MOELLER

Hardware and Engineering

DF4-...
Frequency Inverter
DE4-KEY-1
Keypad

07/98 AWB-C823-1278GB

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Warning!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (AWA) of the device concerned.
- Only suitably qualified personnel in accordance with EN 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 to the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference do not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that a line or wire breakage on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the low voltage for the 24 volt supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD 384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.

- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause damage to persons or property, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).
- According to their degree of protection frequency inverters may feature during operation live, bright metal, or possibly moving, rotating parts or hot surfaces.
- The impermissible removal of the necessary covers, improper installation or incorrect operation of motor or frequency inverter may cause the failure of the device and may lead to serious injury or damage.
- The relevant national regulations apply to all work carried on live frequency inverters.
- The electrical installation must be carried out in accordance with the relevant regulations (e. g. with regard to cable cross sections, fuses, PE).
- All work relating to transport, installation, commissioning and maintenance must only be carried out by qualified personnel. (IEC 60364 and HD 384 and national work safety regulations).
- Installations fitted with frequency inverters must be provided with additional monitoring and protective devices in accordance with the relevant safety regulations etc. Modifications to the frequency inverters using the operating software are permitted.
- All shrouds and doors must be kept closed during operation.
- In order to reduce hazards to persons or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the drive (increased motor speed or sudden standstill of motor). These measures include:
  - Other independent devices for monitoring safety-related variables (speed, travel, end positions etc.).
  - Electrical or non-electrical system related measures (interlocks or mechanical interlocks).
  - Live parts or cable connections of the frequency inverter must not be touched after it has been disconnected from the power supply due to the charge in capacitors. Appropriate warning signs must be provided.

Contents

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About This Manual

This manual contains the information you need to connect up the frequency inverter correctly and to configure the drive parameters to your requirements.

The information in this manual only applies to the specified hardware and software versions.

The manual is subdivided into 2 parts. Part 1 describes the frequency inverter models DF4-120, DF4-340 and DF4-341 together with all of the configurable parameters. The models are not described in separate sections. Furthermore, where differences and special points apply to a particular frequency inverter model, this is made clear in the text.

Part 2 describes the optional LCD keypad. The LCD keypad does not belong to the standard scope of delivery of the DF4 frequency inverter series. It is covered in this manual nonetheless, because you can also use it to configure the drive parameters.

The manual uses the following abbreviations and symbols:

PNU: Parameter number
WE: Factory setting

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This symbol refers to interesting tips and additional information.

Attention!
This symbol warns you of damage. This symbol warns you about instructions which should be observed to avoid possible damage to equipment, other items in the vicinity or data.

Warning!
This symbol warns you of serious damage. Other items in the vicinity or data may be seriously damaged or destroyed. Persons may be seriously or fatally injured.

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1 About The Product Family

System overview

The frequency inverters have a type designation based on the following code. The type code for frequency inverters shows its position in the Moeller product family:

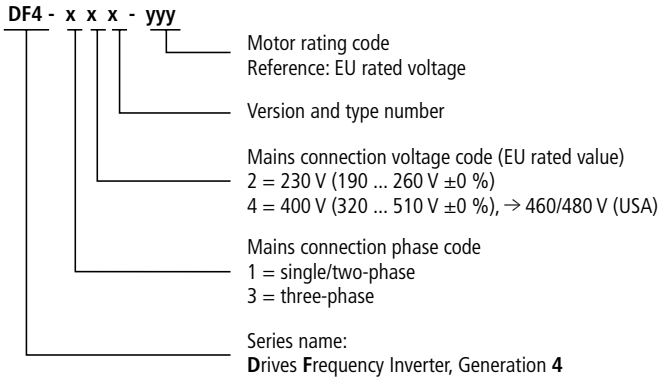

Figure 1: Structure of type code

The following example shows the type code for a typical frequency inverter.

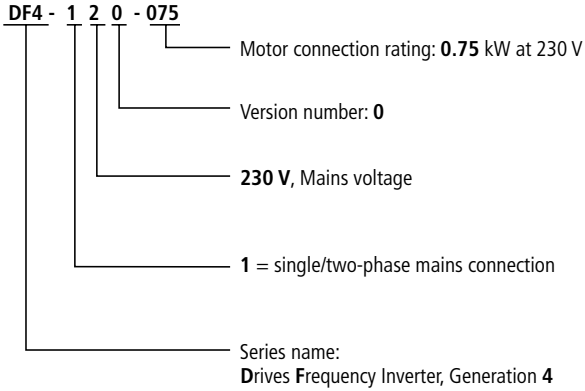

Figure 2: Type code for frequency inverters

Frequency inverters of the DF4 series convert the voltage and frequency of a 3-phase mains supply to a DC voltage and then generate 3-phase power with variable voltage and frequency. The variable 3-phase power output allows continuous adjustment of the speed of rotation of 3-phase asynchronous motors.

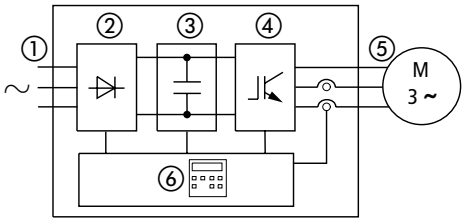

Figure 3: Block diagram of a frequency inverter

① Mains voltage (U_{LN}):
1(2) × 230 V, 50/60 Hz (DF4-120)
3 × 400 V, 50/60 Hz (DF4-340, DF4-341)
3 × 460 V, 50/60 Hz (DF4-340)
3 × 480 V, 50/60 Hz (DF4-341)

② 3-phase rectifier bridge converts AC power to DC.

③ DC internal bus with charging resistor and smoothing capacitor.
DC voltage (U_{ZK}) = $\sqrt{2}$ × Mains voltage (U_{LN})

④ The IGBT chopper converts the DC bus voltage to 3-phase power with variable voltage and frequency.

⑤ Output voltage (U_2):
3-phase AC with variable voltage, 0 to 100 % of the mains voltage (U_{LN})

Output frequency (f_2):
3-phase AC with variable frequency, 0 to 480 Hz

⑥ Rated output current (I_2N):
2.4 to 180 A; starting current 1.5 higher at a max. ambient temperature of 40 °C

Motor shaft rating (P_2):
0.37 to 2.2 kW at 230 V
0.75 to 90 kW at 400 V

⑦ Programmable control components contain modules to control the power section. They process the control commands, setpoints and actual values.

Features of the frequency inverter family

DF4-...	...-120	...-340	...-341
Compact construction	✓	✓	✓
Up to 150 % I_N overload for 1 min	✓	✓	✓
Chopper output short-circuit proof	✓	✓	✓
Earth fault test during power up	✓	✓	✓
Earth fault proof under all operating conditions	–	–	✓
Chopper frequency 9.2 kHz	✓	–	–
Chopper frequency optionally 4 kHz, 8 kHz, 12 kHz, 16 kHz	–	✓	✓
U/*f* characteristic control with constant U_{min} boost or auto-boost	✓	–	–
Optionally either motor current control or *U*/*f* characteristic control	–	✓	✓
Mains voltage compensation	✓	✓	✓
Motor slip compensation	✓	✓	✓
Configurable *U*/*f* characteristic with adjustable current limits	✓	✓	✓
PWM chopper with IGBT output stages	✓	✓	✓
Connections for interconnected DC bus and brake unit	✓	✓	✓
Galvanically isolated analog input/output	✓	✓	✓
Relay output (changeover contacts)	1	1	2
Galvanically isolated digital inputs with programmable functions	4	4	4
Up to three jog frequencies per parameter set	✓	✓	✓
DC injection brake	✓	✓	✓
TRIP-set and TRIP-reset functions	✓	✓	✓
Motor potentiometer	✓	✓	✓
Output frequency up to 240 Hz (480 Hz with limitations)	✓	–	–
Output frequency up to 480 Hz	–	✓	✓
Motor flying restart circuit	✓	✓	✓
Two parameter sets	✓	✓	✓
Running time meter, power on time meter	✓	✓	✓

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DF4-...	...-120	...-340	...-341
Temperate-dependent ventilator control	–	–	✓
Input for PTC motor temperature monitoring	–	–	✓
Plug-in accessories for control and parameter setting			
Optional LCD keypad DE 4-KEY-1 with parameter buffer	✓	✓	✓
RS 232/485 interface module DE 4-COM-2X	✓	✓	✓
InterBus-S fieldbus module DE 4-NET-S	✓	✓	✓
PROFIBUS-DP fieldbus module DE 4-NET-DP	✓	✓	✓
Suconet-K fieldbus module DE 4-NET-K	–	✓	✓

Version selection criteria

The main factor when choosing the correct model of frequency inverter is the rated motor current. The rated output current of the frequency inverter must be the same as or larger than the rated motor current.

The following motor data must be known: X

Type of motor (3-phase asynchronous motor),

Mains supply voltage = supply voltage of motor (3 AC; 400 V),

Rated motor current (guiding value, dependent on the method of connection and motor supply voltage),

Torque characteristics (quadratic or constant characteristic, with starting torque factor 1.5 higher),

Ambient temperature (max. temperature 40 °C).

When connecting several motors in parallel to the output of the frequency inverter, the motor currents are added geometrically, i.e. separately for the in-phase current and the reactive current components. The rating of the frequency inverter should be chosen to be large enough to supply both the total apparent current and the reactive current components.

If a motor is connected to the output of the frequency inverter when the latter is already under power, the motor initially takes a current which is several times higher than its rated current. If this situation can arise, you should choose the rating of the frequency inverter such that the starting current plus the sum of currents of the running motors does not exceed the rated output current of the frequency inverter.

The rated output current of the different models of frequency inverter can be found in the Appendix under “Technical Data”.

Power losses P_V

The power loss P_V of the frequency inverter is dependent on the operating state of the connected motor. The values in the following table relate to rated values for the motor parameters (motor operating at rated motor power, 4 pole ASM) at an ambient temperature of 40 °C.

Model	Power loss P_V in W	Motor rated power in kW
at U_{LN} = 230 V		
DF4-120-037	30	0.37
DF4-120-075	50	0.75
DF4-120-1K5	70	1.5
DF4-120-2K2	100	2.2
at U_{LN} = 400/460 V		
DF4-340-075	55	0.75
DF4-340-1K5	75	1.5
DF4-340-2K2	90	2.2
DF4-340-3K0	100	3
DF4-340-4K0	150	4
DF4-340-5K5	200	5.5
DF4-340-7K5	280	7.5
DF4-340-11K	400	11
at U_{LN} = 400/460/480 V		
DF4-341-15K	430	15
DF4-341-22K	640	22
DF4-341-30K	810	30
DF4-341-45K	1100	45
DF4-341-55K	1470	55
DF4-341-75K	1960	75
DF4-341-90K	2400	90

Admissible environmental influences

Protection class:
IP 20 at an ambient operating temperature of 0 to +40 °C.

Installation height:
Up to 1000 m above sea level; above this height the rated current drops by 5 % per 1000 m additional height.

Temperature:

Operation	Ta = 0 to +40 °C at rated current I_{2N}. Above +40 °C to T_{max} = +50 °C the output current drops by 2.5 % per Kelvin temperature rise (better than class 3K3 to EN 50 178).
Storage	Ta = –25 °C to +55 °C (Class 1K4 to EN 50 178)
Transport	Ta = –25 °C to +70 °C (Class 2K3 to EN 50 178)

Relative humidity:

Operation	5 % to 80 %, 1 g/m^3 to 25 g/m^3 without condensation or icing (Class 3K3 to EN 50 178)
Storage	5 % to 95 %, 1 g/m^3 to 25 g/m^3 without condensation or icing (Class 1K3 to EN 50 178)
Transport	95 %, highest relative humidity, if the temperature increases slower than 40 K or if the device is heated up directly from –25 °C to +30 °C. 60 g/m^3, highest absolute air humidity, if the device is heated up directly from +70 °C to +15 °C.

Air pressure:

Operation	86 kPa to 106 kPa (Class 3K3 to EN 50 178)
Storage	86 kPa to 106 kPa (Class 1K4 to EN 50 178)
Transport	70 kPa to 106 kPa (Class 2K3 to EN 50 178)

Intended use

Frequency inverters of the DF4 series are electrical components for installation in control cabinets of electrical equipment or machines.

The units of the DF4 series are intended for use as components to control variable speed drives with 3-phase motors for installation in machines or assembly together with other components to form machines or equipment.

When installing in machines, the commissioning of the frequency inverter is not permissible until it has been determined that the machines it is assigned to meet the safety requirements of the Machinery Directive 89/392/EEC; EN 60 204 must also be observed.

Use of the equipment is only allowed if it complies with the EU EMC Directive 89/336/EEC.

The frequency inverters meet the requirements of the EU Low Voltage Directive 73/23/EEC.

The harmonized standard
EN 50 178/DIN VDE 0160 in conjunction with
EN 60 439-1/DIN VDE 0660 Part 500 and
EN 60 146/DIN VDE 0558 apply to the frequency inverters.

The output of the frequency inverter (terminals U, V, W) should not be

- connected to a voltage or capacitive load (such as phase compensation capacitors)
- you must not connect several frequency inverters in parallel at their outputs;
- you must not make any direct connection back to the input of the frequency inverter (bypass).

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

DF4 series devices are

- suitable for use in public and private mains networks
- are not household devices but are components which are solely for use in commercial applications;
- are not machines as covered by the EU Machine Directives;
- in the system configurations described suitable for industrial, domestic and commercial applications.
- comply in typical drive configurations with the EU EMC Directives and the EU Low-Voltage Directive for the specified standards.

The user is responsible for compliance with the EEC Directives in machine applications.

Due to the PE connection required by the radio interference suppression filter, the CE-typical drive system described in the manual is not suitable for connecting to IT protective systems (mains supplies without reference to earth potential).

Any other usage constitutes improper use.

Storage, transport, recycling

The DF4 series frequency inverters are carefully packed and prepared for shipment. Transport may only take place in the original packing using suitable lifting and transport devices (see weight details). Observe the information and instructions on the packaging. The instructions also apply to the unpacked equipment.

After receiving the delivery,

- check whether the packaging has been damaged externally;
- check whether the details on the delivery note match your original order

Open the packaging with suitable tools and check whether:

- parts have been damaged during transport;
- the equipment corresponds to the model which you ordered;
- the assembly instructions are also present.

In case of damage, incomplete or incorrect shipment, please make your claim directly to the responsible sales office.

If the frequency inverter has been stored for more than 2 years without use, the capacity of the capacitors for the internal DC bus may be impaired. Before using the frequency inverter, connect it to the mains supply without load for 2 hours in order to regenerate the capacitors.

According to the currently valid national regulations, frequency inverters of the DF4 series can be recycled as electronic scrap.

2 Engineering

EMC compliance

The EU Directive 89/336/EEC has been applicable for the European Commercial Region (EU and EFTA) since 1st Jan. 1996. This contains the radio interference limit values for variable-speed drives in relation to standardEN 55 011. The relevant EMC product standard (EN 61 800-3) takes into account the combination of frequency inverter, cables and motor.

EMC = **E**lectro **M**agnetic **C**ompatibility.

EN 55 011 is a product family standard for devices used in medical scientific and medical applications.

Apart from the filtering required on the mains supply, design measures affecting construction and the wiring are also necessary to achieve the reduction of radio interference emission in accordance with EN 55 011 limit value class A and B. Poor earthing and screening will also reduce the effect of the interference suppression filter. The required levels of radio interference can only be maintained through the combination of suitable filters and correct installation.

Construction

Connect together all metal components of the equipment and/or cabinet using a large-area contact surface; ensure that the connection has a low impedance. If possible, avoid painted surfaces (e.g. Eloxal or yellow chrome coating) and use contact washers or serrated washers. If several mounting plates are used, connect them together and connect cabinet doors to the cabinet using short runs of RF braiding which contacts the components over a large surface.

Mount the mains filter and the frequency inverter on a metal plate, and as close to each other as possible (See figure 4).

Lay cables in the control cabinet as close as possible to the 0 V potential. Cables which hang freely act as antennas.

Noise protected cables (e.g. mains supply cables in front of the filter) and signal cables should be kept as far apart possible from cables with high RF noise (e.g. mains supply cables behind the filter, motor feeders), in order to prevent interference coupling. Never use the same cable duct for laying these two types of cable.

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

Earthing

Connect the earth plate (mounting plate) with the protective earth using a short cable. All conductive components (frequency inverters, mains filters, motor filters, mains chokes) must be connected to the RF braid which must be laid from a central earthing point from the protective conductor. This will ensure optimum results (See figure 4).

Filtering

Motor chokes and motor voltage filters are particularly effective for reducing higher frequency interference and are connected directly to the output of the frequency inverter. The characteristics of the motor voltage filters should be matched to the chopper frequency of the frequency inverter.

Only use mains filters, radio interference suppression filters and mains chokes which are intended for use with the frequency inverter, motor etc. Radio interference suppression filters reduce inadmissible high frequency interference to an acceptable level. Mains chokes reduce low frequency interference. Mains filters combine the function of the mains chokes and radio interference suppression filters.

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Screening

The effectiveness of a screened cable is dependent on the good connection of the screening and low screen impedance. Only use screens with tinned or nickel plated copper braiding; screens from steel braiding are unsuitable. The screen braid must offer a degree of covering of at least 70 % to 80 % and the braiding angle should be 90°.

Keep the motor feed cable between the frequency inverter and the motor as short as possible. To observe the limit values in accordance with EN 55 011 the cables must be screened. Connect the screening of the motor feed cable to earth at both ends of the cable using a large-area contact surface. Unbraiding of the screening and earth connection using pigtails is not permissible (See figure 4).

The screening of control of signal cables must only connect at one end of the cable. Make sure the screen connects to earth using a large-area contact surface; ensure that the connection has a low impedance. This screen of digital signal cables must be connected at both ends of the cable. If earth potential differences are present, an additional potential equalisation cable should be fitted, particularly in the case of long cable runs or cables which go to other equipment or components. In the case of interference caused by contactors, magnetic valves etc. to control or signal cables, fit an RC filter (for AC circuits) or freewheeling diode (for DC circuits) to the respective winding.

If contactors, motor protective switches or terminals are installed in the motor cabling, interconnect the screens of the cabling on both sides of these components and connect the screens with the mounting plate using a large-area contact surface.

If the cable between the mains filter and the frequency inverter is longer than 300 mm, the cable must be screened at both ends and connected to the mounting plate using a large-area contact surface (See figure 4).

If a brake unit is used, connect the screen of the cable for the braking resistor directly to the brake unit and to the mounting plate of the braking resistor using a large-area contact surface. Connect the cable screen between the frequency inverter and the braking unit at both ends and connect to the mounting plate using a large-area contact surface.

When using DF4-34x series frequency inverters in residential areas, you must provide additional screening with an effectiveness of ≥10 dB to reduce interference. This is normally achieved by installing equipment in standard, closed metal control cabinets or switch boxes that are properly earthed.

Changes in correct gaps provided for insulation purposes or the removal of insulation or cover plates is not admissible since the equipment will no longer comply with the EMC and/or Low-Voltage Directives.

The user of the equipment is responsible for ensuring that the machine application complies with the relevant EU Directives.

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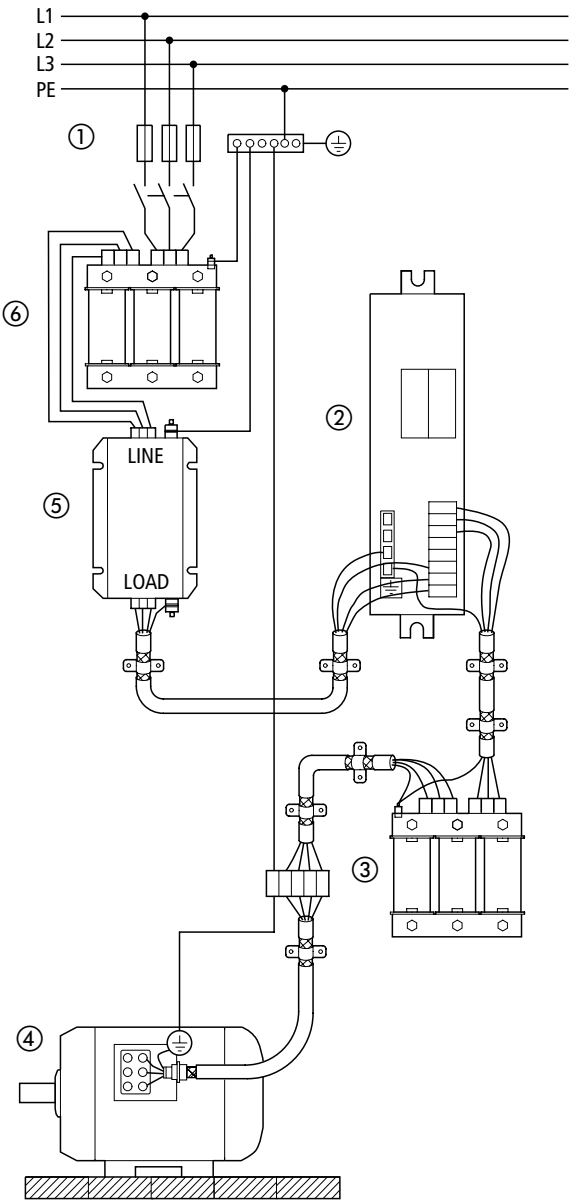

① Cable protective fuses
② Frequency inverter
③ Motor filter
④ Motor
⑤ Radio interference suppression filter
⑥ Mains choke

Figure 4: Overview of screening measures and installation

CE requirements for the installation of the drive system

If other equipment is in use in the vicinity of the frequency inverter which does not meet the CE requirements with respect to interference immunity EN 50 082-2, this equipment can be affected electro-magnetically by the frequency inverter.

In the case of installations which deviate from the recommendations in this section of the manual, such as:

- use of unscreened cables,
- use of central interference suppression filters instead of radio interference suppression filters matched to the equipment,
- failure to install mains chokes,

then the machine or plant must be tested for compliance with the EMC limiting values to assess its compliance with the EMC Directives.

Protection of personnel and domestic animals to DIN VDE 0100 with earth leakage circuit-breakers

Frequency inverters contain a mains rectifier. A DC fault current caused by an earth fault can prevent the release of classical residual current circuit-breakers. For this reason we recommend the use of:

- pulse-residual current circuit-breakers for equipment containing DF4-120 frequency inverters, and
- all-current sensitive residual current circuit-breakers for equipment containing DF4-340 and DF4-341 frequency inverters.

When choosing the tripping current, please note that capacitive equalisation currents in the cable screens and radio interference suppression filters which occur during normal operation can trip circuit-breakers unintentionally.

Mains network configurations

Not all frequency inverters of the DF4 series are suitable for unrestricted use with all types of mains network configuration:

Mains network configurations

with an earthed star point can be used with frequency inverters of the DF4 series without limitation. Please observe the technical specification for the DF4 series frequency inverters.

For mains network configurations with an earthed star point and interconnected operation, there is a limitation for DF4-120 series frequency inverters. For 3 AC/N/P mains networks and symmetrical distribution of current across the three phase conductors, it must be ensured that the mains r.m.s. current does not exceed the rated capacity of the common N conductor. If necessary, increase the cross-section of the N conductor.

For mains network configurations with isolated star point (IT networks), frequency inverters cannot be used with the recommended mains filter. The mains filter will be destroyed if an earth fault occurs. Please contact the supplier for further information.

Mains network configurations with earthed phase conductor are not suitable for standard frequency inverter models. Please contact the supplier for further information.

