Vector Frequency Inverter DV51
and
Keypad DEX-KEY-6...

Hardware and Engineering

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MOELLER

Think future. Switch to green.

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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 the device.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (AWA) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-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 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 does 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 an open circuit on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the extra-low voltage of the 24 V supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD384.4.41 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 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed and 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 injury or material damage, 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.).
- Depending on their degree of protection, frequency inverters may contain live bright metal parts, moving or rotating components or hot surfaces during and immediately after operation.
- Removal of the required 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 applicable national accident prevention and safety 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).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing frequency inverters must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the frequency inverters using the operating software are permitted.

- All covers and doors must be kept closed during operation.
- To reduce the hazards for people 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-wide measures (electrical or mechanical interlocks).
  – Never touch live parts or cable connections of the frequency inverter after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be live after disconnection. Fit appropriate warning signs.

Contents

About this manual

This manual describes the DV51 series frequency inverters.

It contains special information which is required for engineering, installation and operation of the DV51 frequency inverters. The features, parameters and functions are described in detail and illustrated with examples of the most important applications. All information applies to the specified hardware and software versions.

Abbreviations and symbols

The following abbreviations and symbols are used in this manual:

EMC	**E**lectro **M**agnetic **C**ompatibility
ESD	**E**lectro**s**tatic **D**ischarge
HF	**H**igh **F**requency
IGBT	**I**nsulated **G**ate **B**ipolar **T**ransistor
PES	**P** ositive **E**arth connection of the cable **S**creen
PNU	**P**arameter **Nu**mber
RCD	**R**esidual **C**urrent Protective **D**evice
DS	Factory **d**efault **s**etting

All measurements are in millimetres unless otherwise stated.

To improve the clarity of the illustrations, the enclosures of the frequency inverter and other safety components may not be shown in some figures. In practice, the frequency inverter must always be operated with the enclosure and all necessary components that affect equipment safety correctly fitted.

Read the manual thoroughly 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 electrical systems and the applicable principles and are able to read, interpret and apply the information contained in technical drawings.

▶ indicates instructions to be followed

→ Indicates useful 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.

Danger!
Warns about the possibility of major material damage and severe injury or death.

To improve 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. except on the title page of each section and the blank pages at the end of each section.

1 About the DV51 series

System overview

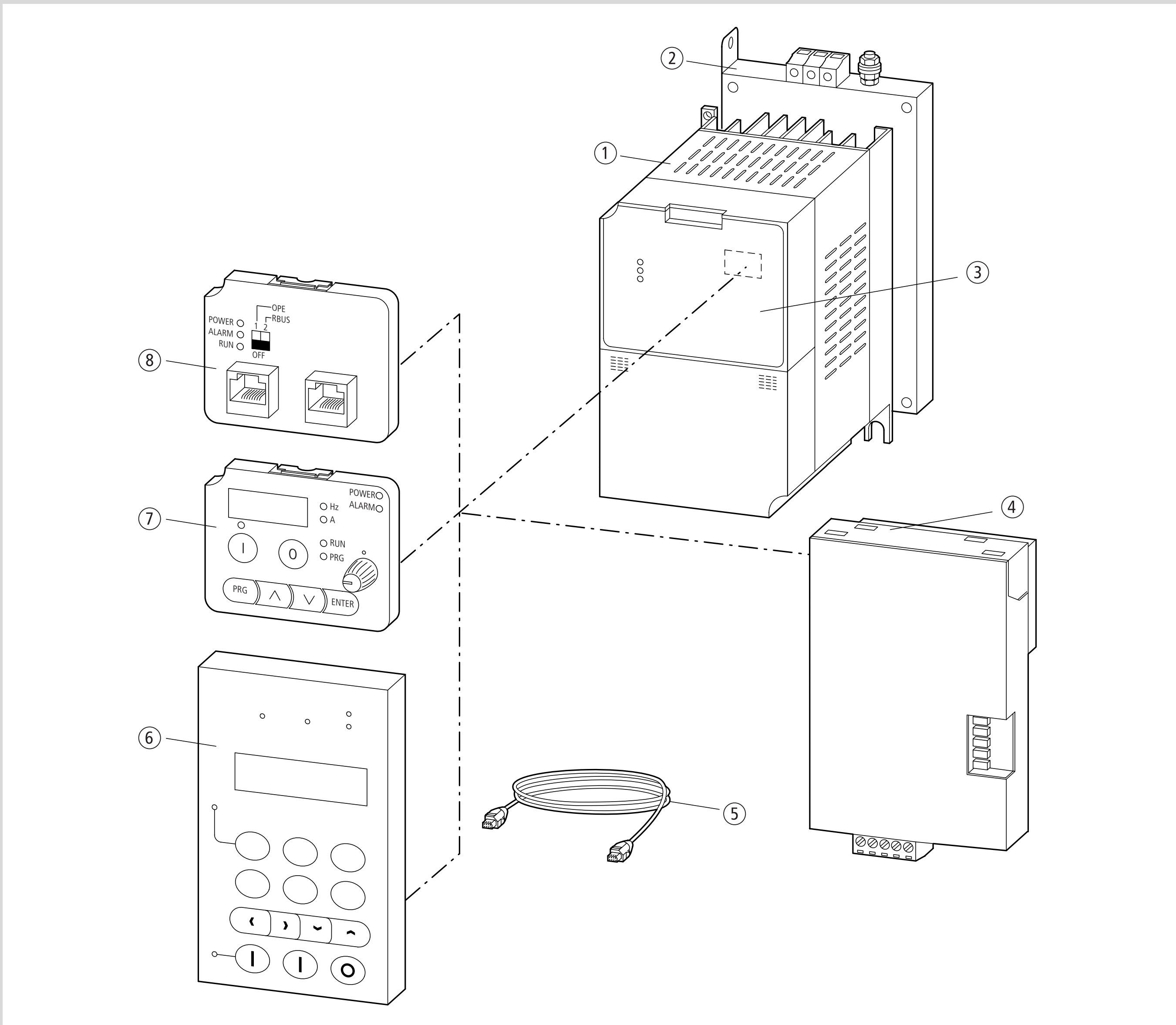


Figure 1: System overview

① DV51-... frequency inverter
② DE51-LZ... RFI filters
③ Cover with built-in DE51-KEY-FP LED display
④ Fieldbus module DE51-NET-CAN, DE51-NET-DP (CANopen, PROFIBUS DP)
⑤ DEX-CBL-...-ICS connection cables
⑥ DEX-DEY-10 external keypad
⑦ Optional LCD keypad DEX-KEY-6, DEX-KEY-61, for external or built-in use
⑧ Optional T adapter DEV51-NET-TC

Type code

Type codes and part numbers of the DV51 series frequency inverters:

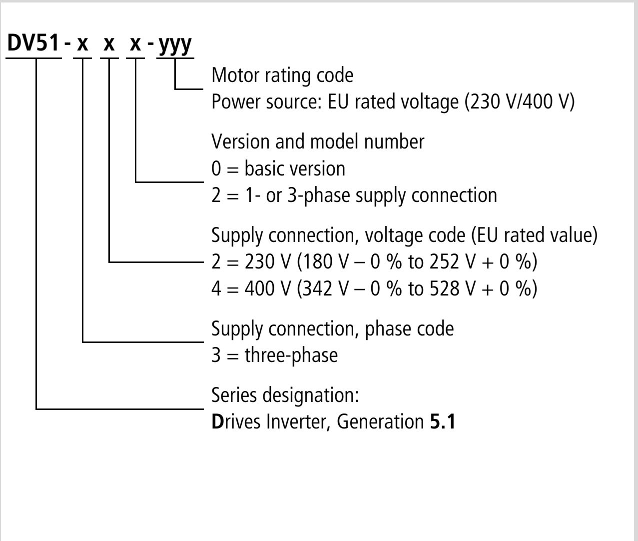


Figure 2: Type codes of the DV51 frequency inverters

Examples:

DV51-320-3K0	The DV51 frequency inverters
	Three-phase mains supply voltage: 230 V
	Assigned motor rating: 3 kW at 230 V
DV51-322-075	The DV51 frequency inverters
	Single-phase or three-phase supply: 230 V
	Assigned motor rating: 0.75 kW at 230 V
DV51-340-5K5	The DV51 frequency inverters
	Three-phase mains supply voltage: 400 V
	Assigned motor rating: 5.5 kW at 400 V

Rating and nameplate

The electrical connection ratings are printed on the terminal shroud.

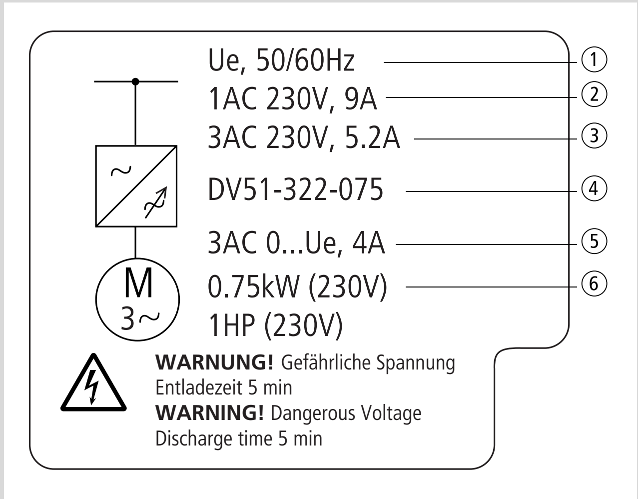


Figure 3: Terminal shroud example

① Ue = rated voltage (mains supply voltage) 230 V
50/60 Hz = mains frequency

② 9A = phase current at single-phase connection

③ 5.2A = phase current at three-phase connection

④ DV51-322-075 = part number

⑤ 3AC = three-phase output voltage in range from zero to mains supply voltage (Ue) rated current 4 A

⑥ 0.75 kW = assigned motor rating at rated voltage (230 V) or 1 HP (horse power)

The DV51's rating is recorded on the nameplate on the unit's side.

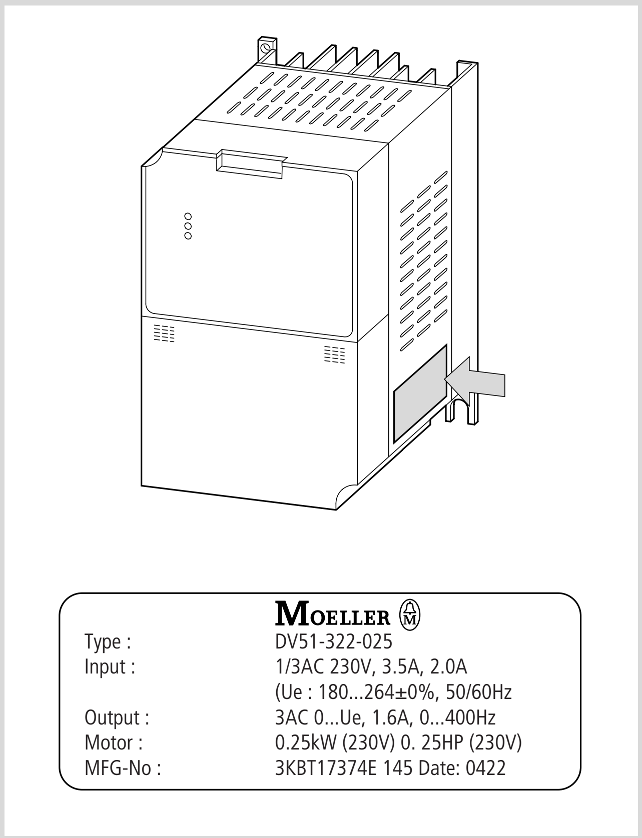


Figure 4: Nameplate of DV51 frequency inverter

The labelling has the following meaning (example):

Type	Part number:	DV51-322-025
Input	Mains input values: phases, rated voltage, phase current and permissible voltage range, mains frequency	1AC 230 V, 3.5 A 3 AC 230 V, 2.0 A (Ue: 180–264 V±0 %, 50/60 Hz)
Output	Motor output values: phases, voltage range, rated current, frequency range	3AC 0–Ue, 1.6 A, 0–400 Hz
Motor	Assigned motor rating at specified rated voltage:	0.25 kW (230 V) 0.25 HP (230 V)
MFG-No	Manufacturer number and date	3KBT17374E 145 Date: 0422

Inspecting the package content

The DV51 frequency inverters have been carefully packaged and prepared for 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 has been removed from its packaging.

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

- one DV51 frequency inverter
- installation instructions AWA8230-2147
- a CD with:
  - this manual in PDF format in English and other languages
  - the parameterization software for Windows PCs (98 to XP).

For the parameterization software you will need the connection cable with the DEX-CBL-2M0-PC interface converter (not included as standard).

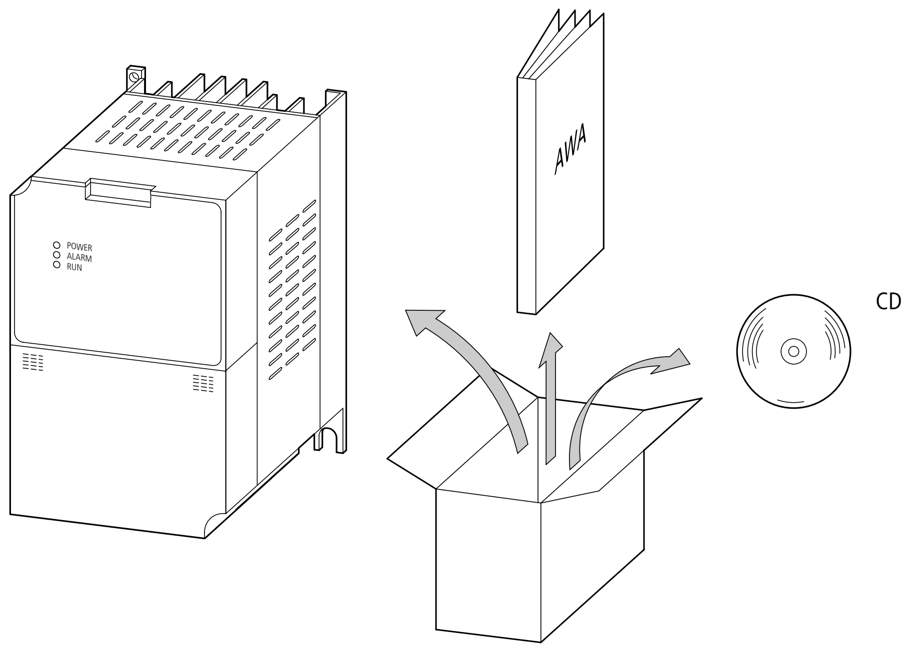


Figure 5: Equipment supplied

→ Check the nameplate attached to the frequency inverter (→ section "Rating and nameplate", page 8) to ensure that the frequency inverter is the type you have ordered.

Layout of the DV51

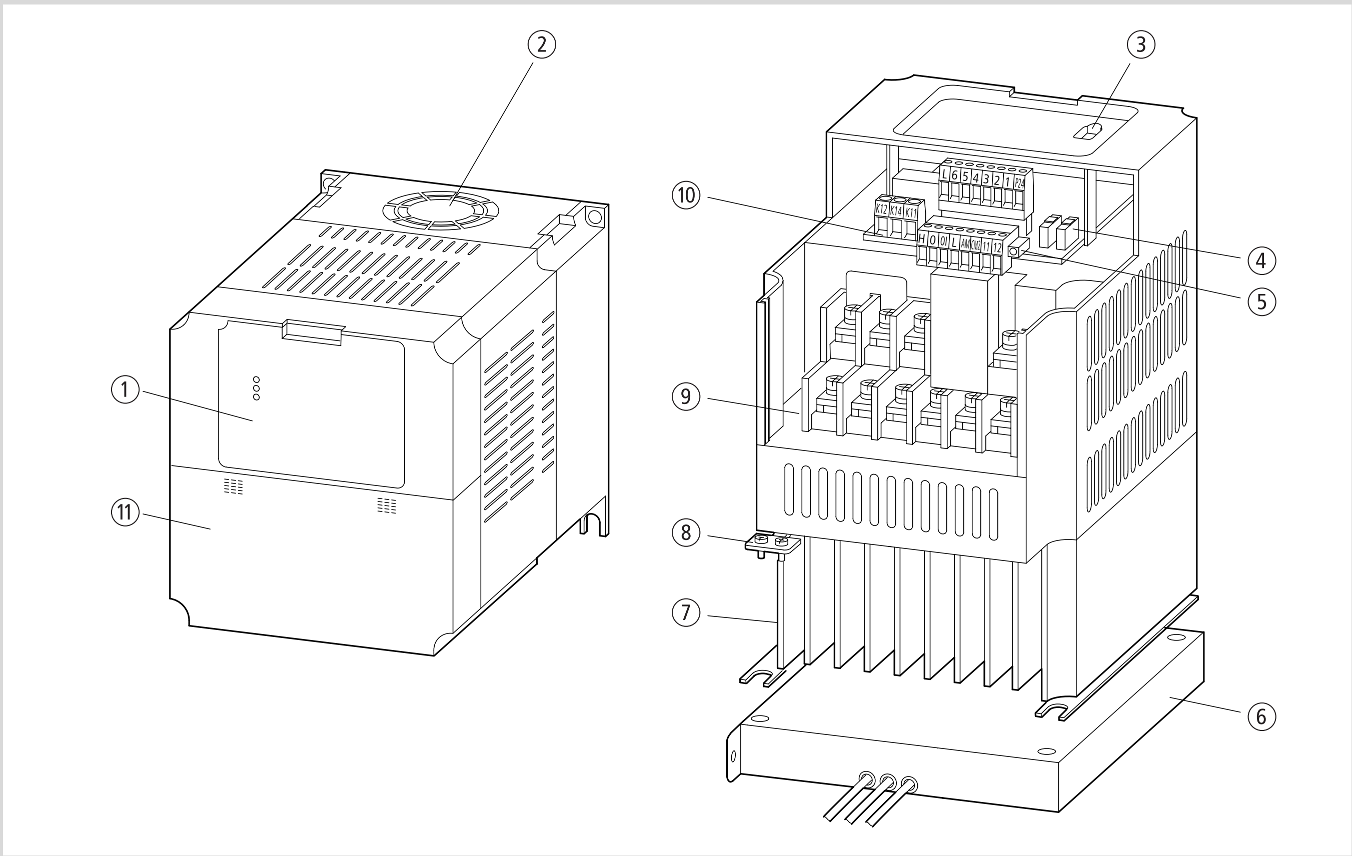


Figure 6: Overview of the DV51

① Cover with built-in LED display (DE51-KEY-FP)
② Device fan (DV51...1K5 to ...7K5 only)
③ RJ 45 communication interface (Modbus)
④ Microswitches
⑤ Plug-in control signal terminals
⑥ Earth connection (PE)
⑦ Optional radio interference filter
⑧ Heat sink
⑨ Power terminals
⑩ Signalling relay terminals
⑪ Terminal shroud (control section, power section)

Features of the frequency inverters

The DV51 frequency inverters 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.

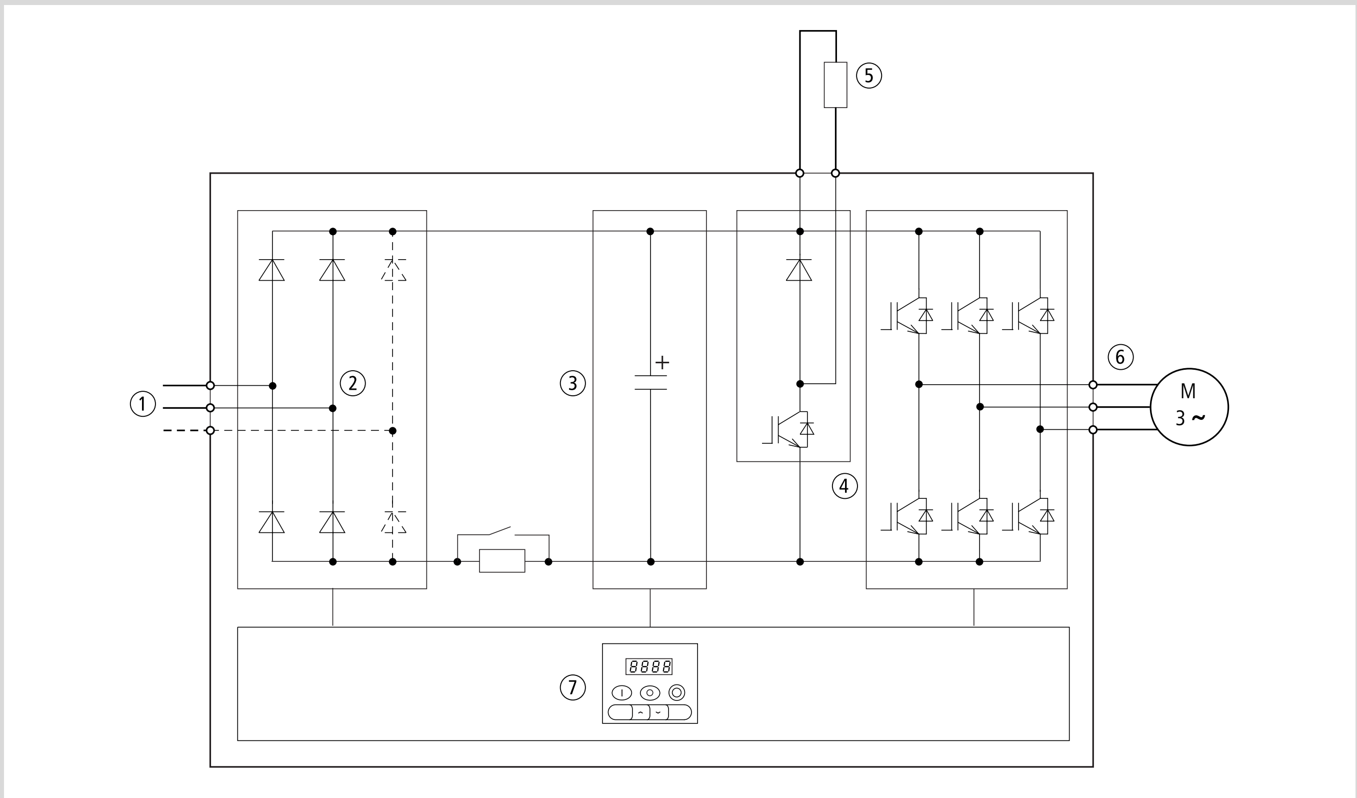


Figure 7: Function diagram of the frequency inverter

① Mains input
Mains voltage U_e (EU rated voltage):
DV51-320 3 AC 230 V, 50/60 Hz
DV51-322 1/3 AC 230 V, 50/60 Hz
DV51-340 3 AC 400 V, 50/60 Hz

② The bridge rectifier converts 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 (U_{ZK}) = $\sqrt{2}$ × mains voltage (U_e)

④ IGBT power inverter:
The power inverter converts the DC voltage of the internal DC link to a variable three-phase alternating voltage with variable frequency. The built-in 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 Optional: external braking resistance

⑥ Output voltage (U_2), motor connection:
three-phase, variable alternating voltage, 0 to 100 % of input voltage (U_e)
Output frequency (f_2): variable from 0 to 400 Hz
Rated output current (I_{2N}):
1.6 to 32 A (230 V series), 1.5 to 16 A (400 V series) with about 1.5 times starting current for 60 s, at an operating frequency of 5 kHz and an ambient temperature of 40 °C. Starting torque: 200 % at 1 Hz.
Motor connection, assigned shaft power (P_2):
0.25 to 7.5 kW at 230 V
0.37 to 7.5 kW at 400 V

⑦ Configurable control section with interface (RJ 45, Modbus).

Selection criteria

Select a suitable frequency inverter according to the rated motor current. The frequency inverter's rated output current must be greater than or equal to the motor's rated current.

The following drive data is assumed to be known:

- Type of motor (three-phase asynchronous motor),
- Mains voltage = supply voltage of the motor (for example 3 ~ 400 V),
- Rated motor current (guide value, dependent on the circuit type and the supply voltage)
- Load torque (square-law, constant, with 1.5 times the starting torque)
- Ambient temperature (rated value 40 °C).

→ If several motors are connected in parallel to the output of a frequency inverter, the motor currents are geometrically added, i.e. separately by active and reactive current components. When you select a frequency inverter, make sure that it can supply the total resulting current.

→ If you connect a motor to an operational frequency inverter, the motor draws a multiple of its rated current. When you select a frequency inverter, make sure that the starting current plus the sum of the currents of the running motors will not exceed the rated output current of the frequency inverter.

For the frequency inverter's rated output current, see the section "Technical data" in the appendix from page 201.

Intended use

The DV51 frequency inverters are not domestic appliances. They are designed only for industrial use as system components.

The DV51 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 markings on the DV51 frequency inverter 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).

In the described system configurations, DV51 frequency inverters are suitable for use in public and non-public networks. Depending on their location of use, external filtering may be necessary.

A connection to IT networks (networks without reference to earth potential) is permissible only to a limited extent, since the device's built-in filter capacitors connect the network with the earth potential (enclosure). On earth free networks, this can lead to dangerous situations or damage to the device (isolation monitoring required).

To the output of the frequency inverter (terminals U, V, W) you must not:

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

Observe the technical data and terminal requirements. For additional information, refer to the equipment nameplate or label and the documentation.

Any other usage constitutes improper use.

From DV5 to DV51

The vector frequency inverter DV51 is a development of the proven DV5 series. It shares its basic functions, terminal markings, menu structure, etc. with its predecessor, but features additional, new functions. The following list gives a short overview of the most important changes.

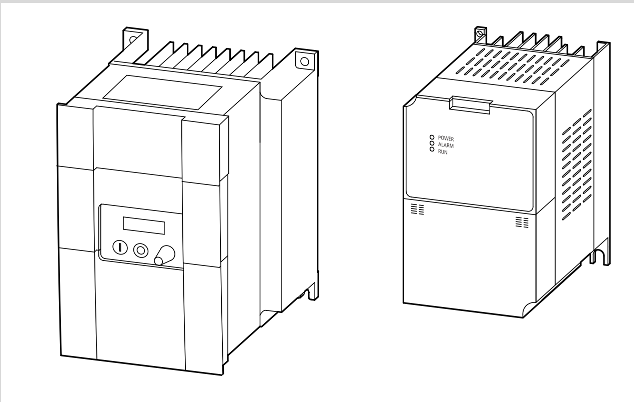


Figure 8: Comparison of DV5 with DV51

- Increased connected load: DV5-322-018 (180 W) → DV51-322-025 (250 W).
- Reduced the enclosure size and fewer enclosure versions. Same footprint dimensions: DV5-322-018, DV5-322-037, DV5-322-056 → DV51-322-025, DV51-322-037, DV51-322-055.
- Volume reduced by up to 48 % (w × h × d) for example DV5-340-4K0 (140 × 184.5 × 175 mm^3) → DV51-340-4K0 (140 × 130 × 166 mm^3)
- Compact design without built-in keypad. The DEX-KEY-6 keypad is available as an option and can also be used remotely, for example mounted on a control panel door with optional mounting frame DEX-MNT-K6.
- Modbus interface RS 485 with 19.2 kbit/s. An optional plug-in T adapter (DEV51-NET-TC) is available.
- Plug-in fieldbus modules for CANopen (Option DE51-NET-CAN) and PROFIBUS DP (Option DE51-NET-DP).
- Plug-in control terminals
- The parameter numbers (PNU) have been retained but – like the DF6 and DV6 series – now have an added, fourth digit. For example A0 becomes A001 and C03 is now C003.
- Extended functionality (e.g. PID controller).
- The new logic function allows logic linking (AND, OR, XOR) of the digital outputs as well as the addition and multiplication of the analog reference and actual values.
- The new intelligent sensorless vector control (iSLV) makes auto tuning and the alignment of the motor parameters unnecessary.
- Because of the units' modular design and extensive communication capability, the control hierarchy can now be defined with microswitches (485/OPE and TM/PRG).

Service and warranty

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

When you call, have the following information ready:

- Exact frequency inverter type designation (→ nameplate)
- Date of purchase
- Detailed 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 section describes the „Features of the DV51" and the requirements and standards relating to the following issues:

- Connection to power supply
- EMC Directive for PDS drive systems

Features of the DV51

General			
Standards			EN 50178, IEC 61800-3, EN 61800-3 incl. A11
Ambient temperature[1)]			
Operating temperature		°C	–10 to +40 with rated current I_e without reduced performance, up to 50 with pulse frequency reduced to 2 kHz and output current reduced to 80 % I_e
Storage, transportation		°C	–25 to +70
Mechanical shock resistance			Impacts and vibration: up to 5.9 m/s^2 (0.6 g) at 10 to 55 Hz
Pollution degree			VDE 0110 Part 2, pollution degree 2
Climatic proofing			Class 3K3 according to EN 50178 (non-condensing, average relative humidity 20 to 90 %)
Installation altitude		m	0 to 1000 a.s.l., up to 4000 m with reduced output current of 2 % I_e per 100 m
Mounting position			Vertically suspended
Free surrounding areas			100 mm above and below device
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		mA	< 3.5 (to EN 50178), without EMC filter
Degree of protection			IP 20
Protection against direct contact			Finger and back-of-hand proof
Protective isolation against switching circuitry			Safe isolation from the mains. Double basic isolation (to EN 50178)
Protective measures			Overcurrent, earth fault, overvoltage, undervoltage, overload, overtemperature, electronic motor protection: I^2t monitoring and PTC input (thermistor or thermostat)
Power section			
DV51-320-…			
Rated operational voltage		V AC	230
Rated voltage	U_e	V	3 AC 180 to 264 V ± 0 %
DV51-322-…			
Rated operational voltage		V AC	230
Rated voltage	U_e	V	1/3 AC 180 to 264 V ± 0 %
DV51-340-…			
Rated operational voltage		V AC	400
Rated voltage	U_e	V	3 AC 342 to 528 V ± 0 %
Mains frequency		Hz	50/60 (47 to 63 ± 0 %)
Modulation method			Pulse width modulation (PWM), *U/f* characteristic control, vector control
Switching frequency			5 kHz, adjustable from 2 to 14 kHz
Output voltage		V	3 AC U_e
Output frequency		Hz	0 – 50, max. 400

Frequency resolution		Hz	0.1 at digital reference values/maximum frequency/1000 at analog reference values
Frequency error limit at 20 °C ± 10 K			±0.01 % of maximum frequency at digital reference values, ±0.1 % of maximum frequency at analog reference values
Permissible overcurrent			150 % for 60 s, every 600 s
Torque during start			From 1 Hz: 200 % or higher
DC braking			DF 0 to 100 %, range: 0.5 to 60 Hz, braking time: 0 to 60 s
Braking transistor			Dynamic braking with external resistor (approx. 80 to 150 %)
Control section			
Internal voltages			
Control		V ⎓	24, max. 30 mA
Reference inputs		V ⎓	10, max. 10 mA
Analog and digital actuation			
Analog output			• 1 output • 0 – 10 V ⎓, max. 1 mA • Resolution 8 bit
Analog inputs			• 1 input, 0 to 9.6 V ⎓ (10 V normal), • Input impedance 10 kΩ • 1 input, 4 to 19.6 mA (20 mA normal), • Load resistor: 250 Ω • Resolution: 10 bit
Digital inputs			• 6 inputs, user-configurable • Up to 27 V ⎓ • Low: ≦ 2 V ⎓ • High: 17.4 … 27 V ⎓ • Input impedance 5.6 kΩ
Digital outputs			• 2 outputs • max. 27 V ⎓, max. 1 mA
Serial interface			RS 485 (Modbus RTU, up to 19.2 Kbit/s)
Relay, changeover contact			• 250 V AC, max. 2.5 A (resistive load) • 250 V AC, max. 0.2 A (inductive load, p.f. = 0.4) • AC 100 V, minimal 10 mA
			• 30 V DC, max. 3 A (resistive load) • 30 V DC, max. 0.7 A (inductive load, p.f. = 0.4) • DC 5 V, minimal 100 mA
Keypad (optional)			DEX-KEY-6, DEX-KEY-61
Operation			• 4 function keys for setting parameters • 2 function keys for actuation
Display			Four-digit 7-segment display and 8 LEDs (status indication)
Potentiometer			Reference input (for DEX-KEY-6)

1) If the frequency inverter is to be installed in a control panel, enclosure or similar installation, the temperature within the enclosure or control panel is considered to be ambient temperature T_a.
All power section ratings are based on an operating frequency of 5 kHz (default) and an ambient temperature of +40 °C, during operation of a four-pole three-phase asynchronous motor.

The following illustration provides an overview of the connections.

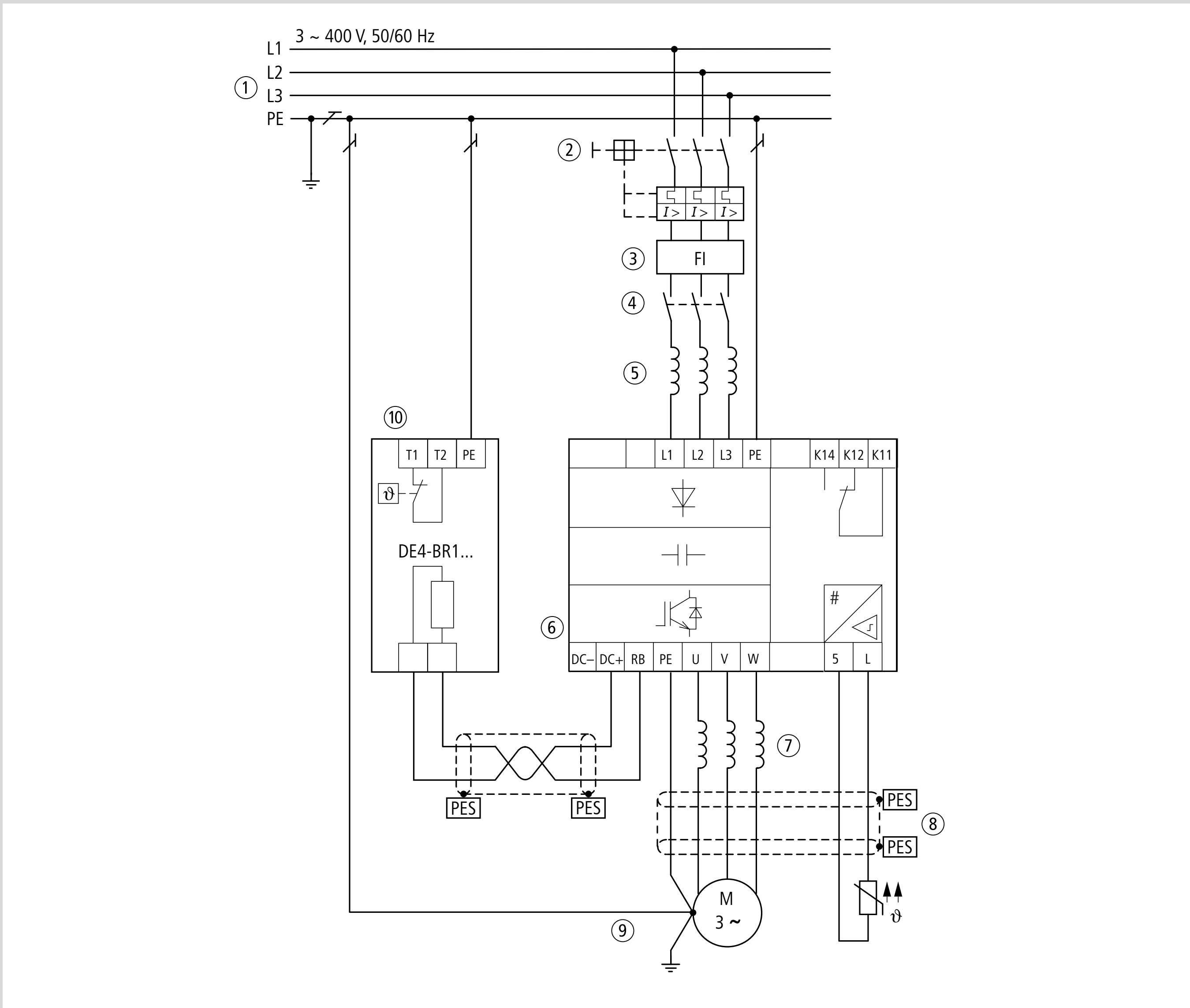


Figure 9: Power input connection overview

① Network configuration, mains voltage, mains frequency
Interaction with p.f. correction systems

② Fuses and cable cross-sections, line protection

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

④ Mains contactor

⑤ Line reactor, radio interference filter, line filter

⑥ Frequency inverter: mounting, installation
Power connection
EMC measures
Circuit examples

⑦ Motor filter
d*u*/d*t* filter
Sine-wave filter

⑧ Motor supply cables, cable lengths, shielding, motor protection,
Thermistor connection: terminals 5 and L

⑨ Motor connection
Parallel operation of multiple motors on a single frequency inverter

⑩ Braking resistors: terminals RB and DC+
DC bus voltage coupling: terminals DC+ and DC–
DC infeed: terminals DC+ and DC–
External braking units: terminals DC+ and DC–

Connection to power supply

The DV51 frequency inverters can not be used in every network configuration without limitations (network configuration according to IEC 364-3).

> **Warning!**
> Use only components (cables, FI switches, chokes, filters and contactors) that match the frequency inverter's rated values. Otherwise there is a danger of fire.

Mains configurations

Networks with earthed centre point (TT/TN networks):

- DV51 frequency inverters can be used without limitations in TT and TN networks. The ratings of the DV51 frequency inverters must, however, be observed.

> → If many frequency inverters with a single-phase supply are connected to the same supply network, they should be distributed symmetrically over all three phases and the load placed on the common neutral connection (mains r.m.s. current) must be taken into account. If necessary, the cross-section of the neutral pole must be increased, if it conducts the total current of all single-phase devices.

Networks with isolated centre point (IT networks):

- The use of DV51 frequency inverters in IT networks is only permissible to a limited extent. In the event of an earth fault in an IT system, the capacitors of the frequency inverter which are switched to earth are subjected to a very high voltage,

> **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. and safe operation of the frequency inverter is no longer guaranteed. To overcome this problem,fit additional isolating transformer to the frequency inverter's supply and earth the transformer's secondary side at its centre point to form, in effect, an individual TN network for the frequency inverter.

Mains voltage, mains frequency

The ratings of the DV51 frequency inverters cover European and American standard voltages:

- 230 V, 50 Hz (EU) and 240 V, 60 Hz (USA) for DV51-320 and DV51-322,
- 400 V, 50 Hz (EU) and 460 V, 60 Hz (USA) for DV51-340

The permissible mains voltage range is:

- 230/240 V: 180 V – 0 % to 264 V + 0 %
- 380/460 V: 342 V – 0 % to 528 V + 0 %

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

The motor rating to mains voltage assignments are listed in the appendix, section "Technical data", page 201.

Interaction with p.f. correction equipment

The DV51 frequency inverters absorb only a small fundamental reactive power from the AC supply. Compensation is therefore unnecessary.

> **Caution!**
> Operate DV51 series frequency inverters on mains with p.f. correction equipment only when this equipment is damped with chokes.

Fuses and cable cross-sections

The fuse ratings and cable cross-sections required for the network connection depend on the rating of the frequency inverter and the drive's operating mode.

> **Caution!**
> When selecting the cable cross-section, take the voltage drop under load conditions into account. Compliance to further standards (for example VDE 0113, VDE 0289) is the responsibility of the user.

The recommended fuses and their assignment to the DV51 frequency inverters are listed in the appendix, section "Mains contactors", page 227.

The national and regional standards (for example VDE 0113, EN 60204) must be observed and the necessary approvals (for example 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 must be used.

The leakage currents to earth (to EN 50178) are greater than 3.5 mA. The connection terminals marked PE and the enclosure must be connected to the earth circuit.

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

Residual current circuit-breakers

To protect persons and domestic animals, residual current circuit-breakers (RCCBs; also called earth-leakage circuit breakers or ELCBs) must be used. Universal current sensitive RCCBs according to EN 50178 and IEC 755.

	Identification on the residual-current circuit-breakers		
Logo			
Type	Alternating-current sensitive (RCD, Type AC)	Pulse-current sensitive (RCD, Type A)	universal current sensitive (RCD, Type B)

The Frequency inverters contain a built-in mains rectifier. When a frame fault occurs, a DC fault current can block the trip of the alternating current sensitive or pulse current sensitive residual-current circuit breaker, thereby preventing its protective function. We therefore recommend the use of:

- Pulse-current sensitive RCCBs with a rated fault current ≧ 30 mA for frequency inverters with a single-phase supply.
- universal RCCBs with a rated fault current ≧ 300 mA for frequency inverters with a three-phase supply.

The approximate fault current values of the DV51 frequency inverters and their assigned radio interference filters are listed in the appendix, section "RFI filters", page 225.

Spurious tripping of a residual-current circuit breaker can be caused by the following:

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

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

Warning!
Use only cables, residual-current circuit breakers and contactors with 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 or L and N (depending on its type) and allows the DV51 frequency inverter on the supplying network to be switched on and off during operation and to be disconnected in the event of a fault.

Mains contactors and their assignment to the DV51 frequency inverters are listed in the appendix, section "Mains contactors", page 227.

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 frequency inverter's input rectifier:

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

In these cases, a mains choke with about 3 % voltage drop at rated operation should be installed.

Line reactor

The line reactor (also called commutating or mains choke) is connected to the mains side input cables L1, L2 and L3, or L and N (depending on type). It reduces the harmonics and therefore – by up to 30 % – the apparent mains current.

A mains reactor also limits any current peaks caused by potential dips (for example caused by p.f. correction equipment or earth faults) or switching operations on the mains.

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

- with single-phase supplies (DV51-322),
- with derating (temperatures above +40 °C, sites of installation more than 1000 m above sea level),
- for 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 their assignment to the DV51 frequency inverters are listed in the appendix, section "Line reactor", page 229.

Line filters

Mains 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 drive unit's leakage current to earth increases. Observe this point when residual-current circuit-breakers are used.

EMC compliance

The DV51 frequency inverters operate with fast electronic switches (IGBTs). For this reason, radio interference can occur on the frequency inverter's output, which may effect other electronic devices in the direct vicinity, such as radio receivers or measurement instruments. To protect against this radio frequency interference (RFI), the devices should be screened and installed as far away as possible from the frequency inverters.

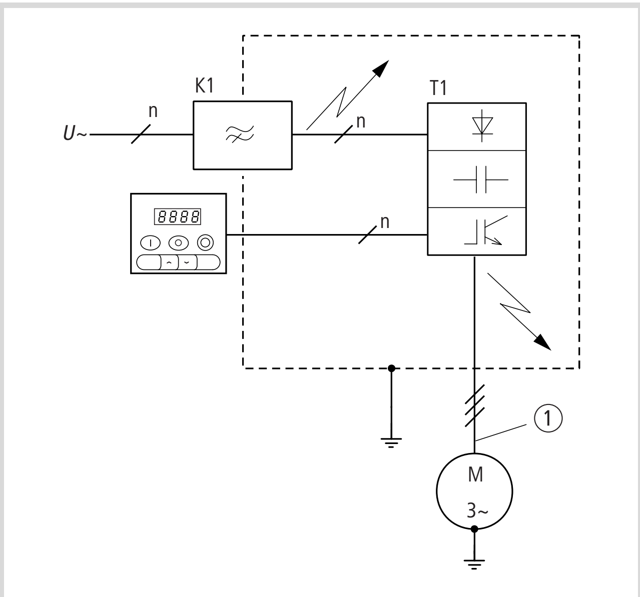


Figure 10: DV51 and radio interference filter in a sealed enclosure

K1: RFI filter

T1: Frequency inverter

① Screened motor cable20Proj_EMV_D.fm18956: t-figure-num-legend: Figure 1: DV51 and RFI filter in enclosure

EMC Directive for PDS drive systems

(PDS = Power Drive System)

In Europe, the EMC Directive must be adhered to by law.

The EMC product standard for drive systems is IEC/EN 61800-3 and EN 61800-3 including A11 (02/2001). This standard must also be maintained by law. The generic standards do not apply to drive systems, although many values are the same.

EN 61800-3 does not apply to the frequency inverter itself, but to a complete drive system including cable and motor. A drive system can consist of more than one drive. EN 61800-3 regards drive systems that consist of several drives as **a single** drive system.

Declarations of conformity relate to a "typical drive system" with given cable length, motor and filter for a single drive. The drive system's manufacturer is responsible for the complete drive system.

Interference immunity

If you use DV51 frequency inverters in European Union (EU) countries, you must observe EMC Directive 89/336/EEC. This includes compliance with the following conditions:

Supply voltage (mains voltage) for the frequency inverter:

- Voltage fluctuation ±10 % or less
- Voltage imbalance ±3 % or less
- Frequency variation ±4 % or less

If one of the conditions listed here cannot be fulfilled, you must install an appropriate mains choke (→ section "Line reactor" in the appendix, page 229).

Emitted interference and radio interference suppression

Used with the assigned radio interference filters, the DV51 frequency inverters meet the requirements of the EMC Product Standard IEC/EN 61800-3 for domestic use (first environment) and therefore also for the higher limit values of industrial environments (second environment).

Table 1: Category of limit values in IEC/EN 61800-3

First environment Power supply from the public mains, which also supplies households.	C1 Corresponds with CISPR 11 Class B	C2 Corresponds with CISPR 11 Class A Group 1 and Warning
Second environment Power supply from a network that does not supply households (industrial networks).	C2 Corresponds with CISPR 11 Class A Group 2 and Warning	C4 Corresponds with CISPR 11 Class A Group 2 or EMC plan

To ensure adherence to the limit values, observe the following points:

- Reduce performance-related interference with line filters and/or radio interference filters including line reactors.

- Reduce electromagnetic emission interference by screening motor cables and signal cables.
- Compliance with installation requirements (EMC-compliant installation).

EMC interference class

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 IEC/EN 61800-3 standard is complied to as follows:

- Limit values for emitted interference corresponding to first environment, interference immunity according to second environment (restricted and unrestricted putting into circulation) = universal use in both environments.
- Maximum cable length in the first environment is 10/20 m.
- The maximum cable length in the second environment is 50 m at 5 kHz operating frequency. Observe installation instructions (→ section “EMC measures in the control panel”, page 30).
- Single-phase frequency inverters can not be operated on the public mains with I_N < 16 A. (They exceed the maximum harmonics values in IEC/EN 61000-3-2, even with chokes fitted.) The values can be maintained only with an inverter on the mains side.

For further information, see section “EMC compliance”, page 29.

Motor and circuit type

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

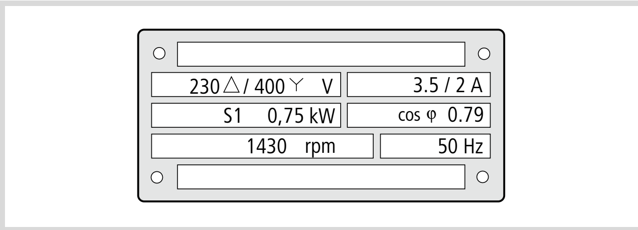


Figure 11: Example of a motor nameplate

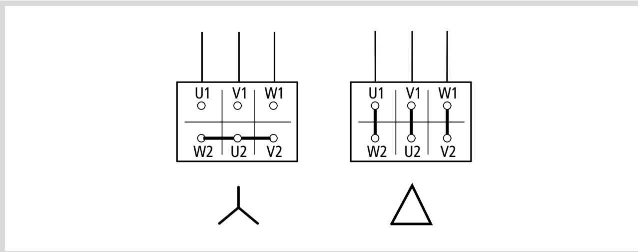


Figure 12: Connection types

Table 2: Assignment of frequency inverters to example motor circuit (fig. 11)

Frequency Inverters	**DV51-322-075**	**DV51-322-075**	**DV51-340-075**	**DV51-340-1K5**
Mains voltage	3-phase 230 V	Single-phase 230 V	3 AC 400 V	3 AC 400 V
Mains current	5.2 A	9 A	3.3 A	5 A
Motor circuit	Delta	Delta	Star	Delta
Motor current	3.5 A	3.5 A	2 A	3.5 A
Motor voltage	3 AC 0 to 230 V	3 AC 0 to 230 V	3 AC 0 to 400 V	3 AC 0 to 230 V
Motor speed	1430 r.p.m.	1430 r.p.m.	1430 r.p.m.	2474 r.p.m.$^{-1}$ 1)
Motor frequency	50 Hz	50 Hz	50 Hz	87 Hz 1)

1) Observe the motor’s limit values!

Connecting motors in parallel

The DV51 frequency inverters allow parallel operation of several motors in *U*/*f* control mode:

- *U*/*f* control: several motors with the same or different ratings. The sum of all motor currents must be less than the frequency inverter’s rated current.
- *U*/*f* control: parallel control of several motors. The sum of the motor currents plus the motors’ inrush current must be less than the frequency inverter’s rated current.

→ By default, DV51 frequency inverters are supplied with control mode SLV (Sensorless Vector Control) enabled. In this control mode parallel operation of several motors is not permissible.

Parallel operation at different motor speeds can be implemented only by changing the number of pole pairs and/or changing the motor’s transmission ratio.

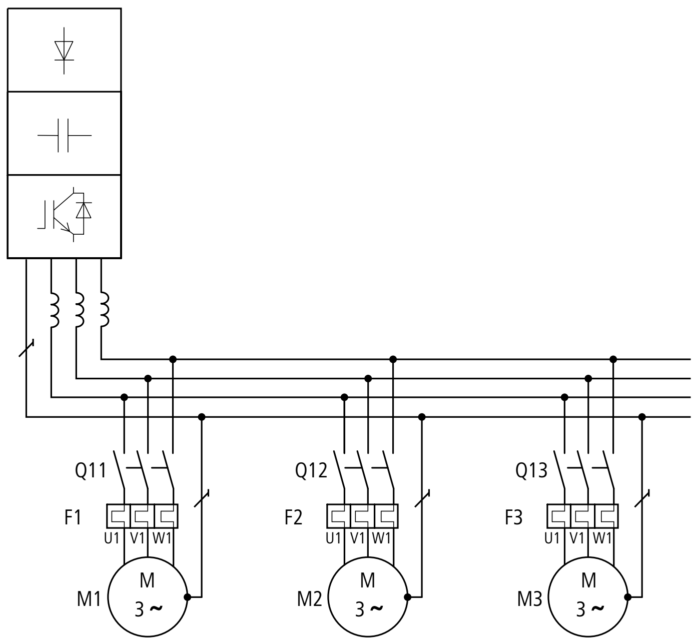


Figure 13: Parallel connection of several motors to one frequency inverter

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. Do not use the mains contactors listed in the table in the appendix (section "Mains contactors", page 227). These mains contactors are only designed for the mains (primary) currents of the frequency inverter. If contactors of this size are used in the motor circuit, the contacts could weld.

Connecting motors in parallel reduces the load resistance at the frequency inverter output and the total stator inductivity, and increases the leakage capacitance. As a result, the current distortion is larger than it is in a single-motor circuit. To reduce the current distortion, motor reactors or → section "Motor reactor"page 230→ section "Sine-wave filters"page 231 sine-wave filters can be connected at the frequency inverter output.

Example:
Copper wire winder

- 16 motors
- P = 60 W
- I = 0.21 A
- U = 400 V
- p.f. = 0.7
- Direct starting current: 2 A

If a wire breaks during winding, the corresponding motor is automatically switched off. When the wire is rejoined, the motor can be started up again. Only one motor can be started up at a time.

Frequency inverter selection:

15 motors in operation:	15 x 0.21 A	= 3.15 A
Connect one motor:		2.00 A
		5.15 A

DV51-340-2K2, rated current 5.5 A.

DEX-LM3-008 motor reactor

→ Constant Torque Curve control mode (→ PNU A044, or PUN 244,) necessary.

→ The current consumption of all motors connected in parallel must not exceed the frequency inverter's rated output current I_{2N}.

→ Electronic motor protection can not be used when operating the frequency inverter with several parallel connected motors. You must, however, protect each motor with thermistors and/or overload relays.

→ The use of motor-protective circuit-breaker at the frequency inverter's output can lead to nuisance tripping.

If motors with widely differing ratings (for example 0.37 kW and 2.2 kW) are connected in parallel to the output of a frequency inverter, problems may arise during starting and at low speeds. Motors with a low motor rating may be unable to develop the required torque due to the relatively high ohmic resistance of their stators. They require a higher voltage during the starting phase and at low speeds.

When an individual motor is switched into the frequency inverter's output, it behaves as if is connected directly to the electrical mains. When you select a frequency inverter, take into account the highest possible inrush current and use a motor reactor or a sine-wave filter.

Motor cable
To ensure EMC, use only screened motor cables. The length of the motor cables and related components has an influence on control mode and operating behaviour. In 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 caused by parasitic cable capacities can cause the "earth fault" message. In this case, motor filters must be used.

To optimize drive behaviour, keep the motor cables as short as possible.

→ If the cable from frequency inverter to motor is longer than about 10 m, the existing thermal relays (bimetallic relays) may malfunction due to high frequency harmonics. Install a motor reactor at the frequency inverter's output in this case.

Motor chokes, du/dt filters, sine-wave filters
Motor 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 chokes is recommended (observe the manufacturers instructions):

- for grouped drives
- three-phase asynchronous motors with a maximum frequencies above 200 Hz,
- for the operation of reluctance motors or permanently excited synchronous motors with maximum frequencies above 120 Hz.

d*u*/d*t* filters are used for limiting the rate of voltage rise at the motor terminals to values below 500 V/ms. They should be applied for motors with unknown or insufficient withstand voltage for the insulation.

▽ **Caution!**
During the engineering phase, keep in mind that the voltage drop across motor filters and d*u*/d*t* filters can be up to 4 % of the frequency inverter's output voltage.

When sine-wave filters are used, the motors are supplied with near-sinusoidal voltage and current.

▽ **Caution!**
During the engineering phase, keep in mind that the sine-wave filter must be matched to the output voltage and to the frequency inverter's pulse frequency.

The voltage drop at the sine-wave filter can be up to 15 % of the frequency inverter's 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 mechanically interlocked:

Caution!
A changeover between the frequency inverter and the mains supply must take place in a voltage-free state.

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

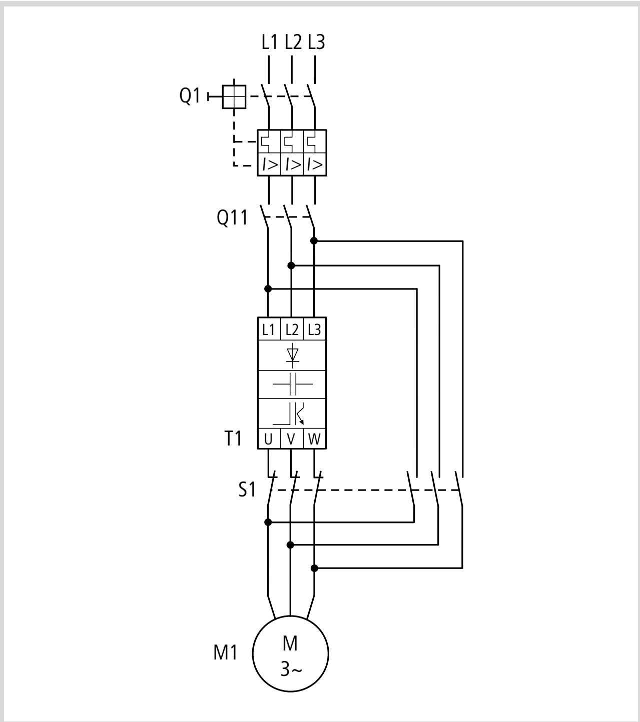


Figure 14: Bypass motor control

Caution!
Switch S1 must switch only when frequency inverter T1 is at zero current.

→ Contactors and switches (S1) in the frequency inverter's output and for DOL starting must be dimensioned for AC-3 and the motor's rated power.

Braking

Motor braking shortens unwanted deceleration distances and times. Braking can be mechanical or electrical.

Mechanical brakes act directly on the motor's rotating shaft and experience mechanical wear. The type of friction surface used depends on the brake's purpose:

- Emergency-Stop braking
- Normal braking during operation
- Holding brakes

Electrical braking – which does not cause wear – can be implemented with frequency inverters:

- DC braking
- Dynamic braking

DC braking

In DC braking – also called induction braking – the frequency inverter supplies three-phase current to the motor's three-phase stator winding. This creates a stationary magnetic field, which in turn induces a voltage in the moving rotor. Because the rotor's electrical resistance is low, even small induction voltages can cause a high rotor current and therefore a strong braking action. As the rotor slows down, the frequency of the induced voltage and with it the inductive resistance drops. The braking effect of the resistive load increases, but the resulting braking torque abruptly drops shortly before the rotor stops and disappears completely as soon as the rotor is stationary. DC braking is therefore not suitable for holding loads or for intermediate braking: once DC braking has been activated, the motor comes to a standstill. Note also that DC braking causes increased heat dissipation in the motor.

Dynamic braking

Dynamic braking allows a controlled speed reduction from a high motor speed to a specific lower speed. During dynamic braking, the motor operates in regenerative mode. The generated power is fed into the frequency inverter's internal DC link, which results in an excessive DC link voltage.

Combined with a braking resistor, frequency inverters with built-in braking transistors (also called braking choppers) can dissipate the braking energy in the form of heat. With the DV51 series, the braking transistor switches the optional external resistor with a pulse-pause ratio according to the supplied regenerative energy. The braking transistor is active only when the DC link voltage rises above the switching threshold during regenerative operation.

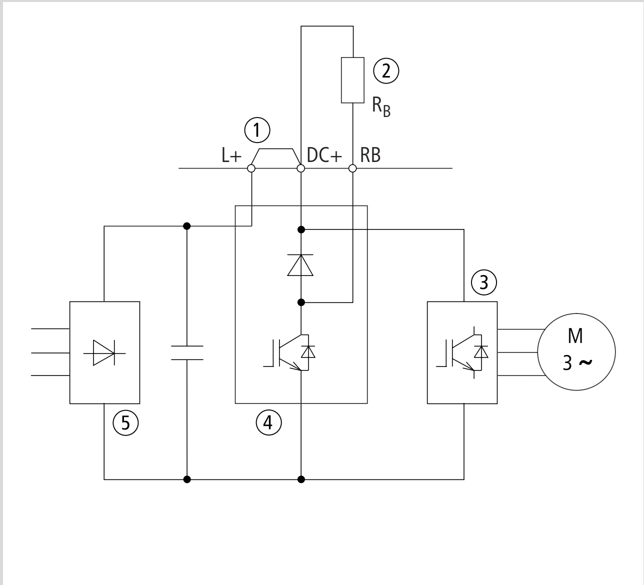


Figure 15: Braking transistor with external braking resistor

① Internal connection (DC link)
② External braking resistor (R_B)
③ Inverter and motor
④ Braking transistor
⑤ Rectifier and internal DC link capacitor

The combination of dynamic braking and DC braking provides optimum electrical braking: dynamic braking is used down to a defined frequency, below which DC braking is used. The DV51 frequency inverters implement this effective combination (→ section "Braking", page 132).

PID control

In closed-loop control systems – in contrast to open-loop control – the actual value of the controlled variable is automatically fed back to the controller. This control circuit consists of a controller and a controlled system. The controller's task is to adjust the actual value to the reference value in as short a time as possible, so that the difference between reference value and actual value (the system deviation) is as close to zero as possible.

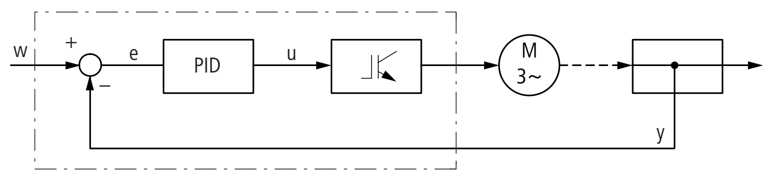


Figure 16: Block diagram of a closed-loop control system

w: Reference input variable (reference value)
e: System deviation (difference between actual value and reference value)
u: Manipulated variable for the frequency inverter
y: Controlled variable (measured or actual value)

Control device: here a frequency inverter with PID controller
Controlled system: here a motor with controlled variable

The PID control is a combination of **p**roportional, **i**ntegral and **d**ifferential components. The control parameters are the proportional-action coefficient K_P, the reset time T_N and the derivative action time T_V. Using all three control methods, PID control meets all basic requirements, such as:

- speed,
- stability,
- static accuracy,
- sufficient damping.

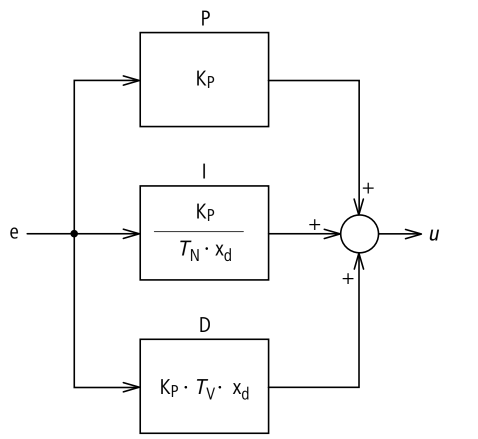


Figure 17: PID control

e: System deviation (difference between actual value and reference value)

u: Manipulated variable for the frequency inverter

K_P: Proportional-action coefficient (gain)

T_N: Reset time

T_V: Derivative action time

x_d: Deviation

In practice, PI control is often used next to PID control.

P: proportional component

Proportional control responds without delay and proportional to any system deviation but can not fully match the reference value so that a deviation always remains. Small values of K (normalizing constant) dampen the control action (i.e. reduce the rate of change), while large values result in instability.

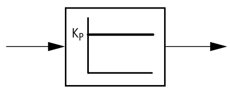


Figure 18: P-control

I: integral component

In integral control, the rate of change is proportional to the system deviation. This avoids fluctuations in the actual value due to overshoot but can not cope with rapid changes. With I-control, zero deviation (actual value = reference value) can be achieved.

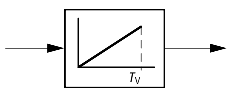


Figure 19: I-control

D: differential component

Differential control increases the value of K and therefore the rate of change while reducing system deviation. If the reference values is static, it does not issue a control signal. D-control is therefore used only in combination with P- or PI control.

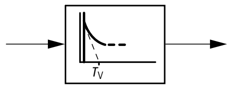


Figure 20: D-control

PID control represents an "ideal" combination, allowing fast, accurate compensation of system deviations. In variable speed control, PID controller are used mainly for controlling speed, pressures and flow rates. In all cases, an actual value sensor is required, which must provide the frequency inverter with a suitable signal (0 to 10 V or 4 to 20 mA).

→ PID-control for frequency inverters is not suitable for systems with a response time below 50 ms.

3 Installation

The DV51 frequency inverters are designed for installation in a control panel or a metal enclosure (for example to IP 54).

→ During installation or assembly operations on the frequency inverter, all ventilation slots and openings should be covered to ensure that no foreign bodies can enter the device.

Fitting the DV51

The DV51 frequency inverters must be mounted vertically on a non-flammable background.

Mounting position

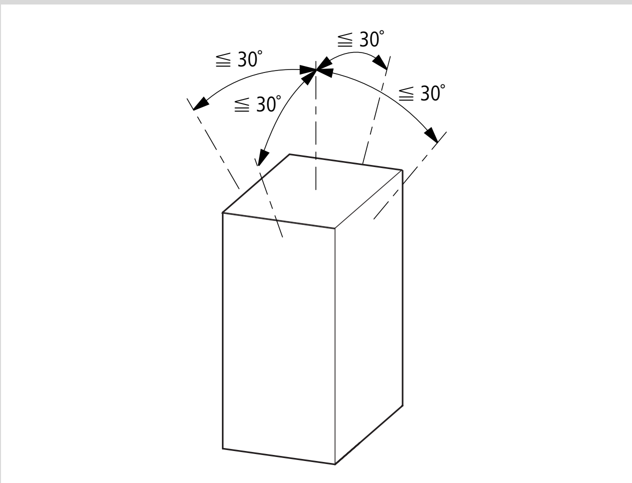


Figure 21: Mounting position

Fitting dimensions

A free space of at least 100 mm is required above and below the device to allow air circulation for cooling. There is no need to maintain a minimum space to the next device on either side.

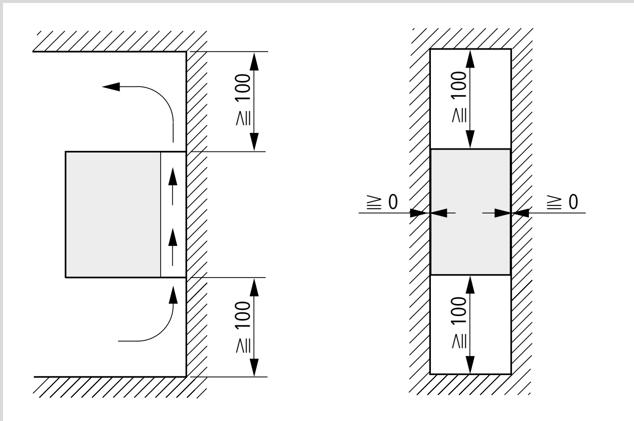


Figure 22: Fitting dimensions in the control panel

To allow connection of the power and control signal terminals, make sure that the terminal shroud can always be opened and closed without impediment.

Greater clearance dimensions are necessary if a fieldbus module (CANopen, PROFIBUS DP) is to be connected. A lateral spacing of about 10 mm is then recommended.

→ Do not fit devices with high magnetic fields (such as reactors or transformers) too near the frequency inverter.

→ Weights and dimensions of the DV51 are listed in the appendix in section "Weights and dimensions", page 205.

→ Minimum clearance dimensions for installation of DV51 inside an enclosure.

When you mount a DV51 in an individual enclosure, for example to increase its degree of protection, the distances to the enclosure walls must be at least as shown below.

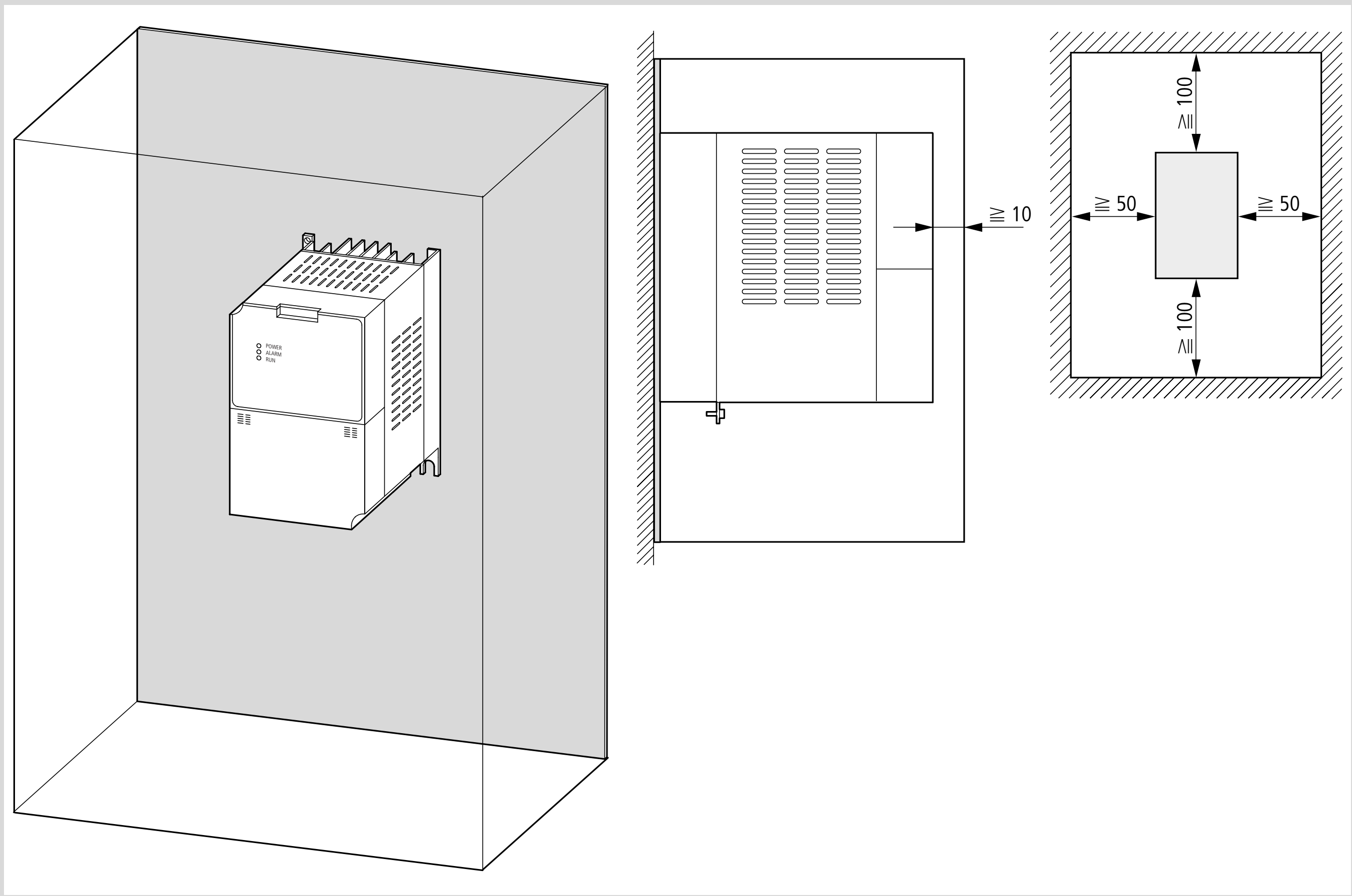


Figure 23: Minimum fitting dimensions in a full enclosure (local installation)

Mounting the DV51

Mount the DV51 frequency inverter as shown in fig. 24 and tighten the screws to the following torque values (→ table 3):

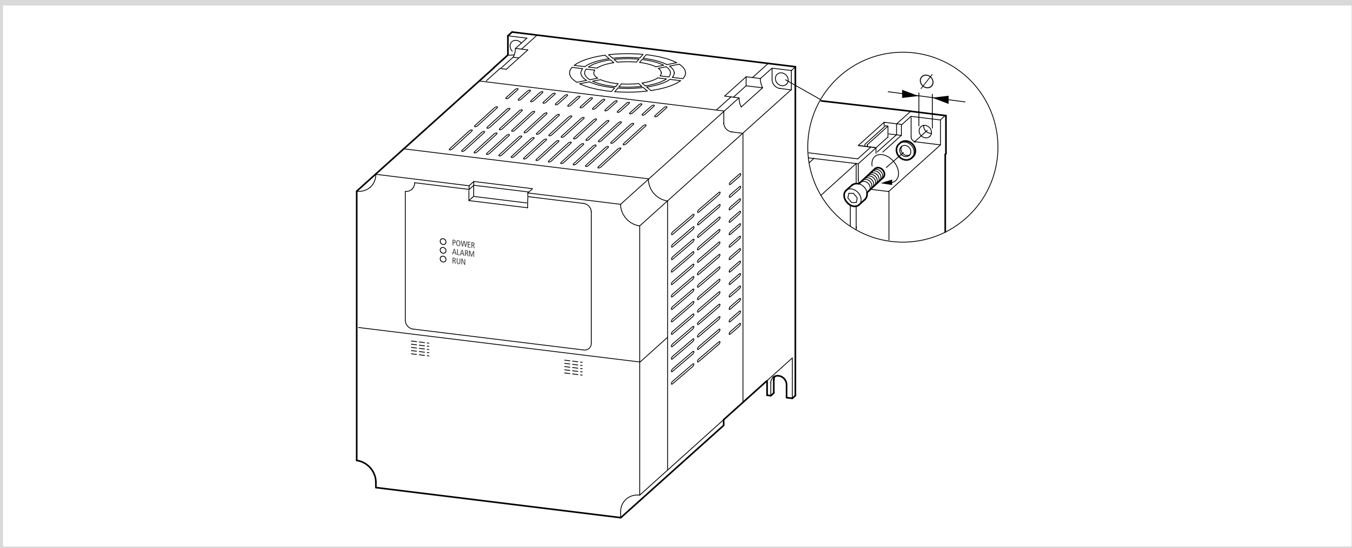


Figure 24: Mounting the DV51

Table 3: Tightening torques of the mounting screws

o [mm]		Nm	ft lbs
5	M4	3	2.6

EMC compliance

EMC-compliant installation

For an EMC-compliant installation, we recommend the following measures:

- 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 and immediately adjacent to the frequency inverter.
- Screened motor cables (short cable lengths).

▶ Earth all conductive components and the enclosure using as short a cable as possible.

Fitting a radio-interference (RFI) filter

The RFI filter should be installed immediately adjacent to 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 mounting surfaces for the frequency inverter and radio interference filter should be as free as possible from paint and oil residue.

The assigned DE51-LZ... radio interference filters (→ section "RFI filters" in the appendix, page 225) can be mounted under (footprint) or next to (book-type) the DV51 frequency inverter.

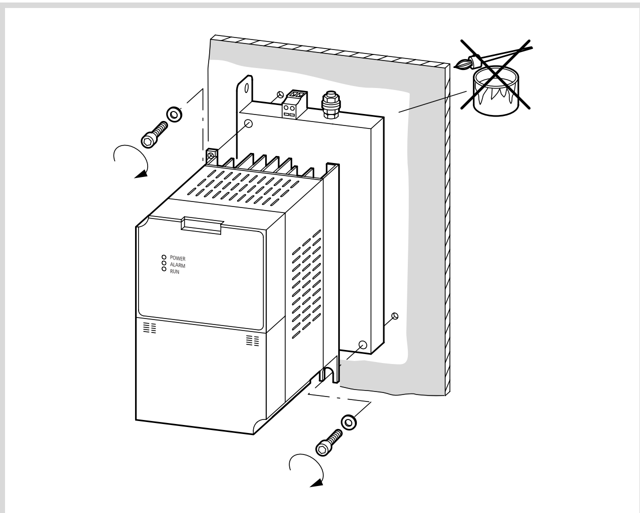


Figure 25: Footprint mounting

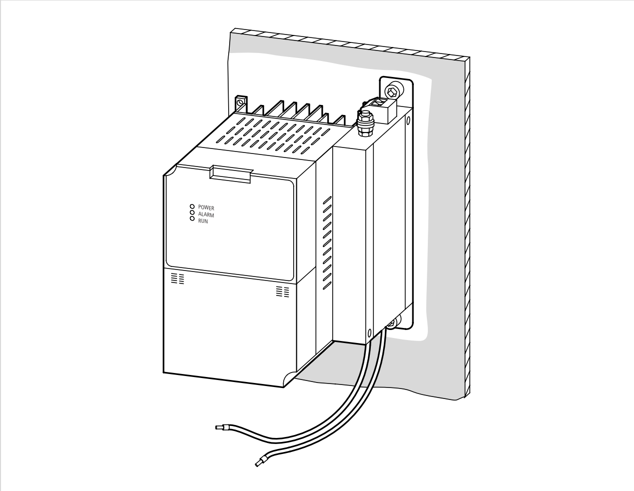


Figure 26: Book-type mounting (on right side in the example)

On the mains side, connect the RFI filter through the filter's screw terminals. Connect the filter's output lines inside the frequency inverter's power section after removing the terminal shroud.

Radio interference filters produce leakage currents which, in the event of a fault (phase failure, load unbalance), can be larger than the rated values. To prevent dangerous voltages, the filters must therefore be earthed before use. As the leakage currents are high-frequency interference sources, the earthing connections and cables must have a low resistance and large contact surfaces.

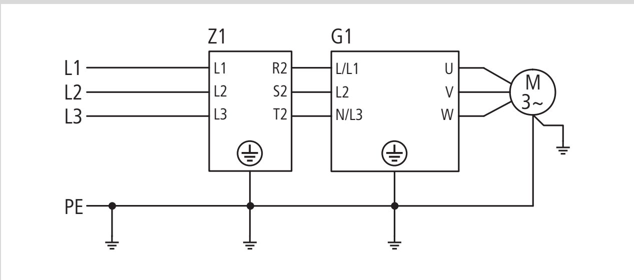


Figure 27: RFI filter connection

K1: RFI filter

T1: Frequency inverter

With leakage currents ≧ 3.5 mA, EN 60335 states that one of the following conditions must be fulfilled:

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

For DV51 frequency inverters, use the assigned DE51-LZ... filters.

EMC measures in the control panel

EMC compliance should already be ensured in the engineering phase: making changes during installation invariably results in higher costs.

To ensure an 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). 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.

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

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

To prevent transfer of electromagnetic energy, lay interference-suppressed cables (e.g. the mains supply line 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 crossovers are unavoidable, cables should always cross at right angles to each other.

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

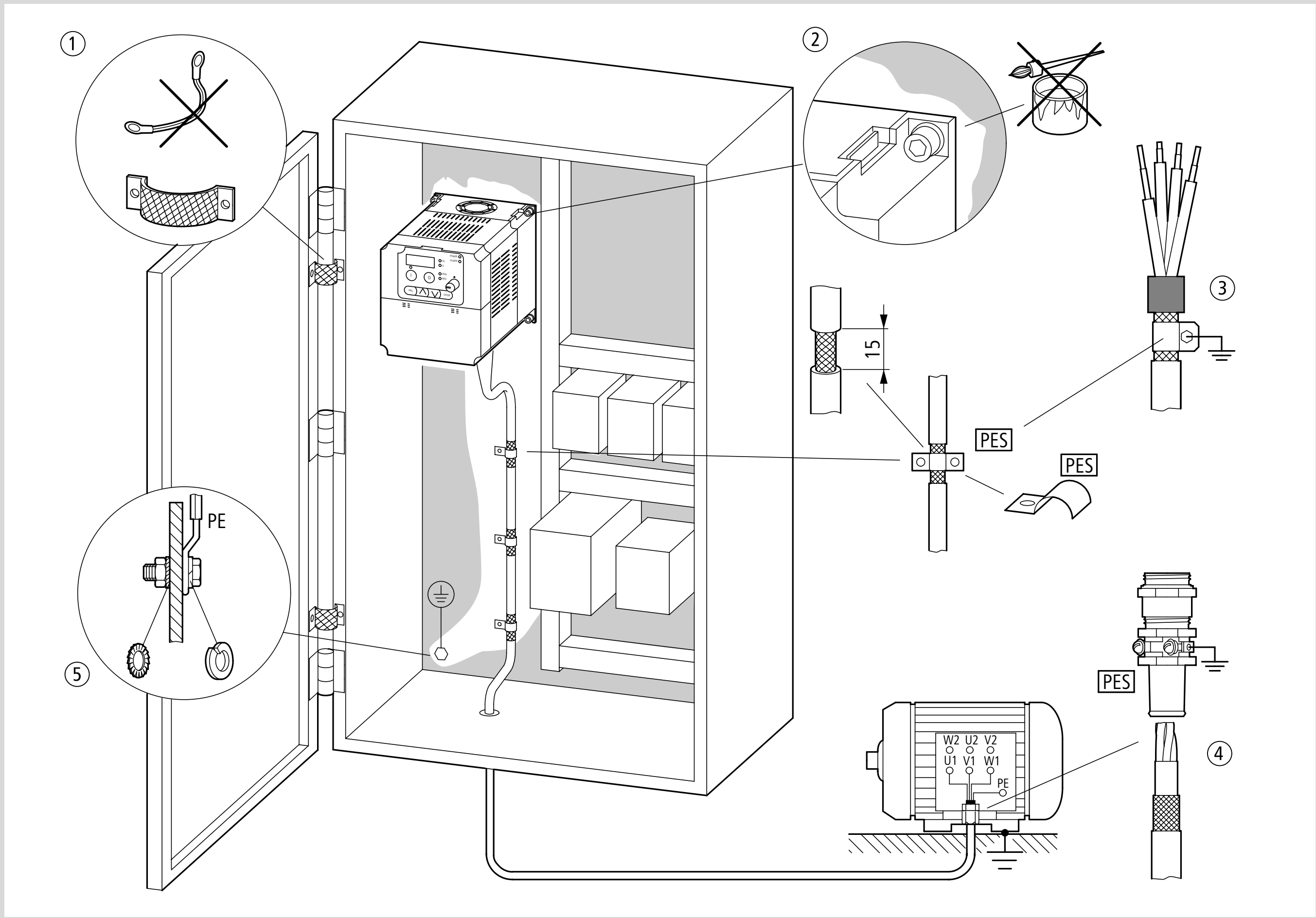


Figure 28: EMC-compliant setup

① Large-area connection of all metallic control panel components.
② Mounting surfaces of frequency inverter, RFI filter and cable screen must be free from paint.
③ Connect screens of cables at frequency inverter's output with earth potential (PES) across large surface area.
④ Large-area cable screen contacts with motor.
⑤ Large-area earth connection of all metallic parts.

Earthing

Connect the base (mounting) plate with the protective earth using a short cable. Connect all conducting components (frequency inverter, mains filter, motor filter, line reactor) by an HF wire and lay the protective conductor in a star configuration from a central earthing point. This achieves the best results.

Ensure that the earthing measures have been correctly implemented (→ fig. 29). 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.

All conductive components (frequency inverter, line filter, line reactor, motor reactor, etc.) should have a large-surface connection with the earth potential (mounting plate).

