VSC Series III variable speed drives

Installation manual

Effective October 2016
New information

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Safety

Warning!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally retriggered.
- Verify isolation from the supply.
- Ground and short-circuit.
- Cover or enclose neighbouring units that are live.
- Follow the engineering instructions (IL) 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 equalizing. 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 connection so that a cable or wire breakage on the signal side does not result in undefined states in the automation device.
- Ensure a reliable electrical isolation of the low voltage for the 24 V supply. Only use power supply units complying with IEC 60364-4-41 or HD 384.4.41 S2 (VDE 0100 part 410).
- Deviations of the mains voltage from the nominal value must not exceed the tolerance limits given in the technical data, 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 switching off devices must not cause restart.
- Built-in devices for enclosures or cabinets must only be run and operated in an installed state, desk-top devices or portable devices only when the housing is closed.
- 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 switching off 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.).
- During operation, and depending on their degree of protection, variable speed drives may have live, uninsulated, moving, and/or rotating parts, as well as hot surfaces.
- The impermissible removal of the required cover, improper installation or incorrect operation of the motor or variable speed drive can cause the failure of the device and serious injury and/or material damage.
- Comply with all applicable national accident prevention regulations (i.e., BGV A3) when working with energized variable speed drives.
- The electrical installation must be carried out in accordance with the relevant regulations (i.e., with regard to cable cross sections, fuses, PE).
- All transport, installation, commissioning and maintenance work must only be carried out by trained personnel (observe IEC 60364, HD 384 or DIN VDE 0100 and national accident prevention regulations).
- If applicable, systems in which variable speed drives are installed must be equipped with additional monitoring and protective devices in accordance with the applicable safety regulations, i.e., the German Equipment and Product Safety Act, accident prevention regulations, etc. Making changes to the variable speed drives by using the operating software is allowed.
- Keep all covers and doors closed during operation.
- When designing the machine, the user must incorporate mechanisms and measures that limit the consequences of a drive controller malfunction or failure (an increase in motor speed or the motor's sudden stop) so as to prevent hazards to people and property, i.e.:
  - Additional stand-alone devices for monitoring parameters that are relevant to safety (speed, travel, end positions, etc.)
  - Electrical and non-electrical safety devices (interlocks or mechanical locks) for mechanisms that protect the entire system

- Due to the possibility of there being capacitors that are still holding a charge, do not touch live device parts or terminals immediately after disconnecting the variable speed drives from the supply voltage. Heed the corresponding labels on the variable speed drives

Read this manual thoroughly and make sure you understand the procedures before you attempt to install, set up, operate or carry out any maintenance work on this VSC Adjustable Speed Drive.

Definitions and symbols

WARNING

This symbol indicates high voltage. It calls your attention to items or operations that could be dangerous to you and other persons operating this equipment. Read the message and follow the instructions carefully.

This symbol is the "Safety Alert Symbol." It occurs with either of two signal words: CAUTION or WARNING, as described below.

WARNING

Indicates a potentially hazardous situation which, if not avoided, can result in serious injury or death.

CAUTION

Indicates a potentially hazardous situation which, if not avoided, can result in minor to moderate injury, or serious damage to the product. The situation described in the CAUTION may, if not avoided, lead to serious results. Important safety measures are described in CAUTION (as well as WARNING).

Hazardous high voltage

WARNING

Motor control equipment and electronic controllers are connected to hazardous line voltages. When servicing drives and electronic controllers, there may be exposed components with housings or protrusions at or above line potential. Extreme care should be taken to protect against shock.

- **Stand on an insulating pad and make it a habit to use only one hand when checking components.**
- **Always work with another person in case an emergency occurs.**
- **Disconnect power before checking controllers or performing maintenance.**
- **Be sure equipment is properly earthed.**
- **Wear safety glasses whenever working on electronic controllers or rotating machinery.**

WARNING

The components in the drive's power section remain energized after the supply voltage has been switched off. After disconnecting the supply, wait at least five minutes before removing the cover to allow the intermediate circuit capacitors to discharge.

Pay attention to hazard warnings!

DANGER

5 MIN

WARNING

Electric shock hazard—risk of injuries! Carry out wiring work only if the unit is de-energized.

WARNING

Do not perform any modifications on the AC drive when it is connected to mains.

Warnings and cautions

This manual contains clearly marked cautions and warnings which are intended for your personal safety and to avoid any unintentional damage to the product or connected appliances.

Please read the information included in cautions and warnings carefully.

About this manual

This manual (LIT-12012386) is used in the installation and programming of the Series III VSC variable speed drives.

Target group

This LIT-12012386 manual is intended for engineers and electricians. Electrical engineering and physics-related knowledge and skills will be required in order to be able to commission the corresponding devices.

We assume that you have a good knowledge of engineering basics and that you are familiar with handling electrical systems and machines, as well as with reading technical drawings.

List of revisions

The following significant amendments have been introduced since previous issues:

Publication date	Page	Keyword	New	Modified	Deleted
10/16		Initial issue			

Writing conventions

Symbols with the following meaning are used in this manual:

- Indicates instructions to be followed.

Hazard warnings of material damages

Notice

Warns about the possibility of material damage.

Hazard warnings of personal injury

⚠ CAUTION

Warns of the possibility of hazardous situations that may possibly cause slight injury.

⚠ WARNING

Warns of the possibility of hazardous situations that could result in serious injury or even death.

⚠ DANGER

Warns of hazardous situations that result in serious injury or death.

Tips

Note: Indicates useful tips.

In order to make it easier to understand some of the figures included in this manual, the variable speed drive housing, as well as other safety-relevant parts, has been left out. However, it is important to note that the variable speed drive must always be operated with its housing in its proper place, as well as with all required safety-relevant parts.

All the specifications in this manual refer to the hardware and software versions documented in it.

Documents with additional information

Note: More information on the devices described here can be found on the Internet under:

www.johnsoncontrols.com

Abbreviations

The following abbreviations are used in this manual:

Abbreviation	Description
dec	Decimal (base-10 numeral system)
DS	Default settings
EMC	Electromagnetic compatibility
FE	Functional earth
FS	Frame Size
FWD	Forward run (clockwise rotating field)
GND	Ground (0-V-potential)
hex	Hexadecimal (base-16 numeral system)
ID	Identifier (unique ID)
IGBT	Insulated gate bipolar transistor
LED	Light Emitting Diode (LED)
OLED	Organic Light Emitting Diode
PC	Personal Computer
PDS	Power Drive System
PE ⏚	Protective earth
PES	EMC connection to PE for screened lines
PNU	Parameter number
REV	Reverse run (counterclockwise rotation field active)
ro	Read Only (read access only)
rw	Read/Write (read/write access)
SCCR	Short Circuit Current Rating
UL	Underwriters Laboratories

Units of measurement

Every physical dimension included in this manual uses international metric system units, otherwise known as SI (Système International d'Unités) units. For the purpose of the equipment's UL certification, some of these dimensions are accompanied by their equivalents in imperial units.

Table 1. Unit conversion examples

Designation	US-American designation	US-American value	SI value	Conversion value
Length	inch	1 in (")	25.4 mm	0.0394
Performance	horsepower	1 hp = 1.014 PS	0.7457 kW	1.341
Torque	pound-force inches	1 lbf in	0.113 Nm	8.851
Temperature	Fahrenheit	1 °F (T_F)	–17.222 °C (T_C)	$T_F = T_C \times 9/5 + 32$
Rotational speed	Revolutions per minute	1 rpm	1 min^{-1}	1
Weight	pound	1 lb	0.4536 kg	2.205
Flow rate	cubic feed per minute	1 cfm	1.698 m^3/min	0.5889

Mains supply voltages

The rated operating voltages stated in the following table are based on the standard values for networks with a grounded star point.

In ring networks (as found in Europe) the rated operating voltage at the transfer point of the power supply companies is the same as the value in the consumer networks (i.e., 230 V, 400 V).

In star networks (as found in North America), the rated operating voltage at the transfer point of the utility companies is higher than in the consumer network. Example: 120 V → 115 V, 240 V → 230 V, 480 V → 460 V.

The VSC variable speed drive's wide tolerance range takes into account a permissible voltage drop of 10% (i.e. U_{LN} –10%) while, in the 400-V category, it takes into account the North American mains voltage of 480 V +10 % (60 Hz).

The rated mains voltage operational data is always based on mains frequencies of 50/60 Hz within a range of 48 to 62 Hz.

The permissible power supply for the VSC series can be found in "Features" on **Page 9**.

VSC device series

Introduction

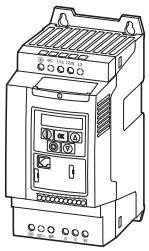
Due to their ease of use and high reliability, VSC Series III variable speed drives are ideal for general applications involving three-phase motors. In addition, an integrated radio interference suppression filter and a flexible interface ensure that the inverters meet a number of important needs in the machine building industry when it comes to the optimization of production and manufacturing processes.

For installations in control panels, devices with a performance range of 0.37 (for 230 V) to 22 kW (for 400 V) are available in a compact and sturdy design featuring three available sizes (FS1, FS2, FS3, FS4) and a degree of protection of IP20.