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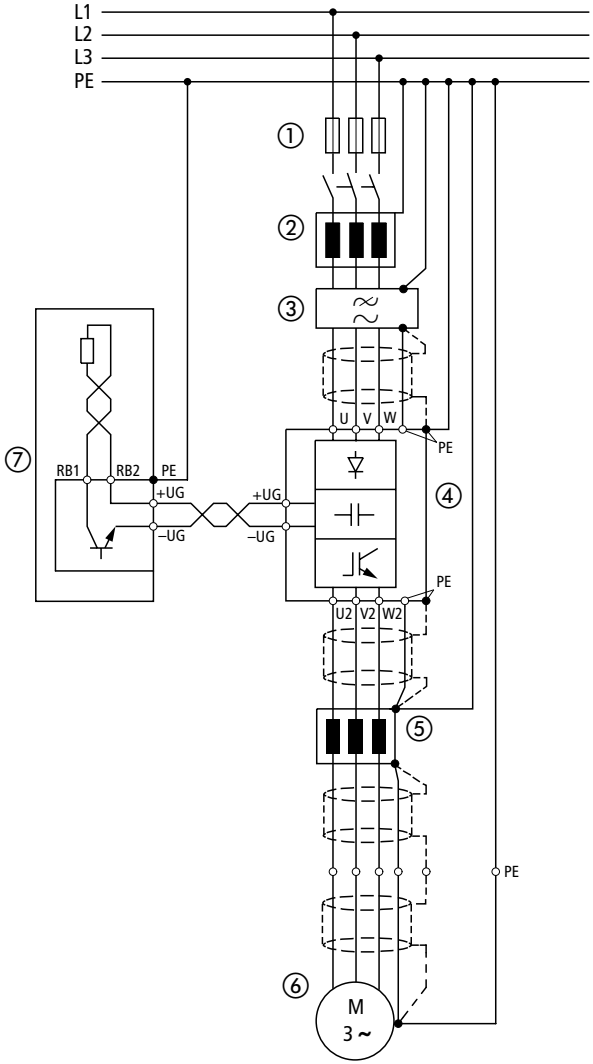
For operation with the DC-supply via +UG/–UG, the DC voltage must be symmetrical to the PE. DF4 series frequency inverters will be destroyed if the +UG conductor or –UG conductor is earthed.

Power cabling



① Cable protective fuses
② Mains choke
③ Radio interference suppression filter
④ Frequency inverter
⑤ Motor filter
⑥ Motor
⑦ Braking unit

Figure 5: Power cabling

The output of the frequency inverter (terminals U, V, W) should not be

- connected to a voltage or capacitive load (such as phase compensation capacitors)
- you must not connect several frequency inverters in parallel at their outputs;
- you must not make any direct connection back to the input of the frequency inverter (bypass).

Protection of the power section should be selected according to the mains network configuration used.

Cable and device protection for AC circuits:

- AC input: use standard commercial cable protection fuses
- Fuses for UL compliant equipment must meet UL approval
- The rated voltages of the fuses must be chosen according to the mains voltage at the installation site. Use devices with tripping characteristics defined with H or k5

Protection devices for cables and equipment in DC circuits:

- DC inputs..., use the recommended DC fuses.

In the case of DC power feed or DC power feed with interconnected operation, fuses F4 and F5 can be implemented by connecting several fuses in parallel. You can also use cables connected in parallel.

The fuses and cross-sections listed in the Appendix do not apply when connecting a braking unit to terminals +UG/–UGH. Refer to the technical documentation of the braking unit for further details.

Cables, contactors, mains filters

The cable types used must comply with the appropriate regulations at the installation site.

Please refer to the section on EMC compliance in the Engineering chapter for information on installing and connecting up cables to meet the EMC regulations. The correct type of mains filter, mains choke, radio interference suppression filter and mains contactor for the chosen frequency inverter model is described in the Appendix under Mains filter/Mains contactor.

Always connect the frequency inverter to the earth circuits using the designated PE terminal and using the housing. Always observe the regulations on the minimum cross-section of PE cables to use (EN 50 178, VDE 0160). The cross-section of the PE conductor must be at least as large as the cross-section of the power terminals ($\geq$10 mm^2).

Information on the correct fuses and cable cross sections for the incoming and outgoing cables are described in the Appendix under Fuses/cable cross-sections

Incoming conductors AC: L1, L2, L3, N, PE (depending on model)

Incoming conductors DC: +UG, –UG, PE (all models)

Outgoing conductors: U, V, W, PE

The information in the Appendix applies to:

installation in control cabinets and machines,

cable installation in cable ducts,

maximum ambient temperature +40 °C.

Fuses and cable cross-sections are dependent on the power rating of the frequency inverter and the operating mode.

When choosing the cable cross-sections, remember to allow for the voltage drop under load. Compliance with other standards (e.g. VDE 0113, VDE 0289) is the responsibility of the user.

Motor types and connections

DF4 series frequency inverters are designed for applications with three-phase asynchronous motors. The use of pole-changing three-phase motors (Dahlander), three-phase motors with slip rings (slipring motors) or reluctance, synchronous and servo motors is also possible. When using these motors check that the requirements of the application (machine) and of the motor manufacturer can be fulfilled.

The switching devices for the motor must meet the following DC voltage requirements:

DF4-120 with U_{DC} max. 400 V

DF4-34x with U_{DC} max. 800 V

Full motor protection to VDE standards is achieved by the use of overcurrent relays and temperature monitoring. This is also obligatory for group operation (motors connected in parallel to a single frequency inverter). PTC thermistors or temperature switches with PTC characteristics are the most suitable devices for monitoring the motor temperature.

Attention!
Motors with insulation that is not suitable for use with frequency inverters may be destroyed if used. Contact your motor supplier for further details. Operation with the appropriate motor filters is normally possible.

The output frequency of the frequency inverter determines the rotary speed of the 3-phase motor. If you want to operate the motor above the rated speed/rated frequency, it is necessary to observe the technical data from the motor manufacturer for mechanical reasons (bearings, motor balancing, ...). This is also necessary when operating the motor for extended periods at a frequency below 25 Hz. This can reduce the motor ventilation to an unacceptable level leadng to overheating. Countermeasures include overdimensioning or the use of an additional ventilator.

Attention!
The frequency inverter parameter PNU 011 allows you to configure the maximum output frequency (max. 480 Hz). Ask the motor manufacturer if the motor is suitable for such frequencies. The use of unsuitable motors can result in dangerous overspeeds and/or destroy the machine.

Three-phase motors can be operated with various circuit configurations. To a degree, the circuit configuration is dependent on the rated power of the motor. With mains supplies of 3 × 400 V they are typically connected as follows

up to approx. 4 kW: star connection (230/400 V)

above 4 kW in delta connection (400/690 V)

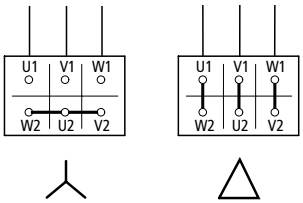


Figure 6: Circuit configuration

Frequency inverters of the DF4 series are configured in the factory for clockwise (CW rotation) of the output signal. Interconnect the motor and the frequency inverter as follows to ensure that the motor turns in a CW direction with the standard settings for the frequency inverter:

Motor	**DF4**
U1	U
V1	V
W1	W

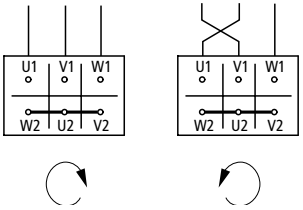


Figure 7: Direction of rotation

You can reverse the direction of the rotation of the motor as follows:

- by exchanging two of the phase connections on the motor (see figure)
- by connecting terminal E4 = LOW (CW),
- by connecting terminal E4 = HIGH (CCW),
- by changing the polarity of the setpoint using the serial interface module.

Length of motor cable and admissible operating mode

To ensure EMC compliance you must only use screened motor cables. The length of the motor cables and the related use of further components affects the motor control mode and the operating behaviour. The motor control mode is configured with PNU 014. The resulting cable length l_{res} must be calculated as follows for group operation (several motors in parallel on one frequency inverter):

$$l_{res} = \text{Total of all motor cable lengths} \times \sqrt{\text{Number of motor cables}}$$

In the case of long motor cables and frequency inverters with lower rated output power, leakage currents through parasitic cable capacitance can trigger the fault message “OCx”. Use a motor filter in such cases.

Try to keep the motor cables as short as possible since this has a positive effect on the response of the drive.

Speak to the supplier if the absolute or resulting cable lengths for the motor are $\geq$ 200 m due to the configuration requirements at hand.

When using unscreened motor cables, refer in the table below to the column for a motor cable which is twice as long.

Motor control mode versus motor cable length (PNU 014)

<table>
<tr><th>Motor cable length (screened)</th><th colspan="2">up to 15 m</th><th>up to 25 m</th><th>up to 50 m</th><th>up to 100 m</th><th>up to 200 m</th></tr>
<tr><td>DF4-120</td><td colspan="2">0, 1, 2, 3</td><td></td><td rowspan="3">2, 3</td><td rowspan="4">2, 3 +
Motor filter</td><td rowspan="3">2, 3 +
Motor voltage filter</td></tr>
<tr><td>DF4-340-1K5</td><td>2, 3, 4</td><td>2, 3</td></tr>
<tr><td>DF4-340-2K2</td><td colspan="2">2, 3, 4</td></tr>
<tr><td>DF4-340-3K0 to
DF4-340-11K</td><td colspan="4" rowspan="3">2, 3, 4</td></tr>
<tr><td>DF4-341-15K,
DF4-341-22K</td><td>2, 3</td></tr>
<tr><td>DF4-341-30K to
DF4-341-90K</td><td colspan="2">2, 3</td></tr>
</table>

Circuit types

Standard connection

The frequency inverter is normally operated with the internal power supply and factory settings. Screening and installation must meet EMC regulations as described in the section EMC compliance.

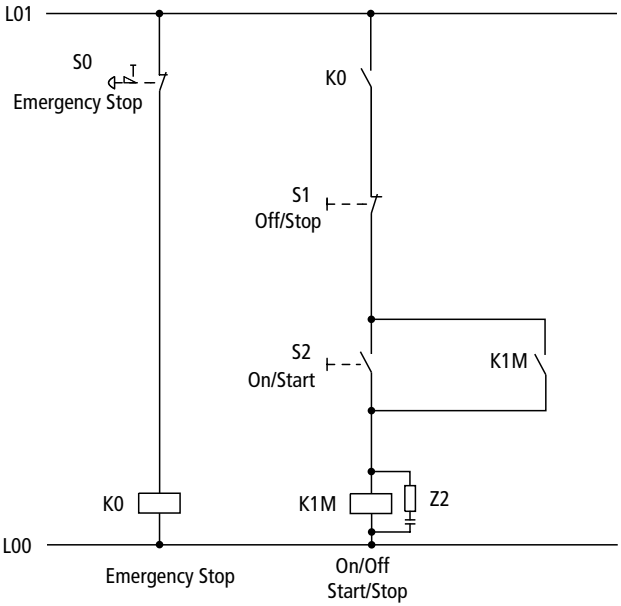


Figure 8: DF4-120

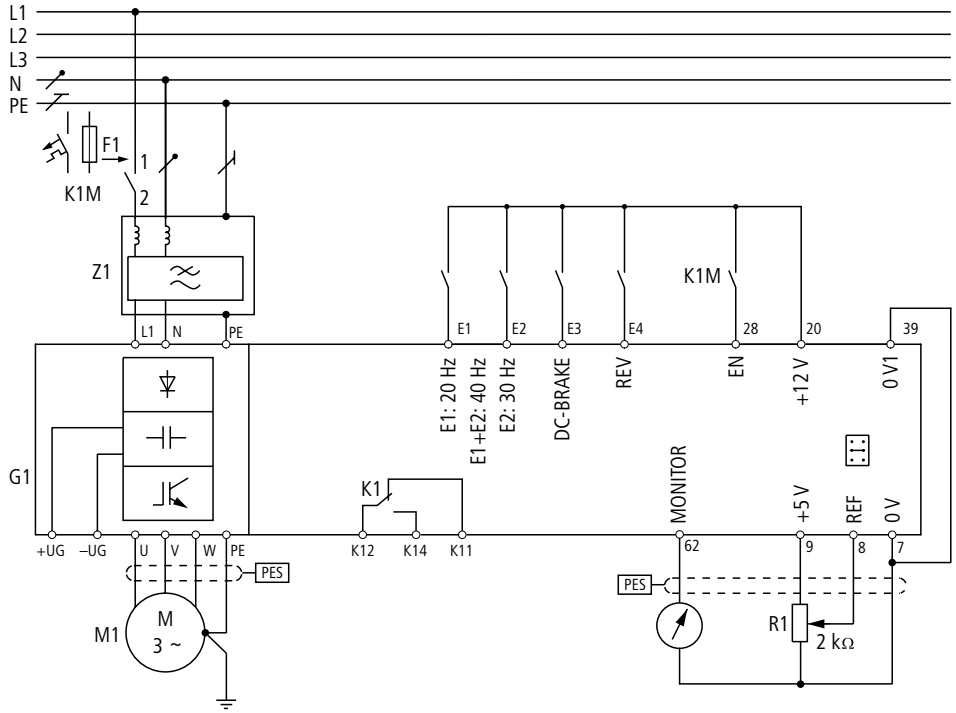


Figure 9: DF4-120

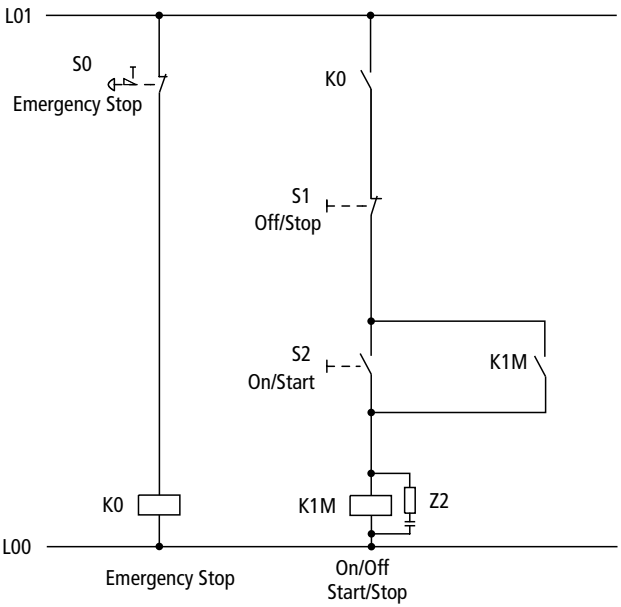


Figure 10: DF4-340

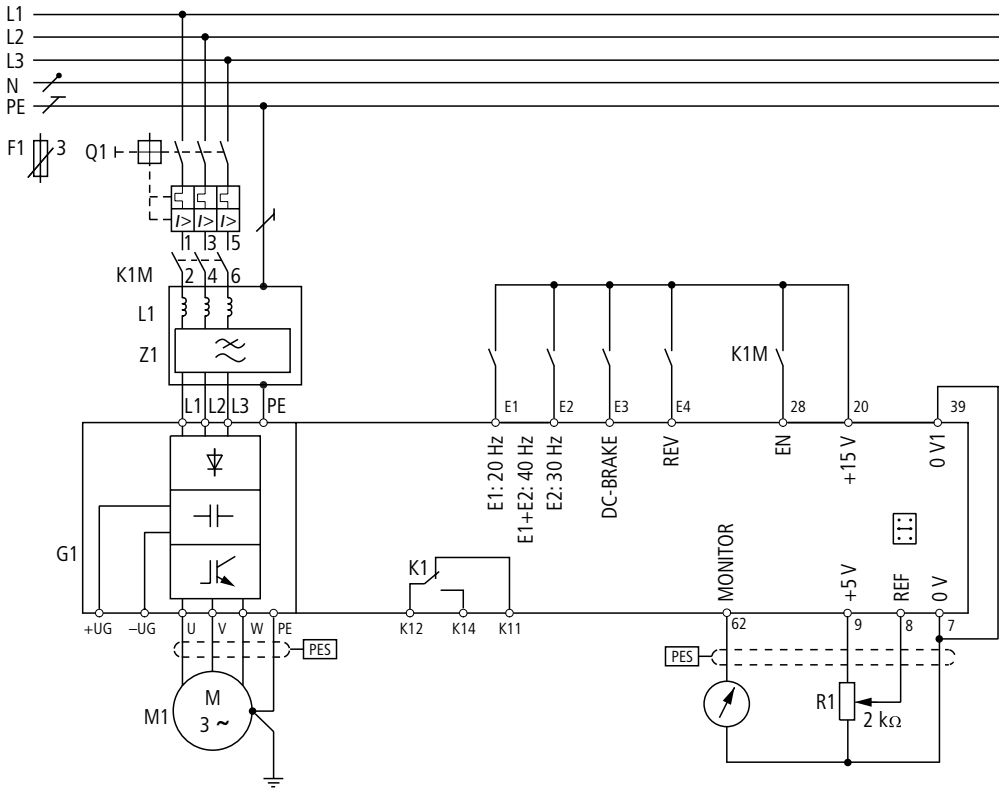


Figure 11: DF4-340

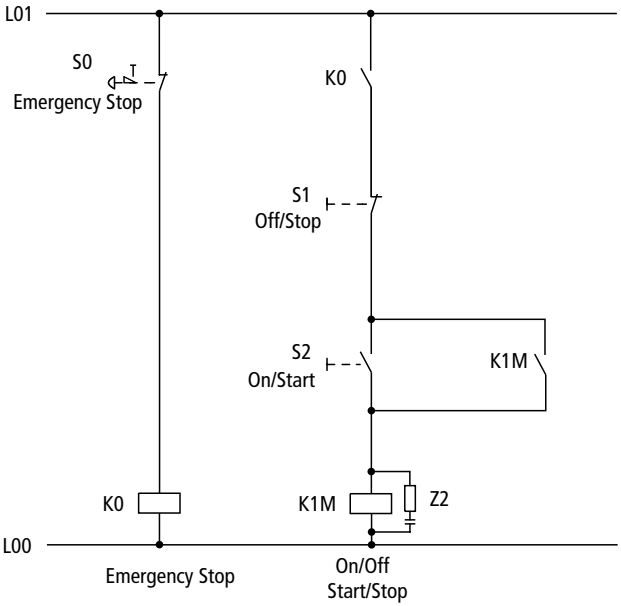


Figure 12: DF4-341

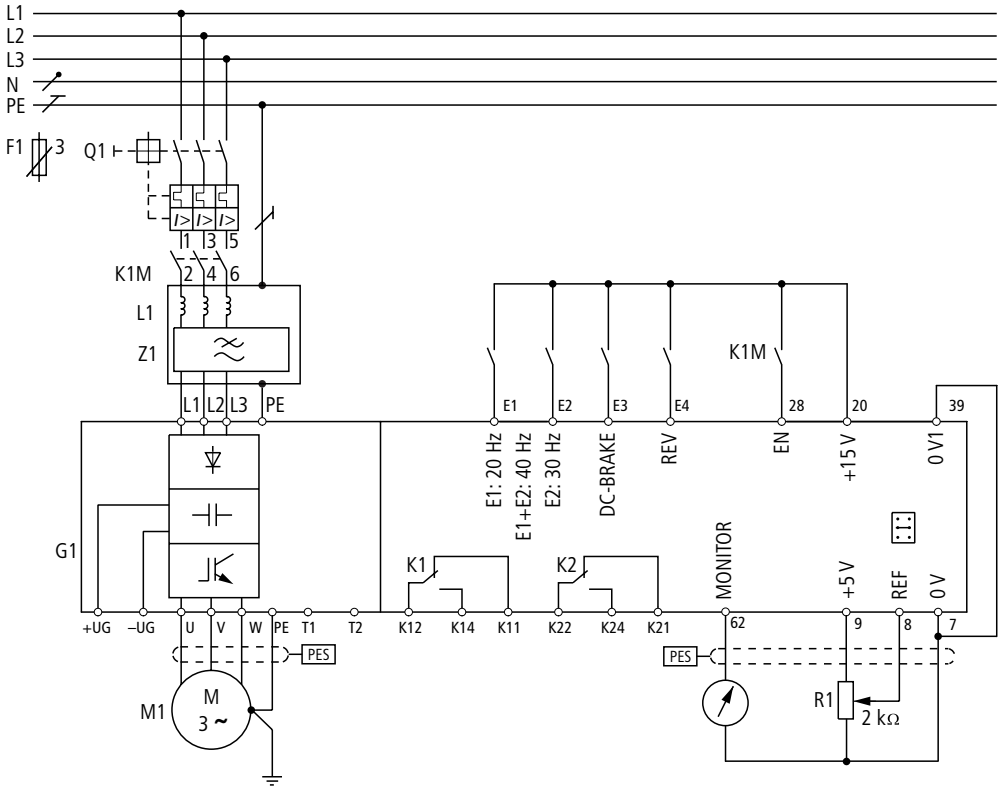


Figure 13: DF4-341

Parallel connection of several motors to one frequency inverter

The DF4 series frequency inverters can control several motors connected in parallel. This is also called group operation. If it is necessary for the motors to turn at different speeds, this must be achieved by choosing motors with a different number of pole pairs and/or by using gearboxes.

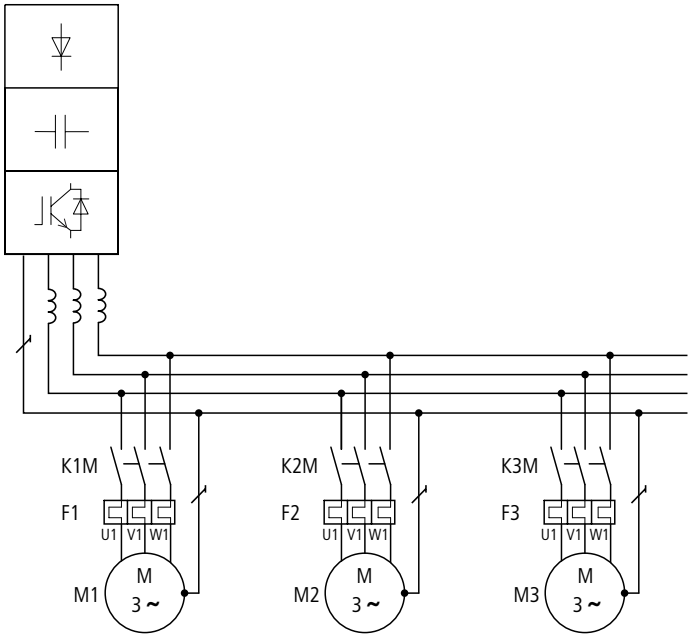


Figure 14: Parallel connection of several motors

Attention!
If you connect several motors to a single frequency inverter in parallel, you must dimension the mains contactors of each of the motors to AC3. You must not choose the mains contactors from the table “Mains filters/mains contactors” in the Appendix. These mains contactors are only for use on the incoming mains side of the frequency inverter. If they are used incorrectly, the contacts may weld.

If motors are connected in parallel, this reduces the load impedance at the output of the frequency inverter. The overall stator inductance decreases and the stray capacitance of the cables increases. When compared to the use of single motors this can lead to current distortion. Use chokes or mains voltage filters at the output of the frequency inverter to reduce the current distortion.

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

If several motors are connected in parallel, it is not possible to use electronic motor protection. You must protect each motor separately with a thermistor and/or a bimetal relay.

Problems may occur at the start and at low speeds when the frequency inverter output has been connected to motors with greatly differing ratings (e.g. 1.5 kW and 11 kW). In some cases, the motor with the smaller rated power cannot produce the required torque. This is due to the relatively large ohmic resistance in the stators of such motors. They require a higher voltage during startup and at low rotary speeds.

Operation with interconnected internal DC bus

Parallel operation of several frequency inverters with interconnection of the internal DC bus allows DC energy to be exchanged between the motors. If one or more of the frequency inverters are operating as a generator (braking mode), energy is recovered and fed back to the common DC bus and/or back to the DC power feed. The energy can then be used by the inter-connected frequency inverters which are operating in motor mode. This can reduce the use of brake units and reduce the energy consumption from the mains power supply.

If you want to operate frequency inverters with an interconnected DC bus, you must only use frequency inverter models with the same DC bus voltage range, e.g. DC 270 to 360 V or DC 320 to 510 V. The cable connections to the common DC bus must be kept short.

Choose the cable cross-sections for +UG/–UG from the table “Fuses/cable cross-sections” in the Appendix.

You can achieve a low cable inductance by using several DC busbars connected in parallel and using several power cables in parallel between the frequency inverters and the shared DC busbar; twist the cables if necessary.

Only use the specified mains chokes/mains filters and DC bus fusing.

Make sure that it is possible to switch on the mains feed to all interconnected frequency inverters simultaneously.

In the case of the DF4-120 series frequency inverters, make sure that the phase conductors are connected up the same way for all of them.

If you want to operate different series of frequency inverters with an interconnected DC bus, please contact the supplier for further details.