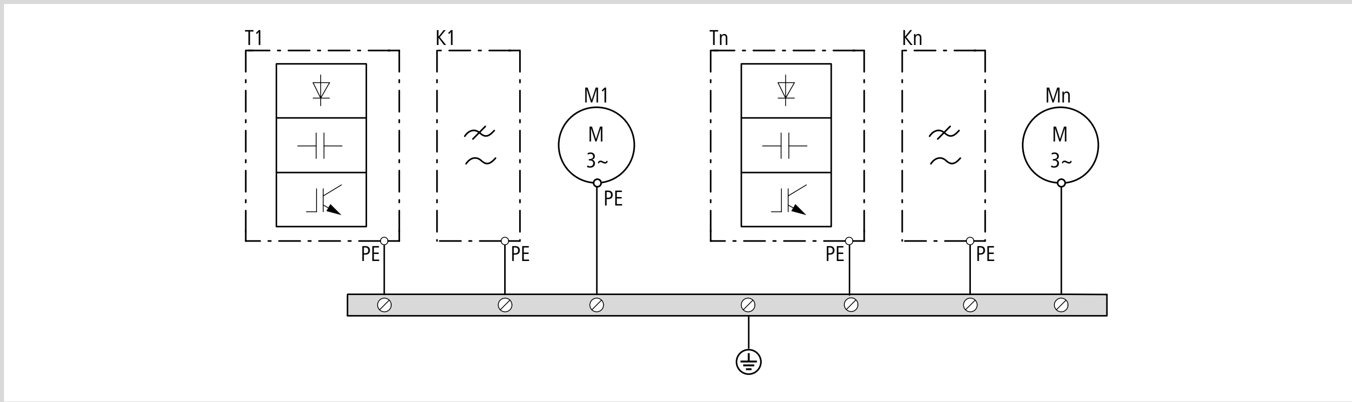


Figure 29: Star-type point-to-point earthing

Cable routing

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

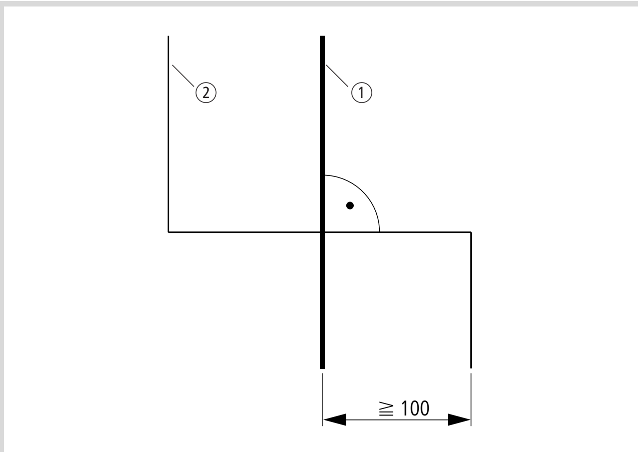


Figure 30: Crossover of signal and power cables

Example: DV51

(1) Power cable: L1, L2, L3 or L and N, PE, U, V, W, L+, DC+, DC–, RB

(2) Control and signal cables: H, O, OI, L, AM, 1 to 6 11 and 12, CM2, P24
Relay control cable: K11, K12, K14

If you are routing power and control cables in parallel, keep a distance of at least 100 mm between them.

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 reference and measured value cables).

Screening control and signal cables

→ To increase operational reliability, screen analog and digital control signal cables and lay them well away from the power cables.

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

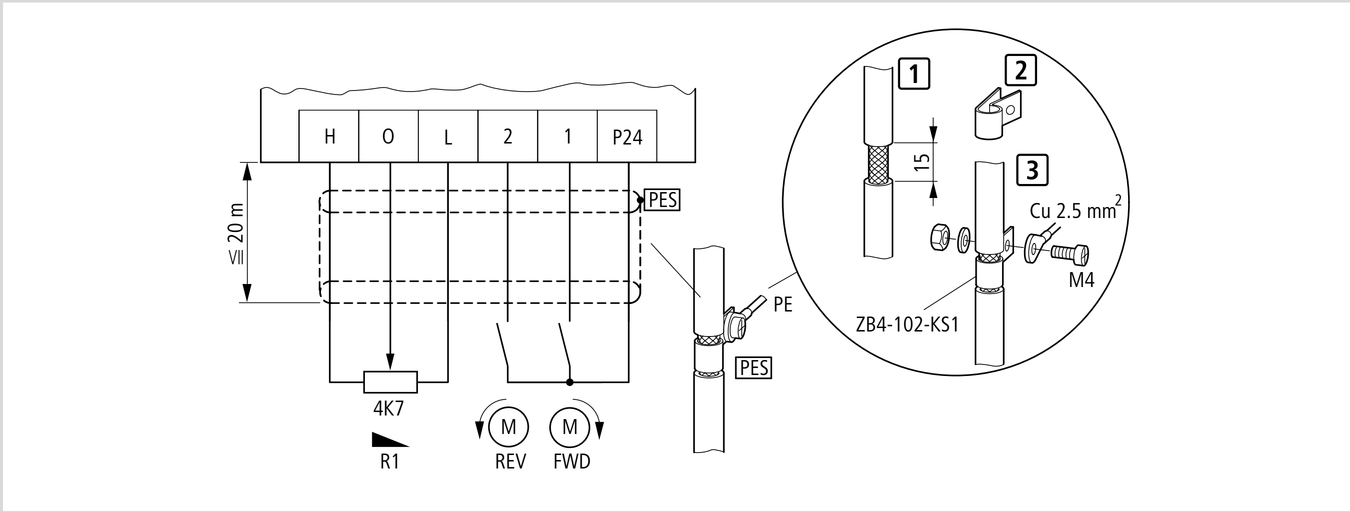


Figure 31: Control terminal connection (default setting)

→ With the optional ZB4-102-KS1, you can connect the control cable screens at one end. Order this item separately.

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°.

Screening motor supply cables

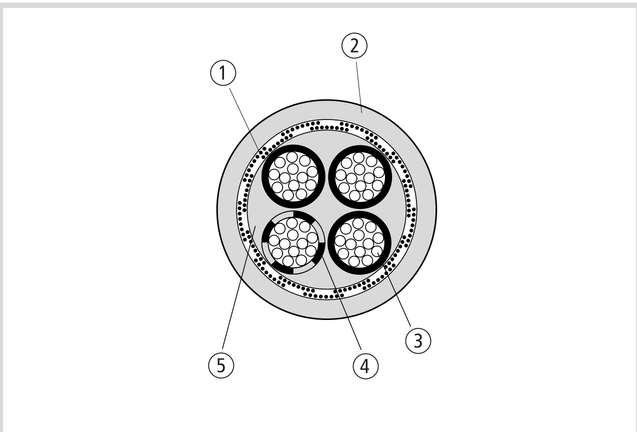


Figure 32: Sample motor cable

① C screen braid
② PVC outer sheath
③ Drain wire (copper 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.

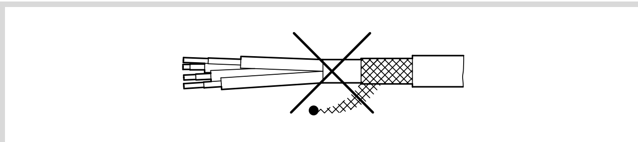


Figure 33: Inadmissible screen grounding (pigtails)

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 than about 100 mm.

Example: Maintenance switch

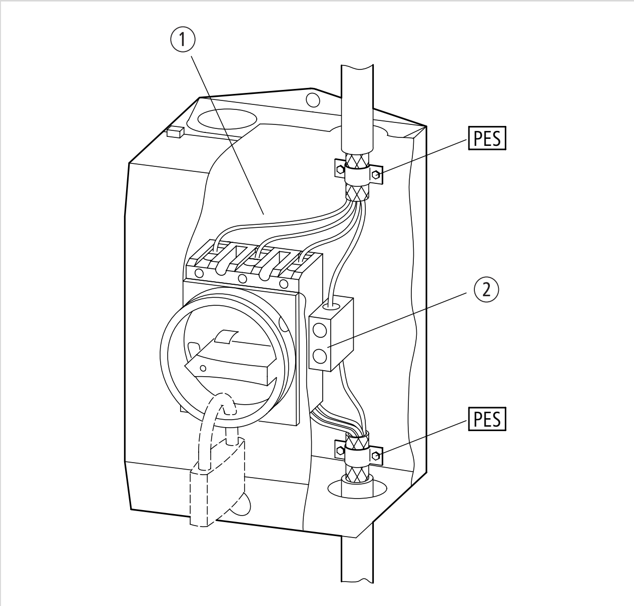


Figure 34: Maintenance switch, for example **T… in an enclosure**

① Metal plate, for example MBS-12 (→ Installation instructions AWA1150-2249)

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 at the control cabinet (PES) with a large surface area connection.

The control cable and signal (analog reference and measured value) cable screens must be connected only at one cable end. The screen connection must have a large contact surface and a low impedance. Digital signal cable screens must be connected at both cable ends, also with large-surface, low-resistance connections.

Electrical connection

This section describes how to connect the motor and the supply voltage to the power terminals, and the signal cables to the control terminals and the signalling relay.

Danger!
Carry out the wiring work only after the frequency inverter has been correctly mounted and secured. Otherwise, there is a danger of electrical shock or injury.

Danger!
Carry out wiring work only under zero voltage conditions.

Warning!
Use only cables, residual-current circuit breakers and contactors with a suitable rating. Otherwise there is a danger of fire.

Connecting the power section

To connect the power supply, motor cables and control signal cables, take off the terminal shroud.

Front cover

The electrical connections of the DV51 are made through plug-in control signal terminals and combination terminal screws in the power section, which is normally covered by a terminal shroud.

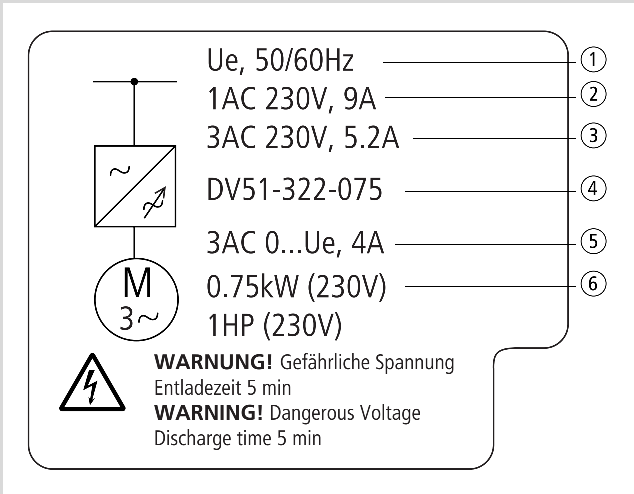


Figure 35: Terminal shroud example

① Ue = rated voltage (mains supply voltage) 230 V
50/60 Hz = mains frequency

② 9A = phase current at single-phase connection

③ 5.2A = phase current at three-phase connection

④ DV51-322-075 = part number

⑤ 3AC = three-phase output voltage in range from zero to mains supply voltage (Ue) rated current 4 A

⑥ 0.75 kW = assigned motor rating at rated voltage (230 V) or 1 HP (horse power)

Opening the terminal shroud

→ Complete the following steps with the specified tools and without using force.

To open the terminal shroud:

- ▶ Press down on the latches 1.
- ▶ Then pull the terminal shroud downwards 2.

On devices DV51-…-5K5 and DV51-…-7K5, the terminal shroud hinges downwards. and can be removed in its lowered position.

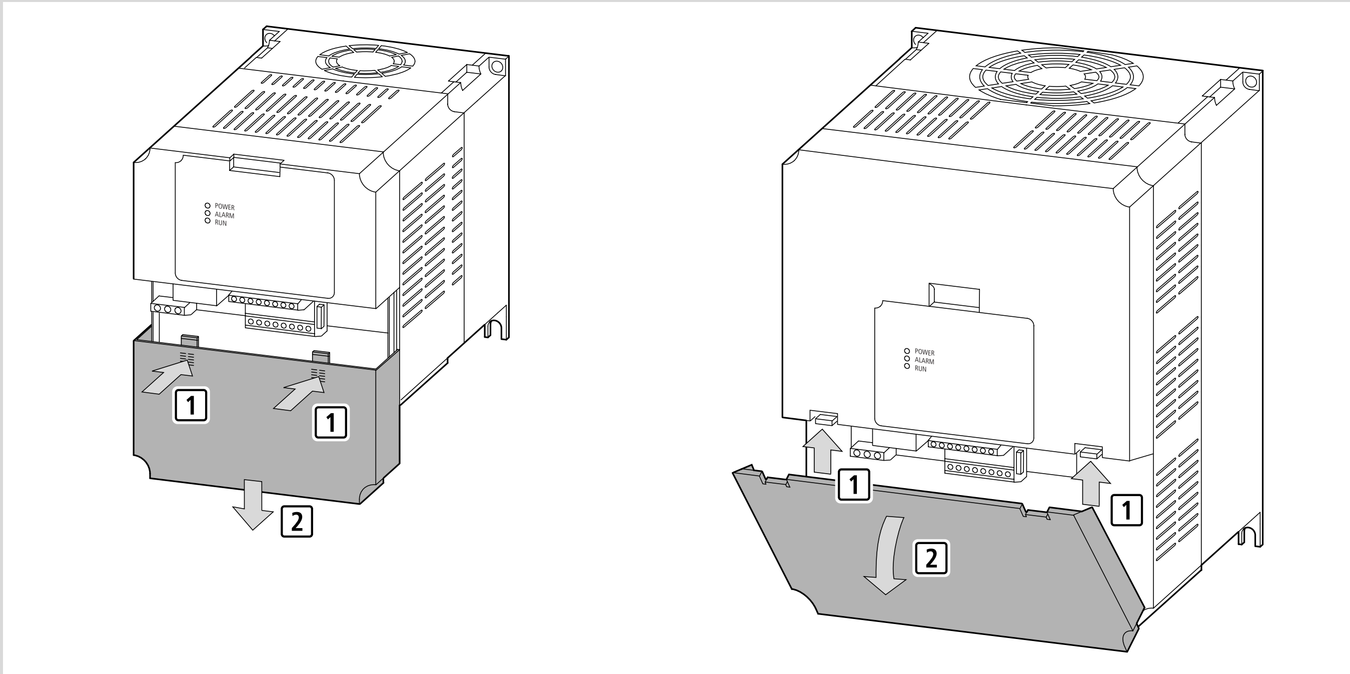


Figure 36: Opening the terminal shroud

▶ Pull out the cable retainer.

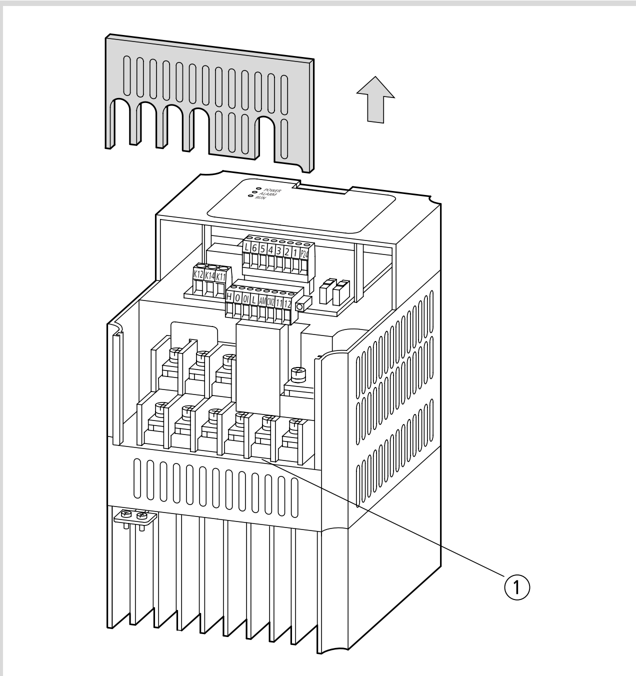


Figure 37: Removing the cable retainer

① Power terminals

Arrangement of the power terminals

The arrangement of power terminals depends on the size of the power section.

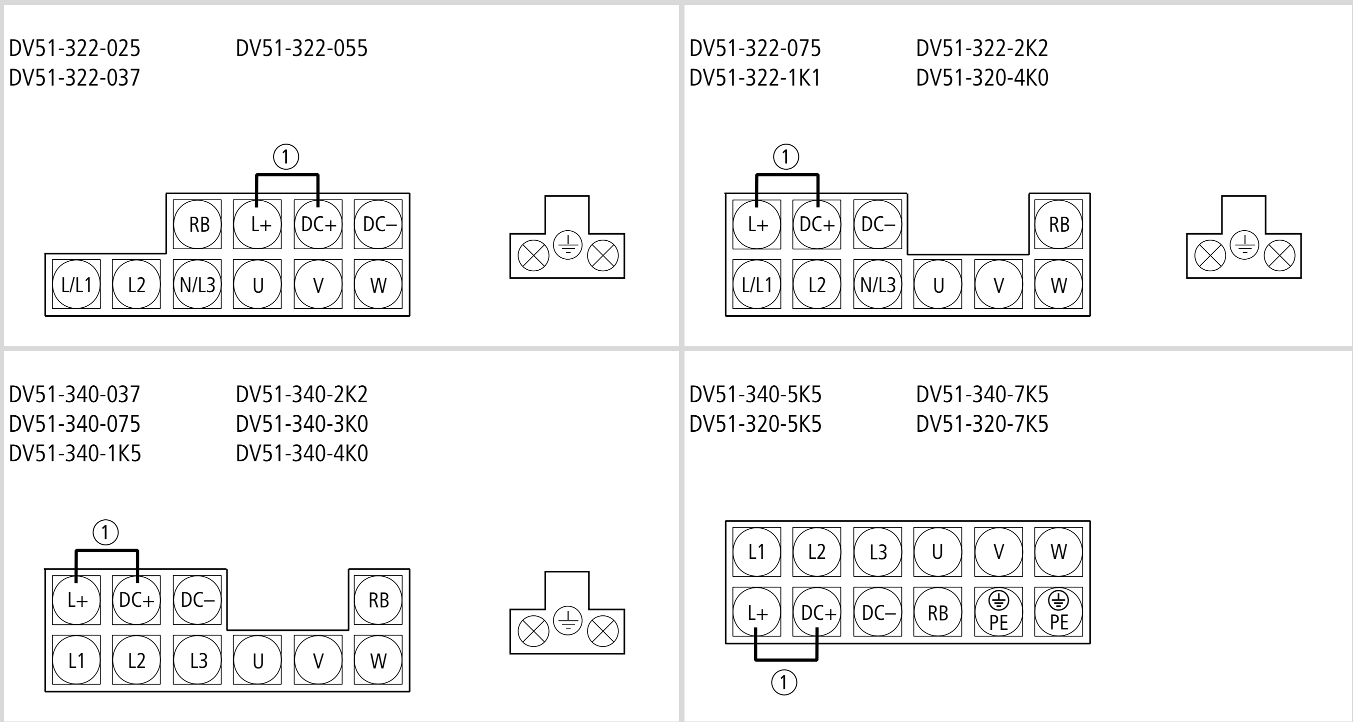
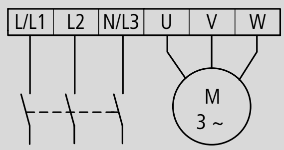


Figure 38: Arrangement of the power terminals

① Internal connection. Remove if a DC link choke is used.

Table 4: 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	Terminals L+ and DC+ are bridged with a jumper. If a DC link choke is used, the jumper must be removed.
DC+, DC–	Internal DC link	These terminals are used for connecting an optional external braking resistor and for DC linking and supplying DC multiple frequency inverters with DC power.
RB, DC+	External braking resistance	To these terminals, an optional external braking resistor can be connected to the built-in braking transistor.
⏚, PE	Earthing	Enclosure earthing (prevents dangerous voltages on metallic enclosure elements in the event of a malfunction).



Connecting the power terminals

Warning!
Select a frequency inverter that is suitable for the available supply voltage (→ section "Technical data", page 201):

- DV51-320: Three-phase 230 V (180 to 264 V ± 0 %)
- DV51-322: Single- or three-phase 230 V (180 to 264 V ± 0 %)
- DV51-340: Three-phase 400 V (342 to 528 V ± 0 %)

Warning!
Never connect output terminals U, V and W to mains voltage. Danger of electrical shock or fire.

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

Warning!
Make sure that all power cables are correctly tightened in the power section.

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

Danger!
Do not connect cables to the unmarked terminals in the power section. Some of these terminals do not have a function (dangerous voltages) DV51or are reserved for internal use.

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
– DC supply and DC link coupling: DC+, DC– and PE.

▶ Refit the cable retainer.

▶ Screw on the cables tightly according to table 5.

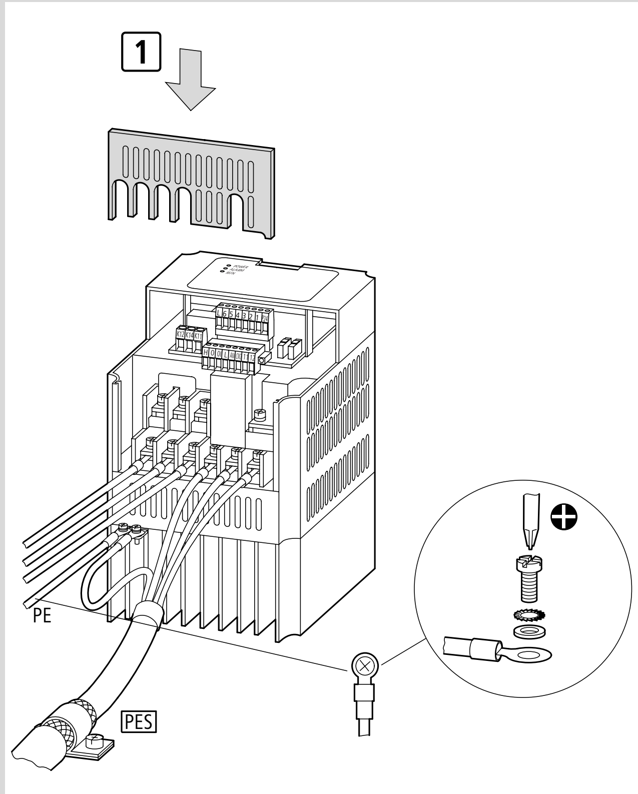


Figure 39: Connecting cables to the power terminals

Tightening torques and conductor cross-sections

Warning!
Tighten the screws on the terminals correctly (→ table 5) so that they do not come loose unintentionally.

Table 5: Tightening torques and cable cross-sections for the power terminals (combination and terminal screws)

L, L1, L2, L3, N, L+, DC+, DC–, RB, U, V, W, PE	mm2	AWG	mm	mm		Nm	ft-lbs	⊕
DV51-322-025 DV51-322-037 DV51-322-055	1.5	16	6 – 8	7.6	M3.5 M4 (PE)	1.3	0.6	1
DV51-340-037 DV51-340-075 DV51-340-1K5 DV51-340-2K2	1.5	16	8 – 10	10	M 4	1.3	0.9	1
DV51-322-075 DV51-322-1K1 DV51-340-3K0 DV51-340-4K0	2.5	14	8 – 10	10	M 4	1.3	0.9	1
DV51-320-4K0 DV51-322-1K5 DV51-340-5K5 DV51-340-7K5	4	12	12 – 14	13	M 5	2	1.5	2
DV51-320-5K5 DV51-322-2K2	4	10	12 – 14	13	M 5	2	1.5	2
DV51-320-7K5	6	8	12 – 14	13	M 5	2 – 2.2	2 – 2.2	2

Example: Connecting the motor supply cable

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

▶ Connect the mains voltage or the RFI filter outputs to the following terminals:

– L, N and PE for single-phase power supply,

– L1, L2, L3 and PE for three-phase power supply.

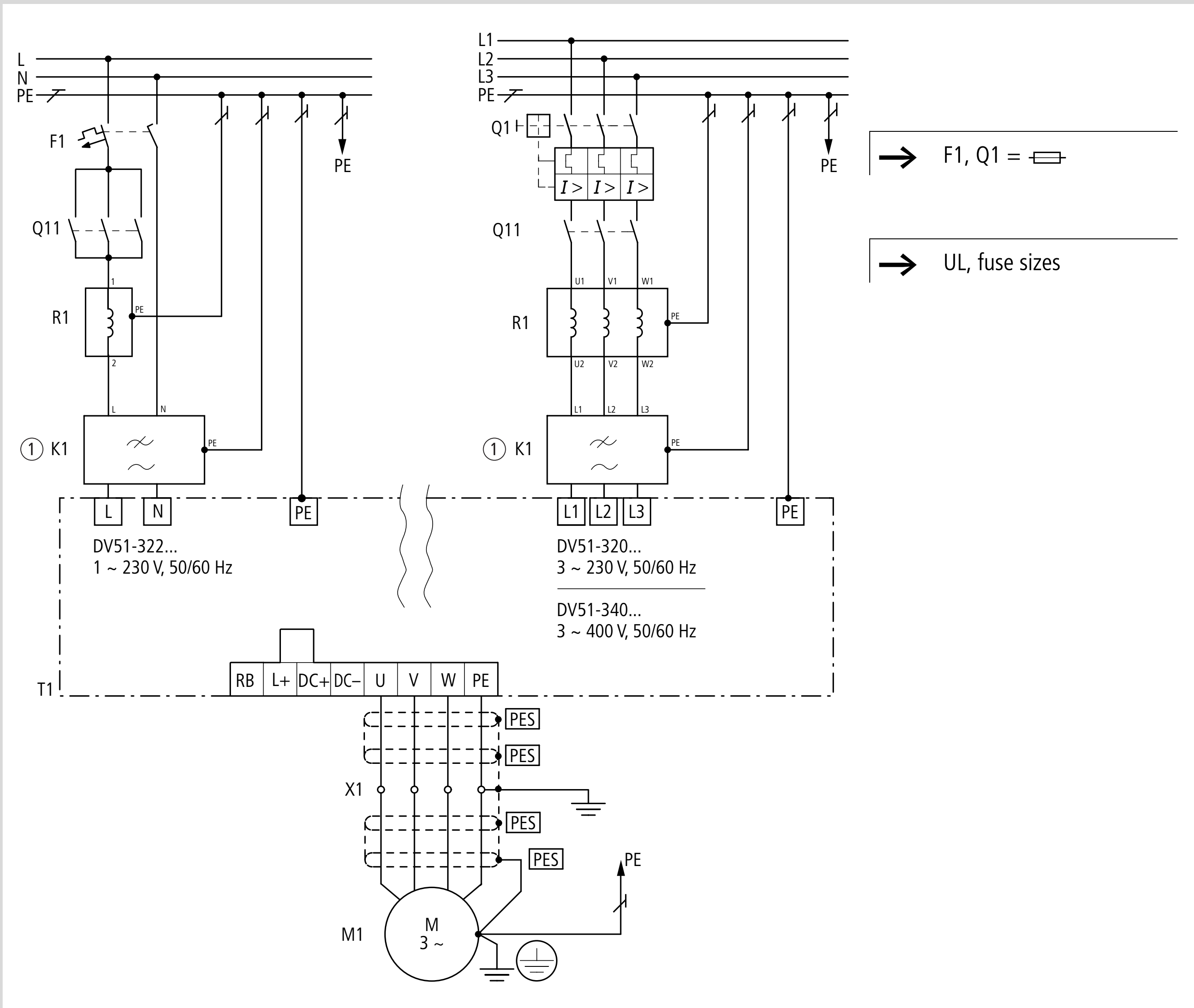


Figure 40: Power terminal connection example

F1, Q1: Line protection
Q11: Mains contactor
R1: Line reactor

① optional
K1: RFI filter
T1: Frequency inverter

M1: Motor
X1: Terminals (for example control panel)

Line protection (F1, Q1)
The mains-side is protected to the current strengths listed here.

Table 6: Fused 230 V and 400 V power supply

Part no.	1 h	3 h
230 V		
DV51-320-4K0	–	35 A
DV51-320-5K5	–	35 A
DV51-320-7K5	–	50 A
DV51-322-025 DV51-322-037 DV51-322-055	10 A	10 A
DV51-322-075 DV51-322-1K1	16 A	16 A
DV51-322-1K5	20 A	16 A
DV51-322-2K2	35 A	20 A
400 V		
DV51-340-037	–	4 A
DV51-340-075	–	6 A
DV51-340-1K5 DV51-340-2K2	–	10 A
DV51-340-3K0 DV51-340-4K0	–	16 A
DV51-340-5K0	–	20 A
DV51-340-7K5	–	25 A

Fuse elements: → section "Cables and fuses", page 224.

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

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

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

By default, the DV51 frequency inverters have a clockwise rotation field. Clockwise rotation of the motor shaft is achieved by connecting the motor and frequency inverter terminals as follows:

Motor	DV51
U1	U
V1	V
W1	W

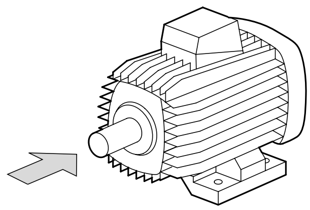


Figure 41: To determine direction of rotation, view from here.

In frequency inverter operation with the DV51, you can reverse the direction of rotation of the motor shaft by:

- exchanging two of the phases connected to the motor.
- actuating terminal 1 (FWD = clockwise rotating field) or 2 (REV = anticlockwise rotating field (default)),
- applying a control signal through the interface or fieldbus interface connection

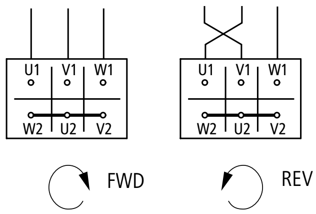


Figure 42: Reversing the direction of rotation

The speed of a three-phase motor is determined by the number of pole pairs and the frequency. The output frequency of the DV51 frequency inverter is indefinitely variable from 0 to 400 Hz.

Pole-changing three-phase motors (Dahlander pole-changing motors), rotor-fed three-phase commutator shunt motors (slipring rotor) or reluctance motors, synchronous motors and servo motors can be connected, provided they are approved for use with frequency inverters by the motor manufacturer.

Warning!
The operation of a motor at speeds above its rated speed (indicated on the 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 about 25 Hz) can lead to thermal damage (overheating) of self-ventilated motors. Possible remedies include over-dimensioning and external cooling independent of motor speed.

Observe the manufacturers recommendations for operation of the motor.

Connecting a signalling relay

The signalling relay consists of a floating contact (changeover switch). The contacts are connected to terminals K11, K12 and K14.

The illustration to the right indicates the position of the signalling relay terminals.

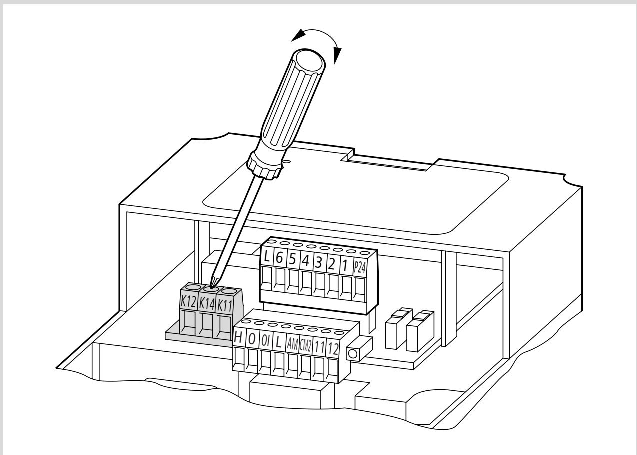
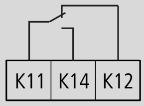


Figure 43: Position signalling relay terminals

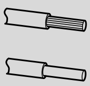
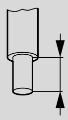
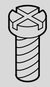
Table 7: Description of the signalling relay terminals

Terminal designation	Description[1)]
K11	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
K12	
K14	

1) You can assign the digital output functions to the signalling relay (PNU C021).

For information about configuring the signalling relay, see → section "Signalling relay K1 (terminals K11, K12, K14)", page 115.

Table 8: Conductor cross-sections, tightening torques and required tools for the signalling relay terminals

					 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

Connecting the control signal terminals

The plug-in type control signal terminals are arranged on two levels, the lower level being secured with two screws for strain relief.

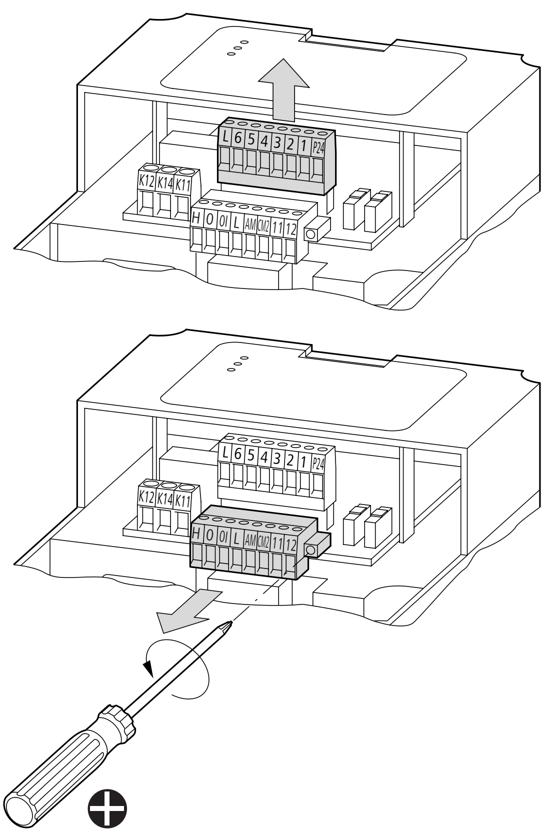
Wire the control signal terminals as appropriate for their application. For instructions for changing the function of the control signal terminals, see section "Control signal terminal overview (input)", page 81.

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

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.

ESD measures
Discharge yourself on an earthed surface before touching the control signal terminals and the circuit board to prevent damage through electrostatic discharge.

The illustration to the right shows the positions and layout of the individual control signal terminals.



L	6	5	4	3	2	1	P24
h	O	OI	L	AM	CM2	12	11

Figure 44: Position of control signal terminals

Table 9: Connection options for control signal terminals

mm2	AWG	mm	mm	M2 Nm	ft-lbs
0.14 – 0.75	18 – 28	5	0.4 × 2.5	0.22 – 0.25	0.16

→ The control signal terminals take solid and stranded cables without ferrule.

If the use of ferrules is required, use only ferrules with push-on sleeves.

Function of the control signal terminals

Table 10: Function of the control signal terminals

No.	Function	Level	DS	Technical data, description
L	Common reference potential	0 V	–	Reference potential for the internal voltage sources P24 and H
6	Digital input	HIGH = 17.4 … 27 V ⎓ LOW: ≦ 2 V ⎓	2CH = Second time ramp	PNP logic, configurable, R_i = 5.6 kΩ Reference potential: terminal L
5	Digital input		RST = reset	PNP logic, configurable, R_i > 100 kΩ Reference potential: terminal L
4	Digital input		FF2 (FF3) = fixed frequency 1 (3)	PNP logic, configurable, R_i = 5.6 kΩ Reference potential: terminal L
3	Digital input		FF1 (FF3) = fixed frequency 2 (3)	
2	Digital input		REV = anticlockwise rotating field	
1	Digital input		FWD = clockwise rotating field	
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	Reference voltage output	+10 V ⎓	–	Supply voltage for external reference value potentiometer. Load carrying capacity: 10 mA Reference potential: terminal L
O	Analog input	0 to +10 V ⎓	Frequency reference value (0 to 50 Hz)	R_i = 10 kΩ Reference potential: terminal L
OI	Analog input	4 to 20 mA	Frequency reference 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
AM	Analog output	0 to +10 V ⎓	Frequency actual value (0 to 50 Hz)	Configurable, DC voltage, 0 to 10 V corresponds to set end frequency (50 Hz). Load carrying capacity: 1 mA Reference potential: terminal L
CM2	Reference potential, transistor output	Up to 27 V ⎓	–	Connection: Common reference potential (0 V, 24 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		Reference frequency reached	

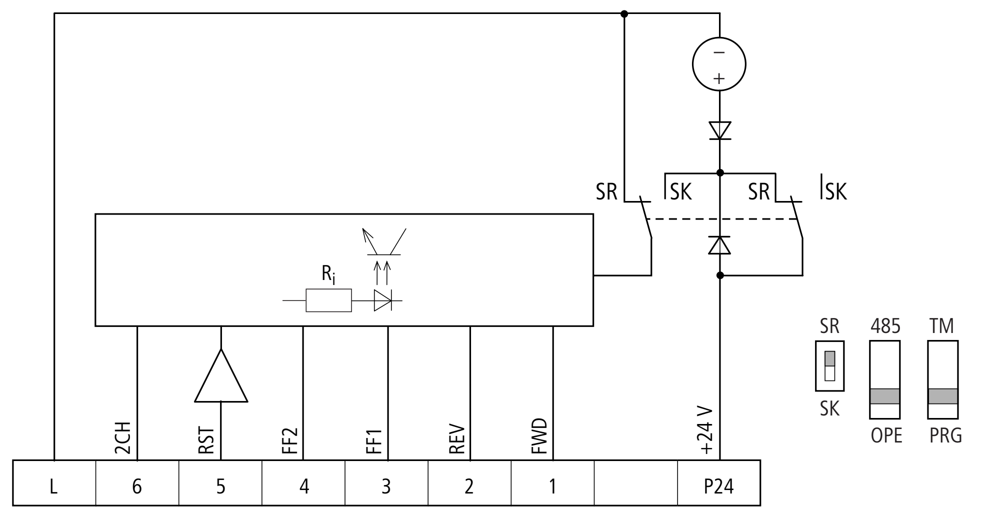


Figure 45: Upper control signal terminal bank

Inputs 1 to 6 all have the same function and mode of operation except for terminal 5, which can also be configured as thermistor input.

Inputs 1 to 6 are optically isolated and metallically isolated from the built-in control section (CPU). They are actuated with +24 V. You can use the device's internal control voltage from terminal P24 or an external voltage source.

You can configure the actuation of inputs 1 to 6 for special control circuits and national circuit types table 11 shows the various versions in dependence of the SR/SK microswitch. This switch is located to the right of the control signal terminals and has two switching contacts:

- SR = source, positive switching logic (default settings)
- SK = sink, negative switching logic

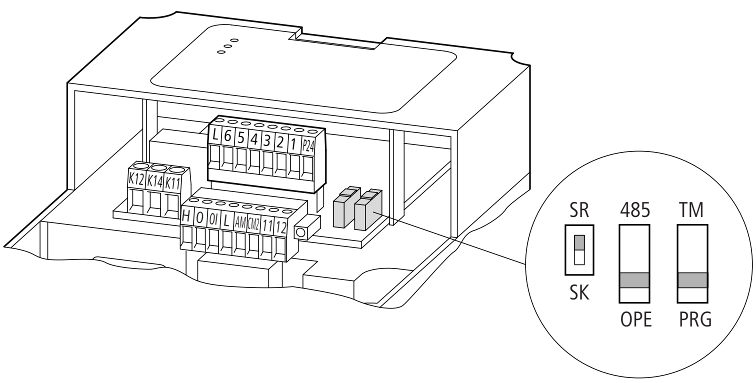
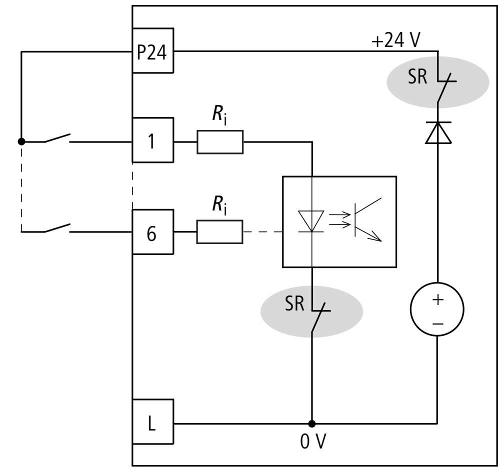
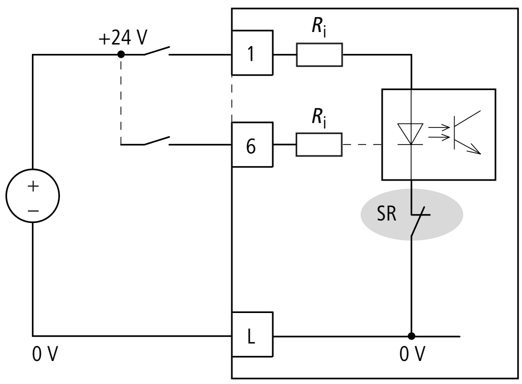
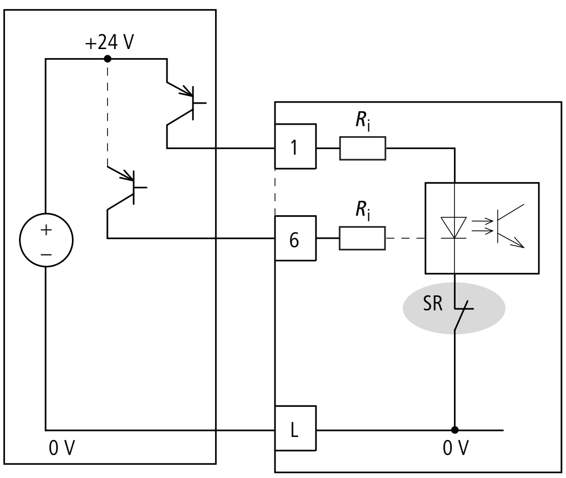
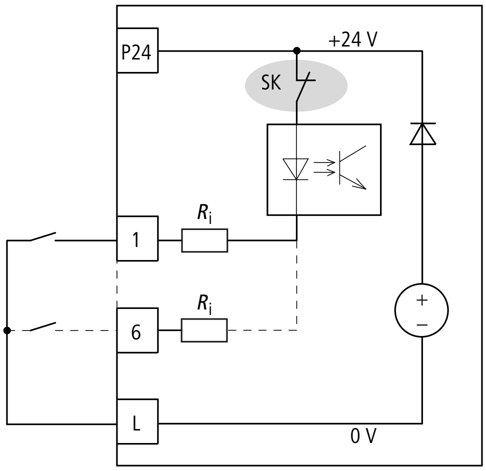
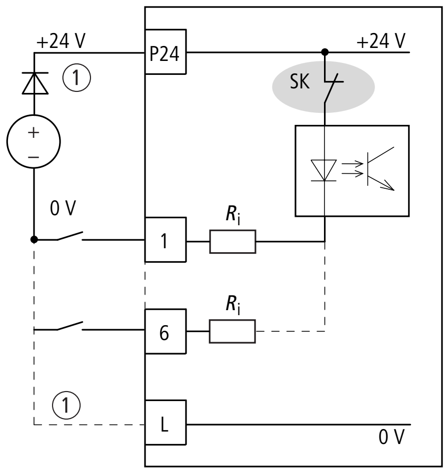
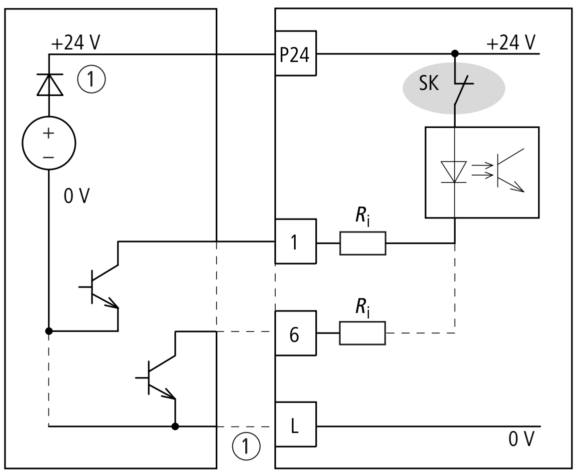


Figure 46: Position of microswitches

Warning!
Before you switch on the internal or external control voltage, check the position of the SR/SK switch. An incorrect setting can damage the control input.

Table 11: Actuation of inputs 1 to 6

Circuit example	SR/SK switch	Description
	SR	• Operation with internal control voltage • Standard circuit
	SR	• Operation with external control voltage +24 V) • Standard circuit • Reference point terminal L
	SR	• Operation with external control voltage from an electronic device (for example PLC, easy) • Reference point terminal L

Circuit example	SR/SK switch	Description
	SK	Operation with internal control voltage
	SK	• Operation with external control voltage +24 V) • Reference point terminal L ① If reference point L is connected with the 0 V potential of the external voltage source, the external 24 V potential should be decoupled through a diode.
	SK	• Operation with external control voltage from an electronic device (for example PLC, easy) • Reference point terminal L ① If reference point L is connected with the 0 V potential of the external voltage source, the external 24 V potential should be decoupled through a diode.

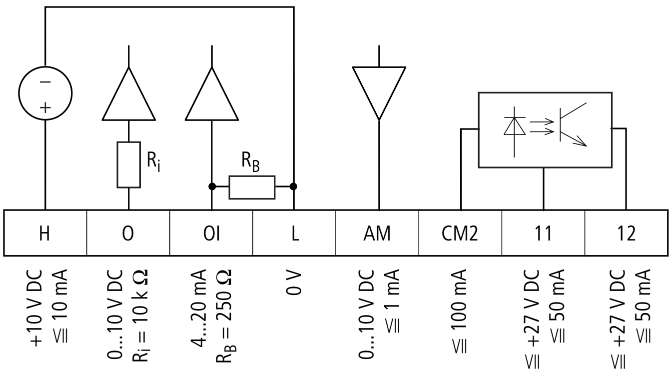
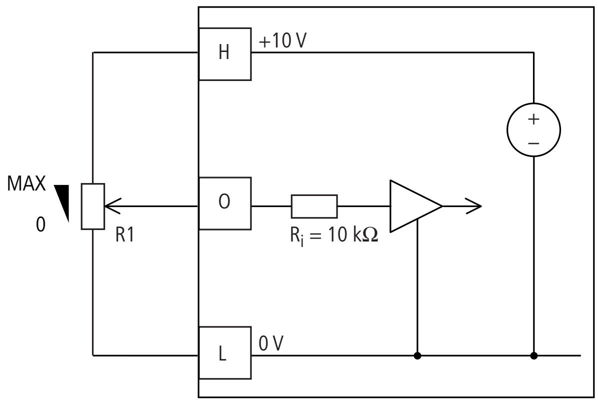
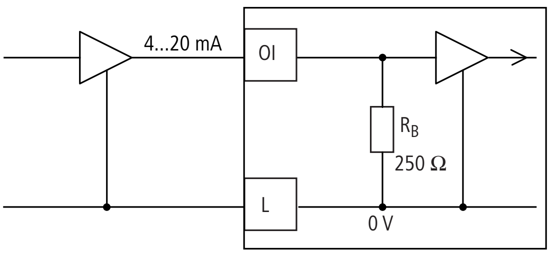


Figure 47: Lower control signal terminal bank

→ All analog inputs and outputs use terminal L as reference potential and are therefore also connected to the reference potential of digital inputs 1 to 6.

Terminal H outputs +10 V (max. 10 mA) to provide the reference voltage for supplying an external potentiometer. Reference point is terminal L.

Table 12: Actuating the analog inputs

Circuit example	Description
	• Frequency reference input (default = 0 to 50 Hz) through an external potentiometer (recommended fixed resistance 1 to 5 kΩ). • Standard circuit
	• Frequency reference input (default = 0 to 50 Hz) through an external 4 to 20 mA current signal. • Standard circuit

→ At the default setting, the input signals at terminals O (0 to 10 V) and OI (4 to 20 mA) are added to the resulting frequency reference input. You can select the reference source with parameter PNU A005 (AT selection) and activate it through a control signal terminal (PNU C00x = 16).

Terminal AM supplies an analog reference signal from 0 to +10 V (default = 0 to 50 Hz). The reference potential is terminal L. The analog signal can be configured with parameters PNU B080, C028 and C086.

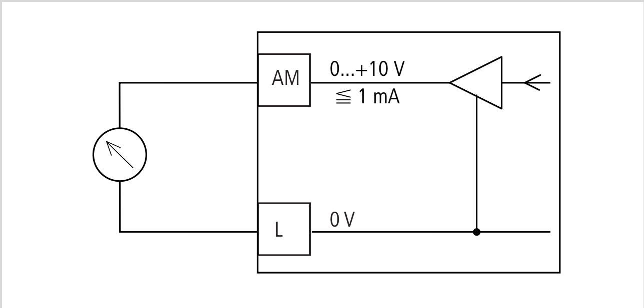


Figure 48: Example: analog measuring instrument

If a relay is connected to one of the digital outputs 11 or 12, connect a freewheel diode in parallel to the relay to prevent destruction of the digital outputs through the self-induced e.m.f. which results when the relay is switched off.

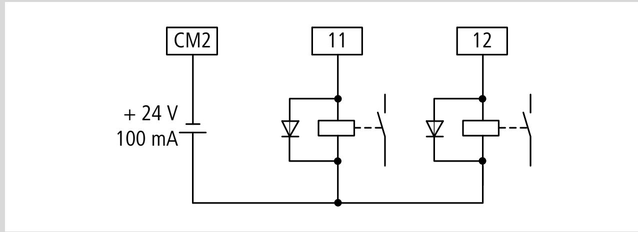


Figure 49: Relay with freewheeling diode (for example ETS-VS3)

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

The two digital outputs 11 and 12 contain optically decoupled open-collector transistors. Up to 50 mA can be applied to each of them. Their common reference potential is terminal CM2 (max. 100 mA).

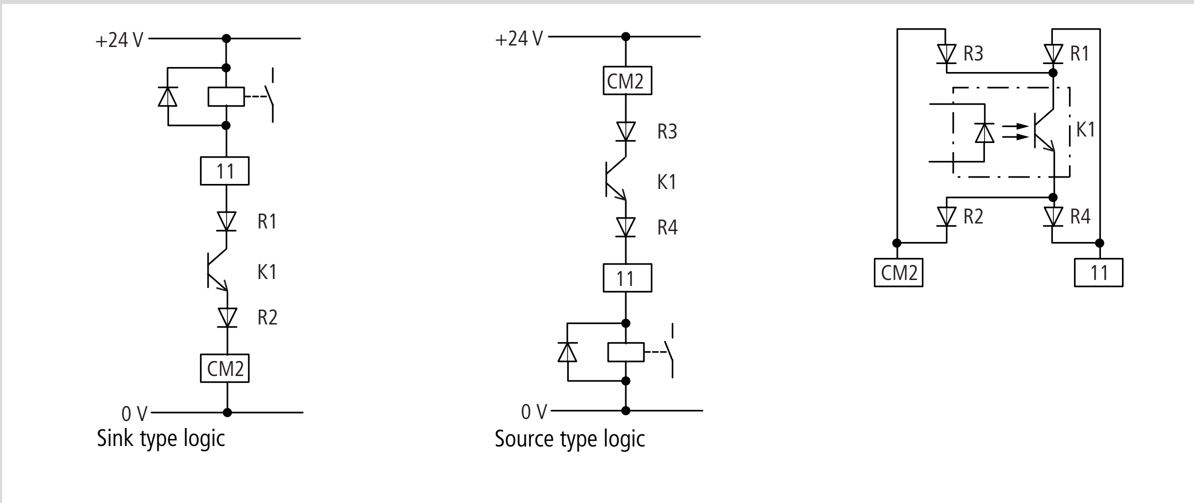


Figure 50: Digital outputs

Internal diode matrix R1 to R4 allows the connection in sink-type or source-type logic (→ fig. 50).

4 Using the DV51

This section describes how to take the DV51 frequency inverter into operation and what you should observe during its operation.

Operational warnings

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

Danger!
If the frequency inverter has been configured so that the stop signal is not issued through 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 this case.

Danger!
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.

Danger!
Never pull on the cable to unplug connectors (for example for fan or circuit boards).

Warning!
If a reset is carried out after a fault, the motor will start again at once automatically 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 a fault message with a reset.

Warning!
When the supply voltage for the frequency inverter is applied while 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!
Do not connect cables or connectors 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 Start key is functional only if the corresponding parameters of the frequency inverter have been configured accordingly (→ section "Start signal input" page 85 This prevents the risk of damage and injury.

→ If motors are to be operated at frequencies above the standard 50 or 60 Hz, consult the motor manufacturer to make sure that the motors are suitable for operation at higher frequencies. The motors could otherwise incur damage.

Block diagram

The following block diagram shows all terminals of the DV51.

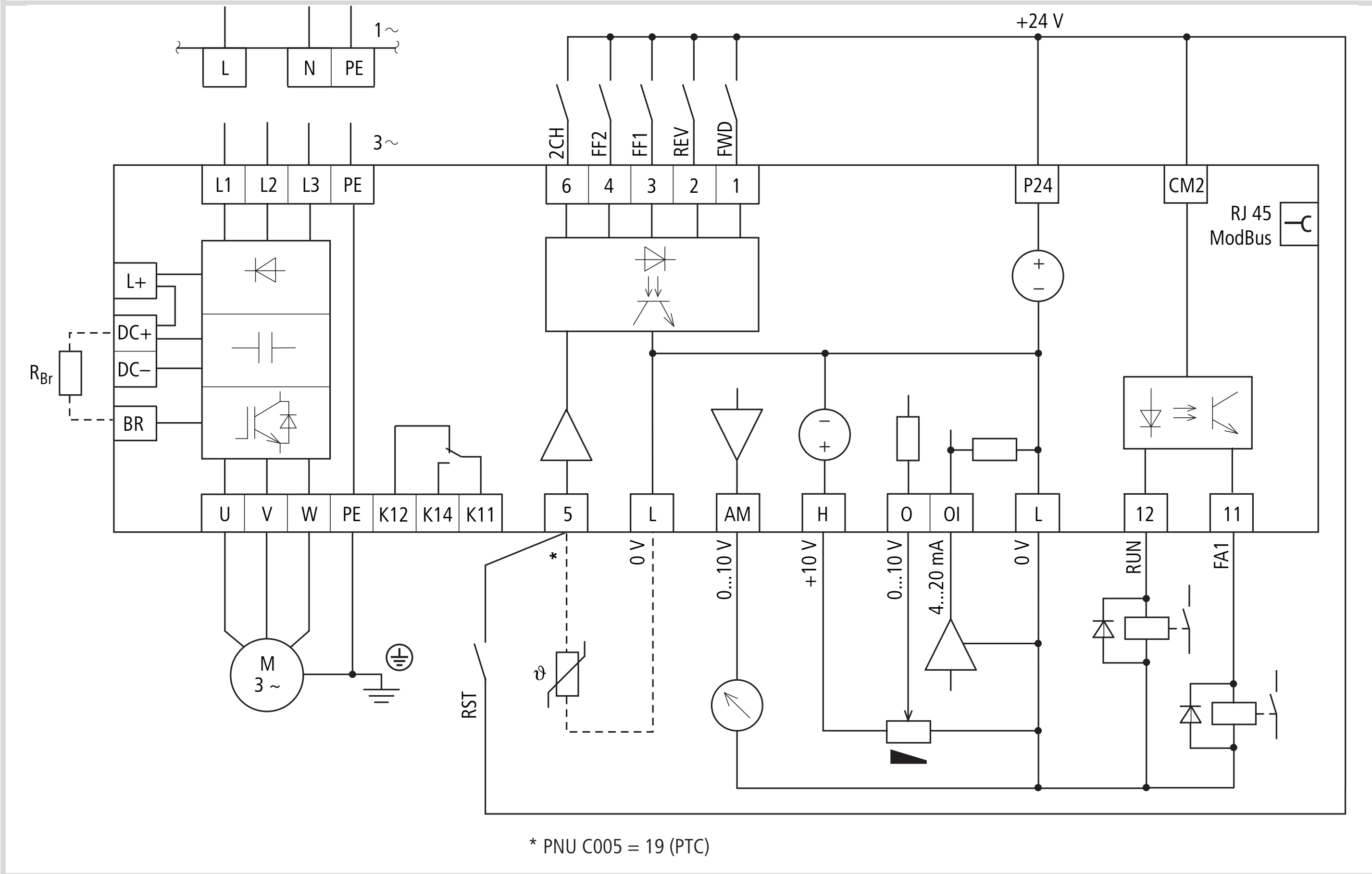


Figure 51: Block diagram, DV51

Power terminals

- L, L1, L2, L3, N Supply (mains) voltage
- U, V, W Frequency inverter output
- L+, DC+ External DC choke
- BR, DC+ External braking resistor
- DC+, DC– Internal DC link
- ⏚, PE Positive earth

Control signal terminals

- P24 Control voltage output, +24 V

- 1 Digital input
- 2 Digital input
- 3 Digital input
- 4 Digital input
- 5 Digital input
- 6 Digital input
- L Common 0 V reference potential
- H Reference voltage output, +10 V
- O Analog input, 0 to +10 V

- OI Analog input, 4 to 20 mA
- AM Analog output, 0 to 10 V
- K11 Signalling relay terminal
- K12 Signalling relay terminal (NC)
- K14 Signalling relay terminal (NO)
- CM2 Reference potential, transistor output
- 12 Transistor output, max. 27 V
- 11 Transistor output, max. 27 V
- RJ 45 Interface connection for expansion

Initial starting

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

- The frequency inverter must be installed vertically on a non-flammable surface (for example a metal surface).
- Remove any residue from wiring operations – such as pieces of wire – and all tools from the vicinity of the frequency inverter.
- Ensure that all terminal screws have been sufficiently tightened.
- Make sure that the cables connected to the output terminals are not short-circuited or connected to earth.
- Make sure that the power lines L1 and N or L1, L2 and L3 and the frequency inverter outputs U, V and W are connected correctly.
- The earth terminal must be connected correctly.
- Only the terminals marked as earthing terminals must be earthed.
- The control lines must be connected correctly.
- Make sure that the frequency inverter and the motor are correct for the mains voltage.
- Check the position of the microswitches.
- Never operate the frequency inverter with opened power section covers (without fitted terminal shroud).
- The configured maximum frequency must match the maximum operating frequency of the connected motor.

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.

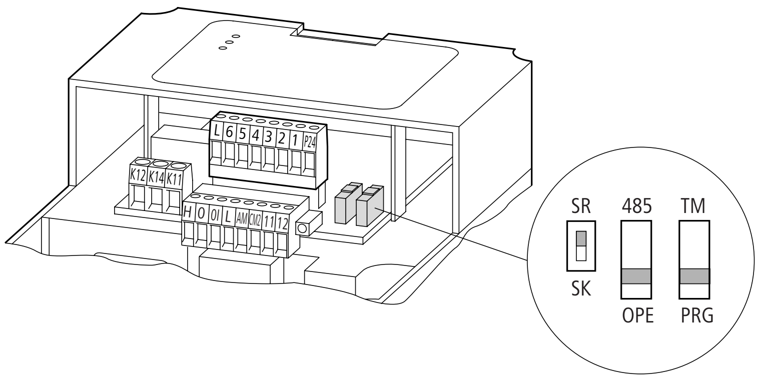


Figure 52: Default settings of microswitches

Table 13: Function of the microswitches

Switch	Function	Description, default setting	DS
SR/SK	SR	SR = source, positive switching logic. Activate by applying control voltage (+24 V)	SR
485/OPE	OPE	OPE = operator keypad (Optional: DEX-KEY-6…, DEX-KEY-10)	OPE
TM/PRG	PRG	PRG = program In this switch position, the control signal and reference value sources set with PNU A001 (A201) and A002 (A202) are taken into account. In the default configuration, these are input values at the control signal terminals. In switch position TM (= control terminals) only control and reference value input signals are accepted through the control signal terminals, regardless of the value of PNU A001 and A002.	PRG

By default, the parameters of the DV51 frequency inverters are configured to fulfill the following requirements:

- Motor ratings: voltage, current and frequency of a normal, surface-cooled, four-pole three-phase asynchronous motor.
- Sensorless vector control: control signals via control signal terminals and linear speed changes via an external, analog potentiometer.
- Maximum speed: 1 500 r.p.m. at 50 Hz (DV51-320: 1 800 r.p.m. at 60 Hz).
- Acceleration and deceleration time = 10 seconds.

For settings for more complex applications, see the parameter list (page 238).

The basic versions of the DV51 frequency inverters contain an operating state LED.

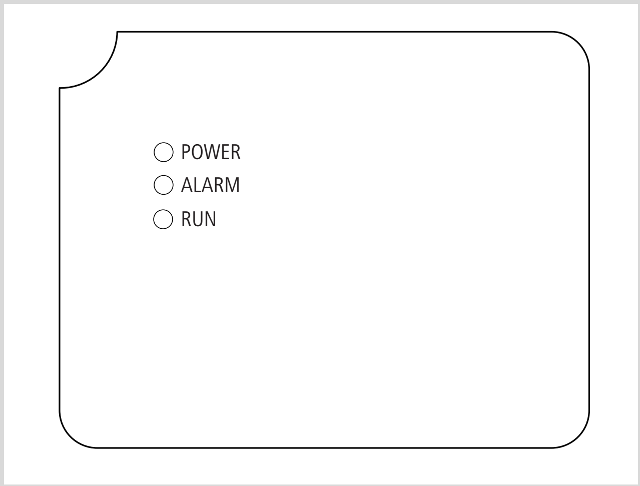


Figure 53: LED display (DEV51-KEY-FP)

Table 14: LEDs

LED	Display	Explanation
POWER	Red	LED is lit when the frequency inverter has power.
ALARM	Red	LED is lit when an alarm message is issued.
RUN	Green	LED lit when frequency inverter operational (Enable signal for clockwise/anticlockwise operation, terminal 1 or 2) or running.

Standard operation, actuation with default settings

Connect cables as shown below.

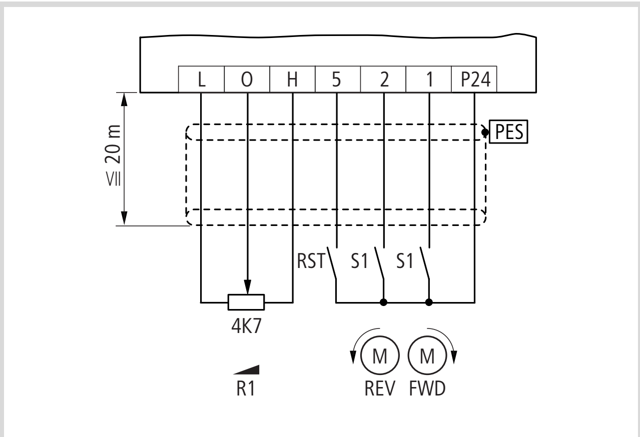


Figure 54: Active inputs at default setting

→ The Reset signal (RST function) is also issued when you switch the supply voltage off (POWER LED off).

With the default settings (→ fig. 54) you can:

- start and stop the motor (S1 or S2),
- reverse the direction of rotation (S2 or S1),
- reset (RST) fault signals (ALARM),
- Control the motor speed (0 to 50 Hz, or 0 to 60 Hz for DV51-DV51-320-…) with potentiometer R1 through the analog reference value input.

Switches and potentiometer are not included as standard with the frequency inverter.

Caution!
During initial operation, check the following to prevent damage to the motor:

- Is the direction of rotation correct?
- Does a fault (ALARM LED) occur during acceleration or deceleration?
- Is the motor speed correct?
- Does any unusual motor noise or vibration occur?

▶ Switch on the supply voltage.

The POWER LED is lit.

▶ Close switch S1 (FWD = clockwise rotation).

The frequency inverter generates a clockwise rotating field and the motor, if connected normally, rotates in a clockwise direction.

▶ With potentiometer R1, you can change the frequency and therefore the motor speed.
▶ Open switch S1.

The motor speed is reduced to zero.

▶ Close switch S2 (REV = anticlockwise rotation).

The frequency inverter generates an anticlockwise rotating field and the motor, if connected normally, rotates in an anticlockwise direction.

▶ With potentiometer R1, you can change the frequency and therefore the motor speed.
▶ Open switch S2.

The motor speed is reduced to zero.

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.

If a fault has occurred due to overcurrent or overvoltage, increase the acceleration or deceleration time. To do this, you need an optional keypad (DEX-KEY-6… or DEX-KEY-10) or the Drive Soft configuration software. The software is included on the CD-ROM supplied with the frequency inverter. To reset fault signals, close RST.

Table 15: Function of control signal terminals (inputs → fig. 54)

No.	Function	Level	DS	Technical data, description
L	Common reference potential	0 V	–	Reference potential for the internal voltage sources P24 and H
5	Digital input	HIGH: 17.4 … 27 V ⎓ LOW: ≦ 2 V ⎓	Reset	PNP logic, configurable, R_i > 100 kΩ Reference potential: terminal L
2	Digital input		REV = anticlockwise rotating field	PNP logic, configurable, R_i = 5.6 kΩ Reference potential: terminal L
1	Digital input		FWD = clockwise rotating field	
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	Reference voltage output	+10 V ⎓	–	Supply voltage for external reference value potentiometer. Load carrying capacity: 10 mA Reference potential: terminal L
O	Analog input	0 to +10 V ⎓	Frequency reference value (0 to 50 Hz)	R_i = 10 kΩ Reference potential: terminal L
L	Common reference potential	0 V	–	Reference potential for internal voltage sources P24, H and analog inputs

Default functions of output terminals

By default, the control signal outputs have the functions described below.

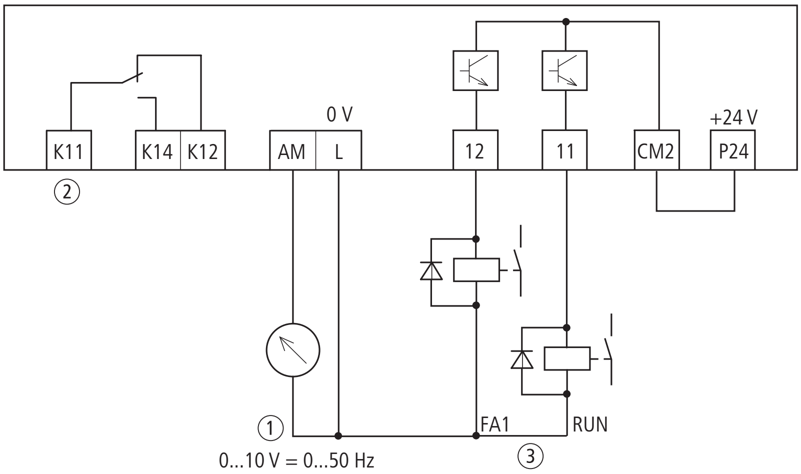


Figure 55: Active outputs with default settings

① Frequency indication, 0 to 10 V = 0 to 50 Hz

② AL fault message

③ FA1 = frequency reached (reference value = actual value)
RUN = Run signal

→ Relay for direct connection to the digital outputs as shown in figure 55, for example ETS-VS3.

Table 16: Function of control signal terminals (outputs)

No.	Function	Value	DS	Technical data, description
P24	Control voltage output	+24 V	–	Supply voltage Load carrying capacity: 30 mA Reference potential: terminal L
12	Transistor output	Up to 27 V = CM2	00 = RUN: Run signal	Configurable, open collector Load carrying capacity: up to 50 mA each
11	Transistor output		01 = FA1: frequency achieved	
CM2	Reference potential, transistor output	0 V +24 V	–	Common reference potential for transistor outputs 11 and 12; max. load carrying capacity 100 mA (total of terminals 11 and 12) "Sink-type logic" connection: reference potential 0 V "Source-type logic" connection: reference potential +24 V (→ page 48)
L	Common reference potential	0 V	–	Reference potential (0 V) for internal voltage source P24 and H, for analog inputs O and OI, and for analog output AM.
AM	Analog output	0 to +9.6 V	Frequency actual value (0 to 50 Hz)	Configurable DC voltage output, 10 V corresponds with the set end frequency (50 Hz). Accuracy: ±5 % from final value Load carrying capacity: 1 mA Reference potential: terminal L
K11	Relay contact	• Up to 250 V AC/2.5 A • Up to 30 V DC/3.0 A	05 = AL: fault signal	• Operating signal: K11–K14 closed. • Fault message or power supply off: K11-K12 closed
K12	Break contact			
K14	Make contact			

5 Optional keypad DEX-KEY-6…

The optional keypad DEX-KEY-6… is available in two versions:

- DEX-KEY-6, with reference value potentiometer;
- DEX-KEY-61, without reference value potentiometer.

These keypads provide access to all inverter parameters and therefore allow user-specific adjustment of the settings of frequency inverters DF51, DV51, DF6 and DV6.

LEDs and a four-digit digital display indicate the operating status, operational data and parameter values. With the keys, you can change the parameter values and control frequency inverter operation (Start/Stop). The frequency reference value can be adjusted with the potentiometer (DEX-KEY-6 only).

→ The DEX-KEY-6… keypads are not included with the frequency inverter.

Type code

Type codes and part numbers of keypads DEX-KEY-6…:

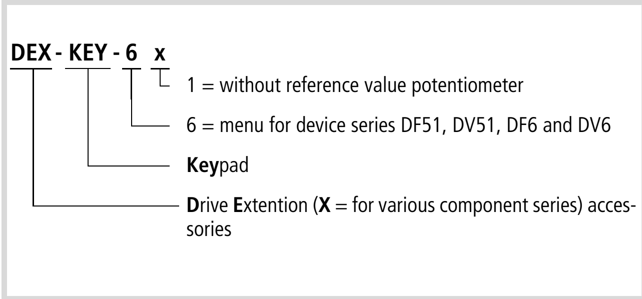


Figure 56: Key to type references, keypads DEX-KEY-6…

Equipment supplied

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

- One keypad DEX-KEY-6 or DEX-KEY-61
- The mounting instructions AWA8240-2148
- One RJ 45 plug-in adapter (DEX-CON-RJ45)

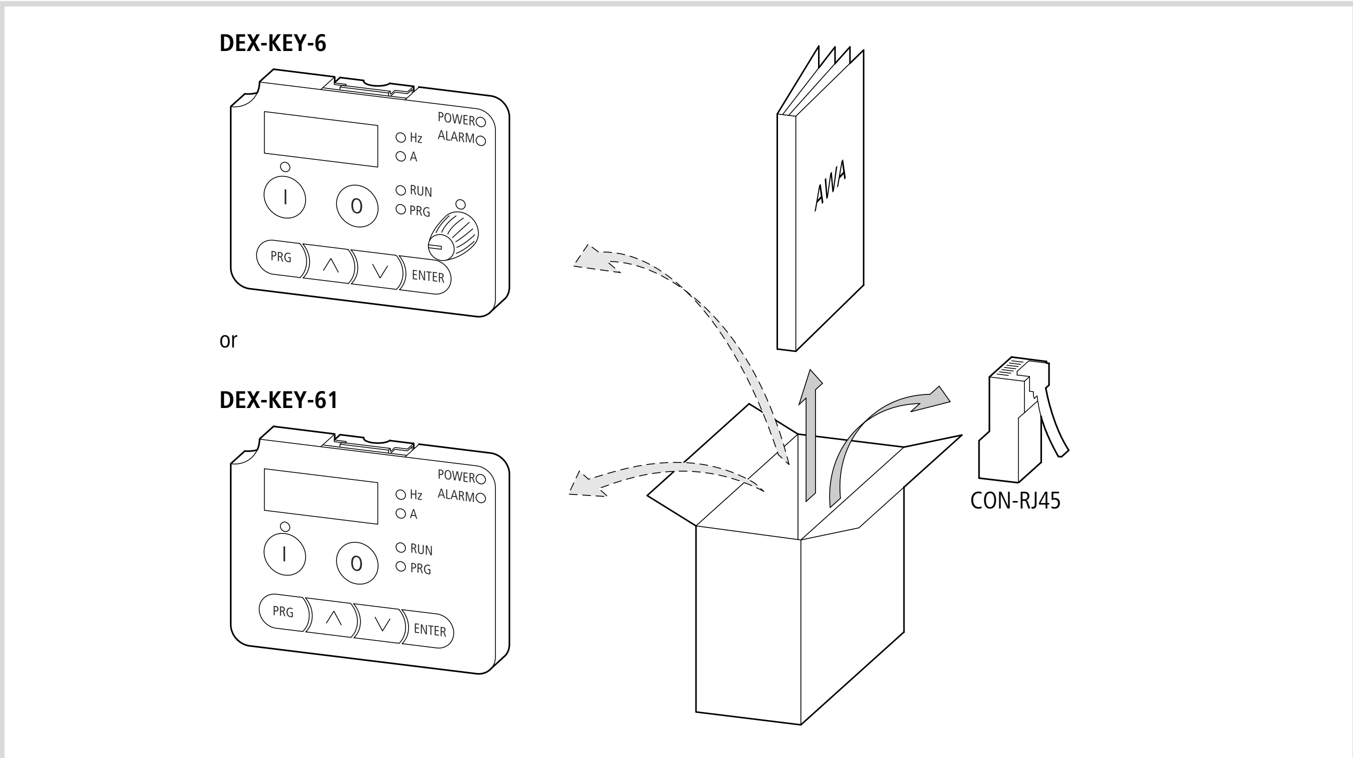


Figure 57: Equipment supplied, keypad DEX-KEY-6…

Layout of the DEX-KEY-6…

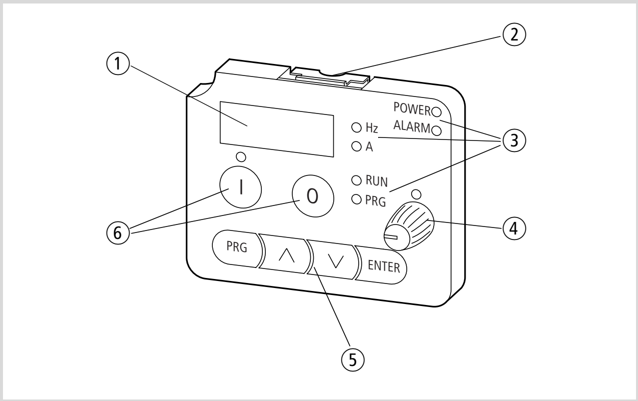


Figure 58: Layout of the DEX-KEY-6…

1. Four-digit digital display
2. Fixing clip (only for use when mounting in DV51)
3. LED status display
4. Reference value potentiometer (only with DEX-KEY-6)
5. Keyboard for altering parameters
6. Keys (Start, Stop)

Fitting a keypad in the DV51

The keypad can be plugged in to frequency inverters of the DV51 series instead of the factory mounted cover (DEV51-KEY-FP).

The DV51 frequency inverter and the keypad are connected with an RJ-45 connector. Adapter CON-RJ45 is included with keypads DEX-KEY-6...

CON-RJ45 = RJ 45 modular interconnect/communications connector

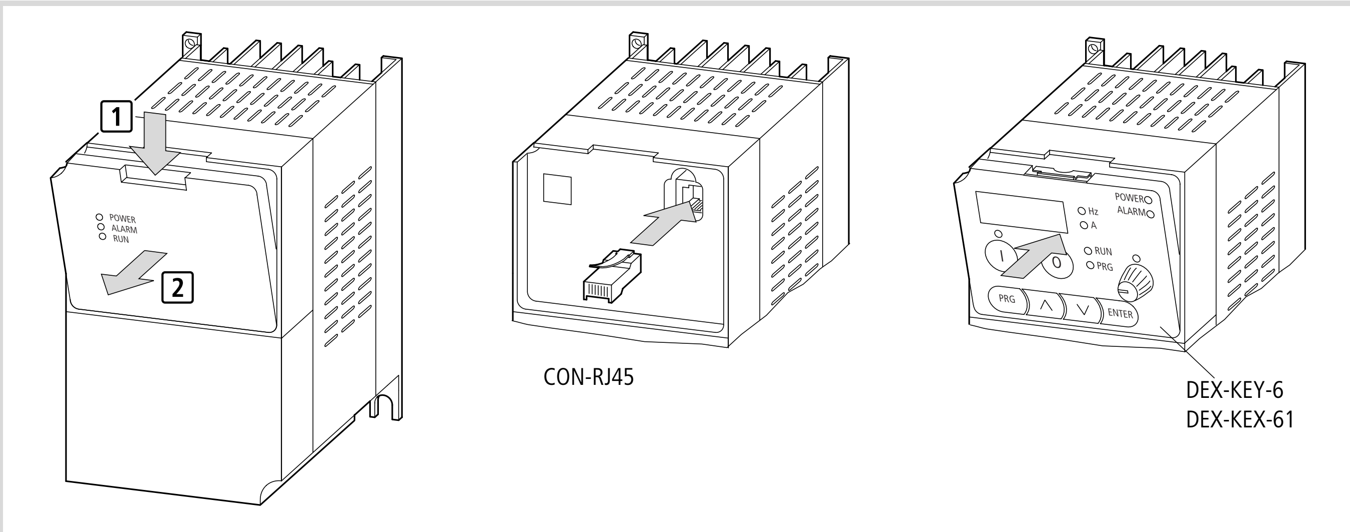


Figure 59: Fitting keypad DEX-KEY-6… in DV51

→ No tools are required to fit and remove the optional keypads, LED displays and plug-in adapters.

▽ **Caution!**
Fit and remove the keypad, LED display or plug-in adapter only under no volt conditions and without using force.

Keypad and connection cable

Connect the LCD keypad through the optional connection cable DEX-CBL-…-ICS.

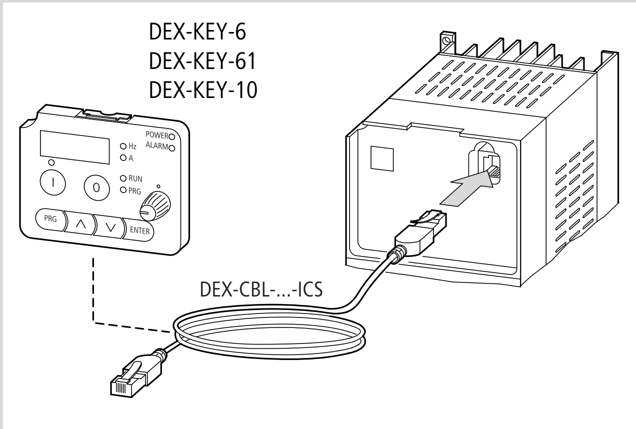


Figure 60: Frequency inverter with connection cable DEX-CBL-…-ICS (→ section "Connection cable", page 215)

Features of keypad DEX-KEY-6…

The following sections describe the configuration and operation of frequency inverter DV51 with keypad DEX-KEY-6 and DEX-KEY-61.

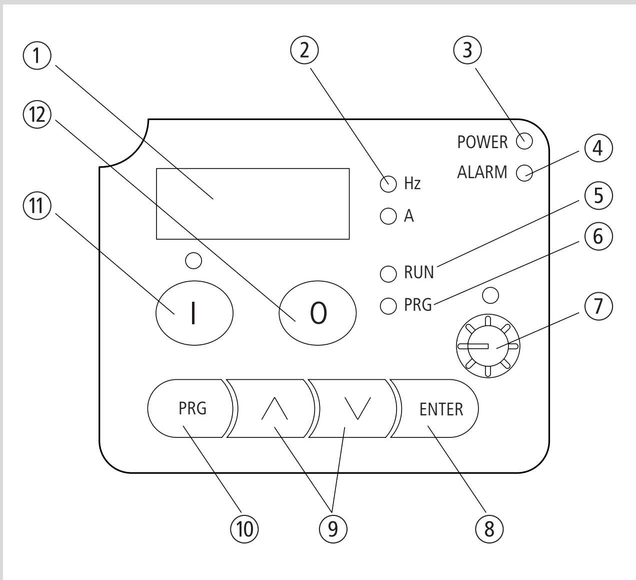


Figure 61: Keypad view

For an explanation of each of the elements, see table 17.

Table 17: Explanation of the operation and display elements

Number	Name	Explanation
①	Four-digit digital display	Display for frequency, motor current, PNU, fault messages, etc.
②	LED Hz or A	Display in ①: output frequency (Hz) → PNU d001 (DS) or output current (A) → PNU d002.
③	POWER LED	LED is lit when the frequency inverter has power.
④	LED ALARM	LED is lit when a fault signal occurs.
⑤	RUN LED	LED lit in **RUN mode** when the frequency inverter is ready for operation or is in operation.
⑥	PRG LED	LED is lit when the input/change of parameter mode is active.
⑦	Potentiometer and LED	Frequency reference value setting LED is lit when the potentiometer is enabled → PNU A001 = 00.
⑧	ENTER key (ENTER)	The key is used for saving entered or changed parameters.
⑨	Arrow keys (⌃) (⌄)	Selecting functions, changing numeric values (⌃) Increase (⌄) Reduce
⑩	PRG key (PRG)	Programming mode. Selection and activation of the specified parameter (PNU)
⑪	Start key and LED (I)	Motor start with the selected direction; disabled by default. LED is lit when the key is enabled → PNU A002 = 02
⑫	Stop key (O)	Stop the running motor and acknowledge a fault signal (RST = Reset). Active by default, also when actuation is through terminals.

DS = default setting
PNU = parameter number

→ The Stop key ⑫ is active in all operating modes (→ PNU b087, page 149).

Navigation within the menu

Press the PRG key to change to parameterization mode.

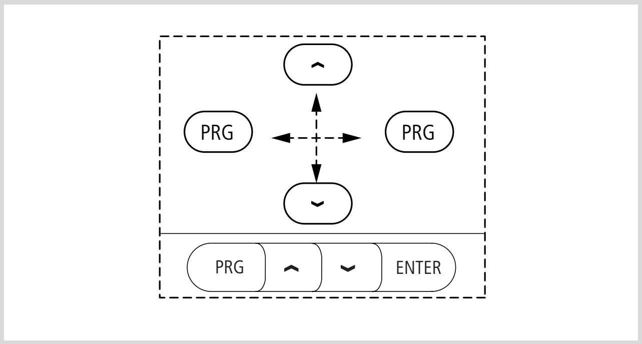


Figure 62: Navigation within the menu

In parameterization mode, the keys have the following functions:

- Use the PRG key to change the display between main menu, parameter and value range.
- To scroll through the individual parameters, digits and functions, use the Up and Down arrow keys.
- To save your settings, press the ENTER key.

→ The changes you make remain saved in (non-retentive memory) as long as the frequency inverterDV51 is supplied with power (POWER LED is lit). The changes are saved permanently (in EEPROM) only when you press the ENTER key.