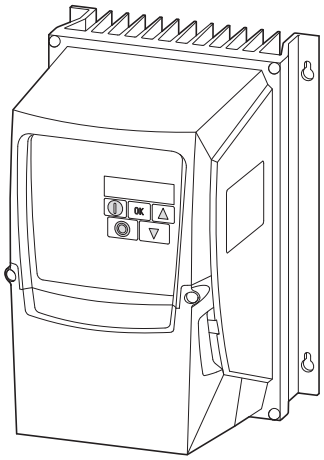
For distributed local installations, there are three sizes covering a performance range of 0.37 (for 230 V) to 7.5 kW (for 400 V) and featuring a degree of protection of IP66. These models come in two versions: with and without local controls. These local controls include a setpoint potentiometer, a selector switch for switching operating directions, and a lockable main switch on the mains side.

The computer-based drivesConnect parameter configuration program ensures data integrity and reduces the time required for commissioning and maintenance.

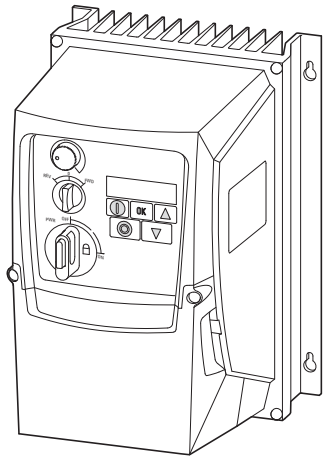
In addition, the comprehensive accessories available increase the inverters' flexibility in all scopes of application.



IP20 degree of protection



IP66 degree of protection



IP66 degree of protection, with local controls

Figure 1. Designs and enclosure versions

System overview

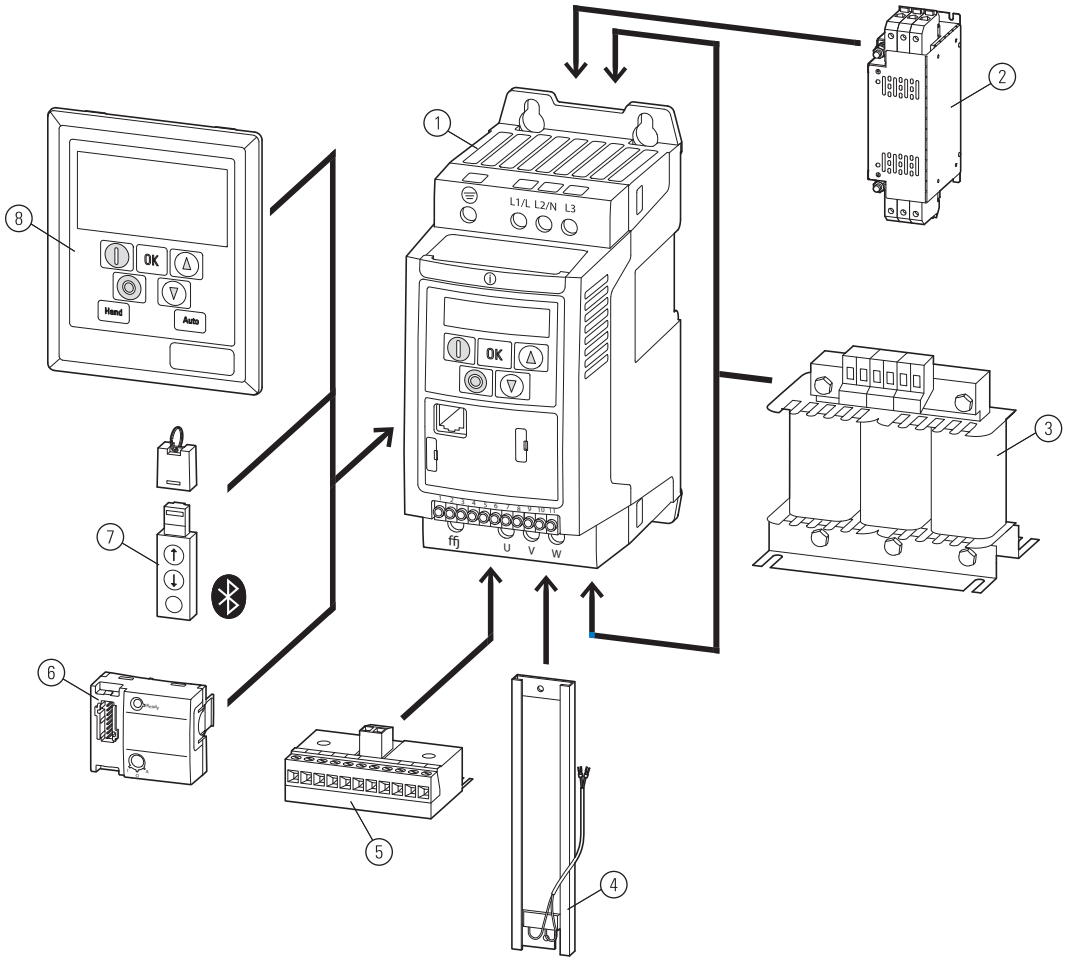


Figure 2. System overview (example: size FS1, degree of protection IP20)

① VSC… variable speed drives
② Extern radio interference suppression filter DX-EMC…
③ DX-LN… mains choke, DX-LM3-… motor choke, DX-SIN3-… sine filter
④ DX-BR… braking resistance
⑤ DXC-EXT-… expansion module
⑥ DX-NET-ETHERNET2-2 EtherNet/IP interface
⑦ DX-COM-STICK2 communication module and accessories (i.e., DX-CBL-… connection cable)
⑧ DE-KEY-… keypad (external)

Checking the delivery

Note: Before opening the package, please check the nameplate on it to make sure that you received the correct variable speed drive.

The VSC series variable speed drives are carefully packaged and prepared for delivery. The devices should be shipped only in their original packaging with suitable transportation materials. Please take note of the labels and instructions on the packaging, as well as of those meant for the unpacked device.

Open the packaging with adequate tools and inspect the contents immediately after receipt in order to ensure that they are complete and undamaged.

The packaging must contain the following parts:

- VSC series variable speed drive
- an instructional leaflet

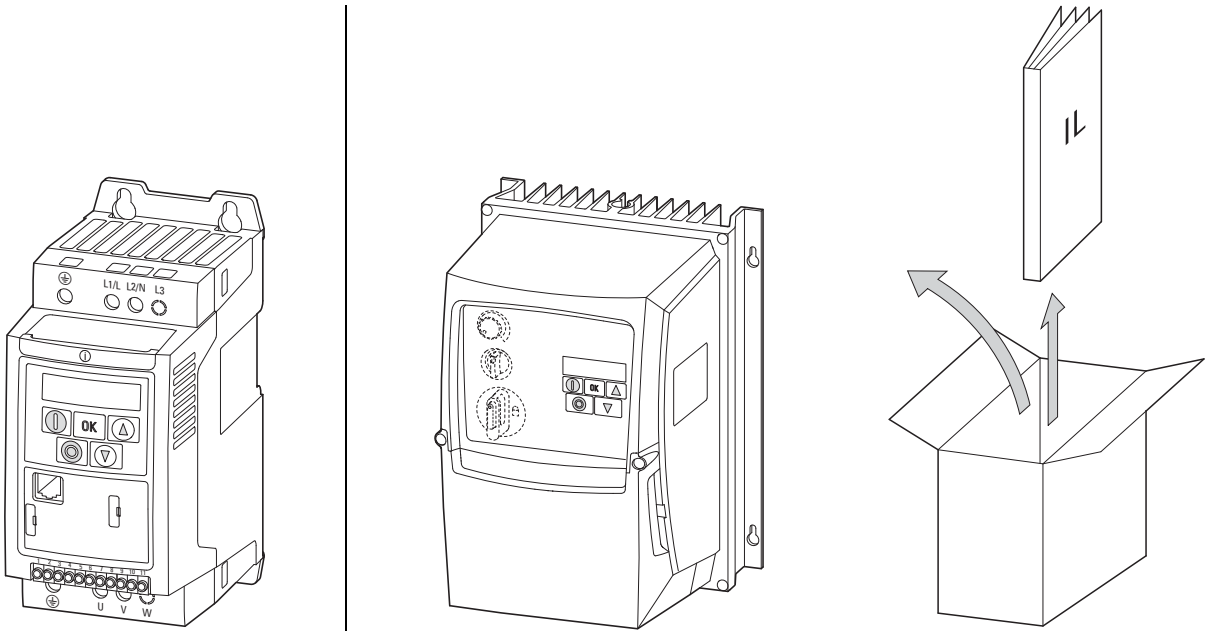


Figure 3. Equipment supplied (example: devices with IP20 / IP66 degree of protection with instruction leaflet)

Rated operational data

Rated operational data on the nameplate

The device-specific rated operational data of the VSC variable speed drive is listed on the nameplate of the device.