Interconnected DC bus, model DF4-120

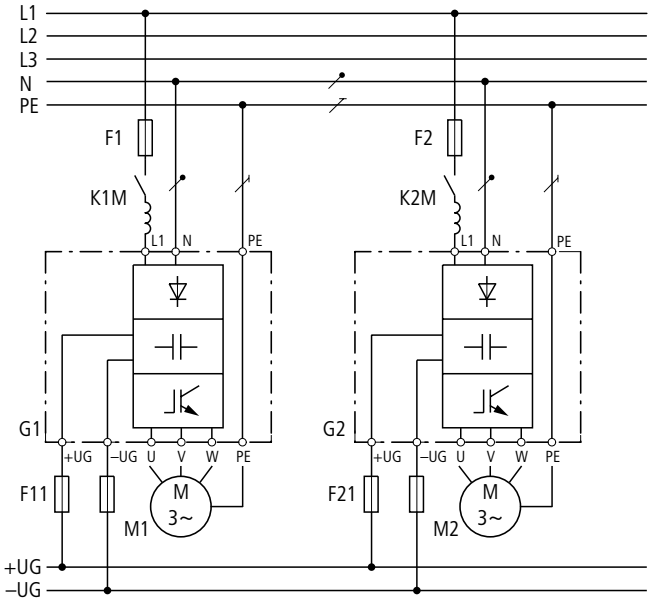


Figure 15: Single-phase AC main feed with interconnected DC bus

K1M	Mains contactor, with incomer for 2 AC; PE; 190 to 260 V ±0 %; 45 to 65 Hz ±0 % single-phase
F1	Circuit protection, with incomer for 2 AC; PE; 190 to 260 V ±0 %; 45 to 65 Hz ±0 % single-phase
F4, F5	Equipment protection for the DC circuits, as specified by table
Z1	Mains choke/mains filter
G1, G2	Frequency inverter

Attention!
The contacts of all mains contactors must switch simultaneously. The input rectifier may otherwise be destroyed due to multiplication of the charging currents.

Interconnected DC bus, model DF4-34x

Attention!
Combined operation of DF4-340 and DF4-341 series frequency inverters is only admissible if the rated mains voltage range of the DF4-340 series is not exceeded. Please refer to the Appendix for more information.

Attention!
The contacts of all mains contactors must switch simultaneously. The input rectifier may otherwise be destroyed due to multiplication of the charging currents.

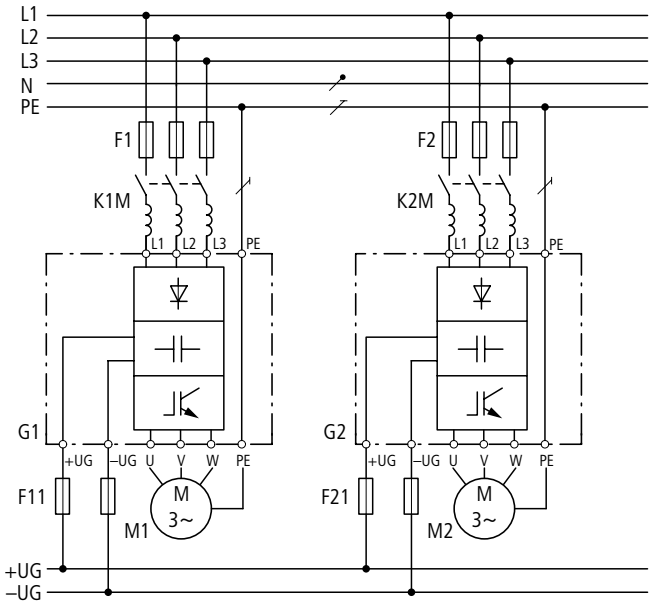


Figure 16: Single-phase AC main feed with interconnected DC bus

K1M	Mains contactor
F1	Cable protection
F4, F5	Equipment protection for the DC circuits
L1	Mains choke/mains filter
G1, G2	Frequency inverter
Z1	Radio interference suppression filter

DC power supply

Warning!
When feeding the devices via a DC voltage source ensure that the voltage between +UG and PE, as well as –UG and PE is symmetrical. If +UG or –UG is earthed, the frequency inverter will be destroyed.

The DF4-120 series frequency inverters are only available for DC power feed on request.

Models DF4-340 and DF4-341

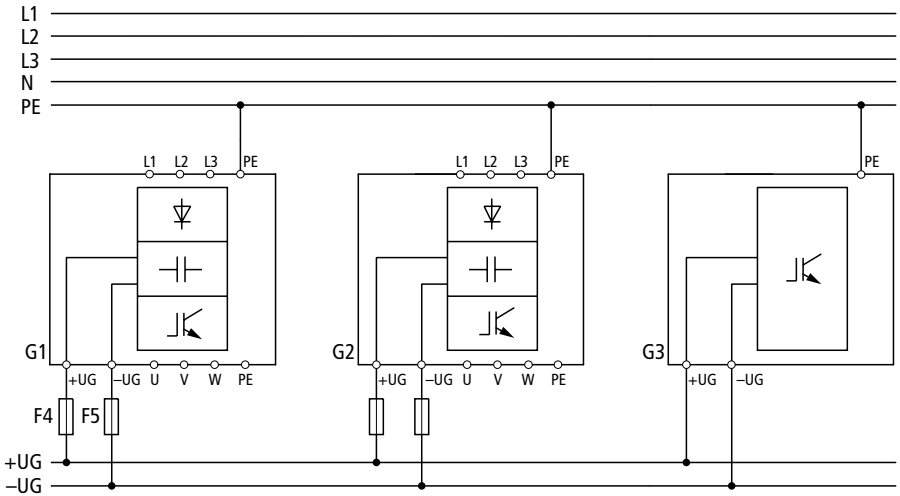


Figure 17: DC main feed with interconnected DC bus

F4, F5 Equipment protection for the DC circuits
G1, G2 Frequency inverter
G3 Brake unit

Connecting the controller

Internal power feed

The DF4 series frequency inverters provide two internal voltages which are available at the following terminals:

Terminal 9 – for analog setpoint

Terminal 20 – for enable signals

Terminal 7 – 0V potential for both signals

Terminal	Output voltage	Rating
9	5.2 V	6 mA
20	12 V for DF4-120 15 V for DF4-34x	20 mA

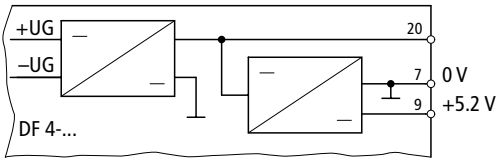


Figure 18: Internal power feed

Earthing the 0 V potential (terminal 39)

With standard operation of the frequency inverters, it is necessary to earth the 0 V potential of the control signal inputs (terminal 39). You should use a cable cross-section of min. 1.5 mm^2 for this purpose. If terminals E1 to E4 and terminal 28 are supplied by the internal power feed (terminal 20), it is necessary to interconnect the 0 V potential of the voltage regulator (terminal 7) and the 0 V potential of the control signal inputs (terminal 39). This is done by bridging terminal 7 and terminal 39.

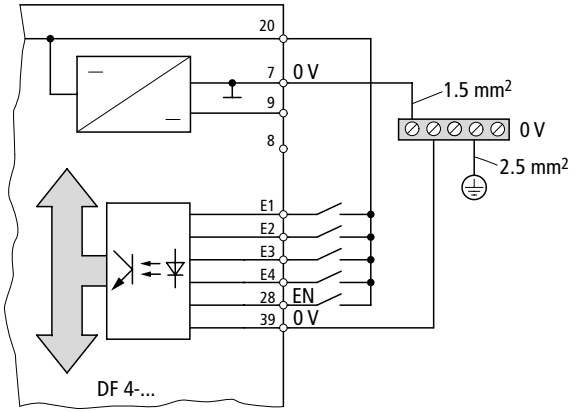


Figure 19: Earthing of 0 V potential

If you want to install several frequency inverters or automation devices in a single system, the 0 V potentials of each of the devices must be interconnected point-to-point in a star arrangement. Each of the devices must be commonly earthed at the "weakest" participant, e.g. a PLC.

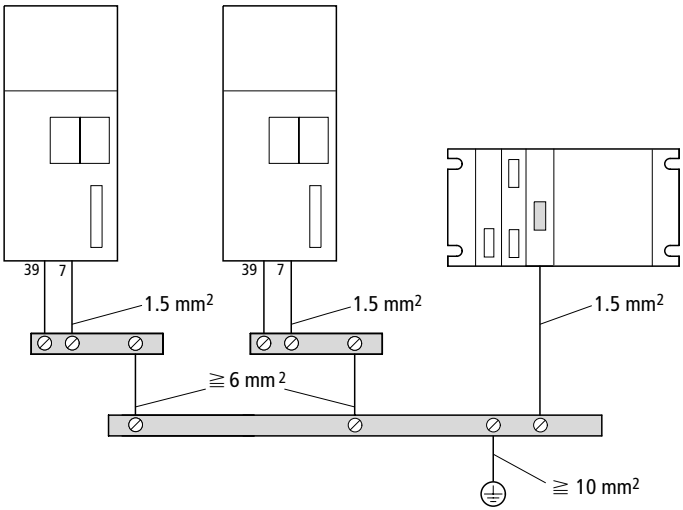


Figure 20: Earthing with star arrangement

Digital Inputs, PLC interconnection

The digital inputs of the DF4 series frequency inverters are optically and galvanically isolated. This allows them to be directly connected to a programmable logic controller (PLC). For greater interference immunity earth the 0V potential of the control inputs (terminal 39) via an unpolarized capacitor (0.1 μF, 250 V DC).

If terminals E1 to E4 and terminal 28 are supplied by an external power feed provided by the PLC, the 0 V potential of the PLC must be connected to the 0 V potential of the control signal inputs (terminal 39).

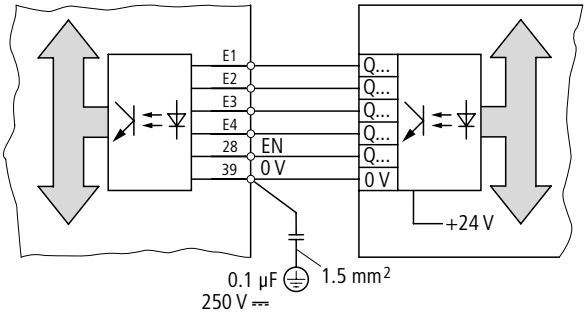


Figure 21: Interconnection with a PLC

If several frequency inverters are controlled by the same PLC within the same system, interconnect the 0 V potentials of all of the devices point-to-point in a star arrangement. The devices must be jointly earthed at the "weakest" participant, i.e. the PLC. In addition, terminal 39 must be capacitively earthed at each frequency inverter. The 0 V potential of the PLC can be directly earthed.

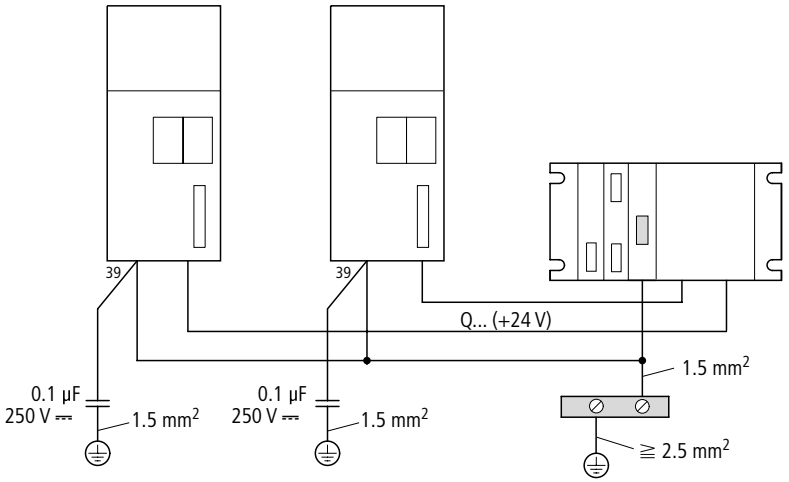


Figure 22: Earthing when a PLC is used

Input for analog setpoint

The analog setpoint signal is connected to terminal 8 and the 0 V potential of analog setpoint signal is connected to terminal 7. The type and range of the setpoint input is specified using jumpers on the front of the frequency inverter.

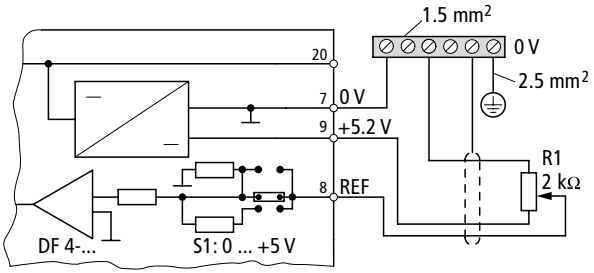


Figure 23: Setpoint entry from a potentiometer with internal power feed

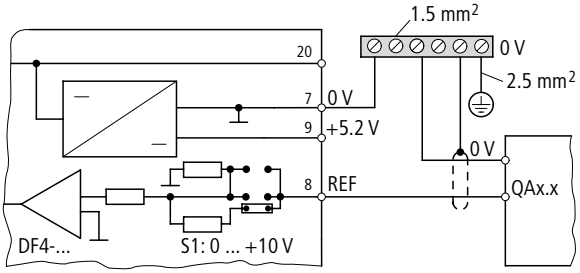


Figure 24: Setpoint entry from a PLC

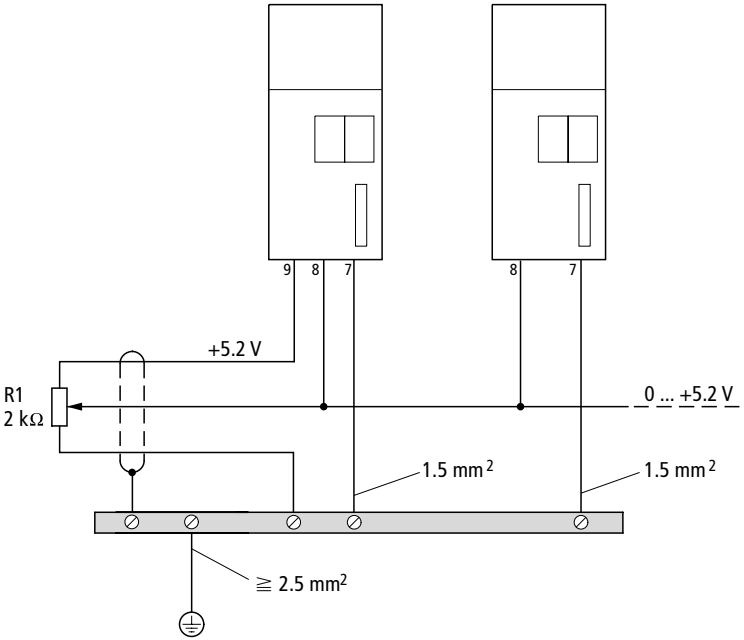


Figure 25: Master setpoint signal for several frequency inverters

Setpoint input with current loop signal

Parameter PNU 034 is used to specify a current loop signal of 0 to 20 mA or 4 to 20 mA. The internal load resistance is 250 Ω.

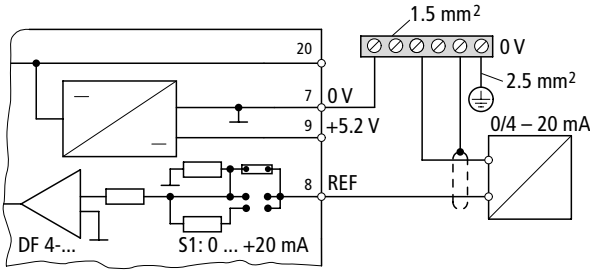


Figure 26: Analog setpoint with current loop signal

Speed setpoint input with current loop signal

Attention!
With this arrangement of frequency inverters, do not earth the 0 V potential (terminal 7) of the internal power feed since this would cause a short-circuit of the setpoint signal.

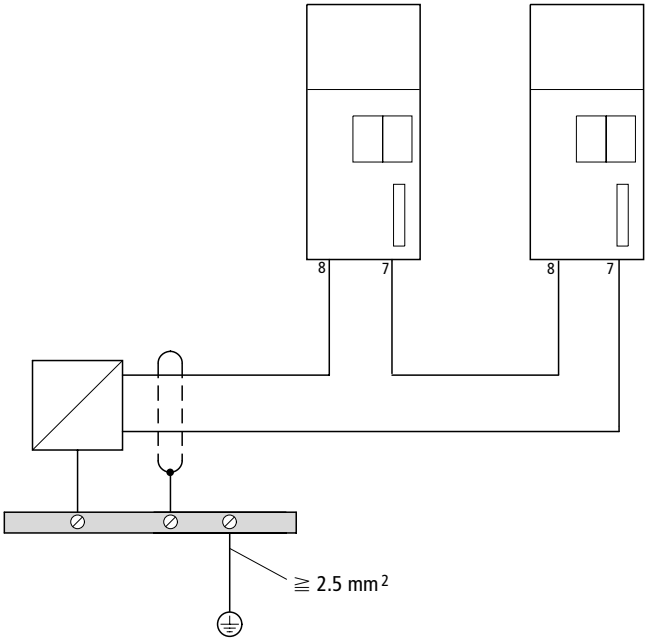


Figure 27: Master setpoint input with current loop signal

Analog output

An analog measuring device can be connected to terminal 62 of the frequency inverter. Parameter PNU 111 is used to specify which monitor signal is output to this terminal. The default setting is the output frequency. The maximum voltage range at terminal 62 is 0 to 6 V.

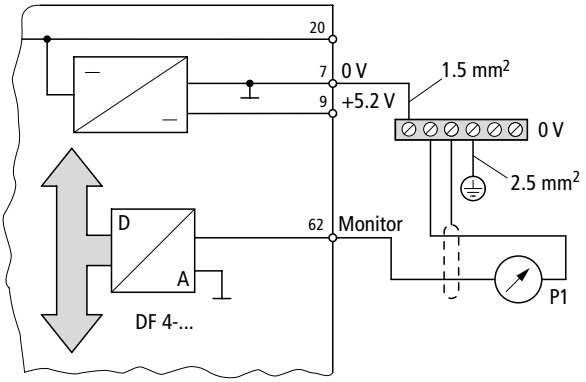


Figure 28: Connecting a meter to the monitor signal

Relay outputs

The DF4-120/DF4-340 series frequency inverters are provided with a relay K1 with changeover contacts. The DF4-341 series frequency inverters are provided with a second relay K2 with changeover contacts. The assignment of signals to the relay contacts is programmable. The relay contacts are galvanically isolated from the frequency inverter.

When connecting external contactors or relays to a changeover contact, you can increase the noise immunity

by connecting an RC filter in parallel (AC circuit)

by connecting a free-wheel diode in parallel (DC circuit)

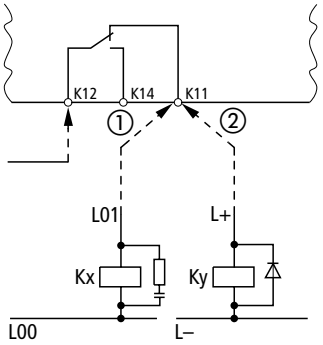


Figure 29: Relay connection for DC or AC circuit

① AC circuit

② DC circuit

Terminal	Assignment	Use	Rating
DF4-120/DF4-34x			
K11	Break contact of K1	Programmable changeover contacts	24 V AC/3 A or 60 V DC/0.5 A
K12	Group of K1		
K14	Make contact of K1		
Series DF4-341 only:			
K21	Break contact of K2	Programmable changeover contacts	250 V AC/3 A or 60 V DC/0.5 A
K22	Changeover contact of K2		
K24	Make contact of K2		

3 Setting Parameters

Basic principles

The purpose of setting parameters for the frequency inverter is to adapt it to your application. The settings are grouped together in different parameters which are identified by parameter number (PNU).

The parameters are set either with the keys of the LCD keypad DE 4-KEY-1 or via serial interface modules using a PC. Both the LCD keypad and the serial interface modules are available as accessories.

Factory settings

The factory settings of the parameter of the DF4 series frequency inverters are chosen such that parameter changes should not be necessary for standard applications. The following table lists the most important settings.

All of the parameters which are described in the following section can be changed only with the LCD keypad or the serial interface module including operating software.

Terminal	WE	
E1, E2	Selection of the three jog frequencies:	
	E1 = HIGH: E2 = HIGH: E1 + E2 = HIGH:	20 Hz 30 Hz 40 Hz
E3	E3 = HIGH:	Start DC injection braking with U = 1 % nominal voltage
E4	E4 = LOW: E4 = HIGH:	Clockwise Counterclockwise
Control characteristics (at rated motor speed)	DF4-120: DF4-34x:	230 V/50 Hz 400 V/50 Hz
Setpoint	0 to 10 V	

Terminal	WE	
Ramp times	+a: –a: f_{max}:	5 s 5 s 50 Hz
Current limit	I_{max}: I_{maxGen}:	150 % nominal motor current 80 % nominal motor current
Monitor signal	Current output frequency	
Relay K1	Switches following a TRIP message	
Relay K2 (only model DF4-341)	Switches when inverter ready to operate	
Start options	Automatic start if terminal 28 = HIGH, flying restart for motor inactive	
Operating mode	Setpoint input and control via terminals	
Chopper frequency	8 kHz	
Fault reset	LOW edge on terminal 28 (EN)	

Changeable parameters

Operating mode

PNU 001 specifies which input channel is used for control, setpoint input and setting parameters.

The setpoint for the controller is stored in non-volatile memory and it is not affected by mains supply interruptions.

If an enable signal is connected to terminal 28, the frequency inverter may start automatically if the operating mode is changed and the mains supply is switched on again.

PNU	Name	Value	Function	WE
001	Operating mode	0	Setpoint input via terminal 8, Control by terminals, Parameter setting via LCD keypad	0
		1	Setpoint input via LCD keypad, Control by terminals, Parameter setting via LCD keypad	
		2	Setpoint input via terminal 8, Control by terminals, Parameter setting via interface module	
		3	Setpoint input via interface module, Control via interface module, Parameter setting via interface module	

Parameter set transfer

PNU 002 is used to manage the parameter sets. According to the value of PNU 002, a parameter set is either overwritten with the factory settings or transferred from/to the optional LCD keypad DE 4-KEY-1.

PNU	Name	Value	Function	WE
002	Parameter set	0	Function executed	0
		1	Overwrite PAR1 with factory default	
		2	Overwrite PAR2 with factory default	
		3	Overwrite PAR1 and PAR2 with data from LCD keypad	
		4	Overwrite PAR1 with data from LCD keypad	
		5	Overwrite PAR2 with data from LCD keypad	
		6	Transfer PAR1 and PAR2 to LCD keypad	

Switching parameter sets

The DF4 frequency inverters have two parameter sets and you can switch from one to the other during drive operation. This allows additional acceleration and deceleration times and/or three additional jog frequencies. Each parameter set contains all configurable parameters. With a few exceptions, all parameters of both sets can have different values. The exceptions are described in the Appendix under "Comments/abbreviations used in the parameter table".

In order to switch from parameter set 1 to 2 or vice-versa, connect signals to the terminals as shown in the table (see the section Terminal configuration).

If you have set different motor control modes in the two parameter sets with PNU 014, only switch between parameter sets when the controller is inhibited.

PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
4, 8, 15, 17, 18	*)	HIGH	*)	*)	Switch to parameter set 2. LOW activates parameter set 1 again.
1, 3, 6, 7, 12	*)	*)	HIGH	*)	

*) Terminal assignment dependent on value of PNU 007

Controller address and baud rate

If you want to connect several frequency inverters in parallel using the RS 485 interface, each of the controllers on the line must have a unique address. The address is set with PNU 009. The possible address ranges for different bus interfaces is shown in the relevant manual for the interface.

PNU	Name	Value	Function	WE
009	Controller address	1 to 99	Only applies to RS 232/RS 485 serial interface module.	1
125	Baud rate	0 = 9600 1 = 4800 2 = 2400 3 = 1200 4 = 19200	The baud rate depends on the interfaces (RS 232/RS 485).	0

Communication behaviour

If you operate the frequency inverter with an interface module, PNU 126 is used to specify how the frequency inverter should behave if the communication to the interface has failed (interface defect or removed).

This function is not available for DF4-120 series frequency inverters. In this case, if an error occurs the superior controller (e.g. PC) must trigger an appropriate reaction (e.g. error message or switch off the frequency inverter).

PNU	Name	Value	Function	WE
126	Communication behaviour	0	No reaction to an error in data transfer between frequency inverter and interface module	0
		1	In case of errors in the data transfer between the frequency inverter and the interface module, the controller is switched off and the error message CE0 is output.	

Control parameters

Terminal configuration

PNU 007 is used to specify the assignment of the digital inputs. The factory setting is 0. There are 23 different combinations as described in the following table. Other terminal assignments are not possible. Please note too that not all functions are available simultaneously and that various function combinations are mutually exclusive.

PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
0	FF1, FF2, FF3		DCB	R/L	FF1 = Jog frequency 1 FF2 = Jog frequency 2 FF3 = Jog frequency 3 DCB = DC injection braking R/L = Selects direction of rotation PAR = Selects parameter set QSP = Quickstop EF = External error DOWN = Motor potentiometer, decrease value UP = Motor potentiometer, increase value R/QSP = Rotation R (CW), quickstop on error L/QSP = Rotation L (CCW), quickstop on error
1			PAR	R/L	
2			QSP	R/L	
3	FF1	DCB	PAR	R/L	
4		PAR	QSP	R/L	
5		EF	DCB	R/L	
6			PAR	R/L	
7	EF	DCB		R/L	
8		PAR	QSP	R/L	
9	FF1	EF		R/L	
10	DOWN	UP	EF	R/L	
11			DCB	R/L	
12			PAR	R/L	
13			QSP	R/L	
14	FF1	DCB	R/QSP	L/QSP	
15		PAR	R/QSP	L/QSP	
16	FF1, FF2, FF3		R/QSP	L/QSP	
17	DCB	PAR	R/QSP	L/QSP	
18	EF		R/QSP	L/QSP	
19		DCB	R/QSP	L/QSP	
20	FF1	EF	R/QSP	L/QSP	
21	DOWN	UP	R/QSP	L/QSP	
22	FF1		R/QSP	L/QSP	

Control word

The control word contained in PNU 135 is a 16-bit word with the designation STW. It contains bit-mapped control commands for the frequency inverter. The following table shows its structure.

Bit	Function DF4-120			Function DF4-34x
0.1	Bit 0	Bit 1	Setpoint	
	0	0	Frequency setpoint (PNU 046)	
	1	0	FF 1 (PNU 037)	
	0	1	FF 2 (PNU 038)	
	1	1	FF 3 (PNU 039)	
2	0 = R (CW) 1 = L (CCW)			
3	0 = Disable quickstop 1 = Enable quickstop			
4	reserved			0 = Ramp generator enabled 1 = Ramp generator paused
5				0 = Ramp generator enabled 1 = Brake ramp generator enabled to setpoint 0 using ramp –a (PNU 013).
6				0 = Motor potentiometer UP disabled 1 = Motor potentiometer UP enabled
7				0 = Motor potentiometer DOWN disabled 1 = Motor potentiometer DOWN enabled
8				reserved
9	0 = Controller (enable) 1 = Controller inhibit			
10	reserved			reserved
11				Edge from 0 to 1 triggers TRIP reset
12	0 = Parameter set 1 1 = Parameter set 2			
13	reserved			

Bit	Function DF4-120	Function DF4-34x
14	0 = Disable DC injection braking 1 = Enable DC injection braking	
15[1)]	0 = Update process output data continuously 1 = Do not update process output data	reserved

[1)] You can disable the updating of information on the status and current values in order to be able to transfer control information at a more accurate timepoint.

Controller enable terminal 28 (EN)/PNU 040

It is necessary to enable the controller before you can start the frequency inverter. Controller enable is controlled with terminal 28 as follows:

LOW = Controller inhibited

HIGH = Controller enabled

In the case of the DF4-120 series frequency inverters, parameters can only be changed when the controller is inhibited. With the DF4-34x it is also possible to modify parameters with the controller enabled.

If you use the optional LCD keypad DE 4-KEY-1, terminal 28 and the RUN/Stop key are logically connected in series. If you press the Stop key on the keypad or connect LOW to terminal 28, the controller cannot be started again until you connect HIGH to terminal 28 and press the RUN key on the keypad.

If you have inhibited the controller using the LCD keypad and then removed the LCD keypad, in order to enable the controller again you must either:

switch the power off and on again, or

attach the LCD keypad again and press the RUN key.

If you are controlling the frequency inverter with the serial interface module, in addition to the hardware enable with terminal 28, it is also necessary to select the software enable.

Software enable (EN) is controlled with PNU 040 as follows:

0 = Controller inhibited (NEN)

1 = Controller enabled (EN)

You can also enable the controller with the control word STW (bit 9).

Flying restart option

Parameter PNU 142 is used to configure the start options for the frequency inverter. The flying restart option synchronizes a coasting motor with the frequency inverter (e.g. after mains power interruption). The frequency inverter determines the speed of rotation of the coasting motor before applying power and then accelerates/brakes the motor to the specified setpoint using the configured acceleration/braking times.

If the controller is enabled through terminal 28, the flying restart option will cause the motor to start immediately (e.g. following mains power interruption or a fault). If automatic start is inhibited, the frequency inverter waits for a LOW/HIGH change before it applies power to the motor.

PNU	Name	Value	Function	WE
142	Start options	0	Automatic start inhibited, deactivate flying start	1
		1	Automatic start if terminal 28 = HIGH, flying restart option inactive	
		2	Automatic start inhibited, flying restart option active	
		3	Automatic start if terminal 28 = HIGH, flying restart option inactive	

Reversing the motor

Control terminals E3 and E4 are used to specify the direction of rotation of the motor. According to the terminal configuration (see parameter PNU 007) specification of the direction of rotation is done with or without protection against wire breaks (quickstop).

Warning!
For parameter values PNU 007 = 0 to 13 – no protection against wire breaks – a wire break can result in unintentional reversal of the motor.

PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
0 to 13	*)	*)	*)	LOW	Clockwise
				HIGH	Counterclockwise
14 to 22	*)	*)	HIGH	LOW	Clockwise
			LOW	HIGH	Counterclockwise
				LOW	Quickstop
			HIGH	HIGH	The motor direction is not reversed. If the drive is running, the signal which is applied first determines the direction of rotation. If the power is switched on and E3 and E4 are HIGH, the controller does a quickstop.

*) Terminal assignment dependent on value of PNU 007

Frequency setpoint

The frequency setpoint is used to specify the required motor speed.

For all models of frequency inverter, the maximum output frequency is limited by the value of f_{max} (PNU 011).

PNU	Name	Value	Function	WE
046	f_{Set}	0.0 to 480.0 Hz (DF4-120) 0.0 to f_{max} Hz (DF4-34x)	Frequency setpoint	0

With the DF4-34x series, entering a value greater than f_{max} will cause the setpoint value to be restricted to f_{max}. In the case of the DF4-120 series, a higher value for PNU 046 is accepted, but the output frequency is limited by the value of f_{max}.

Motor potentiometer function

Setpoint input using the motor potentiometer function is only active for certain values of PNU 007. Changes to the setpoint take place with the configured acceleration and braking times.

PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
10, 11, 12, 13, 21	LOW	LOW	*)	*)	Setpoint = 0 Hz
	HIGH				Decrease setpoint to f_{min}
	LOW	HIGH			Increase setpoint to f_{max}
	HIGH				Maintain current value (freeze)

*) Terminal assignment dependent on value of PNU 007

The motor potentiometer setpoint is stored in a non-volatile memory and is retained even after the following events:

Switching off the power

Controller inhibit

TRIP messages

For the DF4-34x series, activation of the quick stop function sets the motor potentiometer value to 0 Hz.

Motor potentiometer function in combination with jog frequencies
Changes to the setpoint take place with the configured acceleration time. For the DF4-120 the deceleration time is applicable to the braking process whereas for the DF4/-34x the quickstop ramp time is used instead.

In the case of invalid inputs (e.g. E2=HIGH=up and E3=HIGH=down) the frequency inverter decelerates the motor to the setpoint 0 Hz.

PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
22	*)	*)	HIGH	LOW	Decrease setpoint to f_{min}
			LOW		Clockwise
			HIGH	HIGH	Counterclockwise
	LOW	HIGH	LOW	LOW	Increase setpoint to f_{max}
		LOW			Maintain current value (freeze)
	HIGH	*)			Accelerate/brake to jog frequency 1 (PNU 037)

*) Terminal assignment dependent on value of PNU 007

The setpoint configured with the motor potentiometer function sets an upper limit to the jog frequency value 1. If jog frequency 1 is configured higher than the current motor potentiometer setpoint, the frequency inverter only accelerates to the motor potentiometer setpoint. If the jog frequency 1 is smaller than the current motor potentiometer setpoint, the frequency inverter accelerates or decelerates to the jog frequency 1.

If the mains is turned off, the last motor potentiometer setpoint is not stored; the new start value is always 0 Hz.

Jog frequencies

You can configure three fixed inverter frequencies (jog frequencies) with values between 0 and 480 Hz.

PNU	Name	Value	Function	WE
037	Jog frequency 1	0.0 to 480.0 Hz	Preset speeds	20 Hz
038	Jog frequency 2			30 Hz
039	Jog frequency 3			40 Hz

Depending on the value of PNU 007, the signals on terminals E1 and E2 (HIGH/LOW) are used to select one of the 3 jog frequencies as follows:

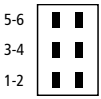
PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
3, 4, 5, 6, 9, 14, 15, 20, 22	HIGH	*)	*)	*)	Selects jog frequency 1. LOW signal returns the controller to the programmed standard setpoint.
0, 1, 2, 16	LOW	LOW			Controller returns to programmed standard setpoint.
	HIGH				Selects jog frequency 1.
	LOW	HIGH			Selects jog frequency 2.
	HIGH				Selects jog frequency 3.

*) Terminal assignment dependent on value of PNU 007

The jog frequencies can be configured lower than f_{min};f_{min} is ignored in this case. However, the f_{max} value applies to jog frequencies. If you configure the jog frequency higher than f_{max}, the output frequency of the frequency inverter is not allowed to exceed f_{max}.

Analog setpoint input

The analog setpoint is applied to terminal 7 and 8. Bridge S1 on the front of the frequency inverter is used to configure the signal range of the analog setpoint. There are 3 positions for the bridge as follows:



5-6 for setpoint range 0 or 4 to 20 mA
3-4 for setpoint range 0 to 5 V
1-2 for setpoint range 0 to 10 V

As supplied by the factory, the bridge is inserted on position 1/2, i.e. a setpoint range of 0 to 10 V.

In order to choose the setpoint range 4 to 20 mA, you must set parameter PNU 034 to 1 in addition to inserting bridge 5/6.

PNU	Name	Value	Function	WE
034	Setpoint range	0	Setpoint 0 to 5 V, 0 to 10 V or 0 to 20 mA	0
		1	Setpoint 4 to 20 mA	

Quickstop $-a_{Quick}$

Quickstop can be configured regardless of operating mode with terminals E3 and E4 in conjunction with the value of (PNU 007).

PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
2, 4, 8, 9, 13	*)	*)	LOW	*)	Activate quickstop
14 to 22				LOW	Activate quickstop with drive running
			HIGH	HIGH	Activate quickstop when power is applied

*) Terminal assignment dependent on value of PNU 007

DF4-120
For this frequency inverter series, if quickstop is activated the frequency inverter brakes to 0 Hz with the configured deceleration time. DC injection braking is activated if *f* goes below 0.1 Hz.

DF4-34x
The DF4-34x series frequency inverters have a quickstop ramp in addition to the deceleration time setting. In this case, if the quickstop function is activated, the frequency inverter brakes to 0 Hz using the quickstop ramp. The quickstop ramp time is configured with PNU 105. The factory setting is 5 s (range 0 to 999 s).

The error signal OU is output if the ramp time is too short and the signal disable is set automatically.

DC injection braking is activated when the speed drops below the configured value (PNU 019, threshold for automatic DC injection brake).

DC injection brake

The DC injection brake is used to rapidly bring the motor to a standstill without the use of a brake unit. In this case, all of the brake energy is dissipated in the motor as heat. You can indirectly configure the braking current with PNU 036 (voltage for DC injection brake).

PNU	Name	Value	Function	WE
DF4-120				
036	Voltage for DC injection brake	0.00 to 40.00 %	Sets the braking current indirectly via motor resistance	Model-dependent
106	Holding time for automatic DC injection brake	0.00 to 50.00 s	Terminates DC injection braking after a specified time, thus prevents the motor from overheating	0.00 s
DF4-34x				
019	Threshold for automatic DC injection brake	0.1 to 5.0 Hz	Automatically activates DC injection braking under the set value	0.1 Hz
036	Voltage for DC injection brake	0.00 to 40.00 %	Sets the braking current indirectly via motor resistance	Model-dependent
106	Holding time for automatic DC injection brake	0.00 to 999.00 s	Terminates DC injection braking after a specified time, thus prevents the motor from overheating	0.02 s

The DC injection brake is activated by applying a HIGH signal to the terminal E2 or E3.

PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
3, 7, 14, 19	*)	HIGH	*)	*)	DC injection brake remains active while E2, E3 = HIGH
0, 5, 11		*)	HIGH		

*) Terminal assignment dependent on value of PNU 007

Automatic DC injection brake

If the setpoint drops below the configured threshold (PNU 019), the DC injection brake is applied automatically for the holding time configured with PNU 106. The frequency inverter then goes into controller inhibit mode.

Only frequency inverters of the DF4-34x series allow the setting of the threshold (PNU 019). For the DF4-120 series, the threshold is fixed at 0.1 Hz.

External fault input

This function allows an external fault signal to be input to the frequency inverter in order to trigger controller inhibit. Please refer to the table for information on the values of PNU 007 and the terminal configuration which is necessary to trigger the external fault function.

For frequency inverters of the DF4-120 series, you cannot activate this function through the terminals if you have chosen the operating mode “setpoint input via interface module” (PNU 001 = 3). There is no such limitation for frequency inverters of the DF4-34x series.

PNU 007 =	Terminal				Function
	E1	E2	E3	E4	
7, 8, 18, 19	LOW	*)	*)	*)	Depending on the configuration, a LOW signal on the specified terminal triggers the external fault function and inhibits the controller.
5, 6, 9, 20	*)	LOW			
10		*)	LOW		

*) Terminal assignment dependent on value of PNU 007

Motor control mode

The setting for motor control mode is used to configure the frequency inverter to the specific application. It is necessary to test from case to case whether you should deviate from the factory setting.

PNU	Name	Value	Function	DF4-120	DF4-34x
014	Motor control mode	0	Linear characteristic with auto-boost (U/f = const.)	✓ (WE)	–
		1	Quadratic characteristic with auto-boost ($U \sim f^2$)	✓	–
		2	Linear characteristic with constant U_{min} boost (U/f = const.)	✓	✓
		3	Quadratic characteristic with constant U_{min} boost ($U \sim f^2$)	✓	✓
		4	Motor current control	–	✓ (WE)

Only the frequency inverters for the specified motor rating can be connected in mode 4; at least two ratings lower.

Linear characteristic, quadratic characteristic

The linear characteristic has the most favourable torque progression since it changes linearly over the entire motor speed range. Quadratic characteristics, i.e. a quadratic torque curve (often used for pumps and fans), allow a reduction in the motor losses due to reversal of magnetisation and a reduction in motor noise. However, in the case of large moments of inertia of the load, the motor may not be able to provide the necessary torque.

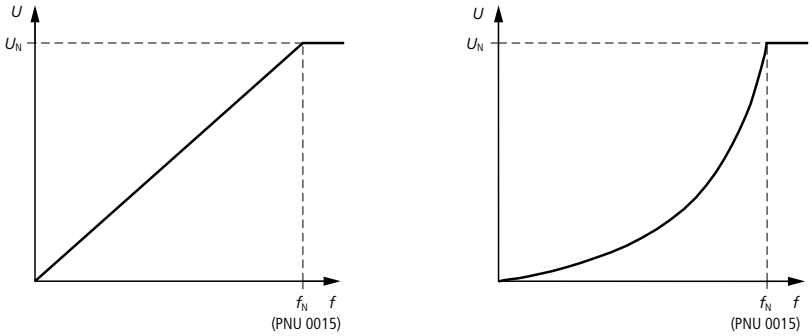


Figure 30: Linear and quadratic frequency response

Constant U_{min} boost/Automatic boost

A voltage increase (Boost, PNU 016) is needed to provide a torque in the motor at frequencies close to zero. With a constant U_{min} boost, the characteristic starts from the specified value and increases linearly up to the rated frequency f_N (PNU 015). The motor will have increased losses when idling (no load) since this value is set for operation under load. This measure is suitable for:

- Applications with several motors
- 3-phase reluctance motors
- 3 phase sliding rotor motors
- Special motors
- Lifting drives and drives with high dynamic loads (e.g. Positioning and feeding drives)

Automatic boost adapts the required voltage boost to the load situation, resulting in lower losses. This approach is particularly suitable for single drives using standard motors.

The voltage boost U_{min} is set via PNU 016. The auto-boost option automatically adapts the voltage boost to the respective motor load.

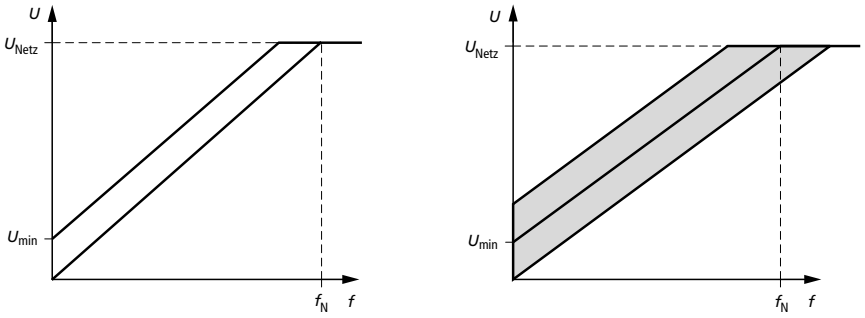


Figure 31: Constant and automatic motor voltage boost

U_{min} boost

The U_{min} boost parameter specifies voltage increase at a frequency of 0 Hz. It can be adjusted between 0 and 40 %. The factory setting for DF4-120 depends on the model concerned and for DF4-34x is 0 %.

The voltage increase set via PNU 016 adjusts the *U/f* characteristic to overcome the resistive load of the motor. This ensures that a high torque is available even at a speed of 0 Hz.

Motor control mode setting of U_{min}

Warning!
Too high a value set for U_{min} will cause increased thermal load and even destruction of the motor.

PNU 014 =	Function of U_{min}
0, 1	U_{min} value is the boost factor of the auto-boost function. The actual voltage increase depends on the load. This adjustment is useful with drives with high start-up torques, drives with quadratic load torque and with special motors
2, 3	The U_{min} value is used to correct the *U/f* characteristic up to the rated frequency
4	The U_{min} value is ignored in the motor control mode "Motor current control".

Motor current control

Motor current control provides a higher torque and lower no load currents compared to *U/f* characteristic control. The frequency inverter thus has a higher dynamic response. This approach is particularly suitable for:

single drives with heavy load changes,

single drives with high start-up torque requirement,

highly-accurate speed control of 3-phase standard motors in conjunction with slip compensation.

Motor current control is not possible if:

several drives with different loads are connected to the same frequency inverter,

several drives with different nominal power ratings are connected to the same frequency inverter.

additional inductance is being used in the motor power circuit (motor chokes, motor voltage filters etc.)

Attention!
Only switch from *U/f* characteristic control to motor current control during controller inhibit.

U/f rated frequency

Parameter PNU 015 depends on the rating data of the motor and the rated voltage of the frequency inverter. If the characteristic is incorrectly specified this can result in reduced torque or overheating of the motor.

PNU	Name	Value	Function	WE
DF4-120				
015	*U*/*f* rated frequency	30.0 to 960.0 Hz	Characteristic point of the rated voltage $= \frac{230\ V}{U_{NMot}} \times f_{NMot}$	50 Hz
DF4-34x				
015	*U*/*f*-rated frequency	7.5 to 960.0 Hz	Characteristic point of the rated voltage $= \frac{400\ V}{U_{NMot}} \times f_{NMot}$	50 Hz

Example:

For frequency inverters of the DF4-34x series with the rated voltage U_{Mains} = 3 AC 400 V and with the motor data U_{NMot} = 380 V and f_{NMot} = 50 Hz the following characteristic points are obtained:

$$\text{PNU 015} = \frac{400\ V}{380\ V} \times 50\ Hz = 52{,}6\ Hz$$

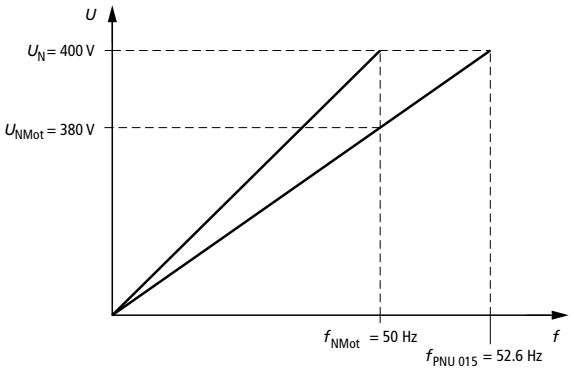


Figure 32: Calculation of characteristic point PNU 015

Maximum and minimum frequency

The maximum and minimum frequency do not have an effect on the *U/f* characteristic but restrict the range in which you can run the frequency inverter in continuous operation. f_{min} is the lower limit and f_{max} the upper limit.

Warning!
If you have set f_{max} too high, the motor may be destroyed due to too high centrifugal forces.

PNU	Name	Value	Function	WE
DF4-120				
010	f_{min}	0.0 to 480.0 Hz	Minimum frequency setpoint value for analog setpoints	0
011	f_{max}	30.0 to 480.0 Hz	Maximum frequency setpoint value for analog setpoints	50
DF4-34x				
010	f_{min}	0.0 to 480.0 Hz	Minimum frequency setpoint value for analog setpoints	0
011	f_{max}	7.5 to 480.0 Hz	Maximum frequency setpoint value for analog setpoints	50

If the frequency inverter starts from 0 Hz, the range up to f_{min} (PNU 010) is not skipped but is progressed with the set ramp time. You cannot adjust the drive to a steady speed between 0 Hz and f_{min}; the frequency inverter will then automatically accelerate to f_{min}. The parameter f_{max} (PNU 011) is the upper limit that should not be exceeded on any account. f_N is the rated frequency that is set with PNU 015. f_{max} is used to normalise the setpoint and is always 100 % setpoint (full scale of potentiometer), f_{min} is always 0 %. Depending on the setting of f_{max} the rated speed of the motor is already reached with small analog setpoints.

Contact the motor manufacturer if you want to operate the motor with a higher speed than the rated speed.

f_{max} limits jog frequencies that were programmed too high to the value of f_{max}. Only change f_{max} during controller inhibit.

In the case of DF4-120 and $f_2 > 240$ Hz the overcurrent disconnection can trip out (such as with a low inductance motor).

In the case of DF4-34x and $f_2 > 300$ Hz chopper frequencies $<$ avoid a frequency of 8 kHz.

f_{min} only affects the analog setpoint value, not the jog frequencies.

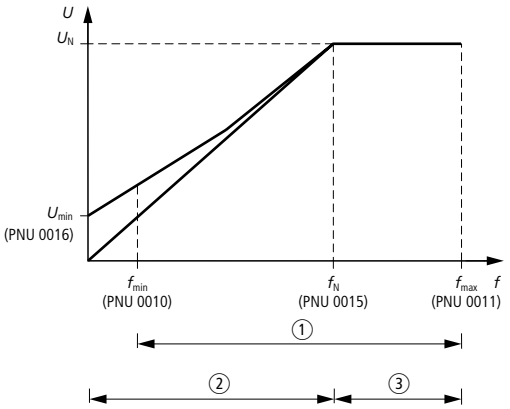


Figure 33: Usable motor speed range

① Usable motor speed range
② M = constant
③ M ~ 1/f

Motor data

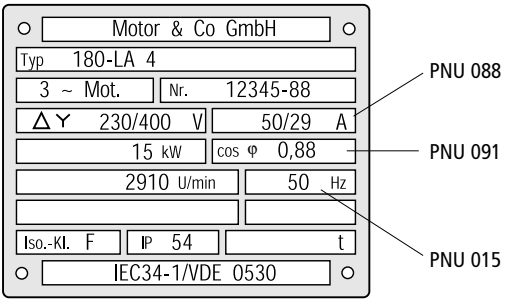


Figure 34: Motor name plate

DF4-34x

PNU	Name	Value	Function	WE
088	Rated motor current	0.0 to 1.2 × I_N	Configures the frequency inverter for size and type of motor	Rated output current
091	Motor cos φ	0.4 to 1.0		Dependent on motor

Rated motor current and motor cos φ are used to optimise the motor current control (PNU 014 = 4). It is only necessary to adjust these parameters if you use 4-pole asynchronous standard motors which are not suitable for the required load power. The factory settings are appropriate for normal situations.

Ramp times

The ramp generator delays sudden changes to the setpoint and ensures the defined acceleration or deceleration of the motor.