Quick parameter selection

To activate quick selection mode, press both arrow keys ⌃ and ⌄ at the same time in parameterization mode. The first digit of the digital display then flashes. To change its value (A, b, C, d, F, H), use the arrow keys (⌃ or ⌄). Each letter corresponds to an area in the main menu.

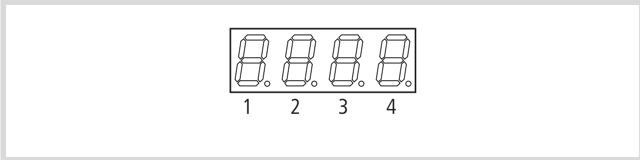


Figure 63: 7-segment display

To change to the second, third and fourth digit of the display, press the Enter key each time. The active digit flashes in each case. To change the value of the active digit (0 to 9), use the arrow keys (⌃ or ⌄).

When you press Enter again after the fourth digit, the entered parameter is called up. If the number you have entered does not exist, the last valid PNU is selected again when you press the Enter key.

To go back to the last valid PNU from the first digit, press the PRG key.

Menu overview

The illustration below shows the structure of the parameter levels.

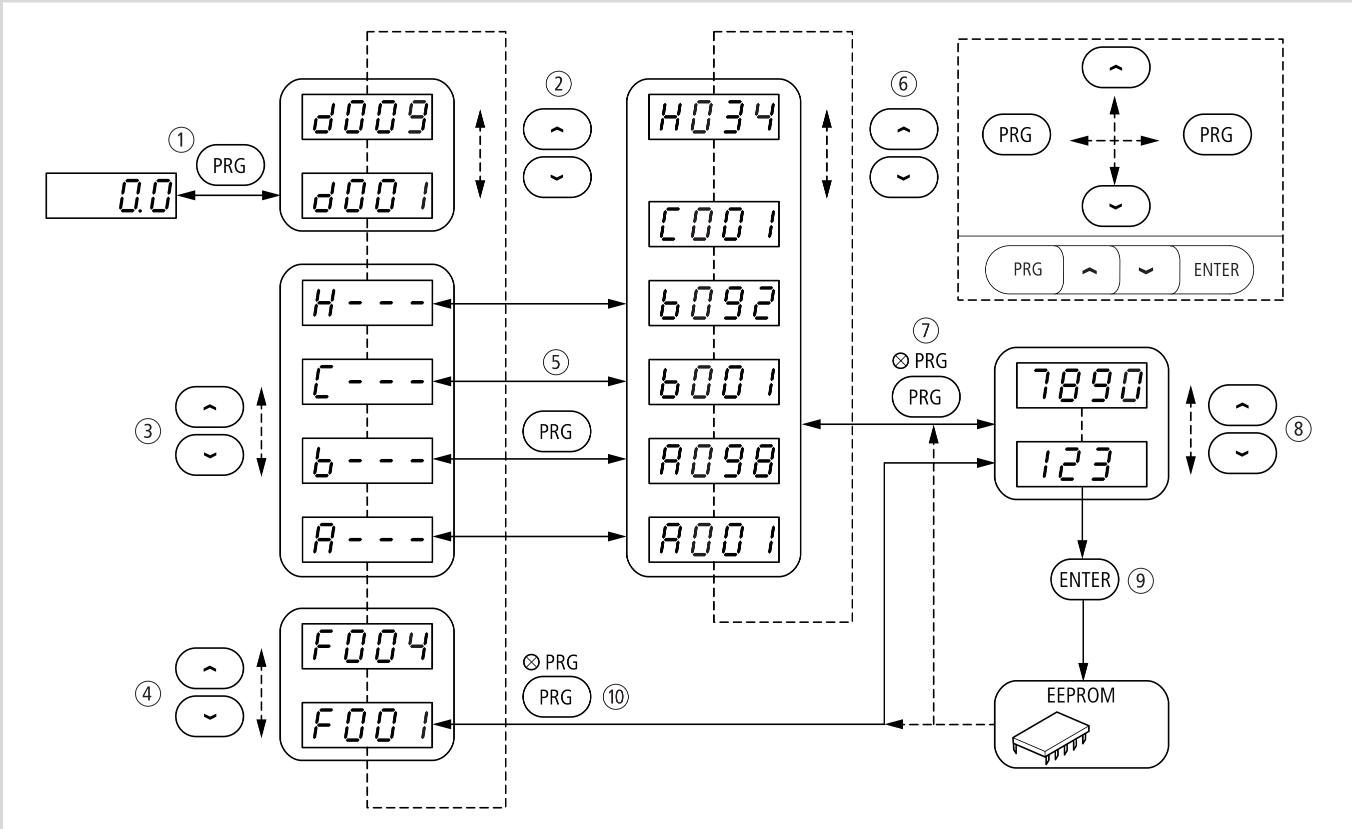


Figure 64: Parameter structure

① Change between the four-position digital display and the display parameters
② Select the display parameter
③ Selection in the main menu
④ Select the basic parameter
⑤ Change between main menu and the parameter level
⑥ Select a parameter (PNU)
⑦ Change between parameters (PNU) and value range
⑧ Select in value range (digits 0 to 9, functions)
⑨ Save values and return to parameter (PNU)
⑩ Return to main menu

Setting the display parameters

By default, the digital display indicates the output frequency (Hz LED is lit). The following section lists the other operational data that can be displayed.

→ You can call up the parameters of the display menu (d…) in both RUN- and STOP mode.

→ The selected display parameter (d…, PNU) is automatically saved in the event of a mains power failure or disconnection and is displayed again when power is restored.

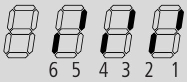
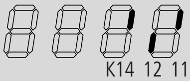
If the PNU value you have selected is to be shown again the next time the device is switched on, press the ENTER key to save it before switching off.

▶ Press the PRG- key. The display indicates PNU d001 (output frequency).
▶ To change to the next display parameter (PNU d002 = motor current) press the arrow key ⌃.

When you have selected a display parameter (d…), press the PRG key, to display that parameter’s value. Parameter and selected indication are not saved. To save the display parameter (d...) (not the selected indication), press first the ENTER key and then PRG. To save the display form, press first the PRG key and then ENTER.

Display parameters d080 to d083 show the identified faults. For each fault signal a fault register entry containing the operational data at the time of the fault (current, voltage, frequency, etc.) is created. You can call up the fault register with the PRG key and the associated operational data with the arrow keys (→ section “Fault register”, page 127).

Table 18: Indication parameter

PNU	Name	Function
d001	Output frequency display	Displays the output frequency in Hertz (Hz). The Hz LED is lit.
d002	Output current display	Displays the output current in amperes (A). The A LED is lit.
d003	Direction of rotation display	Display: • F for clockwise operation (forward), • r for anticlockwise operation (reverse), • o for stop
d004	PID feedback display	Indication in % if PID control enabled. The factor is set with PNU A075. Default is 0.00.
d005	Indication – status of digital inputs 1 to 6	 Example: Digital inputs 1, 3 and 5 are activated. Digital inputs 2 and 4 are deactivated. Digital inputs 2, 4 and 6 are disabled.
d006	Indication – status of digital outputs 11 and 12, and relay K1	 Example: Digital output 11 and relay output (N/O contact K11-K14) are enabled. Digital output 12 is deactivated.
d007	Indication of scaled output frequency	Indication of the product of the factor (PNU b086) and the output frequency. Examples: • Maximum output frequency 50 Hz • Factor PNU b086 = 25 • Indication 1500, corresponds with the synchronous speed of a four-pole motor.
d013	Indication – output voltage	indication of motor voltage at 50 Hz in volts (V).
d016	Indication – operation time counter	Total time in hours in which DV51 is in RUN operation.
d017	Indication – mains On time	Total time in hour in which DV51 was live (mains, internal DC link) (Power display).
d080	Indication – total number of occurred faults	Total number of detected fault signals (E...).
d081	Indication – fault 1 (last fault signal)	Indication of last fault signal. The fault register contains the operational data (current, voltage, frequency, etc.) at the time of the fault.
d082	Indication – fault 2	Display of fourth from last fault message. The fault register contains the operational data (current, voltage, frequency, etc.) at the time of the fault.
d083	Indication – fault 3	Display of third from last fault message. The fault register contains the operational data (current, voltage, frequency, etc.) at the time of the fault.

Examples for changing parameters

→ The following example assumes the default settings.

Changing the acceleration time 1: PNU F002

The frequency inverter is in display mode: LED POWER is lit and the display shows 0.0 Hz ①.

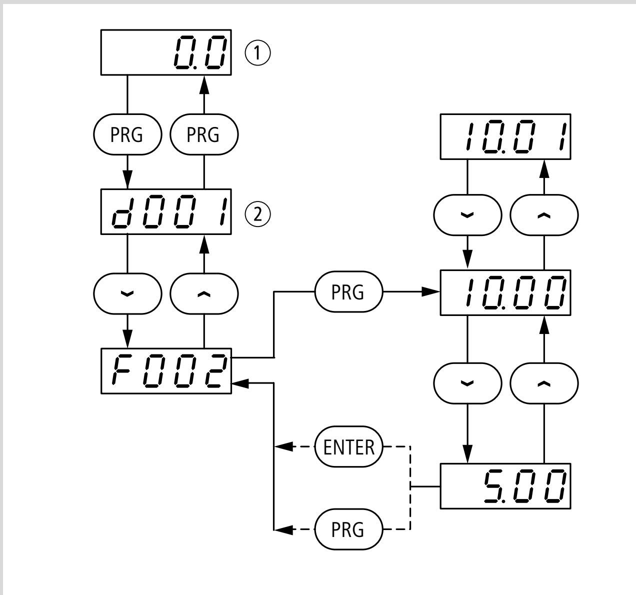


Figure 65: Change acceleration time 1

① Display value (default setting = 0.0 Hz)

② Parameter to the displayed value ①

- Press the PRG key.

The display changes to d001.

- Press the Down key seven times until F002 appears on the display.
- Press the PRG key.

The PRG LED lights up.

The set acceleration time 1 in seconds appears on the display (default value: 10.00).

- With the UP and DOWN arrow keys change the set values, for example to 5.00.

Hold the Down key to change the display value at logarithmically increasing step widths.

There are now two possibilities:

- Press the ENTER key to save the displayed value.

Press the PRG key to save the displayed value to non-retentive memory. When the power supply is switched off (LED POWER off), the value is lost.

F002 appears in the display and the LED PRG goes out.

- Press the Up key seven times until d001 appears.
- Press the PRG key.

The value 0.0 appears again in the display and the Hz LED lights up. You have reduced the acceleration time from 10 s to 5 s.

You can also change the parameter values of groups B and C and H as described in the example.

Changing the end frequency: PNU A004

- Press the PRG- key.
- Press the Down key until the main menu A--- shows in the display.
- Press the PRG key.

The display shows A001.

- Press the Up key until A004 shows in the display.
- Press the PRG key.

The PRG LED lights up. The value set under PNU A004 appears in the display (default value: 50).

- With the Up and Down arrow keys change the set values, for example to 60 Hz.

As this is a limited operating parameter, you must press the ENTER key to accept it. If you press the PRG key, the new value is discarded.

The display shows A004.

- Press the PRG key until A--- shows in the display.
- Press the Up key until d001 shows in the display.
- Press the PRG key.

The frequency inverter changes to 0.0 Hz. You have now set the end frequency to 60 Hz, so that the previous reference value of 0 to 50 Hz now corresponds with 0 to 60 Hz. At 50 Hz (PNU A003), the maximum output voltage is reached. Between 50 Hz and 60 Hz only the output frequency, and therefore the motor speed, changes.

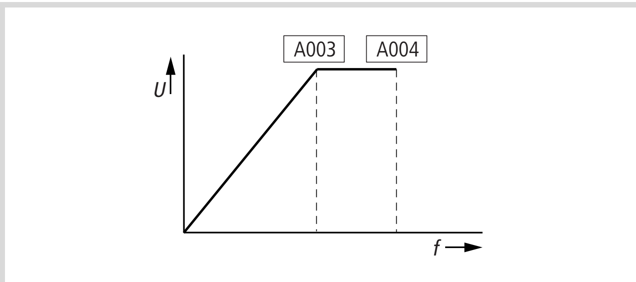


Figure 66: End frequency 60 Hz

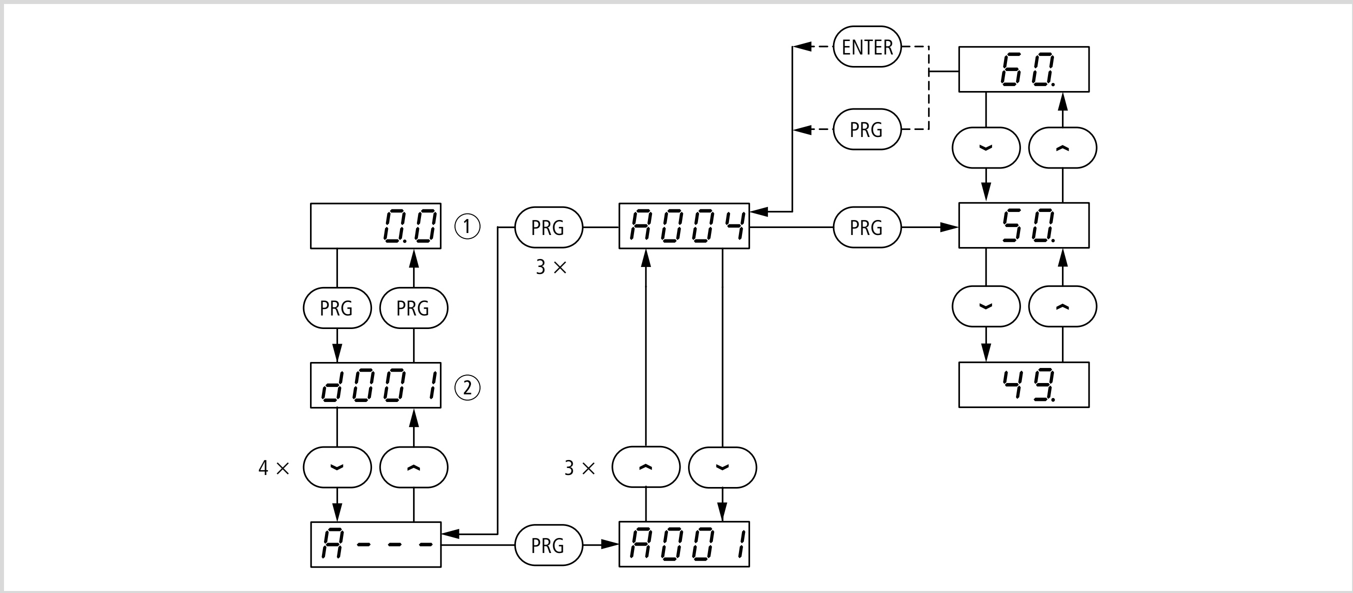


Figure 67: Change end frequency (example with default setting)

① Display value 0.0 Hz

② Parameter to the displayed value ①

Here is a short overview of the most important parameters. This overview is supplied on a self-adhesive foil with every device and when necessary can be affixed, for example, to the inside of the terminal shroud.

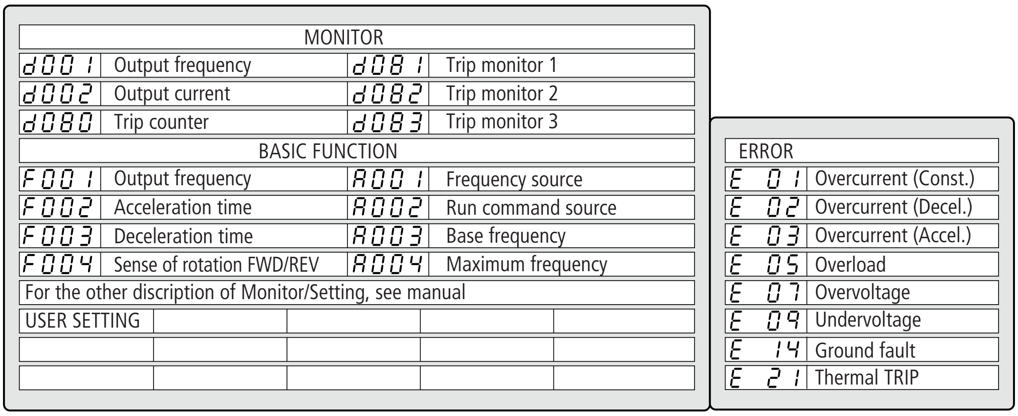


Figure 68: Label for the terminal shroud

Table 19: Brief description of the parameters

MONITOR		**Display values**	USER SETTING Preset user values
d001	Output frequency	Output frequency in Hz	
d002	Output current	Output current in A	
d080	Trip counter	Total number of occurred faults	
d081	Trip monitor 1	First fault (last fault warning)	
d082	Trip monitor 2	Second fault	
d083	Trip monitor 3	Third fault	
BASIC FUNCTION		**Basic functions**	
F001	Output frequency	Reference frequency	
F002	Acceleration time	Acceleration time 1	
F003	Deceleration time	Deceleration time 1	
F004	Sense of rotation FWD/REV	Direction of rotation	
A001	Frequency source	Reference frequency input	
A002	Run command source	Start signal input	
A003	Base frequency	Base frequency	
A004	Maximum frequency	End frequency	
ERROR		**Error messages**	
E 01	Overcurrent (Const.)	Overcurrent in the power output element in static operation	
E02	Overcurrent (Decel.)	Overcurrent in the power output element during the delay	
E03	Overcurrent (Accel.)	Overcurrent in the power output element during the acceleration	
E05	Overload	Overload	
E07	Overvoltage	Overvoltage	
E09	Undervoltage	Undervoltage	
E14	Ground fault	Ground fault	
E21	Thermal trip	Overtemperature	

Controlling the DV51 with keypad DEX-KEY-6

The following example compares the input of control signals (FWD = Start/Stop) and the frequency reference value (R1) using keypad DEX-KEY-6 and the standard connection (→ figure 69).

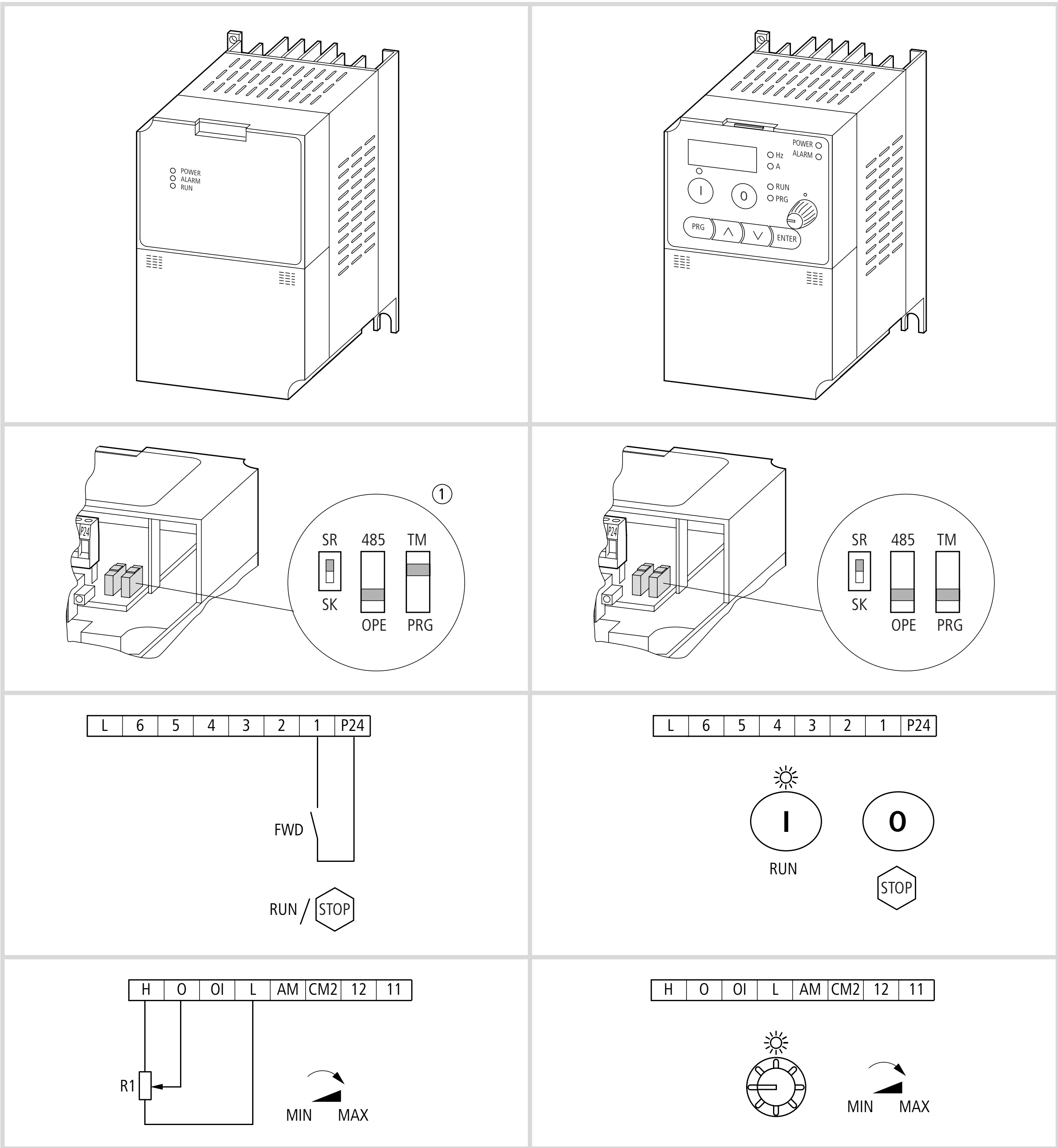


Figure 69: Comparison, standard connection (default setting) with control via the keypad

① In switch position TM, the frequency inverter accepts only control signals and reference value inputs through the control terminals (→ table 13, page 51).

The chart below shows the programming steps required to enable the potentiometer and the start key on the keypad. The assigned green LED lights up to indicate activation.

→ Micro switch TM/PRG must be in the PRG position.

With these parameters the DV51 frequency inverter can be operated through the control signal terminals without control signals.

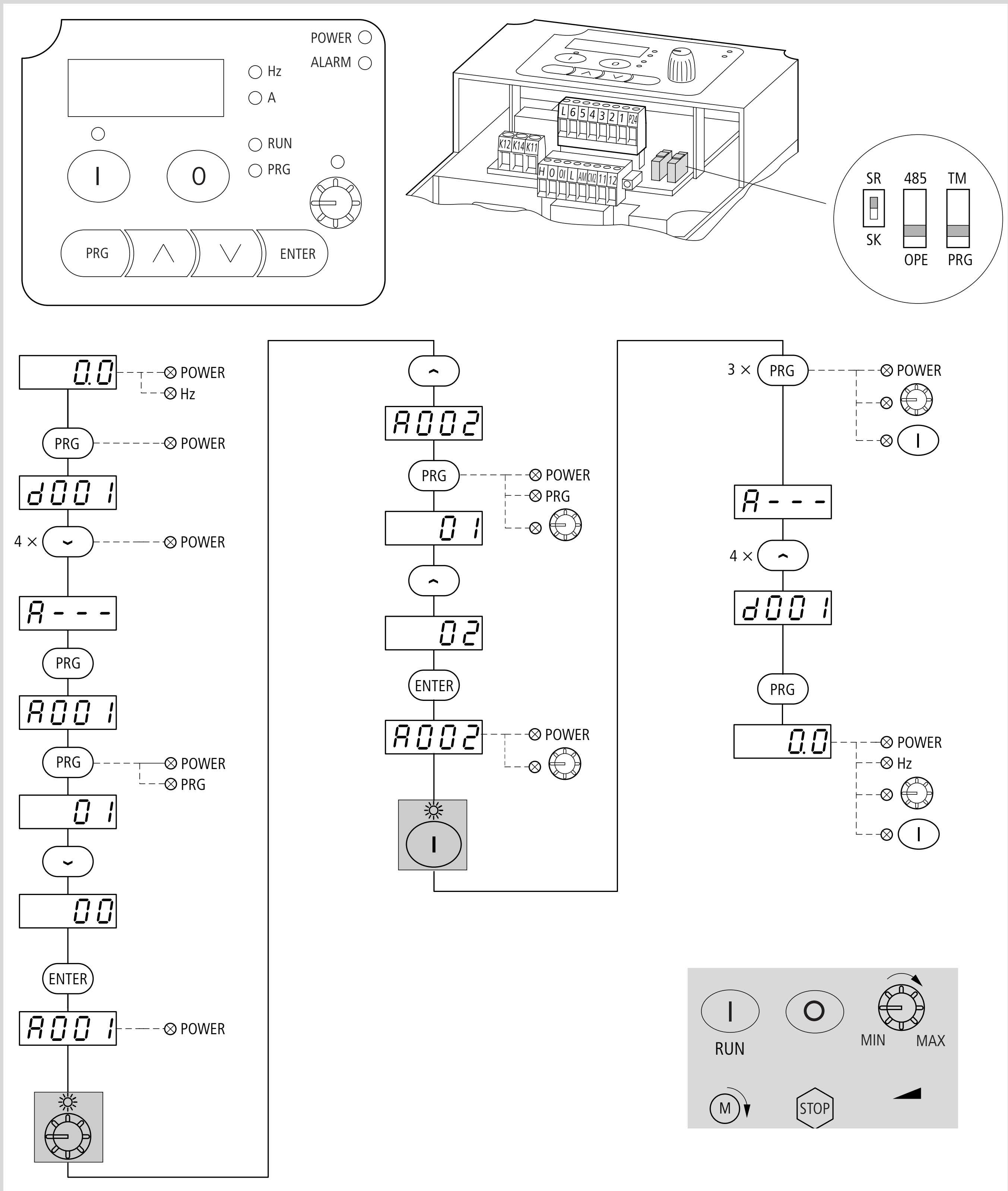


Figure 70: Reference values and control signals via keypad

6 Setting Parameters

You can adapt the DV51 to your specific applications. To do this, you need to change the frequency inverter's parameters with one of the optional keypads DEX-KEY-… or the Drives-Soft configuration software.

Table 20: Devices for changing parameter settings

Part no.	Name	Further optional accessories
Drives-Soft	Parameterization software, executable on PCs with Windows operating system. A CD is supplied with every DV51.	DEX-CBL-2M0-PC, prefabricated connecting cable with interface converter
DEX-KEY-6	Keypad with digital display assembly and potentiometer. The DEX-KEY-6 can be flush mounted in the DV51 frequency inverter or fitted externally.	DEX-CBL-…-ICS, prefabricated connecting cable with RJ 45 plug. DEX-MNT-K6, mounting rack, for example for flush mounting in a control panel door.
DEX-KEY-61	Keypad with digital display assembly. The DEX-KEY-61 can be flush mounted in the DV51 frequency inverter or fitted externally.	
DEX-KEY-10	External keypad with non-volatile parameter memory (copy function) and a backlit two-section LCD display. For notes about handling and parameterization, see manual AWB8240-1416…	DEX-CBL-…-ICS, prefabricated connecting cable with RJ 45 plug.

The parameters listed in this section can be set using the optional keypad DEX-KEY-6…

For a clear overview, the parameters and settings are grouped according to their respective functions.

PNU = parameter number displayed on the LCD keypad.

RUN = access rights to parameters in RUN mode (RUN LED is lit):

b031 = 10 = extended access rights to parameters in RUN mode (RUN LED is lit):

- ✓ = enabled.
- – = disabled.

With the second parameter set, you can assign a second value to some of the parameters.

→ The parameter numbers of the second parameter set (PNU x**2**xx) always start with a "2" and are shown with a grey background in the table . On keypad DEX-KEY-… they are displayed only when this function is enabled (→ PNU C001 = 08: SET).

PNU	Name	RUN	b031 = 10	Value	Function	DS
		–	–		Parameters can **not** be changed in RUN mode (RUN LED is lit).	
		✓	–		Parameters can be changed in RUN mode (RUN LED is lit).	
		–	✓		Access rights for this parameter have been extended to include RUN mode (→ PNU b031= 10)	

Motor data

The motor's ratings plate contains the data you will need to parameterize the frequency inverter.

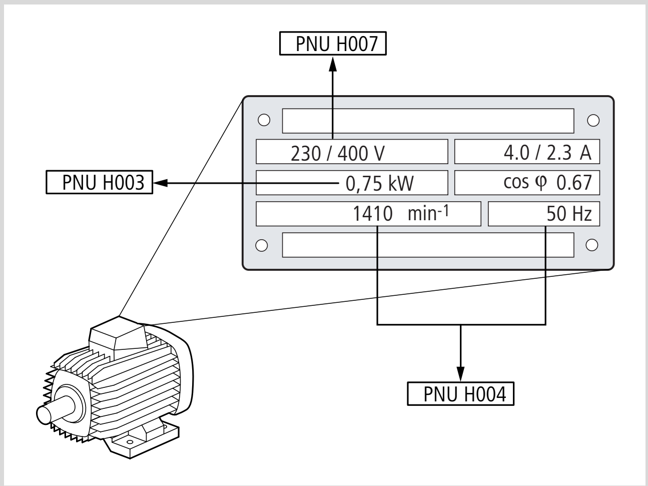


Figure 71: Parameters from motor's ratings plate

→ Note about PNU H004/H204:
The number of poles is determined by the motor's physical design and must be even as the poles are arranged in pairs consisting of a North and a South pole.

The motor speed is determined by the relationship between frequency and rotor speed:

$$n = \frac{f}{p}$$

n: Speed [r.p.m.]
f: Frequency [Hz]
p: Number of pole pairs (number of poles/2)

In the above example, the resulting value for PNU H004 is 4. (The slight error is caused by the slip – a deviation between stator field and rotor speed – inherent to asynchronous motors.)

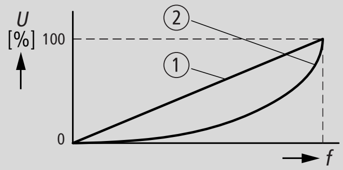
$$p = \frac{f}{n} = \frac{50\ \text{Hz} \times 60\ \frac{1}{\text{Hz} \cdot \text{min}}}{1410\ \text{r.p.m.}} \approx 2$$

Number of poles = p × 2 = 4

PNU	Name	RUN	b031 = 10	Value	Function	DS
H003 H203	Motor – assigned rating [kW]/{HP} at rated voltage (U_e)	–	–	0.2; 0.4; 0.55; 0.75; 1.1; 1.5; 2.2; 3.0; 4.0; 5.5; 7.5; 11.0 {0.2; 0.4; 0.75; 1.5; 2.2; 3.7; 5.5; 7.5; 11.0} Default depends on rated voltage and type rating.	The default setting (DS) is the assigned motor rating here, for example 0.4 = 0.37 kW. In SLV mode (→ PNU A044, page 74) the rating of the connected motor must be only one step smaller (for example 0.25 kW on a DV51-…-037). If the connected load is too low, vector control is inefficient and may cause thermal overload due to the output current.	–
H004 H204	Motor – number of poles	–	–	2, 4, 6, 8	Number of motor poles (→ Note)	4
H006 H206	Motor – stabilization constant	✓	✓	0 – 255	0 = function is not enabled If the motor runs unstably, you can improve its operation with PNU H006. Check first whether the set motor rating (PNU H003) and number of poles (PNU H004) correspond with the connected motor. If the motor's rating is higher than the frequency inverter's output power, reduce the stability constant. If the motor is not running smoothly, you can also reduce the pulse frequency (PNU b083) or change the output voltage (PNU A045).	100
H007 H207	Motor – voltage class	–	–		The default setting (DS) is the DV51's rated motor voltage:	–
				00:	200 V (230 V) = DV51-320/DV51-322	
				01:	400 V = DV51-340	
					→ section "Motor and circuit type", page 21	

Motor control

U/f characteristic

PNU	Name	RUN	b031 = 10	Value	Function	DS
A044	*U*/*f* character-istic	–	–	 ① Linear ② Quadratic	By default, the DV51 works with sensorless vector control. Depending on your application, you can also select a quadratic or linear *U*/*f* characteristic for acceleration and braking. If SLV control is active, you should set the pulse frequency to at least 5 kHz with PNU b083 (→ page 151).	02
				00	Constant torque curve	
				01	Reduced torque curve	
				02	SLV active	

With a linear *U*/*f* characteristic the ratio of output voltage to output frequency remains linear in the range from 0 Hz to the rated frequency (PNU A003, → page 72) → constant torque curve. This facilitates constant load torques also during acceleration and deceleration.

In the range from the motor's rated frequency (PNU A003) up to the manufacturer's specified maximum frequency (speed, PNU A004 → page 72), the output voltage remains constant as the frequency increases.

If you select the square-law torque curve, the *U*/*f* ratio changes in a square-law pattern. This results in a reduced starting torque in the lower frequency/speed range.

Examples:

① Linear *U*/*f* characteristic:

- For parallel operation of several motors at the frequency inverter's output.
- For changeovers at the frequency inverter's output.
- When operating motors with a low rating.

② Quadratic *U*/*f* characteristic:

- Energy-optimized operation of pumps, fans, etc.
- Application requiring a reduced starting torque.

For applications that nee a high starting torque (hoisting gear, drilling and milling machines, compressors, etc.) sensorless vector control is used today.

SLV (sensorless vector control)

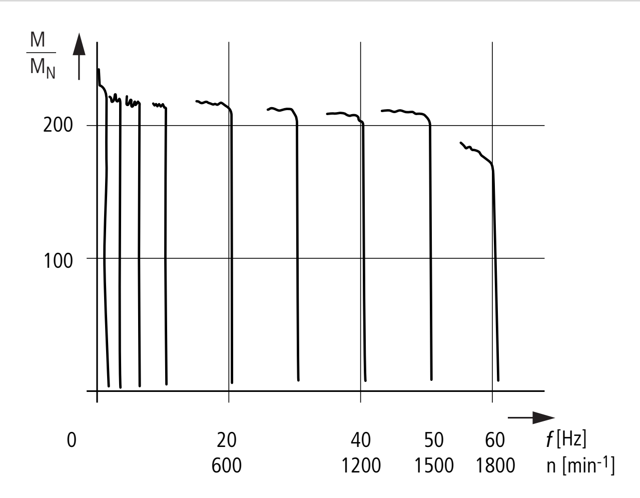


Figure 72: Torque characteristic, SLV

SLV control has the following advantages over *U*/*f* control:

- Short rise times on reference value changes.
- Short transient recovery times on load changes.
- Acceleration and braking at maximum torque.
- High starting torque, also at low speed.
- Motor protection through adjustable current limitation.
- Good speed stability at load changes.

This is made possible through field-orientated vector control, which provides good torque control without feedback (i.e. sensorless).

This is achieved by using the current motor current and the current motor voltage to calculate the magnetization current (flux-generating component) and the active current (torque-generating component). These two current components are enough to provide optimum motor control in combination with the constants for the controlled motor.

The actual controlling is performed by a powerful microprocessor built into the frequency inverter. Although SLV control does not require feedback of the current motor speed from a speed sensor, it is almost as powerful as vector control with feedback signal.

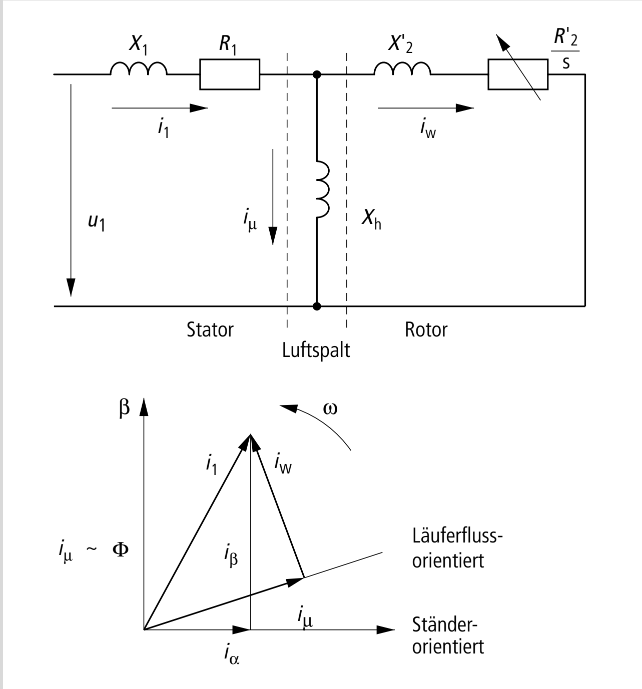


Figure 73: Simplified equivalent circuit diagram of the asynchronous motor and associated current vectors

i_1 = stator current (phase current)

i_μ = flow-generating current component

i_W = torque-generating current component

R'_2 /s = slip-dependent stator resistance

In sensorless vector control the flow-generating dimension i_μ and the torque-generating dimension i_W are calculated from the measured values of stator voltage u_1 and stator current i_1. The calculation is performed in a dynamic motor model (an electrical equivalent circuit diagram of the three-phase motor) with adaptive current controllers taking into account the magnetizing field's saturation and the iron losses. Depending on their value and phase, the two current components are placed into a rotating coordinate system (ω) to the static reference system (α, β). The physical motor data required for the model are formed from the entered parameters.

Principle of slip compensation

Without slip compensation an increasing load torque ① (for example of a conveyor being loaded) reduces the motor speed ②.

With slip compensation the speed reduction caused by the increasing load torque ① is compensated with an increase of the output frequency ②.

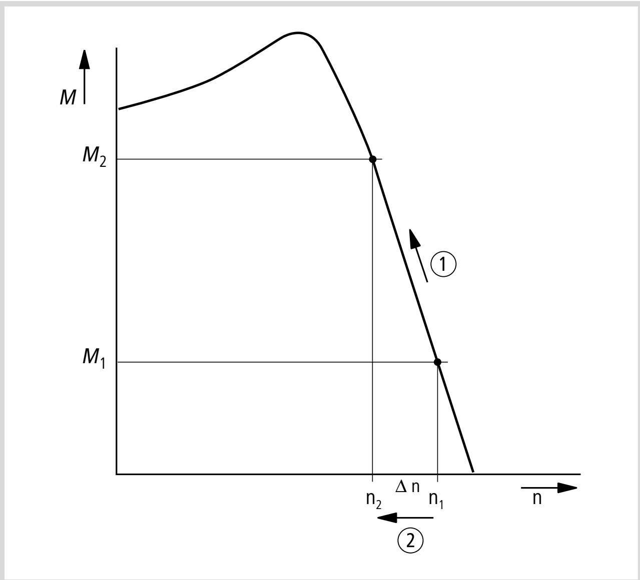


Figure 74: Without slip compensation

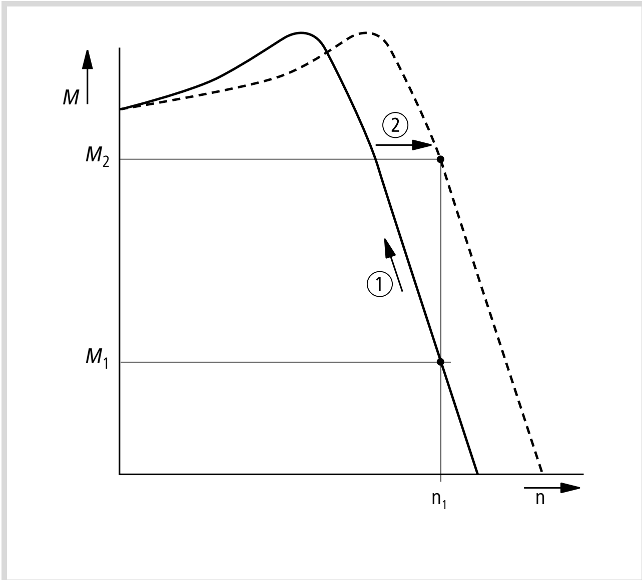


Figure 75: With automatic slip compensation

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 at 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 deceleration, you can therefore deactivate the AVR function under PNU A081.

If the mains voltage is higher than the rated motor voltage, enter the mains voltage under PNU A082 and, under PNU A045 reduce the output voltage to the rated motor voltage (→ page 74).

PNU	Name	RUN	b031 = 10	Value	Function	DS
A081	Output voltage (AVR function)	–	–	00	AVR enabled	00
				01	AVR disabled	
				02	AVR disabled during deceleration	
A082	Output voltage (AVR motor rated voltage)	–	–	200, 215, 220, 230, 240, 380, 400, 415, 440, 460, 480	• 200 V range:DV51-32…-…: 200, 215, 220, 230, 240 • 400 V range: DV51-340-…: 380, 400, 415, 440, 460, 480	230/400

Limit and target values

Base frequency

The base frequency is the frequency at which the output voltage has its maximum value. For standard applications, PNU A003 contains the motor's rated frequency as base frequency (→ section "Motor data", page 68).

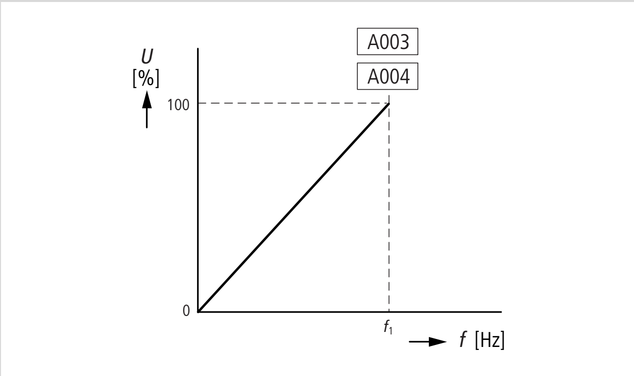


Figure 76: Base frequency = end frequency

f_1: Base frequency

PNU	Name	RUN	b031 = 10	Value	DS
A003 A203	Base frequency	–	–	30 – 400 Hz, up to value of PNU A004 [Hz] (motor's rated frequency)	50 {60}
A004 A204	End frequency (f_{max})	–	–	30 – 400 Hz	50 {60}

1) 60 at DV51-320-…

End frequency

If a constant-voltage frequency range exists beyond the transition frequency set with PNU A003 define this range with PNU A004. The end frequency must not be smaller than the base frequency.

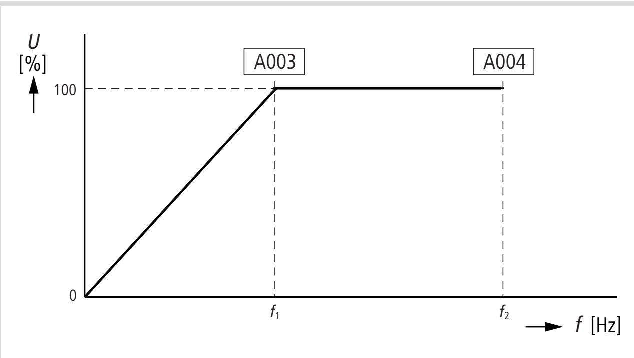


Figure 77: Base and end frequency

f_1: Base frequency

f_2: End frequency

Increased starting frequency

For applications with a high static friction (such as conveyor belts and lifting equipment) increase the starting frequency with PNU 082. The motor then starts directly with the frequency value set here.

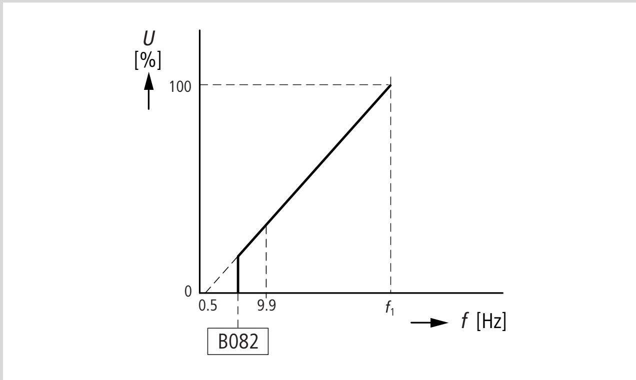


Figure 78: Increased starting frequency

→ Analog reference values below the response threshold are not taken into account.

Example:
0 to 10 V correspond with 0 to 50 Hz. PNU b082 = 5 Hz. The reference value range is 1 to 10 V.

The RUN signal is activated with the value set in PNU b082. It remains active as long as a frequency of or above this value is applied.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b082	Increased starting frequency (e.g. at high static friction)	–	✓	0.5 – 9.9 Hz	A higher starting frequency results in shorter acceleration and deceleration times (for example to overcome high frictional resistance). Up to the set starting frequency, the motor accelerates without a ramp function. If the frequencies are too high, fault message E002 may be issued.	0.5

Control mode U/f (manual boost)

In *U*/*f* control mode (PNU A044/A244 = 01), manual voltage boost increases the voltage, and therefore the torque, in the lower frequency range. The voltage is boosted in a frequency range from the starting frequency (default is 0.5 Hz) to 50 % base frequency (25 Hz at the default setting of 50 Hz) in all operating states (acceleration, static operation, deceleration), regardless of the motor load. A voltage boost may cause a fault message and trip due to the higher currents involved.

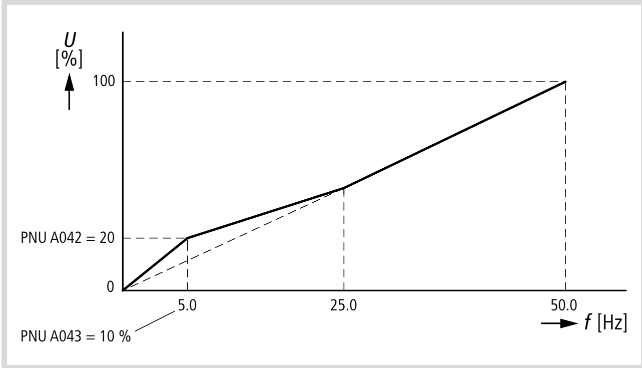
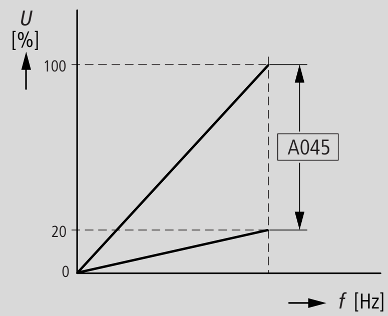


Figure 79: Manual boost characteristic

Parameter settings for manual voltage boost:
A042 = 20 % of the output voltage
A043 = 10 % (= 5 Hz)
A044 = 00 (constant torque characteristic)
A045 = 100 % (output voltage = mains voltage)

PNU	Name	RUN	b031 = 10	Value	Function	DS
A042 A242	Boost, manual voltage boost	✓	✓	0 – 20 %	Setting the voltage increase with manual boost.	5.0
A043 A243	Boost, transition frequency for maximum voltage boost	✓	✓	0 – 50 %	Setting the frequency with the highest voltage boost as a percentage of the base frequency (PNU A003).	3.0
A044	*U*/*f* characteristic	–	–	00	Constant torque curve	02
				01	Reduced torque curve	
				02	SLV active	
A045	*U*/*f* characteristic, output voltage	–	–	20 – 100 %	 If the rated motor voltage is lower than the mains voltage, enter the mains voltage in PNU A082 (→ page 71) and reduce the output voltage in PNU A045 to the rated motor voltage. Example: At 440 V mains voltage and 400 V rated motor voltage enter: PNU 082 = 440 V, PNU A045 = 91 % (= 400/440 × 100 %).	100

SLV control mode

In this control mode (SLV = sensorless vector control with automatic voltage matching), you can in addition adapt the automatic behaviour of your drive unit. This may be necessary, for example, if the motor data deviate and under extreme operating conditions. With the parameters listed here, you can change (overwrite) the automatically determined values. By default (PNU A044/A244 = 02: SLV), voltage boost is performed automatically depending on the connected load.

PNU	Name	RUN	b031 = 10	Value	Function	DS
A042 A242	Boost, manual voltage boost	✓	✓	0 – 20 %	Setting the voltage increase with manual boost.	5.0
A043 A243	Boost, transition frequency for maximum voltage boost	✓	✓	0 – 50 %	Setting the frequency with the highest voltage boost as a percentage of the base frequency (PNU A003).	3.0
A044	*U*/*f* characteristic	–	–	00	Constant torque curve	02
				01	Reduced torque curve	
				02	SLV active	
A046 A246	SLV, gain factor, automatic voltage compensation	✓	✓	0 – 255	Automatic matching of start pedestal to motor load (start compensation). Adjustment of gain factor: 0 to 255 (ratio of rated voltage to rated current). Excessively high values can cause fault messages (for example overcurrent).	100
A047 A247	SLV, gain factor, automatic slip compensation	✓	✓	0 – 255	Automatic matching of load-dependent speed reduction. Gain factor matching: 0 to 255 (ratio of output current to output frequency). Excessively high values can cause a fault message.	100
H006 H206	Motor – stabilization constant	✓	✓	0 – 255	0 = function is not enabled If the motor runs unstably, you can improve its operation with PNU H006. Check first whether the set motor rating (PNU H003) and number of poles (PNU H004) correspond with the connected motor. If the motor's rating is higher than the frequency inverter's output power, reduce the stability constant. If the motor is not running smoothly, you can also reduce the pulse frequency (PNU b083) or change the output voltage (PNU A045).	100

Reference and control signal inputs

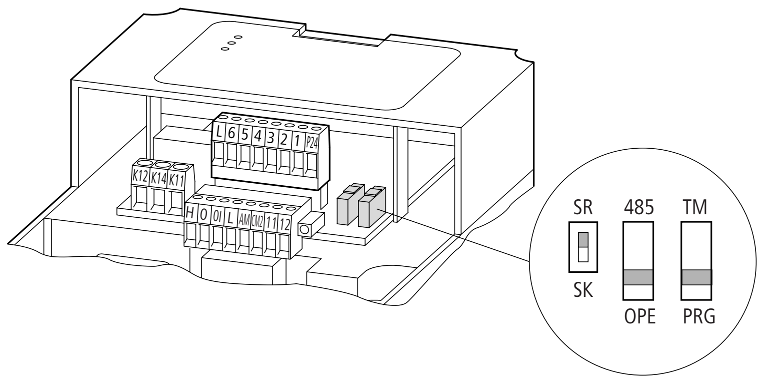


Figure 80: Microswitches

→ Reference value and control signal inputs depend on PNU A001 and A002 and the position of microswitches 485/OPE and TM/PRG.

Microswitch 485/OPE configures the serial interface (RJ 45 communication interface):

Position 485/OPE	Description	Reference and control signal input
485 (RS 485)	Serial interface	Keypad DEX-KEY-6
		Keypad DEX-KEY-61
		Modbus RTU (network)
OPE (operator)	Manual operation (point-to-point connection)	Keypad DEX-KEY-6 1)
		Keypad DEX-KEY-61 1)
		Keypad DEX-KEY-10 1)
		Parameterization software Drive Soft

1) To ensure unrestricted communications, set the switch to position 485.

Microswitch TM/PRG selects the source of the reference value and control signal input.

Position TM/PRG	Description	Reference and control signal input
PRG (program)	Reference input for output frequency	Specification according to setting under PNU A001
	Start (RUN) signal input	Specification according to setting under PNU A002
TM (terminal = control signal terminals)	Reference input for output frequency	Analog input O or OI
	Start (RUN) signal input	Digital inputs FWD and/or REV

By default (PNU A001 = 01 and A002 = 01), the position of microswitch TM/PRG is ignored for the purpose of reference value and control signal input.

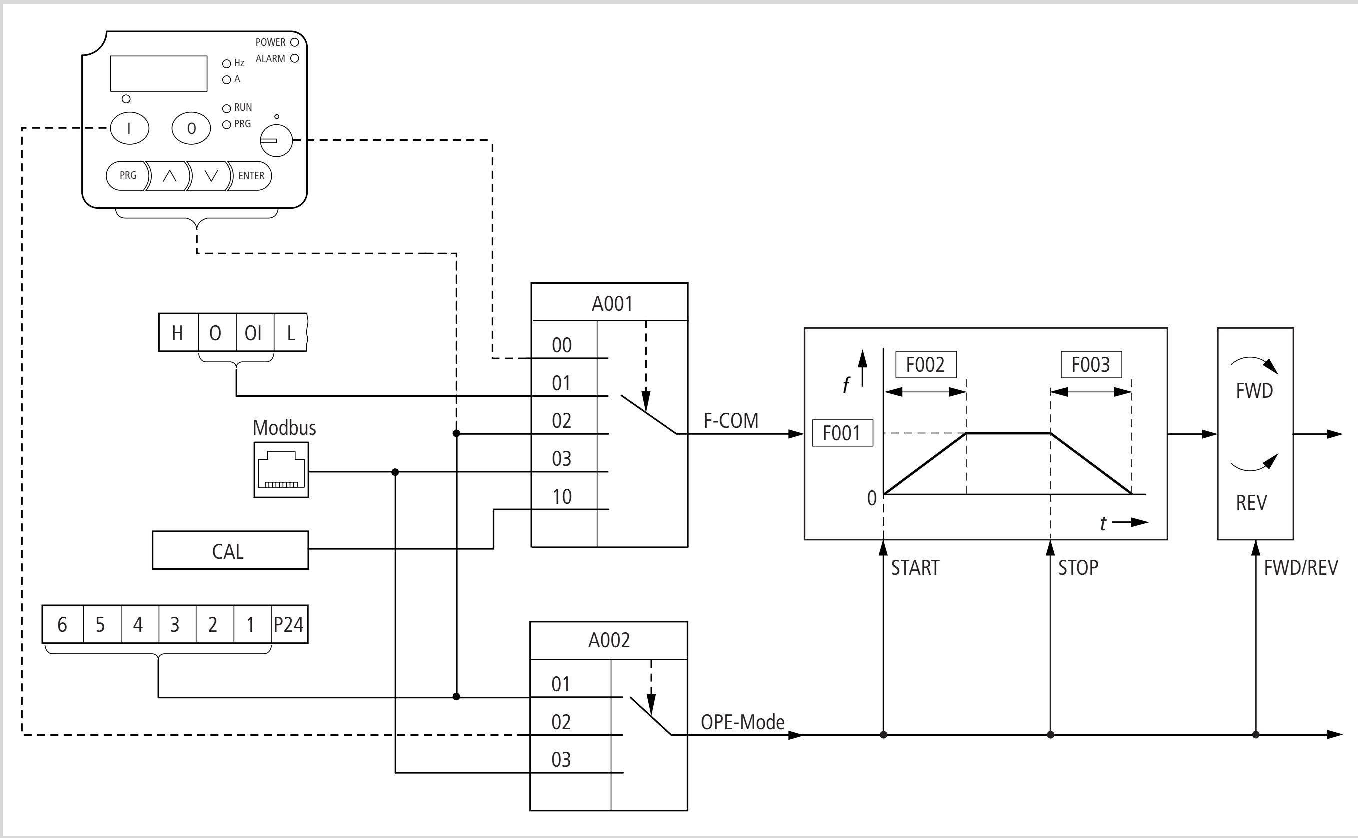


Figure 81: Block diagram, reference value/control signal input

PNU	Name	RUN	b031 = 10	Value	Function	DS
A001	Reference value source selection	–	–	00	The setting range is limited by PNU b082 (raised starting frequency) and A004 (end frequency). • Potentiometer (optional keypad DEX-KEY-6) • Frequency [Hz] • Process variable [%] with active PID control (PNU A071 = 1)	01
				01	Analog input: Control signal terminals O and OI	
				02	Set value (PNU F001) of optional keypad DEX-KEY-… (arrow keys ⋀/⋁). To save the set value, press the ENTER key (PNU A020).	
				03	Serial interface (Modbus)	
				10	Calculator: Calculated value (CAL) (→ section "Mathematical functions", page 136).	
A002	Start signal source selection	–	–	00	Digital input (FWD/REV)	01
				01	Optional keypad DEX-KEY-…: Start and Stop key.	
				03	Modbus: Activates a COIL for RUN/STOP and a COIL for FWD/REV.	
C081	Analog input O – reference value signal compensation	✓	✓	Compensation of analog voltage signals at input O to output frequency (0 – 200 %)		100
C082	Analog input OI – reference value signal compensation	✓	✓	Compensation of analog current signals at input OI to output frequency (0 – 200 %)		100

Additional control signals allow the reference source selected with PNU A001 (F-COM) to be temporarily exceeded. Example: When a fixed frequency (CF1 to CF4) is activated, the analog reference value of control signal terminals O or OI is overwritten.

Priority	Reference input source	Description (page)
1 (highest)	Fixed frequency CF1 to CF4	105
2	Digital input = 31 (OPE)	88
3	Digital input = 51 (F-TM)	88
4	Digital input = 16 (AT)	99
5	Microswitch TM/PRG in position TM	51
6 (lowest)	PNU A001	95

The start signals selected with PNU A002 (OPE mode) can also intermittently be overwritten with the following additional control signals:

Priority	Source for Start (RUN) signal	Description (page)
1 (highest)	Digital input = 31 (OPE)	88
2	Digital input = 51 (F-TM)	88
3	Microswitch TM/PRG in position TM	51
4 (lowest)	PNU A002	77

Compensation of analog input signals (PNU C081, C082) has no effect on the characteristic. You can change the range from the zero point to the maximum value if the reference value does not correspond with the frequency range (0 – 50 Hz).

Example:
Reference value 0 to 10 V, PNU C081 = 200 %.
With the reference voltage 0 to 10 V you can now adjust the output frequency in the range 0 to 25 Hz. With PNU C081 = 50 % you can adjust the output frequency (0 – 50 Hz) with a reference voltage from 0 to 5 V. Values above 5 V are not processed.

→ You can change the values of PNU C081 and C082 in RUN mode. Changes become active when you press the ENTER key.

Basic parameters

Input/indication of reference frequency

PNU F001
indicates the current reference frequency or the current fixed frequency. You can change the frequencies with the arrow keys and save the settings as defined with PNU A001 and the fixed frequency stages CF1 to CF4 (digital inputs) (→ section "Fixed frequencies", page 105).

With PNU F001, you can change the reference value even when parameter protection has been set with PNU b031.

→ Micro switch TM/PRG must be in the TM position.

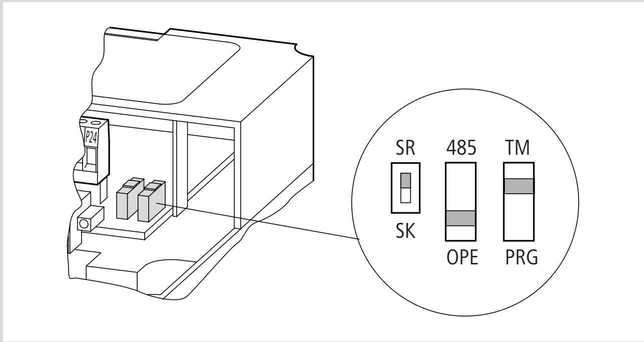


Figure 82: Microswitches

If you have not activated any fixed frequencies, PNU F001 indicates the set reference frequency.

If you specify the reference frequency with PNU A020, you can enter a new value under PNU F001, which is saved automatically in PNU A020:

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

The saved value is automatically written to PNU A020.

PNU	Name	RUN	b031 = 10	Value	Function	DS
A001	Reference value source selection	–	–	00	The setting range is limited by PNU b082 (raised starting frequency) and A004 (end frequency). • Potentiometer (optional keypad DEX-KEY-6) • Frequency [Hz] • Process variable [%] with active PID control (PNU A071 = 1)	01
				01	Analog input: Control signal terminals O and OI	
				02	Set value (PNU F001) of optional keypad DEX-KEY-… (arrow keys ⌃/⌄). To save the set value, press the ENTER key (PNU A020).	
				03	Serial interface (Modbus)	
				10	Calculator: Calculated value (CAL) (→ section "Mathematical functions", page 136).	
F001	Reference value – input through optional keypad DEX-KEY-…	✓	✓	Frequency: 0.0 – 400 Hz (0.1 Hz)	Resolution ±0.1 Hz The reference value can be defined using various methods: • With PNU F001 or A020: Enter the value 02 under PNU A001. • 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 analog input O or OI: Enter the value 01 under PNU A01. • With the digital inputs configured as CF1 to CF4. After selection of the required fixed frequency stage using CF1 to CF4, the frequency for the respective stage can be entered. The display of the reference value is independent of which method was used to set the reference value.	0.0

Second acceleration and deceleration time

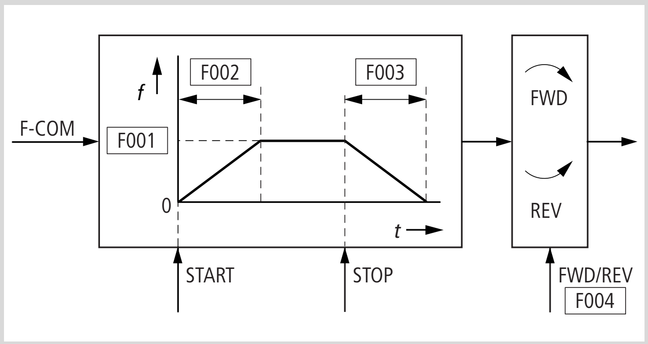


Figure 83: Acceleration/deceleration ramps

Acceleration time 1

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

PNU	Name	RUN	b031 = 10	Value	Function	DS
F002 F202	Acceleration time 1	✓	✓	0.01 – 3000 s	Resolution of 0.01 s at an input of 0.01 to 99.99 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	10.00

Deceleration time 1

Deceleration time 1 defines the time in which the frequency inverter reduces the output frequency from the end frequency to 0 Hz after a stop signal.

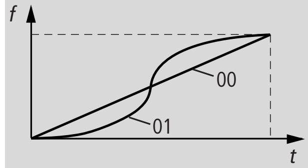
PNU	Name	RUN	b031 = 10	Value	Function	DS
F003 F203	Deceleration time 1	✓	✓	0.01 – 3600 s	Resolution of 0.01 s at an input of 0.01 to 99.99 Resolution of 0.1 s at an input of 100.0 to 999.9 Resolution of 1 s at 1000 to 3600 s	10.00

Direction of rotation

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

PNU	Name	RUN	b31=10	Function	DS
F004	Direction of rotation – function of Start key (optional keypad DEX-KEY-…)	✓	✓	00: Clockwise rotating field (FWD) 01: Anticlockwise rotating field (REV)	00

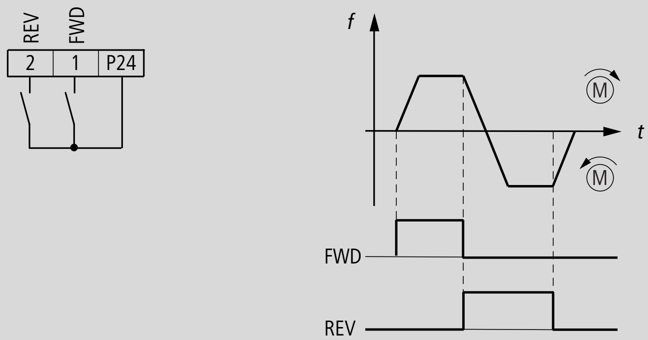
Acceleration and deceleration characteristic

PNU	Name	RUN	b031 = 10	Value	Function	DS
A097	Acceleration time, characteristic	–	–	Here, you can set a linear or an S-curve acceleration characteristic for motor acceleration (first and second time ramp): 		00
				00	linear	
				01	S curve	
A098	Deceleration time, characteristic	–	–	00	linear	00
				01	S curve	

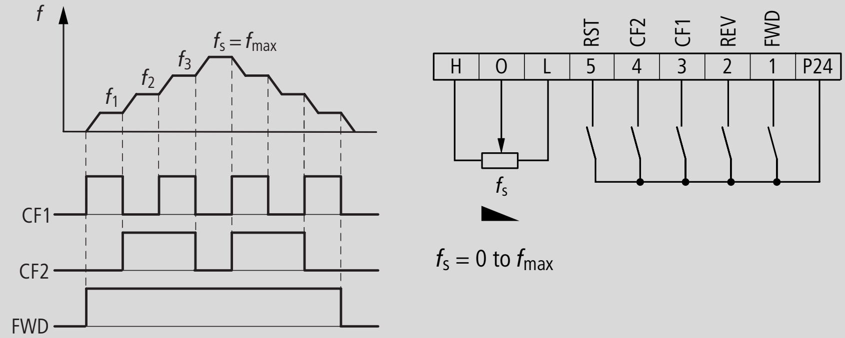
Control signal terminal overview (input)

table 21 provides an overview of the digital and analog control signal terminal inputs. For a detailed description of each function, see from page 112.

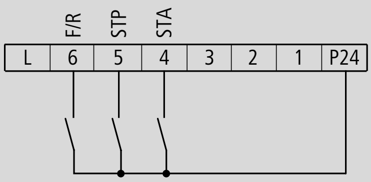
Table 21: Brief description of the functions (digital and analog inputs)

Name	Value[1)]	Function	Description
Parameterizable digital inputs 1 to 6			Parameterizing PNU C001 to C006
FWD	00	Clockwise rotation (RUN/STOP)	
REV	01	Anticlockwise rotation (RUN/STOP)	FWD input closed: motor starts up with a clockwise rotating field. FWD input open: controlled motor deceleration to stop (clockwise rotating field). REV input: As for FWD, but with anticlockwise rotating field FWD and REV inputs closed simultaneously: Motor does not start or controlled motor deceleration to stop.

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

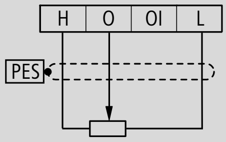
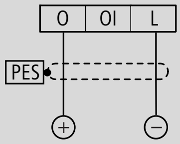
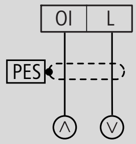
Name	Value[1)]	Function	Description
CF1	02	Programmable fixed frequencies 1 to 4, bit 0 (LSB) to bit 3 (MSB)	Example: Four fixed frequencies 
CF2	03		
CF3	04		
CF4	05		For four fixed frequency stages (three programmable fixed frequencies and a reference value), two fixed frequency inputs (3 = CF1 and 4 = CF2) are required ($2^2 = 4$).
JOG	06	Jog mode	The jog 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 A038 is applied to the motor. Under PNU A039, you can select one of three different operating modes for stopping the motor.
DB	07	DC braking	After the DB input has been enabled, DC braking is carried out.
SET	08	Selection of second parameter set	Switching on SET allows you to select the second parameter set for reference 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
2CH	09	Second time ramp	Activates the second acceleration and deceleration time with PNU A092 and PNU A093 respectively
FRS	11	Controller inhibit (free run stop)	When FRS (free run stop) is switched on, the motor is immediately switched off and coasts to a stop.
EXT	12	External fault message	When the EXT input is switched on, the fault signal activates PNU E012 and the motor switches off. The fault signal can be acknowledged, for example, with the RST input.
USP	13	Unattended start protection	When the USP input is switched on, unattended start protection is active. This prevents a motor restart when the voltage recovers after a mains failure while a start signal is present.
SFT	15	Parameter access inhibit	The parameter protection, which is activated by switching on the SFT input, prevents loss of the entered parameters by inhibiting write operations to these parameters.
AT	16	Reference input OI (4 to 20 mA) active	When the AT input is active, only the reference 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 coasts to a stop. The RST input is a make (NO) contact; it cannot be programmed as a break (NC) contact.
PTC	19	Connection for a PTC thermistor	Only digital input 5 can be programmed as a PTC thermistor input with PNU C005. Use terminal L as the reference potential.

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

<table>
<tr><th>Name</th><th>Value[1)]</th><th>Function</th><th>Description</th></tr>
<tr><td>STA</td><td>20</td><td>Three-wire control, Start signal</td><td rowspan="3">

<table>
<tr><th>Motor start (input)</th><th>STA</th><th>F/R[1)]</th><th>STP[2)]</th></tr>
<tr><td>FWD</td><td>ON[3)]</td><td>OFF</td><td>ON</td></tr>
<tr><td>REV</td><td>OFF</td><td>ON</td><td>ON</td></tr>
<tr><td>STOP</td><td>OFF</td><td>–</td><td>OFF[3)]</td></tr>
</table>
1) A state change (ON/OFF) during operation causes a change in the direction of rotation
2) Open circuit protection (automatic motor stop)
3) Pulse</td></tr>
<tr><td>STP</td><td>21</td><td>Three-wire control, Stop signal</td></tr>
<tr><td>F/R</td><td>22</td><td>Three-wire control, direction of rotation</td></tr>
<tr><td>PID</td><td>23</td><td>PID control enabled</td><td>Closing results in temporary disabling of PID control (PNU A071 = 01).</td></tr>
<tr><td>PIDC</td><td>24</td><td>Reset I-component of PID control</td><td>Closing causes disabling and resetting of the I-component.</td></tr>
<tr><td>UP</td><td>27</td><td>Acceleration (motor potentiometer)</td><td>When input UP is switched on, the motor accelerates (available only if you have specified the reference frequency with PNU F001 or A020).</td></tr>
<tr><td>DWN</td><td>28</td><td>Deceleration (motor potentiometer)</td><td>When input UP is switched on, the motor decelerates (available only if you have specified the reference frequency with PNU F001 or A020).</td></tr>
<tr><td>UDC</td><td>29</td><td>Motor potentiometer, reset saved value of motor potentiometer to 0 Hz</td><td>The UDC control signal deletes the saved values (UP/DWN) of the electronic motor potentiometer (PNU F001).
Precondition: PNU C101 = 00.</td></tr>
<tr><td>OPE</td><td>31</td><td>Keypad (operator)</td><td>The OPE control signal the optional keypad is set to the highest priority for reference frequency input (PNU A001) and for the start signal (PNU A002).</td></tr>
<tr><td>ADD</td><td>50</td><td>Add value from PNU A145 to frequency reference value</td><td>The OPE signal causes the addition of a frequency offset (PNU A145) to the reference frequency (F-COM) (plus/minus = PNU A146).</td></tr>
<tr><td>F-TM</td><td>51</td><td>Digital input, increase priority</td><td>If the F-TM signal is active, the reference frequency input and the Start signal are issued through the control signal terminals regardless of the settings of PNU A001 and/or A002.</td></tr>
<tr><td>RDY</td><td>52</td><td>Inverter, reduce response time.</td><td>The RDY signal reduces the internal response time from the control signal to the inverter (filter time constant minimized and inverter transistors activated).
Caution: Dangerous voltage at terminals U-V-W</td></tr>
<tr><td>SP-SET</td><td>53</td><td>Second parameter set with special functions</td><td>SP-SET enables the second parameter set in the extended functional span.</td></tr>
<tr><td colspan="3">Control and reference voltage</td><td></td></tr>
<tr><td>P24</td><td>–</td><td>+24 V ⎓ for digital inputs</td><td>24 V = potential for digital inputs 1 to 6
Load carrying capacity: 30 mA</td></tr>
<tr><td>h</td><td>–</td><td>+10 V reference voltage for external potentiometer</td><td>10 V = potential for supplying external reference value potentiometers
Load carrying capacity: 10 mA</td></tr>
<tr><td>L</td><td>–</td><td>0 V reference potential</td><td>Reference potential for the following control signal terminals
• Analog inputs O and OI
• Analog output AM
• Reference voltage +10 V (H)
• Control voltage +24 V:</td></tr>
</table>

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

Name	Value[1)]	Function	Description
Analog inputs			
O	–	Analog input for reference frequency (0 to 10 V)	The reference value can be set with the potentiometer:  *R*: 1 to 5 kΩ Reference value through voltage input:  0 to 10 V ⎓ (0 to +9.6 V ⎓) Input impedance: 10 kO Reference value through current input:  4 to 20 mA ⎓ (4 to 19.6 mA ⎓) Load resistor: 250 Ω When the AT control signal (PNU C001 = 16) is issued, only analog input OI is accepted as reference frequency.
OI	–	Analog input for reference frequency (4 to 20 V)	

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

Start signal input

Start signal

By default the start signal is triggered through the inputs configured as FWD (control signal terminal 1) and REV (control signal terminal 2).

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

> ⚠ **Warning!**
> Note that, when the FWD/REV input is opened (inactive condition when it has been configured as a N/O contact) and the input is then reconfigured as N/C contact, the motor may start immediately after the configuration.

Clockwise rotating field (FWD)

When you activate the digital input configured as FWD (forward) input, the frequency in phase sequence U-V-W is applied at the DV51's output. If connected accordingly, the motor then starts up in a clockwise direction. When the input is deactivated, the motor is decelerated.

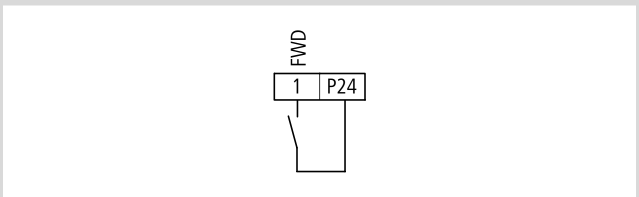


Figure 84: Digital input 1 configured as FWD

Anticlockwise rotating field (REV)

When the digital input configured as REV (reverse) is activated, the motor starts up in an anticlockwise direction (W-V-U). When the input is deactivated, the motor is decelerated.

If you activate the FWD and the REV input at the same time during operation, the motor coasts to a halt.

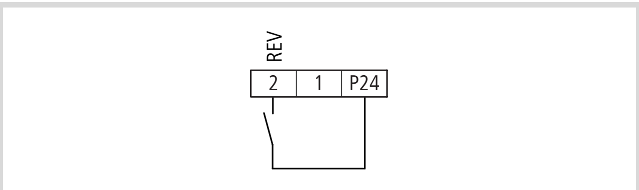


Figure 85: Digital input 2 configured as REV

Under PNU C001 to C006 or C201 to C206 (second parameter set) you can assign the start signal to any digital input: 00 = FWD, 01 = REV.

Parameterizable digital inputs

Various functions can be assigned to terminals 1 to 6. Depending on your requirements, you can configure these terminals as follows:

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

The terminal functions for programmable digital inputs 1 to 6 are configured with PNU C001 to C006. i.e. with PNU C001, you specify the function of digital input 1, with PNU C002 the function of digital input 2, etc. Note, however, that you cannot assign the same function to two inputs at the same time.

Programmable digital inputs 1 to 6 are configured by default as make contacts. If, therefore, the function of an input terminal is to be activated, the corresponding input must be closed (i.e. the input terminal is, for example, connected to terminal P24). Deactivation results in interruption of the input voltage (+24 V).

> ▽ **Caution!**
> If an EEPROM error occurs, (fault message E08), all parameters must be checked to ensure that they are correct (especially the RST input).

Table 22: Digital inputs 1 to 6

PNU	Terminal	Adjustable in RUN mode	Value	DS
C001	1	–	→ table 23	00
C201				
C002	2			01
C202				
C003	3			02
C203				
C004	4			03
C204				
C005	5			18
C205				
C006	6			09
C206				

For a detailed description of the input functions, see the pages listed in table 23.

Table 23: Function of the digital inputs

Value	Function	Description	a page
00	FWD	Start/stop clockwise	85
01	REV	Start/stop anticlockwise	85
02	CF1	Binary input 1 (LSB) (fixed frequency 1)	105
03	CF2	Binary input 2 (fixed frequency 2)	
04	CF3	Binary input 3 (fixed frequency 3)	
05	CF4	Binary input 4 (MSB) (fixed frequency 4)	
06	JOG	Jog mode	109
07	DB	DC braking	132
08	SET	Selection of second parameter set	91
09	2CH	Second acceleration and deceleration time	101
11	FRS	Controller inhibit and coasting to halt	87
12	EXT	External fault	128
13	USP	Unattended start protection	131
15	SFT	Parameter protection	153
16	AT	Select analog input	96
18	RST	Fault signal reset	128
19	PTC	PTC thermistor input (digital input 5 only)	123
20	STA	Start signal (3-wire)	88
21	STP	Stop signal (3-wire)	88
22	F/R	Direction of rotation (3-wire)	88
23	PID	Activation of PID control	145
24	PIDC	Reset integral component	145
27	UP	Acceleration (motor potentiometer)	107
28	DWN	Deceleration (motor potentiometer)	107
29	UDC	Reset frequency (motor potentiometer)	107
31	OPE	LCD keypad	88
50	ADD	Add frequency offset	137
51	F-TM	Control signal terminals mode enabled	88
52	RDY	Inverter, reduce response time to control signals	151
53	SP-SET	Second parameter set with special functions	91
255	–	Not used	–

Optionally, you can configure the digital inputs as break (NC) contacts. To do this, enter 01 under PNU C011 to C016 (corresponding to digital inputs 1 to 6). An exception applies only to inputs configured as RST (reset) or PTC (PTC thermistor input). These inputs can be operated only as make (NO) contacts.

Caution!
If you reconfigure digital inputs set up as FWD or REV as break contacts (the default setting is as a make contact), the motor starts immediately. They should not be reconfigured as break contacts if no motor is connected.

Table 24: Configuring digital inputs as break contacts

PNU	Terminal	Value	RUN	Function	DS
C011	1	00 or 01	–	00: High signal causes switch or activation of the function (NO = normally open). 01: Low signal causes switching or activation of the function (NC = normally closed).	00
C012	2				
C013	3				
C014	4				
C015	5				
C016	6				

Controller inhibit and coasting (free run stop – FRS)

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 inverter's configuration, the frequency output is either synchronized to the current speed of the coasting motor or restarts at 0 Hz.

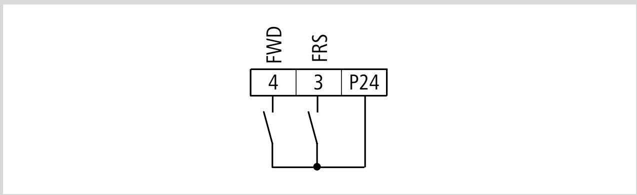


Figure 86: Configuration of digital input 3 as "controller inhibit" FRS (free run stop) and 4 as FWD (start/stop clockwise rotation)

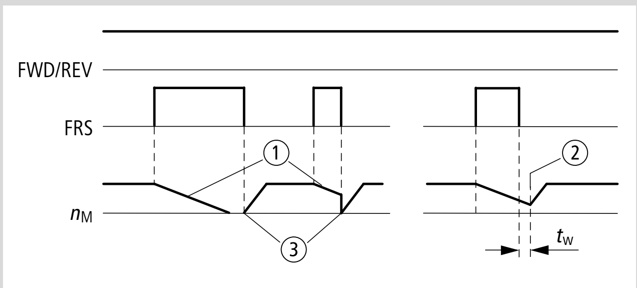


Figure 87: Function chart for FRS (control inhibit and free run stop)

n_M: Motor speed

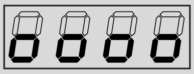
t_W: Waiting time (set with PNU b003)

① Motor coasts to a stop

② Synchronization to the current motor speed

③ Restart from 0 Hz

- ▶ Use PNU b088 to specify whether the motor is to restart at 0 Hz after the FRS input has been deactivated, or if synchronization to the current motor speed should take place after a waiting time specified under PNU b003.
- ▶ Configure one of the digital inputs 1 to 6 as FRS by entering the value 11 under the corresponding PNU (C001 to C006).

PNU	Name	RUN	b031 = 10	Value	Function	DS
b003	POWER, waiting time before automatic restart after power supply failure	–	✓	0.3 – 100 ss	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
b088	Motor restart after removal of the FRS signal	–	✓	00	Restart with 0 Hz	00
				01	Restart with the determined output frequency (current motor speed)	

Three-wire control (STA – STP – F/R)

Three-wire control is a common control method for machines: Two inputs are used for start and stop pulses and a third for selecting the direction of rotation.

Through the digital inputs configured as STA, STP and F/R you can operate the frequency inverter with three switches:

- STA: Start signal
- STP: Stop signal
- F/R: Direction of rotation

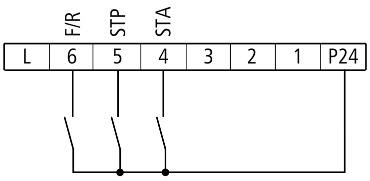


Figure 88: Digital input 4 configured as Pulse Start (STA), digital input 5 as Pulse Stop (STP) and digital input 6 as Reverse Direction (F/R).

▶ Configure three of the digital inputs 1 to 6 as STA, STP and F/R by entering the following values under the corresponding PNU (C001 to C006).
  – STA: 20
  – STP: 21
  – F/R: 22

The frequency inverter accelerates to the reference frequency specified with PNU A020.

▶ In PNU A001 enter the value 02 (reference input through PNU A020).
▶ In PNU A002 enter the value 01 (start signal through digital inputs).
▶ In PNU A020 enter the reference frequency.

If you want to start the inverter through the STA input, the STP input must be enabled (inverse function, open-circuit protection). The signal must be applied for only a short period (pulse, ≧ 50 ms). When the STP input is disabled, the motor stops. When the F/R input is activated (pulse) the motor reverses.

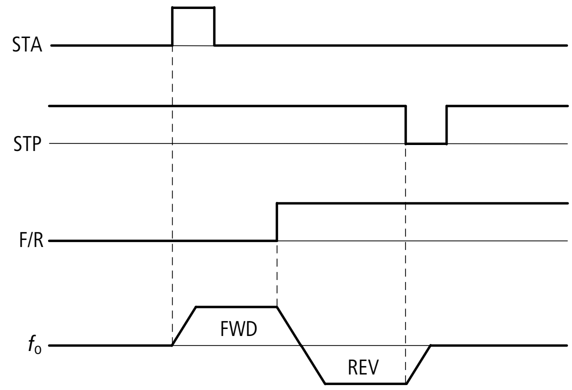


Figure 89: Function chart Pulse start STA, Pulse stop STP and Direction Reversal F/R

→ When three-wire control is activated (STA-STP-F/R), functions 00 (FWD) and 01 (REV) are disabled.

