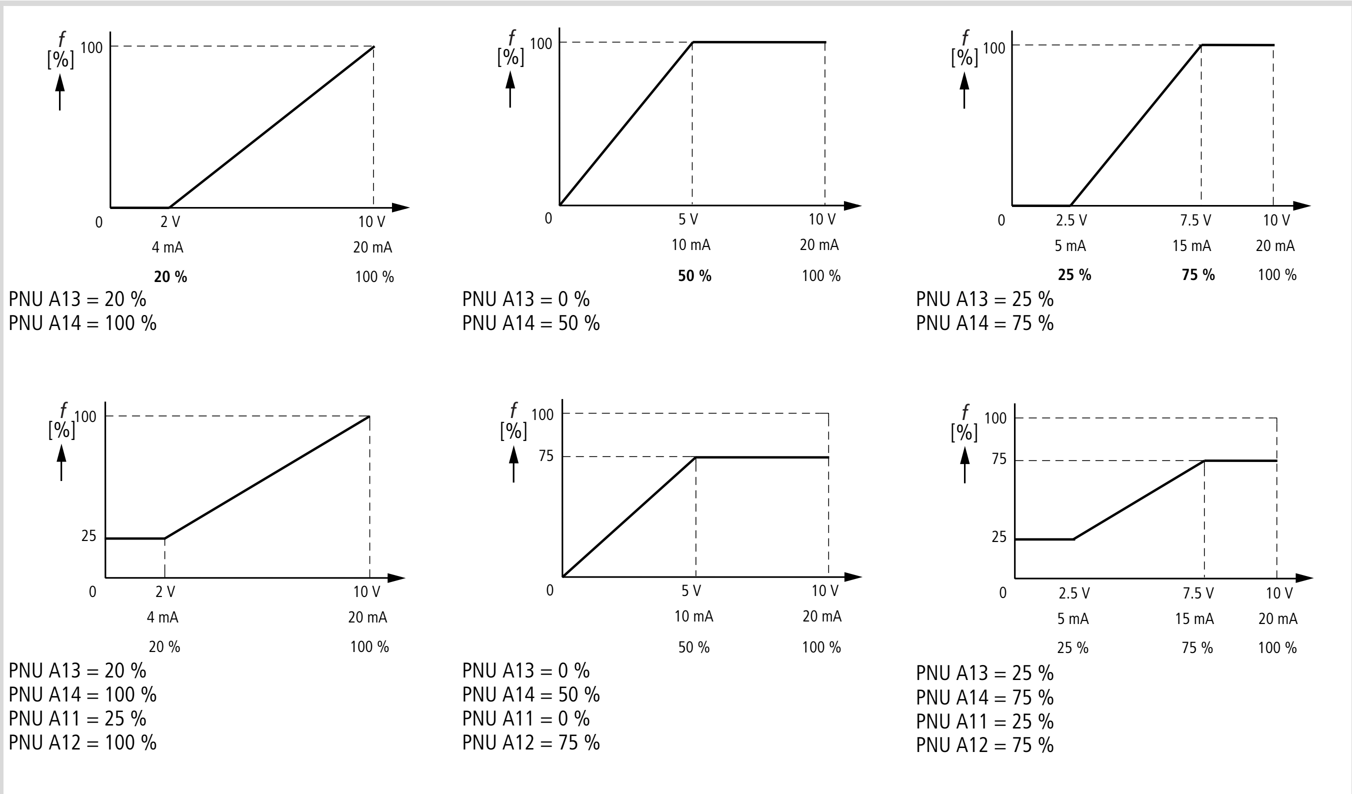


Figure 94: Analog actual value signal matching

As evident from the graphs, the setpoint value must be within the valid range on the vertical axis if you have set functions PNU A11 and A12 to a value not equal to 0. Because there is no feedback signal, stable control cannot otherwise be guaranteed. This means that the frequency inverter will either

- output the maximum frequency,
- go to stop mode,
- or output a lower limit frequency.

Scaling adjustment

Scaling adjustment and scaling allow the setpoint and actual value to be displayed and the setpoint value to be entered directly in the correct physical unit. For this purpose, 100 % of the returned actual value is taken as a basis. By default, inputs and displays are based on 0 to 100 %.

Example: In the first diagram in Figure 94, 20 mA of the feedback signal correspond to 100 % of the PID internal factor. If for example the current flow is 60 m^3/min with a feedback signal of 20 mA, the parameter is set to 0.6 with PNU A75 (= 60/100). With PNU d04, the process corrected value can be displayed and the setpoint value can be entered directly as a process corrected quantity.

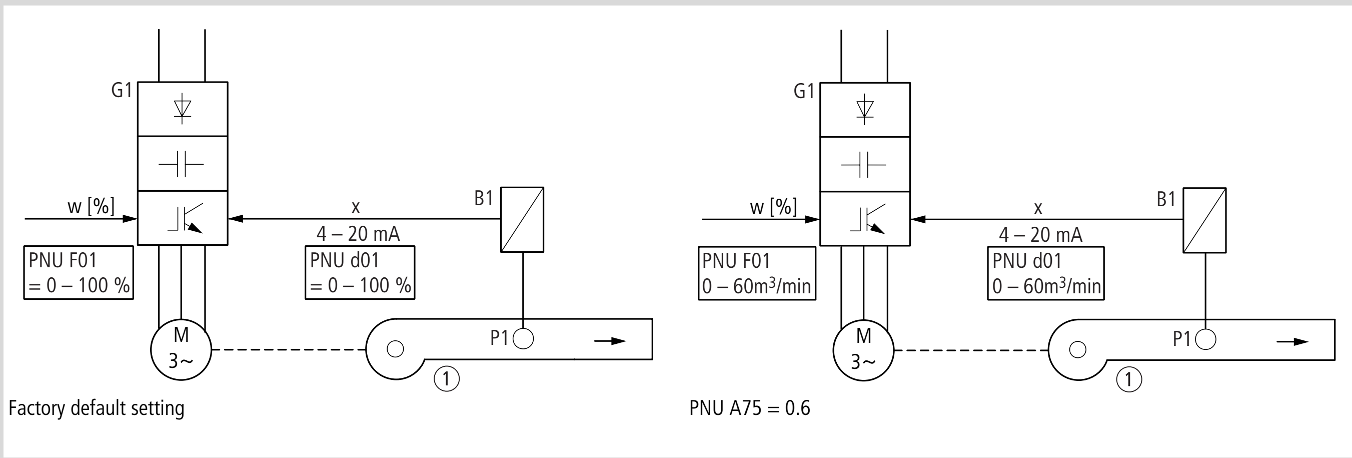


Figure 95: Example for scaling adjustment

w: Setpoint value

x: Returned actual value

① Fan

Summary of the relevant parameters

With the DV5 series frequency inverters, the same parameters are used for both the frequency control mode and the PID mode. The designations of the respective parameter only relate to the frequency control mode, however, as this mode is used in most cases. When the PID mode is used, some of the parameters have other designations.

The following table contains an explanation of these parameters in conjunction with the frequency control mode as well as the PID mode:

PNU	Meaning of the parameters when used in	
	Frequency control mode	PID mode
d04	–	Display of the returned actual value
F01	Displays of the output frequency	Display of the setpoint value
A01	Defined frequency setpoint	Defined setpoint
A11	Frequency with minimum setpoint value (Units: Hz)	Feedback percentage actual value for lower acceptance threshold (units: %)
A12	Frequency with maximum setpoint value (Units: Hz)	Feedback percentage actual value for upper acceptance threshold (Units: %)
A13	Minimum setpoint value (Units: Hz)	Lower acceptance threshold for the voltage or current on the actual value input (Units: %)
A14	Maximum setpoint value (Units: Hz)	Upper acceptance threshold for the voltage or current at the actual value input (Unit: %)
A21 to A35	Fixed frequencies 1 to 15	Digital adjustable setpoint values 1 to 15

PNU	Meaning of the parameters when used in	
	Frequency control mode	PID mode
A71	–	PID control active/inactive
A72		P component of the PID controller
A73		I component of the PID controller
A74		D component of the PID controller
A75		Setpoint factor of the PID controller
A76		Input actual value signal for PID controller

Settings in the frequency control mode

Before you use the PID mode, you must configure the parameters in frequency control mode. Observe the following two points:

Acceleration and deceleration ramp

The output frequency calculated by the PID algorithm is not immediately available on the frequency inverter output, as the output frequency is affected by the set acceleration and deceleration times. Even when, for example, a large D component is defined, the current output frequency is significantly influenced by the acceleration and deceleration time, and this causes unstable regulation.

To achieve stable behaviour in each PID closed loop control range, the acceleration and deceleration times should be set as low as possible.

After every acceleration and deceleration ramp parameter change, parameters PNU A72, A73 and A74 must be rematched.

Frequency jumps/range

Frequency jumps must be defined to meet the following requirement: A change to the feedback actual value signal must not occur during execution of a frequency jump. If a stable operating point exists within a frequency jump range, operation between both end values of this range occurs.

Configuration of setpoint value and actual value

In PID mode, you must first of all specify how the setpoint is to be defined and where the actual value is to be supplied. The following table provides the required settings:

Actual value input	Setpoint value definition				
	Integrated keypad	Digital via control terminals (fixed frequencies)	Integrated potentiometer	Analog voltage on O-L	Analog current on OI-L
Analog voltage (O-L: 0 to 10 V)	PNU A01 = 02 PNU A76 = 01	PNU A01 = 02 PNU A76 = 01	PNU A01 = 00 PNU A76 = 01	–	PNU A01 = 01 PNU A76 = 01
Analog current (OI–L: 4 to 20 mA)	PNU A01 = 02 PNU A76 = 00	PNU A01 = 02 PNU A76 = 00	PNU A01 = 00 PNU A76 = 00	PNU A01 = 01 PNU A76 = 00	–

It is not impossible to enter the setpoint value and the actual value through the same analog input terminal.

Please note that the frequency inverter brakes and stops according to the set deceleration ramp as soon as a stop command is issued during PID operation.

Scaling

Please set the scaling to the process-corrected physical quantity as required by your application, i.e. to flow, pressure, temperature, etc. For a detailed description, see Section ”Scaling adjustment”, Page 94.

Setpoint adjustment via digital inputs

The following points must be observed when setting the setpoint via digital inputs (4 bit):

Assignment of the digital inputs

The DV5 series have six programmable digital inputs. Assign the functions FF1 to FF4 to four of the inputs. Use PNU C01 to C06 for this purpose, corresponding to the inputs 1 to 6 of the frequency inverter.

Adjustment of the setpoint values

First of all, select the required number of different setpoints (up to 16) from the following table. Under PNU A21 (corresponds to the first setpoint) to A35 (corresponds to 15th setpoint), enter the required setpoint. PNU A20 and F01 correspond to setpoint 0.

→ If the setpoints are to be scaled, note that the setpoints must be entered as process-corrected quantity values in accordance with this scaling.

No.	FF4	FF3	FF2	FF1	Setpoint number (PNU)
1	0	0	0	0	Setpoint value 0 (PNU A20 or F 01)
2	0	0	0	1	Setpoint value 1 (PNU A21)
3	0	0	1	0	Setpoint value 2 (PNU A22)
4	0	0	1	1	Setpoint value 3 (PNU A23)
5	0	1	0	0	Setpoint value 4 (PNU A24)
6	0	1	0	1	Setpoint value 5 (PNU A25)
7	0	1	1	0	Setpoint value 6 (PNU A26)
8	0	1	1	1	Setpoint value 7 (PNU A27)
9	1	0	0	0	Setpoint value 8 (PNU A28)
10	1	0	0	1	Setpoint value 9 (PNU A29)
11	1	0	1	0	Setpoint value 10 (PNU A30)
12	1	0	1	1	Setpoint value 11 (PNU A31)
13	1	1	0	0	Setpoint value 12 (PNU A32)
14	1	1	0	1	Setpoint value 13 (PNU A33)
15	1	1	1	0	Setpoint value 14 (PNU A34)
16	1	1	1	1	Setpoint value 15 (PNU A35)

1: On
0: Off

If, for example, you only require up to four different setpoint values, only FF1 and FF2 need to be used; for five to eight different setpoint values, only FF1 to FF3 are required.