PNU	Name	Value	Function	WE
012	+a	0.0 to 999.0 s	Acceleration time from 0 Hz to f_{max}	5 s
013	–a	0.0 to 999.0 s	Deceleration time from f_{max} to 0 Hz	5 s

Under normal conditions, it is possible to operate DF4 frequency inverters continuously at the current limit (trip free function). In order to achieve this, the frequency inverter automatically reduces the setpoint in order to operate the drive at lower speeds with a lower load. However, as a result of this, when the current limit is reached speed changes can no longer be carried out with the configured ramp times. If the load does not decrease as fast as the speed and if the times are configured too short, the frequency inverter can output the fault OC5 (inverter overload).

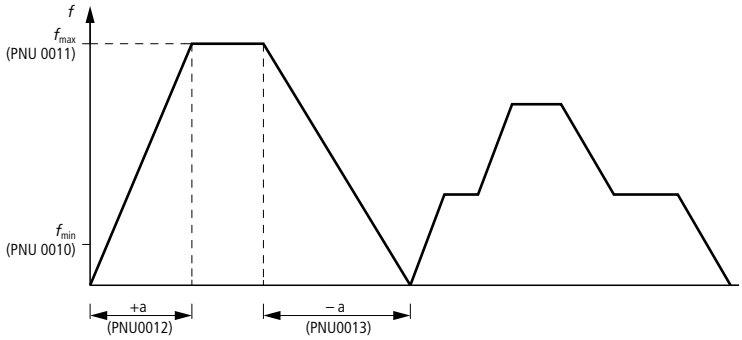


Figure 35: Ramp times

Current limits

The frequency inverter is provided with a current limit control which affects the dynamic behaviour under load. The measured load is compared with the configured values for a driving load (PNU 022) and for the generative load (PNU 023).

The ramp time is lengthened if the current limit is reached during acceleration. If the current limit is reached with increasing load and constant speed, the frequency setpoint is reduced (10 Hz with DF4-120 and 0 Hz with DF4-34x). If the overcurrent continues to increase, the I^2t calculation outputs an overcurrent fault after a short delay.

If the frequency inverter reaches the generative current limit, the frequency setpoint is increased until the current returns below the set limit (to max. f_{max}).

The best current control is achieved when a brake unit is connected or frequency inverters are interconnected (group operation).

When using chopper frequencies $>$ 8 kHz, you must reduce the current limiting (Derating for higher chopper frequencies). Refer to the values of I_{max} for 60 s from the Appendix in the Technical data.

PNU	Name	Value	Function	WE
022	I_{max}	30 to 150 %	Current limit motor mode	150 %
023	I_{maxGen}	30 to 110 %	Current limit generator mode	80 %

Slip compensation

When the drive is loaded, the motor slip increases, resulting in a decrease in motor speed. The slip can be partially compensated by configuring PNU 021

appropriately. The setting is valid for all motor control modes (PNU 014).

In order to calibrate the slip compensation, operate the motor without load and measure the motor speed which is reached. Then operate the motor with load and adjust the slip compensation to reach the same speed again.

Attention!
If the value of this parameter is too high, this can lead to an unstable behaviour of the frequency inverter.

PNU	Name	Value	Function	WE
021	Motor slip compensation	0 to 12 % (DF4-120) 0 to 20 % (DF4-34x)	Compensation of variation of motor speed with changing load	0 %

Chopper frequency (only DF4-34x)

The chopper frequency for the DF4-120 frequency inverter is set permanently to 9.2 kHz.

This parameter is used to adjust the switching frequency of the chopper. You do not normally need to change the factory settings.

However, a change may be useful in the following cases:

Chopper frequency $<$ 8 kHz:
improve torque behaviour with small setpoints

Chopper frequency $>$ 8 kHz:
Lower motor noise
Good sine wave shape of motor current with applications requiring setpoint values over 150 Hz

Attention!
Adjustment of the chopper frequency (PNU 018) does not automatically change the current limits.

PNU	Name	Value	Function	WE
018	Chopper frequency	0	4 kHz	1
		1	8 kHz	
		2	12 kHz	
		3	16 kHz	
		4	12 kHz, noise optimized	
		5	16 kHz, noise optimized	
144	Chopper frequency reduction	0	No chopper frequency reduction	1
		1	Automatic reduction of chopper frequency at heat sink temperature ϑ_{max} –10 °C	

Higher chopper frequencies increase the losses in the frequency inverter. Accordingly, the current limits must be derated in this case.

Automatic chopper frequency reduction (PNU 144) affects the behaviour of the frequency inverter at the chopper frequencies 12 kHz and 16 kHz.

PNU 144 =	Function
0	If ϑ_{max} is exceeded at chopper frequencies of 12 kHz/16 kHz, the controller is inhibited and the TRIP signal is set. The motor coasts to a halt.
1	If ϑ_{max} –10 °C is exceeded at chopper frequencies of 12 kHz/16 kHz, the chopper frequency is automatically reduced to 8 kHz. The drive continues to operate. The reduced chopper frequency causes the motor to generate more noise.

Oscillation damping (only DF4-341)
The parameter for oscillation damping optimises the running behaviour of the motor. This parameter may need to be adjusted for motors whose rated output power is smaller than that of the frequency inverter; e.g. in the case of motors with a large number of poles and special motors. This parameter can also be adjusted to minimise signs of resonance in the frequency inverter.

This value cannot be transferred with the optional LCD keypad DE4-KEY-1.

PNU	Name	Value	Function	WE
079	Oscillation damping	0 to 80	Reduction of vibration under no load	5

Frequency message from relay

The frequency message threshold is set with PNU 017. The frequency f_1 that you set can be between 0.0 and 480.0 Hz. The relay is energized if the output frequency f_2 exceeds the set value $f_2 > f_1$. The factory setting for the frequency is 0 Hz.

Read-only parameters

Status word

The 16-bit status word gives information on the current status of the frequency inverter. The status word is bitmapped and stored in PNU 150. Please refer to the following table for information on the significance of the bits.

Significance of the bits

Bit	Function DF4-120	Function DF4-340, DF4-341
0	reserved	0 = Parameter set 1 active 1 = Parameter set 2 active
1	Impulse inhibit (IMP) 0 = Frequency inverter enabled 1 = Frequency inverter inhibited	
2	0 = Operation below the current limit 1 = Current limit reached	
3	reserved	0 = ($f_2 \neq f_{Set}$) 1 = ($f_2 = f_{Set}$)
4	0 = ($f_2 \neq f_{Set}$) 1 = ($f_2 = f_{Set}$)	Ramp generator (HLG) 0 = (HLG input ≠ HLG output) 1 = (HLG input = HLG output)

Bit	Function DF4-120	Function DF4-340, DF4-341
5	0 = signal threshold not reached ($f_2 < f_1$) 1 = signal threshold reached ($f_2 > f_1$)	
6	0 = ($f_2 \neq 0$) 1 = ($f_2 = 0$)	
7	0 = Controller enabled (EN) 1 = Controller inhibit (NEN)	
8 9 10 11	Inverter status 0 = No fault 8 = Fault 15 = Inverter switched off (message only applies to serial interface module with external power feed)	Inverter status 0 = Inverter initialisation 1 = Autostart Lock 3 = Operation disabled (controller inhibit) 4 = Flying restart option active 5 = DC injection braking active 6 = Controller enabled 7 = Message active (IMP set dynamically, e.g. with OU message) 8 = Fault 15 = Inverter disconnected (Message only applies to serial interface with external power feed)
12	0 = Heatsink temperature below warning threshold 1 = Warning threshold of heat sink temperature reached (ϑ_{max} –10 °C)	
13	0 = DC bus voltage U_{ZKmax} normal 1 = Overvoltage in DC bus	
14	0 = Clockwise 1 = Counterclockwise	
15	0 = not ready for operation 1 = ready for operation (no fault, undervoltage or overvoltage)	

Displaying parameters on the LCD keypad

Several parameters which are measured by the frequency inverter during operation can be displayed on the optional LCD keypad DE 4-KEY-1. See also parameters PNU 500 and 501.

With DF4-34x series frequency inverters you can refer the displayed value to a process variable.

PNU	Name	Value
050	Field frequency	0 to 480 Hz
052	Motor voltage	0 to 260 V for DF4-120 0 to 510 V for DF4-340 0 to 530 V for DF4-341
054	Motor current	0 to 2 × I_N [A] ±20 %
056	Inverter load	0 to 200 % ±20 %
061	Heatsink temperature	0 to 100 °C ±5 %

Analog output signal for monitoring

For monitoring purposes, various process parameters from the frequency inverter can be output to terminal 62 as normalised voltages.

PNU	Name	Value	Function	WE
DF4-120				
111	Monitor output signal	0	Output frequency	0
		1	Inverter load (in-phase current)	
		2	Motor current	
		3	DC bus voltage	
108	Gain for PNU 111	0 to 255	Corresponds to 40 % to 110 %	220
DF4-34x				
111	Monitor signal	0	Output frequency	0
		1	Inverter load (in-phase current)	
		2	Motor current	
		3	DC bus voltage	
108	Gain for PNU 111	0 to 255	Corresponds to 0 % to 200 %	128

The gain for the analog output can be adjusted online with PNU 108.

The following table shows the assignment of voltages to terminal 62 and the process parameters.

PNU 111 =	Function
DF4-120 with PNU 108 = 220 (WE)	
0	6 V, if $f_2 = f_{max}$
1	3 V if PNU 056 = 100 %
2	3 V if PNU 054 = rated motor current
3	6 V at U_G = 380 V DC
DF4-34x with PNU 108 = 128 (WE)	
0	6 V, if $f_2 = f_{max}$
1	3 V if PNU 056 = 100 %
2	3 V if PNU 054 = rated motor current
3	6 V at U_G = 1000 V DC

Switch-on display

The selected display value is active after the power supply has been switched on and can be read on the keypad.

PNU	Name	Value	Function	WE
004	Switch-on display	0	Output frequency f_2	0
		1	Inverter load	
		2	Motor current	

Absolute display of a process parameter

PNU 500 and PNU 501 are used to adapt parameters which specify speeds or frequencies (PNU 010, PNU 011, PNU 017, PNU 019, PNU 037, PNU 038, PNU 039 and PNU 050) to a process parameter to be controlled, e.g. speed. The absolute value of the process parameter is then shown on the display of the LCD keypad.

DF4-34x

PNU	Name	Value	Function	WE
500	Display factor for processing speed, numerator	1 to 25000	Conversion factor (numerator) from a physical value to a process parameter	2000
501	Display factor for processing speed, denominator	1 to 25000	Conversion factor (denominator) from physical value to a process parameter	10

Calibration

The displayed value is calculated as follows:

$$\text{Display PNU XXX} = \frac{f_{\text{PNU XXX}}}{200} \times \frac{\text{PNU 500}}{\text{PNU 501}}$$

Example:

Changing the display of frequency to motor speed.

At f_{max} = 50 Hz the display should show 1500. The units are not shown on the display.

$$\text{Display PNU 011} = \frac{f_{\text{PNU XXX}}}{200} \times \frac{\text{PNU 500}}{\text{PNU 501}}$$

$$1500 = \frac{50}{200} \times \frac{\text{PNU 500}}{\text{PNU 501}}$$

e.g. PNU 500 = 6000, PNU 501 = 1

This function is not available for the DF4-120 series frequency inverters.

Running time meter

The running time meters show the time during which:

the controller of the frequency inverter is enabled (running time meter: PNU 178)

the frequency inverter is connected to the mains power (power-on time meter: PNU 179)

A time duration of 0 to 65000 hours can be displayed.

Relay monitoring functions

Relay output K1

In order to monitor the frequency inverter, you can assign various functions to the changeover contacts of the relay K1 (terminals K11, K12, K14). This is done with parameter PNU 008 as follows:

PNU	Name	Value	Switching condition	WE
008	Relay function of relay K1	0	Inverter ready to operate	1
		1	TRIP signal	
		2	Motor running	
		3	Motor running/CW rotation	
		4	Motor running/CCW rotation	
		5	Output frequency $f_2 = 0$	
		6	f_{Set} reached	
		7	$f_2 > f_1$	
		8	I_{max} reached	
		9	Overtemperature (ϑ_{max} –10 °C)	
		10	TRIP or $f_2 > f_1$ or IMP	

The following table explains each of the switching conditions and describes how the relay reacts:

Switching condition	**Relay K1**	
Inverter ready to operate	Makes:	Inverter ready
	Breaks:	TRIP signal Undervoltage/overvoltage Inverter in programming mode (DF4-120 only)
TRIP signal	Makes:	TRIP signal
Motor running	Makes:	$f_2 \neq 0$ Hz
Motor running/CW rotation Motor running/CCW rotation	Makes: Clockwise:	$f_2 \neq 0$ Hz, rotation direction via terminal $f_2 > 0$ Hz, CCW rotation: $f_2 < 0$ Hz
Field frequency $f = 0$	Makes:	$f_2 = 0$ Hz, because $f_{Set} = 0$ Hz DC injection braking (DCB) active Controller inhibited
f_{Set} reached	Makes:	$f_2 = f_{Set}$
$f_2 > f_1$	Makes:	$f_2 > f_1$ (PNU 017)
I_{max} reached	Makes:	Motor current I_{max} motor mode (PNU 022) = I_{max} generator mode (PNU 023)
Overtemperature	Makes:	ϑ_{max} –10 °C
TRIP, $f_2 > f_1$ or IMP	Breaks:	TRIP signal $f_2 \leq f_1$ Impulse inhibit due to controller inhibit, overvoltage or undervoltage

Relay output K2 (only DF4-341 series)

In order to monitor the frequency inverter, you can assign various functions to the changeover contacts of the relay K2 (terminals K21, K22, K24). This is done with parameter PNU 117 as follows:

PNU	Name	Value	Switching condition	WE
117	Relay function of relay K2	0	Inverter ready to operate	0
		1	TRIP signal	
		2	Motor running	
		3	Motor running/CW rotation	
		4	Motor running/CCW rotation	
		5	Output frequency $f_2 = 0$	
		6	f_{Set} reached	
		7	$f_2 > f_1$	
		8	I_{max} reached	
		9	Overtemperature (ϑ_{max} –10 °C)	
		10	TRIP or $f_2 > f_1$ or IMP	
		11	PTC warning	

Relay output K2 is not available for the DF4-120/DF4-340 series frequency inverters.

The following table explains each of the switching conditions and describes how the relay reacts:

Switching condition	Relay K2		
Inverter ready to operate	Makes:	Frequency inverter ready	
	Breaks:	TRIP signal Undervoltage/overvoltage	
TRIP signal	Makes:	TRIP signal	
Motor running	Makes:	$f_2 \neq 0$ Hz	
Motor running/CW rotation Motor running/CCW rotation	Makes: Clockwise: Countercloc kwise:	$f_2 \neq 0$ Hz, rotation direction via terminal $f_2 > 0$ Hz $f_2 < 0$ Hz	
Field frequency $f = 0$	Makes:	$f_2 = 0$ Hz, because	$f_{Set} = 0$ Hz DC injection braking (DCB) active Controller inhibited
f_{Set} reached	Makes:	$f_2 = f_{Set}$	

Switching condition	Relay K2	
$f_2 > f_1$	Makes:	$f_2 > f_1$ (PNU 017)
I_{max} reached	Makes:	Motor current I_{max} motor mode (PNU 022) = I_{max} generator mode (PNU 023)
Overtemperature	Makes:	ϑ_{max} –10 °C
TRIP, $f_2 > f_1$ or IMP	Breaks:	TRIP signal $f_2 \leq f_1$ Impulse inhibit due to controller inhibit, overvoltage or undervoltage
PTC warning	Breaks:	PTC switch has detected motor overtemperature

Temperature monitoring I^2t

The I^2t monitoring allows temperature monitoring of self-cooled three-phase motors without the need for additional sensors. Set the load limit via PNU 120 between 0 and 100 %. The factory setting is 0 %.

Calibration
Specify a load limit for the motor. If this value is exceeded for a longer period of time, the frequency inverter switches off with the fault OC6.

The current limits set via PNU 022 and PNU 023 only have an indirect influence on I^2t calculation. They avoid operation with the frequency inverter at maximum load (PNU 056).

If the frequency inverter model is chosen incorrectly, the rated output current can be much higher than the rated motor current. Reduce the value for PNU 120 by the same factor as the incorrect dimensioning.

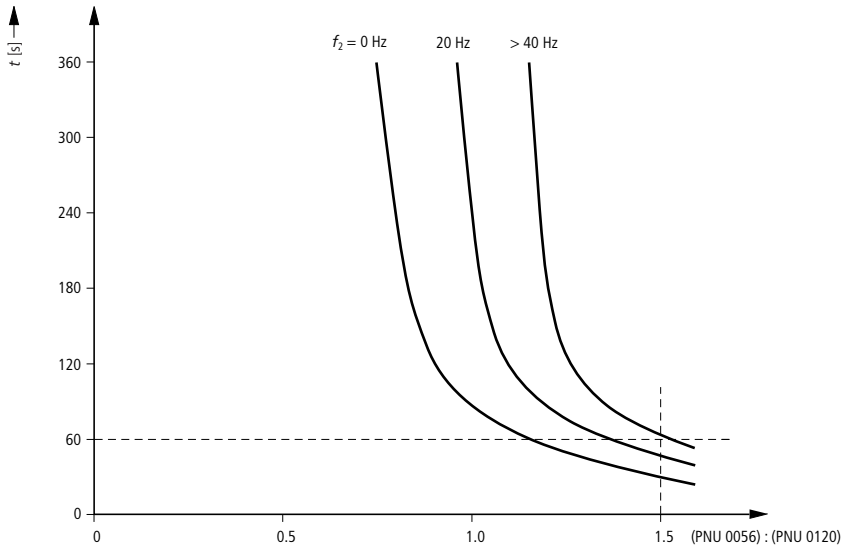


Figure 36: I^2t monitoring

Example:

With PNU 120 = 100 % and with a load PNU 056 = 150 % the inverter will switch off after 60 s if $f_2 > 40$ Hz or earlier if $f_2 < 40$ Hz.

Attention!
The calculated I^2t value is always reset to "0" after the mains supply is switched on. The frequency inverter does not have a thermal memory.

The thermal trip is deactivated by setting PNU 120 = 0.

PTC input terminals

The input is used for connecting PTC resistors to DIN 44 081 and DIN 44 082. The PTC resistor is used for recording motor temperature and incorporating it into the monitoring of the frequency inverter. The same terminals can also be used to connect a temperature switch (break contact).

The PTC input is only available with DF4-341 frequency inverters. The input is designated as T1 and T2 on the frequency inverter.

PNU	Name	Value	Function	WE
119	Function of PTC input	0	PTC input inactive	0
		1	PTC input active, TRIP and controller inhibit are set	
		2	PTC input active, warning is output	

Fault message display

The last four faults are stored in the frequency inverter in non-volatile memory. They are stored in a stack. When a new fault occurs, the last but two fault is discarded from the stack and the others are moved down one position. The faults are identified under the following parameter numbers:

PNU	Name	Value	Function
161	Current fault	0 to 255	Stores the specified fault
162	Previous fault		
163	Last but one fault		
164	Last but two fault		

When using the optional LCD keypad, the fault messages are shown as plain text abbreviations (see table below). When using the serial interface module, only the fault numbers are transferred.

Fault numbers and codes

Fault number	Fault code	Fault
0	---	No fault
11	OC1	Short-circuit
12	OC2	Earth fault
13	OC3	Inverter overload during acceleration or short-circuit
14	OC4	Inverter overload during deceleration
15	OC5	Inverter overload
16	OC6	Motor overload
20	OU	Overvoltage
22	OUE	Overvoltage in DC bus (only DF4-120)

Fault number	Fault code	Fault
30	LU	Undervoltage
50	OH	Heatsink overtemperature
51	OH1	Controller section overtemperature (only DF4-120)
52	OH2	Power section overtemperature (only DF4-120)
53	OH3	PTC motor temperature alarm (only DF4-341)
54	OH4	Inverter overtemperature
61	CE0	Communication error DF4 ↔ serial interface module
71	CCr	System error
72	Pr, Pr1	Faulty parameters transferred (Pr), faulty parameter set 1 transferred (Pr1) (only DF4-340, DF4-341)
73	Pr2	Faulty parameter set 2 transferred (only DF4-340, DF4-341)
76	rST	Fault during auto-TRIP reset
91	EEr	External fault
105	H05	Internal CPU fault

Reset fault message (TRIP reset)

You can configure whether faults which occur are reset manually or automatically. Auto TRIP reset (PNU 170) resets the fault automatically after the time delay specified with PNU 171. Only those faults are automatically reset which are listed in the table.

Attention!
Switching on the power always carries out a TRIP reset. In the case of more than 8 auto-TRIP resets within 10 minutes, the frequency inverter TRIPs with the message rST (counter exceeded). This message is displayed on the optional LCD keypad.

PNU	Name	Value	Function	WE
043	TRIP reset (DF4-34x)	0 (reading)	No current fault	
		0 (writing)	Reset fault	
		1	Fault has occurred	
170	TRIP reset method	0	Manual TRIP reset: via STP key on LCD keypad or LOW signal on terminal 28	0
		1	Auto-TRIP reset enabled for: OC3 Overload during acceleration OC4 Overload during deceleration OC5 Inverter overload OC6 I^2t trip OH Overtemperature OUE Undervoltage in DC bus	
171	Delay for Auto-TRIP reset	0 to 60 s	Time after a fault before Auto-TRIP reset is executed.	0

4 Assembly/Installation

Scope of delivery

When you first receive the frequency inverter, check whether the components in the accessories packet are complete and correct. Please contact your sales office if parts are missing or faulty.

Accessories supplied	DF4-120	DF4-340	DF4-341
7-pin socket connectors for control cable + relay K1	2	2	2
3-pin socket connector for relay output K2	–	–	1
Mounting rail	2	2	–
Mounting bracket, 4 screws	–	–	4
Rubber grommet PG 21	–	–	1
Screen plate for control cables, screw M4 × 10	–	–	1
Screen plate for motor cable, 2 screws	–	–	1
Nut M6, plain washer, spring washer	–	–	10
Assembly instructions	1	1	1

Installation in the control cabinet

During assembly please consider the weight and dimensions of the frequency inverter. Use the necessary technical aids (lifting trolley and/or crane for larger weights) and tools. Improper handling and the use of incorrect tools can damage the frequency inverter.

Attention!
Only install the frequency inverter as a complete unit; do not dismantle.
Provide appropriate countermeasures in the case of:

- cooling air which is polluted with dust, fluff or fat. This can cause short-circuits on the printed circuit board (install filters, use separate ventilation air supply),
- aggressive gases. They can etch tracks on printed circuit boards (install filters, use separate ventilation air supply), and
- dirty filters. They may cause overheating (clean regularly)

In order to avoid overheating,

- ensure that the cooling air supply and the cooling exhaust air can flow freely without obstruction;
- do not install other equipment which generates large amounts of heat close to the frequency inverter;
- ensure that there is a clearance of 100 mm above and below the frequency inverter since otherwise the temperature of the cooling air can increase to over 40 °C causing the frequency inverter to switch off.

For DF4-341 frequency inverters, you must allow a clearance towards the front of the unit of 50 mm.

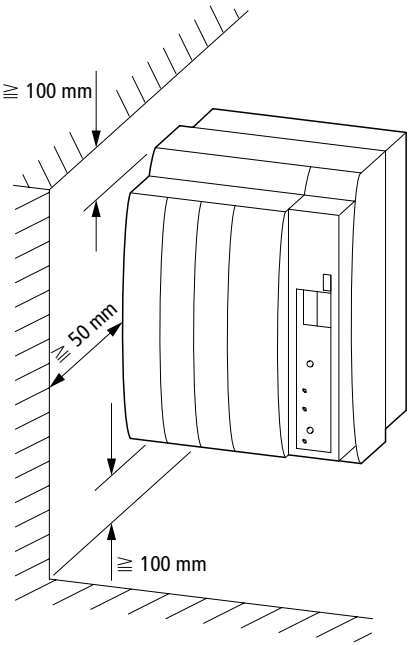


Figure 37: Necessary clearances for the DF4 series

If the frequency inverter is installed at locations which are subject to continuous vibration or shock, consider the use of vibration damping devices.

Mounting angle

The maximum permissible angle of tilt for all frequency inverter models is 30°.