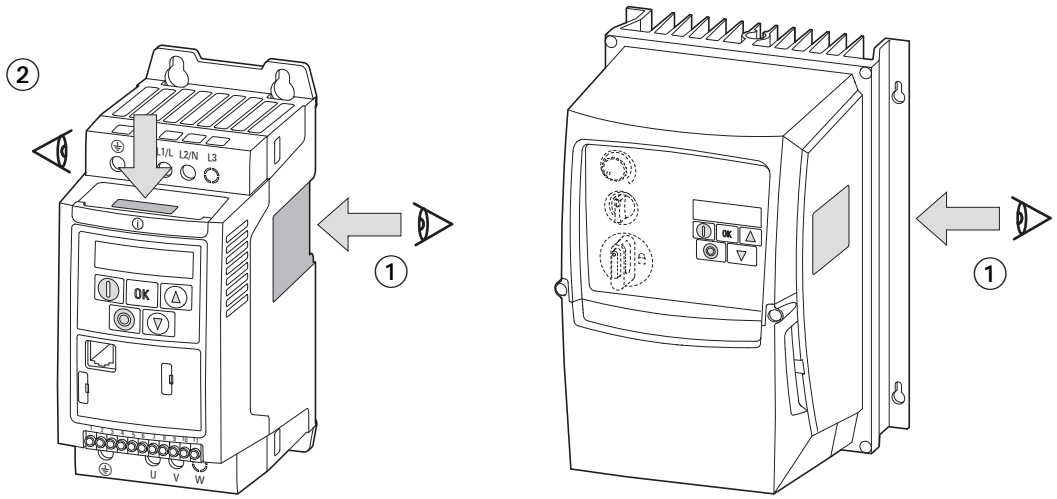


Figure 4. Nameplate location

The nameplate on top (nameplate ②) is a simplified version that can be used to clearly identify the device if the main nameplate (nameplate ①) is blocked by other devices.

Nameplate inscription

The inscription of the nameplate has the following meaning (example):

Table 2. Nameplate inscription

Inscription	Meaning
VSC344D1FBA20C	Part no.: VSC = VSC series variable speed drive 3 = Three-phase mains connection / three-phase motor connection 4 = 400 V mains voltage category 4D1 = 4.1 A rated operational current (4-decimal-1, output current) F = Integrated radio interference suppression filter B = Integrated brake chopper A = LED display (7-segment text display) 20 = IP20 degree of protection C = Coated boards
Input	Rated operational data of mains connection Three-phase AC voltage (U_e 3~ AC), 380–480 V voltage, 50/60 Hz frequency, input phase current (5.6 A).
Output	Load side (motor) rated operational data: Three-phase AC voltage (0–U_e), output phase current (4.1 A), output frequency (0–500 Hz) Assigned motor output: 1.5 kW with a voltage of 400 V/2 hp with a voltage of 460 V for a four-pole, internally cooled or surface-cooled three-phase asynchronous motor (1500 rpm at 50 Hz / 1800 rpm at 60 Hz)
Serial No.:	Serial number
IP20	Degree of protection of the housing: IP 20, UL (cUL) Open Type
Software	Software version (2.0)
25072016	Manufacturing date: 07-25-2016
Max amb. 50 °C	Maximum permissible ambient air temperature (50 °C)

Variable speed drive is an electrical apparatus.
Read the manual (in this case LIT-12012386) before making any electrical connections and commissioning.

Catalog number selection

The catalog no. or part no. for the VSC series of variable speed drives is made up of four sections.

Series — Power section — Model — Version

The following figure shows it in greater detail:

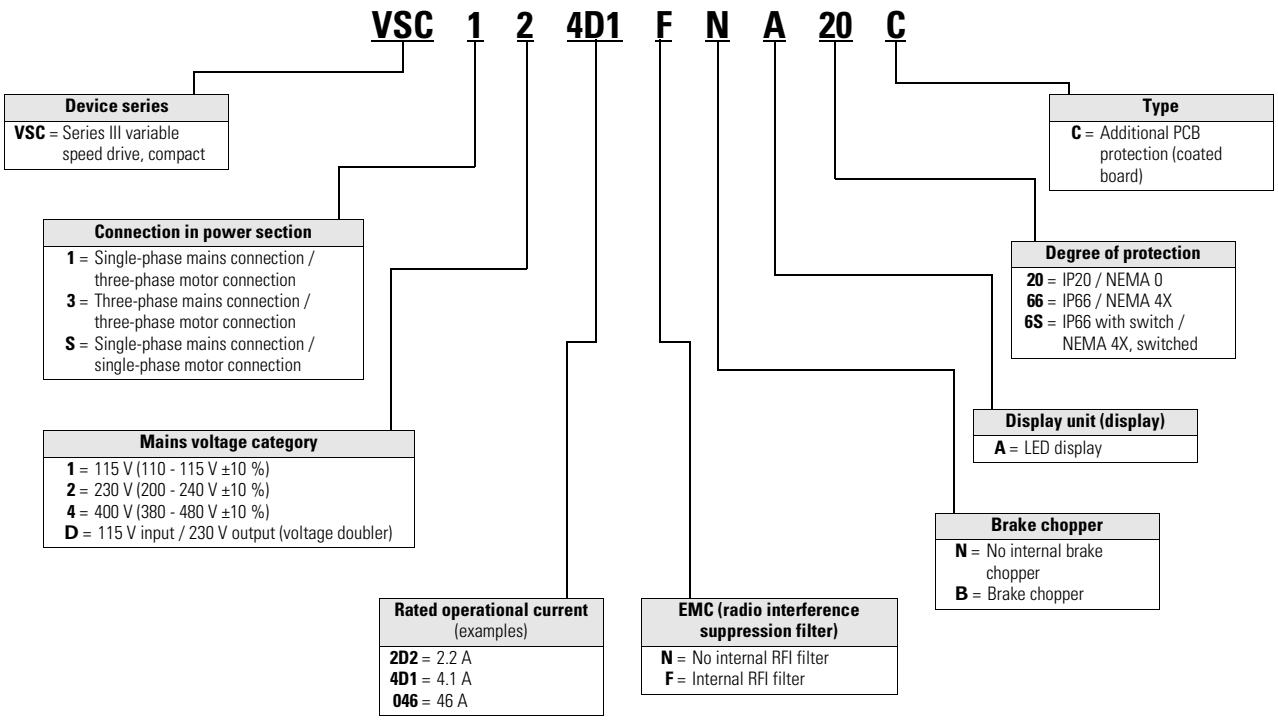


Figure 5. Catalog number selection

Features

VSC1D… device series

Mains voltage: 1 AC 110–115 V (±10 %), 50/60 Hz

Output voltage: 3 AC 230 V, 50/60 Hz

Note: An internal voltage doubler will increase the mains supply voltage to 230 V (output voltage).

Table 3. VSC1D… features

Part no.	Rated operational current I_e A	Assigned instance motor power P ① (230 V, 50 Hz) kW	P ② (230 V, 60 Hz) hp	Display (operating unit)	Local controls	Radio interference suppression filter	Degree of protection	Size	Brake chopper
VSC1D2D3NNA20C	2.3	0.37	1/2	LED	—	—	IP20	FS1	—
VSC1D2D3NNA66C	2.3	0.37	1/2	LED	—	—	IP66_x	FS1	—
VSC1D2D3NNA6SC	2.3	0.37	1/2	LED	✔	—	IP66_x	FS1	—
VSC1D4D3NNA20C	4.3	0.75	1	LED	—	—	IP20	FS1	—
VSC1D4D3NNA66C	4.3	0.75	1	LED	—	—	IP66_x	FS1	—
VSC1D4D3NNA6SC	4.3	0.75	1	LED	✔	—	IP66_x	FS1	—
VSC1D5D8NNA20C	5.8	1.1	1-1/2	LED	—	—	IP20	FS2	✔
VSC1D5D8NNA66C	5.8	1.1	1-1/2	LED	—	—	IP66_x	FS2	✔
VSC1D5D8NNA6SC	5.8	1.1	1-1/2	LED	✔	—	IP66_x	FS2	✔

Notes

① As per IEC standards.

② As per UL 61800-5-1, Table DVE.1, March 6, 2015.

VSC12… device series

Mains voltage: 1 AC 220–240 V (±10 %), 50/60 Hz

Output voltage: 3 AC 220–240 V, 50/60 Hz

Table 4. VSC12… features

Part no.	Rated operational current I_e A	Assigned instance motor power P ① (230 V, 50 Hz) kW	P ② (230 V, 60 Hz) hp	Display (operating unit)	Local controls	Radio interference suppression filter	Degree of protection	Size	Brake chopper
VSC122D3NNA20C	2.3	0.37	1/2	LED	—	—	IP20	FS1	—
VSC122D3FNA20C	2.3	0.37	1/2	LED	—	✔	IP20	FS1	—
VSC122D3NNA66C	2.3 ③	0.37	1/2	LED	—	—	IP66_x	FS1	—
VSC122D3FNA66C	2.3 ③	0.37	1/2	LED	—	✔	IP66_x	FS1	—
VSC122D3NNA6SC	2.3 ③	0.37	1/2	LED	✔	–	IP66_x	FS1	—
VSC122D3FNA6SC	2.3 ③	0.37	1/2	LED	✔	✔	IP66_x	FS1	—
VSC124D3NNA20C	4.3	0.75	1	LED	—	—	IP20	FS1	—
VSC124D3FNA20C	4.3	0.75	1	LED	—	✔	IP20	FS1	—
VSC124D3NNA66C	4.3 ③	0.75	1	LED	—	—	IP66_x	FS1	—
VSC124D3FNA66C	4.3 ③	0.75	1	LED	—	✔	IP66_x	FS1	—
VSC124D3NNA6SC	4.3 ③	0.75	1	LED	✔	—	IP66_x	FS1	—
VSC124D3FNA6SC	4.3 ③	0.75	1	LED	✔	✔	IP66_x	FS1	—
VSC127D0NNA20C	7	1.5	2	LED	—	—	IP20	FS1	—
VSC127D0FNA20C	7	1.5	2	LED	—	✔	IP20	FS1	—
VSC127D0NBA20C	7	1.5	2	LED	—	—	IP20	FS2	✔
VSC127D0FBA20C	7	1.5	2	LED	—	✔	IP20	FS2	✔
VSC127D0NNA66C	7 ③	1.5	2	LED	—	—	IP66_x	FS1	—
VSC127D0FNA66C	7 ③	1.5	2	LED	—	✔	IP66_x	FS1	—
VSC127D0NBA66C	7 ③	1.5	2	LED	—	—	IP66_x	FS2	✔
VSC127D0FBA66C	7 ③	1.5	2	LED	—	✔	IP66_x	FS2	✔
VSC127D0NNA6SC	7 ③	1.5	2	LED	✔	—	IP66_x	FS1	—
VSC127D0FNA6SC	7 ③	1.5	2	LED	✔	✔	IP66_x	FS1	—
VSC127D0NBA6SC	7 ③	1.5	2	LED	✔	—	IP66_x	FS2	✔
VSC127D0FBA6SC	7 ③	1.5	2	LED	✔	✔	IP66_x	FS2	✔

Notes

① As per IEC standards.