Table 25: Three-wire control

Value range PNU C001 to C006			State	Description
20	STA	Three-wire control start signal	ON	Motor start through pulse • Reference input PNU F001 or A020 • Acceleration time PNU F002
			OFF	No change in motor operation
21	STP	Three-wire control stop signal	ON	Required enable signal for motor operation. Wire breakage causes automatic motor stop.
			OFF	Motor stop through pulse (deceleration time PNU F003)
22	F/R	Three-wire control, direction of rotation	ON	Anticlockwise rotating field (REV)
			OFF	Clockwise rotating field (FWD)

Control signal terminal modus (F-TM) and keypad (OPE)

If you apply value 51 (F-TM) to one of digital inputs 1 to 6 under PNU C001 to C006, the control signal terminals are used as source for the start/stop signal and/or for the reference frequency input. The values of PNU A001 and A002 are then ignored.

Example:

In machines, a higher-level controller usually issues the start signal (clockwise rotating field FWD) through control signal terminal 1 and the reference frequency through analog input O. For maintenance and setup tasks, these inputs should be made through a locally mounted optional keypad DEX-KEY-6. Local control mode is activated with a keyswitch.

Set the parameters ass follows for this purpose:

PNU A001 = 00	The keypad's potentiometer as reference frequency source.
PNU A002 = 02	The keypad's Start key as start signal source.
PNU C003 = 51	Digital input 3. Mode "Control signal terminals preferred" is active. The analog reference frequency is taken from control signal terminal O and the start/stop signal from control signal terminal 1 (FWD).

For local operation, the F-TM signal from control signal terminal 3 is then disabled through the keyswitch (N/C contact). On the keypad, the START and potentiometer LEDs light up. The drive can now be controlled with the keypad's Start and Stop keys and its speed is set with the keypad's potentiometer.

→ When the signal state (F-TM) changes in the RUN mode, the motor is automatically stopped and can be restarted only with a new Start signal.

Table 26: "Control signal terminals preferred" mode.

Value range PNU C001 to C006			State	Description
51	F-TM	Digital input, Mode: Control signal terminals preferred.	ON	• Frequency reference value input through control signal terminals (A001 = 01) • Start/Stop input through control signal terminals (A002 = 01)
			OFF	Uses the settings from PNU A001 and A002.
31	OPE	Keypad (operator)	ON	When the OPE input is activated, the start/stop signal (PNU A002) and the reference input (PNU A001) are provided through optional keypad DEX-KEY-….
			OFF	Start/stop signal and reference input are provided by PUN A001 and A002.

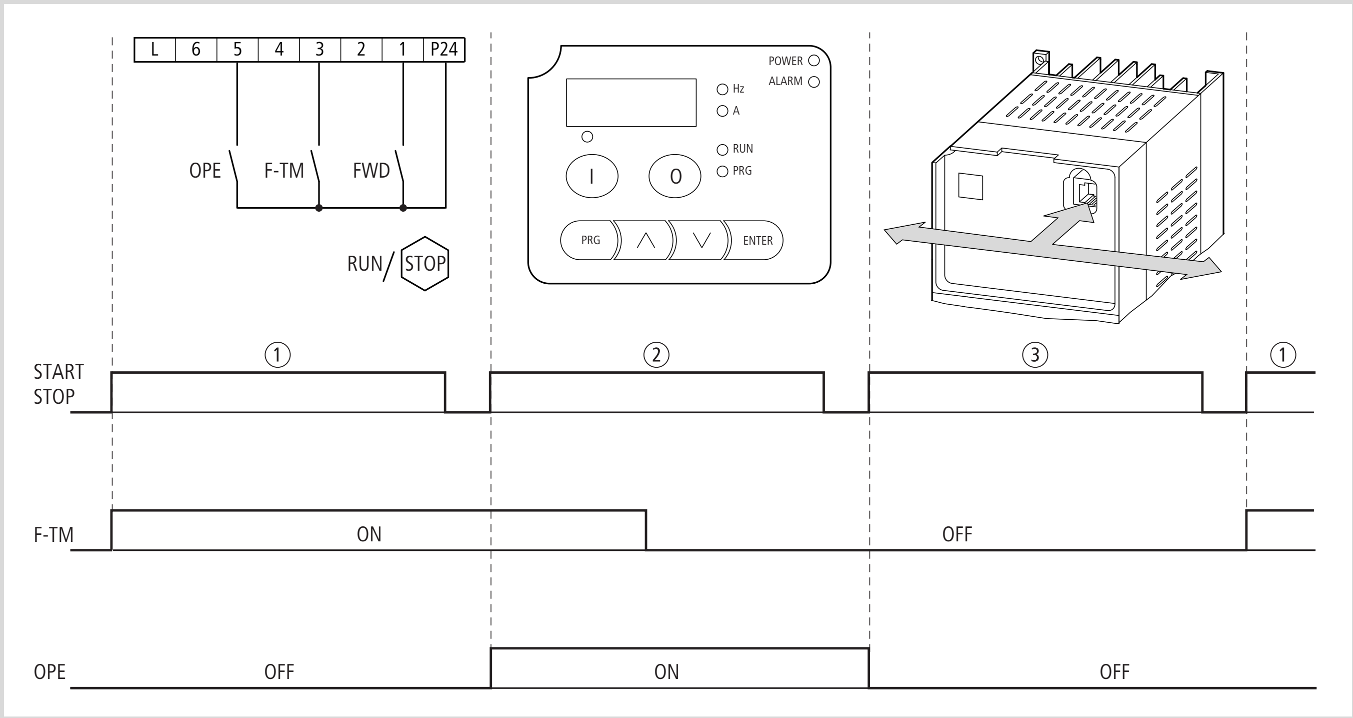


Figure 90: Selecting the control signal source

① Start/Stop through digital input 1 (FWD) with active digital input 3 (F-TM, Force Terminal Mode).
② Start/Stop through optional keypad DEX-KEY-… with active digital input 5 (OPE, Operator).
③ Start/Stop through the serial interface (Modbus).

→ The changeover between the signal sources takes place only when the motor is at standstill (STOP).

Second parameter set (SET)

With function SET you can activate the second parameter set through one of digital inputs 1 to 6.

→ The changeover between the parameter sets can take place only at standstill (STOP).

In combination with an optional keypad (DEX-KEY-…) the parameters of the second parameter set contain a **2** after the parameter group letter (PNU x**2**xx).

In the tables in this manual, the parameters of the second parameter set have a grey background ( ).

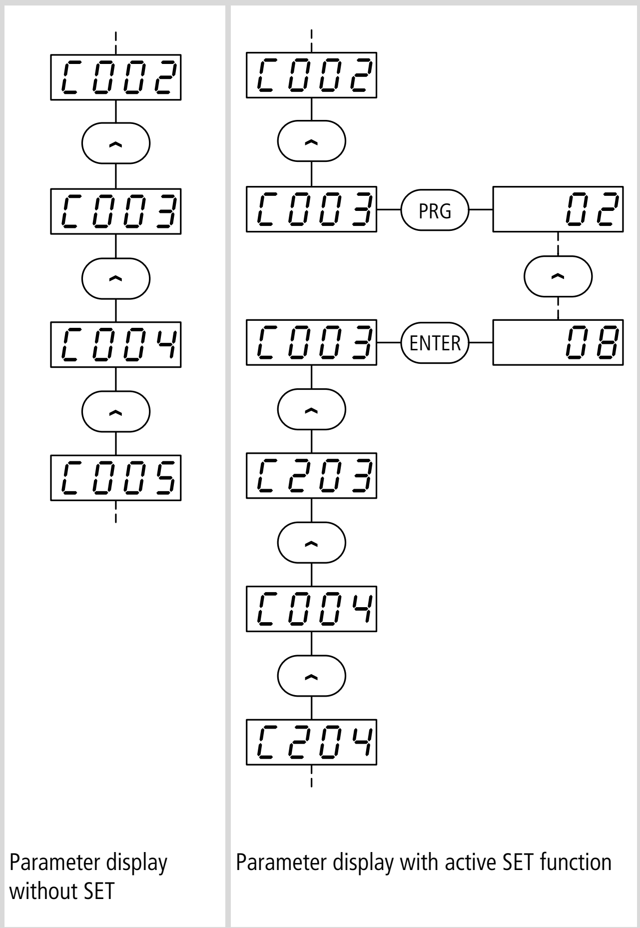


Figure 91: Example of a parameter list with and without SET function (PNU C003 = 08: second parameter set).

When the SET signal is active, the frequency inverter works with the characteristic of the second parameter set. You can use this function, for example, to run a drive with two different acceleration and deceleration times or operate an additional motor using the same frequency inverter (although not at the same time) without having to reconfigure the inverter. Applications with one frequency inverter and two motors can include:

- Roller drives vertical sorting systems in horizontal conveying systems
- Rotation and traction drives of hoisting systems

The functions of the second parameter set are listed in table 28, page 93.

▶ Configure one of the digital inputs 1 to 6 as SET by entering the value 08 under the corresponding PNU (C001 to C006).

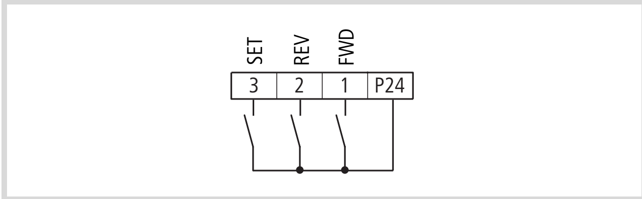


Figure 92: Digital input 3 configured as "second parameter set (SET)

The motor must be at a stop before the SET input is enabled.

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

If the SET input is deactivated while the motor is still running (RUN), the parameters of the second parameter set are used until the motor is stationary again.

Special functions in the second parameter set (SP-SET)

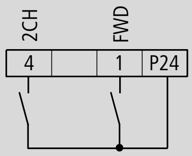
With function SP-SET you can activate the second parameter set through one of digital inputs 1 to 6 with modified authorization levels.

→ Unlike function SET, SP-SET lets you activate selected parameters also in RUN mode (→ table 28, page 93).

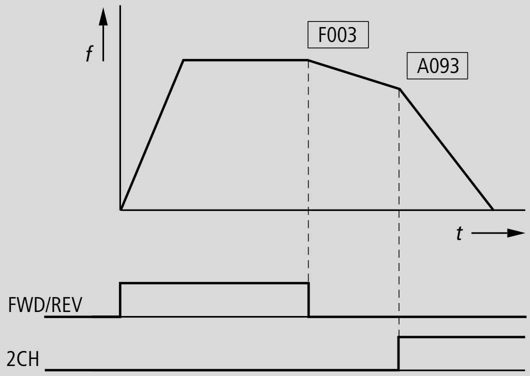
The following example illustrate the possible uses for this parameter changeover function for various deceleration ramps.

→ Function 2CH (second time ramp) must be set in both parameter sets.

1

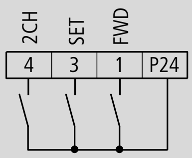


Digital input 4
C005 = 09 (2CH)

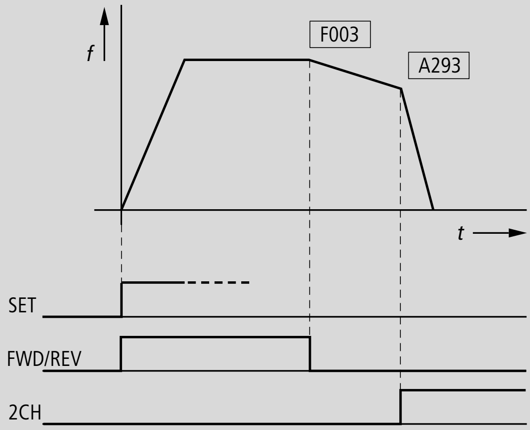


When FWD (digital input 1) is deactivated, the drive is slowed with the deceleration ramp specified in PNU F003. To change to another deceleration ramp (PNU A093), activate 2CH (second time ramp) (→ section "Changing over time ramps", page 101).

2

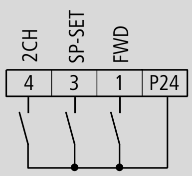


Digital input 3
C003 = 08 (SET)
Digital input 5
C004 = 09 (2CH)

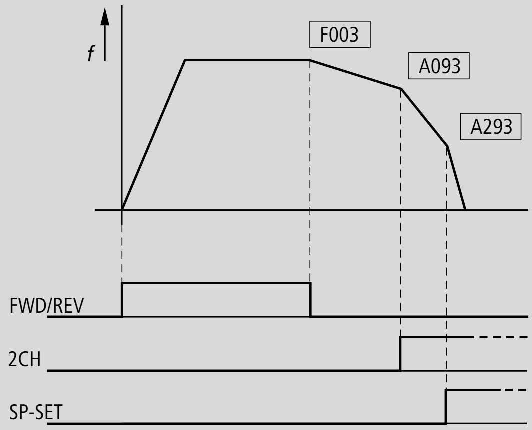


If the second parameter set (SET) is activated at motor stop, activation of 2CH (second time ramp) causes a changeover of the deceleration ramp of F003 to a third deceleration ramp (PNU A293).

3



Digital input 3
C003 = 53 (SP-SET)
Digital input 5
C004 = 09 (2CH)



If, instead of SET, the second parameter set SP-SET is activated, you can change over between all three deceleration ramps in RUN mode. You can therefore choose between three different, individually adjustable deceleration ramps to slow down the motor.

Notes about changing settings in the second parameter set

→ Functions SET and SP-SET can not be assigned at the same time for digital inputs 1 to 6.

→ Functions FRS (11), EXT (12), RST (18), PTC (19) and PID (23) must be assigned to the same digital inputs 1 to 6 (PNU C001 to C006) in the first and second parameter set (SET or SP-SET). The function is otherwise ignored and the value **255** (**no function**) is written to the respective parameters PNU C001 to C006.

Table 27: Example – overwriting with values from the second parameter set

First parameter set		Second parameter set (SET, SP-SET)		Second/first parameter set	
C001	00	C201	00	C201/C001	00
C002	01	C202	01	C202/C002	01
C003	08 [SET] ① →	C203	08 [SET]	C203/C003	255 ③ ←
C004	03	C204	53 [SP-SET] ② →	C204/C004	53 [SP-SET] ↑
C005	18	C205	18	C205/C005	18
C006	09	C206	09	C206/C006	09

When you enter the value 08 (SET) in PNU C003 ①, the second parameter set (x**2**xxx) is activated. The values are the same in both parameter sets. If you now enter the value 53 (SP-SET) under PNU C204 in the second parameter set ②, PNU C004 is also automatically set to 53. Because SET and SP-SET can not be used at the same time, the content of PNU C003 and C203 is overwritten with 255 (no function) ③. Digital input 3 now has no function. With digital input 4 you can now change between the first and second parameter set with special functions (SP-SET). A parameter set changeover is possible only at standstill (STOP).

Table 28: Functions with second parameter set

Description of the function	Parameter number (PNU)		
	Default	Second parameter set	
	(STOP)1)	SET (STOP)1)	SP-SET (RUN)2)
First acceleration time	F002	F202	F202
First deceleration time	F003	F203	F203
Reference value source selection	A001	A201	–
Start signal source selection	A002	A202	–
Base frequency	A003	A203	–
End frequency (f_{max})	A004	A204	–
Frequency reference input – reference value through keypad, PNU A001 must equal 02	A020	A220	A220
Boost, manual voltage boost	A042	A242	A242
Maximum boost relative to the base frequency	A043	A243	A243
U f characteristic	A044	A244	–
U/*f* characteristic, output voltage	A045	A245	–
SLV, gain factor, automatic voltage compensation	A046	A246	–
SLV, gain factor, automatic slip compensation	A047	A247	–
Maximum operating frequency	A061	A261	A261
Minimum operating frequency	A062	A262	A262
Acceleration time 2	A092	A292	A292
Deceleration time 2	A093	A293	A293
Acceleration time, specify signal for changeover from acceleration time 1 to acceleration time 2	A094	A294	A294

1) **(STOP)**: Parameters or functions can be activated only in motor stop.
2) **(STOP)**: Parameters or functions can be activated during operation.

Description of the function	Parameter number (PNU)		
	Default (STOP)1)	Second parameter set SET (STOP)1)	SP-SET (RUN)2)
Acceleration time, frequency for changeover from ramp time 1 to ramp time 2	A095	A295	A295
Deceleration time, frequency for changeover from ramp time 1 to ramp time 2	A096	A296	A296
Thermal overload, tripping current	b012	b212	–
Thermal overload, characteristic (torque curve)	b013	b213	–
Motor current limitation – function	b021	b221	–
Tripping current for motor current limitation	b022	b222	–
Motor current limitation, deceleration time constant	b023	b223	–
Motor current limitation, limit current selection	b028	b228	–
Digital input 1 – function	C001	C201	–
Digital input 2 – function	C002	C202	–
Digital input 3 – function	C003	C203	–
Digital input 4 – function	C004	C204	–
Digital input 5 – function	C005	C205	–
Digital input 6 – function	C006	C206	–
Output function – warning threshold for overload signal (OL)	C041	C241	–
Motor – assigned rating [kW]/{HP} at rated voltage (U_e)	H003	H203	
Motor – number of poles	H004	H204	
Motor – stabilization constant	H006	H206	
Motor – voltage class	H007	H207	

1) **(STOP)**: Parameters or functions can be activated only in motor stop.

2) **(STOP)**: Parameters or functions can be activated during operation.

Specifying reference frequencies

The reference frequency can be assigned in one of three ways, depending on the setting under PNU A001:

- through the potentiometer of optional keypad DEX-KEY-6;
- through analog inputs O (0 to +10 V ⎓) and/or OI (4 to 20 mA ⎓);
- through digital channels (PNU F001, fixed frequency CF1 to CF15 or Modbus).

The reference source is selected with PNU A001.

→ Fixed frequency stage 0 (none of the inputs CF1 to CF4 are activated) corresponds to the frequency reference value. Depending on the value entered in PNU A001, this can be defined with the installed potentiometer, the reference value inputs O, O2 and/or OI or through PNU F001 and PNU A020.

→ If one or more of the fixed frequencies exceeds 50 Hz, you must first increase the end frequency with PNU A004 (→ section “End frequency”, page 72).

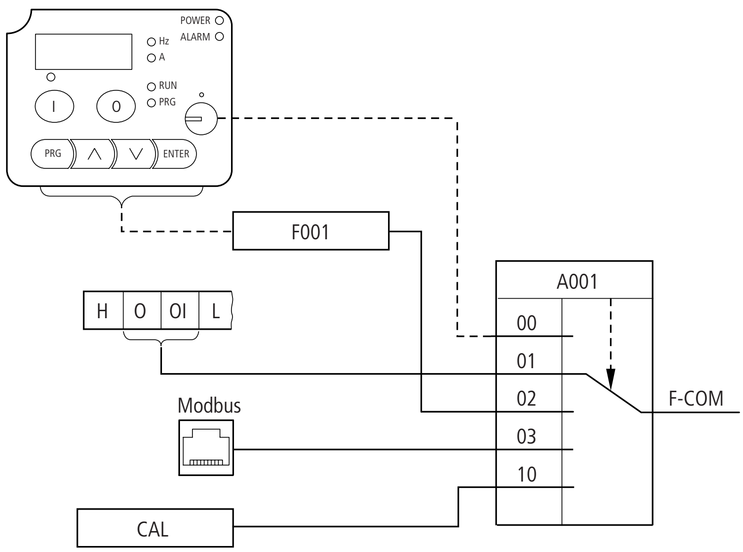


Figure 93: Reference frequency input

PNU	Name	RUN	b031 = 10	Value	Function	DS
A001	Reference value source selection	–	–	00	The setting range is limited by PNU b082 (raised starting frequency) and A004 (end frequency). • Potentiometer (optional keypad DEX-KEY-6) • Frequency [Hz] • Process variable [%] with active PID control (PNU A071 = 1)	01
				01	Analog input: Control signal terminals O and OI	
				02	Set value (PNU F001) of optional keypad DEX-KEY-… (arrow keys ⋀/⋁). To save the set value, press the ENTER key (PNU A020).	
				03	Serial interface (Modbus)	
				10	Calculator: Calculated value (CAL) (→ section "Mathematical functions", page 136).	
A020 A220	Frequency reference input – reference value through keypad, PNU A001 must equal 02	✓	✓	0 – 400 Hz	You can enter a frequency reference value. You must set PNU A001 to 02 for this purpose.	0.0
A021 A022 A023 … A035	Frequency reference input – fixed frequency (1)				You can assign a frequency to each of the 15 fixed frequency parameters from PNU A021 to A035.	
F001	Reference value – input through optional keypad DEX-KEY-…				Indication of the current frequency reference value or the current fixed frequency. Modified values are saved with the ENTER key according to the selection of the digital inputs configured as CF1 to CF4. Resolution ±0.1 Hz	

Analog input

With PNU A001 select the reference frequency source. By default (PNU A001 = 01), the voltage of 0 to 10 V ⎓ at terminal O or the incoming current of 4 to 20 mA ⎓ at terminal OI is interpreted as the reference value. If none of the digital inputs are configured as AT, both voltage input O and current input OI are active. If the current and voltage signals are applied at the same time, the reference frequency is calculated by adding the two signals.

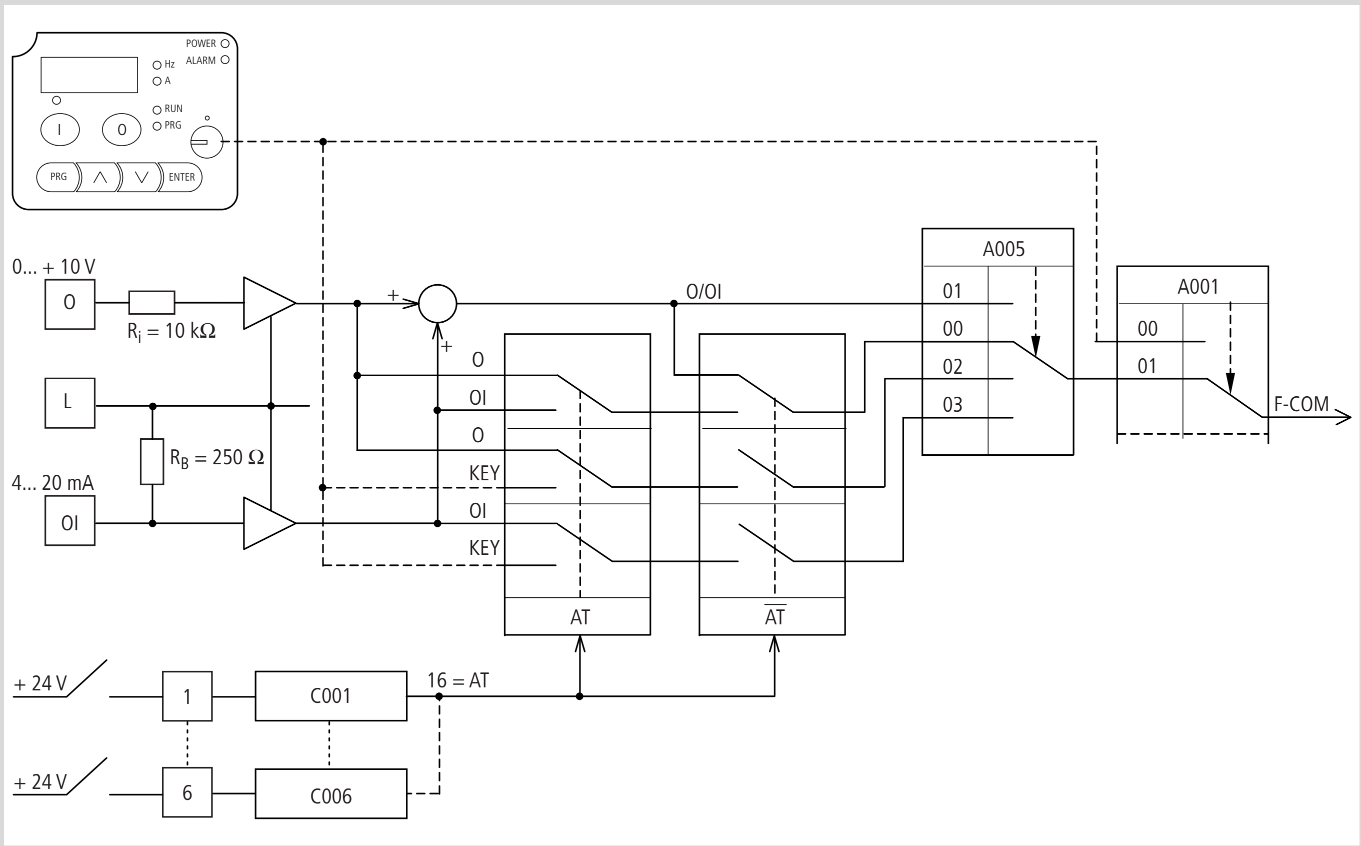


Figure 94: Analog reference input

Defining reference value through voltage
Analog input O

The external reference voltage signal can be specifically matched with parameters PNU A011 to A016, which are described below. You can assign the output frequency to a user-definable voltage reference value range.

Using PNU A016 you can adjust analog reference signal filtering.

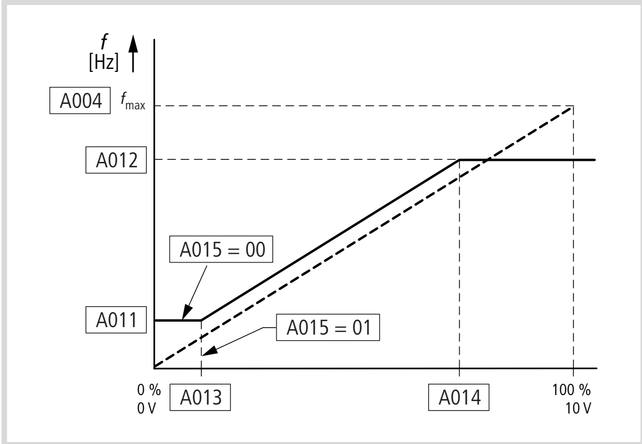


Figure 95: Reference voltage

PNU	Name	RUN	b031 = 10	Value	Function	DS
A011	Analog input (O-L) – frequency at minimum reference value	–	✓	0 – 400 Hz	Here, the frequency that corresponds to the minimum reference voltage under PNU A013 is set.	0.0
A012	Analog input (O-L) – frequency at maximum reference value			0 – 400 Hz	Here, you can set the frequency that corresponds to the maximum reference voltage under PNU A014.	0.0
A013	Analog input (O-L) – minimum reference value (offset)			0 – 100 %	The minimum reference value entered here is a percentage of the highest possible reference voltage (–10 V to +10 V).	0.0
A014	Analog input (O-L) – maximum reference value (offset)			0 – 100 %	The minimum reference value entered here is a percentage of the highest possible reference voltage (–10 V to +10 V).	100.
A015	Analog input (O-L) – selection of starting frequency applied to the motor at minimum reference value			Determines the behaviour at reference values below the minimum reference value.		01
				00	Value of PNU A011	
				01	0 Hz	
A016	Analog input – filter time constant			To reduce the inverter’s response time to reference value changes at analog input O or OI, 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 reference value changes	
				…		
				8	Maximum filtering effect/slow response to reference value changes	

Reference current

Analog input OI

The external reference current signal can be specifically matched with parameters PNU A101 to A106, which are described below. You can assign the output frequency to a user-definable current reference value range.

Using PNU A016 you can adjust analog reference signal filtering.

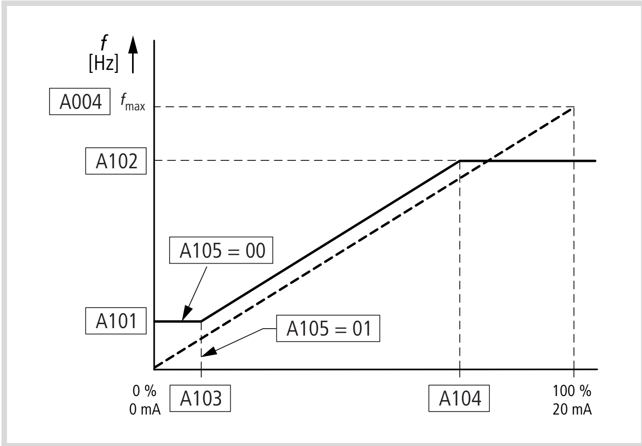


Figure 96: Reference current

PNU	Name	RUN	b031 = 10	Value	Function	DS
A101	Analog input (OI-L), frequency at minimum reference value	–	✓	0 – 400 Hz	Here, the frequency that corresponds to the minimum reference current under PNU A103 is set.	0.0
A102	Analog input (OI-L), frequency at maximum reference value			0 – 400 Hz	Here, you can set the frequency that corresponds to the maximum reference current under PNU A104.	0.0
A103	Analog input (OI-L), minimum reference value (offset)			0 – 100 %	The minimum reference value entered here is a percentage of the highest possible reference current (20 mA).	0.
A104	Analog input (OI-L), maximum reference value (offset)			0 – 100 %	The maximum reference value entered here is a percentage of the highest possible reference current (20 mA).	100.
A105	Analog input (OI-L), selection of starting frequency applied to the motor at minimum reference value			Determines the behaviour at reference values below the minimum reference value.		01
				00	Value from PNU A101	
				01	0 Hz	
A016	Analog input – filter time constant			To reduce the inverter’s response time to reference value changes at analog input O or OI, 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 reference value changes	
				…		
				8	Maximum filtering effect/slow response to reference value changes	

Reference value control (AT)

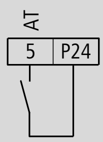
With the AT command you can enable manual selection of analog reference sources.

▶ Configure one of the digital inputs 1 to 6 as AT by entering the value 16 under the corresponding PNU (C001 to C006).

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

PNU	Name	RUN	b031 = 10	Value	Function	DS
A005	Analog input – selection (AT)	–	–	On active AT signal (→ PNU C001 = 16) a changeover takes place between:		
				00	analog inputs O and/or OI	00
				01	analog inputs O and OI (digital input is ignored)	
				02	analog input O or potentiometer (optional keypad DEX-KEY-6)	
				03	analog input OI or potentiometer (optional keypad DEX-KEY-6)	

The table below shows the selection of analog reference value inputs depending on the AT command and PNU A005.

PNU A005	PNU C001 to C006	Digital inputs 1 to 6	Analog input selection	
00 (DS)	$\overline{AT}$ (function not enabled)	–	[O] = 0 … +10 V ⎓ and/or [OI] = 4 … 20 mA ⎓	
	16 = AT	OFF	[O] = 0 … +10 V ⎓	
		ON	[OI] = 4 … 20 mA ⎓	
01	16 = AT	(ignored)	Sum [O] and [OI]	Example: Digital input 5 with function AT
02	16 = AT	OFF	[O] = 0 … +10 V ⎓	
		ON	Potentiometer of optional keypad DEX-KEY-6	
03	16 = AT	OFF	[OI] = 4 … 20 mA ⎓	
		ON	Potentiometer of optional keypad DEX-KEY-6	

Potentiometer (optional keypad DEX-KEY-6)
If you are using keypad DEX-KEY-6, you can use the keypad's potentiometer to set the reference value.

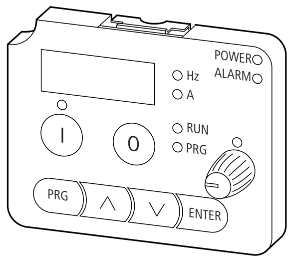


Figure 97: Keypad DEX-KEY-6

The manipulating range can be specifically matched with parameters PNU A151 to A155, which are described below. You can assign the frequency inverter's output frequency to any potentiometer position. To enable the potentiometer, enter value 00 in PNU A001.

To define the potentiometer's function, use the following parameters:

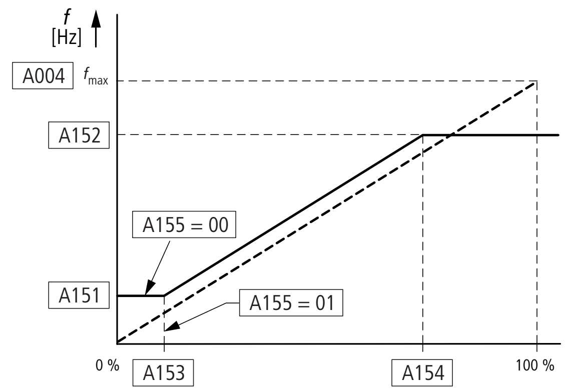


Figure 98: Setting range of the potentiometer of keypad DEX-KEY-6

PNU	Name	RUN	b031 = 10	Value	Function	DS
A001	Reference value source selection	–	–	00	Potentiometer (optional keypad DEX-KEY-6)	01
A201				01	Analog input: Control signal terminals O and OI	
				02	Functions PNU F001 or A020	
				03	Serial interface (Modbus)	
				10	Calculator (calculated value of CAL)	
A151	Potentiometer (optional keypad), starting frequency	–	✓	0 – 400 Hz	The starting frequency output when the potentiometer is set to its left stop.	0.0
A152	Potentiometer (optional keypad), end frequency	–	✓	0 – 400 Hz	The end frequency output when the potentiometer is set to its right stop.	0.0
A153	Potentiometer (optional keypad), starting point	–	✓	0 – 100 %	The starting point (offset) for the potentiometer's setting range.	0
A154	Potentiometer (optional keypad), end point	–	✓	0 – 100 %	The end point (offset) for the potentiometer's setting range.	100
A155	Potentiometer (optional keypad), starting frequency source	–	✓	00	Value from PNU A151	01
				01	0 Hz	
				These functions are enabled only if parameters PNU A151 and A153 contain a value above zero.		

Changing over time ramps

During operation, you can change over from the time ramps set under PNU F002 and F003 to those programmed under PNU A092 and A093. This can be done either by applying an external signal to digital input 2CH at any time or when the frequencies configured under PNU A095 and A096 are reached.

Use PNU A094 to set the changeover mode.

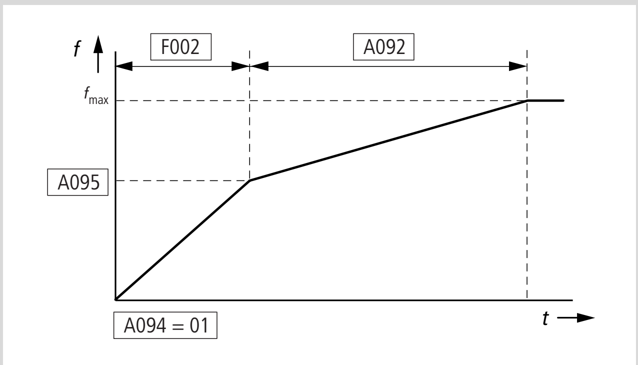


Figure 99: Frequency-controlled acceleration ramp changeover

▶ Use PNU A095 to define the required output frequency for automatic changeover.

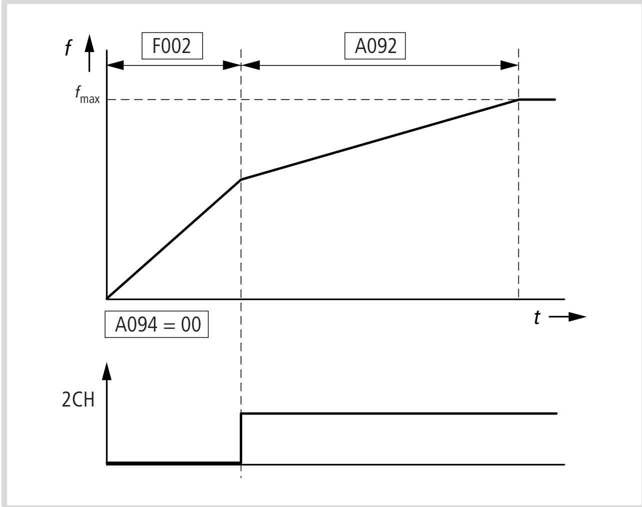


Figure 100: Contact-controlled changeover of acceleration ramps

▶ Configure one of the digital inputs as 2CH by entering the value 09 in the corresponding PNU C001 to CC006.

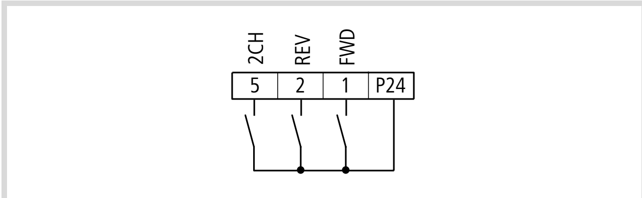
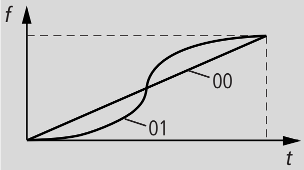


Figure 101: Digital input 5 = 2CH (second time ramp)

The deceleration time is set with PNU A093 and A096.

PNU	Name	RUN	b031 = 10	Value	Function	DS
A092 A292	Acceleration time 2	✓	✓	0.01 – 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	15.00
A093 A293	Deceleration time 2					
A094 A294	Acceleration time, specify signal for changeover from acceleration time 1 to acceleration time 2	–	–	00	Digital input (2CH)	00
				01	Frequency (PNU A095 or A096)	
A095 A295	Acceleration time, frequency for changeover from ramp time 1 to ramp time 2	–	–	0.0 – 400 Hz	Here, set a frequency at which the changeover from the first to the second acceleration time is to take place.	0.0

PNU	Name	RUN	b031 = 10	Value	Function	DS
A096 A296	Deceleration time, frequency for changeover from ramp time 1 to ramp time 2	–	–	0.0 – 400 Hz	Here, set a frequency at which the changeover from the first to the second deceleration time is to take place.	0.0
A097	Acceleration time, charac-teristic	–	–	Here, you can set a linear or an S-curve acceleration characteristic for motor acceleration (first and second time ramp): 		00
				00	linear	
				01	S curve	
A098	Deceleration time, charac-teristic	–	–	00	linear	00
				01	S curve	
F002 F202	Acceleration time 1	✓	✓	0.01 – 3000 s	Resolution of 0.01 s at an input of 0.01 to 99.99 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	10.00
F003 F203	Deceleration time 1	✓	✓	0.01 – 3600 s	Resolution of 0.01 s at an input of 0.01 to 99.99 Resolution of 0.1 s at an input of 100.0 to 999.9 Resolution of 1 s at 1000 to 3600 s	10.00

If the deceleration ramp is to have different changeover times from the acceleration ramps, use the “second parameter set” command.

Example:

▶ Parameterize as follows:
- PNU C004 = 08 (SET, second parameter set selected)
- PNU C005 = 09 (2CH, second time ramp)

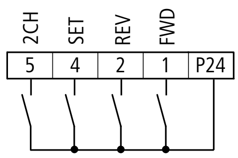


Figure 102: Digital input 5 = 2CH (second time ramp), digital input 4 = SET (second parameter set)

Minimum and maximum operating frequency

With PNU A061 and A062 you can limit the frequency range defined with PNU b082 (starting frequency) and PNU A004 (end frequency) (→ fig. 103). As soon as the frequency inverter receives a start signal, it outputs the frequency set with PNU A062; at maximum reference frequency, the frequency set with PNU A061.

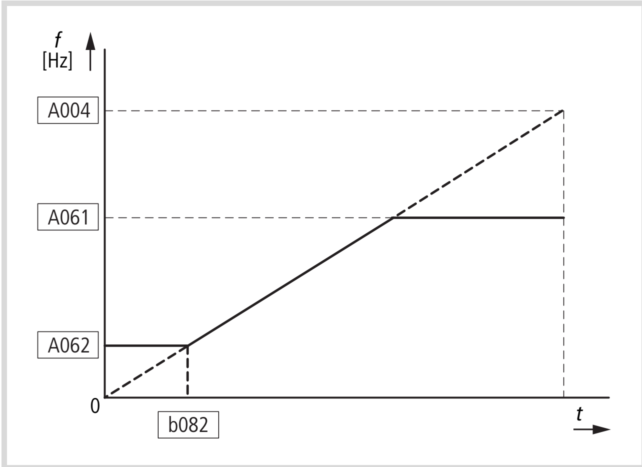


Figure 103: Upper frequency limit (PNU A061) and lower frequency limit (PNU A062)

PNU	Name	RUN	b031 = 10	Value	Function	DS
A004 A204	End frequency (f_{max})	–	–	30 – 400 Hz	Maximum output frequency	50 {60}
A061	Maximum operating frequency	–	✓	0 – 400 Hz	This function can be deactivated by entering 0.0	0.0
A062 A262	Minimum operating frequency			0 – 400 Hz		0.0
b082	Increased starting frequency (e.g. at high static friction)	–	✓	0.5 – 9.9 Hz	A higher starting frequency results in shorter acceleration and deceleration times (for example to overcome high frictional resistance). If the frequencies are too high, fault message E002 may be issued. Up to the set starting frequency, the motor accelerates without a ramp function.	0.5

For further information, see section "Limit and target values", page 72.

Suppressing frequency ranges

To prevent resonances occurring in the drive system, you can, in addition, program three frequency jumps under PNU A063 to A068.

In the example (→ fig. 104), the first frequency jump (PNU A063) is at 15 Hz, the second (PNU A065) at 25 Hz and the third (PNU A067) at 35 Hz. The jump widths (adjustable under PNU A064, A066 and A068) are set to 0.5 Hz in the example.

The jump width (PNU A064) is the range above and below the selected frequency value (PNU A063). With PNU A063 set to 1 Hz and A064 to 15 Hz the range from 14.5 Hz to 15.5 Hz is suppressed.

In this example, the drive can be operated in the following frequency ranges:

- 0 to 14.5 Hz.
- 15.5 to 24.5 Hz.
- 25.5 to 34.5 Hz.
- 35.5 to f_{max}.

Static operation in the suppressed frequency ranges is not possible.

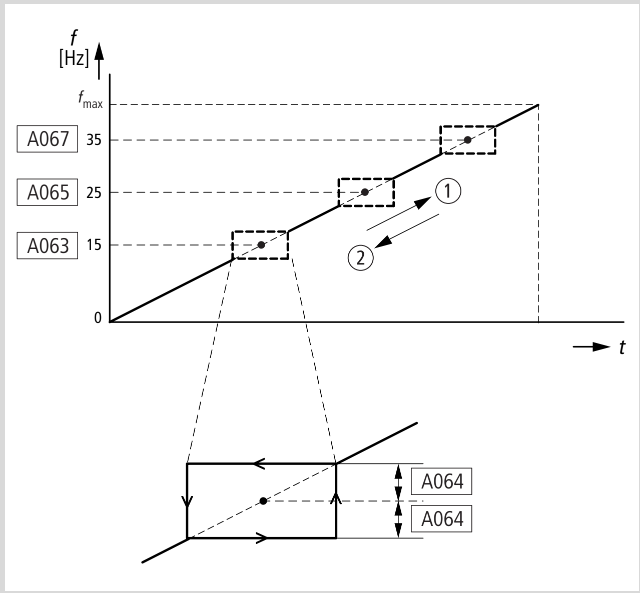


Figure 104: Frequency jumps

① Acceleration
② Deceleration

PNU	Name	RUN	b031 = 10	Value	Function	DS
A063	Frequency jump (1)	–	✓	0 – 400 Hz	This function can be deactivated by entering 0.0	0.0
A064	Frequency jump (1) – jump width			0 – 10 Hz		0.5
A065	Frequency jump (2)			0 – 400 Hz		0.0
A066	Frequency jump (2) – jump width			0 – 10 Hz		0.5
A067	Frequency jump (3)			0 – 400 Hz		0.0
A068	Frequency jump (3) – jump width			0 – 10 Hz		0.5

Fixed frequencies

Through digital input configured as CF1 to CF4 you can select up to 16 user-definable fixed frequencies (including a reference frequency) (→ table 29).

The fixed frequencies have a higher priority than all other reference values and can be accessed at any time through inputs CF1 to CF4 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 29: Fixed frequencies

Fixed frequency stage	PNU	Input			
		CF4	CF3	CF2	CF1
0 = *f*s	Reference frequency	0	0	0	0
f	A021	0	0	0	1
f	A022	0	0	1	0
f	A023	0	0	1	1
f	A024	0	1	0	0
f	A025	0	1	0	1
f	A026	0	1	1	0
f	A027	0	1	1	1
f	A028	1	0	0	0
f	A029	1	0	0	1
f	A030	1	0	1	0
f	A031	1	0	1	1
f	A032	1	1	0	0
f	A033	1	1	0	1
f	A034	1	1	1	0
f	A035	1	1	1	1

0 = input deactivated
1 = input activated

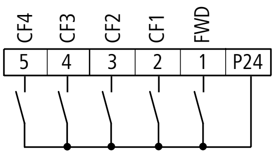


Figure 105: Digital inputs 2 to 5 configured as CF1 to CF4 (fixed frequency)

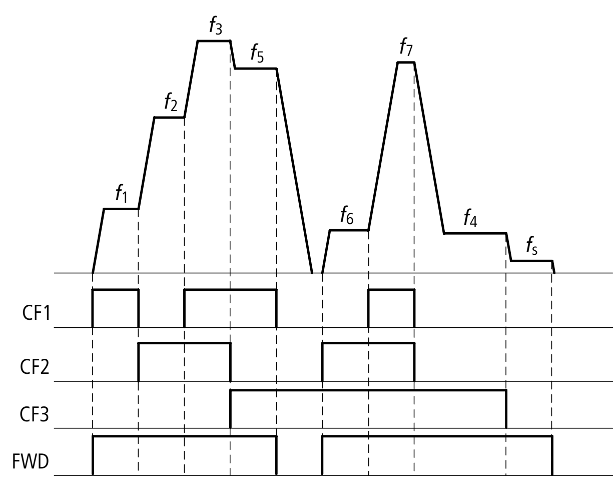


Figure 106: Function chart for CF1 to CF3 (fixed frequency control)

▶ Program one or more of the digital inputs 1 to 6 as CF1 to CF4, by entering the values 02 (CF1) to 05 (CF4) under the corresponding PNU (C001 to C006).

By default, CF1 is preassigned to digital input 3 (= A021) and CF2 to digital input 4 (= A022). When both inputs (3 and 4) are activated, the value of A023 is selected.

The fixed frequencies can be configured in two ways:

- by entering the fixed frequencies under PNU A021 to A035;
- by entering the fixed frequencies under PNU F001.

→ Below is a description of how to define the fixed frequencies using the optional keypad (DEX-KEY-…).

Entering the fixed frequencies under PNU A021 to A035;

▶ Go to PNU A021 and press the PRG key.
▶ Use the arrow keys (⌃ and ⌄) to enter the fixed frequency and confirm with the ENTER key.
▶ Repeat these steps for PNU A022 to A035 to define the remaining fixed frequencies.

Entering the fixed frequencies under PNU F001.

→ With PNU F001, you can change the reference frequencies even when parameter protection has been enabled with PNU b031 → section "Parameter inhibit (PNU b031)"page 153.

PNU F001 lets you set the fixed frequency of the active digital input directly.

Example:

▶ Go to PNU F001.
▶ Activate digital input 3 (= CF1).
▶ Press the PRG- key.

The default value 0.0 is displayed.

▶ With the arrow keys (⌃ and ⌄), set the required frequency value.
▶ Press the ENTER key to save the value in PNU A021.

You can also make this setting during operation in RUN mode.

▶ Disable digital input 3 and activate digital input 4 (= CF2).
▶ Repeat your input with the arrow keys.
▶ Press the ENTER key to save the value in PNU A022.
▶ Activate digital inputs 3 and 4 (= CF3).
▶ Repeat your input with the arrow keys.
▶ Press the ENTER key to save the value in PNU A023.

If you have configured further digital inputs with CF3 and CF4 (PNU C001 to C006), you can enter up to 15 fixed frequencies. The DV51 saves these values in PNU A021 to A035 (→ table 29).

Motor potentiometer

With the UP and DWN (down) signals, you can enter the reference frequency using an electronic motor potentiometer.

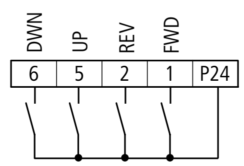


Figure 107: Control using electronic motor potentiometer

- ▶ Because the terminal functions UP and DWN can be used only when the reference frequency has been specified with PNU F001 or A020, you need to make sure that PNU A001 contains the value 02.
- ▶ Configure one to 6 of the digital inputs 1 to as UP or DWN by setting the corresponding PNU (C001 to CC006) to 27 (UP) or 28 (DWN).

Through the use of the input configured as UP, the reference frequency set under PNU A020 is also increased or, with DWN, reduced (→ fig. 108).

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

The current reference frequency is saved when parameter PNU C101 contains the value 01. It remains in memory even in the event of a power cut (POWER OFF).

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

The output frequency range for UP and DWN ranges from 0 Hz up to the end frequency specified under PNU A004 (→ section "End frequency", page 72).

To operate the electronic motor potentiometer through control signal terminals, microswitch TM/PRG must be in its PRG position.

You can also use the electronic motor potentiometer function with the arrow keys (⌃ and ⌄) of optional keypad DEX-KEY-…

- ▶ In PNU A001 enter the value 02 and save your input with the ENTER key.
- ▶ Select PNU A020 and press the PRG key to open it.
- ▶ Enable a direction of rotation for the Motor (for example with the default settings by setting digital input 1 = FWD).
- ▶ With the arrow keys (⌃ and ⌄), set the required frequency value.

If you are using the keypad, you save the set reference frequency with the ENTER key. PNU C101 is not used in this control mode.

The UP command accelerates the drive up to the limit value f_{max} (PNU F001) at the acceleration ramp set with PNU F002.

The deceleration (DWN) down to 0 Hz takes place at the deceleration ramp set with PNU F003.

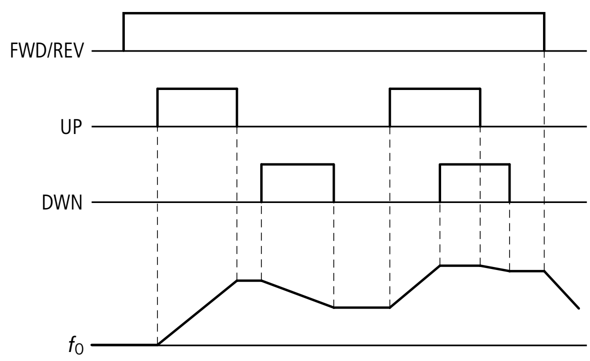


Figure 108: Function chart for UP/DWN (acceleration/deceleration – motor potentiometer)

f_O: Output frequency

PNU	Name	RUN	b031 = 10	Value	Function	DS
A001	Reference value source selection	–	–	00	The setting range is limited by PNU b082 (raised starting frequency) and A004 (end frequency). • Potentiometer (optional keypad DEX-KEY-6) • Frequency [Hz] • Process variable [%] with active PID control (PNU A071 = 1)	01
				01	Analog input: Control signal terminals O and OI	
				02	Set value (PNU F001) of optional keypad DEX-KEY-… (arrow keys ⌃/⌄). To save the set value, press the ENTER key (PNU A020).	
				03	Serial interface (Modbus)	
				10	Calculator: Calculated value (CAL) (→ section "Mathematical functions", page 136).	
C101	Motor potentiometer – reference value for motor potentiometer after power supply interruption	–	✓	00	Clear last value and use default for PNU F001	00
				01	Use saved motor potentiometer value set with UP/DWN function through digital inputs.	

Jog mode

Jog mode is used, for example, to set up a machine in manual control mode. To use jog mode, one of the digital inputs (1 to 6) must be activated with the JOG signal (= 06) with PNU C001 to C006. When a start signal is then applied to the FWD or REV input, a relatively low frequency without acceleration ramp is applied to the motor.

You can set this jog frequency with PNU A038. Make sure that the frequency is not too high, as it is applied directly to the motor without an acceleration ramp. Excessively high jog frequencies can cause a fault signal. It is best to use a frequency below 5 Hz.

→ Operation in jog mode is not possible when the jogging frequency set under PNU A038 is less than the start frequency set under PNU b082 (→ section "Increased starting frequency", page 72,).

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

By default (PNU A002 = 01) the position of microswitch TM/PRG has no function.

The value of PNU A039 determines how the motor is slowed.

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

The jogging frequency can be read off with an optional keypad.

- ▶ To do this, enter the value 02 in PNU A002.
- ▶ Set microswitch TM/PRG to its PRG position.
- ▶ Activate the digital input configured as JOG.

Use the START and Stop keys to start and stop the motor respectively.

→ Jog mode is started only through the active JOG input, not through the keypad.

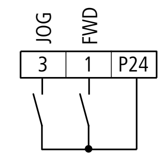


Figure 109: Digital input 1 configured as FWD (start/stop clockwise operation) and 3 as JOG (jog mode).

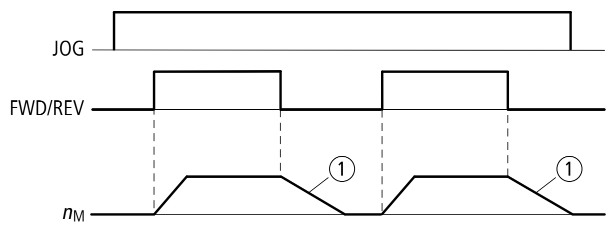


Figure 110: Function chart for JOG mode

n_M: Motor speed

① Depending on the value of PNU A039
00: Coasting
01: Deceleration ramp
02: DC braking

PNU	Name	RUN	b031 = 10	Value	Function	DS
A002	Start signal source selection	–	–	00	Digital input (FWD/REV)	01
				01	Optional keypad DEX-KEY-…: Start and Stop key.	
				03	Modbus: Activates a COIL for RUN/STOP and a COIL for FWD/REV.	
A038	Jog mode – jog mode reference value	✓	✓	0 – 9.99 Hz	The frequency to be applied to the motor in jog mode.	1.00
A039	Jog mode – motor stop method	–	✓	00	Free coasting (FRS)	00
				01	Deceleration ramp	
				02	DC braking	

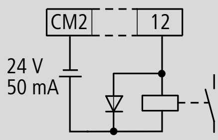
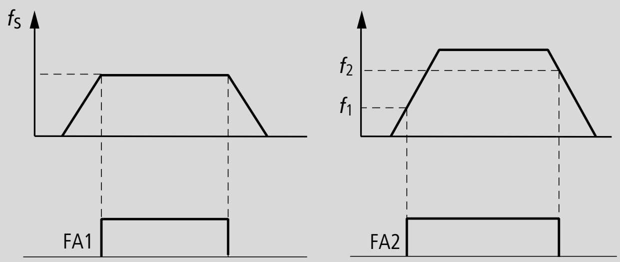
Actual value and status signals

This section describes how to assign various actual values and status signals to the control signal terminals.

Control signal terminal overview (output)

The table below provides an overview of the output control signal terminals and a brief description of the functions which you can assign to the analog and digital outputs. The following pages contain a detailed description of each function.

Table 30: Brief description of the functions

Name	Value[1]	Name	Description
Analog output			
AM	–	Analog output, measured value indication selection	Through this output, the frequency can be issued through a connected analog or digital measurement device. Alternatively, the motor current can be output (PNU C028). 0 to +10 V ⎓ Load carrying capacity: 1 mA
L	–	0 V	Reference potential for the following control signal terminals • Analog inputs O and OI • Analog output AM • Reference voltage +10 V (H) • Control voltage +24 V:
Digital outputs 11 and 12			Parameterizing PNU C021 and C022
RUN	00	RUN signal	The RUN signal is output during operation of the motor. Connection of a signal relay to digital output 11 or 12:  Transistor output (open collector) (maximum 27 V⎓, 50 mA)
FA1	01	Reference frequency reached	 f_S = reference frequency
FA2	02	Frequency signal	If a digital output is configured as FA1, a signal is issued as long as the reference value is reached. If a digital signal is configured as FA2, a signal is output as long as the frequencies defined under PNU C042 (during acceleration ramp) and PNU C043 (during deceleration ramp) are exceeded.
OL	03	Overload warning	The OL (overload) signal is output when the overload alarm threshold (adjustable under PNU C041) is exceeded.
OD	04	PID control deviation	The OD (Output Deviation) signal is issued when the PID control deviation set with PNU C044 is exceeded.
AL	05	Fault/alarm signal	The AL (alarm) signal is issued when a fault occurs.
Dc	06	Warning: Analog reference value signal interrupted	Dc (Disconnect Detect) monitors the analog inputs in RUN mode and signals any failure or drop-off below the reference value signal. • Input O (0 to 10 V) below value in PNU b082 or • current signal at input OI less than 4 mA.
FBV	07	Warning:: Actual value signal to PID controller interrupted	FBV (Feedback Value Check) monitors the PV feedback signal from the PID controller in RUN mode. Reference/actual value differential of PID control exceeds the tolerance range in PNU C052/C053.

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.

Name	Value1)	Name	Description
NDc	08	Fault/Warning: Faulty communication through serial interface.	NDc (Network Detection Signal) monitors den the watchdog timer during communication through the RS 485 serial interface (Modbus). Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.
LOG	09	Result of logic link (PNU C143)	LOG (Logical Output) shows the result of PNU C143 (High, Low) of the logic function (AND, OR, XOR).
ODc	10	Fault/Warning: Interrupted communication through serial interface.	ODc (Overload Disconnect Detect) monitors the serial RS 485 interface (Modbus) in connection with optional field bus interface modules DE51-NET-CAN and DE51-NET-DP. The ODc signal is issued in the event of a power interruption or an overload of the internal power supply.
CM2	–	0 V, +24 V	Common reference potential for the parametrizable digital outputs 11 and 12. Depending on the circuit type, CM2 can be connected with: • 0 V: Sink-type logic • +24 V: Source-type logic CM2 is isolated from reference potential L.
Signalling relay K12)			Parameterizing PNU C024
K11	–	Signalling relay K1 (contact)	During normal fault-free operation, terminals K11-K14 are closed. If a malfunction occurs or the supply voltage is switched off, 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 required values: 100 V ~ at a load of 10 mA or 5 V⎓ at a load of 100 mA
K12			
K14			

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.

Analog output (AM)

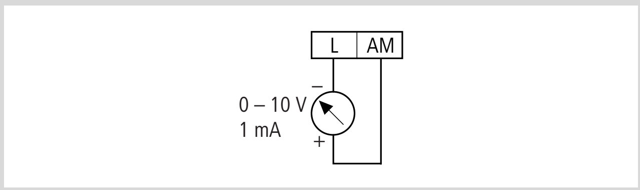


Figure 111: Analog output AM

The AM terminal provides the output frequency or the motor current as voltage signal (0 to +10 V). The reference potential is 0 V (terminal L).

The selection between the frequency and motor current indication is made with PNU C028.

Analog output signal

For signal compensation, PNU b080 (gain) and PNU C086 (offset) are used. The signal accuracy after compensation is about ±5 %.

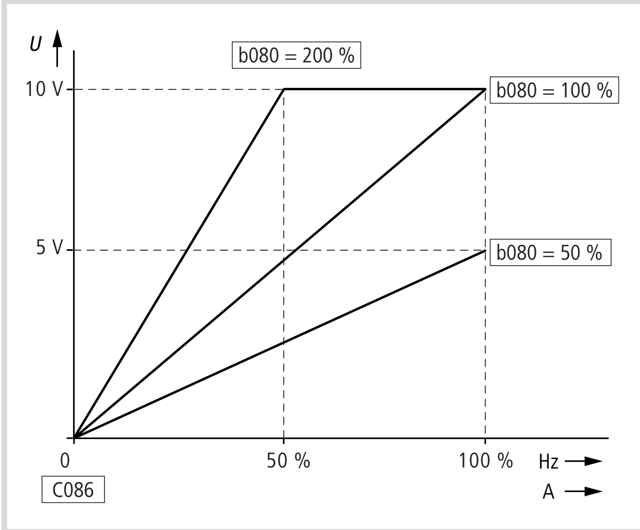


Figure 112: Analog output signal

PNU	Name	RUN	b031 = 10	Value	Function	DS
b080	Analog output AM, gain factor	✓	✓	0 – 255	Here the analog 0–10 V signal output at the AM terminal can be compensated and matched to the frequency actual value or the output current.	100
b086	Frequency indication scaling factor for value in PNU d007	✓	✓	0.1 – 99.9	The product of the value displayed under PNU d001 and this factor is displayed at PNU d007. This value is also available at the AM terminal.	1.0
C028	Analog output AM, measured value indication selection	–	–	00	f-Out: Current output frequency: Indicates the output frequency in the range 0 to f_{max} (PNU A004)	00
				01	I-Out: Current output current: Indicates the motor current in the range 0 to 200 %)	
C086	Analog output AM – offset compensation	✓	✓	0 – 10 V	Offset compensation for analog output signal AM.	0.0

Parameterizable digital outputs

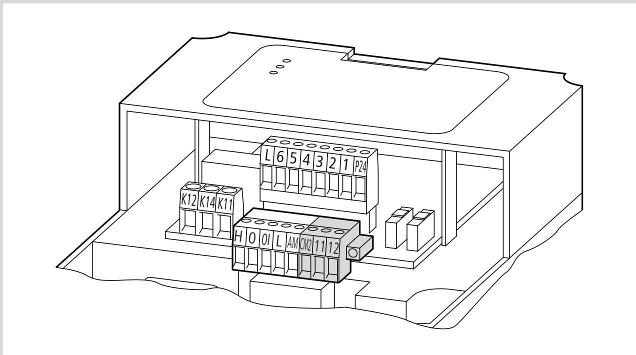


Figure 113: Digital outputs 11 and 12, CM2

Configurable digital outputs 11 and 12 are open collector transistor outputs (→ fig. 114), to which you can connect, for example, relays (such as ETS4-VS3, Order No. 083094). These outputs can both be used for various functions, for example to signal when a determined reference frequency is reached or when a fault occurs.

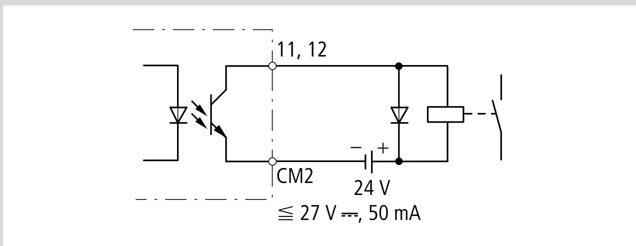


Figure 114: Digital output (sink-type)

Transistor output: maximum 27 V ⎓, 50 mA

Terminal CM2 is the common reference potential for digital outputs 11 and 12. CM2 can be connected to 0 V in sink-type logic and to +24 V in source-type logic (→ fig. 50, page 48).

Table 31: Digital outputs 11 and 12

PNU	Terminal	Adjustable in RUN mode	Value	DS
C021	11	–	→ table 32	01
C022	12			00

For a detailed description of the output functions, see the pages listed in table 32.

Table 32: Functions of the digital outputs

Value	Function	Description	a page
00	RUN	RUN: In operation	117
01	FA1	FA1: Frequency reference value reached	118
02	FA2	FA2: Frequency signal – output frequency exceeds value in PNU C042 (during acceleration ramp) or PNU C043 (during deceleration ramp)	
03	OL	OL: Overload warning – motor current exceeds value in PNU C041.	121
04	OD	OD: PID control – reference/actual value difference exceeds signalling threshold set with PNU C044.	145
05	AL	AL: Fault – fault/alarm signal	128
06	Dc	Dc: Warning – Reference value at input O (0 to +10 V) lower than value in PNU b082 or current signal at input OI below 4 mA. (reference value signal interrupted)	
07	FBV	FBV: PID control – Actual value monitoring (PV) signal on breach of limit values PNU C052/C053. (actual value signal interrupted)	
08	NDc	NDc: Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.	
09	LOG	LOG: Shows result of logic link performed through PNU C143. (High, Low)	
10	ODc	ODc: Fault/warning: Communication overload or interrupted (with optional DE51-NET-CAN, DE51-NET-DP). (overload)	

Configurable digital outputs 11 and 12 are by default configured as N/O contacts. When an assigned function activates the output, terminal CM2 is connected with terminal 11 or 12.

Optionally, you can configure the digital outputs as break (NC) contacts. To do this, enter 01 under PNU C031 and C032 (corresponding to digital output 11 and 12).

Table 33: Configuration of digital outputs as break contacts

PNU	Terminal	Value	Adjustable in RUN mode	Function	DS
C031	11	00 or 01	–	00: Make contact 01: Break contact	00
C032	12				

Response time of outputs

You can set the response time of digital outputs 11 and 12 between 0 and 100 s. The On- and off-delay can be adjusted separately.

Example:

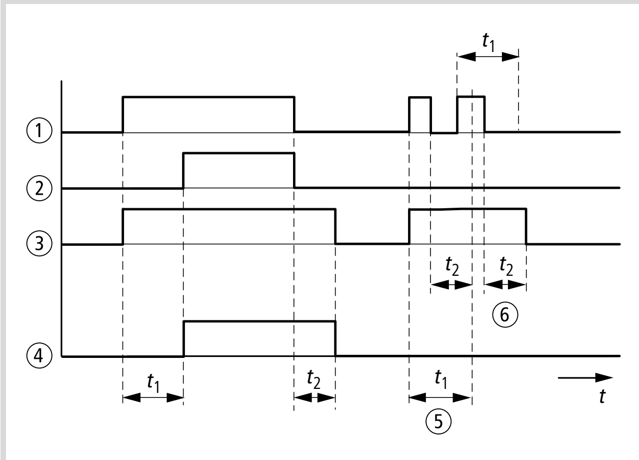


Figure 115: Output signal

① Output signal without delay
② Output signal with on-delay
③ Output signal with off-delay
④ Output signal with on- and off-delay
⑤ When the output signal is lower than the On-delay, the output is not activated.
⑥ The off-delay is activated regardless of the signal duration.
t_1: On-delay
t_2: Off-delay

PNU	Name	RUN	b031 = 10	Value	Function	DS
C144	Digital output 11 – deceleration time (On)	–	✓	0 – 100 s	Delay on energization	0.0
C145	Digital output 11 – deceleration time (Off)	–	✓	0 – 100 s	Delay on power off	0.0
C146	Digital output 12 – deceleration time (On)	–	✓	0 – 100 s	Delay on energization	0.0
C147	Digital output 12 – deceleration time (Off)	–	✓	0 – 100 s	Delay on power off	0.0

Signalling relay K1 (terminals K11, K12, K14)

At zero voltage, contacts K11-K12 are closed. When the supply voltage is applied, signalling relay K1 is activated (K11-K14).

By default, the signalling relay is switched off when a fault occurs. With PNU C026 you can change the assigned signal. The relay contact (changeover contact) can be connected directly into control circuits (24 V ⎓ – 230 V ~) (→ section "Connecting a signalling relay", page 41).

→ Signalling relay K1 closes when supply voltage is applied to contact K11-K12. When a fault occurs, this contact opens. Fault signals must be reset with the Reset command (RST) or with a disconnection of the supply voltage.

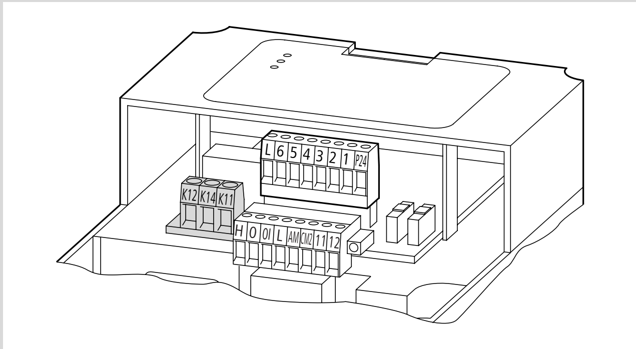


Figure 116: Signalling relay K1

Table 34: Default setting of the signalling relay

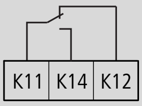
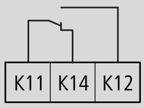
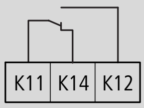
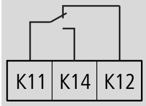
Default setting of the signalling relay				Reconfigured signalling relay terminals (PNU 036 = 00)			
Fault or DV51 switched off 		Run signal 		Fault message 		Run signal or DV51 switched off 	
Voltage	**Operating state**	**K11-K12**	**K11-K14**	**Voltage**	**Operating state**	**K11-K12**	**K11-K14**
On	Normal	Open	Closed	On	Normal	Closed	Open
On	Fault	Closed	Open	On	Fault	Open	Closed
Off	–	Closed	Open	Off	–	Closed	Open

Table 35: Functions of the signalling relay

PNU	Name	RUN	b031 = 10	Value	Function	DS
C026	Relay K1 – signal	–	–	00	RUN: In operation	05
				01	FA1: Frequency reference value reached	
				02	FA2: Frequency signal – output frequency exceeds value in PNU C042 (during acceleration ramp) or PNU C043 (during deceleration ramp)	
				03	OL: Overload warning – motor current exceeds value in PNU C041.	
				04	OD: PID control – reference/actual value difference exceeds signalling threshold set with PNU C044.	
				05	AL: Fault – fault/alarm signal	
				06	Dc: Warning – Reference value at input O (0 to +10 V) lower than value in PNU b082 or current signal at input OI below 4 mA. (reference value signal interrupted)	
				07	FBV: PID control – Actual value monitoring (PV) signal on breach of limit values PNU C052/C053. (actual value signal interrupted)	
				08	NDc: Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.	
				09	LOG: Shows result of logic link performed through PNU C143. (High, Low)	
				10	ODc: Fault/warning: Communication overload or interrupted (with optional DE51-NET-CAN, DE51-NET-DP).	
C036	Relay K1 (K11-K12) – logic	–	–	00	Normally open contact (NO)	01
				01	Normally closed contact (NC)	

Response time

You can set the response time of signalling relay K1 between 0 and 100 s. The On- and off-delay can be adjusted separately.

PNU	Name	RUN	b031 = 10	Value	Function	DS
C148	Relay K1 – deceleration time (On)	–	–	0 – 100 s	Delay on energization	0.0
C149	Relay K1 – deceleration time (Off)	–	–	0 – 100 s	Delay on power off	0.0

→ figure 115, page 114

RUN signal

The RUN signal is issued when an enable signal (FWD/REV) is applied. With the set deceleration ramp, the RUN signal remains active until the output frequency has reached 0 Hz.

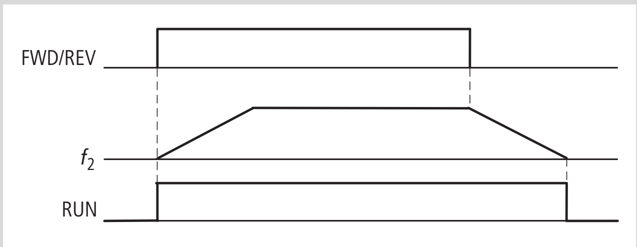


Figure 117: Function chart for RUN “operational”

f_2: Output frequency

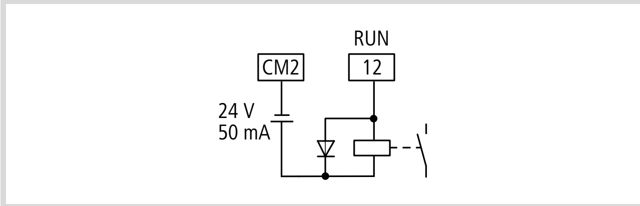


Figure 118: Digital output 12 configured as RUN (Run signal)

By default, RUN is assigned to digital output 12.

▶ Configure one of the digital outputs 11 or 12 as RUN by entering the value 00 under PNU C021 or C022, or under PNU C026 for signalling relay K1.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b082	Increased starting frequency (e.g. at high static friction)	–	✓	0.5 – 9.9 Hz	A higher starting frequency results in shorter acceleration and deceleration times (for example to overcome high frictional resistance). If the frequencies are too high, fault message E002 may be issued. Up to the set starting frequency, the motor accelerates without a ramp function.	0.5

Frequency value signal (FA1/FA2)

Signal FA1 (FA = Frequency Adjustment) is issued when the output frequency is the same as the reference frequency.

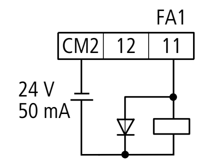


Figure 119: Digital output 11 configured as FA1 (frequency reached)

To ensure system hysteresis, signals FA1 and FA2 are activated each time the actual frequency is 0.5 Hz short of the reference value or the frequency set under PNU C042 and deactivated 1.5 Hz past the reference value or the frequency set under PNU C043.

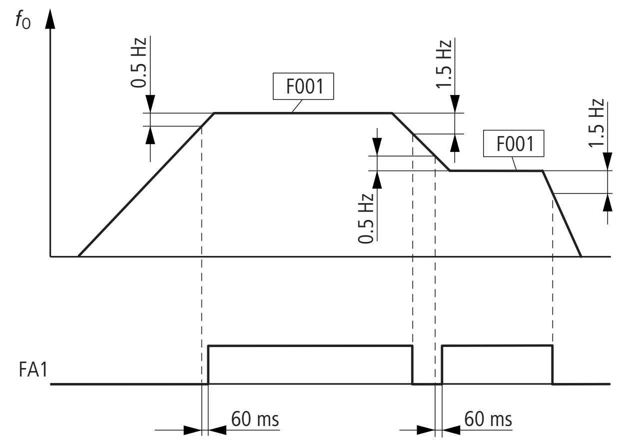


Figure 120: Function chart for FA1 (frequency reached)

f_O: Output frequency

F001:Reference value

The digital output configured as FA2 becomes active when the frequency falls below the frequency set under PNU C042. FA2 is deactivated as soon as the actual frequency falls below the value set in PNU C043. The frequency specified with PNU C042 must be higher than the frequency in PNU C043. If PNU F001 or PNU A020 is used for the reference input, the frequency set with PNU C042 can be smaller than the value in PNU C043. (→ fig. 121).

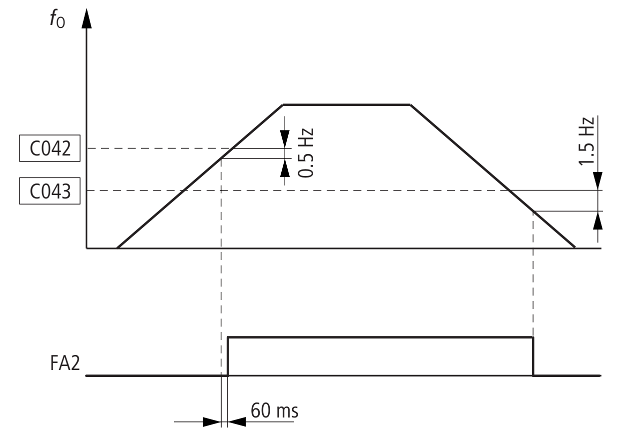


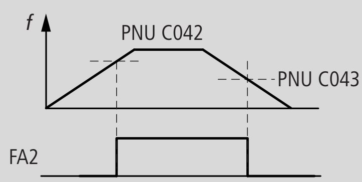
Figure 121: Function chart for FA2 (frequency exceeded)

f_O: Output frequency

- ▶ If you configure a programmable digital output as FA2, you must also, under PNU C042, enter the frequency from which the FA2 signal is active during acceleration.
- ▶ With PNU C043, set the respective frequency which is to remain active until the FA2 signal is deactivated during deceleration.
- ▶ Then, program one of the digital outputs 11 or 12 as the FA1 or FA2 output by setting PNU C021 or PNU C022 to 01 for FA1 or 02 for FA2.

By default, FA1 is assigned to digital output 11.

→ 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	RUN	b031 = 10	Value	Function	DS
C042	Output function – signalling threshold for frequency signal FA2 during acceleration	–	✓	0 – 400 Hz	 The digital output (11 or 12) configured as FA2 becomes active when the frequency entered here is exceeded during acceleration.	0.0
C043	Output function – signalling threshold for frequency signal FA2 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 C042).	

Monitoring functions

The functions described here are used to monitor the power section for overload and to protect the connected motor.

Limiting motor current

If the output current (= motor current, I_M) exceeds the value set with PNU b022 (b222), the output frequency (rotating field frequency) is reduced. You can set the deceleration time constant with PNU b023 (b223).

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).

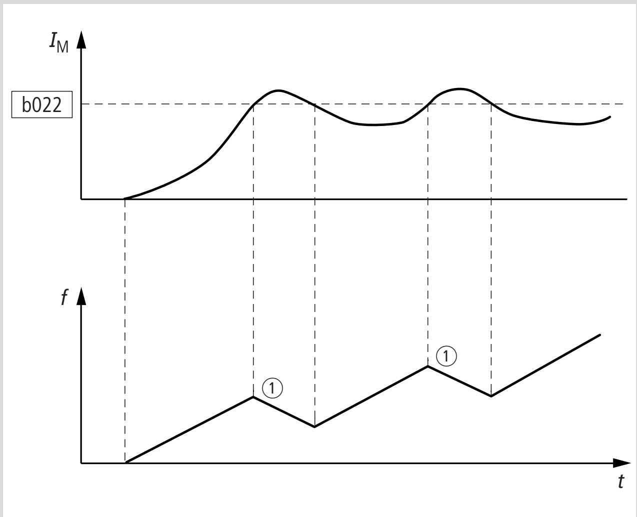


Figure 122: Current limit enabled

① Deceleration time constant (PNU b023/b223)

b022 (b222): Tripping current limit

I_M: Motor current

With PNU b028 (b228) you can match the current limitation to the process. The reference frequency must be provided digitally through:

- Digital inputs 1 to 6:
  - Fixed frequency (f_1 to f_{15})
  - Electronic motor potentiometer (UP, DWN)
- Optional keypad DEX-KEY-6…
  - Fixed frequency PNU A020
  - Electronic motor potentiometer: Arrow keys ⌃ and ⌄.

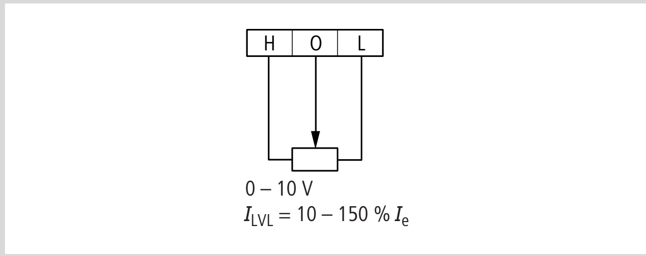


Figure 123: Connection of potentiometer to the external overload limitation

With an analog 0 to +10 V reference value signal (terminal O-L) you can adjust current limitation (I_{LVL}) in a range from 10 to 150 % of the rated device current (I). The change of the analog current limitation is delayed by 100 to 200 ms by the "sampling time ① (internal process time of CPU and controller).

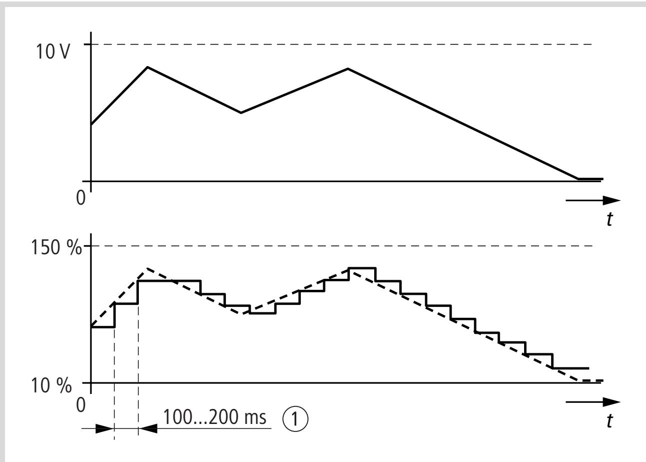


Figure 124: Variable overload limitation

① Sampling time (internal processing time of CPU and controller)

Suppressing overcurrent stopping

In applications with highly dynamic drives and rapid load changes, motor current limitation (PNU b020 to b028) can not prevent sudden overcurrents. The result is a motor stop with the fault message E 01 to E 03.

With PNU b140 you can access the inverter directly when a sudden overcurrent is detected. PNU b140 = 01 sets an automatic reduction of the pulse frequency and a delay of the output values (voltage, frequency) until the current is within the control range again. This prevents unintentional stopping and generation of a fault signal.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b021 b221	Motor current limitation – function	–	✓	00	Off: Disabled	01
				01	On: Enabled in acceleration phase and at constant speed	
				02	Enabled only at constant speed. This allows higher acceleration currents for short periods.	
b022 b222	Tripping current for motor current limitation	–	✓	Default, dependent on frequency inverter's rated current (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).	$I_e \times 1.5$
b023 b223	Motor current limitation, deceleration time constant	–	✓	0.1 – 3000 s	When specified current limit is reached, the frequency is reduced in the time set here. Caution: If possible, do not enter a value below 0.3 here!	1.0
b028 b228	Motor current limitation, limit current selection	–	✓	00	Value of PNU b022 (constant tripping current limit)	00
				01	Analog input O-L (variable tripping current limit) Externally adjustable current limitation (0 – 10 V → 10 – 150 % I_e)	
b140	Suppress stop on overcurrent	–	✓	00	Off: Disabled	00
				01	On: Enabled. Automatic reduction of pulse frequency at overcurrent.	

I_e = inverter rated current

Overload signal (OL)

The overload signal (OL) is output when the current value set with PNU C041 is exceeded.

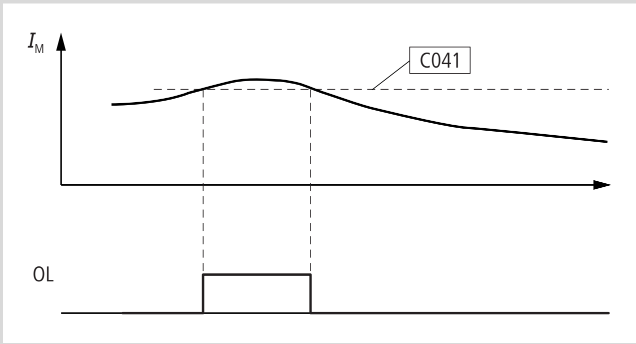


Figure 125: Function chart for OL (overload signal)

I_M: Motor current

- ▶ To configure digital output 11 or 12 or signalling relay K1 as OL, define the current under PNU C041 at which, when exceeded, the OL signal is activated.
- ▶ Then configure one of the outputs 11 or 12 as OL by entering the value 03 under PNU C021 or C022, or under PNU C026 for signalling relay K1.