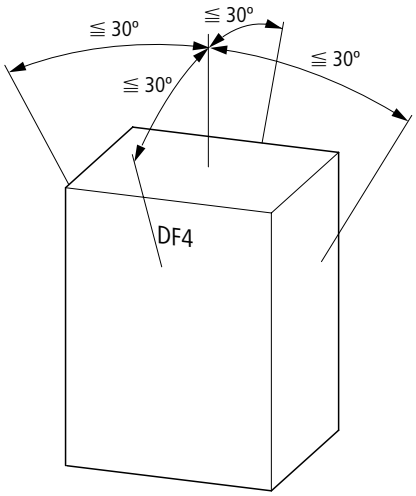


Figure 38: Mounting angle for DF4 series

DF4-120-037 to DF4-340-3K0
The frequency inverters can be installed in two different positions:

- mount with the rear against the back plate of the control cabinet with the terminals pointing towards the front. Use the mounting rails provided or use special clips for top-hat rails, or
- mount with the side against the back plate of the control cabinet with the terminals pointing towards the side. Use the mounting rails provided or special clips for the top-hat rails and fit them in the guide provided on the heat sink

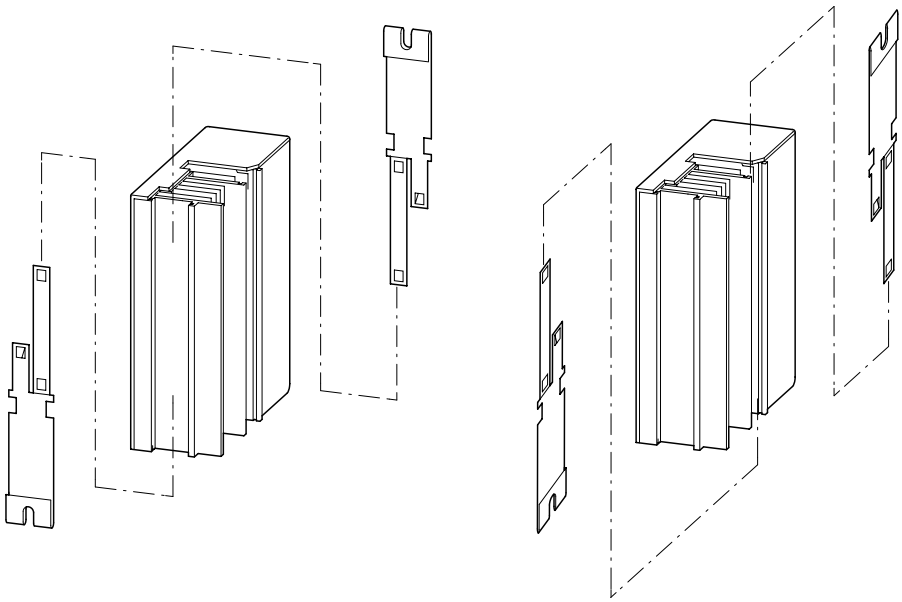


Figure 39: Inserting the mounting rails

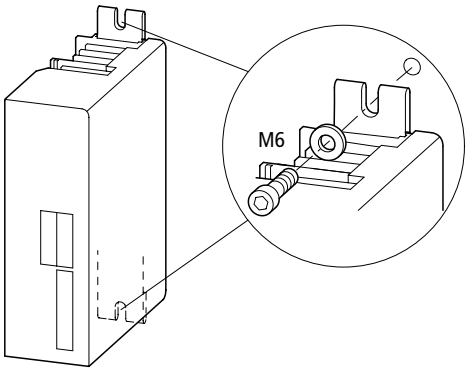


Figure 40: Attaching to the mounting plate

The frequency inverter can also be installed in swing frames. This is suitable for mounting depths <198 mm, allowing easy operation and access to the interface.

DF4-341

The frequency inverters should be fastened to the mounting plate with the fixing brackets provided; the terminals should be pointing to the front.

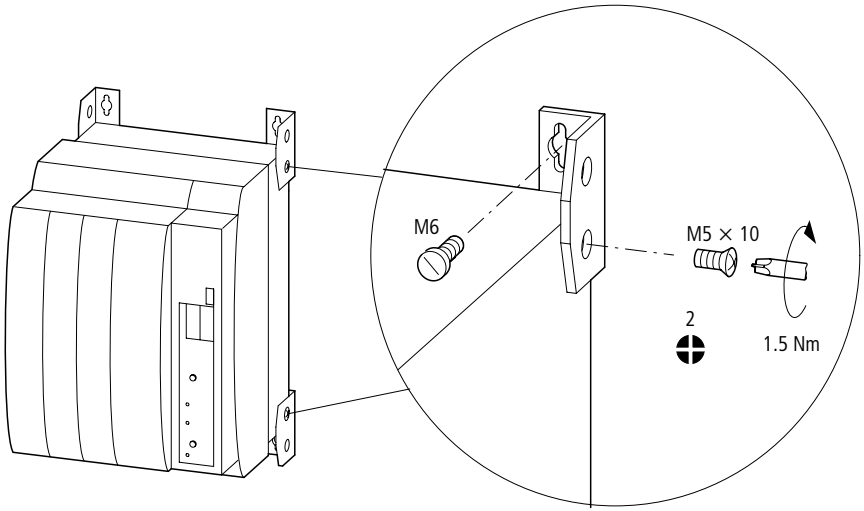


Figure 41: Fixing to the mounting plate (DF4-341-15K to 30K)

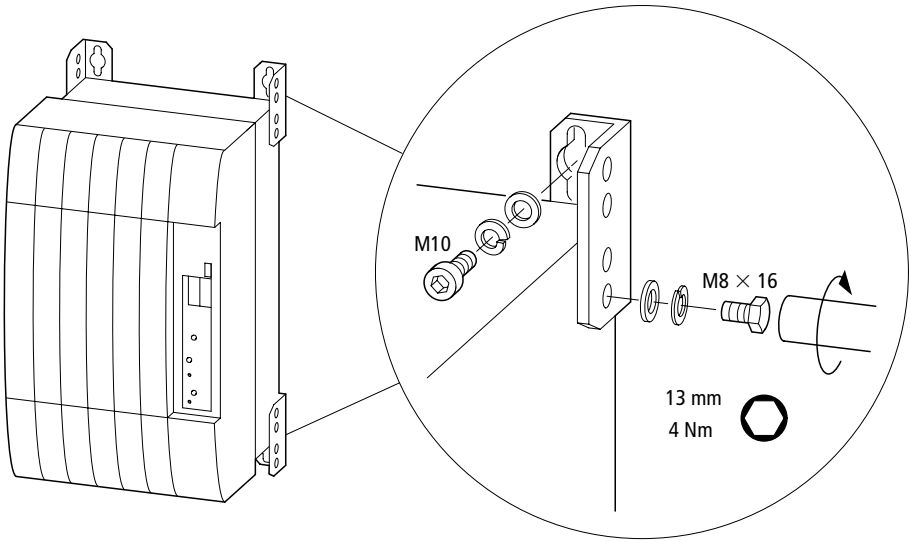


Figure 42: Fixing to the mounting plate (DF4-341-45K to 90K)

Assembly instructions are provided with each frequency inverter.

Connections

Only insert or remove the plug-in screw terminals when the power is off.

The DF4-341 frequency inverter has terminals (terminal clips) for temperature monitoring.The two terminals are located close to the power terminals for the motor (U, V, W).

Attention!
Frequency inverters contain components which can be damaged by electrostatic charges (ESD). Discharge any electrostatic charges before undertaking installation and service work in the vicinity of the terminals by touching a PE mounting screw or another earthed metal surface within the control cabinet.

Attention!
The electrical installation and commissioning work may only be carried out by suitably qualified personnel. They are responsible for ensuring that appropriate earthing and conductor protection is provided for the incomers in accordance with currently valid local and national regulations. The motor must be protected against overload.

Connecting the motor cables

If possible keep all cables away from the motor cable.

The specified cable cross sections apply to conductors L1, L2, L3, N, PE, U, V, W, +UG, –UGH. The cable cross sections required for the frequency inverters and tightening torques for the cable terminals are specified in the Appendix under Fuses/cable cross sections.

Connecting the screen for the motor cables

DF4-120-037 to DF4-340-3K0
Connect the screen of the motor cables to the frequency inverter using the fast-on connector on the front of the frequency inverter.

DF4-340-4K0 to DF4-340-11K
Connect the screen of the motor cables to the metal surface on the front of the frequency inverter.

DF4-341
Connect the screen of the motor cables to the supplied screen plate (Figure 41) and attach it to the metal PE surface on the frequency inverter.

Connect the screen of the motor cables to the screen plate which is then attached to the metal surface on the front of the frequency inverter close to the terminals U, V, W using the two screws provided (Figure 41).

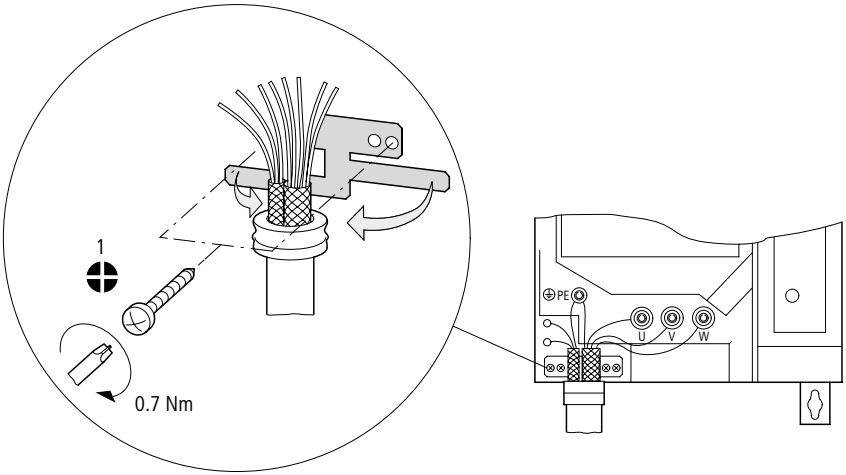


Figure 43: Fastening the screen

Attention!
With DF4-341-15K frequency inverter models up to 30K, you cannot use the screen plate for strain relief.

Connecting the control cables

The values of the table apply to all DF4 frequency inverters.

Model	Torque, Nm	Cable-cross section
DF4	0.5 to 0.6	1.5 mm^2 (AWG 14)

The control terminals are protected against polarity reversal. This prevents incorrect connection of the control inputs. However, the use of excessive force allows them to be inserted the wrong way round. The controller cannot be enabled in this case.

Only models of the DF4-341 frequency inverter series control terminals K21, K22 and K24.

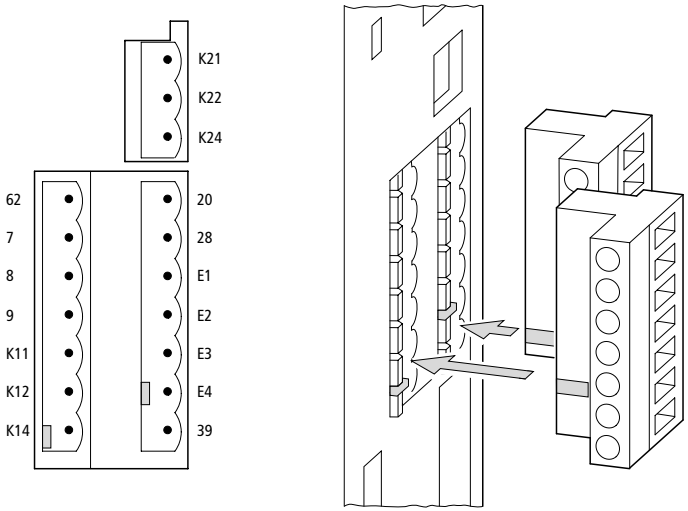


Figure 44: Inserting the plug-in terminals for the control signals

If the cables for control signals and relays are not installed in a single cable run, the screening of the two sections of cable must be connected together using a short earthing cable. The mounting screw for the setpoint potentiometer must also be connected to PE.

Connecting the screen for the control cables

In the case of DF4-340-4K0 to DF4-341-90K, the length of the screws used to connect the cable screen and/or the screen plate must not exceed 12 mm.

Always screen cables for analog signals. For such cables only connect the screen at one end of the cable in order to avoid distortion of the signal.

DF4-120/DF4-340-075 to DF4-340-3K0
Connect the screens of the control cables for analog signals using the fast-on connectors located on the front of the frequency inverter.

DF4-340-4K0 to DF4-340-11K
Connect the screens of the control cables for analog signals using the metal surface located on the front of the frequency inverter.

DF4-341
Connect the screen of the control cables for analog signals to the supplied screen plate which is then

attached to the metal surface on the front of the frequency inverter using the screw provided.

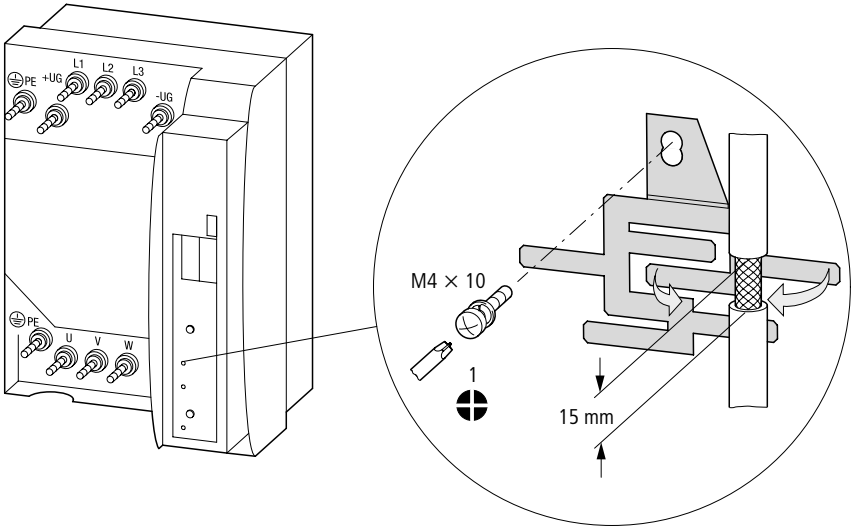


Figure 45: Connecting the screen of the control signal cables

5 Operation

Commissioning

DF4-120
The frequency inverters are factory set to operate a 4-pole standard motor 230/400 V, 50 Hz of appropriate power rating.

DF4-34x
The DF4-34x series frequency inverters are factory set to operate a 4-pole standard motor of appropriate power rating. The settings should not need to be changed for standard applications.

Attention!
Make sure before switching on the frequency inverter that the admissible ambient conditions have not been exceeded and that no signs of moisture are visible within the frequency inverter. Moisture can condense if the frequency inverter is stored in a cold place. If moisture has entered the device, dry it out completely before use.

Attention!
The electrical installation and commissioning work may only be carried out by suitably qualified personnel. They are responsible for ensuring that appropriate earthing and conductor protection is provided for the incomers in accordance with currently valid local and national regulations. The motor must be protected against overload.

You must not carry out voltage breakdown tests on any of the frequency inverter components. Use a suitable measuring instrument (internal resistance at least 10 kΩ/V) to measure signal voltages.

Switching on

Observe the following during installation:

- when using the internal power feed, interconnect terminals 7 and 39,
- after switching on the power, the frequency inverter is ready to operate after approx. 2 seconds,
- specify the direction of rotation of the motor: clockwise – terminal E4 LOW signal (0 to 3 V)
- Counterclockwise – terminal E4 HIGH signal (12 to 30 V),
- specify the setpoint (terminal 8).

You can now enable the controller with a HIGH signal on terminal 28.

If you want to change the parameter settings of the frequency inverter for special applications, this is done with the optional LCD keypad (DE 4-KEY-1) or the optional serial interface module.

Operation

If you want to apply power to the frequency inverter when the motor is already turning, activate the flying restart option.

It is admissible to install switches or contactors in the outgoing side (motor side) of the frequency inverter for safety functions (e.g. for emergency stop). However, if the drive is operating and the controller is enabled, operating a switch on the motor side can result in fault messages from the frequency inverter.

If the power is switched on and off cyclically, make sure that the frequency inverter is not switched on more than once every 3 minutes because otherwise the internal switch-on current limiting circuit may become overloaded.

The DF4-341 series frequency inverters have a temperature-dependent fan control circuit.

The fans only operate when the factory preset temperature has been exceeded.

When switching on the power with the controller enabled, the fault message “OCx” (short circuit or earth fault) may be shown on the display of the LCD keypad (see chapter Diagnostics, fault messages)

All DF4 series frequency inverters must be operated with appropriate mains chokes/mains filters.

Warning!
All terminals of the frequency inverter can carry dangerous voltages up to three minutes after switching off the power; do not work on the terminals or within the unit under any circumstances before this period has elapsed. Never open the unit when the mains power supply is switched on. There is a danger of serious injury or death if this precaution is not observed.

Warning!
Never open the unit when the mains power supply is switched on. Wait at least three minutes after switching off before working on the terminals or in the unit. There is a danger of serious injury or death if this precaution is not observed.

Warning!
Frequency inverters are electrical components for use in industrial heavy current systems. During operation, the components of the frequency inverter and drive can carry dangerous voltages and may also have moving or rotating parts and hot surfaces. There is a danger of serious injury if the safety precautions are not observed.

Warning!
The unauthorised removal of the necessary covers, incorrect installation and operation of the motor or frequency inverter can lead to failure of the unit and serious injury to operating personnel or damage to equipment.

Attention!
If you specify the direction of rotation of the motor with values of PNU 007 = 0 to 13, a wire break or failure of the control voltage can cause the motor to reverse unintentionally.

Attention!
If the drive is not uncoupled from the mains power supply when stationary (by using the mains contactor/mains switch), a fault may cause the motor to start unintentionally.

Attention!
If you use the flying restart function (PNU 142 = 2, 3) with motor loads with low moments of inertia and/or friction, the motor may turn briefly or reverse direction briefly after enabling the controller.

If the frequency inverter has been stored for more than two years without use, the capacity of the capacitors for the internal DC bus may be impaired. Before using the frequency inverter, connect it to the mains supply without load for two hours in order to regenerate the capacitors.

6 Diagnostics

Warning!
All terminals of the frequency inverter can carry dangerous voltages up to three minutes after switching off the power; do not work on the terminals or within the unit under any circumstances before this period has elapsed. Never open the unit when the mains power supply is switched on. There is a danger of serious injury or death if this precaution is not observed.

When replacing fuses only use the specified types.

Fault-finding

Motor does not turn
Possible reasons:

- DC bus voltage too low
- Controller inhibited
- Setpoint = 0
- DC injection brake active
- Quickstop function active
- FF setpoint (jog frequency) activated and FFx = 0
- TRIP message received
- Mechanical motor brake is not released

Motor does not turn smoothly
Possible reasons:

- Motor cable defect
- Maximum currents set too low with PNU 022 and PNU 023
- Motor overexcited or underexcited (check parameter settings)

Motor takes too much current
Possible reasons:

- Setting of PNU 016 too small
- Setting of PNU 015 too small

Motor turns too fast
Possible reasons:

- Frequency inverters can generate an output frequency up to 480 Hz. If an unsuitable motor is being used this can lead to dangerous overspeed.

Overcurrent trip for DF4-120
Possible reasons:

- Can trip with frequencies >240 Hz

Overheating of the motor
Possible reasons:

- Too long operation of the DC injection brake
- Too long operation of self-cooled motors at low rotary speeds

Fault messages and rectification

Attention!
Frequency inverters contain components which can be damaged by electrostatic charges (ESD). Discharge any electrostatic charges before undertaking installation and service work in the vicinity of the terminals by touching a PE mounting screw or another earthed metal surface within the control cabinet.

LED display

The frequency inverter is provided with 2 LED lamps which show the operating state as follows:

Green	Red	Operating state
On	Off	Controller enabled
On	On	Power switched on, autostart inactive (AS_LC)
Flashing	Off	Controller inhibited
Off	Flashing (every second)	Fault message
Off	Flashing (every 0.4 seconds)	Undervoltage trip
Off	Off	Programming mode

Monitoring messages

The controller is inhibited if monitoring messages are detected. The controller is enabled again automatically as soon as the fault has been cleared.

The messages listed in the following table are displayed on the optional LCD keypad.

Message	Fault	Cause	Remedy
LU	Undervoltage	Mains voltage too low	Check mains voltage
OU	Overvoltage	Mains voltage too high	Check mains voltage
		Generator mode, Braking mode	Increase deceleration time Operation with brake unit: Check dimensioning and correct connection of the brake resistor
		Creeping ground fault on the motor side	Check motor feed cable and motor for ground fault (disconnect motor from inverter)

Voltage limits for undervoltage and overvoltage message. Measured values for DC bus voltage $U_G$min and $U_G$max.

Message	Fault	DF4-120	DF4-340	DF4-341
LU	Undervoltage	240 to 180 V_{DC}	429 to 340 V_{DC}	430 to 330 V_{DC}
OU	Overvoltage	375 to 395 V_{DC}	751 to 772 V_{DC}	784 to 794 V_{DC}

Fault messages on turning on the power

A complete test of the hardware and the setting is carried out after the power is switched on.

When switching on the power with the controller enabled, the fault message “OCx” (short circuit or earth fault) may be shown on the display of the LCD keypad.
In the case of long motor cables and frequency inverters with lower rated output power, leakage currents through parasitic cable capacitance can trigger the fault message “OCx”. Use a motor filter in such cases.

Message	Fault	Cause
OC1*	Short-circuit	Short-circuit on the motor side due to: Faulty motor cable Fault between turns in motor
OC2*	Earth fault	Frame fault in motor or in motor cable
EEr	External fault input	External fault signal received
H02	Overload terminal 20	Short-circuit, overload of the terminal, check wiring

* Check the wiring before resetting the fault message, if these fault messages occur when the power supply is switched on.

Fault message during operation of the drive

If a fault message occurs, the controller is inhibited and the fault is automatically displayed on the optional LCD keypad.

Fault messages which have been reset are stored in non-volatile memory to simplify faultfinding. A total of 4 fault messages are stored in parameters PNU 161 to PNU 164, whereby the last acknowledged fault is stored in PNU 162.

Message	Fault	Cause	Remedy
---	No fault	–	–
CCR	System fault	Serious interference on control cables	Screen control cables
		Chassis or earth loops in the wiring	–
OC1	Short circuit motor	Faulty motor cable Fault between turns in motor	Check motor feed cable for short circuit, check motor Check motor
OC3	Inverter overload during acceleration or short-circuit	Acceleration time too short, Faulty motor cable Fault between turns in motor	Lengthen acceleration time (PNU 012) Check wiring Check drive engineering
OC4	Inverter overload during deceleration	Deceleration time too short	Increase deceleration time (PNU 013) Check dimensioning of brake resistor or connect brake unit
OC5	Inverter overload	Frequent or too long acceleration with overcurrent Excessive load at constant speed	Check settings for inverter Check dimensioning of drive
OC6	Motor overload	Inadmissible continuous current; Frequent or too long acceleration with overcurrent	Check dimensioning of drive Check setting of PNU 120
OH	Heatsink overtemperature	Ambient temperature >40 °C Heatsink excessively dirty	Improve cooling Check ambient temperature in the control cabinet Clean heatsink
OH3[1)]	PTC motor temperature alarm	Motor too hot	Reduce motor load Check motor for fault between turns; check wiring to PTC thermistor

Message	Fault	Cause	Remedy
OH4[2)]	Inverter overtemperature	Temperature inside inverter too high	Reduce inverter load Improve cooling Check inverter fan
rSt	Fault during Auto-TRIP reset	More than 8 fault messages in 10 min.	Depends on the faults which occurred
EEr	External fault	External fault signal received via the digital input “TRIP set”	Check external signal source Check for external fault
OUE	Overvoltage	Mains overvoltage for longer than 5 s	Check mains voltage
Pr	Faulty parameter transfer	Faulty data transfer with LCD keypad Both parameter sets PAR1 and PAR2 are faulty.	Before the controller is enabled, transfer data again or load factory settings
Pr1	PAR1 transfer fault	Faulty data transfer with LCD keypad Parameter set PAR1 is faulty	Before the controller is enabled, transfer data again or load factory settings
Pr2	PAR2 transfer fault	Faulty data transfer with LCD keypad Parameter set PAR2 is faulty	Before the controller is enabled, transfer data again or load factory settings
H02	Overload control terminal 20	Short circuit or overload	Check wiring
H05	Checksum error	Severe electromagnetic interference, interference voltages etc.	Contact your after-sales service

1) Only with DF4-341, option with DF4-120 and DF4-340

2) Only with DF4-341

7 LCD Keypad DE 4-KEY-1

The optional LCD keypad DE4-KEY-1 can be used to configure the frequency inverter to your requirements. The 5-position LCD display displays current values and status messages. The DE 4-KEY-1 keypad has 6 function keys for modifying frequency inverter parameters. It stores the parameters in non-volatile memory to allow the parameters to be transferred to another frequency inverter of the same series.

Parameters cannot be transferred between DF4-120, DF4-340 and DF4-341 due to the different parameter sets of the frequency inverters.