② As per UL 61800-5-1, Table DVE.1, March 6, 2015.

③ Rated operational current at switching frequencies of up to 16 kHz and ambient temperatures of up to +40 °C.

Table 4. VSC12… features, continued

Part no.	Rated operational current I_e A	Assigned instance motor power P ① (230 V, 50 Hz) kW	P ② (230 V, 60 Hz) hp	Display (operating unit)	Local controls	Radio interference suppression filter	Degree of protection	Size	Brake chopper
VSC12011NBA20C	10.5 ⑥	2.2	3	LED	—	—	IP20	FS2	✔
VSC12011FBA20C	10.5 ⑥	2.2	3	LED	—	✔	IP20	FS2	✔
VSC12011NBA66C	10.5 ③	2.2	3	LED	—	—	IP66_x	FS2	✔
VSC12011FBA66C	10.5 ③	2.2	3	LED	—	✔	IP66_x	FS2	✔
VSC12011NBA6SC	10.5 ③	2.2	3	LED	✔	—	IP66_x	FS2	✔
VSC12011FBA6SC	10.5 ③	2.2	3	LED	✔	✔	IP66_x	FS2	✔
VSC12015NBA20C	15.3 ⑤	4	5	LED	—	—	IP20	FS3	✔
VSC12015NBA66C	15.3 ⑤	4	5	LED	—	—	IP66_x	FS3	✔
VSC12015NBA6SC	15.3 ⑤	4	5	LED	✔	—	IP66_x	FS3	✔

Notes

① As per IEC standards

② As per UL 61800-5-1, Table DVE.1, March 6, 2015

③ Rated operational current at switching frequencies of up to 16 kHz and ambient temperatures of up to +40 °C

④ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +50 °C

⑤ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +40 °C

⑥ For UL conformity: Rated operational current at ambient temperatures of up to +45 °C over a period of 24 hours

VSC32… device series

Mains voltage: 3 AC 220–240 V (±10 %), 50/60 Hz

Output voltage: 3 AC 220–240 V, 50/60 Hz

Table 5. VSC32… features

Part no.	Rated operational current I_e A	Assigned instance motor power P ① (230 V, 50 Hz) kW	P ② (230 V, 60 Hz) hp	Display (operating unit)	Local controls	Radio interference suppression filter	Degree of protection	Size	Brake chopper
VSC322D3NNA20C	2.3	0.37	1/2	LED	—	—	IP20	FS1	—
VSC322D3NNA66C	2.3 ③	0.37	1/2	LED	—	—	IP66_x	FS1	—
VSC322D3NNA6SC	2.3 ③	0.37	1/2	LED	✔	—	IP66_x	FS1	—
VSC324D3NNA20C	4.3	0.75	1	LED	—	—	IP20	FS1	—
VSC324D3NNA66C	4.3 ③	0.75	1	LED	—	—	IP66_x	FS1	—
VSC324D3NNA6SC	4.3 ③	0.75	1	LED	✔	—	IP66_x	FS1	—
VSC327D0NNA20C	7	1.5	2	LED	—	—	IP20	FS1	—
VSC327D0NBA20C	7	1.5	2	LED	—	—	IP20	FS2	✔
VSC327D0FBA20C	7	1.5	2	LED	—	✔	IP20	FS2	✔
VSC327D0NNA66C	7③	1.5	2	LED	—	—	IP66_x	FS1	—
VSC327D0NBA66C	7③	1.5	2	LED	—	—	IP66_x	FS2	✔
VSC327D0FBA66C	7③	1.5	2	LED	—	✔	IP66_x	FS2	✔
VSC327D0NNA6SC	7③	1.5	2	LED	✔	—	IP66_x	FS1	—
VSC327D0NBA6SC	7③	1.5	2	LED	✔	—	IP66_x	FS2	✔
VSC327D0FBA6SC	7③	1.5	2	LED	✔	✔	IP66_x	FS2	✔
VSC32011NBA20C	10.5 ⑥	2.2	3	LED	—	—	IP20	FS2	✔
VSC32011FBA20C	10.5 ⑥	2.2	3	LED	—	✔	IP20	FS2	✔
VSC32011NBA66C	10.5 ⑥	2.2	3	LED	—	—	IP66_x	FS2	✔
VSC32011FBA66C	10.5 ⑥	2.2	3	LED	—	✔	IP66_x	FS2	✔
VSC32011NBA6SC	10.5 ⑥	2.2	3	LED	✔	—	IP66_x	FS2	✔
VSC32011FBA6SC	10.5 ⑥	2.2	3	LED	✔	✔	IP66_x	FS2	✔
VSC32018NBA20C	18	4	5	LED	—	—	IP20	FS3	✔
VSC32018FBA20C	18	4	5	LED	—	✔	IP20	FS3	✔
VSC32018NBA66C	18⑤	4	5	LED	—	—	IP66_x	FS3	✔
VSC32018FBA66C	18⑤	4	5	LED	—	✔	IP66_x	FS3	✔
VSC32018NBA6SC	18⑤	4	5	LED	✔	—	IP66_x	FS3	✔
VSC32018FBA6SC	18⑤	4	5	LED	✔	✔	IP66_x	FS3	✔

Notes

① As per IEC standards.

② As per UL 61800-5-1, Table DVE.1, March 6, 2015.

③ Rated operational current at switching frequencies of up to 16 kHz and ambient temperatures of up to +40 °C.

④ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +50 °C.

⑤ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +40 °C.

⑥ For UL conformity: Rated operational current at ambient temperatures of up to +45 °C over a period of 24 hours.

Table 5. VSC32… features, continued

Part no.	Rated operational current I_e A	Assigned instance motor power P ① (230 V, 50 Hz) kW	P ② (230 V, 60 Hz) hp	Display (operating unit)	Local controls	Radio interference suppression filter	Degree of protection	Size	Brake chopper
VSC32024NBA20C	24	5.5	7-1/2	LED	—	—	IP20	FS3	✔
VSC32024FBA20C	24	5.5	7-1/2	LED	—	✔	IP20	FS3	✔
VSC32030NBA20C	30	7.5	10	LED	—	—	IP20	FS4	✔
VSC32030FBA20C	30	7.5	10	LED	—	✔	IP20	FS4	✔
VSC32046NBA20C	46	11	15	LED	—	—	IP20	FS4	✔
VSC32046FBA20C	46	11	15	LED	—	✔	IP20	FS4	✔

Notes

① As per IEC standards.
② As per UL 61800-5-1, Table DVE.1, March 6, 2015.
③ Rated operational current at switching frequencies of up to 16 kHz and ambient temperatures of up to +40 °C.
④ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +50 °C.
⑤ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +40 °C.
⑥ For UL conformity: Rated operational current at ambient temperatures of up to +45 °C over a period of 24 hours.

VSC34… device series

Mains voltage: 3 AC 380–480 V (±10 %), 50/60 Hz

Output voltage: 3 AC 380–480 V, 50/60 Hz

Table 6. VSC34… features

Part no.	Rated operational current I_e A	Assigned instance motor power P ① (230 V, 50 Hz) kW	P ② (230 V, 60 Hz) hp	Display (operating unit)	Local controls	Radio interference suppression filter	Degree of protection	Size	Brake chopper
VSC342D2NNA20C	2.2	0.75	1	LED	—	—	IP20	FS1	—
VSC342D2FNA20C	2.2	0.75	1	LED	—	✔	IP20	FS1	—
VSC342D2NNA66C	2.2 ③	0.75	1	LED	—	—	IP66_x	FS1	—
VSC342D2FNA66C	2.2 ③	0.75	1	LED	—	✔	IP66_x	FS1	—
VSC342D2NNA6SC	2.2 ③	0.75	1	LED	✔	—	IP66_x	FS1	—
VSC342D2FNA6SC	2.2 ③	0.75	1	LED	✔	✔	IP66_x	FS1	—
VSC344D1NNA20C	4.1	1.5	2	LED	—	—	IP20	FS1	—
VSC344D1NBA20C	4.1	1.5	2	LED	—	—	IP20	FS2	✔
VSC344D1FNA20C	4.1	1.5	2	LED	—	✔	IP20	FS1	—
VSC344D1FBA20C	4.1	1.5	2	LED	—	✔	IP20	FS2	✔
VSC344D1NNA66C	4.1 ③	1.5	2	LED	—	—	IP66_x	FS1	—
VSC344D1NBA66C	4.1 ③	1.5	2	LED	—	—	IP66_x	FS2	✔
VSC344D1FNA66C	4.1 ③	1.5	2	LED	—	✔	IP66_x	FS1	—
VSC344D1FBA66C	4.1 ③	1.5	2	LED	—	✔	IP66_x	FS2	✔
VSC344D1NNA6SC	4.1 ③	1.5	2	LED	✔	—	IP66_x	FS1	—
VSC344D1NBA6SC	4.1 ③	1.5	2	LED	✔	—	IP66_x	FS2	✔
VSC344D1FNA6SC	4.1 ③	1.5	2	LED	✔	✔	IP66_x	FS1	—
VSC344D1FBA6SC	4.1 ③	1.5	2	LED	✔	✔	IP66_x	FS2	✔
VSC345D8NBA20C	5.8	2.2	3	LED	—	—	IP20	FS2	✔
VSC345D8FBA20C	5.8	2.2	3	LED	—	✔	IP20	FS2	✔
VSC345D8NBA66C	5.8 ③	2.2	3	LED	—	—	IP66_x	FS2	✔
VSC345D8FBA66C	5.8 ③	2.2	3	LED	—	✔	IP66_x	FS2	✔
VSC345D8NBA6SC	5.8 ③	2.2	3	LED	✔	—	IP66_x	FS2	✔
VSC345D8FBA6SC	5.8 ③	2.2	3	LED	✔	✔	IP66_x	FS2	✔
VSC349D5NBA20C	9.5	4	5	LED	—	—	IP20	FS2	✔
VSC349D5FBA20C	9.5	4	5	LED	—	✔	IP20	FS2	✔