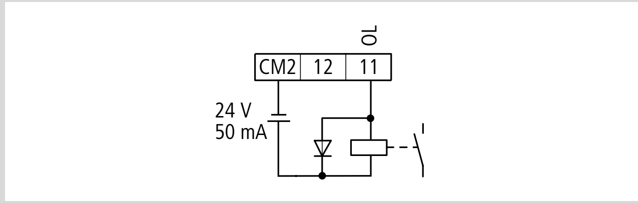


Figure 126: Digital output 11 configured as an OL (overload signal)

PNU	Name	RUN	b031 = 10	Value	Function	DS
C041 C241	Output function – warning threshold for overload signal (OL)	–	✓	$0 - 2 \times I_e$ [A] Default, dependent on frequency inverter's rated current (I_e)	The current value entered here determines when the OL signal should be activated.	I_e 1)

1) Frequency inverter rated current

Thermal overload

Using an electronically simulated bimetallic strip, the DV51 frequency inverters can provide thermal monitoring of the connected motor. With PNU b012, match the electronic motor protection to the motor's rated current. 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.

Adjust the current indicated by PNU d002 to the current drawn by the motor The current indicated under PNU d002 forms the basis for calibrating the electronic motor protection.

Caution!
At low motor speeds, the output of the motor cooling fan is diminished, and the motor may overheat despite its electronic overload protection. You should therefore provide protection with PTC thermistors or bimetal contacts.

In PNU b013, set the overload protection according to the applicable motor load.

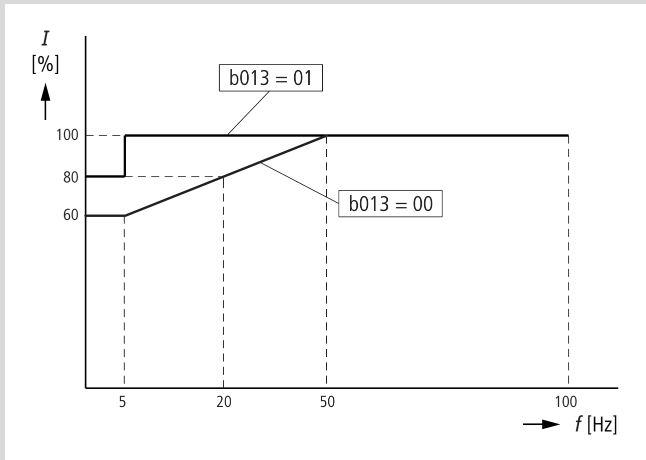


Figure 127: Overload protection

PNU	Name	RUN	b31= 10	Value	Function	DS
b012 b212	Thermal overload, tripping current	–	✓	0.2 – 1.2 × I_e [A][1]	Setting range of the tripping current as a multiple of the frequency inverter rated current, i.e. the range is given in amperes (A).	xx
b013 b213	Thermal overload, characteristic (torque curve)	–	✓	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_2: Output current		01
				00	Reduced torque 1	
				01	Constant torque	
				02	Reduced torque 2	

1) Frequency inverter rated current

Thermistor (PTC)

You can configure digital input 5 as PTC thermistor input. The PTC thermistor connected to terminal 5 and L monitors the motor's temperature. If the resistance of the thermistor rises above 3000 Ω (±10 %), the motor is stopped and fault signal E35 is issued.

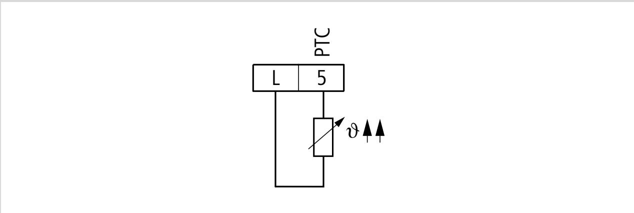


Figure 128: Digital input 5 configured as PTC (thermistor input)

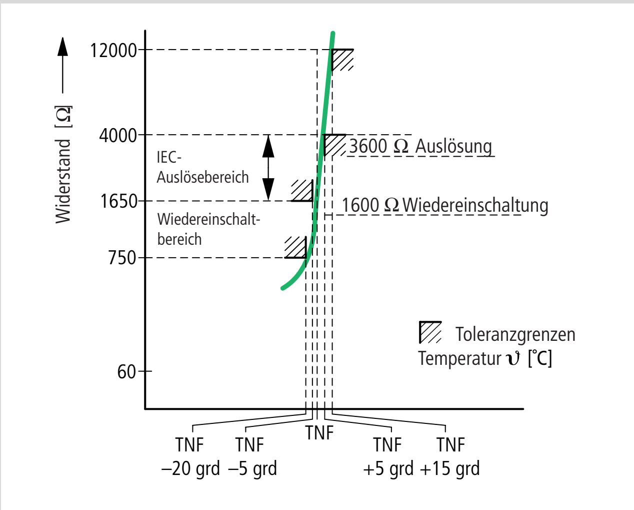


Figure 129: Characteristic of a PTC thermistor

▶ Configure digital input 5 as PTC by setting PNU C005 to 19.

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

→ If digital input 5 is configured as PTC, but no thermistor is connected, fault message E 35 is displayed.

→ Instead of thermistors you can also use thermo-clicks which break the connection 5–L when the temperature threshold is exceeded.

If the DV51 has issued fault signal E 35 and you want to reconfigure digital input 5, which is configured as PTC, do the following:

▶ Connect a link between digital input 5 and terminal L.
▶ Press the Stop key to acknowledge the fault message.
▶ You can now assign a new function to digital input 5 under PNU C005.

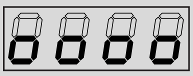
PNU	Name	RUN	b031 = 10	Value	Function	DS
C085	Thermistor compensation (digital input 5)	✓	✓	0 – 200 %	Compensation for thermistor connection.	100

Supply voltage (POWER)

The DV51 frequency inverters can be supplied with AC voltage (50/60 Hz mains voltage) or DC voltage. In both cases the energy is loaded into the internal DC link where it is stored in capacitors. The internal DC link, in turn, supplies the switched-mode power supply, generating the required control voltage for the electronics, the reference voltage (+10 V) and the voltage for the control signal terminals (+24 V). Charging of the internal DC link and correct operation of the switched-mode power supply is indicated by the red POWER LED.

Device series	Mains connection (50/60 Hz)		DC voltage	
	Terminals	Voltage	Terminals	Voltage
DV51-320	L1, L2, L3	3 ~ 230 V (180 V – 0 % to 264 V + 0 %)	DC+, DC–	201 V – 374 V “Voltage too low” signal 190 V ± 10 V Overvoltage signal 395 V ± 20 V
DV51-322	L/L1, L3/N	1 ~ 230 V (180 V – 0 % to 264 V + 0 %)		
	L/L1, L2, L3/N	3 ~ 230 V (180 V – 0 % to 264 V + 0 %)		
DV51-340	L1, L2, L3	3 ~ 400 V (342 V – 0 % to 528 V + 0 %)	DC+, DC–	416 V to 749 V “Voltage too low” signal 395 V ± 20 V Overvoltage signal 790 V ± 40 V

With PNU b001 to b005 you can define the frequency inverter’s behaviour when an undervoltage signal (E 09) is detected.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b001	POWER, restarting mode after power supply interruption	–	✓	00	Fault signal E 09, automatic restart at 0 Hz. Fault signal E 09. When you acknowledge the fault signal (RST or Stop key on the keypad), the drive automatically starts up again with 0 Hz.	00
				01	Automatic restart at set starting frequency after expiry of time set with PNU b003.	
				02	After the time set with PNU b003 has elapsed, the frequency inverter synchronizes to the current motor rotation speed and the motor is accelerated to the current reference value in the set ramp times.	
				03	After the time set under PNU b003 has elapsed, the inverter synchronizes to the current motor rotation speed and the motor brakes to a stop in the set deceleration time. A fault message is then displayed..	
b002	POWER, permissible power supply downtime	–	✓	0.3 – 25 s	Here, you set a time duration during which the undervoltage condition is met without the corresponding fault message in PNU E 09 being initiated.	1.0
b003	POWER, waiting time before automatic restart after power supply failure	–	✓	0.3 – 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

PNU	Name	RUN	b031 = 10	Value	Function	DS
b004	POWER, fault signal on intermittent supply voltage failure or undervoltage	–	✓	00	Off: Disabled. No fault message is issued.	00
				01	On: Enabled. In the event of an intermittent power supply failure or undervoltage, the frequency inverter goes into fault status (E 09).	
b005	POWER, number of automatic restarting attempts after intermittent supply voltage failure or undervoltage	–	✓	00	Sixteen restart attempts on intermittent supply voltage failure or undervoltage	00
				01	The number of restart attempts is not limited.	

Fault messages

Frequency inverter DV51 features several built-in monitoring functions. To protect against damage, the inverter is automatically inhibited when a fault signal is detected. The connected motor then coasts to a halt and the fault signal is indicated by the red ALARM LED. If an LCD keypad (DEX-KEY-…) is fitted, an error code (E…) is issued. DV51 remains inhibited until the fault signal is acknowledged. To acknowledge the fault message:

- Press the Stop key (optional keypad),
- activate the digital input configured as RST,
- switch off the power supply.

Display	Cause	Description
E 01	Inverter overcurrent in static operation	In the following cases, the output current is too high: • The frequency inverter's output is short-circuited • The motor is blocked • An excessive load is suddenly applied to the output.
E02	Inverter overcurrent during deceleration	
E03	Inverter overcurrent during acceleration	
E04	Inverter overcurrent at standstill	
E05	Overload	The internal electronic motor protection has switched off the output voltage because of an overload.
E06	Overload	If the duty factor of the DV51's built-in braking transistor is too great, the braking transistor is switched off (the generated overvoltage disconnects the output voltage).
E07	Overvoltage	Overvoltage in regenerative mode.
E08	EEPROM fault	The program memory is not operating reliably due to radio frequency interference, a control voltage short-circuit (P24–L) or excessive temperature. If the supply voltage is switched off while the RST input is active, an EEPROM fault may occur when the supply voltage is switched on again.
E09	Undervoltage	Insufficient DC voltage (error-free electronics function not possible; potential problems such as overheating of motor and insufficient torque).
E11	Processor malfunction	Processor is not working correctly, for example because of RFI or excessive temperature.
E12	External fault message	An external fault signal is applied to a digital input configured as EXT input.
E13	Restart inhibit activated	The mains voltage was switched on or an intermittent interruption in the supply voltage has occurred while unattended start protection (input USP) was active.
E14	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 at startup, but does not protect the operating personnel.
E15	Mains overvoltage	The mains voltage exceeds the permissible value. Shutdown about 100 s after activation of power supply.
E21	Overtemperature	The built-in temperature sensor in the power section is measuring an operating temperature above the permissible limit value.
E 22	Processor malfunction	Processor is not working correctly, for example because of RFI or excessive temperature.
E23	Gate array fault	Internal communication error between CPU and the logical vector groups (gate array). The IGBT power module is switched off immediately.
E35	Thermistor fault signal	The resistance of the externally fitted PTC thermistor connected to the PTC input (digital input configured as PTC input) is too high.
E60	Communication fault	Communication with the frequency inverter timed out → PNU C076 and C077.
- - - -	Undervoltage (intermittent display)	The undervoltage signal appears briefly if the supply voltage (mains voltage or internal DC link voltage) is too low. The output to the motor (U, V, W) is switched off immediately.

Fault register

The frequency inverters DV51 have a fault register. to which the three most recent fault messages are saved. You can retrieve these under PNU d081 to d083. PNU d081 shows the most recent fault message, PNU d082 last but one, etc. When a new fault occurs, it is saved to PNU d081 and all older faults are moved on by one PNU (PNU d081 → d082, PNU d082 → d083, etc.)

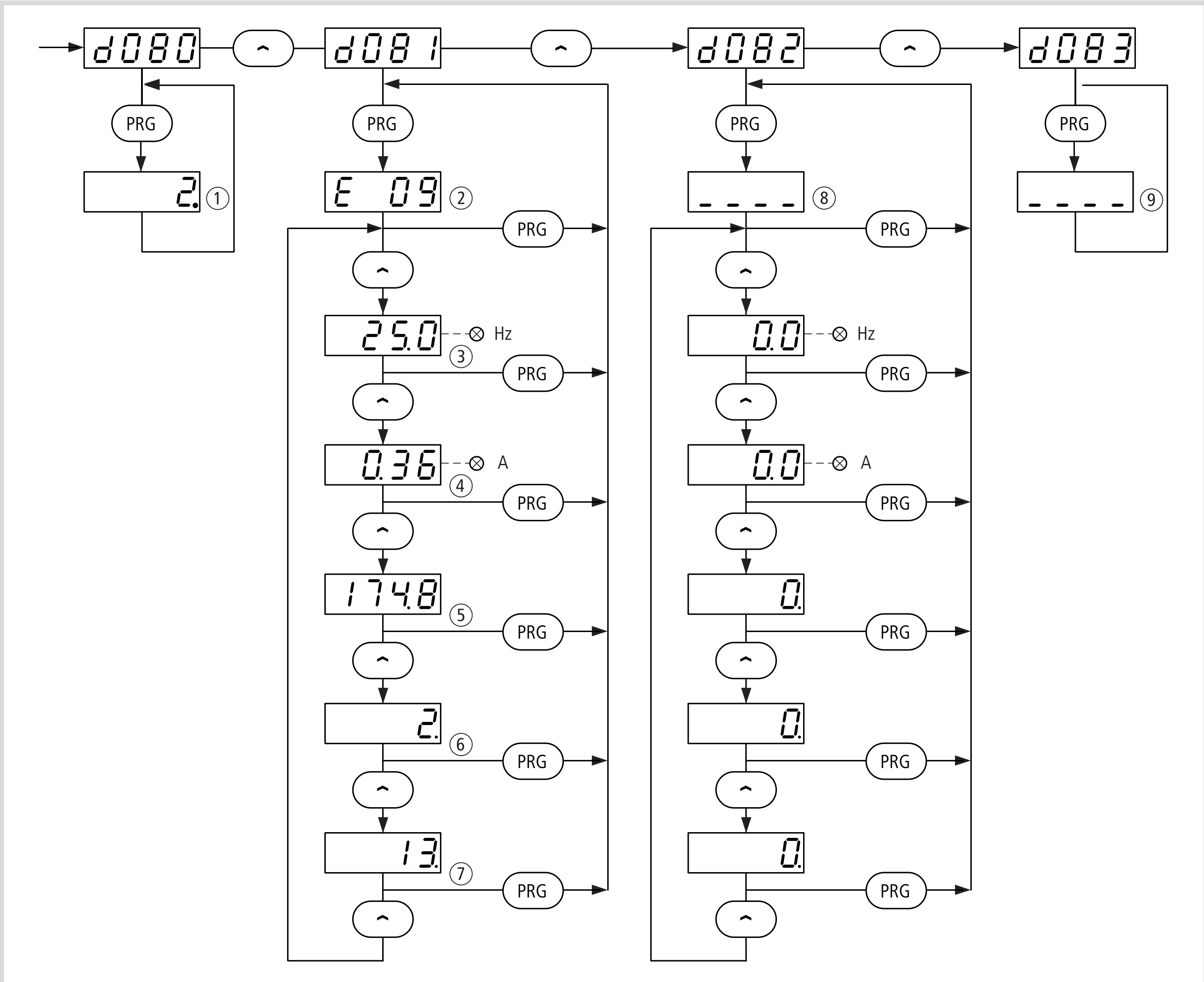


Figure 130: Data in the fault register at the time of the fault signal

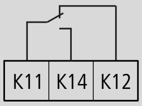
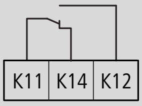
① Total number of occurred faults
② Code of the current fault signal
③ Frequency in Hz
④ Output current in A
⑤ Internal DC link voltage in V
⑥ Total operating time in h in RUN mode up to the fault signal
⑦ POWER ON time in h, power supply switched on up to fault signal
⑧ Most recent fault signal (no fault indicated in example)
⑨ Last but one fault signal

→ You can clear the fault register under PNU b084 (00 or 02).

Fault signal (AL)

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

By default, function AL is assigned to signalling relay K1 (terminals K11, K12, K14) (PNU C036 = 00).

Default setting of the signalling relay			
Fault or DV51 switched off 		**Run signal** 	
Voltage	**Operating state**	**K11-K12**	**K11-K14**
On	Normal	Open	Closed
On	Fault	Closed	Open
Off	–	Closed	Open

When the supply voltage is applied, the internal monitoring functions are scanned. If no fault message is present, K1 is energized (contact K11-K14 closed). When a fault message is present (E…), K1 drops out (K11-K12 closed).

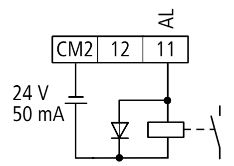


Figure 131: Digital output 11 configured as AL (fault occurrence)

▶ Configure one of the digital outputs 11 or 12 as an AL by setting PNU C021 or PNU C022 to 05.

When the AL output is configured as a break contact, 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.

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.

External fault signal (EXT)

A digital input configured as EXT allows the direct inclusion of external monitoring devices (temperature and vibration monitoring, limit switches, etc.)

When the digital input configured as EXT is activated, fault message E12 is issued and output through the communication interface (RS 485/Modbus). 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 Stop key.
- Alternatively, the supply voltage can be switched off and on again.

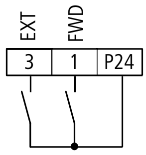


Figure 132: Digital input 1 configured as FWD (start/stop clockwise operation) and digital input 3 as EXT (external fault)

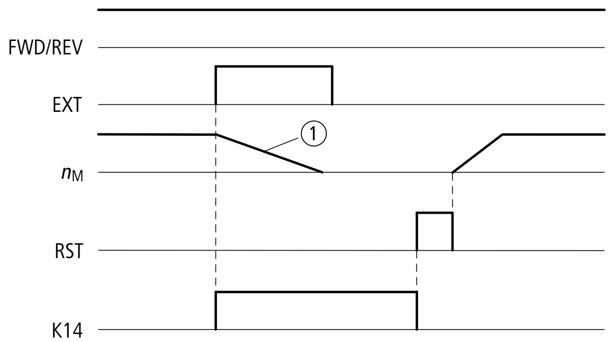


Figure 133: Function chart for EXT (external fault message)

n_M: Motor speed

K14: Signalling relay contact K14

① Motor coasts to a stop

▶ Configure one of the digital inputs 1 to 6 as EXT by entering the value 12 under the corresponding PNU (C001 to C006).

⚠ **Warning!**
After a reset, the motor restarts immediately if a start signal (FWD or REV) is active.

Resetting fault signals (RST)

By default, RS is assigned to digital input 5.

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

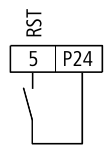


Figure 134: Digital input 5 configured as RST (reset)

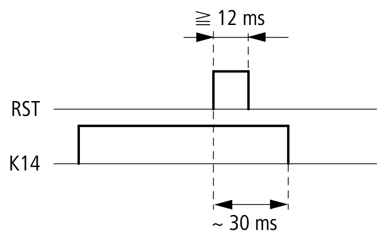


Figure 135: Function chart for RST (reset)

K14: Signalling relay contact K14

▶ Configure one of the digital inputs 1 to 6 as RST by entering the value 18 under the corresponding PNU (C001 to C006).

Danger!
If a reset is carried out after a fault, 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 This prevents the risk of damage and injury.

→ When a fault has occurred, the Stop 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 four seconds, it can cause a false trip.

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

→ 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 coasts to a stop.

You can specify the response to the Reset signal (RST) through a digital input with PNU C102.

PNU	Name	RUN	b031 =10s	Value	Function	DS
C102	Reset function (RST) – response to a Reset signal	–	✓	00	On a rising edge the fault signal is reset and the motor is stopped.	00
				01	On a falling edge the fault signal is reset and the motor is stopped.	
				02	On a rising edge the fault message is reset.	

Automatic restart after a fault

Danger!
When a fault has occurred, this function initiates an automatic restart of the frequency inverter if a start signal 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 fault triggers a fault message. An automatic restart is possible after the following fault messages have occurred:

- Overcurrent (up to three restarting attempts, then fault signal E 01 to E 04)
- Overvoltage (up to three restarting attempts, then fault signal E 07 and E 15)
- Undervoltage, intermittent supply voltage failure (up to 16 restart attempts, then fault signal E 09)

When the maximum number of permissible automatic restarts (3 or 6) is reached, the frequency inverter must be restarted.

With PNU b002 and b003, specify the behaviour on mains failure (→ fig. 136 and fig. 137).

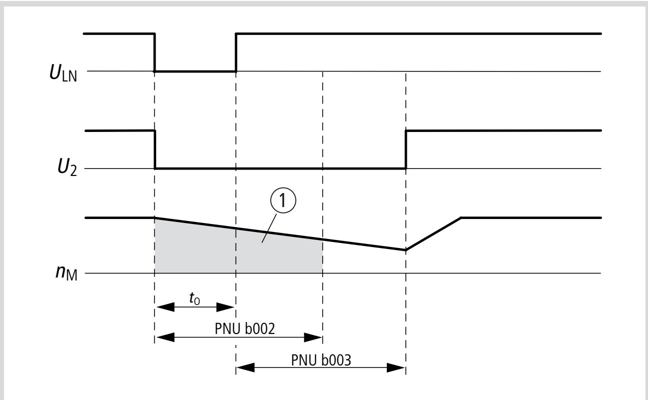


Figure 136: Supply voltage downtime less than value in PNU b002, automatic restart

ΔU_{LN}: Supply voltage
ΔU_2: Output voltage
n_M: Motor speed
t_0: Duration of supply failure
① Free run stop (coasting)

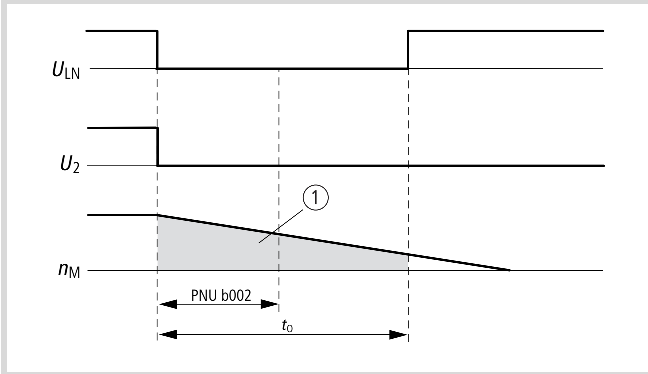


Figure 137: Supply voltage downtime greater than value in PNU b002

ΔU_{LN}: Supply voltage
ΔU_2: Output voltage
n_M: Motor speed
t_0: Duration of supply failure
① Free run stop (coasting)

Under PNU b004, define how the DV51 frequency inverter responds to an intermittent power supply failure or undervoltage.

With PNU b005, define whether the DV51 frequency inverter attempts a restart up to 16 times or indefinitely in the event of an intermittent power supply failure or undervoltage.

If mains power returns after expiry of the time set with PNU b002 and a start signal is applied, a restart is performed.

Unattended start protection

If the digital input configured as USP is activated, unattended start protection is also activated. This prevents a restart of the motor when the voltage recovers after a mains fault while a start signal (active signal on FWD or REV) is present. Fault message E13 is issued. E13 is cancelled by pressing the Stop key or with an active signal on the RST input. Alternatively, the start signal can be revoked.

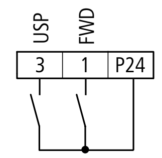


Figure 138: Digital input 1 configured as FWD (start/stop clockwise operation) and digital input 3 as USP (unattended start protection).

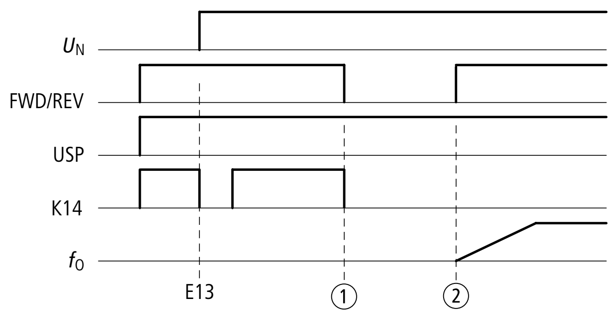


Figure 139: Function chart for USP (unattended start protection)

ΔU_N:Supply voltage

K14: Signalling relay contact K14

f_0: Output frequency

① Revoke start signal (alarm no longer present)

② Start signal

▶ Configure one of the digital inputs 1 to 6 as USP by entering the value 13 under the corresponding PNU (C001 to C006).

Danger!
If unattended start protection is triggered (fault message E013) and the fault message is acknowledged with a reset command while a start signal is still active (input FWD or REV active), the motor will restart immediately.

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

→ Unattended start protection can still be activated when you issue a reset command through the RST input after an undervoltage fault message (E09) has occurred.

Braking

Braking is the slowing down of a drive system to standstill or a specific lower speed within a specified time. Braking can take place mechanically (using a friction brake) or electrically (DC braking or braking choppers).

The DV51 devices allow the following braking methods:

- Actuation of an external mechanical holding brake through relay K1 (→ section "Signalling relay K1 (terminals K11, K12, K14)", page 115) or a digital output (→ section "Parameterizable digital outputs", page 113).
- DC braking: applying direct current to the three-phase motor
- Braking transistor as electrical switch (brake chopper), which directs the braking energy to an external braking resistor.

DC braking (DCB)

To activate DC braking for decelerating the motor, do the following:

- apply a stop signal (PNU A051 = 01) or
- activate the digital input configured as DB.

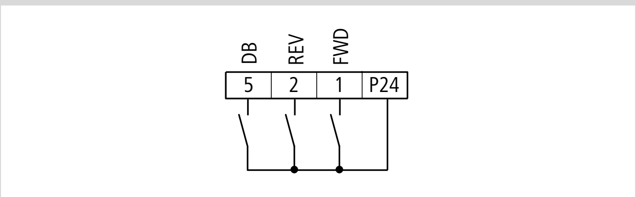


Figure 140: Digital input 1 configured as FWD (start/stop clockwise rotating field), input 2 as REV (start/stop anticlockwise rotating field) and input 5 as DB (DC braking)

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.

Under PNU A051, define whether DC braking is to be activated automatically when the frequency set under PNU A052 us reached and/or when the DB input is activated.

Under PNU A052 enter the frequency at which DC braking is activated when PNU A051 is 00.

Under PNU A053, enter the waiting time which is to elapse before DC braking becomes active after activation of the DB input or when the set startup frequency is reached.

Under PNU A054 enter the braking torque between 0 and 100 %.

In PNU A055, enter the DC braking duration.

Under PNU A056 specify the braking behaviour when the DB input is active:

- 00: DC braking starts when the DB input is activated and ends only when the time defined under PNU A055 has expired.
- 01: Braking starts as soon as the DB input is active and ends when the DB input is deactivated.

DC braking can also be activated before motor acceleration, for example in lifting and conveying applications (releasing the mechanical holding brake) or with drives which are operated using process variables, such as fans, pumps and compressors.

Caution!
DC braking results in additional heating of the motor. You should therefore configure the braking torque (PNU A054) as low and the braking duration (PNU A055) as short as possible.

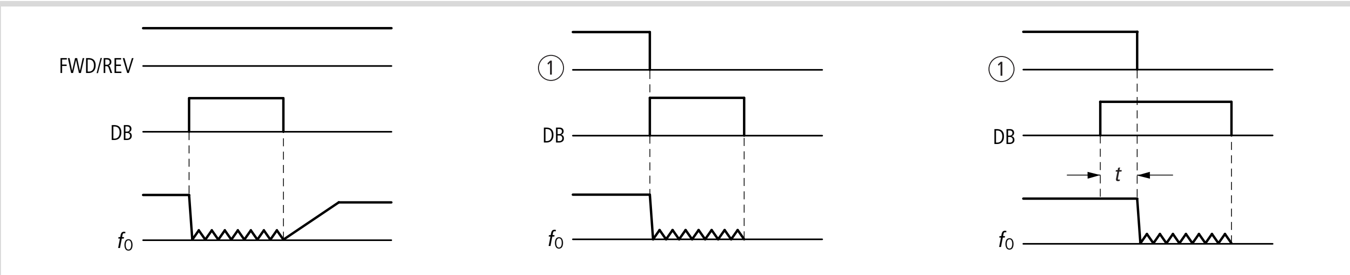


Figure 141: Function chart for DB (DC braking)

f_0: Output frequency

t: Waiting time PNU A053

① Start signal through keypad

- ▶ Configure one of the digital inputs 1 to 6 as DB by entering the value 07 under the corresponding PNU (C001 to C006).
- ▶ In PNU A053, enter a delay time t (→ fig. 141) from 0 to 5.0 s, which is to expire before DC braking takes effect after activation of the DB input.
- ▶ Under PNU A054, set a braking force between 0 % and 100 %.

PNU	Name	RUN	b031 =10s	Value	Function	DS
A051	DC braking	–	✓	00	Off: Disabled	00
				01	On: Enabled	
A052	DC braking – starting frequency	–	✓	0 – 60 Hz	When PNU A51 is set to 01, DC braking is activated when the actual frequency falls below the frequency entered here.	0.5
A053	DC braking – waiting time	–	✓	0 – 5 s	When the frequency set with PNU A052 is reached, the motor coasts for the time duration entered here before DC braking is activated.	0.0
A054	DC braking torque	–	✓	0 – 100 %	Adjustment range for the level of braking torque.	0.
A055	DC braking duration	–	✓	0 – 60 s	The time during which DC braking is active.	0.0
A056	DC braking – behaviour on activation of the digital input (DB)	–	✓	00	Timed braking according to value of PNU A055	01
				01	Continuous operation	

Braking transistor

In connection with an external braking resistor, the built-in braking transistor allows dynamic braking (→ section "Braking resistance", page 233).

Under PNU b095, specify when the built-in braking transistor is to operate.

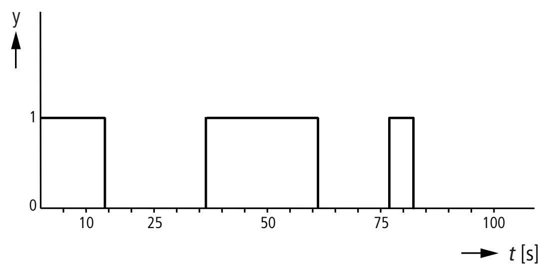
Under PNU b096, set the voltage threshold at which the built-in braking transistor becomes active.

Under PNU b090 enter the permissible relative duty factor of the DV51's built-in braking transistor. The value entered here is a percentage of the longest permissible (continuous) total running time of the braking transistor, which is 100 s.

Using an example of three braking operations within 100 seconds, the illustration below 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 b090 to 40 %, a fault message is issued.



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

Figure 142: Example: Braking duration

y: Braking transistor enabled

The braking transistor is activated automatically. In the event of a braking transistor overload, fault signal E06 is issued.

The assigned external Braking resistor must not fall below the following minimum values:

DV51-	Assigned motor rating P kW	DC link voltage (PNU b096)	R_{min} Ω	DF_{max} (PNU b090) %
320-4K0	4	370 V DC (330 – 395 V)	100	100
320-5K5	5.5		50	70
320-7K5	7.5		50	70
322-025	0.25		100	80
322-037	0.37		100	80
322-055	0.55		100	80
322-075	0.75		35	39
322-1K1	1.1		35	39
322-1K5	1.5		35	70
322-2K2	2.2		35	100
340-037	0.37	740 V DC (660 – 790 V)	180	36
340-075	0.75		180	60
340-1K5	1.5		180	90
340-2K2	2.2		100	67
340-3K0	3		100	100
340-4K0	4		100	100
340-5K5	5.5		50	70
340-7K5	7.5		50	70

R_{min} = smallest permissible resistance value
DF_{max} = greatest permissible duty factor of the braking transistor at the specified R_{min}

Connect the external braking resistor to terminals BR and DC+. The maximum cable length between frequency inverter and braking resistor must not be greater than five metres.

If you are using an external braking device, enter 0 % under PNU b090 and remove any external braking resistors at terminals BR and DC+. Connect external braking devices to terminals BR and DC+.

PNU	Name	RUNs	b031 = 10	Value	Function	DS
b090	Braking transistor, permissible percentage duty factor within a 100 s interval	–	✓	0 – 100 %	To disable the relative permissible duty factor of the built-in braking device, enter 0 %.	00

PNU	Name	RUNs	b031 = 10	Value	Function	DS
b095	Braking transistor, control	–	✓	00	Function disabled	00
				01	Enabled in RUN mode	
				02	Always enabled	
b096	Braking transistor, starting voltage threshold	–	✓	330 – 395 V (U_e = 230 V) 660 – 790 V (U_e = 400 V)	Default, dependent on rated voltage of DV51 (U_e)	360/720

Caution!
With PNU b095 = 02 the braking transistor is also enabled in STOP mode (RUN LED is not lit). Depending on the level of the DC link voltage and the value set with PNU b096, a continuous load is applied to the external braking resistor. This can cause overload and damage of the braking resistor and presents a fire risk.

Mathematical and logic functions

The DV51 can establish mathematical links (CAL) between two analog inputs and logic links (LOG) between two digital inputs.

Mathematical functions

With PNU A143 you can establish a mathematical link between two input signals (A and B). With PNU A142 select an input signal as value A and with PNU A143 a second input signal as value B.

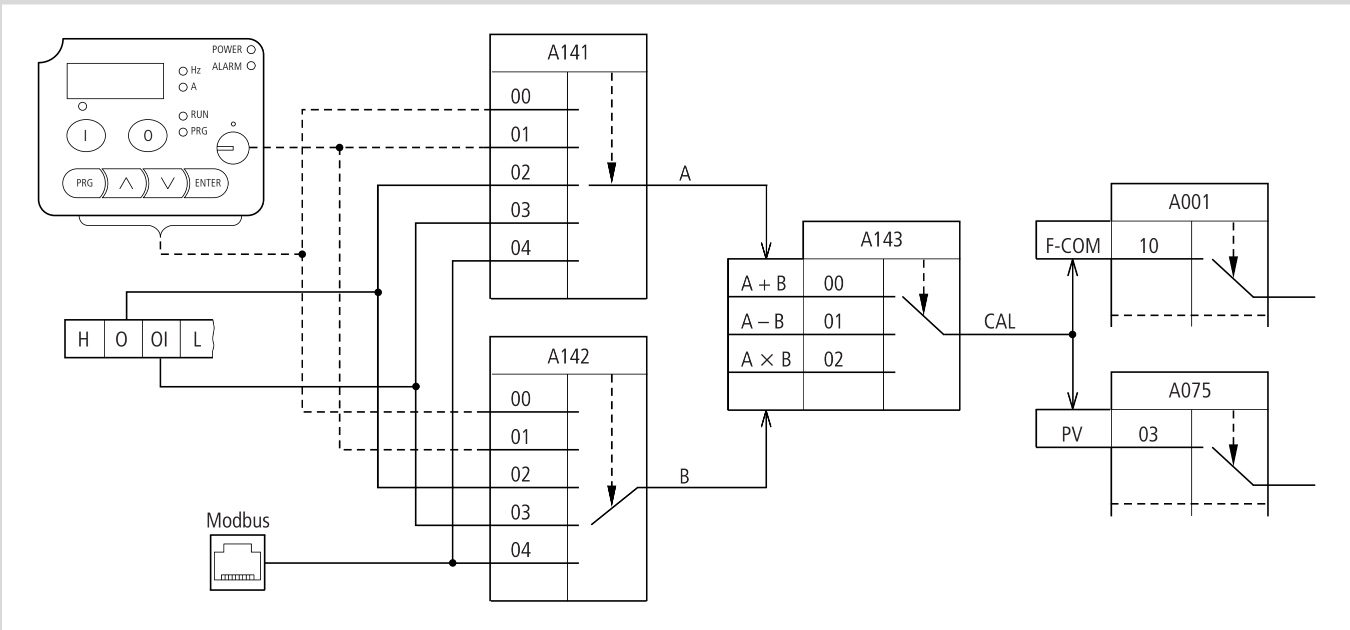


Figure 143: Mathematical linking of A and B

The result (CAL) is available as reference frequency (F-COM) in PNU A001 or as process variable (PV=) for PID control in PNU A075.

PNU	Name	RUN	b031 = 10	Value	Function	DS
A141	Calculator – select input A	–	✓	00	Value of keypad (option DEX-KEY-…)	02
				01	Potentiometer of keypad (option DEX-KEY-6)	
				02	Analog input (O)	
				03	Analog input (OI)	
				04	Serial interface (Modbus)	
A142	Calculator – select input B	–	✓	00	Value of keypad (option DEX-KEY-…)	03
				01	Potentiometer of keypad (option DEX-KEY-6)	
				02	Analog input (O)	
				03	Analog input (OI)	
				04	Serial interface (Modbus)	
A143	Calculator – operation	–	✓	00	Addition (A + B)	00
				01	Subtraction (A – B)	
				02	Multiplication (A × B)	

Frequency offset (ADD)

In PNU A145 you can save a frequency offset and add it to or subtract it from the specified reference frequency with PNU A146.

▶ Configure one of the digital inputs 1 to 6 as ADD (add frequency) by entering the value 50 under the corresponding PNU (C001 to C006).

The reference frequency source is selected with PNU A001. By default the activation of digital input ADD adds the frequency offset to the reference frequency. With PNU A145 = 01 the frequency offset is subtracted.

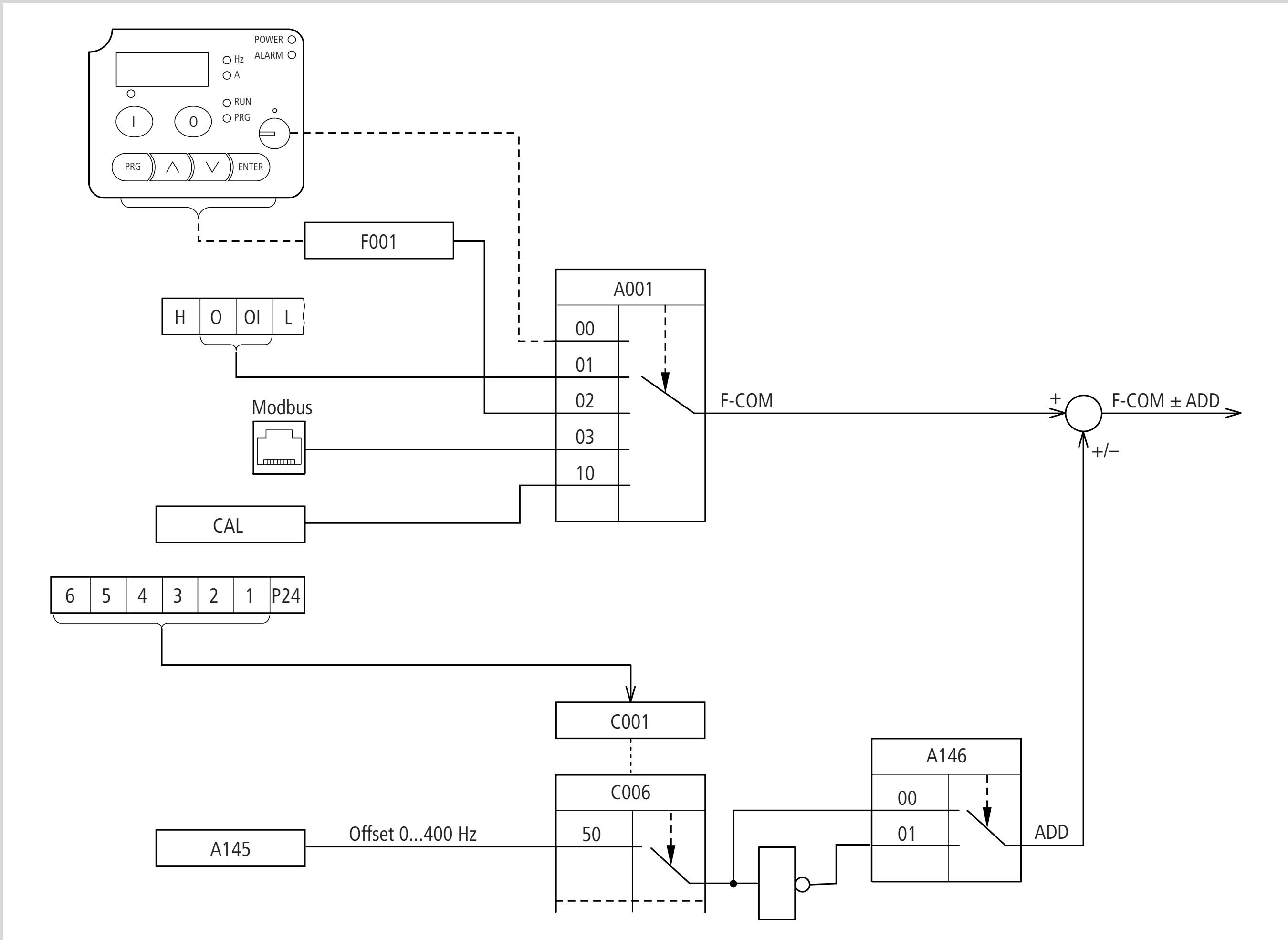


Figure 144: Mathematical linking of reference frequency and offset

PNU	Name	RUN	b031 = 10	Value	Function	DS
A145	Calculator – offset frequency	✓	✓		0 – 400 Hz Frequency offset for addition to or subtraction from reference frequency. (→ PNU C001 = 50: ADD)	0.0
A146	Calculator – offset frequency, prefix	–	✓	00	Plus, adds the value of PNU A145 to the reference frequency (→ selection PNU A001, page 95)	00
				01	Minus, subtracts the value of PNU A145 from the reference frequency (→ selection PNU A001, page 95)	

→ When adding reference frequency and offset, the maximum output frequency is limited by the value in PNU A004 (→ section “End frequency”, page 72).

Example:
PNU A145 = 20 Hz, A004 = 50 Hz, A146 = 00,
A001 = 0 … 50 Hz.

In the range 0 to 30 Hz the full frequency offset (20–Hz) is added to the reference frequency (PNU A001). In the range 30 to 50 Hz only the value that applies up to the end frequency (PNU A004) is added, for example 40 Hz + 20 Hz → 50 Hz (limited).

Caution!
Automatic change of direction on subtraction (PNU A146 = 01) when the frequency offset set with PNU A145 is greater than the reference frequency.

Example: PNU A145 = 20 Hz, A146 = 01, A001 = 0 – 50 Hz.

In the range 20 to 50 Hz the frequency offset (20–Hz) is subtracted from the reference frequency (PNU A001). If the reference frequency is set below 20 Hz, the direction of rotation is automatically reversed and the drive is adjusted to the differential value, for example 10 Hz (FWD) – 20 Hz (PNU A145) = 10 Hz (REV).

Logic functions

With PNU C143 you can establish a logic link between two digital signals (A and B). PNU C141 specifies signal A and PNU C142 signal B.

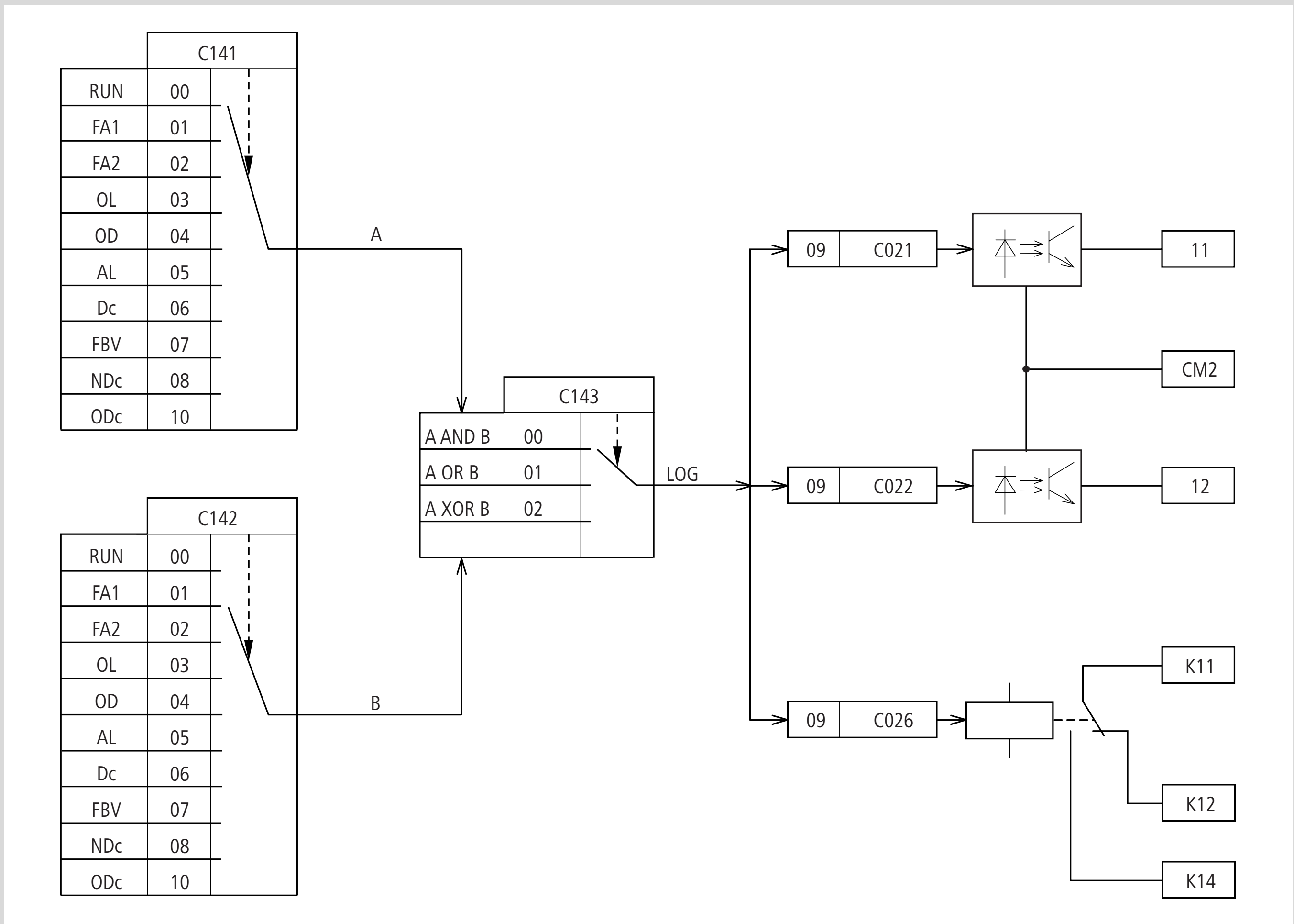


Figure 145: Logic linking of A and B

The table below lists the possible logic links:

Signal		Logic link (LOG)		
A	B	AND	OR	XOR (exclusive or)
0	0	0	0	0
0	1	0	1	1
1	0	0	1	1
1	1	1	1	0

You can assign the result of this logic link (LOG) to a digital output with PNU C021, C022 or C026.

PNU	Name	RUN	b031 = 10	Value	Function	DS
C141	Logic function – select input A	–	–	00	RUN: In operation	00
				01	FA1: Frequency reference value reached	
				02	FA2: Frequency signal – output frequency exceeds value in PNU C042 (during acceleration ramp) or PNU C043 (during deceleration ramp)	
				03	OL: Overload warning – motor current exceeds value in PNU C041.	
				04	OD: PID control – reference/actual value difference exceeds signalling threshold set with PNU C044.	
				05	AL: Fault – fault/alarm signal	
				06	Dc: Warning – Reference value at input O (0 to +10 V) lower than value in PNU b082 or current signal at input OI below 4 mA.	
				07	FBV: PID control – Actual value monitoring (PV) signal on breach of limit values PNU C052/C053.	
				08	NDc: Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.	
				10	ODc: Fault/warning: Communication overload or interrupted (with optional DE51-NET-CAN, DE51-NET-DP).	
C142	Logic function – select input B	–	–	00	RUN: In operation	01
				01	FA1: Frequency reference value reached	
				02	FA2: Frequency signal – output frequency exceeds value in PNU C042 (during acceleration ramp) or PNU C043 (during deceleration ramp)	
				03	OL: Overload warning – motor current exceeds value in PNU C041.	
				04	OD: PID control – reference/actual value difference exceeds signalling threshold set with PNU C044.	
				05	AL: Fault – fault/alarm signal	
				06	Dc: Warning – Reference value at input O (0 to +10 V) lower than value in PNU b082 or current signal at input OI below 4 mA.	
				07	FBV: PID control – Actual value monitoring (PV) signal on breach of limit values PNU C052/C053.	
				08	NDc: Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.	
				10	ODc: Fault/warning: Communication overload or interrupted (with optional DE51-NET-CAN, DE51-NET-DP).	
C143	Logic function – select link [LOG]	–	–	00	[LOG] = A AND B, AND sequence	00
				01	[LOG] = A OR B, OR sequence	
				02	[LOG] = A XOR B, Exclusive OR sequence	

PID control

The DV51 frequency inverters have a PID controller, which you can enable with PNU A071 = 1 or through a digital input (PNU C001 to C006 = 23, PID).

→ PID control is superimposed on the frequency inverter function. You should therefore set all of the frequency inverter's drive-related parameters, such as maximum output frequency (motor speed), acceleration and deceleration ramps (mechanical load, belts). Frequency inverter and motor are process-integrated actuators. The output frequency to the motor (which determines the speed) is specified as manipulated variable from the PID controller.

→ When PID control is enabled, the reference and actual values become process variables and are automatically converted into percentages. The specified reference value (0 – 100 %) corresponds with, for example, a volume flow rate (0 – 50 m^3/h). The process variable is the reading (m^3/h) from a sensor and is again evaluated as a percentage (0   100 %). If this process data is to be output as a physical unit (m^3/h), you can set the conversion with PNU A075 (see display factor A075, page ###).

PNU	Function	RUN	b031 = 10	Value	Function	DS
A001	Reference value source selection	–	–	00	The setting range is limited by PNU b082 (raised starting frequency) and A004 (end frequency). • Potentiometer (optional keypad DEX-KEY-6) • Frequency [Hz] • Process variable [%] with active PID control (PNU A071 = 1)	01
				01	Analog input: Control signal terminals O and OI	
				02	Set value (PNU F001) of optional keypad DEX-KEY-… (arrow keys ⌃/⌄). To save the set value, press the ENTER key (PNU A020).	
				03	Serial interface (Modbus)	
				10	Calculator: Calculated value (CAL) (→ section “Mathematical functions”, page 136).	
A071	PID control	–	✓	Activating PID control		00
				00	Off: Disabled	
				01	On: Enabled	
A072	PID controller – P-component	✓	✓	0.2 – 5.0	Proportional gain (K_P) • Low values attenuate the control action • High values can cause oscillation.	0.1
A073	PID controller – I-component	✓	✓	0.0 – 150 s	Integral time constant	0.1
A074	PID controller – D-component	✓	✓	0.00 – 100 s	Differential time constant	0.01
A075	PID control, display factor	–	✓	0.01 – 99.99	Actual value indication, multiplication factor for displaying process variables.	1.00
A076	PID controller – actual value signal PV input	–	✓	Selection of actual value input		00
				00	Analog input OI (4 – 20 mA)	
				01	Analog input O (0 – 10 V)	
				02	Serial interface (Modbus)	
				10	Calculated value (PNU A143) (→ section “Mathematical functions”, page 136)	
A077	PID control – invert input signals	–	✓	00	Off: Disabled, reference value (+), actual value (–)	00
				01	On: Enabled, reference value (–), actual value (+)	

PNU	Function	RUN	b031 = 10	Value	Function	DS
A078	PID controller – output signal limit	–	✓	0.0 – 100 %	Percentage limitation of PID control output	0.0
d004	PID feedback display	✓	✓	–	Indication only with active PID control (PNU A071 = 01). The display factor is set with PNU A075. 0.00 – 99.99 (0.01 %) 100.0 – 999.9 (0.1 %) 1000 – 9999 (1 %)	–
F001	Reference value – input through optional keypad DEX-KEY-…	✓	✓	–	• Frequency: 0.0 – 400 Hz (0.1 Hz) • Process variable 0.00 to 9999 % with PID control enabled (A071 = 01) with display factor (A075).	0.0

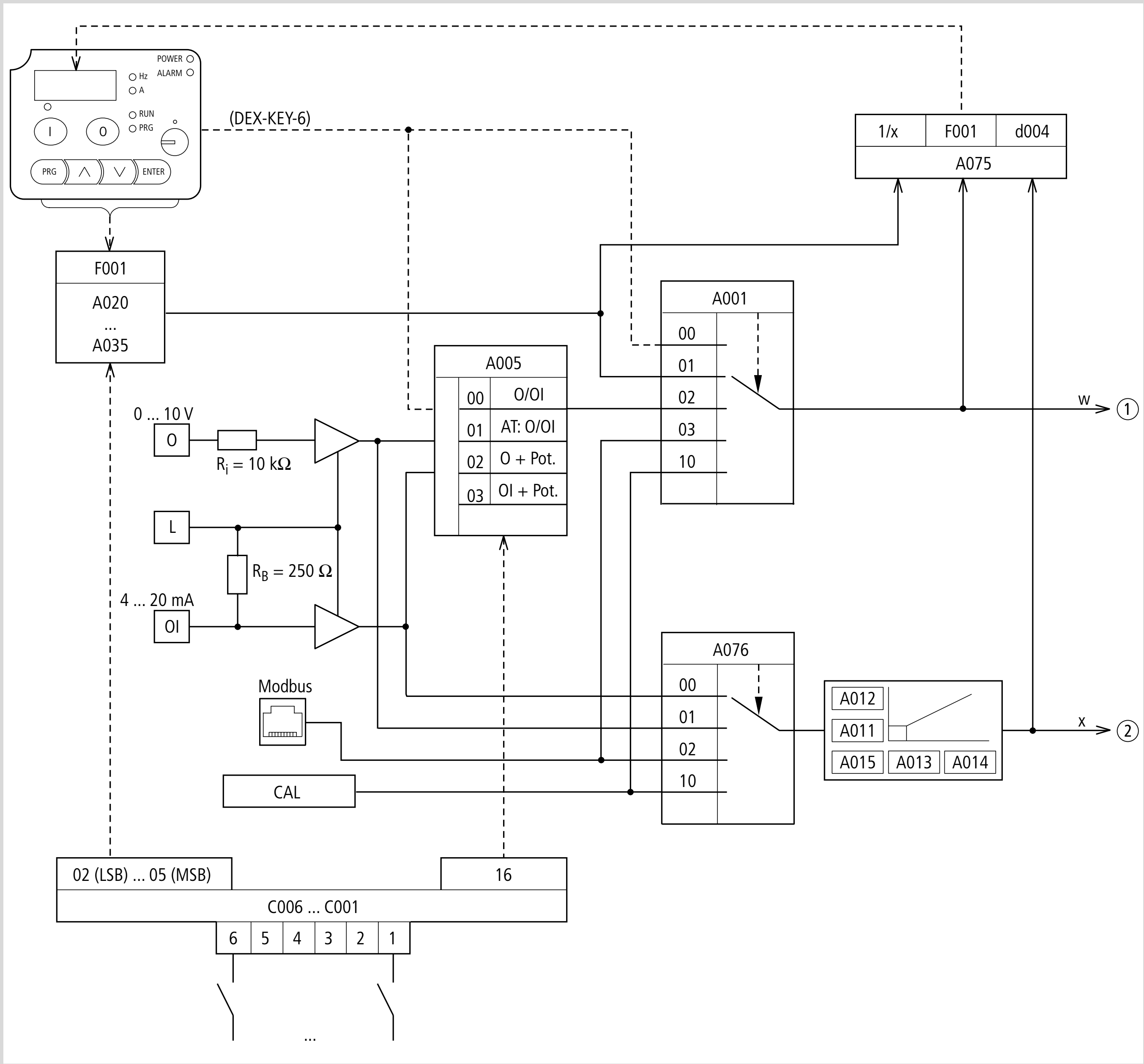


Figure 146: Block diagram, PID control (cont.: → fig. 147)

① w = reference value channel

② x = actual value channel (process variable PV)

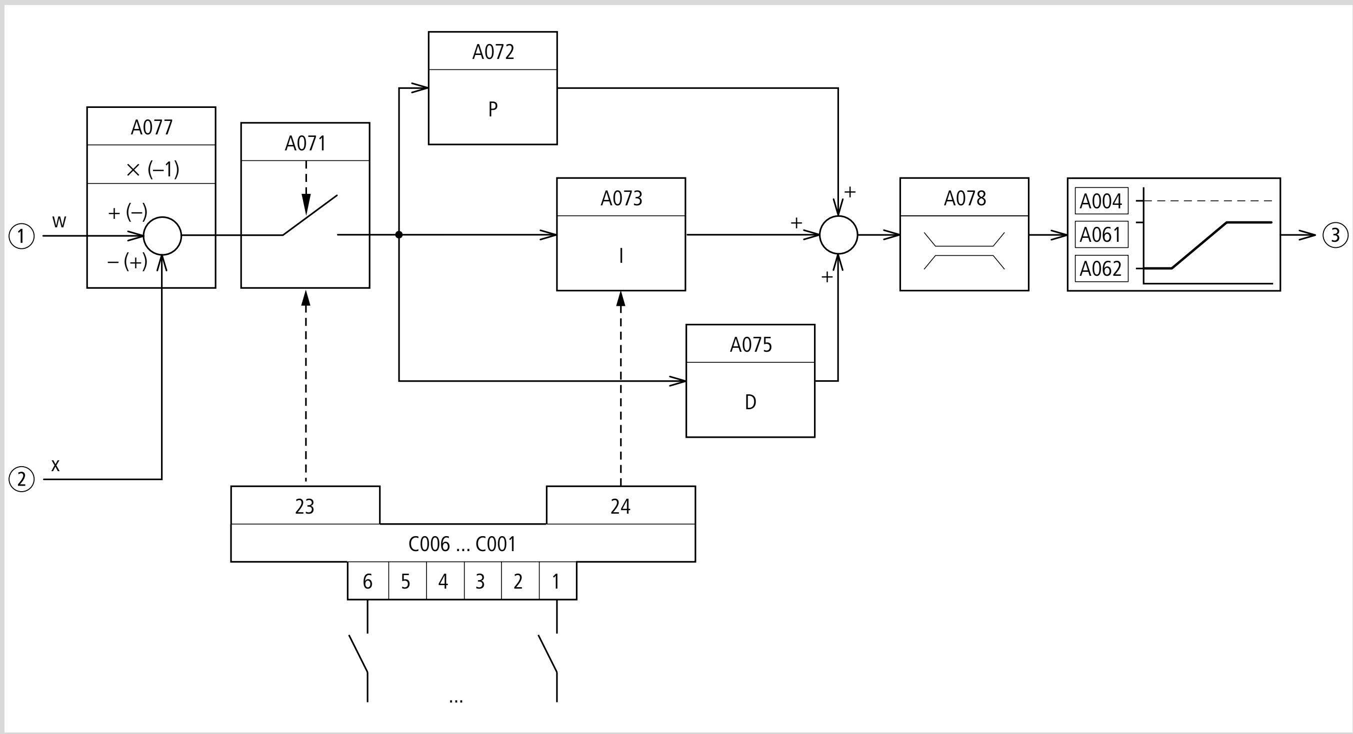


Figure 147: Block diagram, PID control (cont. from fig. 146)

① w = reference value channel
② x = actual value channel (process variable PV)
③ Manipulated variable (output frequency)

Configuring PID control

Actual value

Process variable (PV) feedback requires an analog input:

- Voltage signal: 0 – 10 V ⎓ → input O or
- Current signal: 4   20 mA → input OI.

The selection is made with PNU A076 and also assigns the other, previously unassigned, analog input as reference value input (if PNU A001 = 01).

Reference value

The analog reference value input is automatically assigned through the selection of the analog actual value input. In addition to this automatic assignment, you can select other reference value sources with PNU A001.

PNU A001	Reference value source
00	Potentiometer of optional keypad DEX-KEY-6
02	Input through PNU F001 (DEX-KEY-6) or as fixed value PNU A020 to A035 (binary-encoded selection CF1 to CF4 through digital input 1 to 6).
03	Serial interface (Modbus)
10	Calculator (calculated value of CAL)

The fixed values (PNU A020 to A035) have priority over all other reference value sources.

The reference values are given as a percentage (0 to 100 %) except for PNU F001 and the fixed values PNU A020 to A035, which are given as specified in PNU A075.

Output limitation (PNU A078)

The PID controller has an automatic output limit function. It monitors the percentage deviation of the manipulated variable (output frequency) from the control difference (e = reference value – actual value). You can specify the limit value with PNU A078. This setting can be made only at the lower and upper operating frequency limits (→ section "Minimum and maximum operating frequency", page 103).

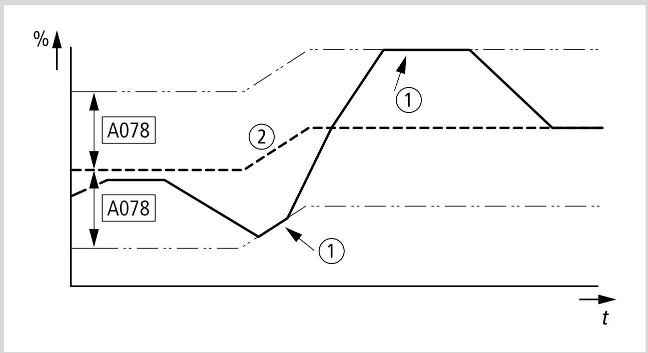


Figure 148: PID control – limitation of minimum output frequency

① Limitation active

② System deviation (reference value – actual value)

A078: Percentage limit value.

- If the system deviation (reference value – actual value) is less than or equal to the value set with PNU A078, the controller works within its normal, linear range.
- If the system deviation is greater than the value set with PNU A078, the controller changes the output frequency so that the limit value is not reached.
- The polarity of the system deviation can be set PNU A077.

Inversion (PNU A077)

In typical control applications, such as heating and ventilation control systems, an increase in power consumption is the result of a rising actual value (system deviation = reference value minus actual value); in cooling systems, increased power consumption results from a falling (negative) actual. With PNU A077 you can set the polarity of the system deviation.

Display factor (PNU A075)

When PID control is enabled (PNU A071 = 01), the reference and actual values become process variables and are automatically converted into percentages. The specified reference value (0 – 100 %) corresponds with, for example, a volume flow rate (0 – 50 m^3/h). The process variable (PV) is the reading (m^3/h) from a sensor and is again evaluated as a percentage (0 100 %).

With PNU A075 you can scale the displayed value so that the process data is displayed in its physical units, in this case m^3/h. The reference value is output at PNU F001 and the actual value at PNU d001.

Activating and deactivating PID control (PID)

With a digital input configured as PID, PID control can be switched on and off through control signal terminals. When you activate the PID input, PID control is disabled. The frequency inverter then works with its standard frequency control again.

→ This function is available only when PID control is active (PNU A071 = 01).

→ Do not switch the PID controller on and off while the frequency inverter is in RUN mode (RUN LED is lit).

▶ Configure one of the digital inputs 1 to 6 as PID by entering the value 23 under the corresponding PNU (C001 to C006).

→ The Activate/Disable PID Control function is optional. If you want PID control to be active all the time, you only need to set PNU A071 to 01.

With the digital input configured as PIDC, the integral component of the PID control can be reset. If the PIDC input is activated, the integral component is reset to zero.

▶ Configure one of the digital inputs 1 to 6 as PIDC by entering the value 24 under the corresponding PNU (C001 to C006).

→ Do not reset the integral component of the PID controller while the frequency inverter is in RUN mode (RUN LED is lit), as this can cause overcurrent tripping and rapid deceleration, resulting in unpredictable operating states.

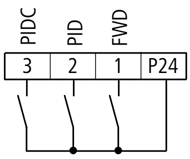


Figure 149: Digital input 1 configured as FWD (start/stop clockwise operation), input 2 as PID (activate/deactivate switch PID control) and input 3 as PIDC (reset integral component)

PID system deviation (OD)

The PID-system deviation (e) is the difference between reference and actual value (process variable PV).

The digital output configured as OD is activated when PID control is active (PNU A071 = 01) and a user-definable system deviation (PNU C044) is exceeded. The OD output remains active as long as this limit value is exceeded.

▶ To configure a parameterizable digital output (11 or 12) or signalling relay K1 as OD, define the limit value under PNU C044 above which the OD signal is activated.
▶ Configure one of the digital outputs (11, 12) as OD by entering the value 04 under PNU C021 or C022, or under PNU C026 for signalling relay K1.

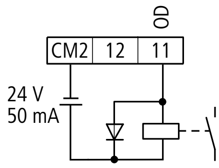


Figure 150: Digital output 11 configured as OD "PID deviation"

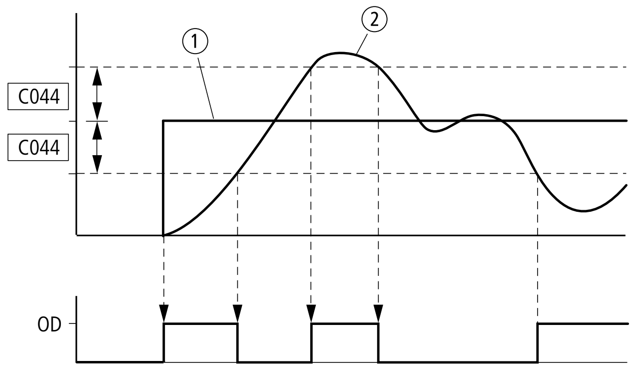


Figure 151: Function chart for OD (PID system deviation)

① Reference value
② Actual value

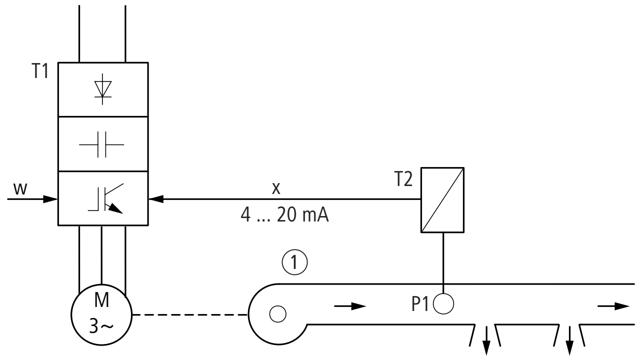
PNU	Name	RUN	b031 = 10	Value	Function	DS
C044	Output function: Signalling threshold, maximum PID control deviation	–	✓	0 – 100 %	If the deviation between the reference and actual value exceeds the value entered here when PID control is active (PNU A071 = 01), the OD signal is activated.	3.0

Application examples

This section contains a few setting examples.

Flow control

In the example shown in the figure below, the reference values are 150 m3/min and 300 m3/min:



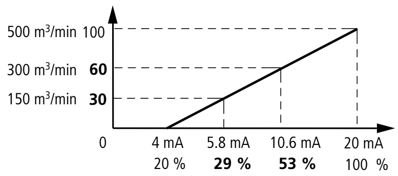


Figure 152: Examples for flow control

w: Reference value, 10-bit digital

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

T2: Measuring transducer

P1: Flow sensor

① Pump

PNU	Meaning in PID control mode	Value	Notes
F001	Reference value	150	Direct input of “150 m3/min”, since the scaling factor has been set
A001	Reference frequency input	02	LCD keypad
A011	Feedback percentage actual value for lower acceptance threshold (units: %)	0	0 %
A012	Feedback percentage actual value for upper acceptance threshold (units: %)	100	100 %
A013	Lower acceptance threshold for voltage or current on the actual value input (in %)	20	20 %
A014	Upper acceptance threshold for voltage or current on the actual value input (in %)	100	100 %
A021	Digitally adjustable reference value 1	300	300 m3/min
A071	PID control active/inactive	01	PID mode active
A072	P component of the PID control	–	Application-dependent
A073	I component of the PID control	–	
A074	D component of the PID control	–	
A075	Reference value factor of the PID control	5.0	100 % at 500 m3/min
A076	Input actual value signal for PID control	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 reference value and falls if the feedback signal is greater than the reference value. With temperature control, the opposite behaviour must be implemented: if the temperature is above the reference value, 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 reference values 20 and 30 °C:

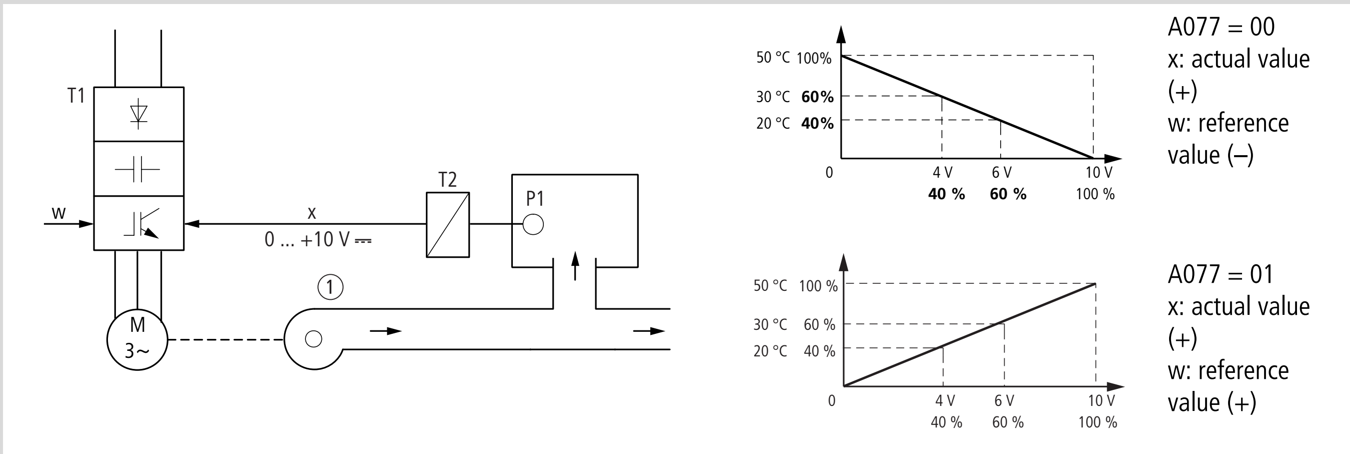


Figure 153: Example of temperature control

w: Reference value, 10-bit digital

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

T2: Measuring transducer

P1: Temperature sensor

① Fan

PNU	Meaning in PID control mode	Value	Notes
F001	Reference value	20	Direct input of "20 °C", as the scaling factor has been set
A001	Reference frequency input	02	LCD keypad
A011	Feedback percentage actual value for lower acceptance threshold (units: %)	100	100 %
A012	Feedback percentage actual value for upper acceptance threshold (units: %)	0	0 %
A013	Lower acceptance threshold for voltage or current on the actual value input (in %)	0	0 %
A014	Upper acceptance threshold for voltage or current on the actual value input (in %)	100	100 %
A021	Digitally adjustable reference value 1	30	30 °C
A071	PID control active/inactive	01	PID mode active
A072	P component of the PID control	–	Application-dependent
A073	I component of the PID control	–	
A074	D component of the PID control	–	
A075	Reference value factor of the PID control	0.5	100 % at 50 °C
A076	Input actual value signal for PID control	01	Feedback from O-L terminal
A077	Inverting input signals	00	With a positive actual value signal, the input signal (w) must be negative.
		01	If the actual value signal is positive, a positive input signal (w) is inverted with this setting.

Feedback value check signal (FBV)

The FBV (Feedback Value Check) signal is issued when the actual (process) value (PV) drops below the lower limit value (PNU C053) in RUN mode. It remains active until:

- the actual value exceeds the upper limit value (PNU C052);
- the frequency inverter changes from RUN mode to STOP mode (deceleration with the set ramp time).

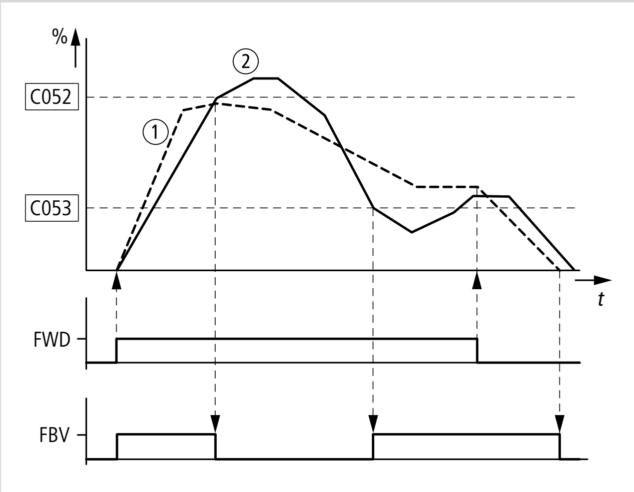


Figure 154: PID control, feedback value check signal (FBV)

① Output frequency (Hz)

① Actual value (process variable – PV)

FWD: Start signal, clockwise rotating field

FBV: Feedback value check signal, limit values PNU C052, C053 exceeded

→ The upper and lower actual value limits (PNU C052, C053) are "process signals": they can not be used for monitoring the feedback value check signal. FBV is not a fault signal.

With PNU C021 or C022 you can set value 07 (FBV) for a digital outputs (11, 12) or, with PNU C026, for signalling relay K1 (K11-K12).

With the feedback value check signal (FBV), the DV51's PID controller can provide a direct "two-stage control", as commonly used for ventilation and air conditioning applications.

Example: ventilation system with two fans (frequency inverter). Under normal operating conditions, the maximum output power of fan 1 (M1) is sufficient to maintain the actual value (PV) at the reference value. When fan 1 is fully utilized and additional airflow is required, a second fan (M2) with constant power is a simple solution.

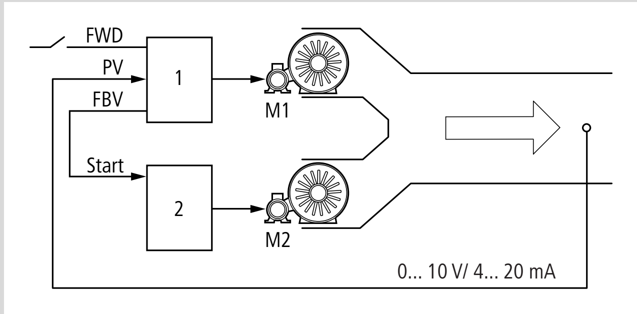


Figure 155: Block diagram, ventilation with "two-stage control"

1: Frequency inverter with PID control for fan motor M1

2: Motor starter (frequency inverter, soft starter, contactor) for fan motor M2

FWD: Start signal, drive 1 (clockwise rotating field)

FBV: Feedback value check signal from drive 1 for actuating drive 2

PV: Process variable (airflow m^3/h) as normalized actual value signal

Start: Start signal, drive 2

The control sequence for the example cited here is illustrated by the graph in fig. 154. The process variable and the limit values are shown as a percentage here. The output frequency (Hz) is also shown.

- Start of fan motor M1 with signal FWD. The actual value (PV) lies below the limit value specified with PNU C053. The FBV output (11, 12, K1) therefore switches to also start fan motor M2.
- The actual value rises and reaches the upper limit (PNU C052). The FBV output is automatically switched off (= fan M2 Off). Fan M1 remains in operation and works in linear control mode. In a correctly set up system, this is the normal operating range.
- If the actual value drops below the limit value (PNU C053), the FBV output is switched and fan M2 is activated again to support fan M1.
- When the FWD signal is removed from frequency inverter 1, the inverter goes from RUN to STOP mode decelerates the drive over the set ramp time.
- When frequency inverter 1 is stopped, the FBV output is automatically de-energized so that fan M2 also stops.

System settings

Stop key

If you are using optional keypad DEX-KEY-…, the keypad's red Stop key is enabled in all control modes. The Stop key has the following functions:

- Decelerating (braking) the drive (PNU F003, → page 80)
- Resetting fault signals (E xx, → page 126)
- Triggering an initialization (loading default settings, → page 154)

You can adapt the Stop key braking function to your drive with the parameter settings:

- Deceleration ramp 1 (PNU F003/F203, → page 80)
- Deceleration ramp 2 (PNU A093/A293, → page 101)
- Automatic deceleration ramp changeover (PNU A096/A296, see → page 102)
- Deceleration ramp characteristic (PNU A098, → page 102)
- DC braking (DEC) or free-run stop (FRS), selection with PNU b091 (→ page 149)

You can also disable the Stop key function with PNU b087.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b087	Stop key, (optional keypad DEX-KEY-…)	–	✓	00	Enabled	00
				01	Disabled: Stop and reset signals are issued only through the control signal terminals or the serial RS 485 interface (Modbus).	

Type of motor stop

Here you can specify in what way the motor speed is reduced when the Stop key of optional keypad DEX-KEY-… is pressed:

PNU	Name	RUN	b031 = 10	Value	Function	DS
b091	Stop key, (optional keypad DEX-KEY-…), selection of motor stop on actuation	–	–	00	DEC, braking to 0 Hz with deceleration ramp	00
				01	FRS, free coasting down to 0 Hz	

Interrupting deceleration ramp

Excessively short deceleration ramps or high-inertia loads can cause unsynchronized operation during deceleration. The motor then works regeneratively and charges up the internal DC link. Excessive voltage results in fault signal E 07.

With PNU b130 you can automatically stop the deceleration ramp when the DC link voltage reaches an excessive value during deceleration. The switching threshold is defined with PNU b131.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b130	Internal DC link, stop deceleration ramp on over-voltage in the internal DC link	–	✓	00	Off: Disabled	00
				01	On: Enabled: When activated, the deceleration ramp is interrupted until the DC link voltage falls below the value set with PNU b131 again.	
b131	Deceleration ramp, switching threshold dependent on internal DC link voltage	✓	✓	330 – 395 V (U_e = 230 V)	The default setting depends on the frequency inverter's rated voltage (U_e).	380/760
				660 – 790 V (U_e = 400 V)		

Fan control

From a rated output current of 1.5 kW, the DV51 frequency inverters are fitted with a fan for assisted air circulation. Mounted on top of the heat sink, the fan is always in operation when supply voltage is applied to the DV51 (POWER LED is lit).

Use PNU b092 to set fan operation.

If you enter the value 01 here, the fan runs on for about five minutes after the frequency inverter power supply is switched on, allowing you to make sure that the fan is working correctly. The fan also continues to run for five minutes after the connected motor has stopped to dissipate residual heat (supply voltage switched on).

Table 36: Frequency inverter DV51 with fan:

…-320-4K0	…-340-2K2
…-320-5K5	…-340-3K0
…-320-7K5	…-340-4K0
…-322-1K5	…-340-5K5
…-322-2K2	…-340-7K5
…-340-1K5	

PNU	Name	RUN	b031 = 10	Value	Function	DS
b092	Device fan, configuration	–	–	00	The built-in fan is always switched on.	00
				01	The built-in fan is switched on during operation (RUN mode); automatic switch-off 5 min after Stop signal..	
				02	Built-in fan operation is temperature-controlled.	

Pulse frequency (PNU b083)

The pulse frequency is the operating frequency of the inverter's transistors. It provides pulse-width modulated conversion of DC link voltage in three-phase, sinusoidal AC voltage for the three-phase motor.

A high pulse frequency results in low noise generation and loss in the motor but higher losses in the inverter and a higher interference level on the mains and motor supply cables (EMC). At pulse frequencies above 12 kHz and an ambient temperature of 40 ºC the DV51 can be operated only at about 80 % rated current I_e.

→ All ratings of frequency inverter DV51 are based on the default pulse frequency of 5 kHz.

You can set the pulse frequency in the range from 2 to 14 kHz. In SLV (sensorless vector, PNU A044 = 02, default) control mode, the pulse frequency must be at least 2.1 kHz.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b083	Pulse frequency	–	–	2 – 14 kHz	Pulse frequency	5.0
b150	Clock frequency, automatic clock frequency reduction on overtempera-ture	–	✓	00	Off: Disabled DV51 continually works with the pulse frequency set with PNU b083	00
				01	On: Enabled On overtemperature the pulse frequency is automatically reduced to the smallest permissible value (2 or 2.1 kHz).	

Reduced response time (RDY)

The response time is the internal transmission time of a control signal from the time it is issued to the application of voltage at the inverter (motor connection). The mean response time of the DV51 is about 38 ms (for example for the start signal from digital input 1 (FWD) to application of motor voltage. It can vary, however, depending on the signal path and program size.

With PNU b151 you can configure the device to reduce the response time. The frequency inverter then changes directly to RUN mode (RUN LED lit).

⚠ **Dangerous voltage!**
With PNU b151 = 01 the output transistors are activated. Output terminals U-V-W carry dangerous mains voltage, even if the enable signal (FWD/REV) was not yet issued.

→ With PNU b151 = 01, RUN mode is selected and access to some parameters is disabled.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b151	Inverter, reduce inverter's response time (RDY) to a control signal	✓	✓	00	OFF	00
				01	ON Transistors active **Caution**: Dangerous voltage (U-V-W)	

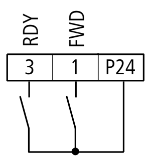


Figure 156: Digital input 1 configured as FWD (start/stop clock-wise rotating field) and digital input 3 as RDY (ready).

⚠ **Dangerous voltage!**
The output transistors are activated and dangerous mains voltage is present at output terminals U-V-W, even if the enable signal (here FWD at terminal 1) was not yet issued.

→ In RUN mode, access to some parameters is blocked.

To activate the RDY function through one of digital inputs 1 to 6, assign the value 52 (RDY) (PNU C001 to C006) to the corre-sponding control signal terminal.