Transferring parameters to different frequency inverters is made particularly easy because the LCD keypad can be removed and plugged into frequency inverters while the motor is running.

The keys of the keypad can also be used to adjust the setpoint and to inhibit and enable the controller.

Assembly

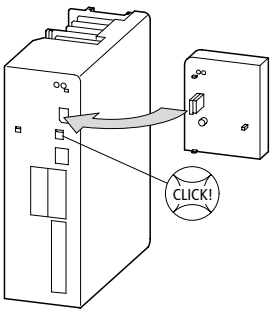


Figure 46: Plugging in the LCD keypad

Plug in and remove the LCD keypad without using force

The dimensions of the LCD keypad are specified in the Appendix under “Assembly/installation” on page 144.

Functions of keys and LCD display

Functions of the keys

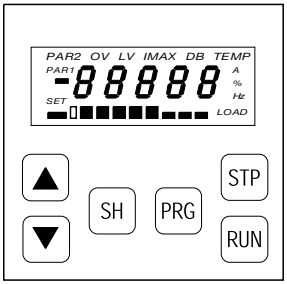


Figure 47: Display symbols on the LCD keypad

In the following, “SH+” means that you should press the SH key on the keypad and hold it down while you press another key.

PRG	Toggle between operation mode and parameter mode
SH	Toggle between operation mode and value mode
▲	Increase displayed value
▼	Reduce displayed value
SH + ▲	Increase displayed value rapidly
SH + ▼	Reduce displayed value rapidly
SH + PRG	Save change
STP	Inhibit controller
RUN	Enable controller

Status indicators

The six status indicators on the LCD keypad above the 7-segment display give information on the current status of the equipment:

OV	Overvoltage
LV	Undervoltage
IMAX	Set current limit exceeded
TEMP	Heatsink temperature near temperature limit (ϑ_{max} –10 °C)
PAR1	Parameter set 1 active, PAR1 flashing: Programming possible
PAR2	Parameter set 2 active, PAR2 flashing: Programming possible
SET	Setpoint input via keypad,
DB	DC brake DC voltage braking

Messages which use the 5-position 7-segment display

The five-position 7-segment display is used to output messages which result from operator actions or – depending on the current mode – the parameter number or the parameter value.

OFF	Controller inhibited by LOW signal on terminal 28
STOP	Controller inhibited (by STP key or Quickstop function or f_2 = 0 Hz)
AS_LC	Autostart lockout, controller enable after LOW to HIGH edge on terminal 28
STO	Parameter is saved
dC_b	DC injection brake active
LU	Undervoltage
SET1	Parameter set 1 overwritten with factory setting
SET2	Parameter set 2 overwritten with factory setting
rEAd1	Parameter set 1 overwritten with keypad data
rEAd2	Parameter set 2 overwritten with keypad data
STOE	Parameter sets PAR1 and PAR2 transferred to keypad

Motor load display

The bottom edge of the LCD display is used to show the motor load graphically.

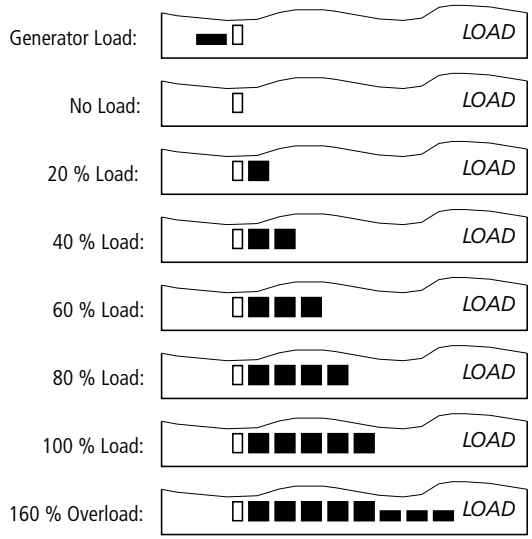


Figure 48: Motor load display

Structure of the operating program

The operating program has 3 program modes – operation mode, parameter mode and value mode. Configuration of the frequency inverter takes place in the parameter and value modes.

Operation mode

Each time the power is switched on, the frequency inverter is initially in operation mode. The switch-on display (i.e. the information shown on the display directly after switch on, configurable with PNU 004). This is the factory default. Press the PRG key to switch to the parameter mode.

Parameter mode

In the parameter mode, use the ▲ and ▼ keys to choose a parameter number. After finding the required parameter number, press the SH key to switch to the value mode.

Value mode

In value mode use the ▲ or ▼ keys to change the set value that is shown in the 7-segment display. There are different ways of storing the new value depending on the parameter number and the frequency inverter model.

Frequency inverters of the DF4 series have two parameter sets; PAR1 and PAR2. You can switch from PAR1 to PAR2 by pressing the SH key. Each parameter set contains a complete set of configurable parameters for the frequency inverter. The status indicator PAR1 or PAR2 flashes to show which parameter set you are currently viewing or changing.

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There are 4 different types of parameter:

- Absolute values of a physical variable (e.g. 400 V, 10 s)
- Relative values of inverter parameters (e.g. 50 % setpoint value)
- Number code for specified states (e.g. 0 = Controller inhibited, 1 = Controller enabled)
- Some values can be displayed but not changed (e.g. motor current).

The absolute and relative values can only be changed in discrete steps. In some cases the step size has several values for the same parameter. The step sizes cannot be chosen or changed by the user.

For example, the acceleration time +a (parameter PNU 012) has 3 different step sizes depending on the value:

+a from 0.01 s to 1 s: Step width 0.01 s
+a from 1 s to 10 s: Step width 0.1 s
+a from 10 s to 100 s: Step width 1 s

Changing and saving parameters

Each configurable parameter has a factory setting. Depending on the parameter number, there are 3 different ways to change and store the value:

accept and store the parameter change immediately without required confirmation (these parameters are marked with ONLINE in the parameter table)

accept and store the parameter change with the SH + PRG keys (these parameters are markedwith SH + PRG[1]) in the parameter table)

accept and store the parameter change during controller inhibit with the SH + PRG keys (these parameters are marked with SH + PRG[2] in the parameter table)

DF4-120

In the case of the DF4-120 series frequency inverters, parameters can only be changed when the controller is inhibited. To inhibit the controller connect a LOW signal to terminal 28 or press the STP key on the LCD keypad. The sole exception is the gain factor for the monitor signal (PNU 108). This parameter can be changed ONLINE.

DF4-34x

With these models of frequency inverters, nearly all parameters can be changed with the controller enabled. Changes to parameters are accepted ONLINE. However, parameters that influence the initialisation of the controller must be confirmed SH + PRG. Furthermore, you can only overwrite the parameter sets (PNU 002) when the controller is inhibited.

Accept and store the parameter change immediately without requiring confirmation
(marked with ONLINE in the parameter table)

The controller accepts the changed parameters immediately.

Change from operation mode to parameter mode by pressing the PRG key.

Choose the parameter to change by pressing the ▲ or ▼ key.

Press the SH key to change to the value mode for parameter set PAR1. Press the SH key again if you want to change the values for parameter set PAR2.

When either PAR1 or PAR2 is flashing in the display, you can change the value of the chosen parameter with the ▲ or ▼ key even when the drive is operating. As soon as this happens, the frequency inverter operates with the new parameter value.

Press the SH key to change back to parameter mode.

Press the PRG key to change back to operation mode.

The changed parameter value is stored permanently.

Accept and store the parameter change (SH + PRG)
(marked SH + PRG[1)] in the parameter table)

The controller only accepts the changed parameter during controller inhibit and after pressing the key combination SH + PRG.

Change from operation mode to parameter mode by pressing the PRG key.

Choose the parameter to change by pressing the ▲ or ▼key.

Press the SH key to change to the value mode for parameter set PAR1. Press the SH key again if you want to change the values for parameter set PAR2.

When either PAR1 or PAR2 is flashing in the display, you can change the value of the chosen parameter with the ▲ or ▼ key even when the drive is operating.

Press key combination SH + PRG. The display shows STO for about 1 s. The program then returns to parameter mode. As soon as this happens, the frequency inverter operates with the new parameter value.

Press the PRG key to change back to operation mode.

The changed parameter value is stored permanently.

Accept and store the parameter change during controller inhibit with the SH + PRG keys (these parameters are marked with SH + PRG[2)] in the parameter table)

The controller only accepts the changed parameters during controller inhibit and after pressing the key combination SH + PRG.

Inhibit the controller in operation mode by pressing the STP key.

Change from operation mode to parameter mode by pressing the PRG key.

Choose the parameter to change by pressing the ▲ or ▼ key.

Press the SH key to change to the value mode for parameter set PAR1. Press the SH key again if you want to change the values for parameter set PAR2.

When either PAR1 or PAR2 is flashing in the display, you can change the value of the chosen parameter with the ▲ or ▼ key.

Press key combination SH + PRG. The display shows STO for about 1 s. The program then returns to parameter mode.

Press the PRG key to change back to operation mode.

Enable the controller again by pressing the RUN key. As soon as you do this, the frequency inverter operates with the new parameter value.

The changed parameter value is stored permanently.

Appendix

Compliance with standards

Type of standard	Standard	Title	Limiting values
Enclosure class	IP 20 to VDE 0470 (EN 60 529)		
Interference immunity	IEC 801-2 /91	Electrostatic discharge to housing and heatsink	Degree of severity 3 6 kV for contact, 8 kV air gap
	IEC 1000-4-3	Electromagnetic fields Frequency range 26 to 1000 MHz	Degree of severity 3 10 V/m
	ENV 50 140 /93	High frequency field, frequency range 80 to 1000 MHz, 80 % amplitude modulated	Degree of severity 3 10 V/m
		Jog frequency 900 MHz with 200 Hz, 100 % modulated	10 V/m
	IEC 801-4 /88	Fast transients, burst to power terminals	Degree of severity 3 2 kV /5 kHz
		Burst on bus and control cables	Degree of severity 4 2 kV /5 kHz
	IEC 801-5 (only DF4-340)	Surge voltage test, mains power conductors	Installation class 3
Emitted interference	EN 55 022 7/92	Emitted radio interference, case and mains supply, frequency range 0.15 to 1000 MHz	Class B, for use in domestic and commercial environments
	EN 55 011 7/92 (used in addition to the requirements of IEC 22G)	Emitted radio interference, case and mains supply, frequency range 0.15 to 1000 MHz The emitted radio interference is not limited in IEC 22G for commercial environments.	Class A, for use in industrial environments
Radio interference suppression	EN 50 081-2, EN 55 011 (with mains filter or mains choke + radio interference filter)		
Overvoltage resistance	Class I to EN 50 178		
Insulation resistance	Overvoltage category III to VDE 0110		
Permissible pollution	Degree of pollution 2 to VDE 0110, part 2		
Admissible humidity	80 % relative air humidity, no condensation		
Vibration resistance	Manufactured to the German Lloyd specifications, vibration test		

Technical data for DF4-120 series

DF4-120-...	...-037	...-075	...-1K5	...-2K2
General				
Mains supply voltage	Standard1 AC 230 V; 50/60 Hz Permissible range190 to 260 V ±0 %; 45 to 65 Hz ±0 %			
	Alternative I2 AC 230 V; 50/60 Hz Permissible range190 to 260 V ±0 %; 45 65 Hz ±0 %			
	Alternative II2 DC 325 V Permissible range270 to 360 V ±0 %			
Output voltage[1]	3 AC; 0 to U_{Mains}; 0 to 50 Hz, optionally to 480 Hz			
r.m.s. mains current [2] with mains choke/mains filter	4.2 A	7.5 A	12.5 A	17 A
Power losses [3]	30 W	50 W	70 W	100 W
Chopper frequency	Max. 9.2 kHz			
Accuracy of output frequency: – Resolution – Digital setpoint input Analog setpoint input – Linearity – Temperature dependency 0 to 40 °C – Offset	 0.05 Hz absolute 0.05 Hz ±0.5 % (max. selected signal level, 5 V or 10 V) +0.4 % (max. selected signal level, 5 V or 10 V) ±0.3 % (max. selected signal level, 5 V or 10 V)			
Weight	1 kg	1.3 kg	2.2 kg	2.2 kg
1 AC 230 V; 50/60 Hz				
Rated motor power, 4-pole ASM	0.37 kW 0.5 HP	0.75 kW 1 HP	1.5 kW 2 HP	2.2 kW 3 HP
Output current	2.6 A	4 A	7 A	9.5 A
Maximum output current for 60 s	3.9 A	6 A	10.5 A	14.2 A
Output power	1 kVA	1.5 kVA	2.7 kVA	3.6 kVA

1) With mains choke/mains filter: max. output voltage = approx. 96% of mains supply voltage

2) Check N conductor current rating for multiple inverters and symmetrical distribution of current across the three phase conductors! (see page 21)

3) AT rated current

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Technical data DF4-340

Model DF4-340-...	...-075	...-1K5	...-2K2	...-3K0	...-4K0	...-5K5	...-7K5	...-11K
General								
Mains supply voltage	Standard: 3 AC 460 V; 50/60 Hz Permissible range: 320 V to 510 V ±0 %; 45 to 65 Hz ±0 % Alternative: 2 DC 650 V Permissible range: 450 V to 715 V ±0 %							
Output voltage[1]	3 AC; 0 to U_{Mains}; 0 to 50 Hz, optionally up to 480 Hz							
r.m.s. mains current [2] with mains choke/mains filter	2.5 A	3.9 A	5 A	7 A	8.8 A	12 A	15 A	20.5 A
Power losses [3]	55 W	75 W	90 W	100 W	150 W	200 W	280 W	400 W
Chopper frequency f_{CH}	Adjustable 4 kHz, 8 kHz, 12 kHz, 16 kHz / Observe derating data!							
Accuracy of output frequency: – Resolution – Digital setpoint input Analog setpoint input – Linearity – Temperature dependency 0 to 40 °C – Offset	 0.02 Hz absolute 0.05 Hz ±0.5 % (Ref f_{max}) ±0.4 % ±0 %							
Weight	2.2 kg	2.2 kg	2.2 kg	2.2 kg	5.3 kg	5.3 kg	5.3 kg	5.3 kg

1) With mains choke/filter: max. output voltage = approx. 96 % of mains supply voltage

2) Data for operation using factory settings at chopper frequency 8 kHz

3) At rated current and 8 kHz chopper frequency

Model DF4-340-...		...-075	...-1K5	...-2K2	...-3K0	...-4K0	...-5K5	...-7K5	...-11K
3 AC 400 V; 50/60 Hz									
Rated motor power, 4-pole ASM		0.75 kW	1.5 kW	2.2 kW	3 kW	4 kW	5.5 kW	7.5 kW	11 kW
Output current	4/8 kHz	2.4 A	3.9 A	5.5 A	7.3 A	9.4 A	13 A	16.5 A	23.5 A
	12 kHz	2.0 A	3.3 A	4.6 A	6.1 A	7.9 A	10.9 A	13.9 A	19.7 A
	16 kHz	1.8 A	2.9 A	4.1 A	5.5 A	7.0 A	9.7 A	12.3 A	17.6 A
Noise optimized	12 kHz	1.9 A	3.1 A	4.4 A	5.8 A	7.5 A	10.4 A	13.2 A	18.8 A
	16 kHz	1.6 A	2.5 A	3.6 A	4.7 A	6.1 A	8.4 A	10.7 A	15.3 A
Maximum output current for 60 s	4/8 kHz	3.6 A	5.9 A	8.3 A	11 A	14.1 A	19.5 A	24.8 A	35.3 A
	12 kHz	3.0 A	4.9 A	6.9 A	9.2 A	11.9 A	16.4 A	20.8 A	29.6 A
	16 kHz	2.7 A	4.4 A	6.2 A	8.2 A	10.6 A	14.6 A	18.6 A	26.5 A
Noise optimized	12 kHz	2.9 A	4.7 A	6.6 A	8.8 A	11.3 A	15.6 A	19.8 A	28.2 A
	16 kHz	2.4 A	3.8 A	5.4 A	7.1 A	9.1 A	12.7 A	16.1 A	22.9 A
Output power	4/8 kHz	1.6 kVA	2.7 kVA	3.8 kVA	5.2 kVA	6.5 kVA	9 kVA	11.4 kVA	16.3 kVA
3 AC 460 V; 50/60 Hz									
Rated motor power, 4-pole ASM		1 HP	2 HP	3 HP	3 HP	5 HP	7.5 HP	10 HP	15 HP
Output current	4/8 kHz	2.4 A	3.9 A	5.5 A	7.3 A	9.4 A	13 A	16.5 A	23.5 A
	12 kHz	1.9 A	3.0 A	4.3 A	5.7 A	7.4 A	10.3 A	13.0 A	18.5 A
	16 kHz	1.7 A	2.7 A	3.8 A	5.1 A	6.6 A	9.1 A	11.6 A	16.5 A
Noise optimized	12 kHz	1.8 A	2.9 A	4.1 A	5.4 A	7.0 A	9.7 A	12.4 A	17.6 A
	16 kHz	1.5 A	2.3 A	3.3 A	4.4 A	5.6 A	7.8 A	9.9 A	14.1 A
Maximum output current for 60 s	4/8 kHz	3.6 A	5.9 A	8.3 A	11 A	14.1 A	19.5 A	24.8 A	35.3 A
	12 kHz	2.8 A	4.6 A	6.6 A	8.7 A	11.1 A	15.4 A	19.6 A	27.9 A
	16 kHz	2.5 A	4.1 A	5.8 A	7.7 A	9.8 A	13.6 A	17.4 A	24.7 A
Noise optimized	12 kHz	2.7 A	4.4 A	6.2 A	8.2 A	10.6 A	14.6 A	18.6 A	26.4 A
	16 kHz	2.1 A	3.5 A	5.0 A	6.6 A	8.5 A	11.7 A	14.9 A	21.1 A

Technical data DF4-341

Model DF4-341-...	...-15 K	...-22 K	...-30 K	...-45K	...-55K	...-75K	...-90K
General							
Mains supply voltage	Standard Permissible range Alternative Permissible range		3 AC 480 V; 50/60 Hz 320 V to 530 V ±0 %/45 to 65 Hz ±0 % 2 DC 680 V 450 V to 752 V ±0 %				
Output voltage[1]	3 AC; 0 to U_{Mains}/0 to 50 Hz, optionally to 480 Hz						
r.m.s. mains current [2] with mains choke/mains filter	29 A	42 A	55 A	80 A	100 A	135 A	165 A
Power losses [3]	430 W	640 W	810 W	1100 W	1470 W	1960 W	2400 W
Chopper frequency f_{CH}	Adjustable 4 kHz, 8 kHz, 12 kHz, 16 kHz, Observe derating data!						
Accuracy of output frequency – Resolution – Digital setpoint input Analog setpoint input – Linearity – Temperature dependency 0 to 40 °C – Offset	 0.02 Hz absolute 0.05 Hz ±0.5 % (Ref f_{max}) +0.4 % ±0 %						
Weight	15 kg	15 kg	15 kg	33.5 kg	36.5 kg		

1) With mains choke/mains filter: max. output voltage = approx. 96 % of mains supply voltage

2) Data for operation using factory settings at chopper frequency 8 kHz

3) At rated current and 8 kHz chopper frequency

Model DF4-341-...		...-15 K	...-22 K	...-30 K	...-45K	...-55K	...-75K	...-90K
3 AC 400 V; 50/60 Hz								
Rated motor power, 4-pole ASM		15 kW	22 kW	30 kW	45 kW	55 kW	75 kW	90 kW
Output current	4/8 kHz	32 A	47 A	59 A	89 A	110 A	150 A	180 A
	12 kHz	27 A	40 A	50 A	75 A	92.4 A	126 A	151 A
	16 kHz	24 A	35 A	44 A	67 A	82.5 A	112 A	135 A
Noise optimized	12 kHz	25 A	37 A	47 A	71 A	88.0 A	120 A	144 A
	16 kHz	21 A	30 A	38 A	58 A	71.5 A	97 A	117 A
Maximum output current for 60 s	4/8 kHz	48 A	70.5 A	96 A	143 A	165 A	225 A	270 A
	12 kHz	40 A	59 A	76 A	112 A	138 A	189 A	227 A
	16 kHz	36 A	53 A	68 A	100 A	124 A	168 A	202 A
Noise optimized	12 kHz	38 A	56 A	73 A	107 A	132 A	180 A	216 A
	16 kHz	31 A	46 A	59 A	87 A	107 A	146 A	175 A
Output power	4/8 kHz	22.2 kVA	32.6 kVA	41.6 kVA	61.7 kVA	76.2 kVA	103.9 kVA	124.7 kVA
3 AC 480 V; 50/60 Hz								
Rated motor power, 4-pole ASM		20 HP	30 HP	40 HP	60 HP	75 HP	100 HP	125 HP
Output current	4/8 kHz	32 A	47 A	56 A	84 A	110 A	150 A	180 A
	12 kHz	25 A	37 A	47 A	70 A	87 A	118 A	142 A
	16 kHz	22 A	33 A	41 A	62 A	77 A	105 A	126 A
Noise optimized	12 kHz	24 A	35 A	44 A	67 A	82 A	112 A	135 A
	16 kHz	19 A	28 A	35 A	53 A	66 A	90 A	108 A
Maximum output current for 60 s	4/8 kHz	48 A	70.5 A	96 A	133 A	156 A	214 A	256 A
	12 kHz	38 A	56 A	72 A	105 A	130 A	177 A	213 A
	16 kHz	33 A	49 A	64 A	93 A	115 A	15 7 A	189 A
Noise optimized	12 kHz	36 A	53 A	68 A	100 A	123 A	168 A	202 A
	16 kHz	92 A	42 A	54 A	80 A	99 A	135 A	162 A

Control inputs/outputs

Terminal	Functions	WE	Current consumption/Load rating
Digital inputs DF4-120/DF4-34x			
E1	Clockwise Counterclockwise DC injection brake Jog frequency 1 to 3 Quickstop External fault Motor potentiometer Switch parameter sets	Jog frequencies 20 Hz, 30 Hz, 40 Hz E1 = 20 Hz E2 = 30 Hz E1 + E2 = 40 Hz	+12 V/4 mA (DF4-120) +15 V/5 mA (all models) +24 V/8 mA (all models)
E2			
E3		DC injection braking HIGH = Active	
E4		Clockwise/ Counterclockwise LOW = Clockwise; HIGH = Counter-clockwise	
20	Power feed for digital inputs		12 V/20 mA (DF4-120) 15 V/20 mA (DF4-34x)
28	Controller enable		+12 V/4 mA (DF4-120) +15 V/5 mA (all models) +24 V/8 mA (all models)
39	0 V reference		
Analog inputs DF4-120/DF4-34x			
7	0 V reference for terminal 8, 9, 62		
8	Setpoint range 0/4 to 20 mA 0 to 5 V 0 to 10 V	0 to 10 V	+5 V/0.05 mA +10 V/0.1 mA 10 Bit resolution Linearity ±0.5 % Temperature dependency: 0.4 % (0 to +40 °C) Load resistance for current setpoint = 250 Ω
9	Power feed for setpoint potentiometer		5.2 V/6 mA

Terminal	Functions	WE	Current consumption/Load rating
Analog output DF4-120/DF4-34x			
62	Monitor output Output frequency Inverter load Motor current DC bus voltage	Output frequency	0 to 6 V/2 mA 10 Bit resolution
Relay outputs DF4-120/DF4-34x			
K11	Relay K1 break contact, relay energizes when the configured function occurs: Ready to operate TRIP message Motor running, CW, CCW Output frequency = 0 Hz Setpoint reached Min. speed reached Current limit reached Overtemperature	Fault message	24 V AC/3 A or 60 V DC/0.5 A
K12	Relay K1 changeover contact		
K14	Relay K1 make contact		
Relay outputs DF4-341			
K21	Relay K2 break contact, relay energizes when the configured function occurs: Ready to operate TRIP message Motor running, CW, CCW Output frequency = 0 Hz Setpoint reached Min. speed reached Current limit reached Overtemperature Thermistor warning / fault	Inverter ready to operate	250 V AC/3 A or 60 V DC/0.5 A
K22	Relay K2 changeover contact		
K24	Relay K2 make contact		

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PTC input

DF4-341 series frequency inverters have built-in motor temperature monitoring. This monitors motor temperature via terminals T1 and T2. Temperature monitoring is available for DF4-120 and DF4-340 series frequency inverters.

Attention!
If you do not want to use motor temperature monitoring, set PNU 119 = 0.