Activating PID mode

▶ Set PNU A71 to 01.

You can make this setting at the very start, before making all other settings.

Example for setting K_p and T_i

As for the parameter changes, check the output frequency or the feedback actual value signal with an oscilloscope (→ Fig. 89 to Fig. 92, Page 90).

Use two different setpoint values and switch between them using the digital control signal terminals.

The output should then always exhibit a stable behaviour.

Adjustment of the P component

Begin by setting only the P component, but not the I component and the D component.

▶ First of all, set a small P component via PNU A72 and check the result.
▶ If necessary, slowly increase this value until an acceptable output behaviour has been achieved.

Alternatively, set a very large P component and observe the behaviour of the output signal. If the behaviour is unstable, set a lower value and observe the result. Repeat this process.

If the behaviour is unstable, reduce the P component.

The P component is correct when the system deviation reaches a static state within acceptable limits.

Setting the integral component and matching K_p

▶ First of all, define a very small integral component in PNU A73.
▶ Set the P component a little lower.

If the system deviation does not decrease, reduce the integral component a little. If the performance becomes unstable as a result, reduce the P component.

▶ Repeat this process until you have found the correct parameter settings.

Note about the automatic voltage regulation (AVR) function

If you have set the AVR function (PNU A81) to 02, whereby the automatic voltage regulation function with an active PID closed loop control is deactivated only during deceleration of the motor, the motor may, depending on the application, start to "knock". In such cases, the motor accelerates and decelerates repeatedly and smooth running of the motor is not guaranteed. In this case, set the AVR function to 01 (OFF).

Application examples

This section contains some setting examples for practical applications.

Flow control

The example shown in the figure below has the setpoint values 150 m3/min and 300 m3/min:

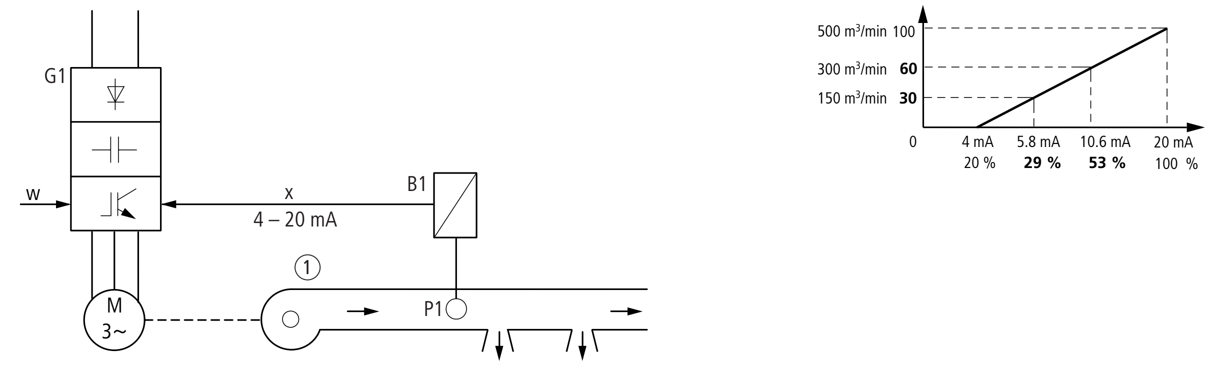


Figure 96: Examples for flow control

w: Setpoint value, 4 Bit digital

x: feedback actual value (500 m3/min at 20 mA)

B1: Measured value converter

P1: Flow sensor

① Pump

PNU	Meaning in PID control mode	Value	Notes
F01	Setpoint	150	Direct input of "150 m3/min", as the scaling factor has been set
A01	Frequency setpoint definition	02	Keypad
A11	Feedback percentage actual value for lower acceptance threshold (Units: %)	0	0 %
A12	Feedback percentage actual value for upper acceptance threshold (Units: %)	100	100 %
A13	Lower acceptance threshold for voltage or current on the actual value input (in %)	20	20 %
A14	Upper acceptance threshold for voltage or current on the actual value input (in %)	100	100 %
A21	Digitally adjustable setpoint value 1	300	300 m3/min
A71	PID control active/inactive	01	PID mode active
A72	P component of the PID controller	–	Application dependent
A73	I component of the PID controller	–	
A74	D component of the PID controller	–	
A75	Setpoint factor of the PID controller	5.0	100 % at 500 m3/min
A76	Input actual value signal for PID controller	00	Feedback from OI–L terminal

Temperature control

With the flow control in the previous example, the frequency inverter's output frequency increases if the feedback signal is less than the setpoint and falls if the feedback signal is greater than the setpoint. With temperature control, the opposite behaviour must be implemented: if the temperature is above the setpoint, the inverter must increase its output frequency to increase the speed of the connected fan.

The following figure contains an example for temperature control with the two setpoints 20 and 30 °C:

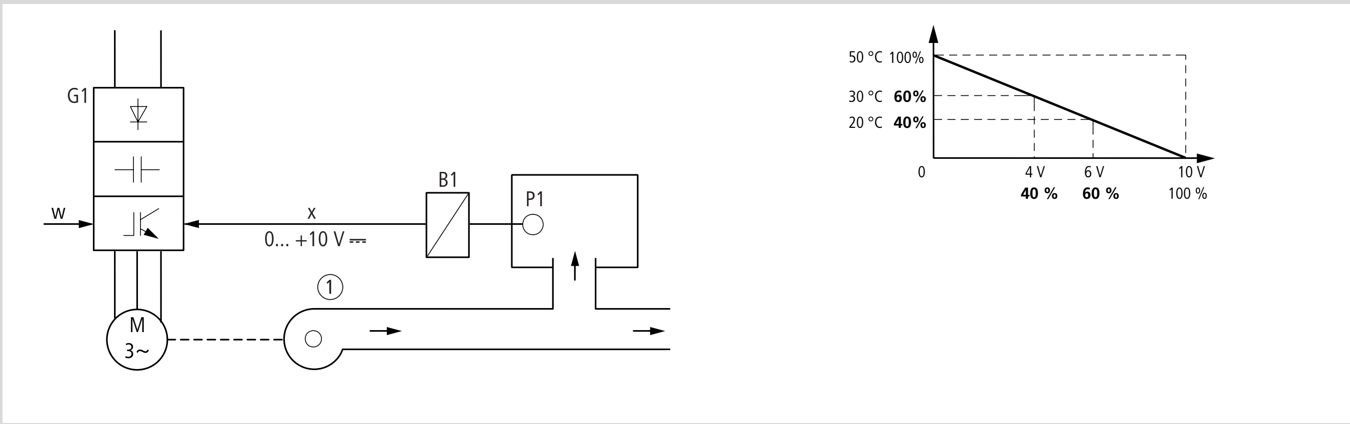


Figure 97: Example for temperature control

w: Setpoint value, 4 Bit digital

x: Feedback actual value (50 °C at 10 V)

B1: Measured value converter

P1: Temperature sensor

① Fan

PNU	Meaning in PID control mode	Value	Notes
F01	Setpoint	20	Direct input of "20 °C", as the scaling factor has been set
A01	Frequency setpoint definition	02	Keypad
A11	Feedback percentage actual value for lower acceptance threshold (Units: %)	100	100 %
A12	Feedback percentage actual value for upper acceptance threshold (Units: %)	0	0 %
A13	Lower acceptance threshold for voltage or current on the actual value input (in %)	0	0 %
A14	Upper acceptance threshold for voltage or current on the actual value input (in %)	100	100 %
A21	Digitally adjustable setpoint value 1	30	30 °C
A71	PID control active/inactive	01	PID mode active
A72	P component of the PID controller	–	Application dependent
A73	I component of the PID controller	–	
A74	D component of the PID controller	–	
A75	Setpoint factor of the PID controller	0.5	100 % at 50 °C
A76	Input actual value signal for PID controller	01	Feedback from O-L terminal

Automatic voltage regulation (AVR)

The AVR function stabilizes the motor voltage if there are fluctuations on the DC bus voltage. These deviations result from, for example:

- Unstable mains supplies or
- DC bus voltage dips or peaks caused by short acceleration and deceleration times.

A stable motor voltage provides a high level of torque, particularly during acceleration.

Regenerative motor operation (without AVR function) results in a rise in the DC bus voltage in the deceleration phase (particularly with very short deceleration times), which also leads to a corresponding rise in the motor voltage. The increase in the motor voltage causes an increase in the braking torque. For this reason, you can deactivate the AVR function for deceleration under PNU A81.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
A81	Characteristic of the AVR function	–	00	AVR function active during entire operation.	02
			01	AVR function is not active.	
			02	AVR function active during operation except for deceleration	
A82	Motor voltage for AVR function	–	200, 220, 230, 240, 380, 400, 415, 440, 460	The settings depend on the device series used: • 200 V series: 200, 220, 230, 240 V • 400 V series: 380, 400, 415, 440, 460 V	230/400

If the mains voltage is higher than the rated motor voltage, enter the mains voltage under PNU A82 and reduce the output voltage in PNU A45 to the rated motor voltage.

Example: With 440 V mains voltage and 400 V rated motor voltage, enter 440 under PNU A82 and 91 % (= 400/440 × 100 %) under PNU A45.

Time ramps

During operation, you can switch over from the time ramps configured under PNU F02 and F03 to those configured under PNU A92 and A93. This can be done either by applying an external signal to input 2CH at any time or when the frequencies configured under PNU A95 and A96 are reached.

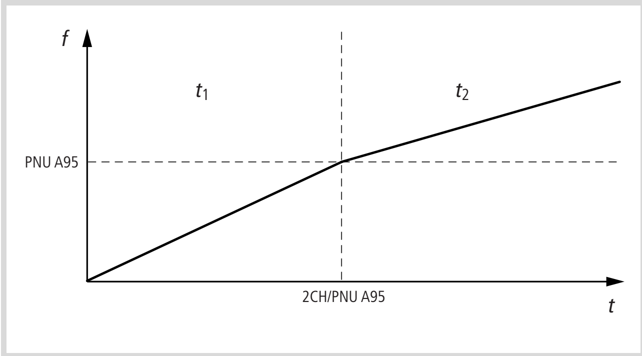
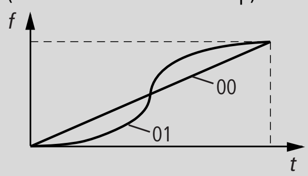


Figure 98: Time ramps

t_1: acceleration time 1

t_2: acceleration time 2

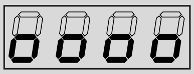
PNU	Name	Adjustable in RUN mode	Value	Function	WE
A92 A292	Second acceleration time	✓	0.1 to 3000 s	Setting times for the second acceleration and deceleration time 0.1 to 999.9 s; resolution: 0.1 s 1000 to 3000 s; resolution: 1 s	15
A93 A293	Second deceleration time				
A94 A294	Changeover from the first to the second time ramp	–	00	Changeover to the second time ramp if an active signal is present on a 2CH digital input.	00
			01	Changeover to the second time ramp when the frequencies entered under PNU A95 and/or A96 are achieved	
A95 A295	Acceleration time changeover frequency	–	0.0 to 360.0 Hz	Here, set a frequency at which the changeover from the first to the second acceleration time is to occur.	0.0
A96 A296	Deceleration time changeover frequency	–	0.0 to 360.0 Hz	Here, set a frequency at which the changeover from the first to the second deceleration time is to occur.	0.0
A97	Acceleration characteristic	–	Here, you can set a linear or an S-curve acceleration characteristic for motor acceleration (first and second time ramp): 		00
			00	Linear acceleration of the motor from the first to the second time ramp	
			01	S-curve characteristic for acceleration of the motor from the first to the second time ramp	
A98	Deceleration characteristic	–	00	Linear deceleration of the motor from the second to the first time ramp	00
			01	S-curve characteristic for deceleration of the motor from the second to the first time ramp	

Automatic restart after a fault

Warning!
When a fault has occurred, this function initiates an automatic restart of the frequency inverter if a start command is present after the set waiting time has expired. Ensure an automatic restart does not present a danger for personnel.