When you activate the digital input configured as RDY, the transis-tors in the inverter are activated, filter time constants are mini-mized and RUN mode is called (RUN LED lit).

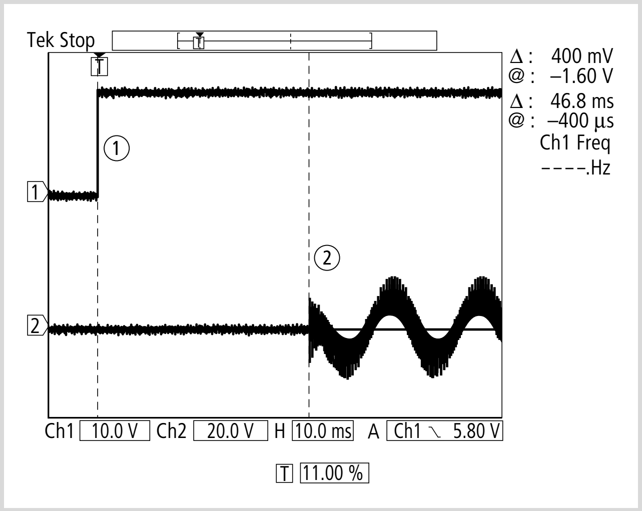


Figure 157: Example: Start signal and output frequency (response time)

① Start signal through optional DE51-NET-CAN
② Output frequency f_2 (phase L1), e.g. after about 48 ms (without RDY).

Parameter access inhibit (SFT)

When you activate the digital input configured as SFT (terminal 1 to 6), the entered Parameter values are write-protected.

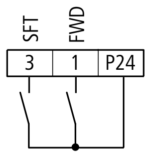


Figure 158: Digital input 3 configured as SFT (software protection)

- ▶ With PNU b031, specify whether software protection will also apply to the reference frequency input (PNU A020, A220, A021 to A035, A038 and F001).
- ▶ Then configure one of the digital inputs 1 to 6 as SFT by setting the corresponding PNU (C001 to C006) to 15.

Parameter inhibit (PNU b031)

Parameter inhibit is active when the SFT input is active. Depending on the value of PNU b031, access to some parameters is permitted even with parameter protection activated.

Some parameters can not be accessed in RUN mode. These are marked "–" in the RUN column. With PNU b031 you can extend parameter access in RUN mode. These additional parameters are marked "✓" in the "b031=10" column.

Run	b031 = 10
–	✓

→ Parameter inhibit restricts parameter access but does not provide password protection.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b031	Parameter access inhibit (access rights)	–	✓	00	Access to all parameters except PNU b031 disabled when digital input SFT is enabled (→ PNU C001: 15)	01
				01	Access to all parameters except PNU b031 and F001 (A020, A220, A021 to A035, A038) disabled when digital input SFT is enabled (→ PNU C001: 15)	
				02	Access to all parameters disabled, except PNU b031	
				03	Access rights to all parameters except PNU b031 and F001 (A020, A220, A021 to A035, A038) disabled	
				10	Extended access rights to parameters in RUN mode.	

Initialization (restoring default settings)

→ To initialize the frequency inverter or restore its default settings, an optional keypad (DEX-KEY-6…) is required.

You can perform the following initialization actions:

- Clearing the fault register.
- Restoring the default parameter settings
- Activating country-specific settings.

→ With the initialization, **all** parameters are reset to heir factory default values.

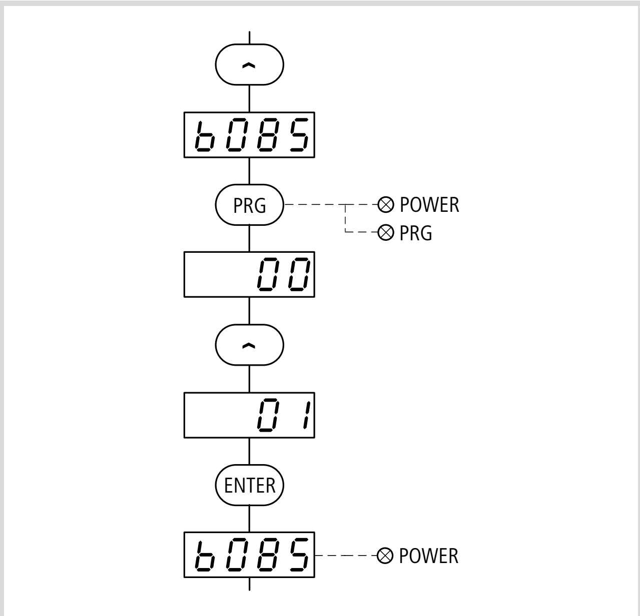


Figure 159: Initializing the country-specific default settings for Europe

To clear the fault register and/or to restore the default settings, proceed as follows:

▶ Make sure that PNU b085 is set to the correct country version.

Caution!
For DV51-322 and DV51-340 only the value 01 (EU) is permissible, and for DV51-320 only the value 02 (USA).

▶ In PNU b085 enter the value 01 {02} and confirm your input with the ENTER key.

→ Carry out this initialization step after setting PNU b084 and before pressing any keys only when needed.

→ The default settings can be recalled only in STOP mode (→ PNU b151 = 00, page 151).

▶ Under PNU b084 enter the corresponding value (00, 01 or 02).
▶ Press the ENTER key to save the value.
▶ On the keypad, press and hold arrow key ∨ and the PRG key at the same time.
▶ While holding the arrow and PRG keys, briefly press the Stop key.

The keypad's display shows EU (if b085 = 01) or USA (if b085 = 02).

▶ Now release all keys again.

In the display's left field the individual segments light up in sequence. At the same time, the Hz, START, RUN and – on the DEX-KEY-6 – the potentiometer LEDs light up. When initialization is completed, all LEDs go out and the display shows d001 (frequency indication).

Initialization is now complete.

You can now press the PRG key to return to the frequency indication (Hz) and ENTER to save this display preference.

PNU	Name	RUN	b031 = 10	Value	Function	DS
b084	Initializing – function	–	–	00:	TRP: Clear fault register	00
				01:	DATA: Load default settings (DS)	
				02:	ALL: Clear fault register and load default settings (DS)	
b085	Initialization, country-specific default settings	–	–	00	Japan	01 {02}1)
				01	Europe	
				02	USA	

1) 02 forDV51-320-…

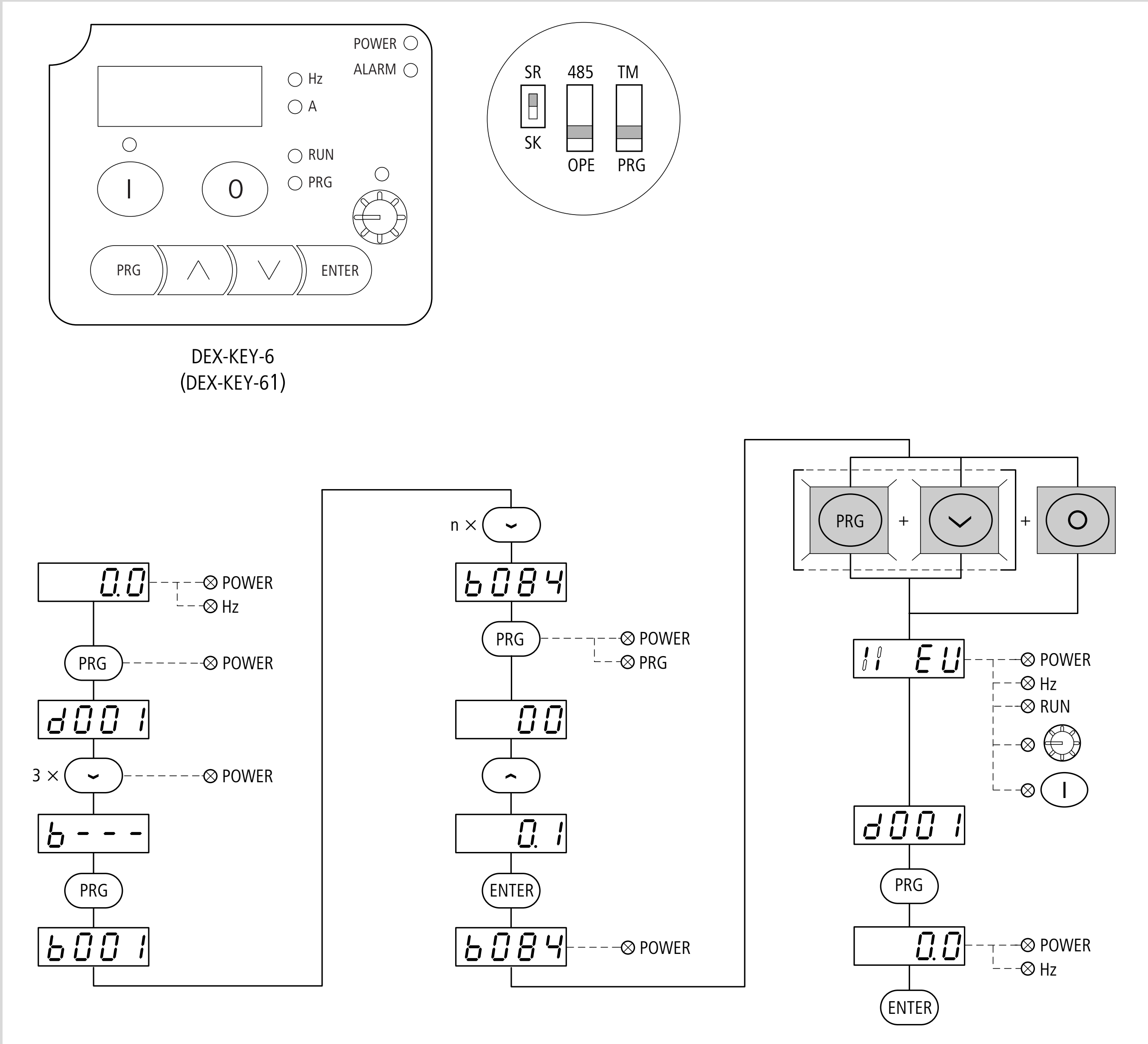


Figure 160: Load default settings (DS)

Debug mode (PNU C091)

Caution!
The parameters and information listed in this section are intended only for specially trained personnel.

Any changes to the parameters listed here can cause unpredictable operating states.

→ To activate PNU C091 you need keypad DEX-KEY-6….

→ During operation, PNU C091 must always contain the value 00.

With PNU C091 = 01 the parameters listed in the table below are displayed.

PNU	Name	RUN	b031 = 10	Display and value range	Manipu-lated vari-able	Remark
C091	Debug mode	✓	✓	00: Disabled (do not show parameter) 01: Enabled (display parameter)		00
C092	Indication, DC link voltage	✓	✓	0000 - FFFF (do not change)	–	1200
C093	Indication, debug mode	✓	✓	0000 - FFFF (do not change)	–	1200
C094	Indication, debug mode (bit)	✓	✓	Address range 0000 – FFFF → 0 – 7 bit selected (do not change)	–	1200
C095	Selected debug mode	✓	✓	00: Internal 01: IO range	–	00
C121	O compensation	–	–	0 - 65535	1.	Default settings
C122	OI compensation	–	–	0 - 65535	1.	Default settings
C123	OI zero compensa-tion	–	–	0 - 65535	1/10	Default settings
C190	Test safety mode	–	–	00: OFF 01: ON	–	–
C193	Test flag	–	–	0 - 65535	–	–
C194	Test flag mode	–	–	00: Standard 01: Test routine mode 02: Function routine mode	–	–
C195	Initialization, country-coding	–	–	00: Japan 01: Europe 02: USA		
C196	Assigned motor rating	–	–	200 V class • Japan, USA: 0.2; 0.4; 0.75; 1.5; 2.2; 3.7; 5.5; 7.5 [HP] • Europe: 0.2; 0.4; 0.55; 0.75; 1.1; 1.5; 2.2; 3.0; 4.0; 5.5; 7.5 [kW] 400 V class • Japan: 0.2; 0.4; 0.75; 1.5; 2.2; 3.7; 5.5; 7.5 [HP] • USA: 0.2; 0.4; 0.75; 1.1; 1.5; 2.2; 3.7; 4.0; 5.5; 7.5 [HP] • Europe: 0.2; 0.4; 0.55; 0.75; 1.1; 1.5; 2.2; 3.0; 4.0; 5.5; 7.5 [kW]	–	Default settings
C197	Voltage class, coding	–	–	• 00: 200 V class • 01: 400 V class		Default settings
d101	Indication, output frequency			0.0 – 400.0	0.1 [Hz]	–
d102	Indication, DC link voltage			0.0 – 999.9 (DC+/DC–)	0.1 [V]	–
d103	Indication, duty time of braking tran-sistor			0.0 – 100.0	0.1 [s]	–
d104	Indication, thermal load on electronics			0.0 – 100.0	0.1 [%]	–
d106	Indication, MCU number			0000 – 9999	1	–
d107	Indication, IO MCU number			0000 – 9999	1	-
d109	Indication, maximum DC link voltage			0.0 – 999.9	0.1 [V]	

7 Serial interface (Modbus)

This section describes the mounting and function of the serial interface.

General information about Modbus

Modbus is a centrally polled bus system in which the master (PLC) controls the entire data flow on the bus. Internode communication between the individual stations (slaves) is not possible.

Every data transfer is initiated by a request from the master. Only one signal at a time can be transferred along the bus line. Slaves cannot initiate a transmission; they can only respond to a request.

Two types of dialog are possible between master and slave:

- The master sends a message to a slave and waits for a response.
- The master sends a message to all slaves and does not wait for a response (broadcast).

Caution!
The master cyclically polls slaves' fault messages. It is therefore advisable to send device-specific and safety-relevant fault messages directly through the control signal terminals (for example fault indication relays DV51).
Example:
A short-circuit in the motor conductor at the output of the DV51 switches on the mechanical brake directly.

The RS 485 port

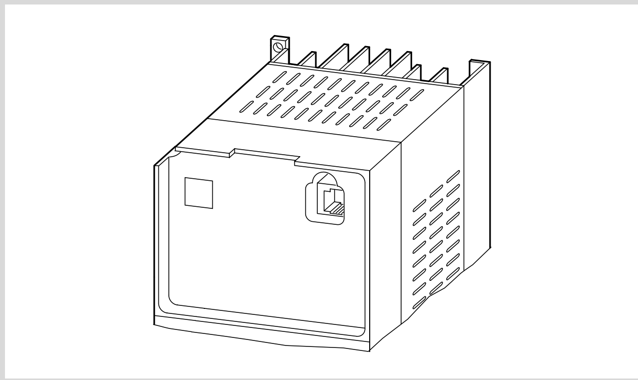


Figure 161: RS 485 interface (RJ 45 socket)

The DV51's built-in RS 485 port supports the Modbus RTU protocol and therefore allows a direct network connection without an additional interface module.

Communications in a Modbus network

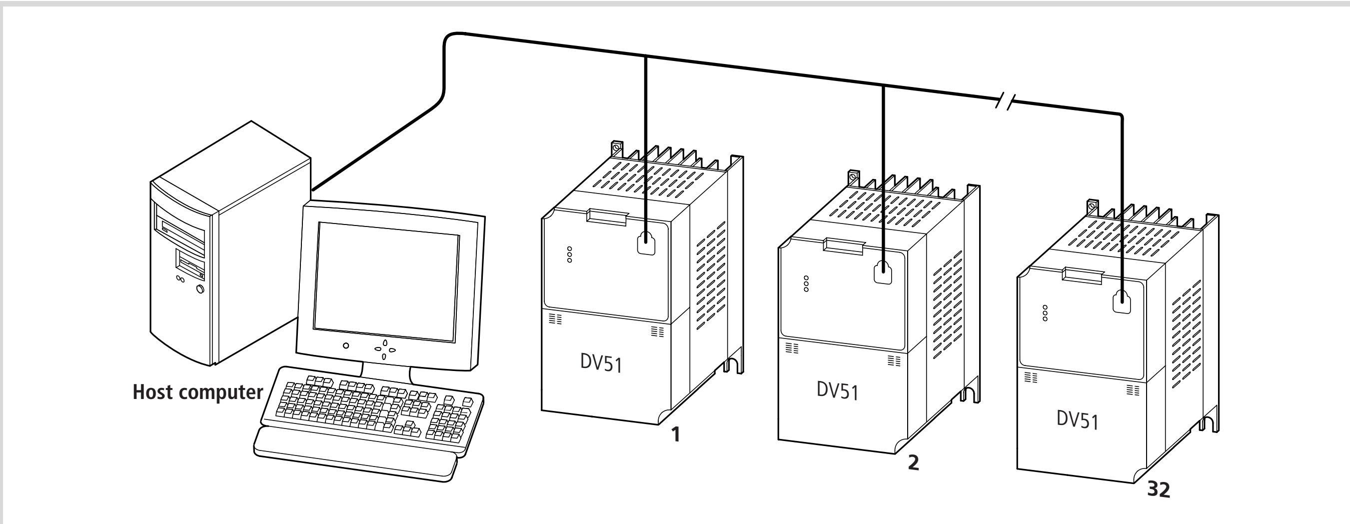


Figure 162: Modbus network with DV51

figure 162 shows a typical arrangement with a host computer (master) and any number of DV51 frequency inverters (up to 31 stations). Each frequency inverter has a unique address in the network. The addresses are defined through PNU C072 and independent of the DV51's physical position within the network.

Table 37: Technical features of the serial interface

Name	Specification	User adjustable
Baud rate (data transfer speed)	4800/9600/19200 Bit/s	Yes
Communication mode	Asynchronous	No
Character code	Binary	No
LSB positioning	LSB first transmission	No
Data bits	8 bit (Modbus RTU mode)	(ASCII mode not possible)
Parity	None/even/uneven	Yes
Stop bits	1 or 2 bits	Yes
Data traffic	starting the control (host, master)	No
Communications fault (waiting time to fault indication)	0 to 1000 ms	Yes
Address	Addressing from 1 to 32	Yes
Interface	RS 485, differential transmission	No
Connection	RJ 45 socket	–
Twisted pair cable	Twisted, double screened cable	–
Fault monitoring	Overflow, test code, CRC-16, horizontal parity	–

Connecting to a Modbus network

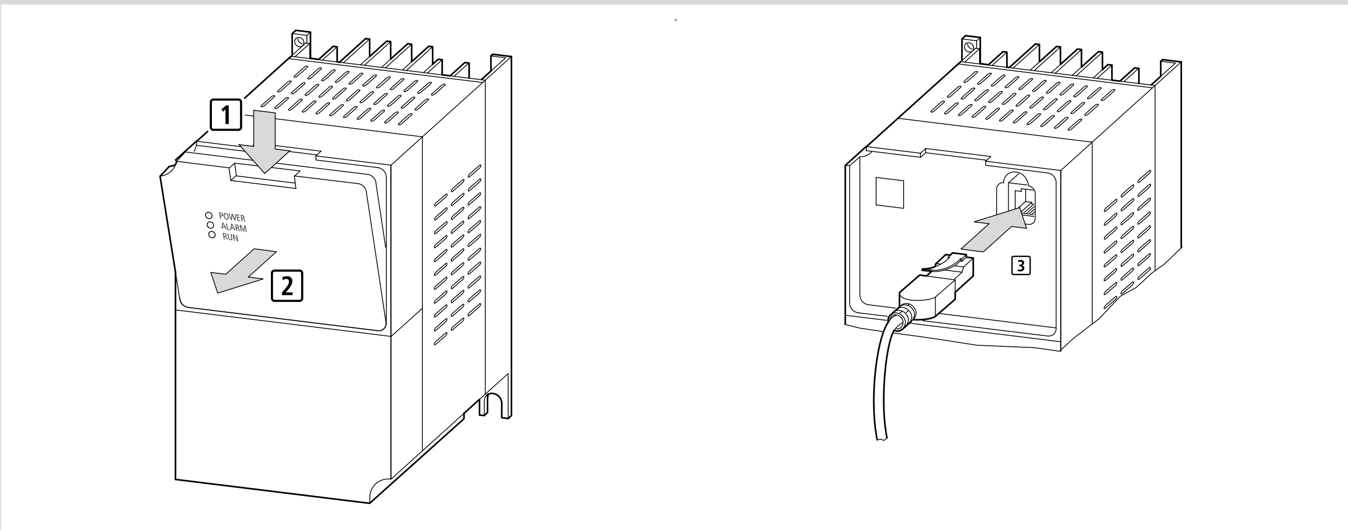


Figure 163: Plugging in the connection cable

The DV51 is connected through its RJ 45 socket. Remove the factory-fitted LED display DEV51-KEY-FP.

- ▶ Press the interlock down 1.
- ▶ Remove the LED display DEV51-KEY-FP 2.
- ▶ Plug the communications cable into the RJ 45 socket, which is now free 3.

→ In place of the direct communications cable, you can use the optional T adapter DEV51-NET-TC (→ section "T adapter DEV51-NET-TC", page 211).

→ No tools are required to fit and remove the optional keypads, LED displays and plug-in adapters.

Caution!
Fit and remove the keypad, LED display or plug-in adapter only under no volt conditions and without using force.

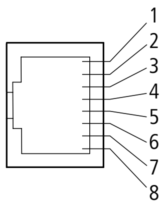
→ Do not connect terminals 1 to 4, 7 and 8. They are used by the DV51 system for internal data transfer.

→ Optional DEV51-NET-TC: RJ 45 T adapter with bus termination resistor, → section “T adapter DEV51-NET-TC”, page 211

→ The network cable must have a bus termination resistor (120 ohm) connected at each physical end to prevent reflections and the resulting transmission faults.

The DV51 frequency inverter has no internal bus termination resistor. When a DV51 is connected at the end of a bus conductor, the bus termination must be connected externally (pin 5 and 6). Keep in mind the network conductor’s impedance.

Table 38: PIN allocation, RJ 45 (RS 485)

	Pin	Name	Description
	1	–	Not connected
	2	–	Not connected
	3	–	Not connected
	4	–	Not connected
	5	SP	Send/receive, positive data channel
	6	SN	Send/receive, negative data channel
	7	–	Not connected
	8	–	Not connected

Parameter settings for Modbus

Prerequisites for correct operation with Modbus-RTU are:

- The PLC (master) is fitted with a serial interface RS 485 and with the required driver software for Modbus-RTU.
- The parameters of the DV51 frequency inverters (slaves) are set for communication via Modbus. For reliable setting of some user-defined parameters, you will need the master’s (i.e. the host PC’s) settings, such as the baud rate.

→ Parameters PNU C071 to C078 can not be altered through the bus. They must be initially set using a keypad (DEX-KEY-…) or a PC.

→ The values in the “Required settings” column (such as baud rate, bus address and parity) must be taken into account for communications through Modbus.

Table 39: Required parameter settings

PNU	Run	b031 = 10	Function	Value range		DS	page	Required settings
A001	–	–	Reference value source selection	00:	Potentiometer (optional keypad DEX-KEY-6)	01		03
				01:	Analog input: Control signal terminals O and OI			
				02:	Functions PNU F001 or A020			
				03:	Serial interface (Modbus)			
				10:	Calculator (calculated value of CAL)			
A002	–	–	Start signal source selection	01:	Digital input (FWD/REV)	01		03
				02:	Start key, (optional keypad DEX-KEY-…)			
				03:	Serial interface (Modbus)			
C071	–	✓	Communication – baud rate	04:	4800 bit/s	06		Dependent on the setting of the PLC (master) setting
				05:	9600 bit/s			
				06:	19200 bit/s			

PNU	Run	b031 = 10	Function	Value range		DS	page	Required settings
C072	–	✓	Communication – address	1 – 32		1		Individual address in network. Each address must be unique.
C074	–	✓	Communication – parity	00:	None	00		Dependent on the PLC (master)
				01:	Even			
				02:	Odd			
C075	–	✓	Communication – stop bits	1:	1 bit	1		Dependent on the PLC (host, master)
				2:	2 bits			
C076	–	✓	Communication: Behaviour of frequency inverter on communication errors	00:	Switch off on fault signal E60	02		Individual
				01:	Decelerate to standstill at deceleration ramp and then switch off with error E60.			
				02:	No fault signal			
				03:	FRS: Free run stop (free coasting, = controller inhibit)			
				04	DEC: Braking to 0 Hz at set deceleration ramp			
C077	–	✓	Communication – set monitoring time (watchdog).	0 – 99.99 s		0.00		Individual
C078	–	✓	Communication – waiting time (latency between request and response)	0 – 1000 ms		0		Individual

Setting the OPE/485 DIP switch

By default, the RS 485 interface DV51 frequency inverters' RS 485 interface is set for operation with a keypad (DEX-KEY-…). In this control mode, you can set parameters PNU C071 to C078 for bus operation using a keypad (DEX-KEY-…) or a PC. To save these changes, press the ENTER key on the keypad or use the Save command of the DrivesSoft software.

▶ To set up the interface for communications through Modbus, switch off the power supply.
▶ Set the microswitch OPE/485 to position 485.

With this setting, Modbus communications begin when the DV51 frequency inverter's power supply is switched on (POWER LED is lit). The changed parameter values apply immediately.

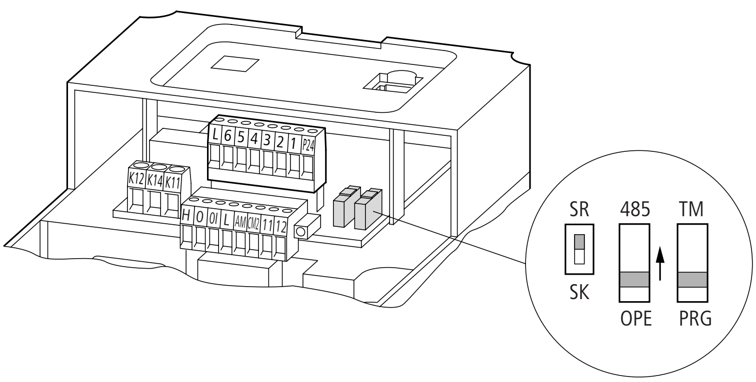


Figure 164: Microswitch OPE/485

The network protocol

Transmission

Transmission takes place in RTU mode. The message contains no header or end characters and conforms to the following syntax:

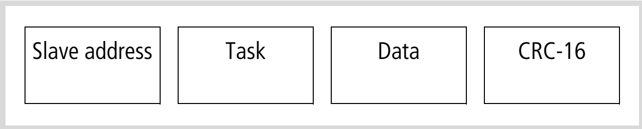


Figure 165: RTU mode

CRC-16: Block parity test character (cyclic redundancy check)

The data is transmitted in binary code. The end of the telegram is recognized by a pause in transmission of at least 3.5 characters (latency).

The data transmission between a PLC and the frequency inverter (DV51) has the following pattern:

- Request – the PLC sends a protocol (Modbus) frame to the frequency inverter.
- Response – after the cyclic waiting time defined by the system (plus the time in PNU C078), the frequency inverter responds with a protocol (Modbus) frame to the PLC.

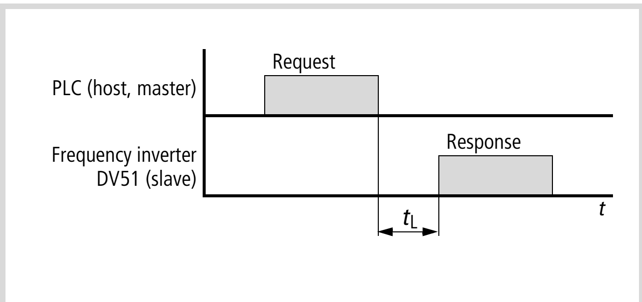


Figure 166: Error checking

t_L: Latency (waiting time plus PNU C078)

→ The frequency inverter (slave) sends a response only if it has previously received a request from the master.

The protocol (Modbus) frame has the following structure:

- Header (non-operative mode)
- Slave address
- Function code
- Data
- Error check
- Trailer (non-operative mode)

Structure of request

Slave address:

- Here the slave address (1 to 32) of the recipient frequency inverter is entered. (Only the frequency inverter with this address can respond to the request).
- Slave address 0 is used for broadcasting (sending a message to all bus stations). In this mode no single station can be addressed and slaves can not respond.

Data format:

The DV51 frequency inverters' data format corresponds to the Modbus data format:

Data name	Description
Coil (bit)	1-bit binary data, which can be allocated and changed
Holding register (word)	16-bit binary data, which can be allocated and changed

Function names and numbers

→ In this manual, the following standard English names and designations for Modbus are used

Table 40: Specified function of the DV51:

Function code dec	Function code hex	Function	Modbus standard name	Maximum data size (vavailable bytes per message)	Maximum number of data elements per message
1	01	Read variable bit (coils)	Read multiple coil status	4	32 coils (in bits)
3	03	Read word variables (register)	Read multiple holding registers	4	4 registers (in bytes)
5	05	Write a bit variable (coil)	Force single coil	1	1 coil (in bits)
6	06	Write a word variable (register)	Force single register	1	1 register (in bytes)
8	08	Connection test	Loop back diagnostic test (00: return query data)	–	–

Function code dec	Function code hex	Function	Modbus standard name	Maximum data size (vavailable bytes per message)	Maximum number of data elements per message
15	0F	Write multiple bit variables (coils)	Force multiple coil	4	32 coils (in bits)
16	10	Write multiple word variables (register)	Force multiple registers	4	4 registers (in bytes)

Data elements: 1 byte = 8 bit

Error check

Modbus RTU uses cyclic block testing, also called CRC (cyclic redundancy checking) to check the data transfer for errors. The CRC code is a 16-bit data word consisting of 8-bit data blocks of any length. The CRC checksum is generated with generated polynomial CRC-16 (X16 + X15 + X2 + 1).

Non-operational mode (header and trailer):

The latency is the time between the request from the master and the response from the frequency inverter (slave), i.e. the time in which the changeover between transmission and reception takes place. At least 3.5 characters (24-bit rest time) of latency are always required. If the time is shorter, is the frequency inverter does not respond. The actual latency is the sum of the rest time (3.5 characters) and PNU C078 (waiting time until fault message).

Structure of response

Required transfer time

- The time between receiving a request from the master and the frequency inverter's response consists of the rest time (3.5 characters) and PNU C078 (the waiting time to the fault message).
- Once the master has received a response from the frequency inverter, it must wait for at least the rest time before it can send a new request.

Normal response

- If the master's request contains the loopback function (08_{hex}), the frequency inverter returns the same content.
- If the request contains a write register function (05_{hex}, 06_{hex}, $0F_{hex}$ or 10_{hex}), the frequency inverter returns the request as its response.
- If the request contains a read register function (01_{hex}, hex or 03_{hex}), the frequency inverter returns the read data with the slave address and function code as its response.

Response in fault condition

If the request contains an error (except for a transmission error), the frequency inverter responds with an exception message and does not perform an action.

The exception message can be evaluated in the user program. It consists of the sum of the enquiry's function code and code 80_{hex}.

Structure of exception message:

- Address (slave)
- Function code
- Error code
- CRC-16

Exception code hex	Description
01	The function is not supported.
02	The specified address does not exist or was not found.
03	The data format is not supported or is wrong.
21	The number of the holding registers is too large or the data is outside the frequency inverter's range.
22	• The function for changing register contents can not be used during frequency inverter operation. • The function sends an ENTER signal during operation • The function writes to the register during operation • The function writes to read-only register or coil

No response

In the following cases, the frequency inverter ignores the request and does not send a reply:

- On receiving a broadcast request
- If the request contains a transmission error
- If the slave address in the request does not match the inverter's address
- If the time interval between the data blocks is less than 3.5 characters
- If the data length is invalid

→ The master must be programmed to repeat the request if it does not receive a response within a specified time.

Explanation of function codes

Read coil status [01_{hex}]:

This function reads the status (On/Off) of the selected coils. For example: reading input signal terminals 1 to 6 of the DV51 with slave address 8. In this example, the inputs have the following states.

Name	Function					
Digital input	[1]	[2]	[3]	[4]	[5]	[6]
Coil status	ON	ON	ON	OFF	ON	OFF

Request

No.	Name	Example hex
1	Slave address (broadcast is disabled)	08
2	Function code	01
3	Coil start number (High byte)	00
4	Coil start number (Low byte)	07
5	Number of coils (High byte) If this value is 0 or greater than 32, a fault message with code 03_{hex} is issued.	00
6	Number of coils (Low byte). If this value is 0 or greater than 32, a fault message with code 03_{hex} is issued.	06
7	CRC-16 (High byte)	0D
8	CRC-16 (Low byte)	50

Response

No.	Name	Example hex
1	Slave address	08
2	Function code	01
3	Data size (in bytes)	01
4	Coil data. Number of selected bit variables (data size)	17
5	CRC-16 (High byte)	12
6	CRC-16 (Low byte)	1 A

The data range of the response contains the states of coils 7 to 14.

The status is given by 17_{hex} (00010111_{bin}). COIL 7 is the least significant bit (LSB)

Term	Data							
Coil number	14	13	12	11	10	9	8	7
Coil status	OFF	OFF	OFF	ON	OFF	ON	ON	ON

If a read coil lies outside the specified range, the remaining bytes to be transmitted have a zero value to indicate the out-of-range value.

If a coil can not be given as a normal value, an exception message (→ section "Exception signal (error code)", page 170) is generated.

Reading the holding registers [03_{hex}]

This function reads the content of a series of consecutive holding registers with specified register addresses.

Example:
Reading three set parameters of a frequency inverter DV51 with slave address 5 and the following content:

DV51 command	d001 (N)	d002 (N-1)	d003 (N-2)
Register number	1002_{hex}	1003_{hex}	1003_{hex}
Messages	Output frequency 50 Hz	Output current 0.13 A	Clockwise rotating field

Request:

No.	Name	Example hex
1	Slave address (broadcast disabled)	05
2	Function code	03
3	Register start number (High byte)	10
4	Register start number (Low byte)	02
5	Number of holding register (High byte)	00
6	Number of holding register (Low byte)	03
7	CRC-16 (High byte)	CRC
8	CRC-16 (Low byte)	CRC

Response:

No.	Name	Example hex
1	Slave address	05
2	Function code	03
3	Data length (in bytes)1)	06
4	Register start number (High byte)	01
5	Register start number (Low byte)	F4
6	Register start number + 1 (High byte)	00
7	Register start number +1 (Low byte)	32
8	Register start number + 2 (High byte)	00
9	Register start number +2 (Low byte)	01
10	CRC-16 (High byte)	CRC
11	CRC-16 (Low byte)	CRC

1) Number of data bytes needed for a response to the request; here 6 bytes to return the content of three holding registers.

The reply record looks as follows:

Response memory	4	5	6	7	8	9
Register number	+ 0 (High byte)	+ 0 (Low byte)	+ 1 (High byte)	+ 1 (Low byte)	+ 2 (High byte)	+ 2 (Low byte)
Register status	01_{hex}	$F4_{hex}$	00_{hex}	32_{hex}	00_{hex}	01_{hex}
Messages	Output frequency 50 Hz		Output current 0.13 A (5 % of 2.6 A)		Direction of rotating field • 01 = clockwise • 02 = anticlockwise	

If the read register status command cannot be run correctly, an exception message is generated (→ page 170).

Writing to coil [05_{hex}]

This function writes data to a single coil. You can change the coil's status as follows:

Data	Coil status	
	Off a On	On a Off
Change data (High byte)	FF_{hex}	00_{hex}
Change data (Low byte)	00_{hex}	00_{hex}

Example:
This example writes the start signal for a frequency inverter with slave address 10 to coil number 1.

Precondition: PNU A002 has the value 03.

Request:

No.	Name	Example hex
1	Slave address (broadcast disabled)	0A
2	Function code	05
3	Coil start number (High byte)	00
4	Coil start number (Low byte)	01
5	Change data (High byte)	FF
6	Change data (Low byte)	00
7	CRC-16 (High byte)	DC
8	CRC-16 (Low byte)	81

Response:

No.	Name	Example hex
1	Slave address	0A
2	Function code	05
3	Coil start number (High byte)	00
4	Coil start number (Low byte)	01
5	Change data (High byte)	FF
6	Change data (Low byte)	00
7	CRC-16 (High byte)	DC
8	CRC-16 (Low byte)	81

Writing to holding register [06_{hex}]

This function writes data to a selected holding register.

Example.

- Reference input (PNU A020). Write 50 Hz as first fixed frequency to the frequency inverter with slave address 5.
- Frequency reference value 50 Hz is transferred in the form of value 500 (01 $F4_{hex}$) as reference input 0 (PNU A020) to holding register 00 $3A_{hex}$. The first value is 0.1 Hz.

If the data written to the selected coil contains errors, an exception message is issued (→ page 170).

Request:

No.	Name	Example hex
1	Slave address (broadcast disabled)	05
2	Function code	06
3	Register start number (High byte)	00
4	Register start number (Low byte)	3 A
5	Change data (High byte)	01
6	Change data (Low byte)	F4
7	CRC-16 (High byte)	A8
8	CRC-16 (Low byte)	54

Response:

No.	Name	Example hex
1	Slave address	0A
2	Function code	05
3	Register start number (High byte)	00
4	Register start number (Low byte)	3 A
5	Change data (High byte)	01
6	Change data (Low byte)	F4
7	CRC-16 (High byte)	A8
8	CRC-16 (Low byte)	54

Loopback [08_{hex}]

This function tests the transfer between master and slave (response loop).

Example:
Sending any test data (request) to the frequency inverter with slave address 1 and return of this data (response) for the loopback test.

Request:

No.	Name	Example hex
1	Slave address (broadcast disabled)	01
2	Function code	08
3	Test control bit (High byte)	00
4	Test control bit (Low byte)	00
5	Data (High byte)	Any
6	Data (Low byte)	Any
7	CRC-16 (High byte)	CRC
8	CRC-16 (Low byte)	CRC

The test control bit (00_{hex}, 00_{hex}) can be used only for echoing; it is not available for other commands.

If the data written to the selected coil contains errors, an exception message is issued (→ page 170).

Response:

No.	Name	Example hex
1	Slave address	0A
2	Function code	05
3	Test control bit (High byte)	00
4	Test control bit (Low byte)	00
5	Data (High byte)	Any
6	Data (Low byte)	Any
7	CRC-16 (High byte)	CRC
8	CRC-16 (Low byte)	CRC

Writing to coils [0F$_{hex}$]

This function writes data to successive coils.

Example:
State change of digital inputs 1 to 6 of a frequency inverter with slave address 5. The inputs have the following state:

Name	Data					
Digital input	1	2	3	4	5	6
Coil number	7	8	9	10	11	12
Status of digital input	ON	ON	ON	OFF	ON	OFF
Change data (binary)	1	1	1	0	1	0

Request:

No.	Name	Example hex
1	Slave address (broadcast disabled)	05
2	Function code	0F
3	Coil start number (High byte)	00
4	Coil start number (Low byte)	07
5	Number of coils (High byte)	00
6	Number of coils (Low byte)	06
7	Byte number[1)]	02
8	Change data (High byte)[1)]	17
9	Change data (Low byte)[1)]	00
10	CRC-16 (High byte)	DA
11	CRC-16 (Low byte)	EF

1) The change data is a group of High bytes and Low bytes whose sum must be an even number. If it is odd, a 1 is added to make it even.

Response:

No.	Name	Example hex
1	Slave address	05
2	Function code	0F
3	Data volume in bytes	00
4	Coil data. Number of selected bit variables (data size)	07
5	Number of coils (High byte)	00
6	Number of coils (Low byte)	06
7	CRC-16 (High byte)	65
8	CRC-16 (Low byte)	8C

Writing to holding register [10_{hex}]

This function writes data in consecutive holding registers.

Example:

- Acceleration time 1 (PNU F002). Write 3000 Hz as value to the frequency inverter with slave address 1.
- A value of 3000 seconds is transferred to holding registers 0024_{hex} and 0025_{hex} in the form of the value 300000 ($493E0_{hex}$). The first value is 0.01 s.

If the data written to the selected holding registers contains errors, an exception message is issued (→ page 170).

Request:

No.	Name	Example hex
1	Slave address (broadcast disabled)	01
2	Function code	10
3	Start address (High byte)	00
4	Start address (Low byte)	24
5	Number of holding registers (High byte)	00
6	Number of holding registers (Low byte)	02
7	Byte number[1)]	04
8	Change data 1 (High byte)	00
9	Change data 1 (Low byte)	04
10	Change data 2 (High byte)	93
11	Change data 2 (Low byte)	E0
12	CRC-16 (High byte)	DC
13	CRC-16 (Low byte)	FD

1) The number of changing data bytes is entered here, not the number of the holding register.

Response:

No.	Name	Example hex
1	Slave address	01
2	Function code	10
3	Start address (High byte)	00
4	Start address (Low byte)	24
5	Number of holding registers (High byte)	00
6	Number of holding registers (Low byte)	02
7	CRC-16 (High byte)	01
8	CRC-16 (Low byte)	C3

Exception signal (error code)

In the Modbus protocol only the master manages the data exchange. It addresses each slave separately and waits for a response (except in broadcasting, in which it does not wait for a reply).

If the slave does not respond within a specified time (the latency), the master declares it not present. If a transmission error occurs, the master repeats the request.

If a slave receives an incomplete message it sends an exception message to the master. The master then decides whether it resends the data or not.

The exception message contains the following fields:

- Address (slave)
- Function code
- Error code
- CRC-16

The function code of the exception message is formed by adding 80_{hex} to the request's function code.

Function code	
Request hex	**Exception response hex**
01	11
03	13
05	15
06	16
0F	1F
10	90

The error code describes the reason for the exception response:

Error code hex	Description
01	The function is not supported.
02	The address was not found.
03	The data format is not permissible or is incorrect.
21	The number of the holding register is too high.
22	The register's content must not be changed while the frequency inverter is in RUN mode: • The function sends an ENTER signal during operation • The function writes to the register during operation • The function writes to read-only register or coils

Saving new register data (ENTER function)

The data transmitted to the frequency inverter with function "Force single register" or "Force multiple registers" (06_{hex}, 10_{hex}) is initially saved only in temporary memory. If the frequency inverter is switched off (POWER = Off), this data is lost. After a restart, the frequency inverter would then load the previously saved data data.

With the ENTER function, the new data is saved permanently.

Sending the ENTER signal

Write the selected data to holding register 0901_{hex} with function "Force single register" (06_{hex}).

→ The ENTER function requires a long time. You can query its status with the "Force data" coil ($001A_{hex}$).

The frequency inverter's memory has a limited service life (about 100000 write cycles). Frequent use of the ENTER function reduces its lifespan.

Modbus register

Coil register (bit variables)

The tables below contain the basic registers for the DF51 and DV51 frequency inverters in Modbus networks. The access rights are indicated with "ro" and "rw":

- ro = read-only value.
- rw = read/write value.

Coil number hex	Name	Access rights	Description
0000	(reserved)	ro	
0001	Start signal	rw	0 = STOP 1 = RUN (disabled when PNU A003 = 03)
0002	Direction of rotation	rw	0 = REV 1 = FWD (disabled when PNU A003 = 03)
0003	External fault (EXT)	rw	1 = Fault signal
0004	Reset fault signal (RST)	rw	1 = Reset
0005	(reserved)	rw	–
0006	(reserved)	rw	–
0007	Digital input 1	rw	0 = OFF 1 = ON1)
0008	Digital input 2	rw	0 = OFF 1 = ON1)
0009	Digital input 3	rw	0 = OFF 1 = ON1)
000 A	Digital input 4	rw	0 = OFF 1 = ON1)
000B	Digital input 5	rw	0 = OFF 1 = ON1)
000C	Digital input 6	rw	0 = OFF 1 = ON1)
000D	(do not use)	ro	
000E	RUN/STOP Status	ro	0 = STOP (connected with PNU d003) 1 = RUN
0000F	FWD/REV status	ro	0 = FWD 1 = REV
0010	Frequency inverter ready	ro	0 = not ready 1 = ready
0011	(reserved)	ro	–
0012	(reserved)	ro	–
0013	(reserved)	ro	–
0014	Alarm signal	ro	0 = no fault signal 1 = fault signal
0015	PID difference signal	ro	0 = OFF 1 = ON
0016	Overload signal	ro	0 = OFF 1 = ON
0017	Frequency reached signal	ro	0 = OFF 1 = ON
0018	Frequency reached signal at constant speed	ro	0 = OFF 1 = ON

Coil number hex	Name	Access rights	Description
0019	RUN mode signal	ro	0 = OFF 1 = ON
001 A	Force data	ro	0 = normal status 1= force
001B	CRC fault	ro	0 = no fault signal[2)] 1 = fault signal
001C	Overflow error	ro	0 = no fault signal[2)] 1 = fault signal
001D	Bus frame fault	ro	0 = no fault signal[2)] 1 = fault signal
001E08	Parity fault	ro	0 = no fault signal[2)] 1 = fault signal
001F	Checksum error signal	ro	0 = no fault signal[2)] 1 = fault signal

1) The default state is On when one of the control signal terminals (digital inputs) or a coil is set to On. The control signal terminals have the highest priority. If the master can not reset the coil, it must be switched off through the control signal terminals to set the coil status to Off.

2) Transmission errors are held until they are reset. Errors can be reset during frequency inverter operation.

Holding register (word variable)

MSB = **m**ost **s**ignificant **b**it
LSB = **l**east **s**ignificant **b**it

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
2	0000	Frequency reference input	rw	Active when PNU A001 = 03 (value range: 0 to 4000)		0.1 [Hz]
3	0000	Status of frequency inverter	ro	00:	Initialization	–
				01:	(Reserved)	
				02:	STOP mode	
				03:	RUN mode	
				04:	FRS, free coasting (free run stop)	
				05:	JOG, jog mode	
				06:	DB, DC braking	
				07:	Ready for operation	
				08:	AL, fault signal	
				09:	Undervoltage	
4	0000	Reserved	ro	–		–
5	0000	Actual value signal PV input	rw	Active when PNU A076 = 02 (value range: 0 to 1000)		0.1 [%]
6	Reserved		–	–		–
…						
10						
11	d080	Indication – total number of occurred faults	ro	–		1 [times]
12	d081	Indication – fault 1 (last fault signal)	ro	Fault signal E…		–
13	d081		ro	Reserved		–
14	d081		ro	Frequency (Hz)		0.1 [Hz]
15	d081		ro	Reserved		–
16	d081		ro	Current (A)		0.1 [%]
17	d081		ro	Internal DC link voltage (VDc)		1 [V]
18	d081		ro	Total operating hours in RUN mode		–
19	d081		ro	Total operating hours in RUN mode		1 [h]
1 A	d081		ro	Total Power On time, power supply connected (h)		–
1B	d081		ro	Total Power On time, power supply connected (h)		1 [h]

Holding register hex	Function code	Name	Access rights	Value range	Manipulated variable
1C	d082	Indication – fault 2	ro	Fault signal E…	–
1D	d082		ro	Reserved	–
1E05	d082		ro	Frequency (Hz)	0.1 [Hz]
1F	d082		ro	Reserved	–
20	d082		ro	Current (A)	0.1 [%]
21	d082		ro	Internal DC link voltage (VDc)	1 [V]
22	d082		ro	Total operating hours in RUN mode	–
23	d082		ro	Total operating hours in RUN mode	1 [h]
24	d082		ro	Total Power On time, power supply connected (h)	–
25	d082		ro	Total Power On time, power supply connected (h)	1 [h]
26	d083	Indication – fault 3	ro	Fault signal E…	–
27	d083		ro	Reserved	–
28	d083		ro	Frequency (Hz)	0.1 [Hz]
29	d083		ro	Reserved	–
2 A	d083		ro	Current (A)	0.1 [%]
2B	d083		ro	Internal DC link voltage (VDc)	1 [V]
2C	d083		ro	Total operating hours in RUN mode	1 [h]
2D	d083		ro	Total operating hours in RUN mode	–
2E05	d083		ro	Total Power On time, power supply connected (h)	1 [h]
2F	d083		ro	Total Power On time, power supply connected (h)	–
30 … 1000	Reserved		–	–	–
1001	d001	Reserved	ro	–	–
1002	d001	Output frequency display	ro	0.0 – 400.0 Hz (0.1 Hz)	0.1 [Hz]
1003	d002	Output current display	ro	0.0 – 999.9 A (0.1 A)	0.1 [%]
1004	d003	Direction of rotation display	ro	F: Clockwise (forward) rotating field O: STOP R: Anticlockwise (reverse) rotating field	–
1005	d004	PID feedback display (MSB)	ro	0.00 – 99.99 (0.01 %) 100.0 – 999.9 (0.1 %) 1000 – 9999 (1 %) 0.0 – 400.0 Hz (0.1 Hz)	0.01
1006	d004	PID feedback display (LSB)	ro		
1007	d005	Indication – status of digital inputs 1 to 6	ro	–	–
1008	d006	Indication – status of digital outputs 11 and 12, and relay K1	ro	–	–
1009	d007	Indication of scaled output frequency (MSB)	ro	0.00 – 9999 (0.01/0.1/1/10 Hz)	0.01
100 A	d007	Indication of scaled output frequency (LSB)	ro		
100B	d012	Reserved	ro	–	–

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
100C	d013	Indication – output voltage	ro	0 – 600 V (1 V)		1 [%]
100D	d014	Reserved	ro	–		–
100E05	d016	Indication – operation time counter (MSB)	ro	0 – 9999 (1 h) 10000 – 99990 (10 h) 100000 – 999000 (1000 h)		1 [h]
100F		Indication – operation time counter (LSB)				
1010	d017	Indication – mains On time	ro	0 – 9999 (1 h) 10000 – 99990 (10 h) 100000 – 999000 (1000 h)		1 [h]
1011						
1012	–	Reserved	rw	–		–
1013	–	Reserved	rw	–		–
1014	F002	Acceleration time 1 (MSB)	rw	0.01 – 99.99 (0.01 s) 100.0 – 999.9 (0.1 s) 1000 – 3000 (1 s)		0.01 [s]
1015	F002	Acceleration time 1 (LSB)				
1016	F003	Deceleration time 1 (MSB)	rw	0.01 – 99.99 (0.01 s) 100.0 – 999.9 (0.1 s) 1000 – 3000 (1 s)		0.01 [s]
1017	F003	Deceleration time 1 (LSB)	rw			
1018	F004	Direction of rotation – function of Start key (optional keypad DEX-KEY-…)	rw	00: Clockwise rotating field (FWD) 01: Anticlockwise rotating field (REV)		–
1019	A001	Reference value source selection	rw	00:	Potentiometer (optional keypad DEX-KEY-6)	–
				01:	Analog input: Control signal terminals O and OI	
				02:	Functions PNU F001 or A020	
				03:	Serial interface (Modbus)	
				10:	Calculator (calculated value of CAL)	
101 A	A002	Start signal source selection	rw	01:	Digital input (FWD/REV)	–
				02:	Start key, (optional keypad DEX-KEY-…)	
				03:	Serial interface (Modbus)	
				04:	Potentiometer (optional keypad DEX-KEY-6)	
101B	A003	Base frequency	rw	30 – 400 Hz, up to value of PNU A004 [Hz]		1 [Hz]
101C	A004	End frequency (f_{max})	rw	30 – 400 Hz		1 [Hz]
101D	A005	Analog input – selection (AT)	rw	00:	analog inputs O and/or OI	–
				01:	analog inputs O and OI (digital input is ignored)	
				02:	analog input O or potentiometer (optional keypad DEX-KEY-6)	
				03:	analog input OI or potentiometer (optional keypad DEX-KEY-6)	
101E05	A006	Reserved	rw	–		–
101F	A011	Reserved	rw	–		–
1020	A011	Analog input (O-L) – frequency at minimum reference value	rw	0 – 400 Hz		0.1 [Hz]
1021	A012	Reserved	rw	–		–

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1022	A012	Analog input (O-L) – frequency at maximum reference value	rw	0 – 400 Hz		0.1 [Hz]
1023	A013	Analog input (O-L) – minimum reference value (offset)	rw	0 – 100 %		1 [%]
1024	A014	Analog input (O-L) – maximum reference value (offset)	rw	0 – 100 %		1 [%]
1025	A015	Analog input (O-L) – selection of starting frequency applied to the motor at minimum reference value	rw	00:	Value of PNU A011	–
				01:	0 Hz	
1026	A016	Analog input – filter time constant	rw	1 – 8		1 [times]
1027	A019	Reserved	rw	–		–
1028	A020	Reserved	rw	–		–
1029	A020	Frequency reference input – reference value through keypad, PNU A001 must equal 02	rw	0 – 400 Hz		0.1 [Hz]
102 A	A021	Reserved	rw	–		–
102B	A021	Frequency reference input – fixed frequency (1)	rw	0 – 400 Hz		0.1 [Hz]
102C	A022	Reserved	rw	–		–
102D	A022	Frequency reference input – fixed frequency (2)	rw	0 – 400 Hz		0.1 [Hz]
102E05	A023	Reserved	rw	–		–
102F	A023	Frequency reference input – fixed frequency (3)	rw	0 – 400 Hz		0.1 [Hz]
1030	A024	Reserved	rw	–		–
1031	A024	Frequency reference input – fixed frequency (4)	rw	0 – 400 Hz		0.1 [Hz]
1032	A025	Reserved	rw	–		–
1033	A025	Frequency reference input – fixed frequency (5)	rw	0 – 400 Hz		0.1 [Hz]
1034	A026	Reserved	rw	–		–
1035	A026	Frequency reference input – fixed frequency (6)	rw	0 – 400 Hz		0.1 [Hz]
1036	A027	Reserved	rw	–		–
1037	A027	Frequency reference input – fixed frequency (7)	rw	0 – 400 Hz		0.1 [Hz]
1038	A028	Reserved	rw	–		–
1039	A028	Frequency reference input – fixed frequency (8)	rw	0 – 400 Hz		0.1 [Hz]
103 A	A029	Reserved	rw	–		–

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
103B	A029	Frequency reference input – fixed frequency (9)	rw	0 – 400 Hz		0.1 [Hz]
103C	A030	Reserved	rw	–		–
103D	A030	Frequency reference input – fixed frequency (10)	rw	0 – 400 Hz		0.1 [Hz]
103E05	A031	Reserved	rw	–		–
103F	A031	Frequency reference input – fixed frequency (11)	rw	0 – 400 Hz		0.1 [Hz]
1040	A032	Reserved	rw	–		–
1041	A032	Frequency reference input – fixed frequency (12)	rw	0 – 400 Hz		0.1 [Hz]
1042	A033	Reserved	rw	–		–
1043	A033	Frequency reference input – fixed frequency (13)	rw	0 – 400 Hz		0.1 [Hz]
1044	A034	Reserved	rw	–		–
1045	A034	Frequency reference input – fixed frequency (14)	rw	0 – 400 Hz		0.1 [Hz]
1046	A035	Reserved	rw	–		–
1047	A035	Frequency reference input – fixed frequency (15)	rw	0 – 400 Hz		0.1 [Hz]
1048	A038	Jog mode – jog mode reference value	rw	0 – 9.99 Hz		0.01 [Hz]
1049	A039	Jog mode – motor stop method	rw	00:	Free coasting	–
				01:	Deceleration ramp	
				02:	DC braking	
104 A	A041	Boost function: **DF51 only**	rw	00:	Manual	00
				01:	Automatic	
104B	A042	Boost, manual voltage boost	rw	0 – 20 %		0.1 [%]
104C	A043	Boost, transition frequency for maximum voltage boost	rw	0 – 50 %		0.1 [%]
104D	A044	*U*/*f* characteristic	rw	00:	Constant torque curve	–
				01:	Reduced torque curve	
				02:	SLV active **DV51 only**	
104E05	A045	*U*/*f* characteristic, output voltage	rw	0 – 255		1 [%]
104F	A046	SLV, gain factor, automatic voltage compensation **DV51 only**	rw	0 – 255		1 [%]
1050	A047	SLV, gain factor, automatic slip compensation **DV51 only**	rw	0 – 255		1 [%]
1051	A051	DC braking	rw	00:	Off: Disabled	–
				01:	On: Enabled	
1052	A052	DC braking – starting frequency	rw	0 – 60 Hz		0.1 [Hz]

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1053	A053	DC braking – waiting time	rw	0 – 5 s		0.1 [s]
1054	A054	DC braking torque	rw	0 – 100 %		1 [%]
1055	A055	DC braking duration	rw	0 – 60 s		0.1 [s]
1056	A056	DC braking – behaviour on activation of the digital input (DB)	rw	00:	Timed braking according to value of PNU A055	–
				01:	Continuous operation	
1057	A057	Reserved	rw	–		–
1058	A058	Reserved	rw	–		–
1059	A059	Reserved	rw	–		–
105 A	A061	Maximum operating frequency	rw	0 – 400 Hz		0.1 [Hz]
105B	A062	Minimum operating frequency	rw	0 – 400 Hz		0.1 [Hz]
105C	A063	Reserved	rw	–		–
105D	A063	Frequency jump (1)	rw	0 – 400 Hz		0.1
105E05	A064	Frequency jump (1) – jump width	rw	0 – 10 Hz		0.1 [Hz]
105F	A065	Reserved	rw	–		–
1060	A065	Frequency jump (2)	rw	0 – 400 Hz		0.1
1061	A066	Frequency jump (2) – jump width	rw	0 – 10 Hz		0.1 [Hz]
1062	A067	Reserved	rw	–		–
1063	A067	Frequency jump (3)	rw	0 – 400 Hz		0.1
1064	A068	Frequency jump (3) – jump width	rw	0 – 10 Hz		0.1 [Hz]
1065	A069	Reserved	rw	–		–
1066	A069	Reserved	rw	–		–
1067	A070	Reserved	rw	–		–
1068	A071	PID control	rw	00:	Off: Disabled	–
				01:	On: Enabled	
1069	A072	PID controller – P-component	rw	0.2 – 5.0		0.1
106 A	A073	PID controller – I-component	rw	0.00 – 100 s		0.1 [s]
106B	A074	PID controller – D-component	rw	0.00 – 100 s		0.1 [s]
106C	A075	PID control, display factor	rw	0.01 – 99.99		0.01
106D	A076	PID controller – actual value signal PV input	rw	00:	Analog input OI (4 – 20 mA)	–
				01:	Analog input O (0 – 10 V)	
				02:	Serial interface (Modbus)	
				10:	Calculated value (PNU A143)	

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
106E05	A077	PID control – invert input signals	rw	00:	Off: Disabled, reference value (+), actual value (–)	–
				01:	On: Enabled, reference value (–), actual value (+)	
106F	A078	PID controller – output signal limit	rw	0 – 100 %		0.1 [%]
1070	A081	Output voltage (AVR function)	rw	00:	On: Enabled	–
				01:	Off: Disabled	
				02:	DOFF: Disabled during deceleration	
1071	A082	Output voltage (AVR motor rated voltage)	rw	DV51-32…-…: 200, 215, 220, 230, 240		–
				DV51-340-…: 380, 400, 415, 440, 460, 480		
				Default setting depends on series		
1072	A085	Reserved	rw	–		–
1073	A086	Reserved	rw	–		–
1074	A092	Acceleration time 2 (MSB)	rw	0.01 – 3000 s		0.01 [s]
1075	A092	Acceleration time 2 (LSB)	rw	0.01 – 3000 s		
1076	A093	Deceleration time 2 (MSB)	rw	0.01 – 3000 s		0.01 [s]
1077	A093	Deceleration time 2 (LSB)	rw	0.01 – 3000 s		
1078	A094	Acceleration time, specify signal for changeover from acceleration time 1 to acceleration time 2	rw	00:	Digital input (2CH)	–
				01:	Frequency (PNU A095 or A096)	
1079	A095	Reserved	rw	–		–
107 A	A095	Acceleration time, frequency for changeover from ramp time 1 to ramp time 2	rw	0.0 – 400 Hz		0.1 [Hz]
107B	A096	Reserved	rw	–		–
107C	A096	Deceleration time, frequency for changeover from ramp time 1 to ramp time 2	rw	0.0 – 400 Hz		0.1 [Hz]
107D	A097	Acceleration time, characteristic	rw	00:	linear	–
				01:	S curve	
107E05	A098	Deceleration time, characteristic	rw	00:	linear	–
				01:	S curve	
107F	A101	Reserved	rw	–		–
1080	A101	Analog input (OI-L), frequency at minimum reference value	rw	0 – 400 Hz		0.1 [Hz]
1081	A102	Reserved	rw	–		–
1082	A102	Analog input (OI-L), frequency at maximum reference value	rw	0 – 400 Hz		0.1 [Hz]
1083	A103	Analog input (OI-L), minimum reference value (offset)	rw	0 – 100 %		1 [%]

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1084	A104	Analog input (OI-L), maximum reference value (offset)	rw	0 – 100 %		1 [%]
1085	A105	Analog input (OI-L), selection of starting frequency applied to the motor at minimum reference value	rw	00:	Value from PNU A101	–
				01:	0 Hz	
1086	A111	Reserved	rw	–		–
1087	A111	Reserved	rw	–		–
1088	A112	Reserved	rw	–		–
1089	A112	Reserved	rw	–		–
108 A	A113	Reserved	rw	–		–
108B	A114	Reserved	rw	–		–
108C	A131	Reserved	rw	–		–
108D	A132	Reserved	rw	–		–
108E05	A141	Calculator – select input A	rw	00:	Value of keypad (option DEX-KEY-…)	–
				01:	Potentiometer of keypad (option DEX-KEY-6)	
				02:	Analog input (O)	
				03:	Analog input (OI)	
				04:	Serial interface (Modbus)	
108F	A142	Calculator – select input B	rw	Values → PNU A141		–
1090	A143	Calculator – operation	rw	00:	Addition (A + B)	–
				01:	Subtraction (A – B)	
				02:	Multiplication (A × B)	
1091	A145	Calculator – offset frequency	rw	0 – 400 Hz		0.1 [Hz]
1092	–	Reserved	rw	–		–
1093	A146	Calculator – offset frequency, prefix	rw	Value from PNU A145		–
				00:	plus	
				01:	minus	
1094	A151	Reserved	rw	–		–
1095	A151	Potentiometer (optional keypad), starting frequency	rw	0 – 400 Hz		0.1 [Hz]
1096	A152	Reserved	rw	–		–
1097	A152	Potentiometer (optional keypad), end frequency	rw	0 – 400 Hz		0.1 [Hz]
1098	A153	Potentiometer (optional keypad), starting point	rw	0 – 100 %		1 [%]
1099	A154	Potentiometer (optional keypad), end point	rw	0 – 100 %		1 [%]
109 A	A155	Potentiometer (optional keypad), starting frequency source	rw	00:	Value from PNU A151	–
				01:	0 Hz	

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
109B … 10A4	–	Reserved	rw	–		–
10A5	b001	POWER, restarting mode after power supply interruption	rw	00:	Fault signal E 09, automatic restart at 0 Hz	–
				01:	Automatic restart at set starting frequency after expiry of time set with PNU b003.	
				02:	After the time set with PNU b003 has elapsed, the frequency inverter synchronizes to the current motor rotation speed and the motor is accelerated to the current reference value in the set ramp times.	
				03:	After the time set under PNU b003 has elapsed, the inverter synchronizes to the current motor rotation speed and the motor brakes to a stop in the set deceleration time. A fault message is then displayed.	
10A6	b002	POWER, permissible power supply downtime	rw	0.3 – 25 s		0.1 [s]
10A7	b003	POWER, waiting time before automatic restart after power supply failure	rw	0.3 – 100 s		0.1 [s]
10A8	b004	POWER, fault signal on intermittent supply voltage failure or undervoltage	rw	00:	Off: Disabled	–
				01:	On: Enabled	
10A9	b005	POWER, number of automatic restarting attempts after intermittent supply voltage failure or undervoltage	rw	00:	16 restarts	–
				01:	No limit	
10AA	b006	Reserved	rw	–		–
10AB	b007	Reserved	rw	–		–
10AC	–	Reserved	rw	–		–
10AD	b012	Thermal overload, tripping current	rw	$0.2 – 1.2 \times I_e$ [A] $0.2 – 1.2 \times I_e$ [A]		0.01 [%]
10AE	b013	Thermal overload, characteristic (torque curve)	rw	00:	Reduced torque 1	–
				01:	Constant torque	
				02:	Reduced torque 2	
10AF	b015	Reserved	rw	–		–
10B0	b016	Reserved	rw	–		–
10B1	b017	Reserved	rw	–		–
10B2	b018	Reserved	rw	–		–
10B3	b019	Reserved	rw	–		–
10B4	b020	Reserved	rw	–		–
10B5	b021	Motor current limitation – function	rw	00:	Off: Disabled	–
				01:	On: Enabled in acceleration phase and at constant speed	
				02:	Enabled only at constant speed	

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
10B6	b022	Tripping current for motor current limitation	rw	0.1 – 1.5 × I_e for DV51 0.2 – 1.5 × I_e for DF51 Default, dependent on frequency inverter's rated current (I_e)		0.01 [A]
10B7	b023	Motor current limitation, deceleration time constant	rw	0.1 – 3000 s		0.1 [s]
10B8	b024	Reserved	rw	–		–
10B9	b025	Reserved	rw	–		–
10BA	b026	Reserved	rw	–		–
10BB	b028	Motor current limitation, limit current selection	rw	00:	Value of PNU b022	–
				01:	Analog input O-L	
10BC	b031	Parameter access inhibit (access rights)	rw	00:	Access to all parameters except PNU b031 disabled when digital input SFT is enabled (→ PNU C001: 15)	–
				01:	Access to all parameters except PNU b031 and F001 (A020, A220, A021 to A035, A038) disabled when digital input SFT is enabled (→ PNU C001: 15)	
				02:	Access to all parameters disabled, except PNU b031	
				03:	Access rights to all parameters except PNU b031 and F001 (A020, A220, A021 to A035, A038) disabled	
				10:	Extended access rights to parameters in RUN mode.	
10BD	b032	Reserved	rw	–		1 [%]
10BE	b034	Reserved	rw	–		–
10BF	b035	Reserved	rw	–		–
10C0	b036	Reserved	rw	–		–
10C1	b037	Reserved	rw	–		–
10C2	b040	Reserved	rw	–		–
10C3	b041	Reserved	rw	–		–
10C4	b042	Reserved	rw	–		–
10C5	b043	Reserved	rw	–		–
10C6	b044	Reserved	rw	–		–
10C7	b045	Reserved	rw	–		–
10C8	b046	Reserved	rw	–		–
10C9	b050	Reserved	rw	–		–
10CA	b051	Reserved	rw	–		–
10CB	b052	Reserved	rw	–		–
10CC	b053	Reserved	rw	–		–
10CD	b053	Reserved	rw	–		–
10CE	b054	Reserved	rw	–		–
10CF	b080	Analog output AM, gain factor	rw	0 – 255		1 [%]

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
10D0	b081	Reserved	rw	–		–
10D1	b082	Increased starting frequency (e.g. at high static friction)	rw	0.5 – 9.9 Hz		0.1 [%]
10D2	b083	Pulse frequency	rw	2 – 14 kHz		0.1 [%]
10D3	b084	Initializing – function	rw	00:	Clear fault register	–
				01:	Load default settings (DS)	
				02:	Clear fault register and load default settings (DS)	
10D4	b085	Initialization, country-specific default settings	rw	00:	Japan	–
				01:	Europe	
				02:	USA	
10D5	b086	Frequency indication scaling factor for value in PNU d007	rw	0.1 – 99.9		0.1
10D6	b087	Stop key, (optional keypad DEX-KEY-…)	rw	00:	Enabled	–
				01:	Disabled	
10D7	b088	Motor restart after removal of the FRS signal	rw	00:	Restart with 0 Hz	–
				01:	Restart with the determined output frequency (current motor speed)	
10D8	b089	Indication, value on mains operation (RS 485) **DF51 only**	r	01:	Output frequency (d001)	–
				02:	Output current (d002)	
				03:	Direction of rotation (d003)	
				04:	Actual value (PV) (d004)	
				05:	State of digital inputs (d005)	
				06:	State of digital outputs (d006)	
				07:	Scaled output frequency (d007)	
10D9	b090	Braking transistor, permissible percentage duty factor within a 100 s interval **DV51 only**	rw	– 0 – 100 %		–
				0 – 100 %		
				0 – 100 %		
10DA	b091	Stop key, (optional keypad DEX-KEY-…), selection of motor stop on actuation	rw	00:	DEC, braking to 0 Hz with deceleration ramp	–
				01:	FRS, free coasting down to 0 Hz	
10DB	b092	Device fan, configuration **DV51 only**	rw	00:	The built-in fan is always switched on.	–
				01:	The built-in fan is switched on during operation (RUN mode); automatic switch-off 5 min after Stop signal.	
				02:	Built-in fan operation is temperature-controlled.	
10DC	b095	Braking transistor, control **DV51 only**	rw	00:	Function disabled	–
				01:	Enabled in RUN mode	
				02:	Always enabled	
10DD	b096	Braking transistor, starting voltage threshold **DV51 only**	rw	330 – 395 V (U_e = 230 V)		1 [V]
				660 – 790 V (U_e = 400 V)		
				Default, dependent on rated voltage of DV51 (U_e)		

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
10DE	b098	Reserved	rw	–		–
10DF	b099	Reserved	rw	–		–
10E0	b100	Reserved	rw	–		–
10E1	b101	Reserved	rw	–		–
10E2	b102	Reserved	rw	–		–
10E3	b103	Reserved	rw	–		–
10E4	b104	Reserved	rw	–		–
10E5	b105	Reserved	rw	–		–
10E6	b106	Reserved	rw	–		–
10E7	b107	Reserved	rw	–		–
10E8	b108	Reserved	rw	–		–
10E9	b109	Reserved	rw	–		–
10EA	b110	Reserved	rw	–		–
10EB	b111	Reserved	rw	–		–
10EC	b112	Reserved	rw	–		–
10ED	b113	Reserved	rw	–		–
10EE	b120	Reserved	rw	–		–
10EF	b121	Reserved	rw	–		–
10F0	b122	Reserved	rw	–		–
10F1	b123	Reserved	rw	–		–
10F2	b124	Reserved	rw	–		–
10F3	b125	Reserved	rw	–		–
10F4	b126	Reserved	rw	–		–
10F5	b130	Internal DC link, stop deceleration ramp on overvoltage in the internal DC link	rw	00:	Off: Disabled	–
				01:	On: Enabled	
10F6	b131	Deceleration ramp, switching threshold dependent on internal DC link voltage	rw	330 – 395 V (U_e = 230 V)		1 [V]
				660 – 790 V (U_e = 400 V)		
				Default, dependent on rated voltage (U_e)		
10F7	b140	Suppress stop on overcurrent **DV51 only**	rw	00:	Off: Disabled	–
				01:	On: Enabled	
10F8	b150	Clock frequency, automatic clock frequency reduction on overtemperature	rw	00:	Off: Disabled	–
				01:	On: Enabled	
10F9	b151	Inverter, reduce inverter's response time (RDY) to a control signal	rw	00:	OFF	–
				01:	ON	
10FA … 1102	–	Reserved	rw	–		–

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1103	C001	Digital input 1 – function	rw	00:	FWD: Clockwise rotating field	–
				01:	REV: Anticlockwise rotating field	
				02:	CF1: Fixed frequency selection, bit 0 (LSB)	
				03:	CF2: Fixed frequency selection, bit 1	
				04:	CF2: Fixed frequency selection, bit 2	
				05:	CF4: Fixed frequency selection, bit 3 (MSB)	
				06:	JOG, jog mode	
				07:	DB, DC braking	
				08:	SET: Select second parameter set	
				09:	2CH: Second time ramp	
				11:	FRS: Free run stop (free coasting, = controller inhibit)	
				12:	EXT: External fault message	
				13:	USP: Unattended start protection	
				15:	SFT: Parameter access inhibit	
				16:	AT: change over to analog input OI	
				18:	RST: Reset fault signal	
				19:	PTC: PTC thermistor input (digital input 5 only)	
				20:	STA: Three-wire control start signal	
				21:	STP: Three-wire control stop signal	
				22:	F/R: Three-wire control, direction of rotation	
				23:	PID: Disable PID control	
				24:	PIDC: Reset integral component of PID control	
				27:	UP: Acceleration (motor potentiometer)	
				28:	DWMN: Deceleration (motor potentiometer)	
				29:	UDC: Motor potentiometer, reset saved value of motor potentiometer to 0 Hz	
				31:	OPE: Operator keypad	
				50:	ADD: Offset – add value from PNU A145 to frequency reference value.	
				51:	F-TM: Digital input, mode: control signal terminals preferred.	
				52:	RDY: Inverter, reduce response time to control signals	
				53:	SP-SET: Second parameter set with special functions	
				255:	-- (no function)	
1104	C002	Digital input 2 – function	rw	Values → PNU C001		–
1105	C003	Digital input 3 – function	rw	Values → PNU C001		–
1106	C004	Digital input 4 – function	rw	Values → PNU C001		–
1107	C005	Digital input 5 – function	rw	Values → PNU C001		–

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1108	C006	Digital input 6 – function **DV51 only**	rw	Values → PNU C001		–
1109	C007	Reserved	rw	–		–
110 A	C008	Reserved	rw	–		–
110B	C011	Digital input 1 – logic	rw	00:	High signal triggers switching	–
				01:	Low signal triggers switching	
110C	C012	Digital input 2 – logic	rw	Values → PNU C011		–
110D	C013	Digital input 3 – logic	rw	Values → PNU C011		–
110E05	C014	Digital input 4 – logic	rw	Values → PNU C011		–
110F	C015	Digital input 5 – logic	rw	Values → PNU C011		–
1110	C016	Digital input 6 – logic **DV51 only**	rw	Values → PNU C011		–
1111	C017	Reserved	rw	–		–
1112	C018	Reserved	rw	–		–
1113	C019	Reserved	rw	–		–
1114	C021	Digital output 11 – signal	rw	00:	RUN: In operation	–
				01:	FA1: Frequency reference value reached	
				02:	FA2: Frequency signal – output frequency exceeds value in PNU C042 (during acceleration ramp) or PNU C043 (during deceleration ramp)	
				03:	OL: Overload warning – motor current exceeds value in PNU C041.	
				04:	OD: PID control – reference/actual value difference exceeds signalling threshold set with PNU C044.	
				05:	AL: Fault – fault/alarm signal	
				06:	Dc: Warning – Reference value at input O (0 to +10 V) lower than value in PNU b082 or current signal at input OI below 4 mA.	
				07:	FBV: PID control – Actual value monitoring (PV) signal on breach of limit values PNU C052/C053.	
				08:	NDc: Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.	
				09:	LOG: Shows result of logic link performed through PNU C143.	
				10:	ODc: Fault/warning: Communication overload or interrupted (with optional DE51-NET-CAN, DE51-NET-DP).	
1115	C022	Digital output 12 – signal	rw	Values → PNU C021		–
1116	C023	Reserved	rw	–		–
1117	C024	Reserved	rw	–		–
1118	C025	Reserved	rw	–		–

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1119	C026	Relay K1 – signal	rw	Values → PNU C021		–
111 A	C027	Reserved	rw	–		–
111B	C028	Analog output AM, measured value indication selection	rw	00:	f-Out: Current output frequency	–
				01:	I-Out: Current output current	
111C	C029	Reserved	rw	–		–
111D	C031	Digital output 11 – logic	rw	00:	Normally open contact (NO)	–
				01:	Normally closed contact (NC)	
111E05	C032	Digital output 12 – logic	rw	Values → PNU C031		–
111F	C033	Reserved	rw	–		–
1120	C034	Reserved	rw	–		–
1121	C035	Reserved	rw	–		–
1122	C036	Relay K1 (K11-K12) – logic	rw	Values → PNU C031		–
1123	C040	Reserved	rw	–		–
1124	C041	Output function – warning threshold for overload signal (OL)	rw	0 – 2 × I_e [A] Default, dependent on frequency inverter’s rated current (I_e)		0.01 [%]
1125	C042	Reserved	rw	–		–
1126	C042	Output function – signalling threshold for frequency signal FA2 during acceleration	rw	0 – 400 Hz		0.1 [Hz]
1127	C043	Reserved	rw	–		–
1128	C043	Output function – signalling threshold for frequency signal FA2 during deceleration	rw	0 – 400 Hz		0.1 [Hz]
1129	C044	Output function: Signalling threshold, maximum PID control deviation	rw	0 – 100 %		0.1 [%]
112 A	C045	Reserved	rw	–		–
112B	C045	Reserved	rw	–		–
112C	C046	Reserved	rw	–		–
112D	C046	Reserved	rw	–		–
112E05	C052	PID controller – switch-off threshold for second stage of PID controller	rw	0 – 100 %		0.1 [%]
112F	C053	PID controller – switch-on threshold for second stage of PID controller	rw	0 – 100 %		0.1 [%]
1130	C055	Reserved	rw	–		–
1131	C056	Reserved	rw	–		–
1132	C057	Reserved	rw	–		–
1133	C058	Reserved	rw	–		–
1134	C061	Reserved	rw	–		–
1135	C062	Reserved	rw	–		–

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1136	C063	Reserved	rw	–		–
1137	C070	Reserved	rw	–		–
1138	C071	Communication – baud rate	ro	04:	4800 bit/s	–
				05:	9600 bit/s	
				06:	19200 bit/s	
1139	C072	Communication – address	ro	1 – 32		–
113 A	C073	Reserved	ro	–		
113B	C074	Communication – parity	ro	00:	None	–
				01:	Even	
				02:	Odd	
113C	C075	Communication – stop bits	ro	1:	1 bit	–
				2:	2 bits	
113D	C076	Communication: Behaviour of frequency inverter on communication errors	rw	00:	Switch off on fault signal E60	–
				01:	Decelerate to standstill at deceleration ramp and then switch off with error E60.	
				02:	No fault signal	
				03:	FRS: Free run stop (free coasting, = controller inhibit)	
				04:	DEC: Braking to 0 Hz at set deceleration ramp	
113E05	C077	Communication – set monitoring time (watchdog).	rw	0 – 99.99 s		0.1 [s]
113F	C078	Communication – waiting time (latency between request and response)	ro	0 – 1000 ms		0.1 [s]
1140	C079	Reserved	ro	–		–
1141	C081	Analog input O – reference value signal compensation	rw	0 – 200 %		0.1 [%]
1142	C082	Analog input OI – reference value signal compensation	rw	0 – 200 %		0.1 [%]
1143	C083	Reserved	rw	–		–
1144	C085	Thermistor compensation (digital input 5)	rw	0 – 200 %		0.1 [%]
1145	C086	Analog output AM – offset compensation	rw	0 – 10 V		0.1 [%]
1146	C087	Reserved	rw	–		–
1147	C088	Reserved	rw	–		–
1148	C091	Debug mode, view additional parameters	ro	00:	Do not show parameter	–
				01:	Show parameter	
1149	C101	Motor potentiometer – reference value for motor potentiometer after power supply interruption	rw	00:	Clear last value and use default for PNU F001	–
				01:	Use saved motor potentiometer value set with UP/DWN function through digital inputs.	