Notes

① As per IEC standards.

② As per UL 61800-5-1, Table DVE.1, March 6, 2015.

③ Rated operational current at switching frequencies of up to 16 kHz and ambient temperatures of up to +40 °C.

④ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +50 °C.

⑤ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +40 °C.

Table 6. VSC34… features, continued

Part no.	Rated operational current I_e A	Assigned instance motor power P ① (230 V, 50 Hz) kW	P ② (230 V, 60 Hz) hp	Display (operating unit)	Local controls	Radio interference suppression filter	Degree of protection	Size	Brake chopper
VSC349D5NBA66C	9.5 ③	4	5	LED	—	—	IP66_x	FS2	✔
VSC349D5FBA66C	9.5 ③	4	5	LED	—	✔	IP66_x	FS2	✔
VSC349D5NBA6SC	9.5 ③	4	5	LED	✔	—	IP66_x	FS2	✔
VSC349D5FBA6SC	9.5 ③	4	5	LED	✔	✔	IP66_x	FS2	✔
VSC34014NBA20C	14 ④	5.5	10	LED	—	—	IP20	FS3	✔
VSC34014FBA20C	14 ④	5.5	10	LED	—	✔	IP20	FS3	✔
VSC34014NBA66C	14 ④	5.5	10	LED	—	—	IP66_x	FS3	✔
VSC34014FBA66C	14 ④	5.5	10	LED	—	✔	IP66_x	FS3	✔
VSC34014NBA6SC	14 ④	5.5	10	LED	✔	—	IP66_x	FS3	✔
VSC34014FBA6SC	14 ④	5.5	10	LED	✔	✔	IP66_x	FS3	✔
VSC34018NBA20C	18 ④	7.5	10	LED	—	—	IP20	FS3	✔
VSC34018FBA20C	18 ④	7.5	10	LED	—	✔	IP20	FS3	✔
VSC34018NBA66C	18 ⑤	7.5	10	LED	—	—	IP66_x	FS3	✔
VSC34018FBA66C	18 ⑤	7.5	10	LED	—	✔	IP66_x	FS3	✔
VSC34018NBA6SC	18 ⑤	7.5	10	LED	✔	—	IP66_x	FS3	✔
VSC34018FBA6SC	18 ⑤	7.5	10	LED	✔	✔	IP66_x	FS3	✔
VSC34024NBA20C	24 ④	11	15	LED	—	—	IP20	FS3	✔
VSC34024FBA20C	24 ④	11	15	LED	—	✔	IP20	FS3	✔
VSC34030NBA20C	30	15	20	LED	—	—	IP20	FS4	✔
VSC34030FBA20C	30	15	20	LED	—	✔	IP20	FS4	✔
VSC34030NBA20C	30	18.5	25	LED	—	—	IP20	FS4	✔
VSC34030FBA20C	30	18.5	25	LED	—	✔	IP20	FS4	✔
VSC34046NBA20C	46	22	30	LED	—	—	IP20	FS4	✔
VSC34046FBA20C	46	22	30	LED	—	✔	IP20	FS4	✔

Notes

① As per IEC standards.

② As per UL 61800-5-1, Table DVE.1, March 6, 2015.

③ Rated operational current at switching frequencies of up to 16 kHz and ambient temperatures of up to +40 °C.

④ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +50 °C.

⑤ Rated operational current at switching frequencies of up to 8 kHz and ambient temperatures of up to +40 °C.

Description

IP20 degree of protection (FS1 to FS4)

The following drawing serves as an example showing the designations used for the elements in VSC variable speed drives with an IP20 degree of protection and a size of FS1.

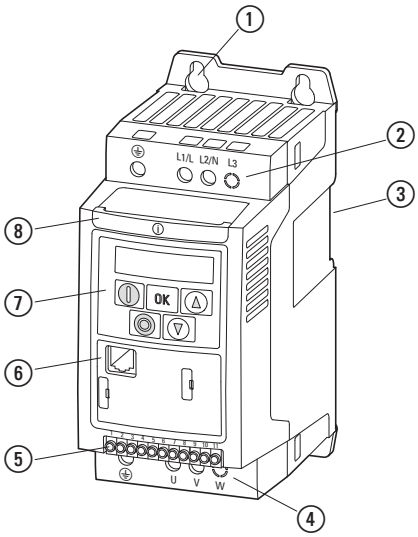


Figure 6. VSC description (FS1, IP20)

① Fixing holes (screw fastening)
② Connection terminals in power section (mains side)
③ Cutout for mounting on mounting rail
④ Connection terminals in power section (motor feeder)
⑤ Control signal terminals (plug-in)
⑥ Communication interface (RJ45)
⑦ Keypad with 5 control buttons and LED display
⑧ Info card

IP66 degree of protection (FS1 to FS3)

The following drawing serves as an example showing the designations used for the elements in VSC variable speed drives with an IP66 degree of protection and a size of FS1.

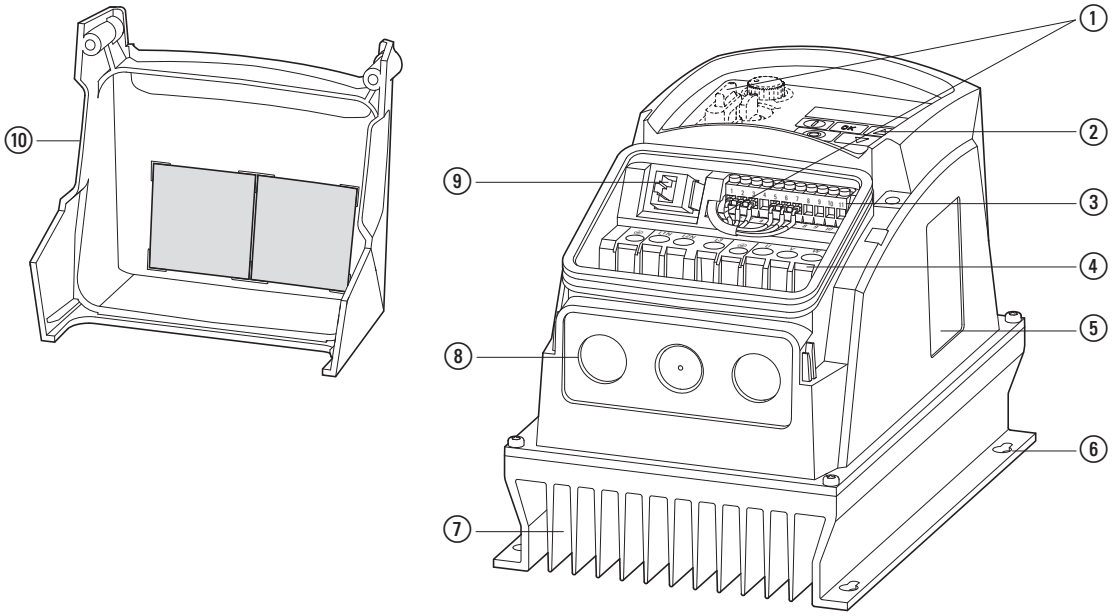


Figure 7. Description (IP66)

① Local controls with connection (VSC…A6SN only)
② Keypad with 5 control buttons and LED display
③ Control terminal (plug-in)
④ Connection terminals in power section
⑤ Nameplate
⑥ Fixing holes
⑦ Heat sink
⑧ Opening for cable gland
⑨ Communication interface (RJ45)
⑩ Cover for connection terminals, featuring info cards

The info cards are found on the inside of the lower cover (10), which features three additional knockouts for cable glands leading to the control section.

Voltage categories

VSC variable speed drives are divided into three voltage categories:

- 115 V: 110–115 V ±10 % → VSC**1D**
- 200 V: 200–240 V ±10 % → VSC**12**…, VSC**32**…
- 400 V: 380–480 V ±10 % → VSC**34**…

For more information on how to run single-phase AC motors using the VSC variable speed drive, please refer to Application Note "VSC Variable Speed Drives – Operating Single-Phase Motors."