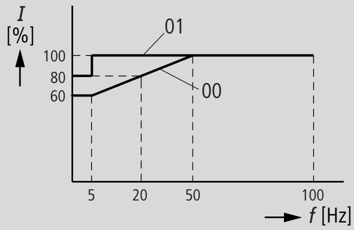
With the default settings, each malfunction triggers a fault message. An automatic restart is possible after the following fault messages have occurred:

- Overcurrent (PNU E01 to E04, up to four restart attempts within 10 minutes before a fault message is issued)
- Overvoltage (PNU E07 and E15, up to three restart attempts within 10 minutes before a fault message is issued)
- Undervoltage (PNU E09, up to 16 restart attempts within 10 minutes, then a fault message is issued)

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b01	Restart mode	–	00	The above fault messages are displayed when the associated fault occurs (restart is not activated).	00
			01	A restart at the start frequency after the time set under PNU b03 has elapsed.	
			02	After the time set under PNU b03 has elapsed, the inverter synchronizes to the current motor rotation speed and the motor accelerates for the set acceleration time.	
			03	After the time set under PNU b03 has elapsed, the inverter synchronizes to the current motor rotation speed and the motor brakes for the set deceleration time. A fault message is then displayed.	
b02	Permissible power failure duration	–	0.3 to 25 s	Here, you set a time duration during which the undervoltage condition is met without the corresponding fault message in PNU E09 being initiated.	1.0
b03	Delay time until restart	–	0.3 to 100 s	Here, set a time which is to expire before an automatic restart is initiated after a fault signal. This time can be used in conjunction with the FRS function. During the delay, the following message appears on the LED display: 	1.0

Electronic motor protection

The DV5 series frequency inverters can monitor the temperature of connected motors with an electronic bimetallic relay. With PNU b12, you can match the electronic motor protection to the rated current of the motor. If the values entered here exceed the rated motor current, the motor cannot be monitored with this function. In this case, PTC thermistors or bimetal contacts in the motor windings must be used.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b12 b212	Tripping current for electronic motor protection device	–	0.5 to 1.2 × I_e	Setting range of the tripping current as a multiple of the frequency inverter rated current, i.e. the range is given in amperes (A).	I_e[1)]
b13 b213	Characteristic for electronic motor protection device	–	The electronic thermal protection of the motor in the low speed range can be increased to improve thermal monitoring of the motor at low frequencies.  I: Output current		01
			00	Enhanced motor protection	
			01	Constant motor protection	

1) Inverter rated current

Current limit

With the current limit parameter, the motor current can be limited. To reduce the load current, the frequency rise ends in the acceleration phase or the output frequency is reduced in the static phase, as soon as the output current exceeds the set current limit. The time constant for control at the current limit is entered under PNU b23. As soon as the output current drops below the set current limit, the frequency increases again to the configured setpoint value. The current limit can be switched off for the acceleration phase (→ PNU b21), to allow higher currents to flow for a brief period.

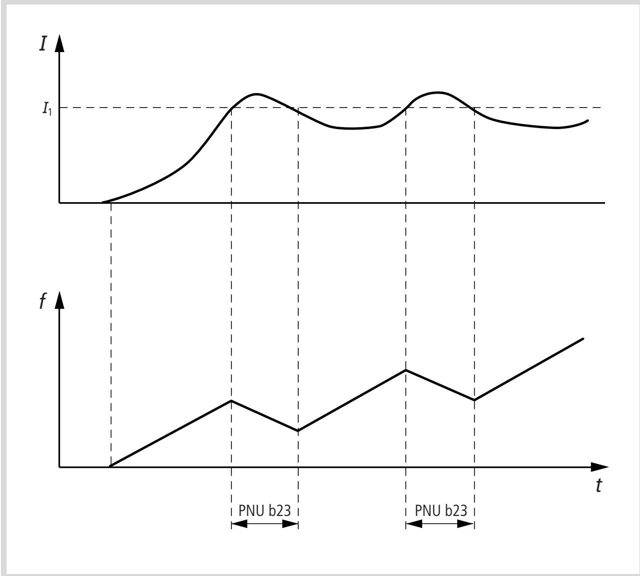


Figure 99: Current limit

I_M: motor current

I_1: current limit

Caution!
Note that the current limit cannot prevent a fault message and shutdown due to a sudden overcurrent (e.g. caused by a short-circuit).

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b21	Current limit characteristic	–	00	Motor current limit not active	01
			01	Motor current limit active in all operating states	
			02	Motor current limit not active during acceleration	
b22	Tripping current	–	0.5 to 1.5 × I_e	Setting range of the tripping current as a multiple of the frequency inverter rated current, i.e. the range is given in amperes (A).	1.25 × I_e 1)
b23	Time constant	–	0.1 to 30 Hz/s	When the set current limit is achieved, the frequency is reduced in the time set here. Caution: If possible, do not enter a value less than 0.3 here!	1.0

1) Inverter rated current

Parameter protection

The four following methods of parameter protection are available:

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b31	Software parameter protection	–	00	Parameter protection through SFT input; all functions inhibited	01
			01	Parameter protection through SFT input; input via PNU F01 possible	
			02	Parameter protection without SFT input; all functions inhibited	
			03	Parameter protection without SFT input; input via PNU F01 possible	

Magnetizing current

Set the magnetizing current with smaller motors or multiple-motor operation accordingly.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b32	Magnetizing current	–	0 to 1.4 × I_e 1)	Setting range of the magnetizing current in multiples of the inverter's rated current	0.58 × I_e 1)

1) Inverter rated current

Other functions

Carrier frequency

High carrier frequencies result in less motor noise and lower power losses in the motor but a higher dissipation in the power amplifiers and more noise in the mains and motor cables. You should therefore set the carrier frequency as low as possible.

During DC braking, the carrier frequency is automatically reduced to 1 kHz.

PNU	Name	Adjustable in RUN mode	Value	WE
b83	Carrier frequency	–	0.5 to 16 kHz	5

Initialization

Two different types of initialization are available:

- Clearing the fault history register
- Restoring the default parameter settings

To erase the fault history register or to restore the factory default settings, proceed as follows:

- ▶ Ensure that 01 has been set under PNU b85.
- ▶ Enter 00 or 01 under PNU b84 (initialization).
- ▶ On the keypad, press both arrow keys and the PRG key at the same time and keep them pressed.
- ▶ While holding the arrow and PRG keys, briefly press the OFF key.
- ▶ Keep the other three keys pressed for the next three seconds until the following flashing display appears: d 00.
- ▶ Now release all keys.

Initialization is now complete.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b84	Initialization	–	00	Clearing the fault history register	00
			01	Restoring the default parameter settings	

Country version

Here you define the country-specific parameter set which will be loaded during initialization (→ PNU b84).

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b85	Country version	–	00	Japan	01
			01	Europe	
			02	USA	
			03	Reserved	

Frequency factor for display via PNU d07

The product of the value displayed under PNU d01 and this factor is displayed at PNU d07.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b86	Frequency factor	✓	0.1 to 99.9	The product of the value displayed under PNU d01 and this factor is displayed at PNU d07. This value is also available on the FM terminal.	1.0

Inhibit of the OFF key

The OFF key located on the keypad or remote operating unit can be inhibited here.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b87	OFF key disabled	–	00	OFF key always active	00
			01	OFF key not active with control via the FWD/REV terminals	

Motor restart after cancellation of the FRS signal

Activation of the digital input configured as FRS causes the inverter to shut down, leaving the motor to coast. Two methods can be selected to deactivate the FRS input.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b88	Motor restart after removal of the FRS signal	–	00	0 Hz restart after deactivation of the FRS input	00
			01	Synchronization of the motor to the current motor speed after the delay time entered under PNU b03.	

Display when a remote operating unit is used

The following operating data can be selected when the DE5-KEY-RO3 remote operating unit is used:

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b89	Display when the remote operating unit is used	✓	01	Actual frequency	01
			02	Motor current	
			03	Direction of rotation	
			04	PID actual value	
			05	Status of the digital inputs	
			06	Status of the digital outputs	
			07	Actual frequency multiplied by the frequency factor	

Relative permissible duty factor of the built-in braking device

Enter the permissible relative duty factor of the DV5's built-in braking device here. The percentage value entered here relates to the longest permissible (continuous) total operating time of the braking device, which is 100 s.

If the braking device is operated for a longer period than the value entered here, fault message E06 is issued.

To further increase the braking effect, you can use an additional, external braking resistor (the maximum cable length between braking resistor and inverter is 5 m). The required minimum values for the resistor are:

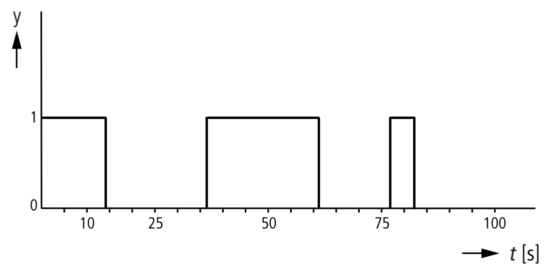
DV5-322-075	> 35 Ω
DV5-322-1K1	
DV5-322-1K5	
DV5-322-2K2	
DV5-322-018	> 100 Ω
DV5-322-037	
DV5-340-2K2	
DV5-340-3K0	
DV5-340-4K0	
DV5-340-037	> 180 Ω
DV5-340-075	
DV5-340-1K5	
DV5-340-5K5	> 70 Ω
DV5-340-7K5	

If you are using an external braking unit, enter 0 % here and, if present, remove the external braking resistor.

Using an example of three braking operations within 100 seconds, the following illustration shows the effect of the relative duty factor:

The current relative duty factor T in this example is 44 %.

If, for example, you set PNU b90 to 40 %, a fault message is issued.



$$T = \frac{14\ s + 25\ s + 5\ s}{100\ s} \times 100\ \% = 44\ \%$$

Figure 100: Example: Braking duration

y: Braking

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b90	Relative permissible duty factor of the built-in braking device	–	0 to 100 %	To deactivate the relative permissible duty factor of the built-in braking device, enter 0 %.	0

Type of motor stop

Specify here, how the motor is to decelerate when the OFF button is pressed:

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b91	Type of motor stop	–	00	Deceleration using the deceleration ramp	00
			01	Free run stop (coasting)	

Fan control

With PNU b92, you can specify when the fan will run.

If you enter the value 01 here, the fan runs for one minute after the frequency inverter power supply is switched on, so that you can make sure that the fan works correctly. The fan also continues to run for one minute after the connected motor has stopped to dissipate residual heat.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
b92	Fan control	–	00	Fan is always switched on	00
			01	Fan is switched on only while the connected motor is running.	

SLV and autotuning

This section describes the function of the SLV (sensorless vector control) and how to automatically determine motor data with the autotuning function.

SLV (Sensorless Vector Control)

SLV can be used instead of the V/*f* characteristic to obtain even higher torques at lower speeds and to achieve an even greater speed stability, and therefore even steadier motor operation.

To achieve this, the current motor current and the current motor voltage are used to calculate the magnetization current (machine flux generating component) and the resistive current (torque-generating component). In combination with the motor constants defined by the motor type (which you can either configure manually or determine automatically with autotuning), these two current components are sufficient for an optimal motor control.

The actual control is implemented with a powerful microprocessor built into the frequency inverter. Even though SLV control does not require actual motor speed feedback, (hence the term "sensorless"), it is nearly as powerful as vector control with motor speed feedback.