Comments/ abbreviations used in the parameter table

Abbreviation	Use
PNU	Parameter number
PNU 000	Parameter can have different values in PAR1 and PAR2.
PNU 000* (PAR1)	Parameter always has the same value in PAR1 and PAR2; it is only displayed in PAR1.
✓	Available
–	Not available
ON LINE	Accept and store parameter change immediately
SH + PRG	Accept and store parameter change after pressing SH + PRG
SH + PRG[1)]	Accept and store parameter change during controller inhibit after pressing SH + PRG
SH + PRG[2)]	Accept and store parameter change for DF4-120 with controller inhibit by pressing SH + PRG
Display only	This parameter cannot be changed, and is displayed only
Not from LCD keypad	The parameter cannot be changed from the LCD keypad; change it e.g. with the serial interface module.

Parameters accessed through the optional serial interface module are specified with a 4-digit parameter number instead of 3 digits. The PNU in PAR1 starts with 0 and in PAR2 with 2.

Parameter table

PNU	Name	Value range	WE: DF4-		Accept parameter change	Comment	Page
			-120	-34x			
001	Operating mode	0 % Setpoint input via terminal 8, control by terminals, parameter setting via DE 4-KEY-1 1 - Setpoint input via DE 4-KEY-1 control by terminals, parameter setting via DE 4-KEY-1 2 - Setpoint input via terminal 8, control by terminals, parameter setting via interface 3 - Setpoint input via interface, control by interface, parameter setting via interface	0	0	SH+PRG SH+PRG[2)]		58
002*	Parameter set	0 % Function executed 1 - Overwrite PAR1 with factory default 2 - Overwrite PAR2 with factory default 3 - Overwrite PAR1 and PAR2 with data from LCD keypad 4 - Overwrite PAR1 with data from LCD keypad 5 - Overwrite PAR2 with data from LCD keypad 6 - PAR1 and PAR2 transferred to keypad	0	0	SH+PRG[1)]		58
004	Switch-on display	0 % Output frequency f_2 1 - Inverter load 2 - Motor current	0	0	SH+PRG SH+PRG[2)]		90

PNU	Name	Value range				WE: DF4-		Accept parameter change	Comment	Page
						-120	-34x			
007*	Terminal configuration	E4	E3	E2	E1	0	0	SH+PRG[1)]		59
		0 % R/L	DCB	FF1/2/3						
		1 - R/L	PAR	FF1/2/3						
		2 - R/L	QSP	FF1/2/3						
		3 - R/L	PAR	DCB	FF1					
		4 - R/L	QSP	PAR	FF1					
		5 - R/L	DCB	EF	FF1					
		6 - R/L	PAR	EF	FF1					
		7 - R/L	PAR	DCB	EF					
		8 - R/L	QSP	PAR	EF					
		9 - R/L	QSP	EF	FF1					
		10 - R/L	EF	UP	DOWN					
		11 - R/L	DCB	UP	DOWN					
		12 - R/L	PAR	UP	DOWN					
		13 - R/L	QSP	UP	DOWN					
		14 - L/QSP	R/QSP	DCB	FF1					
		15 - L/QSP	R/QSP	PAR	FF1					
		16 - L/QSP	R/QSP	FF1/2/3						
		17 - L/QSP	R/QSP	PAR	DCB					
		18 - L/QSP	R/QSP	PAR	EF					
		19 - L/QSP	R/QSP	DCB	EF					
		20 - L/QSP	R/QSP	EF	FF1					
		21 - L/QSP	R/QSP	UP	DOWN					
		22 - L/QSP	R/QSP	UP	FF1					

PNU	Name	Value range	WE: DF4-		Accept parameter change	Comment	Page
			-120	-34x			
008	Relay function of relay K1	0 % Inverter ready to operate 1 - TRIP signal 2 - Motor running 3 - Motor running/CW rotation 4 - Motor running/CCW rotation 5 - Output frequency $f_2 = 0$ 6 - f_{Set} reached 7 - $f_2 > f_1$ 8 - I_{max} reached 9 - Overtemperature (ϑ_{max} –10 °C) 10 - TRIP or $f_2 > f_1$ or IMP	1	1	SH+PRG SH+PRG[2)]		92
009*	Controller address	1 to 99	1	1	ONLINE SH+PRG[2)]	Only applies to RS 232/RS 485 interface	60
010	f_{min}	0.0 to 480.0 Hz	0.0 Hz	0.0 Hz	ONLINE SH+PRG[2)]		79
011	f_{max}	7.5 to 480.0 Hz (DF4-34x) 30.0 to 480.0 Hz (DF4-120)	50 Hz	50 Hz	ONLINE SH+PRG[2)]		79
012	+a	0.0 to 999.0 s	5.0 s	5.0 s	ONLINE SH+PRG[2)]		82
013	–a	0.0 to 999.0 s	5.0 s	5.0 s	ONLINE SH+PRG[2)]		82

PNU	Name	Value range	WE: DF4-		Accept parameter change	Comment	Page
			-120	-34x			
014	Motor control mode	0 - Linear characteristic *U*/*f* with Auto boost	✓ (WE)	–	SH+PRG SH+PRG[2)]		73
		1 - Quadratic characteristic *U*/*f*^{2} with Auto Boost	✓	–			
		2 - Linear characteristic *U*/*f* with constant U_{min} boost	✓	✓			
		3 - Quadratic characteristic *U*/*f*^{2} with constant U_{min} boost	✓	✓			
		4 - Motor current control	–	✓ (WE)			
015	*U*/*f* Rated frequency	7.5 to 960.0 Hz (DF4-34x) 30.0 to 960.0 Hz (DF4-120)	50 Hz	50 Hz	ONLINE SH+PRG[2)]		78
016	U_{min}	0 to 40 %	–	0 %	ONLINE SH+PRG[2)]	for DF4-120 depending on model[3)]	75
017	$f_2 > f_1$	0.0 to 480.0 Hz	0 Hz	0 Hz	ONLINE SH+PRG[2)]		87
018	Chopper frequency	0 - 4 kHz	–	1	SH+PRG		85
		1 - 8 kHz					
		2 - 12 kHz					
		3 - 16 kHz					
		4 - 12 kHz, noise optimized					
		5 - 16 kHz, noise optimized					

PNU	Name	Value range	WE: DF4-		Accept parameter change	Comment	Page
			-120	-34x			
019	Threshold for automatic DC injection brake	0.1 to 5.0 Hz	–	0.1 Hz	ONLINE		71
021	Slip compensation	0 to 20 % (DF4-34x) 0 to 12 % (DF4-120)	0 %	0 %	ONLINE SH+PRG[2)]		84
022	I_{max}	30 to 150 %	150 %	150 %	ONLINE SH+PRG[2)]		83
023	I_{maxGen}	30 to 110 %	80 %	80 %	ONLINE SH+PRG[2)]		83
034*	Setpoint range	0 - 20 mA; 0 to 5 V; 0 to 10 V 1 - 4 to 20 mA	0	0	ONLINE SH+PRG[2)]		69
036	Voltage for DC injection brake	0.00 to 40.00 %	–	–	ONLINE SH+PRG[2)]	depending on model[3)]	71
037	FF 1	0.0 to 480.0 Hz	20 Hz	20 Hz	ONLINE SH+PRG[2)]		68
038	FF 2	0.0 to 480.0 Hz	30 Hz	30 Hz	ONLINE SH+PRG[2)]		68
039	FF 3	0.0 to 480.0 Hz	40 Hz	40 Hz	ONLINE SH+PRG[2)]		68
040	Controller enable		✓	✓		Not from LCD keypad	63

PNU	Name	Value range	WE: DF4-		Accept parameter change	Comment	Page
			-120	-34x			
043	TRIP reset		–	✓		Not from LCD keypad	100
046	f_{Set}		0	0		Not from LCD keypad	66
050*	Output frequency f_2		✓	✓		Display only	89
052*	Motor voltage		✓	✓		Display only	89
054*	Motor current		✓	✓		Display only	89
056*	Inverter load		✓	✓		Display only	89
061*	Heatsink temperature		✓	✓		Display only	89
079	Oscillation damping	0 to 80	–	5		Only DF4-341 not LCD keypad	86
088	Rated motor current	0.0 to 1.2 × I_N	–	✓	ONLINE	model-dependent	81
091	Motor cos φ	0.4 to 1.0	–	✓	ONLINE	model-dependent	81
105	-a_{Quick}	0 to 999 s	–	5 s	ONLINE		66
106	Holding time for automatic DC injection brake	0.00 to 999.00 s (DF4-34x) 0.00 to 50.00 s (DF4-120)	0.00 s	0.02 s	ONLINE		71
108*	Gain for PNU 111	0 to 255	220	128	ONLINE		89

PNU	Name	Value range	WE: DF4-		Accept parameter change	Comment	Page
			-120	-34x			
111	Monitor signal	0 - Output frequency 1 - Inverter load 2 - Motor current 3 - DC bus voltage	0	0	SH+PRG SH+PRG[2)]		89
117	Relay function of relay K2	0 - Inverter ready to operate 1 - TRIP signal 2 - Motor running 3 - Motor running/CW rotation 4 - Motor running/CCW rotation 5 - Output frequency $f_2 = 0$ 6 - f_{Set} reached 7 - $f_2 > f_1$ 8 - I_{max} reached 9 - Overtemperature (ϑ_{max} –10 °C) 10 - TRIP or $f_2 > f_1$ or IMP 11 - PTC warning	–	0	SH+PRG	Only DF4-341	94
119	Function of PTC input	0 - PTC input inactive 1 - PTC input active, TRIP and Impulse inhibit are set 2 - PTC input active, warning is output	–	0	SH+PRG	Only DF4-341	97
120	I^2t- trip	0 to 100 %	0 %	0 %	SH+PRG SH+PRG[2)]		95

PNU	Name	Value range	WE: DF4-		Accept parameter change	Comment	Page
			-120	-34x			
125*	Baud rate	0 = 9600 3 = 1200 1 = 4800 4 = 19200 2 = 2400	0	0	SH+PRG SH+PRG[2)]		60
126	Communication behaviour	0 - No reaction on fault 1 - In the event of faults, disconnection with CEO fault message	–	0		Not from LCD keypad	66
Control word	Control word		✓	✓		Not from LCD keypad	62
142	Start options	0 - Automatic start inhibited, flying restart option inactive 1 - Automatic start if terminal 28 HIGH, flying restart option inactive 2 - Automatic start inhibited, flying restart option active 3 - Automatic start if terminal 28 HIGH, flying restart option active	1	1	SH+PRG SH+PRG[2)]		64
144	Chopper frequency reduction	0 - No chopper frequency reduction 1 - Automatic reduction of chopper frequency at ϑ_{max} –10 °C	–	1	SH+PRG		85
150	Status word		✓	✓		Not from LCD keypad	87
161*	Current fault		✓	✓		Display only	98
162*	Previous fault		✓	✓		Display only	98
163*	Last but one fault		✓	✓		Display only	98
164*	Last but two fault		✓	✓		Display only	98

PNU	Name	Value range	WE: DF4-		Accept parameter change	Comment	Page
			-120	-34x			
170	TRIP reset method	0 % Trip reset via STP key or LOW edge on EN (terminal 28) 1 - Auto Trip reset	0	0	SH+PRG SH+PRG[2)]		100
171	Delay for auto TRIP reset	0 to 60 s	0 s	0 s	ONLINE SH+PRG[2)]		100
178*	Running time meter		✓	✓		Display only	92
179*	Power on time meter		✓	✓		Display only	92
377	Gain DC bus voltage monitoring		–	✓		Must only be changed by Moeller Service personnel; only DF4-341	
500*	Display factor for processing speed, numerator	1 to 25000	–	2000	ONLINE		91
501*	Display factor for processing speed, denominator	1 to 25000	–	10	SH+PRG		91

* Parameter always has the same value in PAR1 and PAR2; it is only displayed for in PAR1.

1) Accept and store parameter change with controller inhibit by pressing SH + PRG

2) Accept and store parameter change for DF4-120 with controller inhibit by pressing SH + PRG

3) See Table “Model-Dependent Parameter Values”

Model-dependent parameter values

PNU 016 = U_{min}
PNU 036 = Voltage for DCB

Frequency inverter Model	PNU 016	PNU 036	Step width for PNU 016 and NU 036
DF4-120-037	8.00 %	5.35 %	0.05 %
DF4-120-075	8.00 %	5.35 %	0.05 %
DF4-120-1K5	6.00 %	4.00 %	0.05 %
DF4-120-2K2	6.00 %	4.00 %	0.05 %
DF4-340-075	0 %	7.50 %	0.02 %
DF4-340-1K5	0 %	7.00 %	0.02 %
DF4-340-2K2	0 %	6.00 %	0.02 %
DF4-340-3K0	0 %	5.50 %	0.02 %
DF4-340-4K0	0 %	2.50 %	0.02 %
DF4-340-5K5	0 %	2.25 %	0.02 %
DF4-340-7K5	0 %	2.00 %	0.02 %
DF4-340-11K	0 %	2.00 %	0.02 %
DF4-341-15K	0 %	1.75 %	0.02 %
DF4-341-22K	0 %	1.75 %	0.02 %
DF4-341-30K	0 %	1.50 %	0.02 %
DF4-341-45K	0 %	1.25 %	0.02 %
DF4-341-55K	0 %	1.25 %	0.02 %
DF4-341-75K	0 %	0 %	0.02 %
DF4-341-90K	0 %	0 %	0.02 %

Fuses/cable cross-sections

Incoming cables AC: L1, L2, L3, N, PE (depending on model)
DC incoming cables: +UG, -UG, PE (all models)
Outgoing cables: U, V, W, PE

Model	AC operation			DC operation		
	Fuses F1, F2, F3	Max. possible cable cross section		Fuses F4, F5 **700 V DC!**	Cable-cross section	
		mm^2	AWG		mm^2	AWG
DF4-120-...						
...-037	FAZN B10	1.5	14	6 A	1.5	14
...-075	FAZN B16	2.5	12	8 A	2.5	12
...-1K5	FAZN B20	4	10	12 A	4	10
...-2K2	FAZN B20	4	10	16 A	4	10
DF4-340-...						
...-075	PKZM 0-6.3	1.0	16	6.3 A	1.0	16
...-1K5	PKZM 0-6,3	1.0	16	6.3 A	1.0	16
...-2K2	PKZM 0-10	1.5	14	8 A	1.5	14
...-3K0	PKZM 0-10	1.5	14	12 A	1.5	14
...-4K0	PKZM 0-16	2.5	12	16 A	2.5	12
...-5K5	PKZM 0-20	4	10	20 A	4	10
...-7K5	PKZM 0-25	4	10	32 A	6	8
...-11K	PKZ2/ZM 32	6	8	40 A	6	8
DF4-341-...						
...-15K	PKZ2/ZM 40	10	6	50 A	16	4
...-22K	NZM 7-63N	16	4	80 A	25	2
...-30K	NZM 7-63N	25	2	100 A	25	2
...-45K	NZM 7-80N	50	0	160 A[1)]	2 × 16 (1 × 50)	2 × 4
...-55K	NZM 7-100N	70	2/0	200 A[1)]	2 × 25 (1 × 70)	2 × 2
...-75K	NZM 7-160N	95	3/0	240 A[1)]	3 × 16 (1 × 95)	3 × 4
...-90K	NZM 7-160N	120	4/0	300 A[1)]	3 × 25 (1 × 120)	3 × 2

1) F4, F5 can also be implemented by connecting fuses in parallel. You can also use cables connected in parallel.

Mains filters/mains contactors

The EMC limit values for line-conducted interference are specified in EN 61 800-3, the product standard for variable-speed drives. The corresponding measuring procedures and limit values are defined in EN 55 011, the product standard for industrial, scientific and medical equipment.

Limit value classes of EN 55 011
Frequency inverters belong to group 1 covering the intentional generation and/or used line-conducted RF energy required for the functioning of the device.

Class A
Use in all areas except domestic environments and those areas that are connected directly to a low-voltage supply for domestic buildings.

Class B,
Use also in domestic environments and those areas that are connected directly to a low-voltage supply for domestic buildings.

Connection and design must meet EMC requirements in order to observe the specified limit values. Mains chokes and radio interference filters must be used for connecting the equipment connection to the mains supply.

Mains filters are a combination of mains choke and radio interference filter. The functions of the individual components are shown here. They also reduce the amount of mounting and wiring required.

Model	Mains filter	Mains choke	Mains filter (Standard/ equivalent type)	Mains contactor	Max. permissible screened motor cable length	
					EN 55 011A	EN 55 011B
DF4-120-...						
...-037	DE 4-LZ1-004	–	–	DIL 00M	50 m	30 m
...-075	DE 4-LZ1-008	–	–	DIL 00M	50 m	30 m
...-1K5	DE 4-LZ1-013	–	–	DIL 00M	50 m	30 m
...-2K2	DE 4-LZ1-017	–	–	DIL 00M	50 m	30 m
DF4-340-...						
...-075	DE 4-LZ3-003	–	–	DIL 00M	50 m	30 m
...-1K5	DE 4-LZ3-004	–	–	DIL 00M	50 m	30 m
...-2K2	DE 4-LZ3-005	–	–	DIL 00M	50 m	30 m
...-3K0	DE 4-LZ3-007	–	–	DIL 00M	50 m	30 m
...-4K0	DE 4-LZ3-009	–	–	DIL 00M	50 m	30 m
...-5K5	DE 4-LZ3-012	–	–	DIL 00M	50 m	30 m
...-7K5	DE 4-LZ3-015	–	–	DIL 00M	50 m	30 m
...-11K	DE 4-LZ3-021	–	–	DIL 00M	50 m	30 m

Model	Mains filter	Mains choke	Mains filter (Standard/ equivalent type)	Mains contactor	Max. permissible screened motor cable length	
					EN 55 011A	EN 55 011B
DF4-341-...						
...-15K	–	AMD 31-26/32-L	FN 258-30-07[1] 36FCD10B[2]	DIL 0M	50 m	30 m
...-22K	–	AMD 31-34/42-L	FN 258-42-07[1] 50FCD10B[2]	DIL 1M	50 m	30 m
...-30K	–	AMD 31-47/58-L	FN 258-55-07[1] 80FCD10B[2]	DIL 1M	50 m	30 m
...-45K	–	AMD 31-90/110-L	FN 258-75-34[1] 80FCD10B[2]	DIL 2M	50 m	30 m
...-55K	–	AMD 31-90/110-L	FN 258-100-35[1] 110FCD10B[2]	DIL 3M	50 m	20 m
...-75K	–	AMD 31-142/180-L	FN 258-130-35[1] 150FCD10B[2]	DIL 4M	50 m	20 m
...-90K	–	AMD 31-142/180-L	FN 258-180-40[1] 180FCD10B[2]	DIL 6M	50 m	20 m

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Interference currents

Input voltage

DF4-120:
1 AC/N 230 V (single-phase mains connection)

DF4-34x:
3 AC 400 V (three-phase mains connection)

Model	Interference current (mA) to earth (PE)[1)]
DF4-120-037	2.4
DF4-120-075	
DF4-120-1K5	
DF4-120-2K2	
DF4-340-075	4.5
DF4-340-1K5	4.6
DF4-340-2K2	4.8
DF4-340-3K0	3.2
DF4-340-4K0	
DF4-340-5K5	3.1
DF4-340-7K5	
DF4-340-11K	5.1
DF4-341-15K	27
DF4-341-22K	
DF4-341-30K	
DF4-341-45K	
DF4-341-55K	
DF4-341-75K	
DF4-341-90K	30

1) Measured values without connected motor

Assembly/Installation

Tightening torque for power cables

Model	Torque, Nm
DF4-120-037	0.5 to 0.6
DF4-120-075	
DF4-120-1K5	
DF4-120-2K2	
DF4-340-075	
DF4-340-1K5	
DF4-340-2K2	
DF4-340-3K0	
DF4-340-4K0	
DF4-340-5K5	
DF4-340-7K5	
DF4-340-11K	
DF4-341-15K	4
DF4-341-22K	
DF4-341-30K	7
DF4-341-45K	
DF4-341-55K	12
DF4-341-75K	
DF4-341-90K	

Dimensions

During assembly please consider the weight and dimensions of the frequency inverter. Use the necessary technical aids (lifting trolley and/or crane for larger weights) and tools. Improper handling and the use of incorrect tools can damage the frequency inverter.

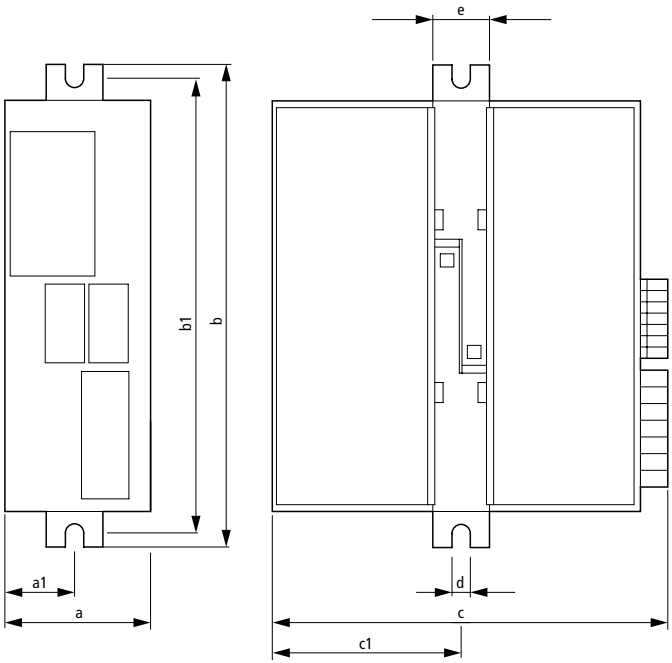

Figure 49: Dimension drawing of DF4-120/340

Model	a mm	a1 mm	b mm	b1 mm	c mm	c1 mm	d mm	e mm	∅	kg
DF4-120-037	64	29	210	190	158	72	6.5	30	M6	1
DF4-120-075					198	110				1.3
DF4-120-1K5	83	38	283	263	211	100				2.2
DF4-120-2K2										
DF4-340-075										
DF4-340-1K5										
DF4-340-2K2										
DF4-340-3K0										
DF4-340-4K0	125	62	283	263	218	62				5.3
DF4-340-5K5										
DF4-340-7K5										
DF4-340-11K										

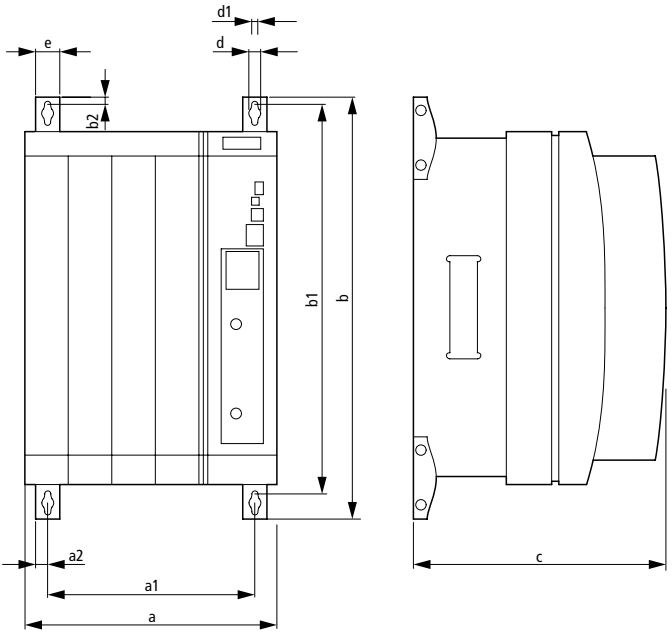

Figure 50: Dimension drawing of DF4-341

Model	a mm	a1 mm	a2 mm	b mm	b1 mm	b2 mm	c mm	d mm	d1 mm	e mm	Ø	kg
DF4-341-15K	250	206	14	402	370	8	250	11	6.5	24	M6	15.3
DF4-341-22K												
DF4-341-30K												
DF4-341-45K	340	283		672	532	10	285	18	11	28	M10	33.5
DF4-341-55K					624							36.5
DF4-341-75K	450	393		749	702							59
DF4-341-90K												

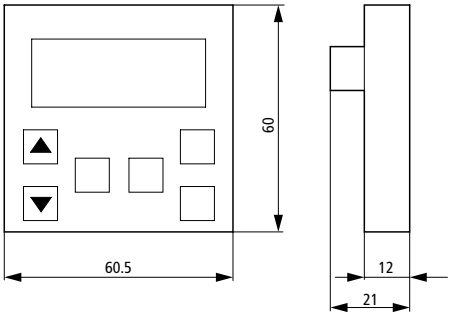

Figure 51: Dimension drawing of LCD keypad

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