- VSC**1D**…
  - Single-phase mains connection, rated operating voltage of 115 V with internal voltage doubler
  - U_{LN} = 1~, 110–115 V ±10 %, 50/60 Hz
  - Ie = 2.3–5.8 A
  - Motor: 0.37–1.1 kW (230 V, 50 Hz), 1/2–1-1/2 hp (230 V, 60 Hz)

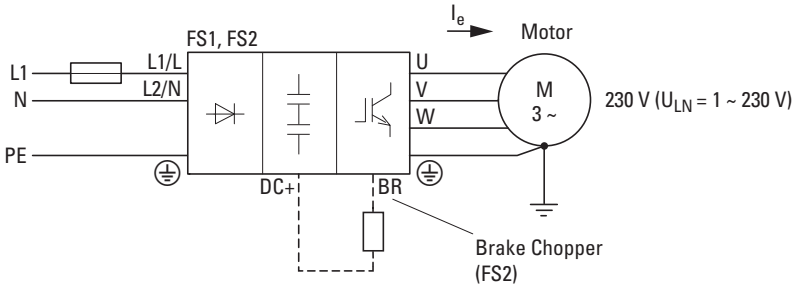


Figure 8. VSC1D…

- VSC**12**…
  - Single-phase mains connection, rated operating voltage 230 V
  - U_{LN} = 1~, 200–240 V ±10 %, 50/60 Hz
  - I_e = 2.3–15.3 A

Motor: 0.37–4 kW (230 V, 50 Hz), 1/2–5 hp (230 V, 60 Hz)

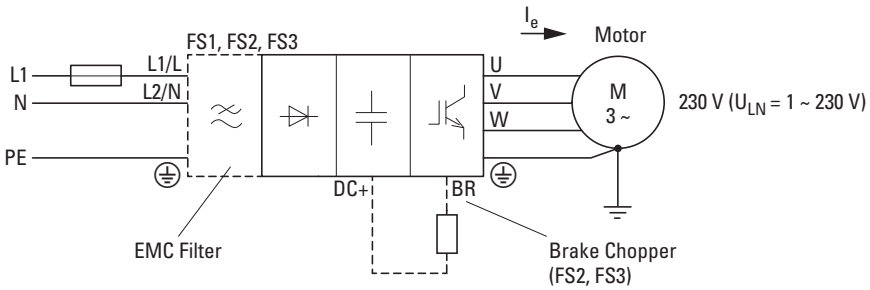


Figure 9. VSC12…

- VSC**32**…
  - Three-phase power supply, rated operating voltage 230 V
  - U_{LN} = 3~, 200–240 V ±10 %, 50/60 Hz
  - I_e = 2.3–46 A
  - Motor: 0.37–11 kW (230 V, 50 Hz), 1/2–15 hp (230 V, 60 Hz)

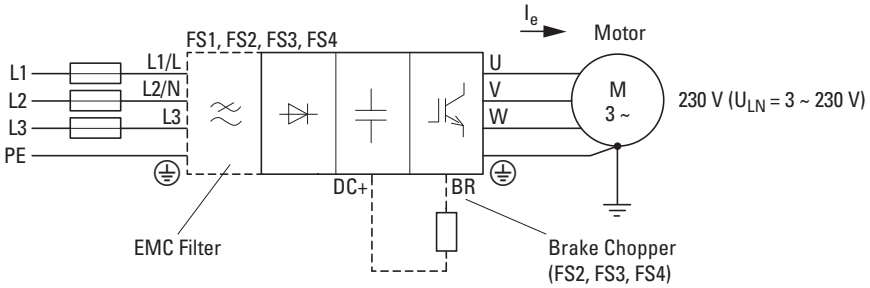


Figure 10. VSC32…

- VSC**34**…
  - Three-phase power supply, rated operating voltage 400/480 V
  - U_{LN} = 3~, 380–480 V ±10 %, 50/60 Hz
  - I_e = 2.2–46 A
  - Motor: 0.75–22 kW (400 V, 50 Hz), 1–30 hp (460 V, 60 Hz)

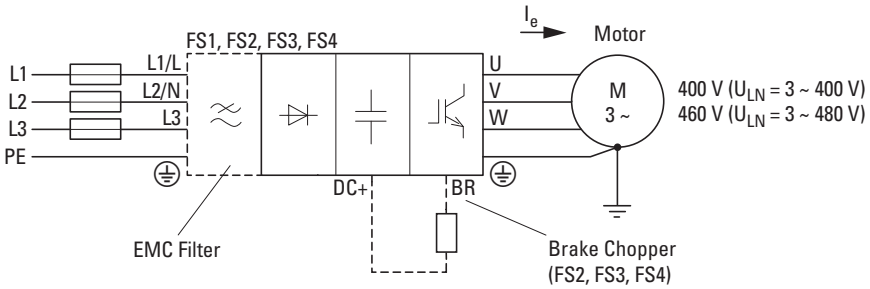


Figure 11. VSC34…

Selection criteria

Select the variable speed drive according to the supply voltage U_{LN} of the supply system and the rated operational current of the assigned motor. The circuit type (Δ / Y) of the motor must be selected according to the supply voltage.

The variable speed drive's rated output current I_e must be greater than or equal to the rated motor current.

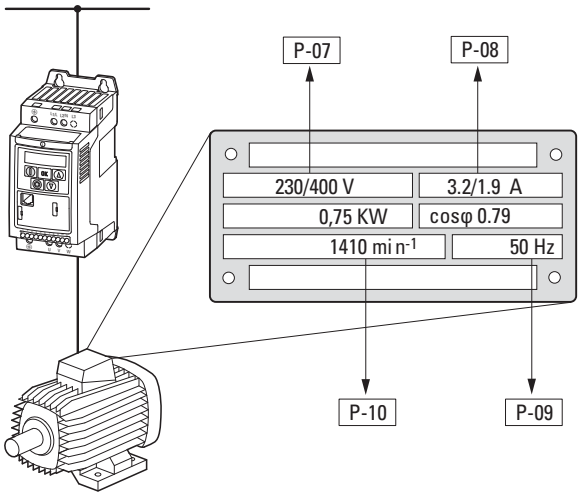


Figure 12. Selection criteria

When selecting the drive, the following criteria must be known:

- Mains voltage = rated operating voltage of the motor (i.e., 3~ 400 V),
- Type of motor (i.e., three-phase asynchronous motor)
- Rated motor current (recommended value, dependent on the circuit type and the power supply)
- Ambient conditions: ambient temperature, control cabinet installation with IP20 degree of protection or direct local installation with IP66 degree of protection.

Example based on figure 12

- Mains voltage: 3~ 400 V, 50 Hz
- Star-connected circuit (400 V)
- Rated operational current: 1.9 A (400 V)
- Control panel installation → IP20 degree of protection
- Ambient air temperature max. 50 °C without output reduction, IP20

Note: Variable speed drive that should be selected: VSC342D2FNA20C

- VSC**34**…: 3-phase main terminal, rated operating voltage: 400 V
- VSC…**2D2**…: 2.2 A – The variable speed drive's rated operational current (output current) guarantees that the motor will be supplied with the required rated operational current (1.9 A).

Output reduction (derating)

Derating the VSC variable speed drive / limiting the maximum continuous output current (I_2) will generally be necessary if, during operation:

- The ambient air temperature is higher than 40 °C
- An installation altitude of 1,000 m is exceeded
- The effective switching frequency is higher than the minimum value

The following tables specify the factors that need to be applied when selecting a VSC variable speed drive if the drive will be run outside these conditions:

Table 7. Derating for ambient temperature

	Maximum permissible ambient air temperature		
Enclosure degree of protection	**Without derating**	**With derating**	**Derate**
IP20	50 °C	50 °C ①	None
IP66	40 °C	50 °C	2.5 % per K

Note

① 45 °C for continuous operation for 24 hours, as per UL, for VSC12011…BA20N and VSC32011…BA20N.

Table 8. Derating for installation altitude

	Permissible altitude		
Enclosure degree of protection	**Without derating**	**With derating**	**Derate**
IP20, IP66	1000 m	2000 m: with UL Certification 4000 m maximum: without UL Certification	1 % per 100 m

Table 9. Derating for switching frequency

Enclosure degree of protection	Switching frequency (P-17), setting (audible) ①					
	4 kHz	**8 kHz**	**12 kHz**	**16 kHz**	**24 kHz**	**32 kHz**
IP20	None	None	20 %	30 %	40 %	50 %
IP66	None	10 %	25 %	35 %	50 %	50 %

Note

① The switching frequency's effective rms value will be approximately half the value set with parameter P-17 (double modulation).

For more information on the subject of derating, please refer to Application Note "VSC Variable Speed Drives – Dependency of the output current on switching frequency and ambient air temperature".

Examples showing how to apply derating factors

2.2 kW motor (400 V, 5 A), installation altitude of 2,000 m above sea level, ambient temperature of 45 °C, wall-mounted in mechanical room, required switching frequency of 16 kHz.

a)
Selected variable speed drive: VSC349D5FBA6SC, rated operational current of 9.5 A, switching frequency of 8 kHz (default setting).

Required derating factors:

- For the 16 kHz switching frequency: **35 %**
- For the 2,000 m installation altitude: **10 %** (1% per 100 m above 1,000 m, 2,000 m–1,000 m = 1,000 m, 1,000 m/100 m = 10)
- For the 45 °C ambient temperature: **12.5 %** (2.5% per kelvin, 45 °C–40 °C = 5 K, IP66 degree of protection)

9.5 A – 35 % – 10 % – 12.5 % = (9.5 x 0.65 x 0.9 x 0.875) A = **4.86 A**

The VSC's permissible continuous rated operational current of 4.86 A is lower than the motor's required rated operational current (5 A).