Before you can use SLV control, you must configure a few parameters:

- ▶ In PNU A44 (or PNU A244 for the second parameter set), enter the value 02 (→ Section "Spannungs-/Frequenzcharakteristik und Boost", Page 85).
- ▶ In PNU H02 (or PNU H202) specify whether the standard motor data (value 00) or the autotuning data (value 01) will be used.
- ▶ In PNU H03 (or PNU H203) enter the motor rating and in PNU H04 (or PNU H204) the number of motor poles.
- ▶ If necessary, in PNU H05, change the response speed of the control and (if motor resonance should occur), in PNU H06 the motor stabilization constant.

Autotuning

With the autotuning function, the motor constants of the connected motor are determined automatically and written to the memory locations of PNU H30 to H34 (standard parameter set) or PNU H230 to H234 (second parameter set). This saves you the effort of entering the constants manually. In fact, you do not even need to know them.

Before you carry out an autotuning, do the following:

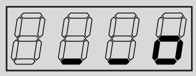
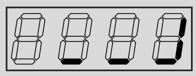
- ▶ In PNU F02 and F03, specify the first acceleration and deceleration time.

To enable autotuning to correctly determine the motor's moment of inertia, the same value must be entered in both parameters. The smaller the entered acceleration and deceleration time, the faster can autotuning be carried out. Make sure that no fault messages are displayed.

- ▶ In PNU H03, enter the motor rating and in PNU H04 the number of motor poles.
- ▶ In PNU A01 enter the value 02, so that the frequency setpoint can be set with PNU A20.
- ▶ In PNU A 03, enter the base frequency (the default value is 50 Hz) and in PNU A20 the setpoint frequency. If this parameter is set to 0 Hz, autotuning can not be carried out.
- ▶ In PNU A82, enter the motor voltage for the AVR (automatic voltage regulation) function.
- ▶ Because the DC brake must not be used, enter the value 00 in PNU A51.
- ▶ With PNU H01, select the autotuning mode: If the motor can be run to determine the autotuning data, enter 01 here (during autotuning, the motor will be accelerated up to 80 % of its base frequency); if autotuning is to be carried out with the motor stationary, enter 02.

To start autotuning, issue the start signal (for example with the On key). To determine the motor data, autotuning first applies AC and DC voltage to the stationary motor.

If you have entered 01 in PNU H01, two further autotuning runs are carried out with running motor: first, the motor is accelerated to 80 % of the base frequency entered in PNU A03 and decelerated again to standstill; then it is accelerated and decelerated again, but this time to the setpoint frequency specified in PNU A20.

Once autotuning is completed successfully, the following message appears on the LED display:	
If an error has occurred during autotuning, the following is displayed:	

The table below lists the parameters of the autotuning function. Parameters which are only defined automatically are marked "(autotuning)" in the Name column.

PNU	Name	Adjustable in RUN mode	Value	Function	WE
H01	Autotuning mode	–	00	Autotuning not active	00
			01	Carry out autotuning with motor operation	
			02	Carry out autotuning (only at motor standstill)	
H02 H202	Motor data to be used	–	00	Use default motor data	00
			01	Use autotuning data	
H03 H203	Motor rating	–	0.18/0.37/ 0.75/1.5/2.2/ 3.7 kW	Enter the motor rating.	Depen- ding on inverter rating
H04 H204	Number of motor poles	–	2/4/6/8	Enter the number of motor poles	4
H05 H205	Motor constant K_p	–	0 to 99	Motor	20
H06 H206	Motor stabilization constant	–	0 to 255	0 function is not active	100
H20 H220	Motor constant R_1	–	0 to 65 Ω	Stator impedence	Depen- ding on model
H21 H221	Motor constant R_2 1)	–	0 to 65 Ω	Rotor resistance	
H22 H222	Motor constant L	–	0 to 65.5 mH	Motor inductivity	
H23 H223	Motor constant I_0	–	0 to 65.5 $A_{r.m.s.}$	Motor current	
H24 H224	Motor constant J 2)	–	1.0 to 1000.0	Moment of inertia of the motor relative to the load	Depen- ding on model
H30 H230	Motor constant R_1 (autotuning)	–	–	Here, the parameters determined with autotuning are saved. They cannot be set manually. The manually adjustable motor constants can be configured with PNU H20 to H24 or H220 to H224.	Depen- ding on model
H31 H231	Motor constant R_2 (autotuning)	–			
H32 H232	Motor constant L (autotuning)	–			
H33 H233	Motor constant I_0 (autotuning)	–			
H34 H234	Motor constant J (autotuning)	–			

1) In case of an over-compensation, reduce R_2

2) The greater J, the slower the motor responds; the smaller J, the faster it responds (J = moment of inertia of the motor relative to the load)

If SLV control is active, you should set the pulse frequency to at least 2.1 kHz with PNU b83 (→ Section "Taktfrequenz", Page 105). If the motor drives a very small load, (i.e. has a low moment of inertia), it may whip or jolt. If this is the case, do the following:

- ▶ Set the motor stabilization constant (PNU H06) accordingly and reduce the pulse frequency (PNU b83).
- ▶ Deactivate the AVR function by entering a 01 in PNU A81.

7 Messages

In this section, the messages issued by the DV5 series frequency inverters are listed and explained.

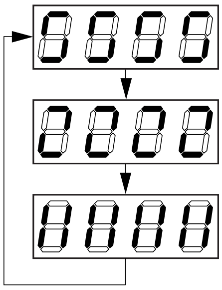
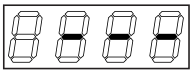
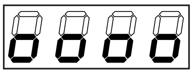
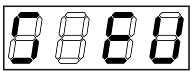
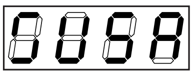
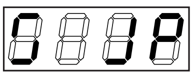
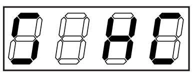
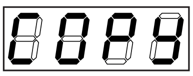
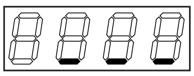
Fault messages

At overcurrent, overvoltage and undervoltage conditions, the output of the DV5 series frequency inverters is shut down to protect against damage. The connected motor then coasts to a stop. The inverter remains in this condition until the fault message is acknowledged with the OFF key or the RST input.

Display	Cause	Description
E 01	Overcurrent in the output stage in static operation	If the output current reaches a level which is too high, the output voltage is shut down. This happens when • there is a short-circuit on the output of the frequency inverter, • the motor is blocked, • the effective load on the output is too high.
E 02	Overcurrent in the output stage during deceleration	
E 03	Overcurrent in the output stage during acceleration	
E 04	Overcurrent in the output stage in standstill	
E 05	Overload	The internal electronic motor protection has switched off the output voltage because the motor was overloaded.
E 06	Overload	If the duty factor of the built-in braking device in the DV5 is too great, the braking device is switched off (the generated overvoltage disconnects the output voltage).
E 07	Overvoltage	The output voltage has been switched off because the motor was operating regeneratively.
E 08	EEPROM fault	If the program memory does not operate reliably due to radio frequency interference or excessive temperature, the output voltage is switched off. If the supply voltage is switched off while the RST input is active, an EEPROM fault occurs when the supply voltage is reapplied.
E 09	Undervoltage	If the DC voltage is too low, the output voltage is switched off (correct function of the electronics is no longer possible; problems such as overheating of the motor and insufficient torque may arise).
E 10	Fault in current transformer	The output voltage is disconnected when a fault occurs in the built-in current transformer of the DV5.
E 11	Processor malfunction	The processor does not operate correctly. The output voltage is switched off.
E 12	External fault message	The output voltage is switched off due to an external fault message which is present on a digital input configured as an EXT input.
E 13	Restart inhibit activated	The mains voltage was switched on or a brief interruption in the supply voltage has occurred while the restart inhibit (input USP) was active.
E 14	Ground fault	Earth faults between the U, V or W terminals and earth are being reliably detected. A protective circuit prevents destruction of the frequency inverter, but does not protect the operating personnel.
E 15	Mains overvoltage	If the supply voltage is higher than permitted, the output voltage is switched off 100 s after the voltage supply has been switched on.
E 21	Over temperature	If the temperature sensor installed in the power section records an operating temperature above the permissible limit value, the output voltage is switched off.
E 22	Processor malfunction	The processor does not operate correctly. The output voltage is switched off.
E 35	PTC fault message	If the resistance of the external PTC thermistor connected to the PTC input (digital input configured as a PTC thermistor input) is too high, the output voltage is switched off.
… … U	Wait state	The frequency inverter is in its wait state because the input voltage is too low.

Other messages

This section describes the messages issued by the DV5 series frequency inverters in standby mode, when the mains voltage is switched off, etc.

Display	Cause
	The frequency inverter is in standby mode or a reset signal is active.
	The mains voltage has been switched off.
	The delay time before automatic restart is counting down (PNU b01 and b03, → Section "Automatic restart after a fault", Page 101).
  	The default settings have been selected and the frequency inverter is in the initialization phase (PNU b84 and b85, → Section "Initialization", Page 105). The values for the European market (EU) are being initialized. For non-European models, versions for North America (USA) and Japan (JP) are available.
	Initialization of the fault history register
	Copy station – copying in progress.
	No data available, e.g. display under PNU d08 and d09, when the fault history register is empty the display under PNU d04, when the PID controller is not active.

8 Fault correction

Fault	Condition	Possible cause	Remedy
The motor will not start.	There is no voltage present at outputs U, V and W.	Is voltage applied to terminals L, N and/or L1, L2 and L3? If yes, is the ON lamp lit?	Check terminals L1, L2, L3 and U, V, W. Switch on the supply voltage.
		Does the LED display on the keypad indicate a fault (E … …)?	Analyze the cause of the fault signal (→ Section "Messages", Page 111). Acknowledge the fault message with the reset command (e.g. by pressing the OFF key).
		Has a start command been issued?	Issue the start command with the ON key or through the FWD/REV input.
		Has a frequency setpoint value been entered under PNU F01 (keypad operation only)?	Enter a frequency setpoint value under PNU F01.
		Are the setpoint definitions via the potentiometer correctly wired to terminals H, O and L?	Check that the potentiometer is connected correctly.
		Are inputs O and/or OI correctly connected for external setpoint definition?	Check that the setpoint signal is correctly connected.
		Are the digital inputs configured as RST or FRS still active?	Deactivate RST and/or FRS. Check the signal on digital input 5 (default setting: RST).
		Has the correct source for the frequency setpoint (PNU A01) been set? Has the correct source for the start command (PNU A02) been set?	Correct PNU A01 accordingly. Correct PNU A02 accordingly. (→ Section "Setting the frequency and start command parameters", Page 82)
	There is voltage present at outputs U, V and W.	Is the motor blocked or is the motor load too high?	Reduce the load acting on the motor. Test the motor without load.
The motor turns in the wrong direction.	–	Are output terminals U, V and W correctly connected? Does the connection of terminals U, V and W correspond with the direction of rotation of the motor?	Connect output terminals U, V and W correctly to the motor according to the required direction of motor rotation (generally the sequence U, V, W causes clockwise rotation).
		Are the control signal terminals correctly wired?	Use control signal terminal FWD for clockwise rotation, REV for anticlockwise rotation.
		Has PNU F04 been correctly configured?	Set the required direction of rotation under PNU F04.
The motor will not start.	–	A setpoint value is not present on terminal O and/or OI.	Check the potentiometer or the external setpoint generator and replace if necessary.
		Is a fixed frequency accessed?	Observe the sequence of priority: the fixed frequencies always have priority over the inputs O and OI.
		Is the motor load too high?	Reduce the motor load as the overload limit will prevent the motor reaching its normal speed if there is an overload.