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
114 A	C102	Reset function (RST) – response to a Reset signal	rw	00:	On a rising edge the fault signal is reset and the motor is stopped.	–
				01:	On a falling edge the fault signal is reset and the motor is stopped.	
				02:	On a rising edge the fault message is reset.	
114B	C103	Reserved	rw	–		–
114C	C111	Reserved	rw	–		–
114D	C121	Reserved	rw	–		–
114E05	C122	Reserved	rw	–		–
114F	C123	Reserved	rw	–		–
1150	C141	Logic function – select input A	rw	00:	RUN: In operation	–
				01:	FA1: Frequency reference value reached	
				02:	FA2: Frequency signal – output frequency exceeds value in PNU C042 (during acceleration ramp) or PNU C043 (during deceleration ramp)	
				03:	OL: Overload warning – motor current exceeds value in PNU C041.	
				04:	OD: PID control – reference/actual value difference exceeds signalling threshold set with PNU C044.	
				05:	AL: Fault – fault/alarm signal	
				06:	Dc: Warning – Reference value at input O (0 to +10 V) lower than value in PNU b082 or current signal at input OI below 4 mA.	
				07:	FBV: PID control – Actual value monitoring (PV) signal on breach of limit values PNU C052/C053.	
				08:	NDc: Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.	
				10:	ODc: Fault/warning: Communication overload or interrupted (with optional DE51-NET-CAN, DE51-NET-DP).	
1151	C142	Logic function – select input B	rw	Values → PNU C141		–
1152	C143	Logic function – select link [LOG]	rw	00:	[LOG] = A AND B	–
				01:	[LOG] = A OR B	
				02:	[LOG] = A XOR B	
1153	C144	Digital output 11 – deceleration time (On)	rw	0 – 100 s		0.1 [s]
1154	C145	Digital output 11 – deceleration time (Off)	rw	0 – 100 s		0.1 [s]
1155	C146	Digital output 12 – deceleration time (On)	rw	0 – 100 s		0.1 [s]

Holding register hex	Function code	Name	Access rights	Value range	Manipulated variable
1156	C147	Digital output 12 – deceleration time (Off)	rw	0 – 100 s	0.1 [s]
1157	C148	Relay K1 – deceleration time (On)	rw	0 – 100 s	0.1 [s]
1158	C149	Relay K1 – deceleration time (Off)	rw	0 – 100 s	0.1 [s]
1159 … 1162	–	Reserved	rw	–	–
1163	H001	Reserved	rw	–	–
1164	H002	Reserved	rw	–	–
1165	H003	Motor – assigned rating [kW]/{HP} at rated voltage (U_e)	rw	0.2; 0.4; 0.55; 0.75; 1.1; 1.5; 2.2; 3.0; 4.0; 5.5; 7.5; 11.0 {0.2; 0.4; 0.75; 1.5; 2.2; 3.7; 5.5; 7.5; 11.0} Default depends on rated voltage and type rating.	–
1166	H004	Motor – number of poles	rw	2, 4, 6, 8	–
1167	H005	Reserved	rw	–	–
1168	H006	Motor – stabilization constant	rw	0 – 255	1 [%]
1169	H007	Motor – voltage class **DV51 only**	rw	200 V (230 V) 400 V Default, dependent on rated voltage and type rating.	–
116 A	H020	Reserved	rw	–	–
116B	–	Reserved	rw	–	–
116C	H021	Reserved	rw	–	–
116D	–	Reserved	rw	–	–
116E05	H022	Reserved	rw	–	–
116F	–	Reserved	rw	–	–
1170	H023	Reserved	rw	–	–
1171	–	Reserved	rw	–	–
1172	H024	Reserved	rw	–	–
1173	–	Reserved	rw	–	–
1174	H030	Reserved	rw	–	–
1175	–	Reserved	rw	–	–
1176	H031	Reserved	rw	–	–
1177	–	Reserved	rw	–	–
1178	H032	Reserved	rw	–	–
1179	–	Reserved	rw	–	–
117 A	H033	Reserved	rw	–	–
117B	–	Reserved	rw	–	–
117C	H034	Reserved	rw	–	–
117D	–	Reserved	rw	–	–
117E05	H050	Reserved	rw	–	–
117F	H051	Reserved	rw	–	–

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1180	H052	Reserved	rw	–		–
1181	H060	Reserved	rw	–		–
1182	H070	Reserved	rw	–		–
1183	H071	Reserved	rw	–		–
1184	H072	Reserved	rw	–		–
1185	H080	Reserved	rw	–		–
1186	H081	Reserved	rw	–		–
1187 … 1500	Reserved		–	–		–
1501	F202	Acceleration time 1 (second parameter set) (MSB)	rw	0.01 – 99.99 (0.01 s) 100.0 – 999.9 (0.1 s) 1000 – 3000 (1 s)		0.01 [s]
1502	F202	Acceleration time 1 (second parameter set) (LSB)				
1503	F203	Deceleration time 1 (second parameter set) (MSB)	rw	0.01 – 99.99 (0.01 s) 100.0 – 999.9 (0.1 s) 1000 – 3000 (1 s)		0.01 [s]
1504	F203	Deceleration time 1 (second parameter set) (LSB)	rw			
1505 … 1509	–	Reserved	rw	–		–
150 A	A201	Frequency reference value source selection (second parameter set)	rw	00:	Potentiometer (optional keypad DEX-KEY-6)	–
				01:	Analog input: Control signal terminals O and OI	
				02:	Functions PNU F001 or A020	
				03:	Serial interface (Modbus)	
				10:	Calculator (calculated value of CAL)	
150B	A202	Start signal source selection (second parameter set)	rw	01:	Digital input (FWD/REV)	–
				02:	Start key, (optional keypad DEX-KEY-…)	
				03:	Serial interface (Modbus)	
				04:	Potentiometer (optional keypad DEX-KEY-6)	
150C	A203	Base frequency (second parameter set)	rw	30 – 400 Hz, up to value of PNU A004 [Hz]		1 [Hz]
150D	A204	End frequency (f_{max}) (second parameter set)	rw	30 – 400 Hz		1 [Hz]
150E05	A220	Reserved	rw	–		
150F	A220	Frequency reference input – reference value through keypad, PNU A001 must equal 02 (second parameter set)	rw	0 – 400 Hz		0.1 [Hz]
1510	A241	Boost function (second parameter set) **DF51 only**	rw	00:	Manual	00
				01:	Automatic	

Holding register hex	Function code	Name	Access rights	Value range		Manipulated variable
1511	A242	Boost, manual voltage boost (second parameter set)	rw	0 – 20 %		0.1 [%]
1512	A243	Boost, transition frequency for maximum voltage boost (second parameter set)	rw	0 – 50 %		0.1 [%]
1513	A244	*U*/*f* characteristic (second parameter set)	rw	00:	Constant torque curve	–
				01:	Reduced torque curve	
				02:	SLV active **DV51 only**	
1514	A245	*U*/*f* characteristic, output voltage (second parameter set)	rw	0 – 255		1 [%]
1515	A246	SLV, gain factor, automatic voltage compensation (second parameter set) **DV51 only**	rw	0 – 255		–
1516	A247	SLV, gain factor, automatic slip compensation (second parameter set) **DV51 only**	rw	0 – 255		–
1517	A261	Maximum operating frequency (second parameter set)	rw	0 – 400 Hz		0.1 [Hz]
1518	A262	Minimum operating frequency (second parameter set)	rw	0 – 400 Hz		0.1 [Hz]
1518	A292	Acceleration time 2 (second parameter set) (MSB)	rw	0.01 – 3000 s		0.01 [s]
1519	A292	Acceleration time 2 (second parameter set) (LSB)	rw	0.01 – 3000 s		
151 A	A293	Deceleration time 2 (second parameter set) (MSB)	rw	0.01 – 3000 s		0.01 [s]
151B	A293	Deceleration time 2 (second parameter set) (LSB)	rw	0.01 – 3000 s		
151C	A294	Acceleration time, specify signal for changeover from acceleration time 1 to acceleration time 2 (second parameter set)	rw	00:	Digital input (2CH)	0.1 [Hz]
				01:	Frequency (PNU A095 or A096)	
151D	A295	Reserved	rw	–		–
151E05	A295	Acceleration time, frequency for changeover from ramp time 1 to ramp time 2 (second parameter set)	rw	0.0 – 400 Hz		0.1 [Hz]
151F	A296	Reserved	rw	–		–
1520	A296	Deceleration time, frequency for changeover from ramp time 1 to ramp time 2 (second parameter set)	rw	0.0 – 400 Hz		

Holding register hex	Function code	Name	Access rights	Value range	Manipulated variable
1521 … 1525	–	Reserved	rw	–	–
1526	b212	Thermal overload, tripping current (second parameter set)	rw	0.2 – 1.2 × I_e [A] 0.2 – 1.2 × I_e [A]	0.01 [%]
1527	b213	Thermal overload, characteristic (torque curve) (second parameter set)	rw	00: Reduced torque 1 01: Constant torque 02: Reduced torque 2	–
1528	b221	Motor current limitation, function (second parameter set)	rw	00: Off: Disabled 01: On: Enabled in acceleration phase and at constant speed 02: Enabled only at constant speed	–
1529	b222	Motor current limitation, tripping current (second parameter set)	rw	0.1 – 1.5 × I_e [A] Default, dependent on frequency inverter's rated current (I_e)	0.01 [%]
152 A	b223	Motor current limitation, deceleration time constant (second parameter set)	rw	0.1 – 3000 s	0.1
152B	b228	Motor current limitation, limit current selection (second parameter set)	rw	00: Value of PNU b022 01: Analog input O-L	–
152C … 1530	–	Reserved	rw	–	–
1531	C201	Digital input 1 – function (second parameter set)	rw	Values → PNU C001 (1103_{hex})	–
1532	C202	Digital input 2 – function (second parameter set)	rw	Values → PNU C001 (1103_{hex})	–
1533	C203	Digital input 3 – function (second parameter set)	rw	Values → PNU C001 (1103_{hex})	–
1534	C204	Digital input 4 – function (second parameter set)	rw	Values → PNU C001 (1103_{hex})	–
1535	C205	Digital input 5 – function (second parameter set)	rw	Values → PNU C001 (1103_{hex})	–
1536	C206	Digital input 6 – function (second parameter set) **DV51 only**	rw	Values → PNU C001 (1103_{hex})	–
1537	C207	Reserved	rw	–	–
1538	C208	Reserved	rw	–	–
1539	C241	Output function – warning threshold for overload warning (OL) (second parameter set)	rw	0 – 2 × I_e [A] Default, dependent on frequency inverter's rated current (I_e)	0.01 [%]

Holding register hex	Function code	Name	Access rights	Value range	Manipulated variable
153 A … 153E05	–	Reserved	rw	–	–
153F	H202	Reserved	rw	–	–
1540	H203	Motor – assigned rating [kW]/{HP} at rated voltage (U_e) (second parameter set)	rw	0.2; 0.4; 0.55; 0.75; 1.1; 1.5; 2.2; 3.0; 4.0; 5.5; 7.5; 11.0 {0.2; 0.4; 0.75; 1.5; 2.2; 3.7; 5.5; 7.5; 11.0} Default depends on rated voltage and type rating.	–
1541	H204	Motor – number of poles (second parameter set)	rw	2, 4, 6, 8	–
1542	H205	Reserved	rw	–	–
1543	H206	Motor – stabilization constant (second parameter set)	rw	0 – 255	1 [%]
1544	H207	Motor – voltage class (second parameter set) **DV51 only**	rw	200 V (230 V) 400 V Default, dependent on rated voltage and type rating.	–

① Note: When a fault message is issued, the associated operational data is saved and can be read with the ENTER function.

8 Troubleshooting

Fault	Condition	Possible cause	Remedy
The motor does 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.
		Is the LED display on the keypad displaying a fault message (E … …)?	Analyze the cause of the fault message (→ section "Fault messages", page 126). Acknowledge the fault message with the reset command (for example by pressing the Stop key).
		Has a start signal been issued?	Issue the start signal with the Start key (optional keypad) or through the FWD/REV input.
		Has a reference frequency been entered under PNU F001 (for control through operator panel only)?	Enter a reference frequency under PNU F001.
		Are the reference inputs definitions through the potentiometer correctly wired to terminals H, O and L?	Check that the potentiometer is connected correctly.
		Are inputs O and OI connected correctly for external reference input?	Check that the reference 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 reference frequency (PNU A001) been set? Has the correct source for the start signal (PNU A002) been set?	Correct PNU A001 accordingly. Correct PNU A002 accordingly.
	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 operation).
		Are the control signal terminals correctly wired?	Control signal terminal FW(D) for clockwise operation and REV for anticlockwise operation.
		Has PNU F004 been correctly configured?	Set the desired direction of rotation under PNU F004.
The motor will not start.	–	No reference value is applied to terminal O or OI.	Check the potentiometer or the external reference value generator and replace if necessary.
		Is a fixed frequency accessed?	Observe the sequence of priority: the fixed frequencies always have priority over 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.
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 A063 to A068) or change the pulse frequency (PNU b083).

Fault	Condition	Possible cause	Remedy
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.	Re-enter 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 reference values cannot be set.	Are PNU A001 and A002 set correctly?	Check the settings under PNU A001 and A002.
	No parameters can be set or changed.	Has software parameter protection been activated?	To allow parameter changes, disable parameter protection with PNU b031.
		Has the hardware parameter protection been activated?	Disable the digital input configured as SFT.
The electronic motor protection activates (fault message E05).	–	Is the manual voltage boost set too high? Were the correct settings made for the electronic motor protection?	Check the boost setting and the electronic motor protection setting.
RUN LED lit without Enable signal	–	No fault PNU b151 = 01: Function RDY enabled (→ page 151)	Set PNU b151 = 00.

To be observed when saving changed parameters:

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

9 Maintenance and inspection

General

Electrocution hazard
The work described below must be performed only by electricians and other suitably trained personnel.

Open the device only when it is safely isolated from its supply and at zero volts!

After disconnecting the power supply, wait for at least 5 minutes before carrying out any maintenance, installation or repair work to allow the capacitors to discharge to harmless values.

Frequency inverters are electronic devices. Maintenance work is therefore not usually required. Local conditions and company procedures may require regular inspection.

In general we recommend the following regular checks:

Item	Inspect for...	Interval	Method	Values, remedies	Own measures
Environment	Extreme temperatures and humidity	Monthly	Thermometer, hygrometer	Ambient temperature between –10 to +40 °C, non-condensing	
Mounting location	Noise and vibration	Monthly	Visual and acoustic check	Compatibility with the environment for electrical controllers.	
Mains power supply	Voltage fluctuations	Monthly	Measure voltage between terminals L1 and N or between L1, L2 and L3	DV51-320, DV51-322: 200 to 240 V 50/60 Hz DV51-340: 380 to 460 V 50/60 Hz	
Insulation	Sufficient resistance	Annually	Measure resistance between PE and terminals	At least 5 MΩ	
Installation	Firmness of screws	Annually	Torque spanner	M3: 0.5 to 0.6 Nm M4: 0.98 to 1.3 Nm M5: 1.5 to 2 Nm	
Power section terminals	Secure connections	Annually	Visual inspection	No abnormalities	
Components (general)	Overheating	Annually	Overtemperature signal	Ambient temperature, mounting position, fan: no tripping	
Capacitors	Leakage, deformation	Monthly	Visual inspection	No abnormalities	
Resistors	Cracks, discolouration	Annually	Visual inspection	Resistance measurement	
Fan	Vibration, unusual noise, dust	Monthly	Visual inspection, function test	Remove dust, rotate by hand	
Enclosure	Dirt, dust, mechanical damage	Annually	Visual inspection	Remove dirt and dust, replace if damaged	
General	Odour, discolouration, corrosion	Annually	Visual inspection	Normal appearance, inspection of general ambient conditions for electronic devices	
Displays, LEDs	Legibility	Monthly	Visual inspection	Correct function of all LED segments	

Device fans

To ensure their proper operation, regularly remove any dust from your frequency inverters. Accumulated dust on fans and heat sink can cause the frequency inverter to overheat.

Removing the fan:

→ Complete the following steps with the specified tools and without using force.

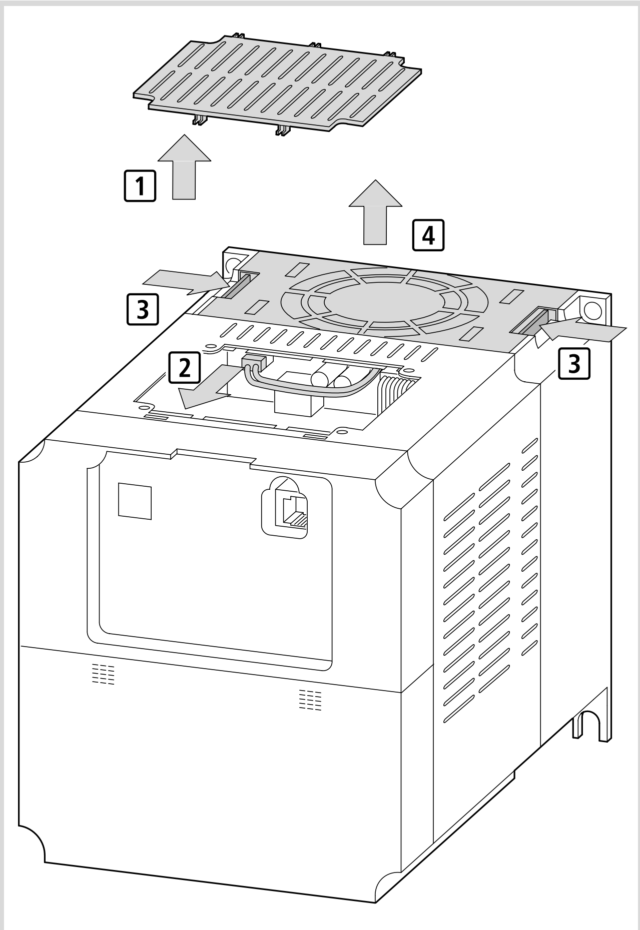


Figure 167: Removal sequence for device fan

- Insert a flat screwdriver in the middle recess and use to lever off the cover 1.
- Pull out the fan's connector 2.
- With your hand, press in the retainer on either side 3 and pull out the fan support 4. Guide the connecting cable and the plug 2 through the cut-out.

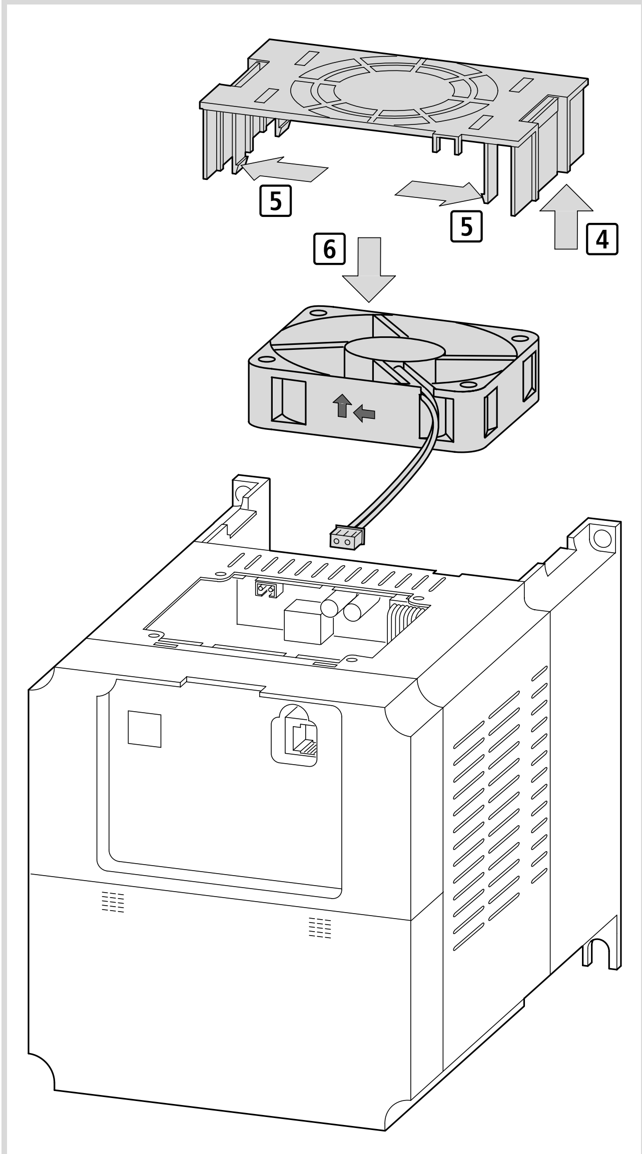


Figure 168: Replacing the device fan

Replace the fan as follows:

- To remove the fan 6, release the fan from the clips 5 in the fan support.
- Fit a new fan in reverse order to removal. Make sure that you fit the fan in the correct position in its support, observing its direction of rotation and airflow.
- When refitting the fan support 4 feed the connector 2 and connecting cable back through the cut-out.
- Reconnect the fan and refit the cover 1, first inserting the three rear studs and then clipping in the two front studs by hand.
- After refitting, test the fan's function (direction of airflow, vibrations, unusual noise).

Appendix

Technical data

General technical data of the DV51

The table below lists the technical data for all DV51 frequency inverters.

		DV51
Protection class according to EN 60529		IP 20
Overvoltage category		III
Secondary side: Frequency range		0 to 400 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 reference value: ±0.01 % of the maximum frequency • Analog reference value: ±0.1 % of the maximum frequency
Frequency resolution		• Digital reference value: 0.1 Hz • Analog reference 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 at linear and non-linear characteristic (applies also for second acceleration/deceleration time)
Inputs		
Frequency setting	LCD keypad	Setting through 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 kO
Clockwise/anticlockwise operation (start/stop)	LCD keypad	Start key (for Start) and OFF key (for Stop); default setting = clockwise operation
	External signals	Digital control inputs programmable as FWD and REV
Digital control inputs programmable as (not a complete list)		• FWD: Start/stop clockwise rotating field • REV: Start/stop anticlockwise rotating field • FF1 to FF4: Fixed frequency selection • JOG: Jog mode • AT: Use reference value 4 to 20 mA • 2CH: Second time ramp • FRS: Free run stop • EXT: External fault message • USP: Unattended start protection • RST: Reset • SFT: Software protection • PTC: PTC thermistor input • DB: DC braking active • SET: Second parameter set active • UP: Remote control, acceleration • DWN: Remote access, deceleration
Outputs		
Digital signalling outputs programmable as (not a complete list)		• FA1/FA2: Frequency reached/exceeded • OL: Overload • AL: Fault • RUN: Motor operational • OD: PID deviation exceeded

	DV51
Monitoring of frequency and current	• Connection of an analog display device: 0 to 10 V⎓, up to 1 mA for frequency or current • Connection of a digital frequency meter
Signalling relay	Relay contacts as two-way switch
Further features (not a complete listing)	• Autotuning • Automatic voltage regulation • Unattended start protection • Variable amplification and output voltage reduction • Frequency jumps • Minimum/maximum frequency limitation • Output frequency display • Fault register available • Freely selectable pulse frequency: 2 to 14 kHz • PID control • Automatic torque boost • On/OFF fan control • Second parameter set selectable
Safety features	• Overcurrent • Overvoltage • Undervoltage • Overtemperature • Earth fault (on Power On) • Overload • Electronic motor protection • Current transformer fault • Dynamic braking function (regenerative)
Ambient conditions	
Ambient temperature	–10 to +50 °C From about +40 to +50 °C, the pulse 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 1000 m above sea level in a housing or control panel (IP 54 or similar)
Optional accessories	• Remote operating units DEX-KEY-10, DEX-KEY-6, DEX-KEY-61 • Line reactor to improve the power factor • RFI filters • Motor reactor • Sine-wave filters • Field bus interface module CANopen (DE51-NET-CAN)

Specific technical data of the DV51-322

The table below contains the specific technical specifications of the single- and three-phase 230 V series, such as current, voltage, and torque values.

DV51-322-…		025	037	055	075	1K1	1K5	2K2
Motor’s maximum permissible active power in kW; data for four-pole three-phase asynchronous motors		0.25	0.37	0.55	0.75	1.1	1.5	2.2
Motor’s maximum permissible apparent 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						

DV51-322-…		025	037	055	075	1K1	1K5	2K2
Primary side: Rated voltage		180 V ~ –0 % to 264 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		1.6	2.6	3.0	4.0	5.0	8.0	11.0
Torque at startup (with SLV)		> 200 %						
Braking torque								
with feedback to the capacitors Reduced braking torque at frequencies above 50 Hz.		100 % at $f \leqq 50$ Hz 50 % at $f \leqq 60$ Hz					70 % at $f \leqq 50$ Hz 50 % at $f \leqq 60$ Hz	20 % at $f \leqq 60$ Hz
With external braking resistance		150 %						100 %
With DC braking		Braking occurs at frequencies below the minimum frequency (minimum frequency, braking time and braking torque are user-definable)						
	External signals	Digital control inputs programmable as FWD and REV						
Fan		–	–	–	–	–	✓	✓

Specific technical data of the DV51-320

The table below contains the technical data specific to the three-phase 230 V series (current, voltage, torque values, etc.)

DV51-320-…		4K0	5K5	7K5
Motor’s maximum permissible active power in kW; data for four-pole three-phase asynchronous motors		4.0	5.5	7.5
Motor’s maximum permissible apparent power in kVA	230 V	6.9	9.5	12.7
	240 V	7.2	9.9	13.3
Primary side: Number of phases		Three-phase		
Primary side: Rated voltage		180 V ~ –0 % to 264 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	Three-phase	22.0	30.0	40.0
Secondary side: Rated current in A		17.5	24.0	32.0
Torque at startup (with SLV)		> 200 %		
Braking torque				
with feedback to the capacitors Reduced braking torque at frequencies above 50 Hz.		20 % at $f \leqq 60$ Hz		
With external braking resistance		100 %	80 %	
With DC braking		Braking occurs at frequencies below the minimum frequency (minimum frequency, braking time and braking torque are user-definable)		

Specific technical data of the DV51-340

The table below contains the technical data specific to the three-phase 400 V series (current, voltage, torque values, etc.)

DV51-340-…	037	075	1K5	2K2	3K0	4K0	5K5	7K5
Motor’s maximum permissible active power in kW; data for four-pole three-phase asynchronous motors	0.37	0.75	1.5	2.2	3.0	4.0	5.5	7.5
Motor’s maximum permissible apparent power in kVA for 460 V	1.1	1.9	2.9	4.2	6.2	6.6	10.3	12.7
Primary side: Number of phases	Three-phase							
Primary side: Rated voltage	342 V ~ –0 % to 528 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
Torque at startup with SLV	> 200 %				> 180 %			
Braking torque								
with feedback to the capacitors Reduced braking torque at frequencies above 50 Hz.	100 % at $f \leqq 50$ Hz 50 % at $f \leqq 60$ Hz			70 % at $f \leqq$ 50 Hz 20 % at $f \leqq$ 60 Hz	20 % at $f \leqq 60$ Hz			
With external braking resistance	150 %			100 %			80 %	
With DC braking	Braking occurs at frequencies below the minimum frequency (minimum frequency, braking time and braking torque are user-definable)							

Weights and dimensions

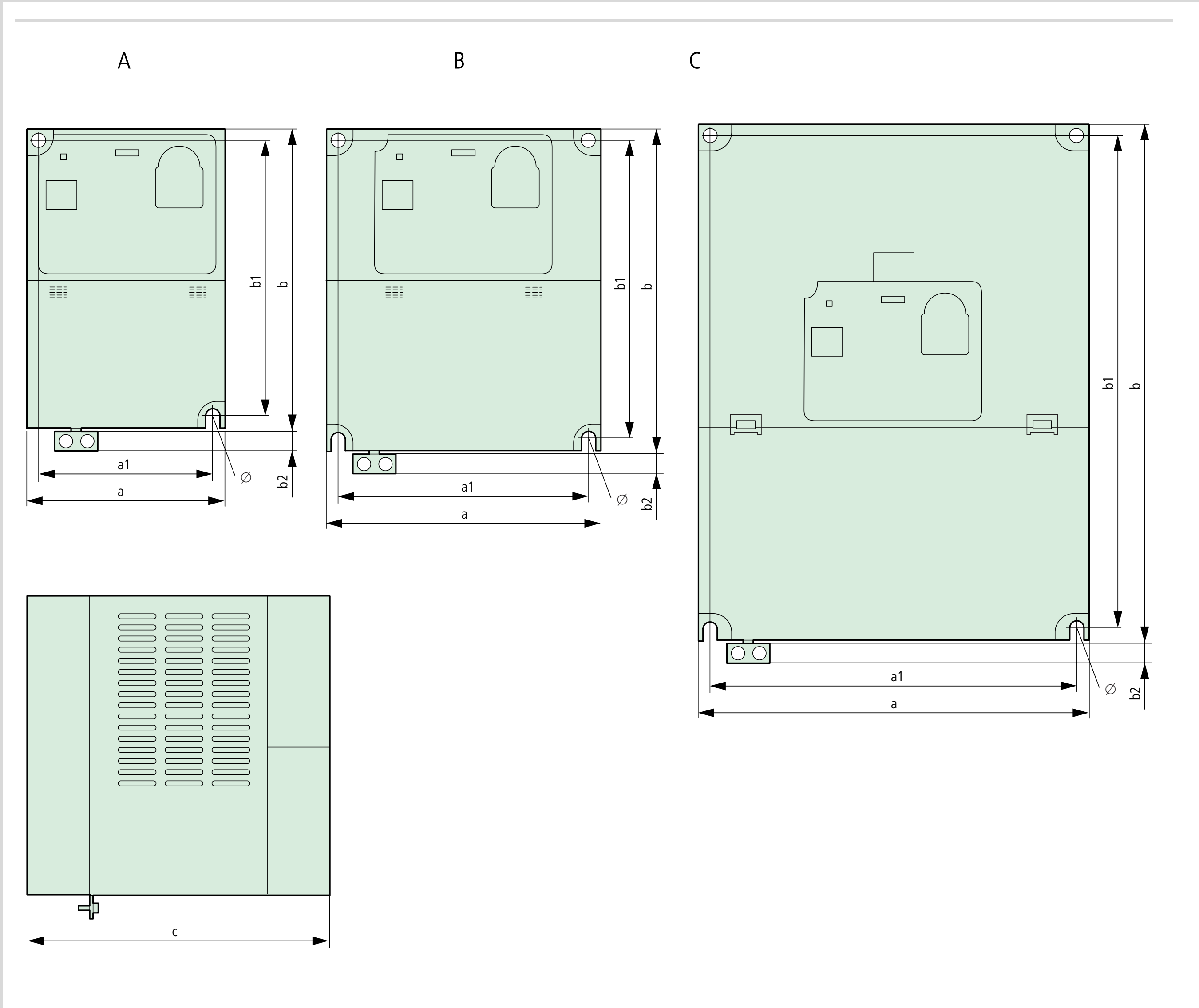


Figure 169: Dimensions and frame size, DV51

DV51-	a	a1	b	b1	b2	c	Ø	[lbin]	kg	
320-4K0	110	98	130	118	10	166	5	4.2	1.9	B
320-5K5	180	164	220	205	–	155	6	12.13	5.5	C
320-7K5	180	164	220	205	–	155	6	12.57	5.7	C
322-025	80	67	120	110	10	103	5	1.75	0.7	A
322-037	80	67	120	110	10	117	5	2.09	0.85	A
322-055	80	67	120	110	10	117	5	2.09	0.95	A
322-075 322-1K1	110	98	130	118	10	139	5	3.09	1.3	B
322-1K5	110	98	130	118	10	166	5	4.2	1.9	B
322-2K2	110	98	130	118	10	166	5	4.2	1.9	B
340-037	110	98	130	118	10	139	5	3.09	1.3	B

DV51-	a	a1	b	b1	b2	c	Ø	[lbin]	kg	
340-075	110	98	130	118	10	166	5	3.09	1.7	B
340-1K5 340-2K2 340-3K0 340-4K0	110	98	130	118	10	166	5	4.19	1.8	B
340-5K5	180	164	220	205	–	155	6	12.13	5.5	C
340-7K5	180	164	220	205	–	155	6	12.57	5.7	C

Optional modules

Mounting frame DEX-MNT-K6

Mounting frame DEX-MNT-K6 is available for external mounting of keypads DEX-KEY-6… (for example in the panel door). Please order the mounting frame separately.

The screws (M3 × 7 mm, 2) are not essential, but they do increase stability at high levels of vibration.

→ The fixing screws are not included as standard.

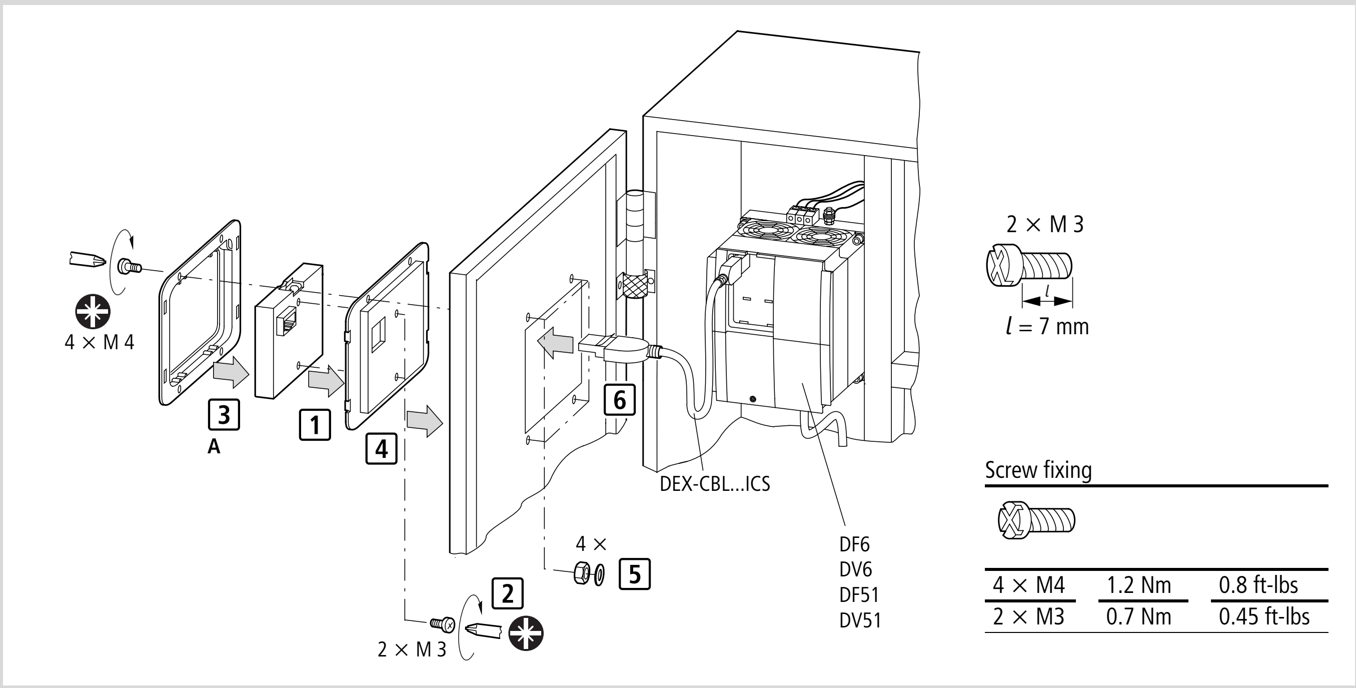


Figure 170: External keypad with mounting frame DEX-MNT-K6

Equipment supplied, mounting frame

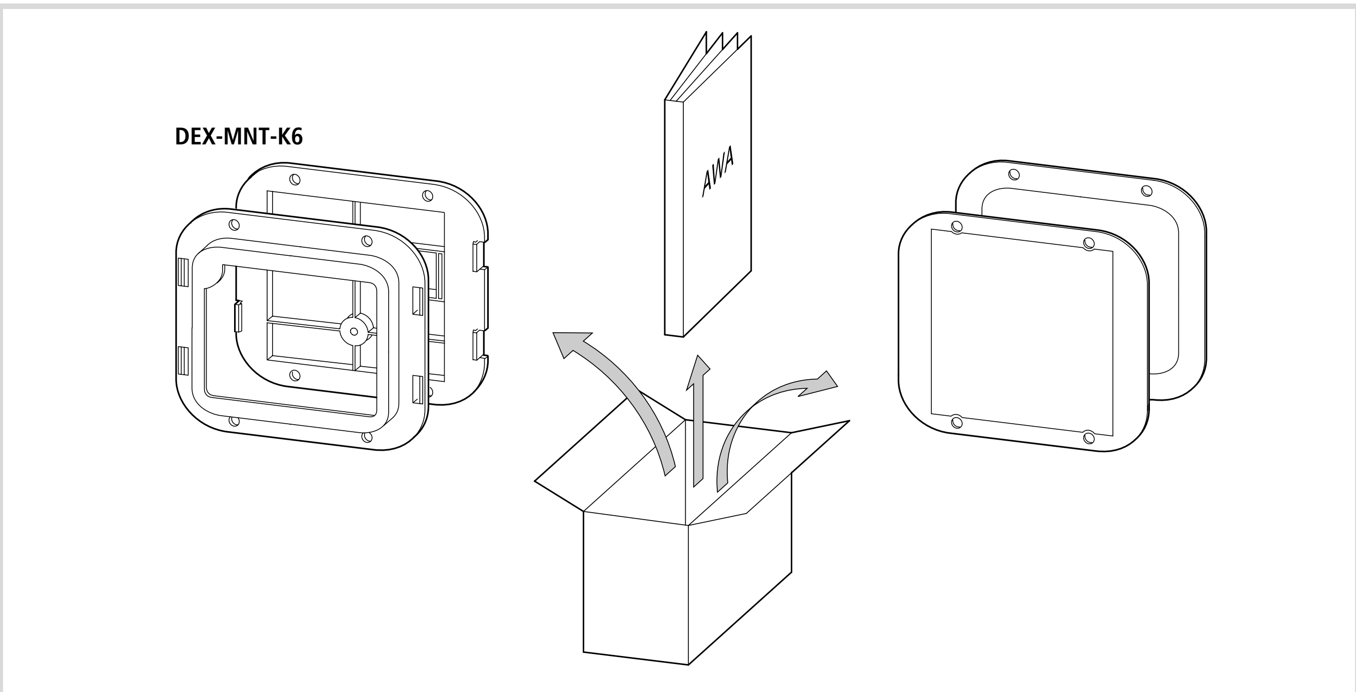


Figure 171: Equipment supplied

Flush mounting the keypad in the mounting frame

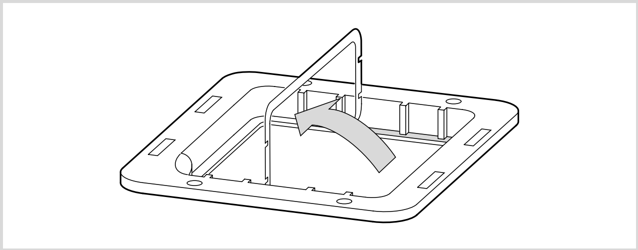


Figure 172: Removing protective foil from the gasket

▶ Remove the protection foil from the gasket on the inner frame.

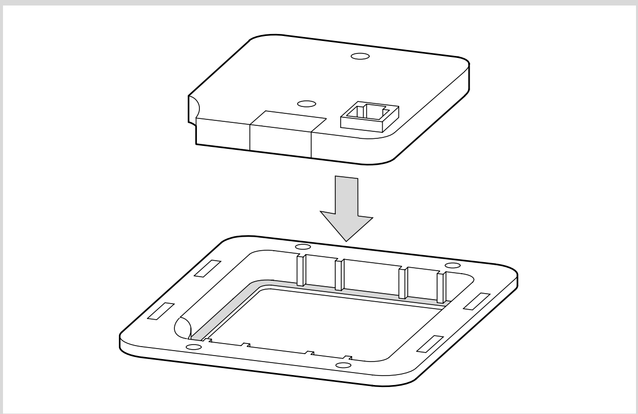


Figure 173: Fitting keypad DEX-KEY-6…

▶ Fit keypad DEX-KEY-6… in the mounting frame.

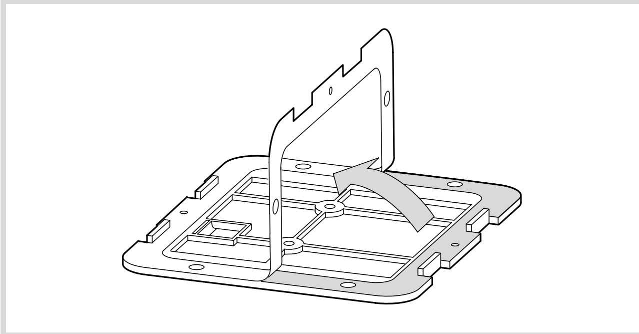


Figure 174: Removing protective foil from the outer gasket

▶ Remove the protection foil from the gasket on the mounting frame.

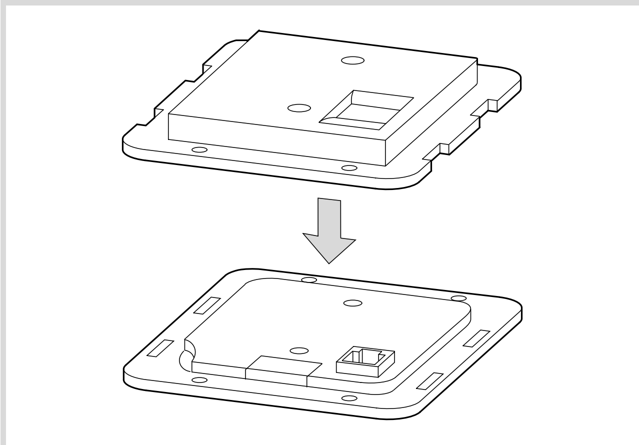


Figure 175: Joining the frames

▶ Press the mounting frame and the front frame (complete with keypad) together until the side fixings engage.

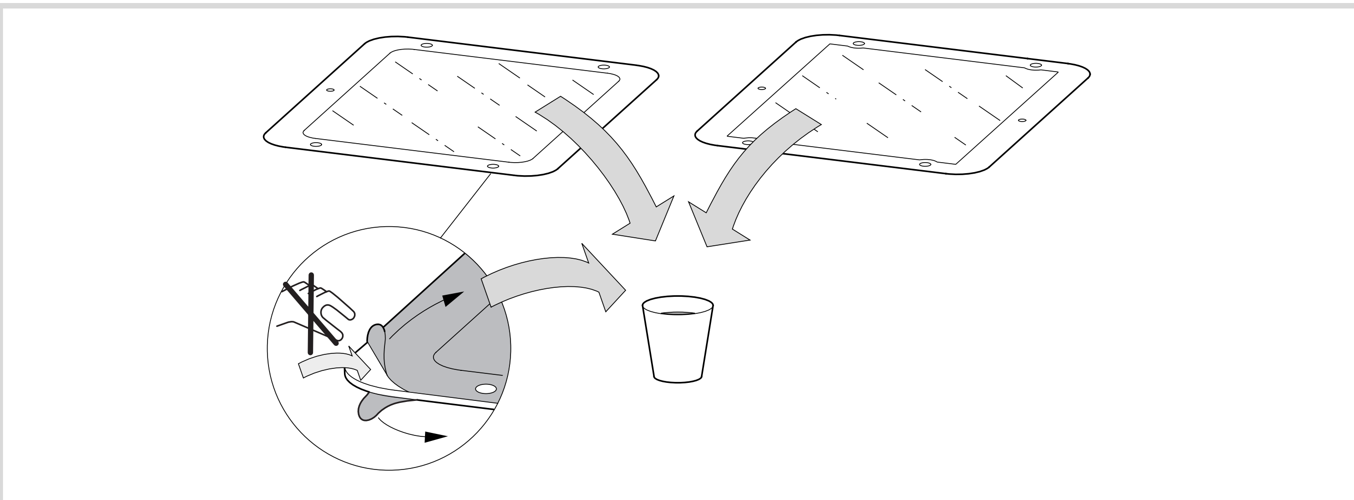


Figure 176: Self-adhesive gasket

▶ Place the supplied gasket on the front or rear of the mounting frame, depending on your application.

→ Remove the second protective foil only when finally mounting the keypad.

The mounting frame can be fitted in one of two ways:

Depending on the application (control panel door or waterproof mounting), apply the supplied gasket to the mounting frame or the front frame.

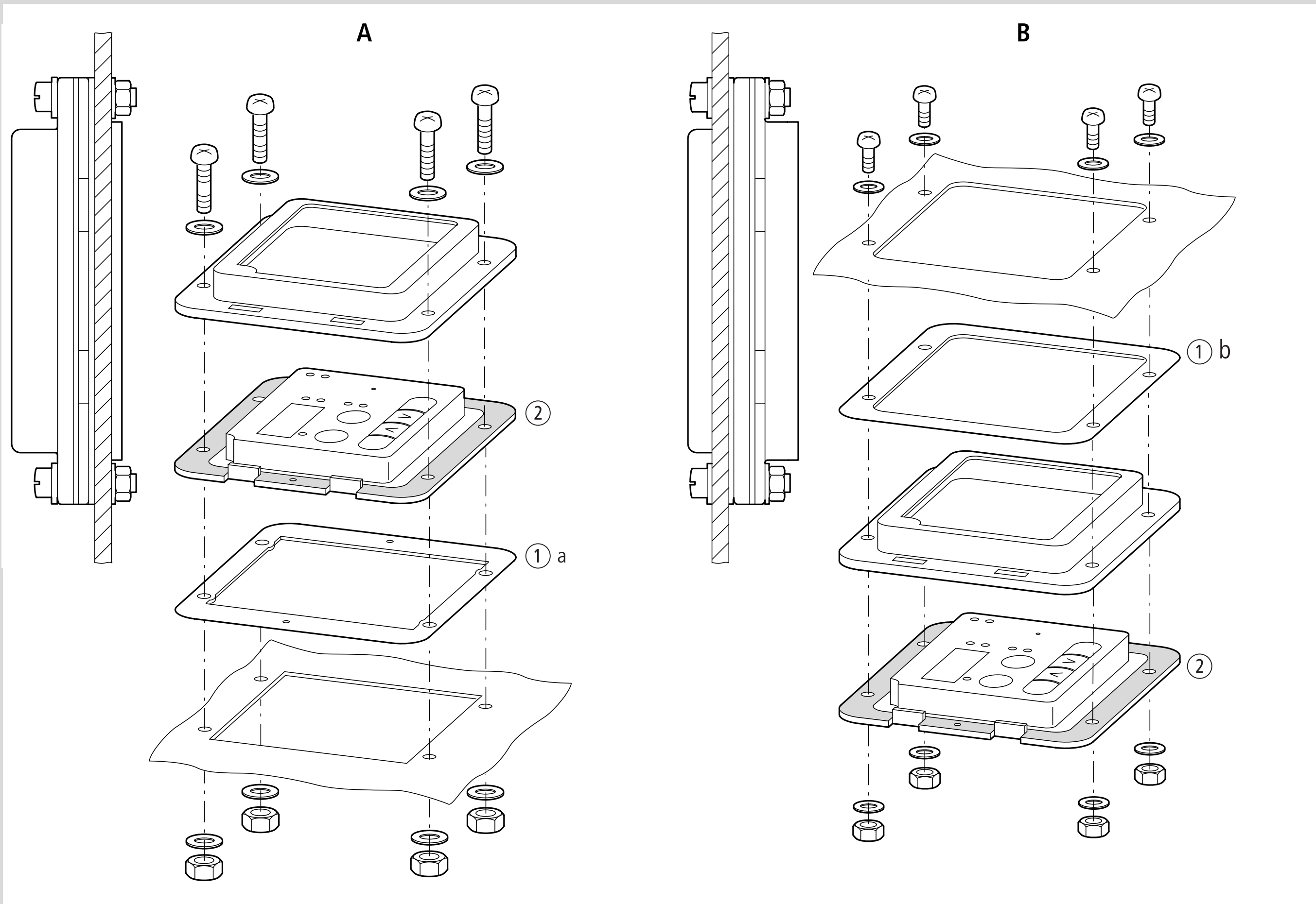


Figure 177: Fitting the mounting frame

A on top of the mounting surface (panel mounting)

B behind the mounting surface (waterproof mounting)

Mounting method A

Mounting in a panel door or on a control desk with standard-size punching tool for instruments (67 mm square hole).

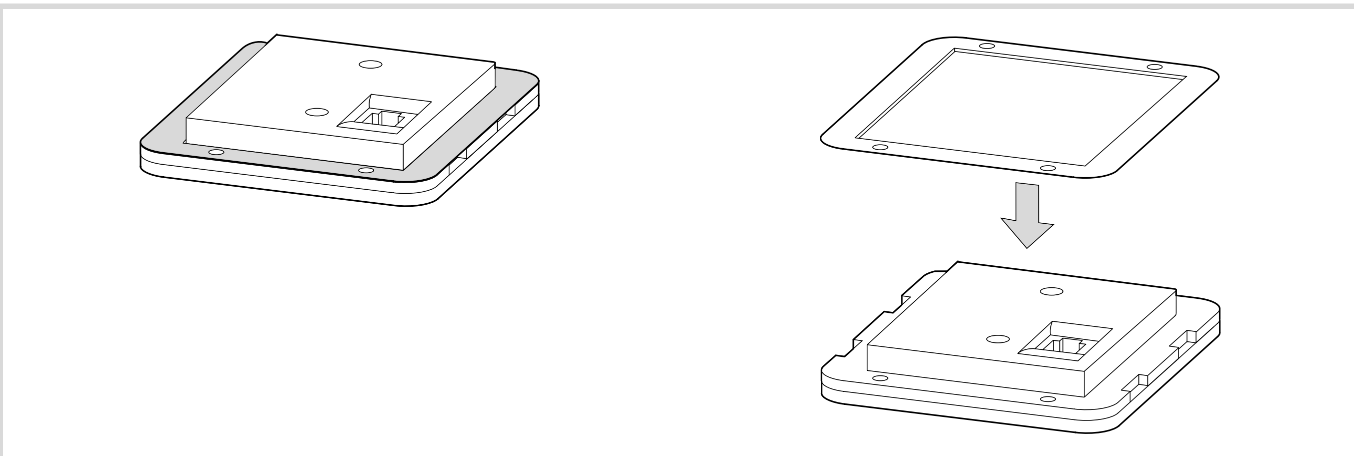


Figure 178: Gasket for control panel door (reverse side, A)

Mounting method B

Mounting in a waterproof enclosure (IP 54, NEMA4). Only possible with DEX-KEY-61, keypad **without** potentiometer.

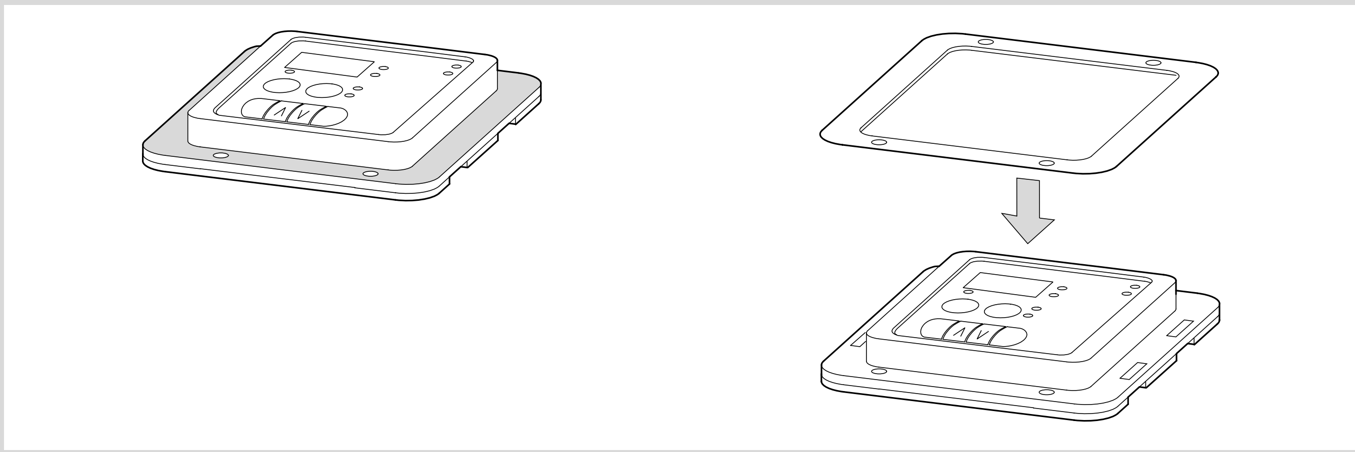


Figure 179: Gasket against ingress of liquid (front, B)

T adapter DEV51-NET-TC

The optional T adapter DEV51-NET-TC allows direct connection of the frequency inverter DV51 to an RS 485 network. In addition to three RJ 45 sockets, the DEV51-NET-TC contains lenses for the DV51's built-in Power, Alarm and Run LEDs and a microswitch for changing the interface over from OPE (operator, keypad DEX-KEY-…) to RS 485 (Modbus RTU).

→ T adapter DEV51-NET-TC is not included as standard with the frequency inverters.

Type code

Type code and part number of T adapter DEV51-NET-TC:

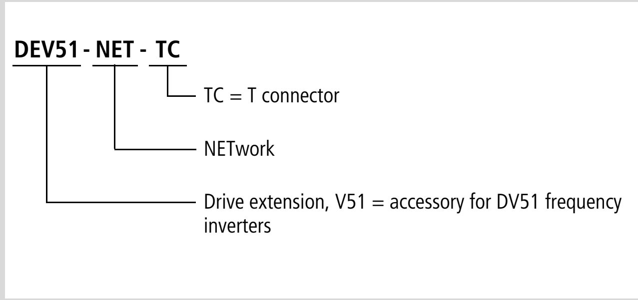


Figure 180: Type code of T adapter DEV51-NET-TC

Equipment supplied

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

- T adapter DEV51-NET-TC
- RJ-45 plug (CON-RJ45),
- Mounting instructions AWA8240-2259

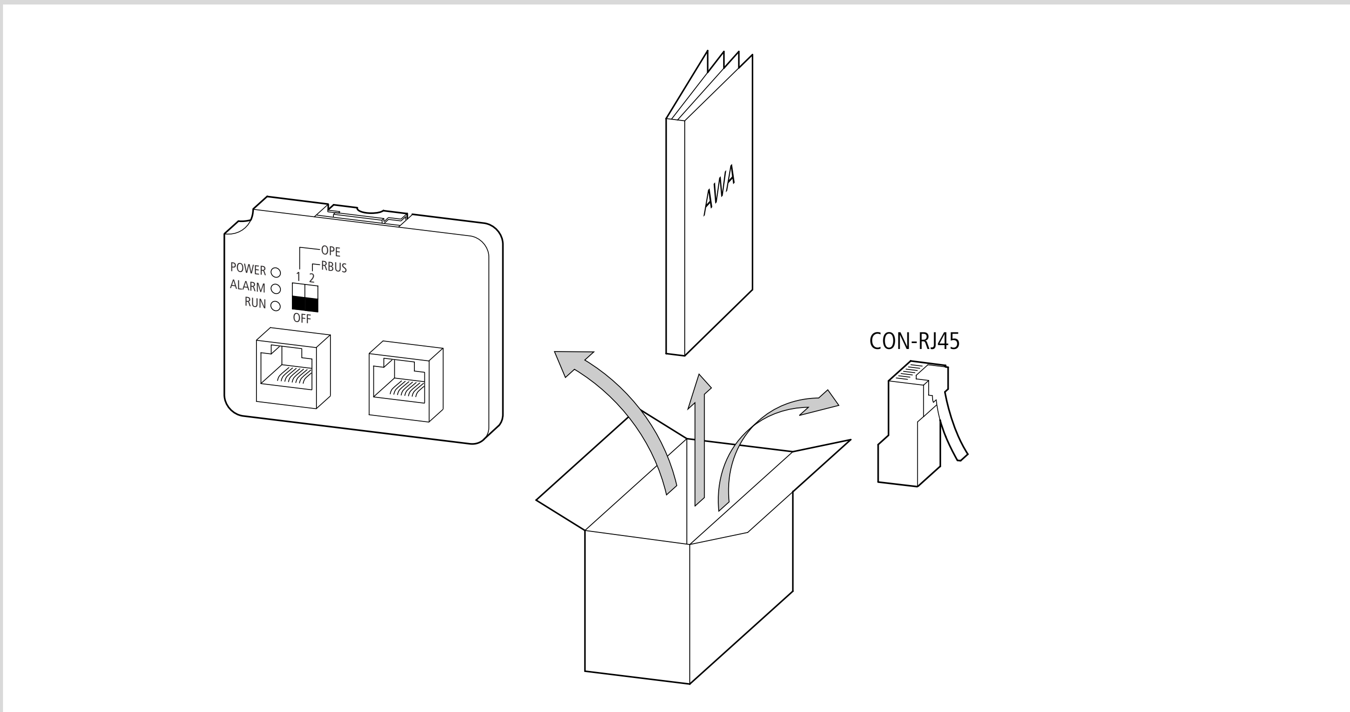


Figure 181: Equipment supplied, T adapter DEV51-NET-TC

Layout of the DEV51-NET-TC

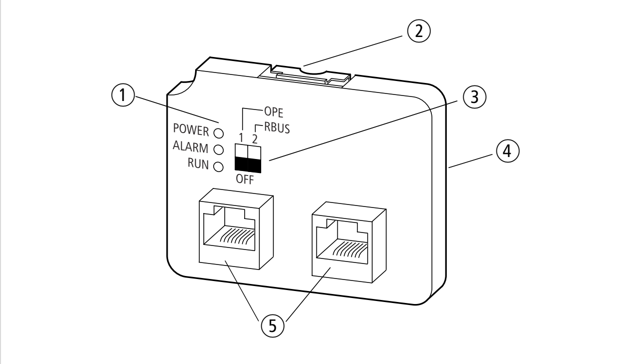


Figure 182: Layout of the DEV51-NET-TC

① Lenses for the DV51's LEDs
② Fixing clip
③ Microswitches
④ Socket for direct connection with DV51 trough CON-RJ45 (on reverse, not visible in illustration)
⑤ Front sockets

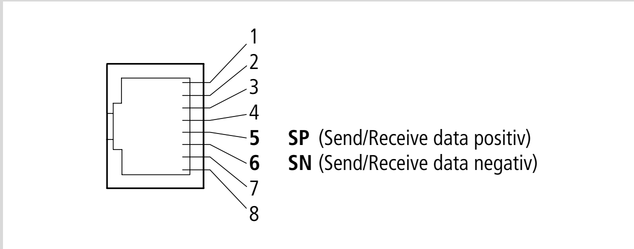


Figure 183: RJ 45 socket

Connections 1, 2, 3, 4, 7, 8: not assigned

Maximum data transfer rate: RS 485, ≦ 19200 bit/s, 8-bit (Modbus RTU)

Fitting the T adapter to DV51

You can fit adapter DEV51-NET-TC to frequency inverters of the DV51 series instead of the standard LED display DEV51-KEY-FP. It functions as a T connector. The sockets at the front ⑤ each have the same function.

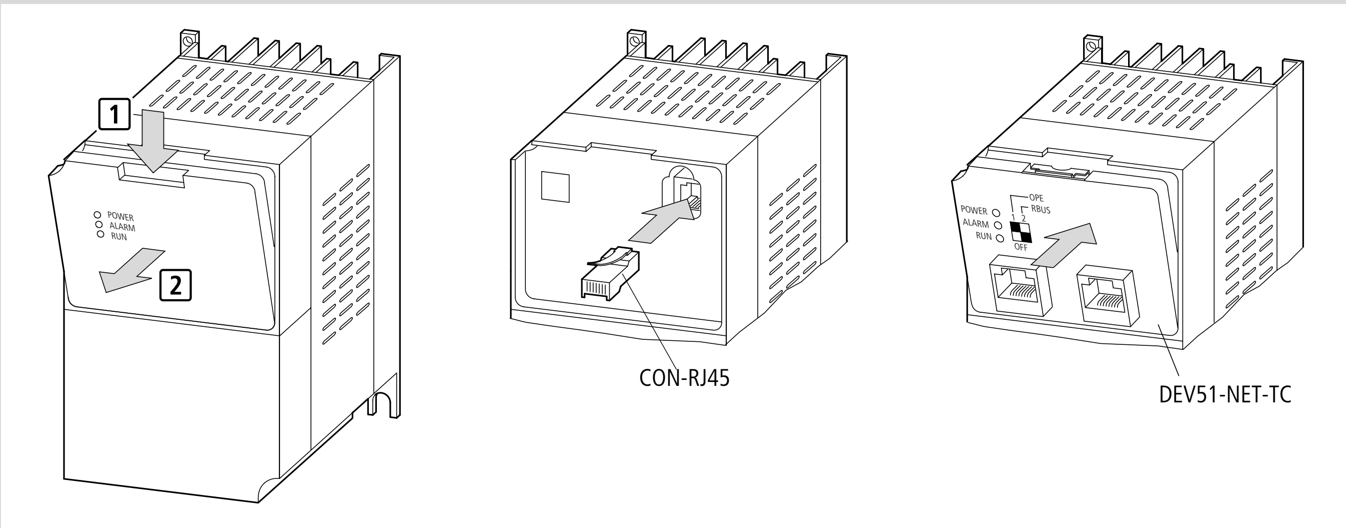


Figure 184: Fitting T adapter DEV51-NET-TC to DV51

→ No tools are required to fit and remove T adapter DEV51-NET-TC.

→ Fit T adapter DEV51-NET-TC only with the frequency inverter under no-voltage conditions and without using force.

→ For further information about fitting, see installation instructions AWA8240-2259.

Interface activation

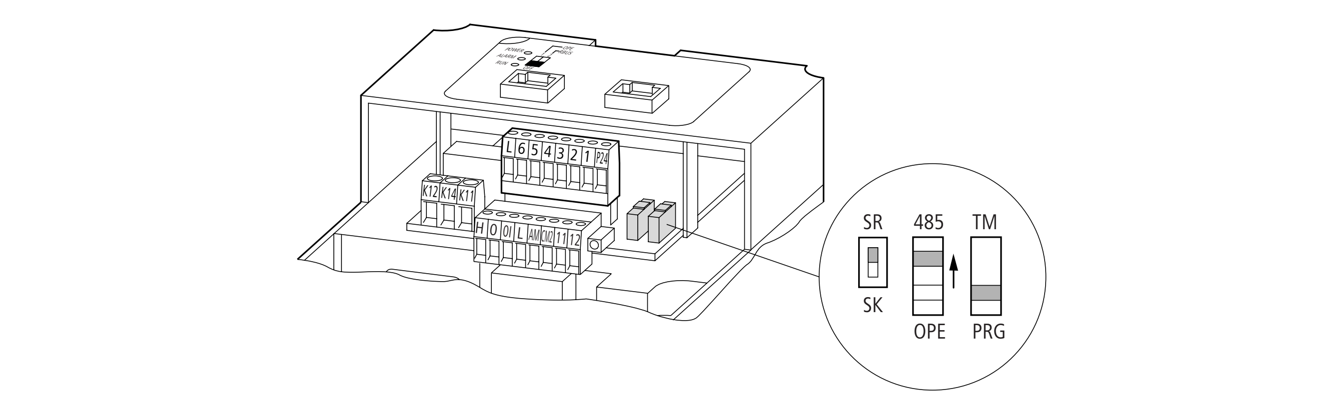


Figure 185: Activating the RJ 45 interface for bus operation

OPE = keypad (operator)

485 = RS 485 (Modbus RTU)

→ For communications through Modbus, use only pins 5 and 6 for the connection. The DV51 needs the remaining pins for its internal data transfer. Do not use them.

→ Make sure that only pins 5 and 6 (twisted pair, screened) are connected on the connection cable. Conductors connected to pins 1 to 4 and 7 to 8 can act as aerials and cause interference in the DV51 or the data traffic.

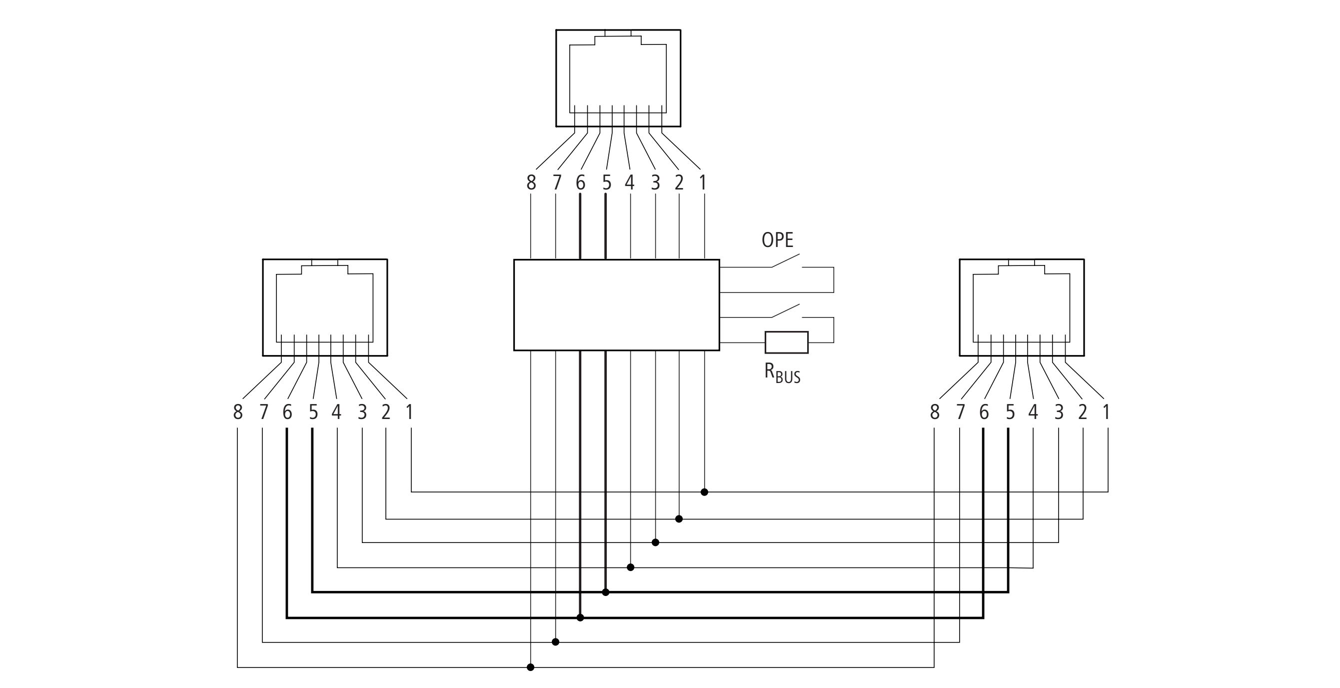


Figure 186: T adapter connections

R_{BUS} = 120 Ω (bus termination resistor)

OPE microswitch

Circuit example

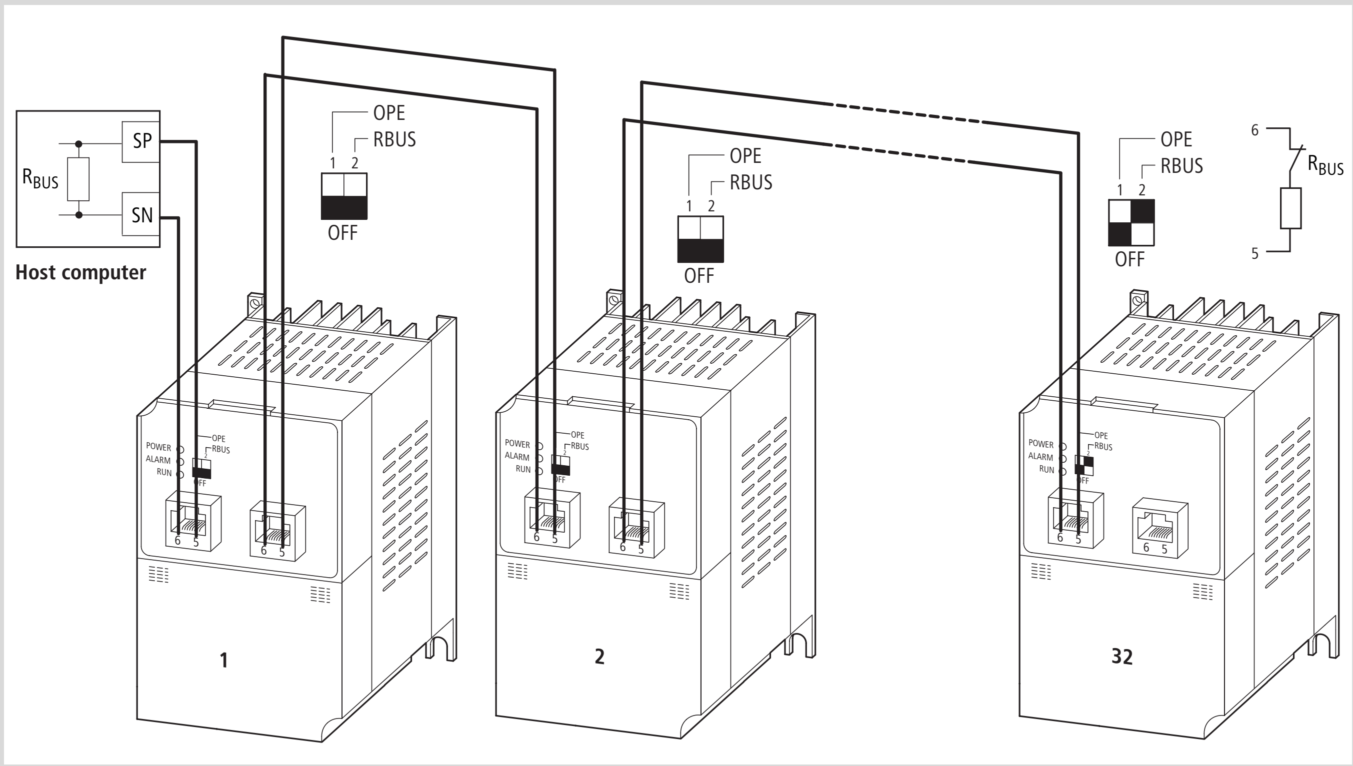


Figure 187: Connection example, Modbus

Connecting the keypad

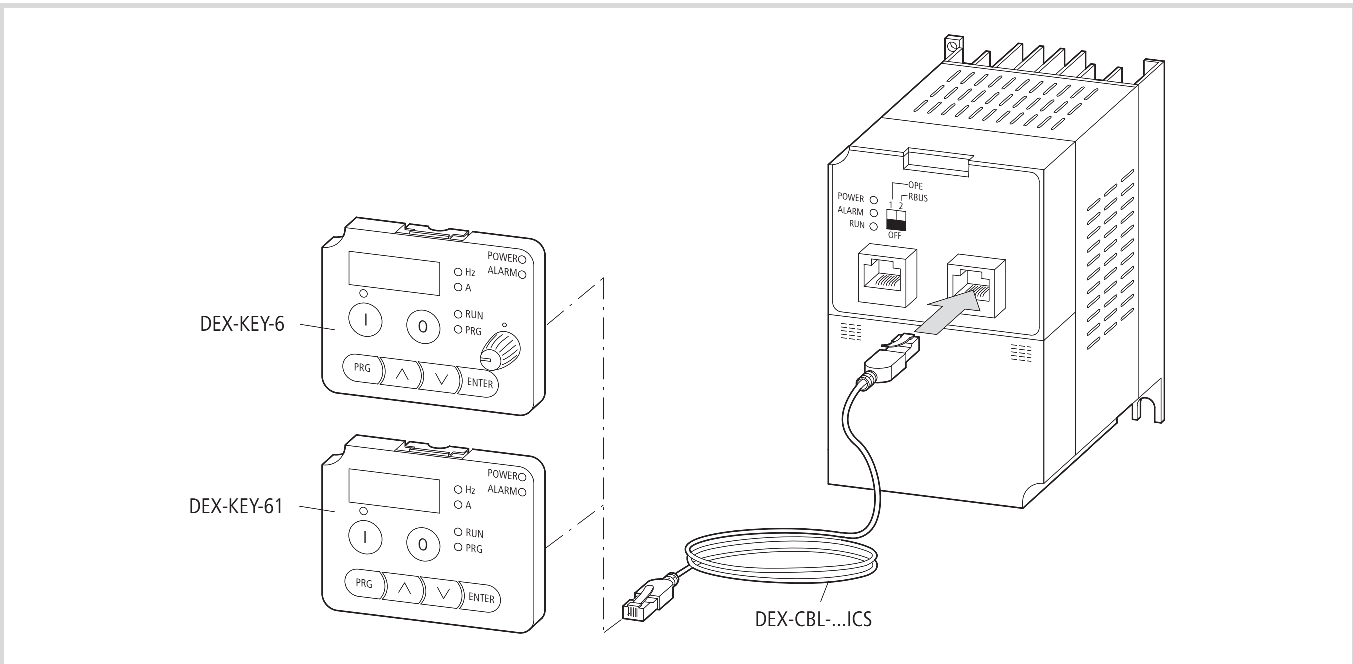


Figure 188: Connecting the keypad

Connection cable

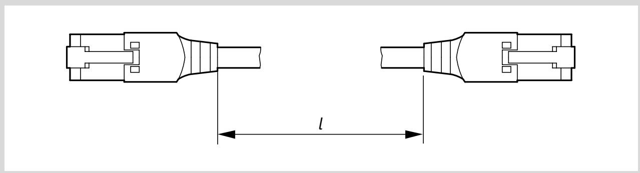


Figure 189: Connection cable

	l	Article number
DEX-CBL-1M0-ICS	1 m	232375
DEX-CBL-3M0-ICS	3 m	232376

	l	Article number
DNW-PC/0050/RJ45/RJ45/5E/CSUTP/GR/PV	0.5 m	237146
DNW-PC/0100/RJ45/RJ45/5E/CSUTP/GR/PV	1.0 m	237147
DNW-PC/0300/RJ45/RJ45/5E/CSUTP/GR/PV	3.0 m	237154

Keypad DEX-KEY-10

The optional keypad DEX-KEY-10 provide access to all inverter parameters and therefore allows user-specific adjustment of the settings of frequency inverters DF5, DF51, DV5, DV51, DF6, DV6 and RA-SP2 (System Rapid Link).

LEDs and a backlit LCD indicate the operating status, operational data and parameter values. With the keys, you can change the parameter values and control frequency inverter operation (Start/Stop).

→ The DEX-KEY-10… keypads are not included with the frequency inverter.

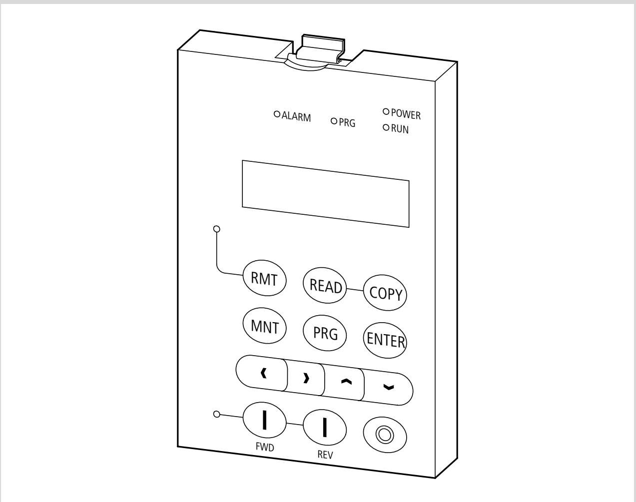


Figure 190: Keypad DEX-KEY-10

Connecting LCD keypad to DV51

The keypad allows a remote parameter programming and operation of the DV51 frequency inverters.

To connect DV51 frequency inverter and keypad, use a prefabricated connection cable (DEX-CBL-…).→ section “Connection cable”page 215:

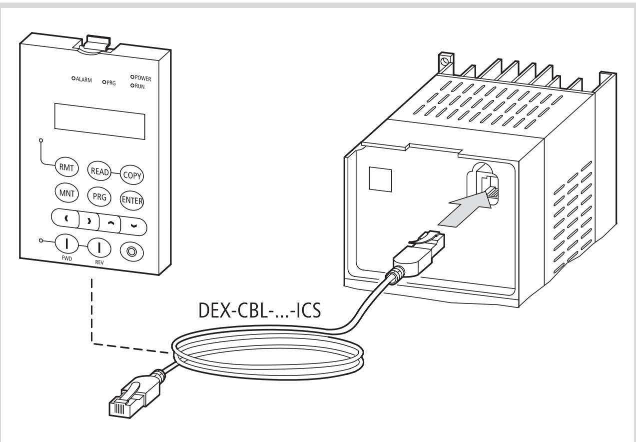


Figure 191: Connecting keypad DEX-KEY-10… with DV51

→ You do not need any tools to connect the optional keypad.

▽ **Caution!**
Connect the keypad and the connection cable only in a voltage-free state and do not use force.

Configuring keypad DEX-KEY-10

→ By default, keypad DEX-KEY-10 is configured for use with frequency inverters DF51, DF6, DV51 and DV6. For the DF5, DV5 and RA-SP devices and for use with several different device series, the keypad must be reconfigured.

Before you configure the keypad, make sure that it is correctly connected to the frequency inverter or speed control unit, which, in turn, is connected to its power supply.

▶ Press and hold the RMT and PRG keys and switch on the keypad’s power supply.

If the keypad is connected to a frequency inverter, the POWER LED lights up; if it is connected to a speed control unit, the UV LED lights up.

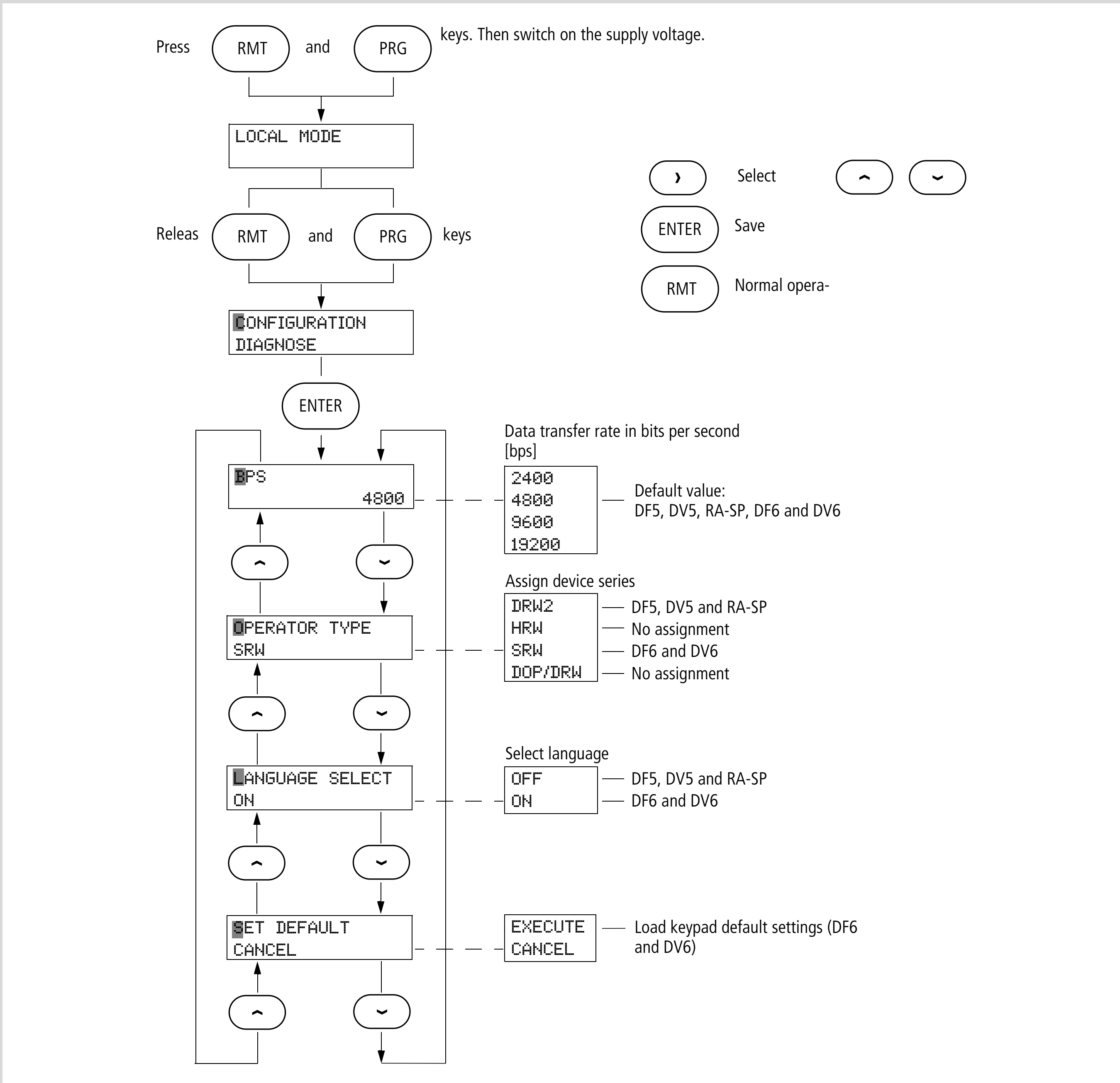


Figure 192: Configuring the keypad

Configuration menu

The examples below illustrate each step in the keypad's configuration:

▶ Press and hold both the RMT and the PRG key while switching on the power supply.

All LEDs light up.

```
LOCAL MODE
```

▶ Release the RMT and PRG keys.

```
CONFIGURATION
DIAGNOSE
```

→ The flashing cursor ▮ indicates the active function or the input value.

To move the cursor, select a function and change the values, use the arrow keys ‹, ›, ∧ and ∨.

In the Monitor menu, allowable changes of values and functions are saved directly.

In the Functions menu, changed settings are indicated with an asterisk (*) and must be saved with the ENTER key. An exclamation mark (!) indicates an impermissible value or function. Use the arrow keys ‹ and › to change the setting or return without saving your changes with the PRG or MNT key.

▶ In the selected menu (CONFIGURATION), press the ENTER key.

```
BPS
            4800
```

BPS (bits per second) is the data transfer rate. For the DF5, DF51, DF6, DV5, DV51, DV6 and RA-SP series devices, this value must be 4800. Any other value causes fault message R-ERROR COMM.<2>. If this happens, repeat step 1 and set the baud rate back to 4800.

▶ Press the ∨ arrow key. OPERATOR TYPE indicates the assigned device.

```
OPERATOR TYPE
SRW
```

▶ Use arrow key > to select the assignment code and assign it with ∧ or ∨:
– SRW = DF51, DF6, DV51 and DV6,
– DRW2 = DF5, DV5 and RA-SP.

```
OPERATOR TYPE
SRW
```

```
OPERATOR TYPE
           *DRW2
```

DOP/DRW and HRW are not used for the devices described in this manual.

Device series	BPS	OPERATOR TYPE
DF6, DV6	4800	SRW
DF5, DV5, RA-SP	4800	DRW2
DF51, DV51	4800	SRW

▶ Confirm your changes with the ENTER key and press the RMT key twice.

```
CONFIGURATION
DIAGNOSE
```

For DF5, DV5 and RA-SP, the display has only a single row, and the texts are displayed in English. The POWER and RMT LEDs are lit.

```
TM 000.0   0.0Hz
```

Used with DF6 and DV6, the display has two rows and you can select the display language in the LANGUAGE menu (see language selection, DF6 and DV6). The POWER LED is lit.

```
FM      0000.00Hz
>F001   0000.00Hz
```

Default settings

You can reload the default settings of keypad DEX-KEY-10 (not of the connected devices!) in menu CONFIGURATION. To do this, carry out the steps described in section "Configuration menu".

▶ With the display showing BPS (4800), press arrow key ∧.

```
SET DEFAULT
CANCEL
```

▶ With arrow key < or > select CANCEL.

▶ With arrow key ∧ or ∨ select EXECUTE.

```
SET DEFAULT
        *EXECUTE
```

▶ Confirm your input with the ENTER key.
▶ Press the RMT key to exit the configuration menu.

→ By default, keypad DEX-KEY-10 is configured for use with frequency inverters DF51, DF6, DV51 and DV6 (OPERATOR TYPE SRW).
Used with other devices, the display shows undefined text and symbols when you press the RMT key. The operating keys have no function in that case. To use the keypad with another device type, you must reconfigure the keypad (OPERATOR TYPE).

Enabling language selection

This function is available only with devices of the DF6 and DV6 series.