By using the default switching frequency instead (default setting: 8 kHz), the motor can be operated continuously at an altitude of 2,000 m (9.5 A–10%–12.5% = 6.73 A).

Note: Use a variable speed drive belonging to a higher output class and repeat the calculations in order to ensure that a sufficiently high output current will be available continuously.

b)
In order to be able to work with the required switching frequency of 16 kHz, a larger variable speed drive would be needed. Selected variable speed drive: VSC34014FBA6SC, rated operational current of 14 A.

Required derating factors:

- For the 16 kHz switching frequency: **35 %**
- For the 2,000 m installation altitude: **10 %** (1% per 100 m above 1,000 m, 2,000 m–1,000 m = 1,000 m, 1,000 m/100 m = 10)
- For the 45 °C ambient temperature: **12.5 %** (2.5% per kelvin, 45 °C–40 °C = 5 K, IP66 degree of protection).

14 A - 35 % - 10 % - 12.5 % = (14 x 0.65 x 0.9 x 0.875) A = approx. **7.2 A**

The VSC34014FBA6SC variable speed drive meets the necessary operating conditions.

Proper use

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

The VSC variable speed drives are not domestic appliances. They are designed only for industrial use as system components.

If the variable speed drive is installed in a machine, it is prohibited to place it into operation until it has been determined that the corresponding machine meets the safety and protection requirements set forth in Machinery Safety Directive 2006/42/EC (i.e., by complying with EN 60204). The user of the equipment is responsible for ensuring that the machine use complies with the relevant EU Directives.

The CE markings on VSC variable speed drives confirm that the devices meet the requirements set forth in the European Union's Low Voltage and EMC Directives (Directives 2014/35/EU, 2014/30/EU and ROHS 2011/65/EU) when used in their typical drive configuration.

In the described system configurations, VSC variable speed drives are suitable for use in public and non-public networks.

A connection of a VSC variable speed drive to IT networks (networks without reference to earth potential) is permissible only to a limited extent, since the device's built-in filter capacitors connect the network with the earth potential (enclosure).

In unearthed networks, this can result in hazardous situations or damage to the device (insulation monitoring is required!).

Note: To the output (terminals U, V, W) of the VSC variable speed drive you must not:

- connect a voltage or capacitive loads (i.e., phase compensation capacitors),
- Connect multiple variable speed drives in parallel
- make a direct connection to the input (bypass).

Note: Always observe the technical data and connection conditions!

For additional information, refer to the equipment nameplate or label at the variable speed drive and the documentation.

Any other use will be considered to be an improper use of the device.

Maintenance and inspection

VSC series variable speed drives will be maintenance-free as long as the general rated operational data (see annex) is adhered to and the specific technical data (see annex) for the corresponding ratings is taken into account. Please note, however, that external influences may affect the operation and lifespan of a VSC variable speed drive.

We therefore recommend that the devices are checked regularly and the following maintenance measures are carried out at the specified intervals.

Table 10. Recommended maintenance for VSC variable speed drives

Maintenance measure	Maintenance interval
Clean cooling vents (cooling slits)	Please enquire
Check to make sure that the fan and the 7-segment display are working properly (press all five buttons simultaneously, starting with the Stop button)	6–24 months (depending on the environment)
Check the filter in the control panel doors (see the manufacturer's specifications)	6–24 months (depending on the environment)
Check all earth connections to make sure they are intact	On a regular basis, at periodic intervals
Check the tightening torques of the terminals (control terminals, power terminals)	On a regular basis, at periodic intervals
Check connection terminals and all metallic surfaces for corrosion	6–24 months; when stored, no more than 12 months later (depending on the environment)
Motor cables and shield connection (EMC)	According to manufacturer specifications, no later than 5 years
Charge capacitors	12 months ("Charging the internal DC link capacitors")

There are no plans for replacing or repairing individual components of VSC variable speed drives!

If the VSC variable speed drive is damaged by external influences, repair is not possible.

Dispose of the device according to the applicable environmental laws and provisions for the disposal of electrical or electronic devices.

Storage

If the VSC variable speed drive is stored before use, suitable ambient conditions must be ensured at the site of storage:

- Storage temperature: –40 to +60 °C,
- Relative average air humidity: < 95 %, noncondensing (EN 50178),
- To prevent damage to the variable speed drive's internal DC link capacitors, it is not recommended to store the variable speed drive for more than 12 months ("Charging the internal DC link capacitors").

Charging the internal DC link capacitors

After extended storage times or extended downtimes during which no power is supplied (> 12 months), the capacitors in the internal DC link must be recharged in a controlled manner in order to prevent damage. To do this, the VSC variable speed drive must be supplied with power, with a controlled DC power supply unit, via two mains connection terminals (i.e., L1 and L2).

In order to prevent the capacitors from having excessively high leakage currents, the inrush current should be limited to approximately 300 to 800 mA (depending on the relevant rating). The variable speed drive must not be enabled during this time (i.e., no start signal). After this, the DC voltage must be set to the magnitudes for the corresponding DC link voltage ($U_{DC} \rightarrow 1.41 \times U_e$) and applied for one hour at least (regeneration time).

- VSC12…, VSC32…: about 324 Vdc at U_e = 230 Vac
- VSC34…: about 560 Vdc at U_e = 400 Vac

Note: Due to the internal voltage doubler circuit, the capacitors in VSC1D… variable speed drives cannot be reformed using the connection terminals!

Please contact your local sales office.

Engineering

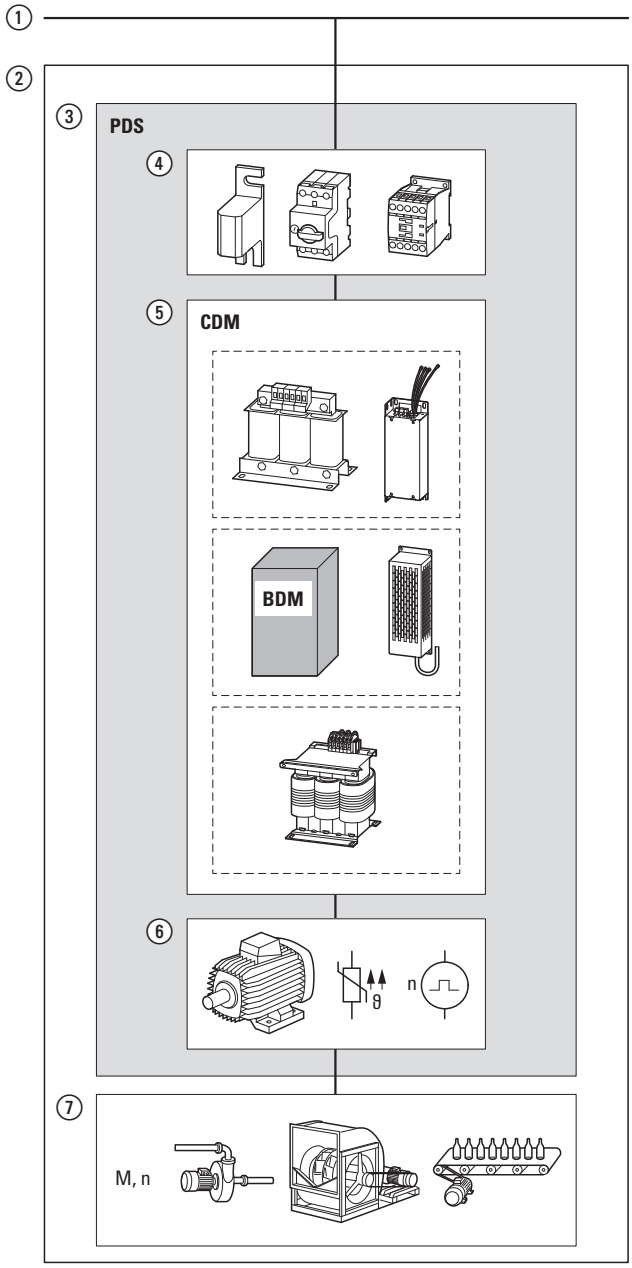
Introduction

This chapter describes the most important features in the energy circuit of a magnet system (PDS = Power Drive System), which you should take into consideration in your project planning.

It contains instructions that must be followed when determining which device to use with which rated motor output, as well as when selecting protection devices and switchgear, selecting cables, cable entries, and operating the VSC variable speed drive.

All applicable laws and local standards must be complied with when planning and carrying out the installation. Not following the recommendations provided may result in problems what will not be covered by the warranty.

An example for a magnet system



① Electrical supply system
(mains connection, grounding system configuration, mains voltage, frequency, voltage balance, THD, compensation systems)

② Overall system – consisting of motor and load systems

③ PDS = Power drive system

④ Safety and switching
(disconnecting devices, fuses, cable cross-sectional areas, residual current circuit-breakers, mains contactors)

⑤ CDM = Complete drive module:
variable speed drive with auxiliary equipment (mains and motor chokes, radio interference suppression filter, brake resistor, sine filter)
BDM = Basic drive module:
VSC variable speed drive

⑥ Motor and sensor
(Temperature, motor speed)

⑦ Load system:
Driven system equipment (process, speed, torque)

Figure 13. Magnet system example (overall system as its own system or as part of a larger system)

Electrical power network

Mains terminal and configuration

VSC variable speed drives can be connected to and run on all neutral point-grounded AC supply systems (TN-S, TN-C, TT grounding systems; please refer to IEC 60364) without any limitations.