Fault	Condition	Possible cause	Remedy
The motor does not operate smoothly.	–	Are the load changes on the motor too high?	Select a frequency inverter and motor with a higher performance. Reduce the level of load changes.
		Do resonant frequencies occur on the motor?	Mask these frequencies with the frequency jumps (PNU A63 to A68, → Section ”Operating frequency range“, Page 87) or change the pulse frequency (PNU b83, → Section ”Carrier frequency“, Page 105).
The drive speed does not correspond with the frequency	–	Is the maximum frequency set correctly?	Check the set frequency range or the set voltage/frequency characteristic.
		Are the rated speed of the motor and the gearbox reduction ratio correctly selected?	Check the rated motor speed or the gearbox reduction ratio.
The saved parameters do not correspond to the entered values.	Entered values have not been saved.	The supply voltage was switched off before the entered values were saved by pressing the ENTER key.	Reenter the affected parameters and save the input again.
		After the supply voltage was switched off, the entered and saved values are transferred into the internal EEPROM. The supply voltage should remain off for at least six seconds.	Enter the data again and switch off the supply voltage for at least six seconds.
	The values of the copy unit were not accepted by the frequency inverter.	After copying the parameters of the external keypad DEX-KEY-10 into the frequency inverter, the supply voltage was left on for less than six seconds.	Copy the data again and leave the supply voltage on for at least six seconds after completion.
It is not possible to make any inputs.	The motor cannot be started or stopped or setpoint values cannot be set.	Are PNU A01 and A02 set correctly?	Check the settings under PNU A01 and A02 (→ Section ”Setting the frequency and start command parameters“, Page 82).
	No parameters can be set or changed.	Has the software parameter protection been activated?	Deactivate the parameter protection with PNU b31 (→ Section ”Parameter protection“, Page 104), so that all parameters can be changed again.
		Has the hardware parameter protection been activated?	Deactivate the digital input configured as SFT (→ Section ”Software protection SFT“, Page 66).
		Is DIP switch position 4 (external keypad DEX-KEY-10) set to ON?	Set switch 4 to the OFF position so that data can be read from the remote operating unit.
The electronic motor protection activates (fault message: E 05).		Is the manual boost set too high? Were the correct settings made for the electronic motor protection?	Check the boost setting and the electronic motor protection setting. (→ Section ”Voltage/frequency characteristics and boost“, Page 85)

To be observed when saving changed parameters:

After saving changed parameters with the ENTER key, no inputs can be made using the keypad of the frequency inverter for at least six seconds. If, however, a key is pressed before this time elapses, or if the reset command is issued or the frequency inverter is switched off, the data may not be correctly saved.

Appendix

Technical Data

The following table contains the technical data for the 230 V series.

DV5-322-...		018	037	055	075	1K1	1K5	2K2
Protection class according to EN 60529		IP20						
Overvoltage category		III						
Maximum permissible effective motor power in kW, details for four pole three-phase current asynchronous motors		0.18	0.37	0.55	0.75	1.1	1.5	2.2
Maximum permissible apparent motor power in kVA	230 V	0.6	1.0	1.1	1.5	1.9	3.1	4.3
	240 V	0.6	1.0	1.2	1.6	2.0	3.3	4.5
Primary side: Number of phases		Single-phase/three-phase						
Primary side: Rated voltage		180 V ~ – 0 % to 252 V ~ + 0 %, 47 to 63 Hz						
Secondary side: Rated voltage		Three-phase 200 to 240 V ~ Corresponding to the primary side rated voltage If the primary voltage drops, the secondary voltage also drops.						
Primary side: Rated current in A	Single-phase	3.5	5.8	6.7	9.0	11.2	17.5	24.0
	Three-phase	2.0	3.4	3.9	5.2	6.5	10.0	14.0
Secondary side: Rated current in A		1.4	2.6	3.0	4.0	5.0	8.0	11.0
Secondary side: Frequency range		0.5 to 360 Hz With motors which are operated at rated frequencies above 50/60 Hz, the maximum possible motor speed should be observed.						
Frequency error limits (at 25 °C ±10 °C)		• Digital setpoint value: ±0.01 % of the maximum frequency • Analog setpoint value: ±0.1 % of the maximum frequency						
Frequency resolution		• Digital setpoint value: 0.1 Hz • Analog setpoint value: Maximum frequency/1000						
Voltage/frequency characteristic		Constant, reduced or increased (SLV) torque)						
Permissible overcurrent		150% for 60 seconds (once every 10 minutes)						
Acceleration/deceleration time		0.1 to 3000 s with linear and nonlinear characteristic (applies also for second acceleration/deceleration time)						
Torque on startup (with SLV)		> 200 %						
Braking torque								
with feedback to the capacitors Reduced braking torque with frequencies above 50 Hz.		Approx. 100 %				Approx. 70 %		Approx. 20 %
with external braking resistor		Approx. 150 %						Approx. 100 %
With DC injection braking		Braking occurs at frequencies below the minimum frequency (minimum frequency, braking time and braking torque are user-definable)						
Inputs								
Frequency setting	Keypad	Setting via keys or potentiometer						
	External signals	• 0 to 10 V⎓, input impedance 10 kΩ; • 4 to 20 mA, load impedance 250 Ω • Potentiometer ≧ 1 kΩ, recommended 4.7 kΩ						
Clockwise/anticlockwise rotation (Start/Stop)	Keypad	ON key (for Start) and OFF key (for Stop); default setting = clockwise rotation						
	External signals	Digital control inputs programmable as FWD and REV						

DV5-322-...	018	037	055	075	1K1	1K5	2K2
Digital control inputs programmable as	• FWD: Start/stop clockwise rotation • REV: Start/stop anticlockwise rotation • FF1 to FF4: Fixed frequency selection • JOG: Jog mode • AT: Use setpoint value 4 to 20 mA • 2CH: Second time ramp • FRS: Free run stop • EXT: External fault message • USP: Restart inhibit • RST: Reset • SFT: Software protection • PTC: PTC thermistor input • DB: DC braking active • SET: Second parameter set active • UP: Remote access, acceleration • DWN: Remote access, deceleration						
Outputs							
Digital signalling inputs programmable as	• FA1/FA2: Frequency achieved/exceeded • OL: Overload • AL: Fault • RUN: Motor operational • OD: PID deviation exceeded						
Monitoring of frequency and current	• Connection of an analog display device: 0 to 10 V ⎓, maximum 1 mA for frequency or current • Connection of a digital frequency meter						
Signalling relay	Relay contact as a two-way switch; relay energized with a fault						
Further features (excerpt)	• Autotuning • Automatic voltage regulation • Restart inhibit • Variable amplification and output voltage reduction • Frequency jumps • Minimum/maximum frequency limitation • Output frequency display • Fault history register available • Freely selectable carrier frequency: 0.5 to 16 kHz • PID closed loop control • Automatic torque boost • On/OFF fan control • Second parameter set selectable						
Safety features	• Overcurrent • Overvoltage • Undervoltage • Overtemperature • Ground fault • Overload • Electronic motor protection • Current transformer fault • Dynamic brake function (regenerative)						

DV5-322-...	018	037	055	075	1K1	1K5	2K2
Ambient conditions							
Ambient temperature	–10 to +50 °C From about +40 to +50 °C, the carrier frequency should be reduced to 2 kHz. The output current should be less than 80 % of the rated current in this case.						
Temperature/humidity during storage	–25 to 70 °C (for short periods only, e.g. during transport) 20 to 90 % relative humidity (non condensing)						
Permissible vibration	Maximum 5.9 m/s^2 (= 0.6 g) at 10 to 55 Hz						
Installation height and location	Maximum 1 000 m above sea level in a housing or control panel (IP54 or similar)						
Optional accessories	• DEX-KEY-10 remote operating unit • Choke to improve the power factor • RFI filter						

The following data contains the technical data for the 400 V series.

DV5-340-...	037	075	1K5	2K2	3K0	4K0	5K5	7K5
Protection class according to EN 60529	IP20							
Overvoltage category	III							
Maximum permissible effective motor power in kW, details for four pole three-phase current asynchronous motors	0.37	0.75	1.5	2.2	3.0	4.0	5.5	7.5
Maximum permissible apparent motor power in kVA for 460 V	1.1	1.9	2.9	4.2	6.2	6.6	9.9	12.2
Primary side: Number of phases	Three-phase							
Primary side: Rated voltage	342 V ~ – 0 % to 506 V ~ + 0 %, 47 to 63 Hz							
Secondary side: Rated voltage	Three-phase 360 to 460 V ~ Corresponding to the primary side rated voltage If the primary voltage drops, the secondary voltage also drops.							
Primary side: Rated current in A	2.0	3.3	5.0	7.0	10.0	11.0	16.5	20.0
Secondary side: Rated current in A	1.5	2.5	3.8	5.5	7.8	8.6	13.0	16.0
Secondary side: Frequency range	0.5 to 360 Hz With motors which are operated at rated frequencies above 50/60 Hz, the maximum possible motor speed should be observed.							
Frequency error limits (at 25 °C ±10 °C)	• Digital setpoint value: ±0.01 % of the maximum frequency • Analog setpoint value: ±0.1 % of the maximum frequency							
Frequency resolution	• Digital setpoint value: 0.1 Hz • Analog setpoint value: Maximum frequency/1000							
Voltage/frequency characteristic	Constant, reduced or increased (SLV) torque)							
Permissible overcurrent	150% for 60 seconds (once every 10 minutes)							
Acceleration/deceleration time	0.1 to 3000 s with linear and nonlinear characteristic (applies also for second acceleration/deceleration time)							
Torque on startup with SLV	> 200 %				> 180 %			
Braking torque								
with feedback in to the capacitors: reduced braking torque at frequencies exceeding 50 Hz.	Approx. 100 %			Approx. 70 %	Approx. 20 %		Approx. 30 %	
with external braking resistor	Approx. 150 %			Approx. 100 %			Approx. 80 %	
With DC injection braking	Braking occurs at frequencies below the minimum frequency (minimum frequency, braking time and braking torque are user-definable)							

<table>
<tr><th colspan="2">DV5-340-...</th><th>037</th><th>075</th><th>1K5</th><th>2K2</th><th>3K0</th><th>4K0</th><th>5K5</th><th>7K5</th></tr>
<tr><td colspan="2">Inputs</td><td colspan="8"></td></tr>
<tr><td rowspan="2">Frequency setting</td><td>Keypad</td><td colspan="8">Setting via keys or potentiometer</td></tr>
<tr><td>External signals</td><td colspan="8">• 0 to 10 V ⎓, input impedance 10 kΩ;
• 4 to 20 mA, load impedance 250 Ω
• Potentiometer ≧ 1 kΩ, recommended 4.7 kΩ</td></tr>
<tr><td rowspan="2">Clockwise/anticlockwise rotation (Start/Stop)</td><td>Keypad</td><td colspan="8">ON key (for Start) and OFF key (for Stop); default setting = clockwise rotation</td></tr>
<tr><td>External signals</td><td colspan="8">Digital control inputs programmable as FWD and REV</td></tr>
<tr><td colspan="2">Digital control inputs programmable as</td><td colspan="8">• FWD: Start/stop clockwise rotation
• REV: Start/stop anticlockwise rotation
• FF1 to FF4: Fixed frequency selection
• JOG: Jog mode
• AT: Use setpoint value 4 to 20 mA
• 2CH: Second time ramp
• FRS: Free run stop
• EXT: External fault message
• USP: Restart inhibit
• RST: Reset
• SFT: Software protection
• PTC: PTC thermistor input
• DB: DC braking active
• SET: Second parameter set active
• UP: Remote access, acceleration
• DWN: Remote access, deceleration</td></tr>
<tr><td colspan="2">Outputs</td><td colspan="8"></td></tr>
<tr><td colspan="2">Digital signalling inputs programmable as</td><td colspan="8">• FA1/FA2: Frequency achieved/exceeded
• OL: Overload
• AL: Fault
• RUN: Motor operational
• OD: PID deviation exceeded</td></tr>
<tr><td colspan="2">Monitoring of frequency and current</td><td colspan="8">• Connection of an analog display device: 0 to 10 V ⎓, maximum 1 mA for frequency or current
• Connection of a digital frequency meter</td></tr>
<tr><td colspan="2">Signalling relay</td><td colspan="8">Relay contact as a two-way switch; relay energized with a fault</td></tr>
<tr><td colspan="2">Further features (excerpt)</td><td colspan="8">• Autotuning
• Automatic voltage regulation
• Restart inhibit
• Variable amplification and output voltage reduction
• Frequency jumps
• Minimum/maximum frequency limitation
• Output frequency display
• Fault history register available
• Freely selectable carrier frequency: 0.5 to 16 kHz
• PID closed loop control
• Automatic torque boost
• On/OFF fan control
• Second parameter set selectable</td></tr>
<tr><td colspan="2">Safety features</td><td colspan="8">• Overcurrent
• Overvoltage
• Undervoltage
• Overtemperature
• Ground fault
• Overload
• Electronic motor protection
• Current transformer fault
• Dynamic brake function (regenerative)</td></tr>
</table>