With the DF5, DF51, DV5, DV51 and RA-SP devices, the display language is always English and LANGUAGE SELECT should be set OFF.

```
LANGUAGE SELECT
ON
```

Copy and Read function

→ The copy function can be used only when the drive is at standstill (in STOP state). During operation, in error condition, during resetting and with software protection enabled, this function is not available.

→ The Copy and Read function is enabled only when the keypad is configured for the connected device and the Monitor menu (RMT key) has been selected.

→ After you have pressed the READ or COPY key, wait for about 10 seconds before pressing any other key, issue a Reset command or switch the power off.

When you have switched the power supply on, you can access all parameters of the connected device through the keypad. You can change functions and parameter values both directly on the device or with the connected LCD keypad. To save the existing device parameters and/or any changed values to the keypad, press the READ key.

Read function

Wen you press the READ key, all parameters of the connected device are read into keypad DEX-KEY-10, where they remain in memory even with the power switched off.

The memory is an EEPROM and has a lifespan of at least 100000 read operations.

```
WRITER INV -> REMT
```

Parameter protection

To protect the parameters saved to the keypad, you can disable the READ command. To do this, press the MNT, 〈 and Stop keys at the same time for about two seconds.

```
CONFIGURATION
```

With arrow keys 〉, ︿ and ﹀ you can select and toggle the read function (READ LOCK = ON).

```
READ LOCK
OFF
```

To enable this function, press ENTER. To exit the configuration menu, press RMT.

→ AWB8240-1416…

Copy function

→ All parameter changes are written directly to the connected device. For the Copy function, you must first load the changes in the keypad with the READ function.

→ The copy function can be used only when the drive is at standstill (in STOP state). During operation, in error condition, during resetting and with software protection enabled, this function is not available.

▶ Press the COPY key.

All parameters saved in the keypad are transferred to the connected device.

```
WRITER REMT -> INV
```

```
WRITER REMT->->INV
```

Fault messages, the content of the fault register and the configuration for the software parameter protection are not transferred.

→ The keypad allows the transfer of parameters only between frequency inverters and speed control units of the same device series with the same rating.

Impermissible attempts to copy data are automatically terminated and error message R-ERROR INV.TYPE is displayed. You must acknowledge the error message with the ENTER key.

```
R-ERROR INV.TYPE
```

→ When you copy data between devices of the same series but with different ratings, you must adapt the ratings data (current limitation, overload protection, etc.) for each new device.

Caution!
Do not copy parameters between 230 V and 400 V frequency inverters of the same series (for example DF51-322… and DF51-340…).

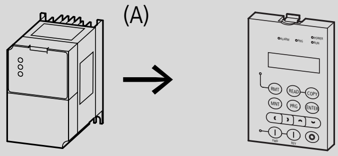
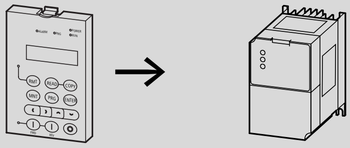
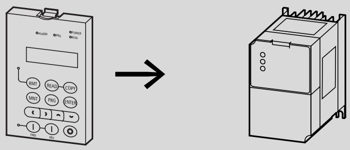
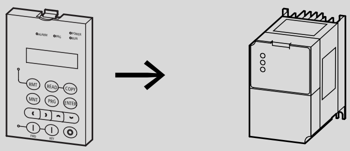
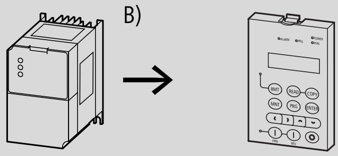
Caution!
Never copy data between devices with different operating systems (for example to Japanese or American versions). The DF5, DF51, DF6, DV5, DV51, DV6 and RA-SP devices described here have a European operating system.

Copy and Read function example

Frequency inverter (A) with connected and configured keypad DEX-KEY-10.

The parameters of frequency inverter (A) are configured for the connected drive unit (application, series machine).

The table below describes the steps required to copy the parameters of frequency inverter (A) to three further, identical frequency inverters (B, C and D), with the same application (drive unit):

Step	Key	Description	Data transfer
1	READ	The parameters saved in the frequency inverter (A) are read into the keypad.	 (A)
2		Switch off the power supply of frequency inverter (A) and disconnect the LCD keypad's connection cable from the frequency inverter.	
3		Connect the keypad's connection cable to frequency inverter (B) and switch on the frequency inverter's power supply.	
4[1)]	COPY	The parameters saved to the keypad are copied to frequency inverter (B). This takes about 10 seconds.	 (B)
5		Switch off the power supply of frequency inverter (B) and disconnect the LCD keypad's connection cable from the frequency inverter.	
6	COPY	Repeat steps 3 to 5 with frequency inverters (C) and (D).	 (C, D)
1) Note on step 4 If individual parameters are changed after you have pressed the COPY key (for example the acceleration time), you can carry out step 4a here without changing the keypad's saved data.			
4a	RMT	After issuing the COPY command, you can use the keypad to change the copied parameters of frequency inverter (B). The changed data is automatically saved to frequency inverter (B). The keypad's memory content is not affected by this operation.	 (B)
To also use the parameters changed in step 4a for frequency inverters (C) and (D), copy them to the keypad.			
4b	READ	The parameters saved in the frequency inverter (B) are read into the keypad. This overwrites the parameters saved in step 1 so that the keypad now contains the parameters changed in step 4a.	 B)

CANopen interface module DE51-NET-CAN

→ For notes about fitting see installation instructions AWA8240-2282.

→ For a detailed description of the interface module, see manual AWB8240-1571.

→ CANopen interface module DE51-NET-CAN is not included as standard with the frequency inverter.

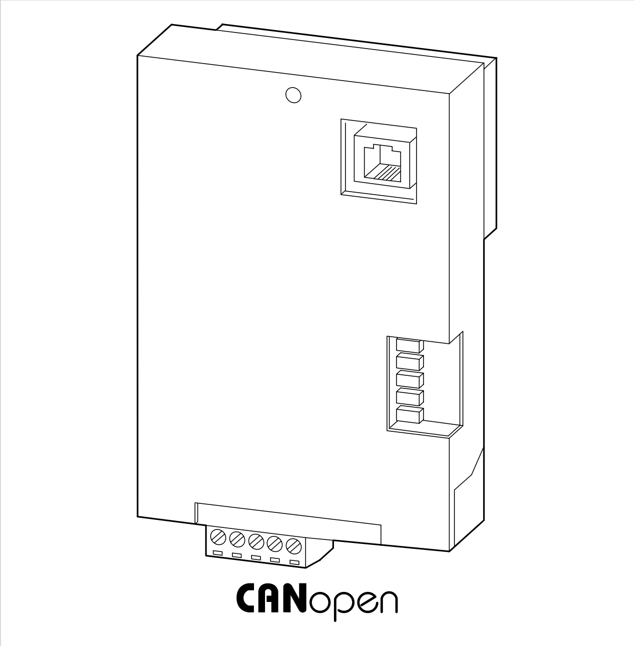


Figure 193: DE51-NET-CAN

The optional DE51-NET-CAN module allows connection of the frequency inverter to a CANopen network. The DE51-NET-CAN can be mounted directly on the front of the DV51.

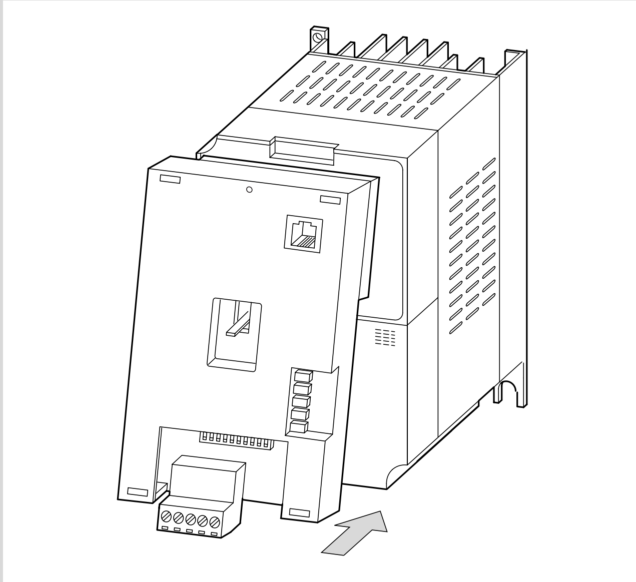


Figure 194: Front installation on DV51

Special features:

- DIP switches for setting node ID and baud rate
- Power supplied through frequency inverter
- Isolated bus interface
- Status LEDs
- Adjustment of all frequency inverter parameters through CANopen.
- Parallel indication of reference and actual values and of all frequency inverter parameters through optional keypad DEX-KEY-6…

→ LCD keypad DEX-KEY-6… can be mounted separately (connection cable DEX-CBL-…-ICS required) or on the frequency inverter's front (adapter DEV51-MNT-K60 required).

Table 41: Overview of technical specifications

Communication profile	DS-301 V4.01
Device profile	DS 402 V2.0
Bus addresses	1 – 127
Data transfer rate	10 kbit/s – 1 Mbit/s
Maximum total area coverage (depending on baud rate and repeaters)	• Up 5000 m at 10 Kbit/s • Up to 25 m at 1 Mbit/s
Transmission medium	Screened, twisted pair cable
Bus termination resistor	120 Ω, suitable for separate mounting
Number of SDOs	1 server, 0 clients
Number of PDOs	4 Rx PDOs, 4 Tx PDOs
PDO mapping	Variable
Terminals	Plug-in, 5-pole terminal block

PROFIBUS-DP interface module DE51-NET-DP

→ For notes about fitting see installation instructions AWA8240-2283.

→ For a detailed description of the interface module, see manual AWB8240-1577 (available soon).

→ PROFIBUS-DP interface module DE51-NET-DP is not included as standard with the frequency inverter.

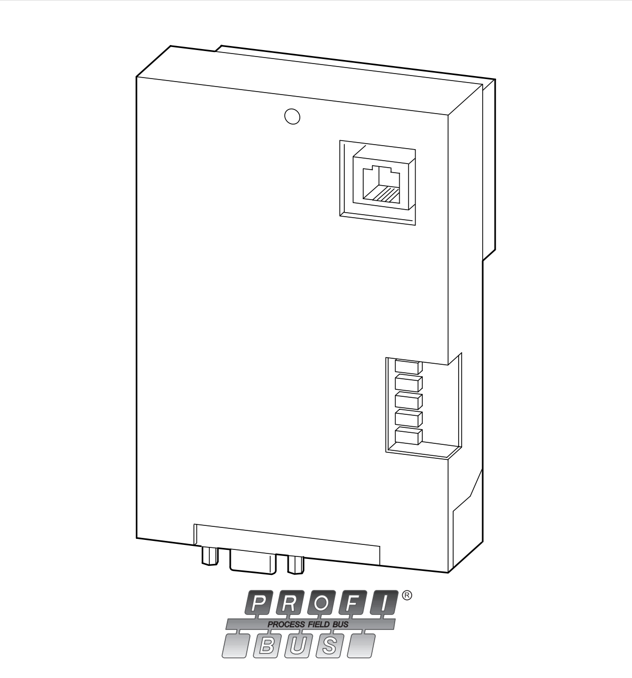


Figure 195: DE51-NET-DP

The optional DE51-NET-DP module allows connection of the frequency inverter to a PROFIBUS-DP network. The DE51-NET-DP can be mounted directly on the front of the DV51.

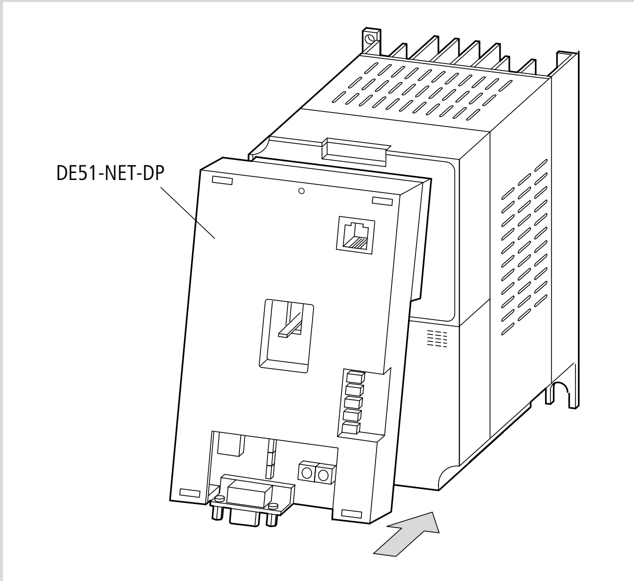


Figure 196: Front installation on DV51

Special features:

- DIP switches for setting node ID and baud rate
- Power supplied through frequency inverter
- Isolated bus interface
- Status LEDs
- Adjustment of all frequency inverter parameters through PROFIBUS-DP.
- Parallel indication of reference and actual values and of all frequency inverter parameters through optional keypad DEX-KEY-6…

→ LCD keypad DEX-KEY-6… can be mounted separately (connection cable DEX-CBL-…-ICS required) or on the frequency inverter’s front (adapter DEV51-MNT-K60 required).

Table 42: Overview of technical specifications

Communication profile	EN 50170
Device profile	Profidrive V2, Profidrive V3
Bus addresses	1 – 99
Data transfer rate	10 kbit/s – 12 Mbit/s
Maximum total area coverage (depending on baud rate and repeaters)	• 1200 m at 9.6 Kbit/s • 100 m at 12 Mbit/s
Transmission medium	Screened, twisted pair cable

Adapter for keypad DEV51-MNT-K60

→ For notes about fitting see installation instructions AWA8240-2282.

→ Adapter DEV51-MNT-K60 is not included as standard with the frequency inverters.

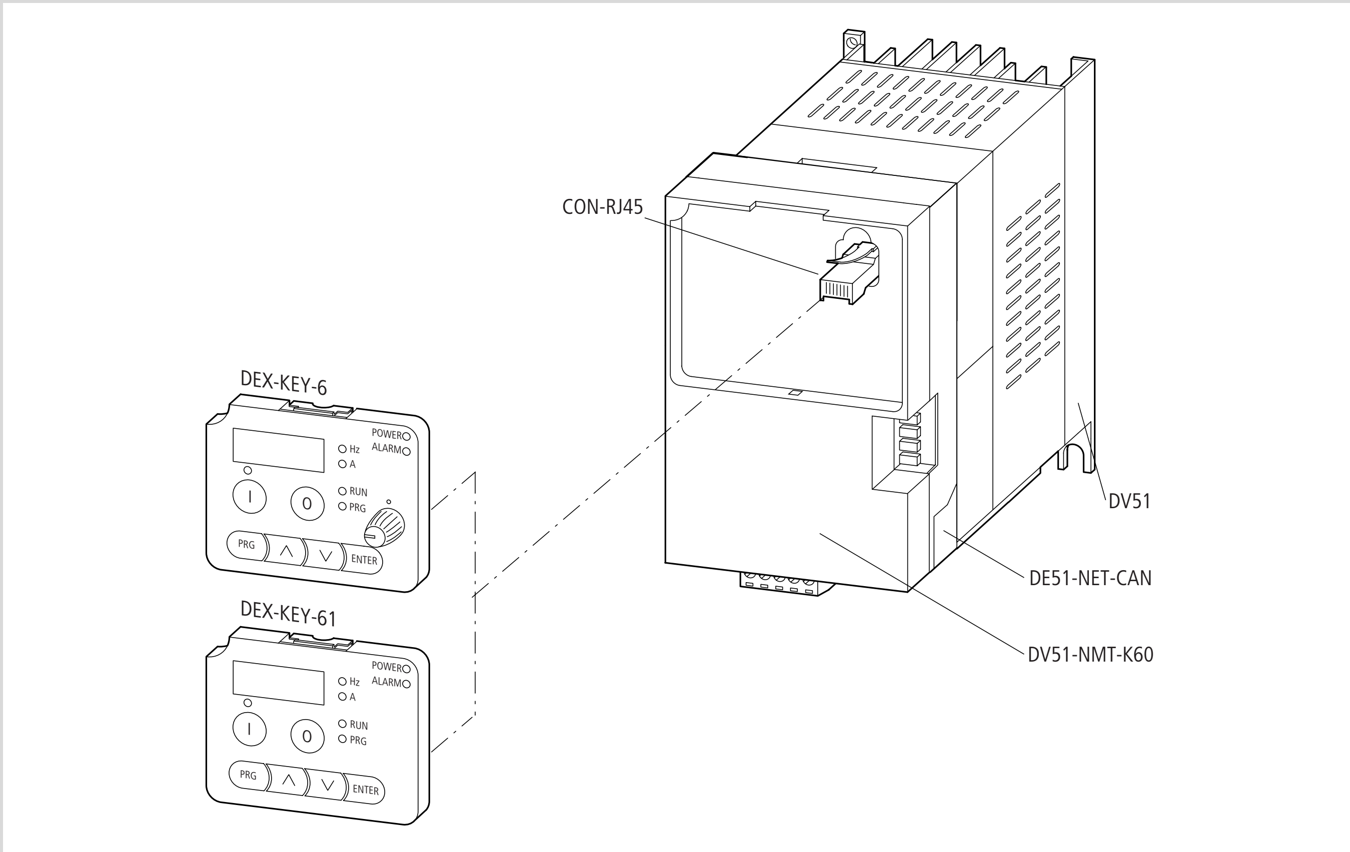


Figure 197: Adapter for keypad DEX-KEY-6… with fitted communication module (CANopen, PROFIBUS DP)

The optional module DEV51-MNT-K60 allows mounting of keypads DEX-KEY-6… on DV51 devices that also have a CANopen or PROFIBUS DP fieldbus connection fitted.

Cables and fuses

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

DV51-	Connection to power supply	VDE	UL[1)]	Moeller	L1, L2, L3, N, U, V, W, PE (2x) mm²	AWG
320-4K0	3-phase 230 V AC	35 A	30 A	PKZM0-32	4.0	12
320-5K5		35 A	40 A	PKZM0-40	6.0	10
320-7K5		50 A	50 A	PKZM0-50	10	8
322-025	1/3-phase 230 V AC	10 A	10 A	FAZ-B10/1N, PKM0-10	1.5	16
322-037	1/3-phase 230 V AC	10 A	10 A	FAZ-B10/1N, PKM0-10	1.5	16
322-055	1/3-phase 230 V AC	10 A	10 A	FAZ-B10/1N, PKM0-10	1.5	16
322-075	1/3-phase 230 V AC	16 A	15 A	FAZ-B16/1N, PKM0-16	2.5	14
322-1K1	1/3-phase 230 V AC	20 A	15 A	FAZ-B16/1N, PKM0-16	2.5	14
322-1K5	Single-phase 230 V	25 A	25 A	FAZ-B20/1N	4.0	12
	3-phase 230 V AC	16 A	15 A	PKM0-16	4.0	12
322-2K2	Single-phase 230 V	30 A	30 A	FAZ-B32/1N	6.0	10
	3-phase 230 V AC	20 A	20 A	PKM0-20	6.0	10
340-037	3 AC 400 V	4 A	3 A	PKM0-4	1.5	16
340-075		6 A	6 A	PKM0-6,3	1.5	16
340-1K5		10 A	10 A	PKM0-10	1.5	16
340-2K2		10 A	10 A	PKM0-10	1.5	16
340-3K0		16 A	15 A	PKM0-16	2.5	14
340-4K0		16 A	15 A	PKM0-16	2.5	14
340-5K5		20 A	20 A	PKM0-20	4.0	12
340-7K5		25 A	25 A	PKM0-25	4.0	12

1) Tripping characteristic UL-rated, class J, 600 V (approved fuses and fuse holders)

For power and motor cables that exceed about 20 m in length, use cables with a larger cross-section.

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

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

RFI filters

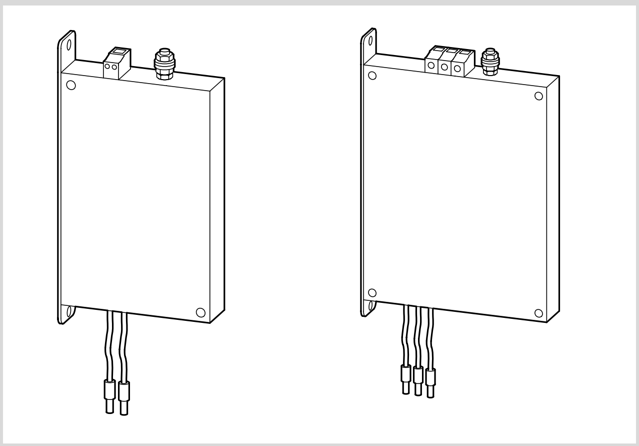


Figure 198: Single- and three-phase RFI filters

→ Radio interference filters DE51-LZ1 and DE51-LZ3 can be side- or footprint-mounted to the frequency inverter (→ section “Fitting a radio-interference (RFI) filter”page 29).

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

For leakage currents ≧ 3.5 mA standards EN 61800-5-1 and EN 50178 specify the following:

- 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.

→ For mobile applications, a plug connector is permissible only when a second, permanently installed, earthing conductor is installed.

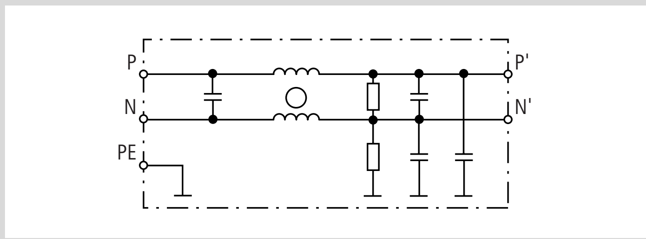


Figure 199: Block diagram, DE51-LZ1

Table 43: Frequency inverter assignments and technical data for DE51-LZ…

DV51-	Rated mains voltage 50/60 Hz	RFI filters	Rated current A	Overload current1) A	Maximum leakage current at rated operation mA	Maximum contact current on fault at interruption PE mA	 PE and N2), PE and 2 phase conductors3) mA	Power loss of RFI filter at rated operation W
320-4K0	3 ~ 230 V + 10 %							
320-5K5								
320-7K5								
322-018 322-037 322-055	1 ~ 230 V + 10 %	DE51-LZ1-007-V2	7	10.5	6	25	47	5
322-075 322-1K1		DE51-LZ1-012-V2	12	18	6	26	51	7
322-1K5 322-2K2		DE51-LZ1-024-V2	24	36	6	24	48	14

DV51-	Rated mains voltage 50/60 Hz	RFI filters	Rated current A	Overload current[1] A	Maximum leakage current at rated operation mA	Maximum contact current on fault at interruption PE mA	PE and N[2], PE and 2 phase conductors[3] mA	Power loss of RFI filter at rated operation W
340-037 340-075 340-1K5 340-2K2	3 ~ 400 V + 10 %	DE51-LZ3-007-V4	7	10.5	11	4	156	6
340-3K0 340-4K0		DE51-LZ3-011-V4	11	16.5	35	5	198	9
340-5K5 340-7K5		DE51-LZ3-020-V4	20	30	46	5.5	210	16

1) 150 % for 60 s, every 30 min

2) with DE51-LZ1

3) with DE51-LZ3

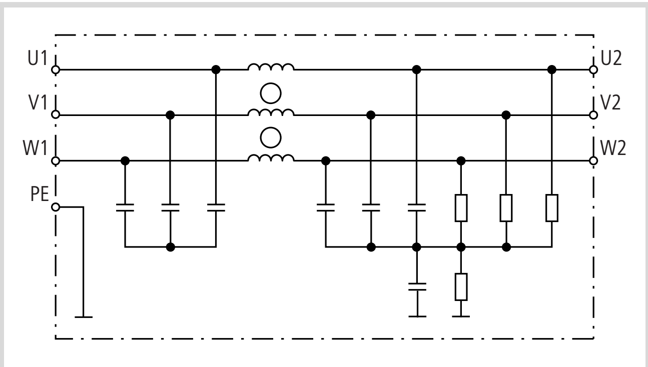


Figure 200: Block diagram, DE51-LZ3

Table 44: Performance features of DE51-LZ…

Ambient temperature	Up to +40 °C
Climatic proofing	IEC 25/085/21
Terminal capacity	0.2 – 4 mm²

Weights and dimensions

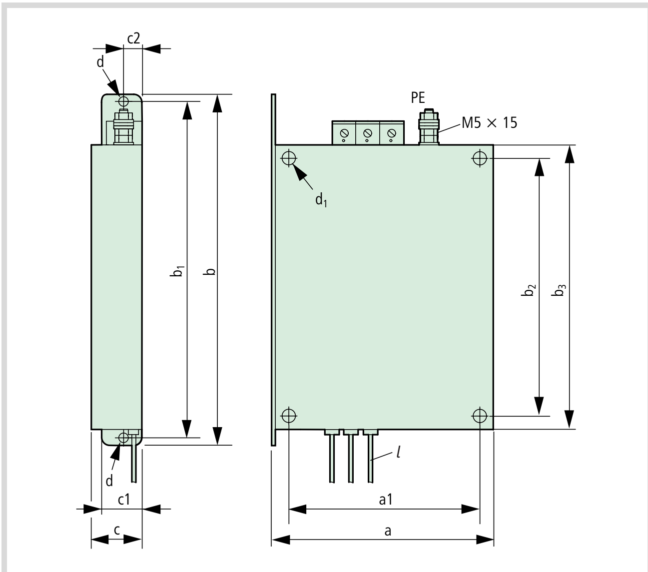


Figure 201: Dimensions

Part no.	a mm	a1 mm	b mm	b1 mm	b2 mm	b3 mm	c mm	c1 mm	c2 mm	d mm	d1 mm	kg	*l* mm
DE51-LZ1-007-V2	80	67	170	160	110	120	27	20	13.5	5	2 × 6	0.45	160
DE51-LZ1-012-V2	110	98	180	170	118	130	35	28	17.5	5	4 × 6	0.5	180
DE51-LZ1-024-V2	110	98	180	170	118	130	35	28	17.5	5	4 × 6	0.67	180
DE51-LZ3-007-V4	110	98	180	170	118	130	35	28	17.5	5	4 × 6	0.7	180
DE51-LZ3-011-V4	110	98	180	170	118	130	35	28	17.5	5	4 × 6	0.75	180
DE51-LZ3-020-V4	180	164	285	269	205	220	40	31	20	6.3	4 × 6.5	1.2	250

Mains contactors

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

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

→ For single-phase mains connection, the use of paralleling link DILM12-XP1 is recommended to ensure even loading of all contact decks.

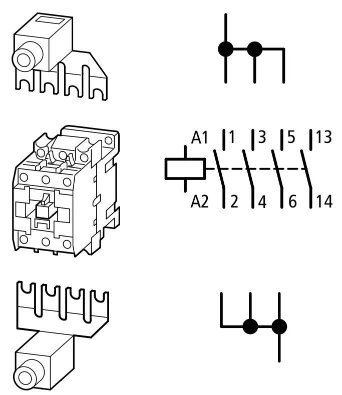


Figure 202: Mains contactor at single-phase connection

DV51-	DV51 phase current	Mains contactor		DV51 starting current (RC load current at maximum input voltage)
		Conventional thermal current $I_{th} = I_e$ AC-1 at 60 %, open	Part no.	
	I_{LN} [A]	I_{th} AC-1 [A]		I_0 [A]
Connection 1 ~ 230 V (240 V g 10 %)				
322-025	3.5	20	DILM7	31.9
322-037	5.8			
322-055	6.7			
322-075	9			
322-1K1	11.2			
322-1K5	17.2			
322-2K2	24		DILM7 + DILM12-XP1[1)]	

1) For single-phase line connection of the DV51-322-2K2, all three contacts must be connected through paralleling link DILM12-SP1.

DV51-	DV51 phase current	I_{th} AC-1 [A]	Part no.	I_0 [A]
Connection 3 ~ 230 V (240 V g 10 %)				
320-4K0	22	35	DILM17	31.9
320-5K5	30	35	DILM17	
320-7K5	40	40	DILM25	16
322-025	2	20	DILM7	31.9
322-037	3.4			
322-055	3.9			
322-075	5.2			
322-1K1	6.5			
322-1K5	10			
322-2K2	14			

DV51-	DV51 phase current I_{LN} [A]	Mains contactor Conventional thermal current I_{th} = I_e AC-1 at 60 %, open I_{th} AC-1 [A]	 Part no.	DV51 starting current (RC load current at maximum input voltage) I_0 [A]
3 ~ 400 V connection				
340-037	2	20	DILM7	63.7
340-075	3.3			
340-1K5	5			
340-2K2	7			
340-3K0	10			
340-4K0	11			
340-5K5	16.5			
340-7K5	20	35	DILM17	31.9

Line reactor

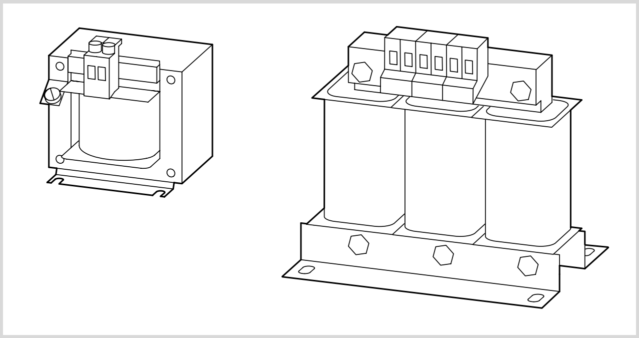


Figure 203: Line reactors DEX-LN…

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

→ Line reactors reduce the magnitude of the current harmonics up to about 30 % and increase the lifespan of frequency inverters and upstream-connected switching devices.

DV51-	Mains voltage	Maximum input voltage V AC_{rms}	Mains current (I_{LN}) of the DV51 without line reactor	Assigned line reactor
320-4K0	3 ~ 230 V	240 V + 10 %	22	DEX-LN3-025
320-5K5			30	DEX-LN3-040
320-7K5			40	DEX-LN3-040
322-025	1 ~ 230 V	240 V + 10 %	3.5	DEX-LN1-006
322-037			5.8	DEX-LN1-006
322-055			6.7	DEX-LN1-009
322-075			9	DEX-LN1-009
322-1K1			11.2	DEX-LN1-013
322-1K5			17.5	DEX-LN1-018
322-2K2			24	DEX-LN1-024
322-025	3 ~ 230 V	240 V + 10 %	2	DEX-LN3-004
322-037			3.4	
322-055			3.9	
322-075			5.2	DEX-LN3-006
322-1K1			6.5	DEX-LN3-006
322-1K5			10	DEX-LN3-010
322-2K2			14	DEX-LN3-016
340-037	3 ~ 400 V	480 V + 10 %	2	DEX-LN3-004
340-075			3.3	DEX-LN3-004
340-1K5			5	DEX-LN3-006
340-2K2			7	DEX-LN3-010
340-3K0			10	
340-4K0			11	
340-5K5			16.5	DEX-LN3-016
340-7K5			20	DEX-LN3-025

→ For technical data for the DEX-LN series line reactors, see installation instructions AWA8240-1711

Motor reactor

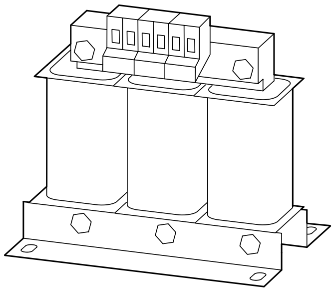


Figure 204: Motor reactor DEX-LM…

DV51-	Maximum output voltage	Rated operational current (motor current) I_e [A]	Assigned motor reactor
320-4K0	3 ~ 240 V + 10 %	17.5	DEX-LM3-035
320-5K5		24	
320-7K5		32	
322-025		1.6	DEX-LM3-005
322-037		2.6	
322-055		3	
322-075		4	
322-1K1		5	
322-1K5		8	DEX-LM3-008
322-2K2		11	DEX-LM3-011
340-037	3 ~ 480 V + 10 %	1.5	DEX-LM3-005
340-075		2.5	
340-1K5		3.5	
340-2K2		5.5	DEX-LM3-008
340-3K0		7.8	
340-4K0		8.6	DEX-LM3-011
340-5K5		13	DEX-LM3-016
340-7K5		16	

→ For technical data for the DEX-LN series mains reactors, see installation instructions AWA8240-1711

Sine-wave filters

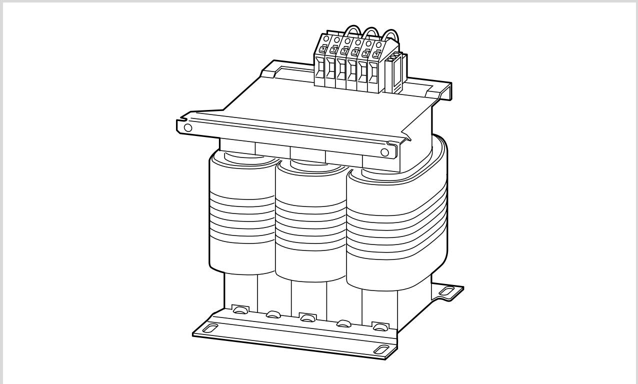


Figure 205: Sine-wave filter SFB 400/...

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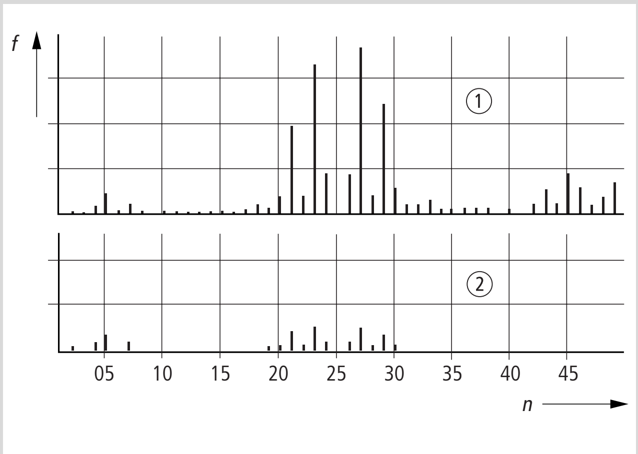

Figure 206: High frequency components of the output voltage

① Without sine-wave filter
② With sine-wave filter
f: Rotating field frequency
n: Harmonics ordinal

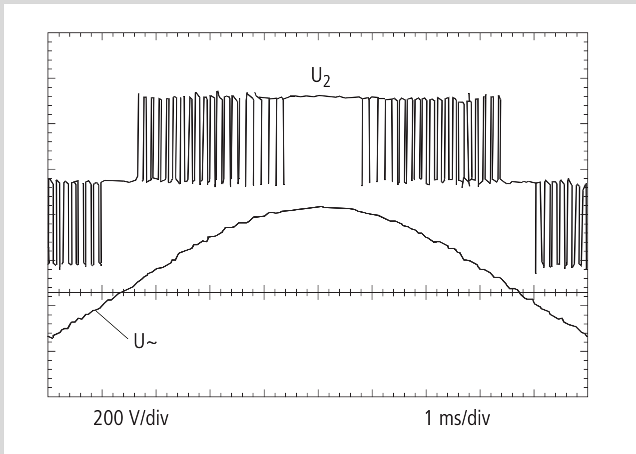

Figure 207: Output voltage to motor

U_2: Inverter output voltage
U~:Sinusoidal voltage to be simulated

Sine-wave filter SFB filters out high-frequency components above the set resonance frequency from the frequency inverter output voltage (→ figure 206). The sine-wave filter's output voltage (→ figure 207) has a sine-wave shape with a low overlaid ripple voltage. The sine-wave voltage's total harmonic distortion is typically 5 to 10 %. This significantly reduces the noise generated by the motor and extends its lifespan to that of a mains-operated motor.

Advantages of the sine-wave filter:

- Long screened motor supply cables possible.
- Extended lifespan of the motor.
- Low noise generation.

DV51-	Maximum output voltage	Rated operational current (motor current) I_e [A]	Assigned sine-wave filter
320-4K0	3 ~ 240 V + 10 %	17.5	SFB 400/16.5[1)] (SFB 400/23.5)
320-5K5		24	SFB 400/23.5
320-7K5		32	SFB 400/32
322-025		1.6	SFB 400/4
322-037		2.6	
322-055		3	
322-075		4	
322-1K1		5	SFB 400/10
322-1K5		8	
322-2K2		11	SFB 400/10[1)] (SFB 400/16.5)
340-037	3 ~ 480 V + 10 %	1.5	SFB 400/4
340-075		2.5	
340-1K5		3.5	
340-2K2		5.5	SFB 400/10
340-3K0		7.8	
340-4K0		8.6	
340-5K5		13	SFB 400/16.5
340-7K5		16	

1) At continuous 100 % motor load, use a sine-wave filter of the next higher (current) rating here.

→ For technical data for the SFB400/… series sine-wave filters, see the manufacturer’s instructions.

Braking resistance

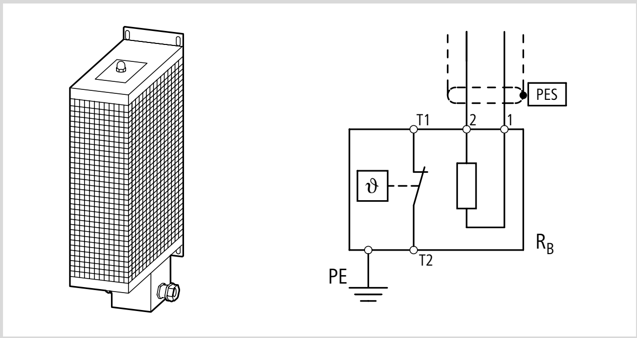

Figure 208: Braking resistance DE4-BR1…

Resistor with thermostat

Ingress protection: IP 20

→ For technical data for the braking resistors, see the Main Catalogues.

Example for assigned resistors DE4-BR1…

DV51-	Assigned motor rating	DC link voltage			Assigned braking resistor			
	P	(PNU b096)	R_{min}	ED_{max}		R_{Bges}	P_D 1)	ED
	kW		Ω	%		Ω	W	%
320-4K0	4	370 V DC (330 – 395 V)	100	100	6 × DE4-BR1-240-285 (serial/parallel)	160	1710	43
320-5K5	5.5		50	70	6 × DE4-BR1-100-200 (serial/parallel)	67	1200	22
320-7K5	7.5		50	70	8 × DE4-BR1-100-200 (serial/parallel)	50	1600	21
322-025	0.25		100	80	DE4-BR1-200-100	200	100	40
322-037	0.37		100	80	DE4-BR1-200-100	200	100	27
322-055	0.55		100	80	DE4-BR1-100-200	100	200	36
322-075	0.75		35	39	DE4-BR1-100-200	100	200	27
322-1K1	1.1		35	39	DE4-BR1-082-245	82	245	22
322-1K5	1.5		35	70	2 × DE4-BR1-082-245 (parallel)	41	490	33
322-2K2	2.2		35	100	2 × DE4-BR1-082-245 (parallel)	41	490	22
340-037	0.37	740 V DC (660 – 790 V)	180	36	DE4-BR1-200-100	200	100	27
340-075	0.75		180	60	DE4-BR1-240-285	240	285	38
340-1K5	1.5		180	90	2 × DE4-BR1-100-200 (serial)	200	400	27
340-2K2	2.2		100	67	2 × DE4-BR1-082-245 (serial)	164	490	22
340-3K0	3		100	100	3 × DE4-BR1-370-215 (parallel)	123	645	22
340-4K0	4		100	100	6 × DE4-BR1-240-285 (serial/parallel)	160	1710	43
340-5K5	5.5		50	70	6 × DE4-BR1-100-200 (serial/parallel)	67	1200	22
340-7K5	7.5		50	70	8 × DE4-BR1-100-200 (serial/parallel)	50	1600	21

1) P_D = continuous braking power of resistor or resistor combination

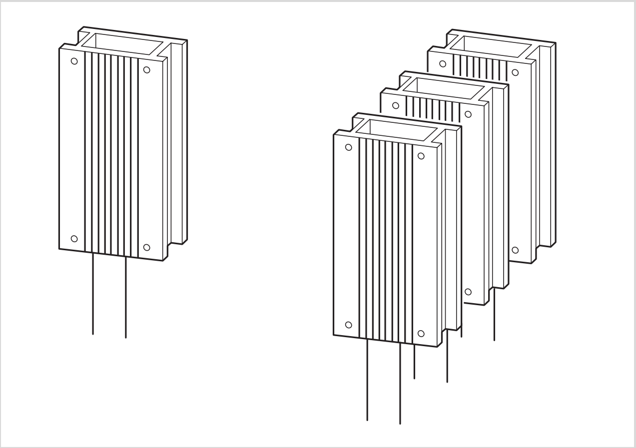

Figure 209: Braking resistor BWD…

Ingress protection: IP 65

KOCH

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→ For technical data for the BWD series braking resistors, see the manufacturer's instructions from Koch.

Example for assigned resistors BWD…

DV51-	Assigned motor rating	Internal DC link voltage			Assigned braking resistor[1]			
	P	(PNU b096)	R_{min}	DF_{max}		R_{Bges}	P_D[2]	ED
	kW		Ω	%		Ω	W	%
320-4K0	4	370 V DC (330 – 395 V)	100	100	5 × BWD500022 (serial)	110	1000	25
320-5K5	5.5		50	70	6 × BWD500300 (parallel)	50	1200	22
320-7K5	7.5		50	70	8 × BWD500430 (parallel)	54	1600	21
322-025	0.25		100	80	BWD250100	100	100	40
322-037	0.37		100	80	BWD250100	100	100	27
322-055	0.55		100	80	BWD500100	100	200	36
322-075	0.75		35	39	1 × BWD500040	40	200	27
322-1K1	1.1		35	39	2 × BWD500100 (parallel)	50	400	36
322-1K5	1.5		35	70	2 × BWD600100 (parallel)	50	480	32
322-2K2	2.2		35	100	2 × BWD600100 (parallel)	50	480	22

DV51-	Assigned motor rating	Internal DC link voltage			Assigned braking resistor[1)]			
	P	(PNU b096)	R_{min}	DF_{max}		R_{Bges}	P_D[2)]	ED
	kW		Ω	%		Ω	W	%
340-037	0.37	740 V DC (660 – 790 V)	180	36	BWD250200	200	100	27
340-075	0.75		180	60	BWD500200	200	200	27
340-1K5	1.5		180	90	2 × BWD500430 (parallel)	215	400	27
340-2K2	2.2		100	67	2 × BWD600200 (parallel)	100	480	22
340-3K0	3		100	100	3 × BWD600300 (parallel)	100	720	24
340-4K0	4		100	100	4 × BWD600100 (serial/parallel)	100	960	24
340-5K5	5.5		50	70	6 × BWD500300 (parallel)	50	1200	22
340-7K5	7.5		50	70	8 × BWD500430 (parallel)	54	1600	21

1) Short-circuit proof, intrinsically safe resistor in anodized aluminium enclosure (thermostat as optionally available).

2) P_D = continuous braking power of resistor or resistor combination

Upgrading from DV5 to DV51

Manual voltage boost

This section contains information about converting the manual voltage boost values (PNU A042) from the DV5 to the DV51.

The percentage manual boost range of the DV5 was 0 to 99 % (the default was 11 %), whereas the DV51's range is 0 to 20 % (default: 5 %).

DV5	a	DV51
A03 = 50 Hz		A003 = 50 Hz
A43 = 10 %		A043 = 10 %
A42 = 50 %		A042 = ?

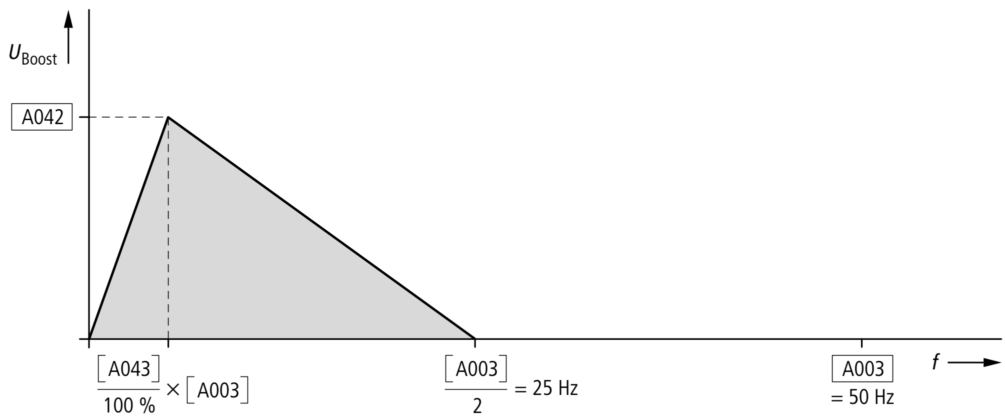


Figure 210: Manual voltage boost

$$[A042] = [A42] \times \frac{20\ \%}{99\ \%} \times \left(1 - \frac{[A43]}{50\ \%}\right)$$

$$[A042] = 50\ \% \times \frac{20\ \%}{99\ \%} \times \left(1 - \frac{10\ \%}{50\ \%}\right)$$

$$[A042] = 8.1\ \%$$

To exhibit the same boost behaviour as the DV5, this value must be set to 8.1 % in the DV51.

Abbreviations of parameters and functions

Designation Message	Function, description German	English
2CH	Second time ramp	2-stage acceleration and deceleration
ADD	Add frequency offset	Add Frequency (Offset)
AL	Fault signal	Alarm signal
AT	Selection of the analog reference value source (AT = reference current 4 to 20 mA)	Analog input voltage/current select
AVR	Automatic voltage regulation	Automatic voltage regulation
CF1 … CF4	Binary input (fixed frequency, fixed reference value)	Binary encoded (fixed frequency)
DB	DC braking	DC Braking
DWN	Deceleration (motor potentiometer)	DOWN-Function (motorized speed potentiometer)
EXT	Input for external malfunction signals	External Trip
F-TM	Control signal terminals mode enabled	Force Terminal Mode
FA1, FA2	Frequency arrival signal (set value reached or exceeded)	Frequency arrival
FRS	Controller inhibit (the motor coasts to a stop)	Free-run Stop
FWD	Clockwise rotating field (forward)	Forward Run
F/R	Direction of rotation (3-wire)	FWD/REV (3-wire interface)
JOG	Jog mode	Jogging
OD	PID control deviation signal	Output deviation for PID control
OL	Overload signal	Overload advance signal
OPE	LCD keypad	Operator Control
FM	Frequency display	Frequency monitor
PID	Activation of PID control	PID-Controller Enable
PIDC	Reset I-component (PID control)	Reset PID-Controller integrator
PTC	Thermistor, PTC thermistor	Thermal Protection (Positive temperature coefficient)
RDY	Reduced response time	Ready
REV	Reverse (backwards, anticlockwise rotating field)	Reverse Run
RST	Reset command	Reset
RUN	Run signal	Running signal
SET	Second parameter set	Select Set 2nd Data
SFT	Software protection to prevent overwrite of parameters	Software lock function
SP-SET	Special functions in the second parameter set	Select Special Set 2nd Data
STA	Pulse start (3-wire)	Start (3-wire interface)
STP	Pulse stop (3-wire)	Stop (3-wire interface)
UDC	Reset frequency (motor potentiometer)	Remote Control Data clearing
UP	Accelerate (motor potentiometer)	UP-Function (motorized speed potentiometer)
USP	Unattended start protection	Unattended start protection

Table for user-defined parameter settings

Parameter list for DV51 frequency inverters.

For a detailed description of the parameters, see the specified page in the manual (AWB8230-1540G).

Frequency inverters DV51-322-… (single- and three-phase mains connection, rated voltage 230 V, 50/60 Hz) and DV51-340-… (three-phase mains connection, rated voltage 400 V, 50/60 Hz) work with the European operating system. The default settings are listed in the DS column. The DV51-320-… devices can be used only on three-phase AC mains (200/215/220/230/240 V, 50/60 Hz) and are supplied with the US version of the operating system. The default values that apply here are shown in curly brackets {xx}.

PNU = parameter number displayed on the LCD keypad.

RUN = access rights to parameters in RUN mode (RUN LED is lit):

b031 = 10 = extended access rights to parameters in RUN mode (RUN LED is lit):

- ✓ = enabled.
- – = disabled.

Enter your application-specific settings in the “User setting” column in the table below.

→ The parameters of the second parameter set (PNU **2**…) always have the figure “2” in the first place and a grey background in the table. On keypad DEX-KEY-… they are displayed only when this function is enabled (→ PNU C001 = 08: SET).

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
A001	–	–	Reference value source selection	00:	Potentiometer (optional keypad DEX-KEY-6)	01	95	
				01:	Analog input: Control signal terminals O and OI			
				02:	Functions PNU F001 or A020			
				03:	Serial interface (Modbus)			
				10:	Calculator (calculated value of CAL)			
A201	–	–	Frequency reference value source selection (second parameter set)	Value → PNU A001		01	95	
A002	–	–	Start signal source selection	01:	Digital input (FWD/REV)	01	77	
				02:	Start key, (optional keypad DEX-KEY-…)			
				03:	Serial interface (Modbus)			
				04:	Potentiometer (optional keypad DEX-KEY-6)			
A202	–	–	Start signal source selection (second parameter set)	Value → PNU A002		01	77	
A003	–	–	Base frequency	30 – 400 Hz, up to value of PNU A004 [Hz]		50 {60}	72	
A203	–	–	Base frequency (second parameter set)	30 – 400 Hz, up to value of PNU A004 [Hz]		50 {60}	72	
A004	–	–	End frequency (f_{max})	30 – 400 Hz		50 {60}	72	
A204	–	–	End frequency (f_{max}) (second parameter set)	Values → PNU A004		50 {60}	72	

PNU	RUN	b031 = 10	Name	Value range	DS	page	User setting
A005	–	–	Analog input – selection (AT)	On active AT signal (→ PNU C001 = 16) a changeover takes place between: 00: analog inputs O and/or OI 01: analog inputs O and OI (digital input is ignored) 02: analog input O or potentiometer (optional keypad DEX-KEY-6) 03: analog input OI or potentiometer (optional keypad DEX-KEY-6)	00	99	
A011	–	✓	Analog input (O-L) – frequency at minimum reference value	0 – 400 Hz	0.0	97	
A012	–	✓	Analog input (O-L) – frequency at maximum reference value	0 – 400 Hz	0.0	97	
A013	–	✓	Analog input (O-L) – minimum reference value (offset)	0 – 100 %	0.0	97	
A014	–	✓	Analog input (O-L) – maximum reference value (offset)	0 – 100 %	100.	97	
A015	–	✓	Analog input (O-L) – selection of starting frequency applied to the motor at minimum reference value	00: Value of PNU A011 01: 0 Hz	01	97	
A016	–	✓	Analog input – filter time constant	1 – 8	8	97	
A020	✓	✓	Frequency reference input – reference value through keypad, PNU A001 must equal 02	0 – 400 Hz	0.0	95	
A220	✓	✓	Frequency reference input – reference value through keypad, PNU A001 must equal 02 (second parameter set)	0 – 400 Hz	0.0	95	
A021	✓	✓	Frequency reference input – fixed frequency (1)	0 – 400 Hz	0.0	95	
A022	✓	✓	Frequency reference input – fixed frequency (2)	0 – 400 Hz	0.0	95	
A023	✓	✓	Frequency reference input – fixed frequency (3)	0 – 400 Hz	0.0	95	
A024	✓	✓	Frequency reference input – fixed frequency (4)	0 – 400 Hz	0.0	95	
A025	✓	✓	Frequency reference input – fixed frequency (5)	0 – 400 Hz	0.0	95	
A026	✓	✓	Frequency reference input – fixed frequency (6)	0 – 400 Hz	0.0	95	
A027	✓	✓	Frequency reference input – fixed frequency (7)	0 – 400 Hz	0.0	95	
A028	✓	✓	Frequency reference input – fixed frequency (8)	0 – 400 Hz	0.0	95	
A029	✓	✓	Frequency reference input – fixed frequency (9)	0 – 400 Hz	0.0	95	

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
A030	✓	✓	Frequency reference input – fixed frequency (10)	0 – 400 Hz		0.0	95	
A031	✓	✓	Frequency reference input – fixed frequency (11)	0 – 400 Hz		0.0	95	
A032	✓	✓	Frequency reference input – fixed frequency (12)	0 – 400 Hz		0.0	95	
A033	✓	✓	Frequency reference input – fixed frequency (13)	0 – 400 Hz		0.0	95	
A034	✓	✓	Frequency reference input – fixed frequency (14)	0 – 400 Hz		0.0	95	
A035	✓	✓	Frequency reference input – fixed frequency (15)	0 – 400 Hz		0.0	95	
A038	✓	✓	Jog mode – jog mode reference value	0 – 9.99 Hz		1.00	109	
A039	–	✓	Jog mode – motor stop method	00:	Free coasting	00	109	
				01:	Deceleration ramp			
				02:	DC braking			
A042	✓	✓	Boost, manual voltage boost	0 – 20 %		5.0	74	
A242	✓	✓	Boost, manual voltage boost (second parameter set)	0 – 20 %		0.0	74	
A043	✓	✓	Boost, transition frequency for maximum voltage boost	0 – 50 %		3.0	74	
A243	✓	✓	Boost, transition frequency for maximum voltage boost (second parameter set)	0 – 50 %		0.0	74	
A044	–	–	*U*/*f* characteristic	00:	Constant torque curve	02	74	
				01:	Reduced torque curve			
				02:	SLV active			
A244	–	–	*U*/*f* characteristic (second parameter set)	Values → PNU A044		02	74	
A045	–	–	*U*/*f* characteristic, output voltage	20 – 100 %		100	74	
A245	–	–	*U*/*f* characteristic, output voltage (second parameter set)	Values → PNU A045		100	74	
A046	✓	✓	SLV, gain factor, automatic voltage compensation	0 – 255		100	75	
A246	✓	✓	SLV, gain factor, automatic voltage compensation (second parameter set)	0 – 255		100	75	
A047	✓	✓	SLV, gain factor, automatic slip compensation	0 – 255		100	75	
A247	✓	✓	SLV, gain factor, automatic slip compensation (second parameter set)	0 – 255		100	75	

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
A051	–	✓	DC braking	00:	Off: Disabled	00	133	
				01:	On: Enabled			
A052	–	✓	DC braking – starting frequency	0 – 60 Hz		0.5	133	
A053	–	✓	DC braking – waiting time	0 – 5 s		0.0	133	
A054	–	✓	DC braking torque	0 – 100 %		0.	133	
A055	–	✓	DC braking duration	0 – 60 s		0.0	133	
A056	–	✓	DC braking – behaviour on activation of the digital input (DB)	00:	Timed braking according to value of PNU A055	01	133	
				01:	Continuous operation			
A061	–	✓	Maximum operating frequency	0 – 400 Hz		0.0	103	
A261	–	✓	Maximum operating frequency (second parameter set)	0 – 400 Hz		0.0	103	
A062	–	✓	Minimum operating frequency	0 – 400 Hz		0.0	103	
A262	–	✓	Minimum operating frequency (second parameter set)	0 – 400 Hz		0.0	103	
A063	–	✓	Frequency jump (1)	0 – 400 Hz		0.0	104	
A064	–	✓	Frequency jump (1) – jump width	0 – 10 Hz		0.5	104	
A065	–	✓	Frequency jump (2)	0 – 400 Hz		0.0	104	
A066	–	✓	Frequency jump (2) – jump width	0 – 10 Hz		0.5	104	
A067	–	✓	Frequency jump (3)	0 – 400 Hz		0.0	104	
A068	–	✓	Frequency jump (3) – jump width	0 – 10 Hz		0.5	104	
A071	–	✓	PID control	00:	Off: Disabled	00	140	
				01:	On: Enabled			
A072	✓	✓	PID controller – P-component	0.2 – 5.0		0.1	140	
A073	✓	✓	PID controller – I-component	0.0 – 150 s		0.1	140	
A074	✓	✓	PID controller – D-component	0.00 – 100 s		0.01	140	
A075	–	✓	PID control, display factor	0.01 – 99.99		1.00	140	
A076	–	✓	PID controller – actual value signal PV input	00:	Analog input OI (4 – 20 mA)	00	140	
				01:	Analog input O (0 – 10 V)			
				02:	Serial interface (Modbus)			
				10:	Calculated value (PNU A143)			
A077	–	✓	PID control – invert input signals	00:	Off: Disabled, reference value (+), actual value (–)	00	140	
				01:	On: Enabled, reference value (–), actual value (+)			
A078	–	✓	PID controller – output signal limit	0 – 100 %		0.0	141	
A081	–	–	Output voltage (AVR function)	00:	On: Enabled	00	71	
				01:	Off: Disabled			
				02:	DOFF: Disabled during deceleration			

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
A082	–	–	Output voltage (AVR motor rated voltage)	DV51-32…-…: 200, 215, 220, **230**, 240		230/400	71	
				DV51-340-…: 380, **400**, 415, 440, 460, 480				
				Default setting depends on series				
A092	✓	✓	Acceleration time 2	0.01 – 3000 s		15.00	101	
A292	✓	✓	Acceleration time 2 (second parameter set)	0.01 – 3000 s		15.00	101	
A093	✓	✓	Deceleration time 2	0.01 – 3000 s		15.00	101	
A293	✓	✓	Deceleration time 2 (second parameter set)	0.01 – 3000 s		15.00	101	
A094	–	–	Acceleration time, specify signal for changeover from acceleration time 1 to acceleration time 2	00:	Digital input (2CH)	00	101	
				01:	Frequency (PNU A095 or A096)			
A294	–	–	Acceleration time, specify signal for changeover from acceleration time 1 to acceleration time 2 (second parameter set)	00:	Digital input (2CH)	00	101	
				01:	Frequency (PNU A295 or A296)			
A095	–	–	Acceleration time, frequency for changeover from ramp time 1 to ramp time 2	0.0 – 400 Hz		0.0	101	
A295	–	–	Acceleration time, frequency for changeover from ramp time 1 to ramp time 2 (second parameter set)	0.0 – 400 Hz		0.0	101	
A096	–	–	Deceleration time, frequency for changeover from ramp time 1 to ramp time 2	0.0 – 400 Hz		0.0	102	
A296	–	–	Deceleration time, frequency for changeover from ramp time 1 to ramp time 2 (second parameter set)	0.0 – 400 Hz		0.0	102	
A097	–	–	Acceleration time, characteristic	00:	linear	00	102	
				01:	S curve			
A098	–	–	Deceleration time, characteristic	00:	linear	00	102	
				01:	S curve			
A101	–	✓	Analog input (OI-L), frequency at minimum reference value	0 – 400 Hz		0.0	98	
A102	–	✓	Analog input (OI-L), frequency at maximum reference value	0 – 400 Hz		0.0	98	
A103	–	✓	Analog input (OI-L), minimum reference value (offset)	0 – 100 %		0.	98	
A104	–	✓	Analog input (OI-L), maximum reference value (offset)	0 – 100 %		100.	98	
A105	–	✓	Analog input (OI-L), selection of starting frequency applied to the motor at minimum reference value	00:	Value from PNU A101	01	98	
				01:	0 Hz			

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
A141	–	✓	Calculator – select input A	00:	Value of keypad (option DEX-KEY-…)	02	136	
				01:	Potentiometer of keypad (option DEX-KEY-6)			
				02:	Analog input (O)			
				03:	Analog input (OI)			
				04:	Serial interface (Modbus)			
A142	–	✓	Calculator – select input B	Values → PNU A141		03	136	
A143	–	✓	Calculator – operation	00:	Addition (A + B)	00	136	
				01:	Subtraction (A – B)			
				02:	Multiplication (A × B)			
A145	✓	✓	Calculator – offset frequency	0 – 400 Hz		0.0	137	
A146	–	✓	Calculator – offset frequency, prefix	Value from PNU A145		00	137	
				00:	plus			
				01:	minus			
A151	–	✓	Potentiometer (optional keypad), starting frequency	0 – 400 Hz		0.0	100	
A152	–	✓	Potentiometer (optional keypad), end frequency	0 – 400 Hz		0.0	100	
A153	–	✓	Potentiometer (optional keypad), starting point	0 – 100 %		0	100	
A154	–	✓	Potentiometer (optional keypad), end point	0 – 100 %		100	100	
A155	–	✓	Potentiometer (optional keypad), starting frequency source	00:	Value from PNU A151	01	100	
				01:	0 Hz			

PNU	RUN	b031 = 10	Name	Value range	DS	page	User setting
b001	–	✓	POWER, restarting mode after power supply interruption	00: Fault signal E 09, automatic restart at 0 Hz 01: Automatic restart at set starting frequency after expiry of time set with PNU b003. 02: After the time set with PNU b003 has elapsed, the frequency inverter synchronizes to the current motor rotation speed and the motor is accelerated to the current reference value in the set ramp times. 03: After the time set under PNU b003 has elapsed, the inverter synchronizes to the current motor rotation speed and the motor brakes to a stop in the set deceleration time. A fault message is then displayed.	00	124	
b002	–	✓	POWER, permissible power supply downtime	0.3 – 25 s	1.0	124	
b003	–	✓	POWER, waiting time before automatic restart after power supply failure	0.3 – 100 s	1.0	124	
b004	–	✓	POWER, fault signal on intermittent supply voltage failure or undervoltage	00: Off: Disabled 01: On: Enabled	00	125	
b005	–	✓	POWER, number of automatic restarting attempts after intermittent supply voltage failure or undervoltage	00: 16 restarts 01: No limit	00	125	
b012	–	✓	Thermal overload, tripping current	0.2 – 1.2 × I_e [A] Depending on frequency inverter's rated current (I_e)	xx	122	
b212	–	✓	Thermal overload, tripping current (second parameter set)	0.2 – 1.2 × I_e [A] Default, dependent on frequency inverter's rated current (I_e)	xx (I_e)	122	
b013	–	✓	Thermal overload, characteristic (torque curve)	00: Reduced torque 1 01: Constant torque 02: Reduced torque 2	01	122	
b213	–	✓	Thermal overload, characteristic (torque curve) (second parameter set)	Values → PNU b013	01	122	
b021	–	✓	Motor current limitation – function	00: Off: Disabled 01: On: Enabled in acceleration phase and at constant speed 02: Enabled only at constant speed	01	120	
b221	–	✓	Motor current limitation, function (second parameter set)	Values → PNU b021	01	120	

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
b022	–	✓	Tripping current for motor current limitation	0.1 – 1.5 × I_e [A] Default, dependent on frequency inverter's rated current (I_e)		I_e × 1.5	120	
b222	–	✓	Motor current limitation, tripping current (second parameter set)	Values → PNU b022		I_e × 1.5	120	
b023	–	✓	Motor current limitation, deceleration time constant	0.1 – 3000 s		1.0	120	
b223	–	✓	Motor current limitation, deceleration time constant (second parameter set)	0.1 – 3000 s		1.0	120	
b028	–	✓	Motor current limitation, limit current selection	00:	Value of PNU b022	00	120	
				01:	Analog input O-L			
b228	–	✓	Motor current limitation, limit current selection (second parameter set)	00:	Value of PNU b222	00	120	
				01:	Analog input O-L			
b031	–	✓	Parameter access inhibit (access rights)	00:	Access to all parameters except PNU b031 disabled when digital input SFT is enabled (→ PNU C001: 15)	01	153	
				01:	Access to all parameters except PNU b031 and F001 (A020, A220, A021 to A035, A038) disabled when digital input SFT is enabled (→ PNU C001: 15)			
				02:	Access to all parameters disabled, except PNU b031			
				03:	Access rights to all parameters except PNU b031 and F001 (A020, A220, A021 to A035, A038) disabled			
				10:	Extended access rights to parameters in RUN mode.			
b080	✓	✓	Analog output AM, gain factor	0 – 255		100	112	
b082	–	✓	Increased starting frequency (e.g. at high static friction)	0.5 – 9.9 Hz		0.5	117	
b083	–	–	Pulse frequency	2 – 14 kHz		5.0	151	
b084	–	–	Initializing – function	00:	Clear fault register	00	154	
				01:	Load default settings (DS)			
				02:	Clear fault register and load default settings (DS)			
b085	–	–	Initialization, country-specific default settings	00:	Japan	01 {02}	154	
				01:	Europe			
				02:	USA			
b086	✓	✓	Frequency indication scaling factor for value in PNU d007	0.1 – 99.9		1.0	112	
b087	–	✓	Stop key, (optional keypad DEX-KEY-…)	00:	Enabled	00	149	
				01:	Disabled			

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
b088	–	✓	Motor restart after removal of the FRS signal	00:	Restart with 0 Hz	00	87	
				01:	Restart with the determined output frequency (current motor speed)			
b090	–	✓	Braking transistor, permissible percentage duty factor within a 100 s interval	0 – 100 %		00	134	
				0 %: Braking transistor disabled				
				> 0 %: Braking transistor enabled				
b091	–	–	Stop key, (optional keypad DEX-KEY-…), selection of motor stop on actuation	00:	DEC, braking to 0 Hz with deceleration ramp	00	149	
				01:	FRS, free coasting down to 0 Hz			
b092	–	–	Device fan, configuration	00:	The built-in fan is always switched on.	00	150	
				01:	The built-in fan is switched on during operation (RUN mode); automatic switch-off 5 min after Stop signal.			
				02:	Built-in fan operation is temperature-controlled.			
b095	–	✓	Braking transistor, control	00:	Function disabled	00	135	
				01:	Enabled in RUN mode			
				02:	Always enabled			
b096	–	✓	Braking transistor, starting voltage threshold	330 – 395 V (U_e = 230 V)		360/720	135	
				660 – 790 V (U_e = 400 V)				
				Default, dependent on rated voltage of DV51 (U_e)				
b130	–	✓	Internal DC link, stop deceleration ramp on overvoltage in the internal DC link	00:	Off: Disabled	00	150	
				01:	On: Enabled			
b131	✓	✓	Deceleration ramp, switching threshold dependent on internal DC link voltage	330 – 395 V (U_e = 230 V)		380/760	150	
				660 – 790 V (U_e = 400 V)				
				Default, dependent on rated voltage (U_e)				
b140	–	✓	Suppress stop on overcurrent	00:	Off: Disabled	00	120	
				01:	On: Enabled			
b150	–	✓	Clock frequency, automatic clock frequency reduction on overtemperature	00:	Off: Disabled	00	151	
				01:	On: Enabled			
b151	✓	✓	Inverter, reduce inverter’s response time (RDY) to a control signal	00:	OFF	00	151	
				01:	ON			

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
C001	–	–	Digital input 1 – function	00:	FWD: Clockwise rotating field	00	85	
				01:	REV: Anticlockwise rotating field			
				02:	CF1: Fixed frequency selection, bit 0 (LSB)			
				03:	CF2: Fixed frequency selection, bit 1			
				04:	CF2: Fixed frequency selection, bit 2			
				05:	CF4: Fixed frequency selection, bit 3 (MSB)			
				06:	JOG, jog mode			
				07:	DB, DC braking			
				08:	SET: Select second parameter set			
				09:	2CH: Second time ramp			
				11:	FRS: Free run stop (free coasting, = controller inhibit)			
				12:	EXT: External fault message			
				13:	USP: Unattended start protection			
				15:	SFT: Parameter access inhibit			
				16:	AT: change over to analog input OI			
				18:	RST: Reset fault signal			
				19:	PTC: PTC thermistor input (digital input 5 only)			
				20:	STA: Three-wire control start signal			
				21:	STP: Three-wire control stop signal			
				22:	F/R: Three-wire control, direction of rotation			
				23:	PID: Disable PID control			
				24:	PIDC: Reset integral component of PID control			
				27:	UP: Acceleration (motor potentiometer)			
				28:	DWMN: Deceleration (motor potentiometer)			
				29:	UDC: Motor potentiometer, reset saved value of motor potentiometer to 0 Hz			
				31:	OPE: Operator keypad			
				50:	ADD: Offset – add value from PNU A145 to frequency reference value.			
				51:	F-TM: Digital input, mode: control signal terminals preferred.			
				52:	RDY: Inverter, reduce response time to control signals			
				53:	SP-SET: Second parameter set with special functions			
				255:	-- (no function)			
C201	–	–	Digital input 1 – function (second parameter set)	Values → PNU C001		00	85	

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
C002	–	–	Digital input 2 – function	Values → PNU C001		01	85	
C202	–	–	Digital input 2 – function (second parameter set)	Values → PNU C001		01	85	
C003	–	–	Digital input 3 – function	Values → PNU C001		02 {16}	85	
C203	–	–	Digital input 3 – function (second parameter set)	Values → PNU C001		02	85	
C004	–	–	Digital input 4 – function	Values → PNU C001		03 {13}	85	
C204	–	–	Digital input 4 – function (second parameter set)	Values → PNU C001		03	85	
C005	–	–	Digital input 5 – function	Values → PNU C001		18 {09}	85	
C205	–	–	Digital input 5 – function (second parameter set)	Values → PNU C001		18	85	
C006	–	–	Digital input 6 – function	Values → PNU C001		09	85	
C206	–	–	Digital input 6 – function (second parameter set)	Values → PNU C001		09	85	
C011	–	–	Digital input 1 – logic	00:	High signal triggers switching	00	86	
				01:	Low signal triggers switching			
C012	–	–	Digital input 2 – logic	Values → PNU C011		00	86	
C013	–	–	Digital input 3 – logic	Values → PNU C011		00	86	
C014	–	–	Digital input 4 – logic	Values → PNU C011		00	86	
C015	–	–	Digital input 5 – logic	Values → PNU C011		00	86	
C016	–	–	Digital input 6 – logic	Values → PNU C011		00	86	

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
C021	–	–	Digital output 11 – signal	00:	RUN: In operation	01	113	
				01:	FA1: Frequency reference value reached			
				02:	FA2: Frequency signal – output frequency exceeds value in PNU C042 (during acceleration ramp) or PNU C043 (during deceleration ramp)			
				03:	OL: Overload warning – motor current exceeds value in PNU C041.			
				04:	OD: PID control – reference/actual value difference exceeds signalling threshold set with PNU C044.			
				05:	AL: Fault – fault/alarm signal			
				06:	Dc: Warning – Reference value at input O (0 to +10 V) lower than value in PNU b082 or current signal at input OI below 4 mA.			
				07:	FBV: PID control – Actual value monitoring (PV) signal on breach of limit values PNU C052/C053.			
				08:	NDc: Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.			
				09:	LOG: Shows result of logic link performed through PNU C143.			
				10:	ODc: Fault/warning: Communication overload or interrupted (with optional DE51-NET-CAN, DE51-NET-DP).			
C022	–	–	Digital output 12 – signal	Values → PNU C021		00	113	
C026	–	–	Relay K1 – signal	Values → PNU C021		05	116	
C028	–	–	Analog output AM, measured value indication selection	00:	f-Out: Current output frequency	00	112	
				01:	I-Out: Current output current			
C031	–	–	Digital output 11 – logic	00:	Normally open contact (NO)	01, 00	114	
				01:	Normally closed contact (NC)			
C032	–	–	Digital output 12 – logic	Values → PNU C031		01, 00	114	
C036	–	–	Relay K1 (K11-K12) – logic	Values → PNU C031		01	116	
C041	–	✓	Output function – warning threshold for overload signal (OL)	$0 - 2 \times I_e$ [A] Default, dependent on frequency inverter's rated current (I_e)		I_e	121	
C241	–	✓	Output function – warning threshold for overload warning (OL) (second parameter set)	$0 - 2 \times I_e$ [A] Default, dependent on frequency inverter's rated current (I_e)		I_e	121	
C042	–	✓	Output function – signalling threshold for frequency signal FA2 during acceleration	0 – 400 Hz		0.0	118	
C043	–	✓	Output function – signalling threshold for frequency signal FA2 during deceleration	0 – 400 Hz		0.0	118	

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
C044	–	✓	Output function: Signalling threshold, maximum PID control deviation	0 – 100 %		3.0	145	
C052	–	✓	PID controller – switch-off threshold for second stage of PID controller	0 – 100 %		100	148	
C053	–	✓	PID controller – switch-on threshold for second stage of PID controller	0 – 100 %		0.0	148	
C071	–	✓	Communication – baud rate	04	4800 bit/s	06	159	
				05:	9600 bit/s			
				06:	19200 bit/s			
C072	–	✓	Communication – address	1 – 32		1	160	
C074	–	✓	Communication – parity	00:	None	00	160	
				01:	Even			
				02:	Odd			
C075	–	✓	Communication – stop bits	1:	1 bit	1	160	
				2:	2 bits			
C076	–	✓	Communication: Behaviour of frequency inverter on communication errors	00:	Switch off on fault signal E60	02	160	
				01:	Decelerate to standstill at deceleration ramp and then switch off with error E60.			
				02:	No fault signal			
				03:	FRS: Free run stop (free coasting, = controller inhibit)			
				04:	DEC: Braking to 0 Hz at set deceleration ramp			
C077	–	✓	Communication – set monitoring time (watchdog).	0 – 99.99 s		0.00	160	
C078	–	✓	Communication – waiting time (latency between request and response)	0 – 1000 ms		0	160	
C081	✓	✓	Analog input O – reference value signal compensation	0 – 200 %		100	77	
C082	✓	✓	Analog input OI – reference value signal compensation	0 – 200 %		100	77	
C085	✓	✓	Thermistor compensation (digital input 5)	0 – 200 %		100	123	
C086	✓	✓	Analog output AM – offset compensation	0 – 10 V		0.0	112	
C091	✓	✓	Debug mode, view additional parameters	00:	Do not show parameter	00	156	
				01:	Show parameter			
C101	–	✓	Motor potentiometer – reference value for motor potentiometer after power supply interruption	00:	Clear last value and use default for PNU F001	00	108	
				01:	Use saved motor potentiometer value set with UP/DWN function through digital inputs.			

PNU	RUN	b031 = 10	Name	Value range		DS	page	User setting
C102	–	✓	Reset function (RST) – response to a Reset signal	00:	On a rising edge the fault signal is reset and the motor is stopped.	00	129	
				01:	On a falling edge the fault signal is reset and the motor is stopped.			
				02:	On a rising edge the fault message is reset.			
C141	–	–	Logic function – select input A	00:	RUN: In operation	00	139	
				01:	FA1: Frequency reference value reached			
				02:	FA2: Frequency signal – output frequency exceeds value in PNU C042 (during acceleration ramp) or PNU C043 (during deceleration ramp)			
				03:	OL: Overload warning – motor current exceeds value in PNU C041.			
				04:	OD: PID control – reference/actual value difference exceeds signalling threshold set with PNU C044.			
				05:	AL: Fault – fault/alarm signal			
				06:	Dc: Warning – Reference value at input O (0 to +10 V) lower than value in PNU b082 or current signal at input OI below 4 mA.			
				07:	FBV: PID control – Actual value monitoring (PV) signal on breach of limit values PNU C052/C053.			
				08:	NDc: Fault/warning dependent on PNU C077 – communication watchdog timer has expired: communications are faulty.			
				10:	ODc: Fault/warning: Communication overload or interrupted (with optional DE51-NET-CAN, DE51-NET-DP).			
C142	–	–	Logic function – select input B	Values → PNU C141		01	139	
C143	–	–	Logic function – select link [LOG]	00:	[LOG] = A AND B	00	139	
				01:	[LOG] = A OR B			
				02:	[LOG] = A XOR B			
C144	–	✓	Digital output 11 – deceleration time (On)	0 – 100 s		0.0	114	
C145	–	✓	Digital output 11 – deceleration time (Off)	0 – 100 s		0.0	114	
C146	–	✓	Digital output 12 – deceleration time (On)	0 – 100 s		0.0	114	
C147	–	✓	Digital output 12 – deceleration time (Off)	0 – 100 s		0.0	114	
C148	–	✓	Relay K1 – deceleration time (On)	0 – 100 s		0.0	116	
C149	–	✓	Relay K1 – deceleration time (Off)	0 – 100 s		0.0	116	

PNU	RUN	b031 = 10	Name	Value range	DS	page
d001	✓	✓	Output frequency display	0.0 – 400.0 Hz (0.1 Hz)	–	60
d002	✓	✓	Output current display	0.0 – 999.9 A (0.1 A)	–	60
d003	✓	✓	Direction of rotation display	• F: Clockwise (forward) rotating field • O: STOP • R: Anticlockwise (reverse) rotating field	–	60
d004	✓	✓	PID feedback display	• 0.00 – 99.99 (0.01 %) • 100.0 – 999.9 (0.1 %) • 1000 – 9999 (1 %)	–	141, 60
d005	✓	✓	Indication – status of digital inputs 1 to 6	–	–	60
d006	✓	✓	Indication – status of digital outputs 11 and 12, and relay K1	–	–	60
d007	✓	✓	Indication of scaled output frequency	0.00 – 9999 (0.01/0.1/1/10 Hz)	–	60
d013	✓	✓	Indication – output voltage	0 – 600 V (1 V)	–	60
d016	✓	✓	Indication – operation time counter	• 0 – 9999 (1 h) • 10000 – 99990 (10 h) • 100000 – 999000 (1000 h)	–	60
d017	✓	✓	Indication – mains On time	• 0 – 9999 (1 h) • 10000 – 99990 (10 h) • 100000 – 999000 (1000 h)	–	60
d080	✓	✓	Indication – total number of occurred faults	0 – 65530	–	60
d081	✓	✓	Indication – fault 1 (last fault signal)	Values at time of power Off: • Fault signal E… • Frequency (Hz) • Current (A) • Internal DC link voltage (VDc) • Total operating hours in RUN mode • Total Power On time, power supply connected (h)	–	60
d082	✓	✓	Indication – fault 2	Values → PNU d081	–	60
d083	✓	✓	Indication – fault 3	Values → PNU d081	–	60

PNU	RUN	b031 = 10	Name	Value range	DS	page	Reference value
F001	✓	✓	Reference value – input through optional keypad DEX-KEY-…	• Frequency: 0.0 – 400 Hz (0.1 Hz) • Process variable 0.00 to 9999 % with PID control enabled (A071 = 01) with display factor (A075).	0.0	95	
F002	✓	✓	Acceleration time 1	• 0.01 – 99.99 (0.01 s) • 100.0 – 999.9 (0.1 s) • 1000 – 3000 (1 s)	10.00	80	
F202	✓	✓	Acceleration time 1 (second parameter set)	Values → PNU F002	10.00	80	
F003	✓	✓	Deceleration time 1	• 0.01 – 99.99 (0.01 s) • 100.0 – 999.9 (0.1 s) • 1000 – 3000 (1 s)	10.00	80	

PNU	RUN	b031 = 10	Name	Value range	DS	page	Reference value
F203	✓	✓	Deceleration time 1 (second parameter set)	Values → PNU F003	10.00	80	
F004	✓	✓	Direction of rotation – function of Start key (optional keypad DEX-KEY-…)	• 00: Clockwise rotating field (FWD) • 01: Anticlockwise rotating field (REV)	00	80	

PNU	RUN	b031 = 10	Name	Value range		DS	page
H003	–	–	Motor – assigned rating [kW]/{HP} at rated voltage (U_e)	0.2; 0.4; 0.55; 0.75; 1.1; 1.5; 2.2; 3.0; 4.0; 5.5; 7.5; 11.0 {0.2; 0.4; 0.75; 1.5; 2.2; 3.7; 5.5; 7.5; 11.0} Default depends on rated voltage and type rating.		–	68
H203	–	–	Motor – assigned rating [kW]/{HP} at rated voltage (U_e) (second parameter set)	Values → PNU H003			68
H004	–	–	Motor – number of poles	2, 4, 6, 8		4	68
H204	–	–	Motor – number of poles (second parameter set)	Values → PNU H004		4	68
H006	✓	✓	Motor – stabilization constant	0 – 255		100	68
H206	✓	✓	Motor – stabilization constant (second parameter set)	Values → PNU F006		100	68
H007	–	–	Motor – voltage class	00:	• 200 V (230 V)	–	68
				01:	• 400 V		
				Default, dependent on rated voltage and type rating.			
H207	–	–	Motor – voltage class (second parameter set)	Values → PNU H007		–	68

UL® cautions, 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 r.m.s. symmetrical amperes, 240 V maximum". For models DV51-322.

Warning!
"Suitable for use on a circuit capable of delivering not more than 5000 r.m.s. symmetrical amperes, 480 V maximum". For models DV51-340.

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.

DV51-	Motor Output		Wiring		Applicable equipment
	kW	HP	Power Lines	Signal Lines	Fuse (class J) rated 600 V
320-4K0	4.0	5	AWG12/3.3 mm^2	18 to 28 AWG/0.14 to 0.75 mm^2 shielded wire. Use 18 AWG/0.75 mm^2 wire for the alarm signal wire (K11, K12, K14 terminals).	30 A
320-5K5	5.5	7 ½	AWG 10/5.3 mm^2		40 A
320-7K5	7.5	10	AWG 8/8.4 mm^2		50 A
322-018	0.18	¼	AWG16/1.3 mm^2		10 A
322-037	0.37	½			
322-055	0.55	¾			
322-075	0.75	1	AWG14/2.1 mm^2		15 A
322-1K1	1.1	1 ½	AWG14/2.1 mm^2		15 A
322-1K5	1.5	2	AWG12/3.3 mm^2		20 A (single-phase) 15 A (three-phase)
340-037	0.37	½	AWG16/1.3 mm^2		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 mm^2		15 A
340-4K0	4.0	5	AWG14/2.1 mm^2		15 A
340-5K5	5.5	7 ½	AWG12/3.3 mm^2		20 A
340-7K5	7.5	10	AWG12/3.3 mm^2		25 A

→ 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.

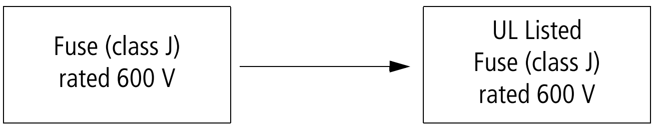
Terminal dimensions and tightening torque

The terminal screw dimensions for all DV51 inverters are listed in table 5 (→ page 38) and table 9 (→ page 42). 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.



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