DV5-340-...	037	075	1K5	2K2	3K0	4K0	5K5	7K5
Ambient conditions								
Ambient temperature	–10 to +50 °C From about +40 to +50 °C, the carrier frequency should be reduced to 2 kHz. The output current should be less than 80 % of the rated current in this case.							
Temperature/humidity during storage	–25 to 70 °C (for short periods only, e.g. during transport) 20 to 90 % relative humidity (non condensing)							
Permissible vibration	Maximum 5.9 m/s^2 (= 0.6 g) at 10 to 55 Hz							
Installation height and location	Maximum 1 000 m above sea level in a housing or control panel (IP54 or similar)							
Optional accessories	• DEX-KEY-10 remote operating unit • Choke to improve the power factor • RFI filter							
Weight in kg (approx.)	1.3	1.7		2.8			5.5	5.7

Dimensions and weights

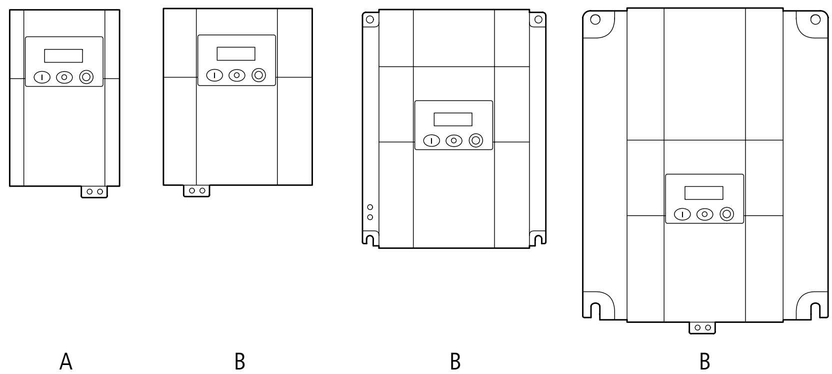


Figure 101: Sizes for DV5

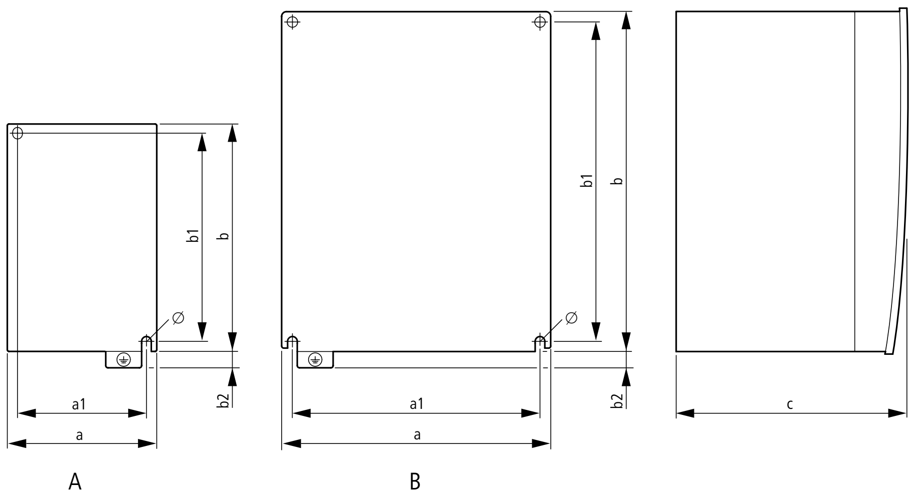


Figure 102: Dimensions for DV5

DV5-	a	a1	b	b1	b2	c	∅	[kg]	
322-018 322-037 322-055	88.5	67	136	118	7	103[1)] 117	5	0.8	a
322-075 322-1K1 340-037	118	98	136	118	7	140	5	1.3	b
340-075 340-1K5 340-2K2	118	98	136	118	–	167	5	1.7	b
322-1K5	140	128	184.5	168	7	164	5	2.2	b
322-2K2 340-3K0 340-4K0	140	128	184.5	168	–	175	5	2.8	b
340-5K5	182	160	260	236	13	177	7	5.5	b
340-7K5	182	160	260	236	13	177	7	5.7	b

1) Dimensions of DV5-322-018

Cables and fuses

The cross-sections of the cables and line protection fuses used must correspond with the applicable standards.

DV5	Connection to the power supply				L1, L2, L3, N, U, V, W, PE (2×)	
		VDE	UL[1)]	Moeller	mm²	AWG
322-018	1/3-phase 230 V	M10 A	10 A	FAZ-1N-B10, PKZM0-10	1.5	15
322-037	1/3-phase 230 V	M10 A	10 A	FAZ-1N-B10, PKZM0-10	1.5	15
322-055	1/3-phase 230 V	M10 A	10 A	FAZ-1N-B10, PKZM0-10	1.5	15
322-075	1/3-phase 230 V	M16 A	15 A	FAZ-1N-B16, PKZM0-16	2.5	13
322-1K1	1/3-phase 230 V	M20 A	20 A	FAZ-1N-B20, PKZM0-20	2.5	13
322-1K5	Single-phase 230 V	M25 A	25 A	FAZ-1N-B25	4.0	11
	3-phase 230 V	M16 A	15 A	PKZM0-16	4.0	11
322-2K2	Single-phase 230 V	M40 A	40 A	FAZ-1N-B40	4.0	11
	3-phase 230 V	M25 A	25 A	PKZM0-25	4.0	11
340-037	3-phase 400 V	M10 A	10 A	PKZM0-10	1.5	15
340-075		M10 A	10 A	PKZM0-10	1.5	15
340-1K5		M10 A	10 A	PKZM0-10	1.5	15
340-2K2		M10 A	10 A	PKZM0-10	1.5	15
340-3K0		M16 A	15 A	PKZM0-16	2.5	13
340-4K0		M16 A	15 A	PKZM0-16	2.5	13
340-5K5		M25 A	25 A	PKZM0-25	4.0	11
340-7K5		M25 A	25 A	PKZM0-25	4.0	11

1) Tripping characteristic "H" or "K5" (approved fuses and fuse holders)

Control cables should be screened with a maximum cross-section of 0.75 mm².

Use cables with a larger cross-section for supply voltage and motor cables which exceed about 20 m in length.

Use a cable cross-section of 0.75 mm² for the cable which is to be connected to the signal output. About 5 to 6 mm of the cable ends should be stripped. The external diameter of the signal cable should be no more than 2 mm, except for the connection to the signalling relay.

Mains contactors

→ The mains contactors listed here assume the network's rated current (I_{LN}) without mains choke/mains filter. Their selection is based on the thermal current (AC-1).

Caution!
Jog mode must not be used through the mains contactor (pause time ≧ 180 s between switching off and on)

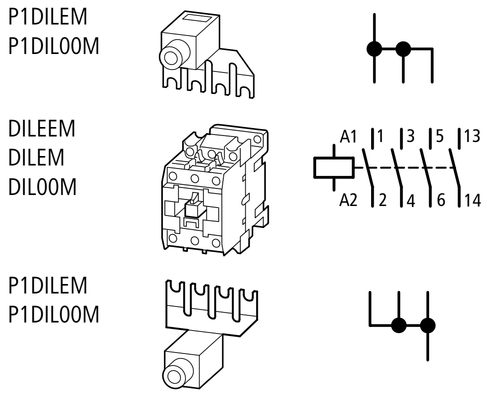


Figure 103: Mains contactor at single-phase connection

DV5-	DV5- phase current I_{LN} [A]	Mains contactor Open/enclosed I_{th} AC-1 [A]	Model	+ Paralleling link 1)
1 ~ 230 V connection				
322-018	3.1	20/16	DILEEM	P1DILEM
322-037	5.8			
322-055	6.7			
322-075	9			
322-1K1	11.2			
322-1K5	16		DIL00M	P1DIL00M
322-2K2	22.5		DIL00M	P1DIL00M
3 ~ 230 V connection				
322-018	1.8	20/16	DILEEM	–
322-037	3.4			
322-055	3.9			
322-075	5.2			
322-1K1	6.5			
322-1K5	9.3			
322-2K2	13		DIL00M	

DV5-	DV5- phase current	Mains contactor		+ Paralleling link 1)
		Open/enclosed	Model	
	I_{LN} [A]	I_{th} AC-1 [A]		
3 ~ 400 V connection				
340-037	2	20/16	DILEEM	–
340-075	3.3			
340-1K5	5			
340-2K2	7			
340-3K0	10		DIL00M	
340-4K0	11		DIL00M	
340-5K5	16.5	35/30	DIL0M	
340-7K5	20	35/30	DIL0M	

1) For a single-phase supply connection, supplement the mains contactors with the corresponding parallel connectors (terminals 1-3-5 and 2-4-6). The fourth pin can be broken off.

Radio interference filter

RFI filters have discharge currents to earth, which can be higher than the nominal values in the event of a fault (phase failure, load unbalance). To avoid dangerous voltages, the filters must be earthed before use.

For discharge currents ≧ 3.5 mA, VDE 0160 and EN 60335 specify that

- the protective conductor must have a cross-section ≧ 10 mm^2 or
- a second protective conductor must be connected, or
- the continuity of the protective conductor must be monitored.

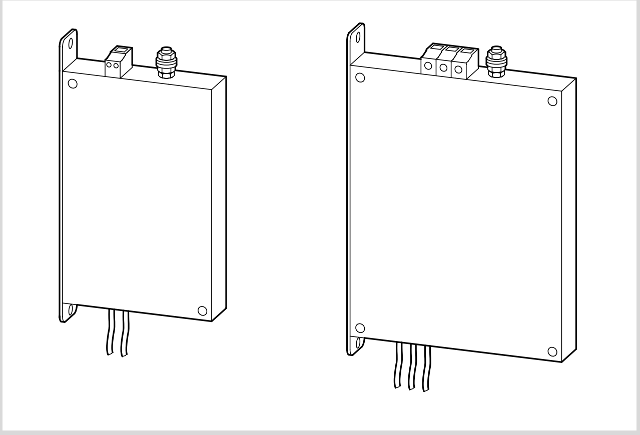


Figure 104: Single- and three-phase RFI filters

→ The DE5-LZ1 and DE5-LZ3 radio interference filters can be fitted to the side or below the frequency inverter.

The table below matches radio interference filters to frequency inverters.

DV5	Rated mains voltage	RFI filter	Maximum leakage current in rated operation mA	Maximum leakage current under fault conditions mA	Power loss of RFI filter at rated operation W
322-018 322-037 322-055	1 ~ 198 V – 0 % to 252 V + 0 %	DE5-LZ1-007-V2	< 3.5	–	6
322-075 322-1K1		DE5-LZ1-012-V2	< 3.5	–	7
322-1K5 322-2K2		DE5-LZ1-024-V2	< 15	–	9
340-037 340-075 340-1K5 340-2K2	3 ~ 342 V – 0 % to 506 V + 0 %	DE5-LZ3-007-V4	< 3.5	< 32	7
340-3K0 340-4K0		DE5-LZ3-011-V4	< 3.5	< 62	10
340-5K5 340-7K5		DE5-LZ3-020-V4	< 10	< 120	14

Mains choke

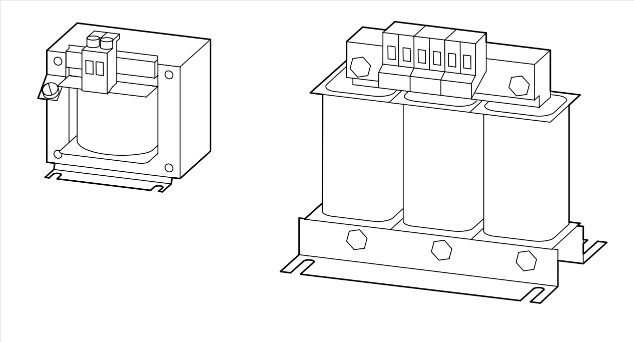


Figure 105: DE4-LN... mains choke

→ When the frequency inverter is operating at its rated current limit, the main choke causes a reduction of the frequency inverter's greatest possible output voltage (U_2) to about 96 % of the mains voltage (U_{LN}).

DV5-	Mains voltage	Mains current (I_{LN}) of the DV5 without mains choke	Assigned mains choke
322-018	1 ~ 230 V	3.1	DE4-LN1-037
322-037		5.8	DE4-LN1-037
322-055		6.7	DE4-LN1-075
322-075		9	DE4-LN1-1K5
322-1K1		11.2	DE4-LN1-1K5
322-1K5		16	DE4-LN1-2K2
322-2K2		22.5	DEK0,1-9,2
322-018	3 ~ 230 V	1.8	DE4-LN3-075
322-037		3.4	DE4-LN3-1K5
322-055		3.9	DE4-LN3-1K5
322-075		5.2	DE4-LN3-2K2
322-1K1		6.5	DE4-LN3-3K0
322-1K5		9.3	DE4-LN3-4K0
322-2K2		13	DE4-LN3-7K5
340-037	3 ~ 400 V	2	DE4-LN3-075
340-075		3.3	DE4-LN3-1K5
340-1K5		5	DE4-LN3-2K2
340-2K2		7	DE4-LN3-3K0
340-3K0		10	DE4-LN3-5K5
340-4K0		11	DE4-LN3-5K5
340-5K5		16.5	DE4-LN3-11K
340-7K5		20	DE4-LN3-11K

→ For technical data of the DE4-LN series mains choke, see installation instructions AWA8240-1711.

Connection examples

Operation through an external potentiometer

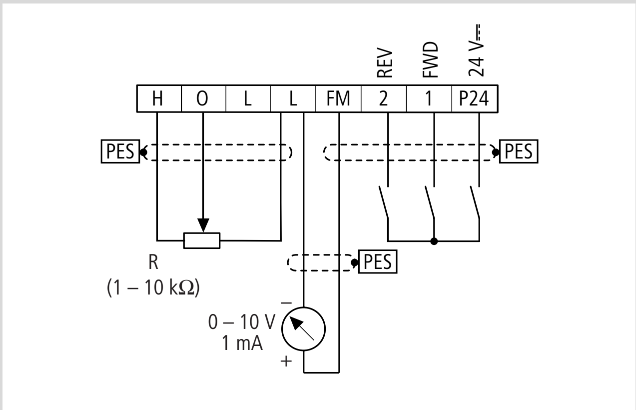


Figure 106: Connect an external potentiometer

Configuration of the parameters

PNU	Value	Function
A01	01	Setpoint value definition via control signal terminal strip
A02	01	Start signal via FWD/REV terminals
F02	10	Acceleration time in s
F03	10	Deceleration time in s
C01	00	FWD: Start clockwise rotation on digital input 1
C02	01	REV: Start anticlockwise rotation on digital input 2
C23	00	Display of the output frequency (analog) via the measurement device connected to terminals L and FM
b81	80	Adjustment of the analog frequency display connected to terminals L and FM

Method of operation

The frequency inverter can be started via terminal 1 in a clockwise direction and via terminal 2 in an anticlockwise direction. If both terminals are closed simultaneously, a stop command is issued.

With the externally connected potentiometer, the required frequency setpoint (voltage setpoint) can be defined.

The measurement device can be used to display the frequency (PNU C23 = 00) or the motor current (PNU C23 = 01). With PNU b81, you can adjust analog output FM to the corresponding measurement range of the measurement device (frequency or current can be displayed).

Operation through an analog setpoint value

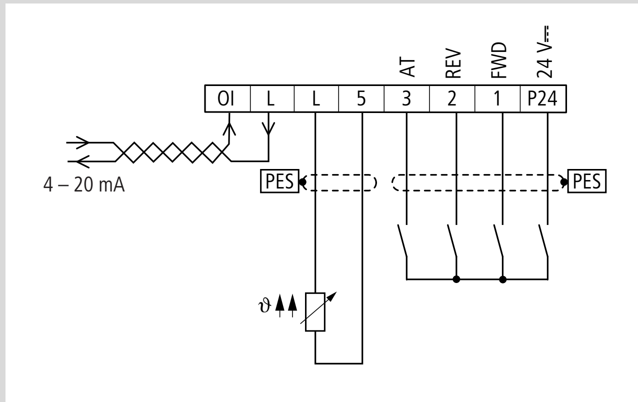


Figure 107: Analog setpoint value definition

Configuration of the parameters

PNU	Value	Function
A01	01	Setpoint value definition via control signal terminal strip
A02	01	Start signal via FWD/REV terminals
F02	10	Acceleration time in s
F03	10	Deceleration time in s
C01	00	FWD: Start clockwise rotation on digital input 1
C02	01	REV: Start anticlockwise rotation on digital input 2
C03	16	AT: Changeover to current setpoint value (4 to 20 mA)
C05	19	PTC: PTC thermistor on digital input 5

Method of operation

Inputs 1 and 2 function exactly as described in the previous example.

With digital input 3 (configured as AT), you can switch over from a voltage setpoint value (0 to 10 V) to a current setpoint value (4 to 20 mA).

Instead of the wiring on terminal 3, which is fixed or realized using a switch, you can set PNU A13 to 01. Digital input 3 is then configured as a break contact (NC).

The circuit example also includes the connection of the motor PTC thermistor. It is important to use a screened control cable and to lay the motor PTC thermistor cable separately from the other motor cables. However, the screen should be grounded at the inverter side only.

Operation with fixed frequencies

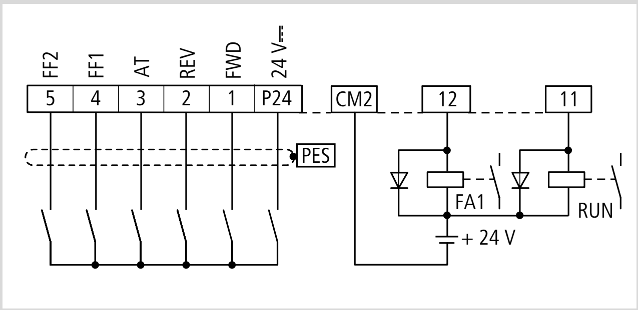


Figure 108: Fixed frequency definition

Configuration of the parameters

PNU	Value	Function
A01	01	Setpoint value definition via control signal terminal strip
A02	01	Start signal via FWD/REV terminals
F02	10	Acceleration time in s
F03	10	Deceleration time in s
C01	00	FWD: Start clockwise rotation on digital input 1
C02	01	REV: Start anticlockwise rotation on digital input 2
C03	16	AT: Changeover to current setpoint value (4 to 20 mA)
C04	02	FF1: Fixed frequency input 1
C05	03	FF2: Fixed frequency input 2
C21	00	RUN output signal on terminal 11
C22	01	FA1 output signal on terminal 12
A21	f_1	The fixed frequency which should be present when FF1 is active and FF2 is inactive is entered here.
A22	f_2	The fixed frequency which should be present when FF1 is inactive and FF2 is active is entered here.
A23	f_3	The fixed frequency which should be present when FF1 and FF2 are both active is entered here.

Method of operation

Inputs 1 and 2 function exactly as described in the first example.

With the activation of one or both fixed frequency inputs FF1 and FF2, the current frequency setpoint applied to the motor is replaced by the fixed frequency determined by FF1 and FF2, and the motor brakes or accelerates according to the fixed frequency applied. If neither of the fixed frequency inputs FF1 and FF2 is activated, the frequency setpoint is determined through analog inputs O (voltage setpoint value) or OI (current setpoint value). The wiring for these terminals is not shown in this circuit example. For the combination of the individual fixed frequency values, see Section ”Fixed frequency FF1 to FF4 selection”, Page 56.

The circuit example also includes the parameter definition for one output signal each on terminals 11 and 12. The type of output signal is configured with PNU C21 for digital output 11 and with C22 for digital output 12.

Abbreviations of parameters and functions

Designation Message	Function, description
2CH	2-stage Acceleration und Deceleration
AL	Alarm signal
AT	Analog input voltage/current select
AVR	Automatic Voltage Regulation
EXT	External Trip
FA...	Frequency arrival
FF...	Fixed Frequency
FRS	Free-run Stop
FWD	Forward Run
JOG	Jogging
OD	Output deviaton for PID control
OL	Overload advance signal
FM	Frequency monitor
PTC	Positive temperature coefficient
REV	Reverse Run
RST	Reset
RUN	Running signal
SFT	Software Look Function
USP	Unattended Start Protection

Standard form for user defined parameter settings

The DV5 series frequency inverters have programmable parameters. In the free Setpoint columns below, you can list the changes you have made from the default settings.

PNU	Function	WE	Setpoint			
F01	Frequency setpoint value	0.0				
F02	Acceleration time 1 in s	10.0				
F202	Acceleration time 1 in s (second parameter set)	10.0				
F03	Deceleration time 1 in s	10.0				
F203	Deceleration time 1 in s (second parameter set)	10.0				
F04	Direction of rotation	00 (clockwise)				

PNU	Function	WE	Setpoint			
A01	Frequency setpoint definition via • 00: Potentiometer • 01: Input O/OI • 02: PNU F01 and/or A20	01				
A02	Start command definition via • 01: Input FWD/REV • 02: ON key	01				
A03	Base frequency	50				
A203	Base frequency (second parameter set)	50				
A04	Maximum end frequency	50				
A204	Final frequency (second parameter set)	50				
A11	Frequency with minimum setpoint value	0				
A12	Frequency with maximum setpoint value	0				
A13	Minimum setpoint value (in %)	0				
A14	Maximum setpoint value (in %)	100				
A15	Start frequency • 00: Apply PNU A11 to motor • 01: Apply 0 Hz to motor	01				
A16	Analog input filter time constant	8				
A20	Frequency setpoint definition (PNU A01 must be 02)	0.0				
A220	Frequency setpoint input (PNU A01 must be 02) (second parameter set)	0.0				
A21	1st fixed frequency	0.0				
A22	2nd fixed frequency	0.0				
A23	3rd fixed frequency	0.0				
A24	4th fixed frequency	0.0				
A25	5th fixed frequency	0.0				
A26	6th fixed frequency	0.0				
A27	7th fixed frequency	0.0				
A28	8th fixed frequency	0.0				
A29	9th fixed frequency	0.0				

PNU	Function	WE	Setpoint			
A30	10th fixed frequency	0.0				
A31	11th fixed frequency	0.0				
A32	12th fixed frequency	0.0				
A33	13th fixed frequency	0.0				
A34	14th fixed frequency	0.0				
A35	15th fixed frequency	0.0				
A38	Frequency in jog mode	1.0				
A39	Motor stop in jog mode via • 00: Free run • 01: Deceleration ramp • 02: DC braking	00				
A41	Boost characteristics • 00: Manual • 01: Automatic	00				
A241	Boost characteristic (second parameter set) • 00: Manual • 01: Automatic	00				
A42	Percentage voltage increase with manual boost	11				
A242	Percentage voltage increase on manual boost (second parameter set)	11				
A43	Maximum boost at x % of the base frequency	10.0				
A243	Maximum boost at x % of the base frequency (second parameter set)	10.0				
A44	V/*f* characteristic • 00: Constant torque curve • 01: Reduced torque curve • 02: SLV active	00				
A244	*U*/*f* characteristic (second parameter set) • 00: Constant torque curve • 01: Reduced torque curve • 02: SLV active	00				
A45	Output voltage (in %)	100				
A51	DC brake • 00: Inactive • 01: Active	00				
A52	DC braking starting frequency	0.5				
A53	DC braking waiting time	0.0				
A54	DC braking torque	0				
A55	DC braking duration	0.0				
A61	Maximum operating frequency	0.0				
A62	Minimum operating frequency	0.0				
A63	1st frequency jump	0.0				
A64	Jump width of the 1st frequency jump	0.5				
A65	2nd frequency jump	0.0				
A66	Jump width of the 2nd frequency jump	0.5				
A67	3rd frequency jump	0.0				
A68	Jump width of the 3rd frequency jump	0.5				

PNU	Function	WE	Setpoint			
A71	PID closed-loop controller • 00: Inactive • 01: Active	00				
A72	P component of the PID controller	1.0				
A73	I component of the PID controller	1.0				
A74	D component of the PID controller	0.0				
A75	Setpoint factor of the PID controller	1.00				
A76	Input actual value signal for PID controller • 00: Input OI • 01: Input O	00				
A81	AVR function • 00: Active • 01: Inactive • 02: Inactive during deceleration	02				
A82	Motor voltage for AVR function	230/400				
A92	2nd acceleration time	15.0				
A292	2nd acceleration time (second parameter set)	15.0				
A93	2nd deceleration time	15.0				
A293	2nd deceleration time (second parameter set)	15.0				
A94	Switch-over from the 1st time ramp to the 2nd time ramp via • 00: Input 2CH • 01: PNU A95 or A96	00				
A294	Switch-over from the 1st time ramp to the 2nd time ramp via • 00: Input 2CH • 01: PNU A95 or A96 (second parameter set)	00				
A95	Changeover frequency from first to second acceleration time	0.0				
A295	Changeover frequency from first to second acceleration time (second parameter set)	0.0				
A96	Changeover frequency from first to second deceleration time	0.0				
A296	Changeover frequency from first to second deceleration time (second parameter set)	0.0				
A97	Acceleration characteristic • 00: Linear • 01: S-curve	00				
A98	Deceleration characteristic • 00: Linear • 01: S-curve	00				

PNU	Function	WE	Setpoint			
b01	Restart mode • 00: Fault message • 01: 0 Hz Start • 02: Synchronization to current motor speed and acceleration • 03: Synchronization and deceleration	00				
b02	Permissible power failure duration	1.0				
b03	Delay time before restart	1.0				
b12	Tripping current for electronic motor protection device	I_e (Inverter)				
b212	Tripping current for electronic motor protection device (second parameter set)	I_e (Inverter)				
b13	Characteristic for electronic motor protection device • 00: Enhanced protection • 01: Normal protection	01				
b213	Characteristic for electronic motor protection device (second parameter set) • 00: Enhanced protection • 01: Normal protection	01				
b21	Motor current limitation • 00: Inactive • 01: Active in every operating status • 02: Inactive during acceleration, otherwise active	01				
b22	Tripping current for motor current limitation	$I_e \times 1.25$				
b23	Time constant of motor current limitation	1.0				
b31	Software dependent parameter protection • 00: Via SFT input; all functions inhibited • 01: Via SFT input; function F01 possible • 02: Without SFT input; all functions inhibited • 03: Without SFT input; function F01 possible	01				
b32	Magnetizing current	$I_e \times 0.58$				
b81	Calibration value for voltmeter on FM terminal	80				
b82	Increased start frequency (e.g. with high level of friction)	0.5				
b83	Carrier frequency (in kHz)	5.0				
b84	Initialization causes • 00: Clearing of the fault history register • 01: Selection of the default settings	00				
b85	Operating system = 01: European version	01				
b86	Frequency factor for display via PNU d07	1.0				
b87	OFF key • 00: Always active • 01: Not active with control via the FWD/REV terminals	00				
b88	Motor restart after removal of the FRS signal • 00: With 0 Hz • 01: With current motor speed	00				

PNU	Function	WE	Setpoint				
b89	Display when a remote operating unit is used • 01: Actual frequency • 02: Motor current • 03: Direction of rotation • 04: PID actual value • 05: Status of the digital inputs • 06: Status of the digital outputs • 07: Actual frequency multiplied by the frequency factor	01					
b90	Permissible relative percentage duty factor for built-in braking device	00					
b91	Type of motor stop when Off button is pressed • 00: Braking/deceleration ramp • 01: Free run stop	00					
b92	Configuration of fan operation • 00: Fan always switched on • 01: Fan switched on only when motor running	00					

PNU	Function	WE	Setpoint				
C01	Function of digital input 1 • 00: FWD, clockwise rotation • 01: REV, anticlockwise rotation • 02: FF1, first fixed frequency input • 03: FF2, second fixed frequency input • 04: FF3, third fixed frequency input • 05: FF4, fourth fixed frequency input • 06: JOG, jog mode • 07: DB, DC braking • 08: SET, second parameter set • 09: 2CH, second time ramp • 11: FRS, controller inhibit • 12: EXT, external fault • 13: USP, restart inhibit • 15: SFT, parameter protection • 16: AT, input OI is used • 18: RST, reset • 19: PTC, thermistor input (only digital input 5) • 27: UP, remote access/acceleration • 28: DWN, remote access/deceleration	00					
C02	Function of digital input 2 (values → PNU C01)	01					
C03	Function of digital input 3 (values → PNU C01)	02					
C04	Function of digital input 4 (values → PNU C01)	03					
C05	Function of digital input 5 (values → PNU C01)	18					
C06	Function of digital input 6 (values → PNU C01)	18					
C11	Digital input 1 • 00: Make contact • 01: Break contact	00					
C12	Digital input 2 (values → PNU C011)	00					
C13	Digital input 3 (values → PNU C011)	00					
C14	Digital input 4 (values → PNU C011)	00					
C15	Digital input 5 (values → PNU C011)	00					
C16	Digital input 6 (values → PNU C011)	00					

PNU	Function	WE	Setpoint			
C21	Signal on digital output 11 • 00: RUN signal • 01: FA1, frequency achieved • 02: FA2, frequency exceeded • 03: OL, overload • 04: OD, PID deviation exceeded • 05: AL, fault	01				
C22	Signal on digital output 12 (Values → PNU C021)	00				
C23	Display via FM output • 00: Frequency, analog • 01: Motor current, analog • 02: Output frequency, pulse signal	00				
C24	Signal at digital output K11-K12 (values → PNU C021)	00				
C31	Digital output 11 • 00: Make contact • 01: Break contact	01				
C32	Digital output 12 • 00: Make contact • 01: Break contact	01				
C33	Digital output K11-K12 (signalling relay) • 00: Make contact • 01: Break contact	01				
C41	Threshold for overload alarm on digital output 11 and 12	I_e				
C42	Frequency from which FA2 is switched on during acceleration	0.0				
C43	Frequency from which FA2 is switched off during deceleration	0.0				
C44	PID control deviation (in % of maximum setpoint value)	3.0				
C81	Compensation of setpoint signal at terminal O	Depending on inverter model				
C82	Compensation of setpoint signal at terminal OI					
C91 to C95	Reserved	Do not change the values of these parameters.				

PNU	Function	WE	Setpoint
H01	Autotuning mode • 00: Autotuning not active • 01: Autotuning/motor operation • 02: Autotuning/motor standstill	00	
H02	Selection of motor data • 00: Standard motor • 01: Use autotuning data	00	
H202	Selection of motor data (second parameter set)	00	
H03	Motor rating: 0.18/0.37/0.75/1.5/2.2/3.7 kW	Depending on inverter model	
H203	Motor rating (second parameter set)		
H04	Number of motor poles: 2/4/6/8	4	
H204	Number of motor poles (second parameter set)	4	
H05	Motor constant K_p	20	
H205	Motor constant K_p (second parameter set)	20	
H06	Motor stabilization constant	100	
H206	Motor stabilization constant (second parameter set)	100	
H20	Motor constant R_1	Depending on inverter model	
H220	Motor constant R_1 (second parameter set)		
H21	Motor constant R_2		
H221	Motor constant R_2 (second parameter set)		
H22	Motor constant L		
H222	Motor constant L (second parameter set)		
H23	Motor constant I_0		
H223	Motor constant I_0 (second parameter set)		
H24	Motor constant J		
H224	Motor constant J (second parameter set)		
H30	Autotuning: motor constant R_1		Do not change these parameters!
H230	Autotuning: motor constant R_1 (second parameter set)		
H31	Autotuning: Motor constant R_2		
H231	Autotuning: Motor constant R_2 (second parameter set)		
H32	Autotuning: Motor constant L		
H232	Autotuning: Motor constant L (second parameter set)		
H33	Autotuning: Motor constant I_0		
H233	Autotuning: Motor constant I_0 (second parameter set)		
H34	Autotuning: Motor constant J		
H234	Autotuning: Motor constant J (second parameter set)		

UL® Caution, Warnings and Instructions

Preparation for Wiring

Warning!
"Use 60/75 °C Cu wire only" or equivalent.

Warning!
"Open Type Equipment".

Warning!
"A Class 2 circuit wired with Class 1 wire" or equivalent.

Warning!
"Suitable for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 240 V maximum". For models DV5-322.

Warning!
"Suitabel for use on a circuit capable of delivering not more than 5000 rms symmetrical amperes, 480 V maximum". For models DV5-340.

Determination of Wire and Fuse Sizes

The maximum motor currents in your application determines the recommended wire size. The following table gives the wire size in AWG. The "Power Lines" column applies to the inverter input power, output wires to the motor, the earth ground connection, and any other component. The "Signal Lines" column applies to any wire connecting to the two green 7 and 8-position connectors just inside the front enclosure panel.

DV5-	Motor Output		Wiring		Applicable equipment
	kW	HP	Power Lines	Signal Lines	Fuse (class J) rated 600 V
322-018	0.18	1/4	AWG16/1.3 mm²	(*) 18 to 28 AWG/ 0.14 to 0.75 mm² shielded wire	10 A
322-037	0.37	1/2			
322-055	0.55	3/4			
322-075	0.75	1	AWG14/2.1 mm²		15 A
322-1K1	1.1	1 1/2	AWG14/2.1 mm²		15 A
322-1K5	1.5	2	AWG12/3.3 mm²		20 A (single ph.) 15 A (three ph.)
340-037	0.37	1/2	AWG16/1.3 mm²		3 A
340-075	0.57	1			6 A
340-1K5	1.5	2			10 A
340-2K2	2.2	3			10 A
340-3K0	3.0	4	AWG14/2.1 mm²		15 A
340-4K0	4.0	5	AWG14/2.1 mm²		15 A
340-5K5	5.5	7 1/2	AWG12/3.3 mm²		20 A
340-7K5	7.5	10	AWG12/3.3 mm²		25 A

(*) Use 18 AWG/0.75 mm² wire for the alarm signal wire (K11, K12, K14 terminals).

→ Field wiring must be made by a UL-listed and CSA-certified closed-loop terminal connector sized for the wire gauge involved. Connector must be fixed by using the crimping tool specified by the connector manufacturer.

→ Be sure to consider the capacity of the circuit-breaker to be used.

→ Be sure to use larger wires for the power lines if the distance exceeds 20 meters.

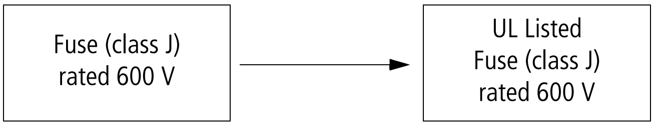
Terminal Dimensions and Tightening Torque

The terminal screw dimensions for all DV5 inverters are listed in Table 3 (→ Page 30) and Table 5 (→ Page 36). This information is useful in sizing spade lug or ring lug connectors for wire terminations.

When connecting wiring, use the tightening torque listed in the above mentioned tables to safely attach wiring to the connectors.

Warning!
When PNU b12 (level of electronic thermal setting) is set to device FLA, device provides Solid State motor overload protection at 115 % of device FLA or equivalent.

This PNU b12 (level of electronic thermal setting) is a variable parameter (→ Section "Electronic motor protection", Page 102).



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