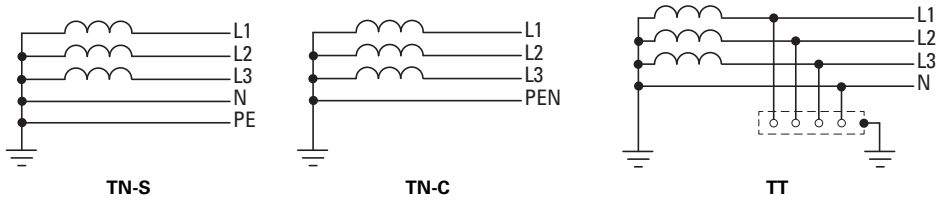


Figure 14. AC supply systems with earthed center point

Note: While planning the project, consider a symmetrical distribution to the three main phase conductors, if multiple variable speed drives with single-phase supplies are to be connected.The total current of all single phase consumers is not to cause an overload of the neutral conductor (N-conductor).

The connection and operation of variable speed drives to asymmetrically grounded TN networks (phase-grounded delta network "Grounded Delta", USA) or non-grounded or high-resistance grounded (over 30 Ω) IT networks is only conditionally permissible (internal radio interference suppression filters).

Note: Operation on non-earthed networks (IT) requires the use of suitable insulation monitoring relays (i.e., pulse-code measurement method)

Note: In networks with an earthed phase conductor, the maximum phase-earth voltage must not exceed 300 Vac.

VSC…A20C variable speed drives can be connected to corner-grounded systems or IT grounding systems (not grounded, insulated). When versions featuring an internal radio interference suppression filter (VSC…**F**NA20C, VSC…**F**BA20C) are connected to one of these systems, the **EMC** screw(s) needs to be removed and the internal radio interference suppression filter needs to be disconnected

Note: Measures for electromagnetic compatibility are mandatory in a power drive system, to meet the legal standards for EMC- and Low Voltage Directive. Good earthing measures are a prerequisite for the effective Use of further measures such as screen earth kit or filters here. Without respective grounding measures, further steps are superfluous.

Mains voltage and frequency

The standardized rated operating voltages (IEC 60038, VDE 017-1) of power utilities guarantee the following conditions at the connection point:

- Deviation from the rated value of voltage: maximum ±10 %
- Deviation in voltage phase balance: maximum ±3 %
- Deviation from rated value of the frequency: maximum ±4 %

The broad tolerance band of the VSC variable speed drive considers the rated value for
European as (EU: U_{LN} = 230 V/400 V, 50 Hz) and
American as (USA: U_{LN} = 240 V/480 V, 60 Hz) standard voltages:

- 115 V, 50 Hz (EU) and 115 V, 60 Hz (USA) for VSC1D…, 110 V –10% - 115 V +10% (99 V -0% - 126 V +0%)
  The internal voltage doubler will increase the mains voltage of 115 V to produce an output voltage of 230 V (motor voltage).
- 230 V, 50 Hz (EU) and 240 V, 60 Hz (USA) at VSC12…, VSC32…
  200 V –10 % - 240 V +10 % (180 V -0 % - 264 V +0 %)
- 400 V, 50 Hz (EU) and 480 V, 60 Hz (USA) at VSC34…
  380 V –10 % - 480 V +10 % (342 V -0 % - 528 V +0 %)

The permissible frequency range for all voltage categories is 50/60 Hz (48 Hz - 0 % - 62 Hz + 0 %).

Voltage balance

Unbalanced voltages and deviations from the ideal voltage shape may occur in three-phase AC supply systems if the conductors are loaded unevenly and if large output loads are connected directly. These supply voltage unbalances may cause the diodes in the variable speed drive's rectifier bridge converter to be loaded unevenly, resulting in premature diode failure.

Note: In the project planning for the connection of three-phase supplied variable speed drives (VSC**3**…), consider only AC supply systems that handle permitted asymmetric divergences in the mains voltage ≤+3 %.

If this condition is not fulfilled, or symmetry at the connection location is not known, the use of an assigned main choke is recommended.

Note: For the rated mains contactors for VSC variable speed drives, please refer to **Page 31**.

Total Harmonic Distortion (THD)

The THD value (THD = Total Harmonic Distortion) is defined in standard IEC/EN 61800-3 as the ratio of the rms value of all harmonic components to the rms value of the fundamental frequency.

Note: In order to reduce the THD value (up to 30%), it is recommended to use a DX-LN… mains choke. (Refer to **Page 31**).

Reactive power compensation devices

Compensation on the power supply side is not required for the variable speed drives of the VSC series. From the AC power supply network they only take on very little reactive power of the fundamental harmonics (cos φ ~ 0.98).

Note: In the AC supply systems with non-choked reactive current compensation devices, current deviations can enable parallel resonance and undefinable circumstances.

In the project planning for the connection of variable speed drives to AC supply systems with undefined circumstances, consider using mains chokes.

Cable cross-sections

The mains cables and motor cables must be sized as required by local standards and by the load currents that will be involved.

The PE conductor's cross-sectional area must be the same as the phase conductors' cross-sectional area. The connection terminals marked with ⏚ must be connected to the earth-current circuit.

Notice

The specified minimum PE conductor cross-sections (EN 61800-5-1) must be maintained.

If there are leakage currents greater than 3.5 mA, a reinforced earthing (PE) must be connected, as required by standard EN 61800-5-1. The cable cross-section must be at least 10 mm^2, or the earthing system must consist of two separately connected earthing cables.

Note: "Specific rated operational data" on **Page 122** provides the leakage currents for the individual models.

Note: "EMC installation" on **Page 46** goes over the EMC requirements for the motor cables.

A symmetrical, fully screened (360°), low-impedance motor cable must be used. The length of the motor cable depends on the RFI class and the environment.

For US installations, UL-listed cables (AWG) should be used exclusively. These cables must have a temperature rating of 70 °C (158 °F), and will often require installation inside a metal conduit (please consult the applicable local standards).

Note: For the rated cable cross-sectional areas for VSC variable speed drives, please refer to "Cable cross-sections" on **Page 132**.

Safety and switching

Disconnecting device

Note: Install a manual disconnecting device between the mains connection and the VSC variable speed drive. This disconnecting device must be designed in such a way that it can be interlocked in its open position for installation and maintenance work.

In the European Union, this disconnecting device must be one of the following devices in order to comply with European Directives as per standard EN 60204-1, "Safety of machinery":

- An AC-23B utilization category disconnector (EN 60947-3)
- A disconnector with an auxiliary contact that in all cases will disconnect the load circuit before the disconnector's main contacts open (EN 60947-3)
- A circuit-breaker designed to disconnect the circuit as per EN 60947-2

In all other regions, the applicable national and local safety regulations must be complied with.

Fuses

The VSC variable speed drive and the corresponding supply cables must be protected from thermal overload and short-circuits.

Note: The fuse ratings and cable cross-sectional areas (wire gauges) for the connection on the mains side will depend on the VSC variable speed drive's input current I_{LN}.

Note: For the recommended fuse sizing and assignments, please refer to "Fuses" on **Page 134**.

The fuses will protect the supply cable in the event of a short-circuit, limit any damage to the variable speed drive, and prevent damage to upstream devices in the event of a short-circuit in the variable speed drive.

Residual current circuit-breaker (RCD)

When using variable speed drives (VSC**3**…) that work with a three-phase power supply (L1, L2, L3), make sure to use type B AC/DC sensitive residual current devices exclusively.

When using variable speed drives that work with a single-phase power supply (L, N) (VSC**1**2… and VSC1D…), you may use type A and type B residual current protective devices (RCD).

Notice

Residual current circuit-breakers (RCD = residual current device) should only be installed between the power feed system (the AC supply system supplying power) and the VSC variable speed drive – but not at the output to the motor!

The leakage currents' magnitude will generally depend on:

- length of the motor cable
- shielding of the motor cable
- height of the switching frequency (switching frequency of the inverter),
- design of the radio interference suppression filter
- grounding measures at the site of the motor.

Other protective measures against direct and indirect contact can be used for VSC variable speed drives, including isolating them from the supply system with the use of a transformer.

Mains contactors

The mains contactor enables an operational switching on and off of the supply voltage for the variable speed drive and switching off in case of a fault. The mains contactor is designed based on the mains-side input current I_{LN} of the VSC variable speed drive for utilization category AC-1 (IEC 60947) and the ambient air temperature at the location of use.

Note: While planning the project, please make sure that inching operation is not done via the mains contactor of the variable speed drive on frequency-controlled drives, but through a controller input of the variable speed drive.

The maximum permissible mains voltage switch-on frequency for the VSC variable speed drive is once every 30 seconds (normal operation).

Note: For UL-compliant installation and during operation, the mains side switching devices must allow for a 1.25 times higher input current.

Note: For the rated mains contactors for VSC variable speed drives, please refer to "Mains contactors" on **Page 30**.

Mains chokes

Mains chokes reduce the total harmonic distortion, the mains feedback and improve the power factor. The apparent current on the mains side is then reduced by around 30 %.

Towards the variable speed drive, the main chokes dampen the interference from the supply network. This increases the electric strength of the variable speed drive and lengthens the lifespan (diodes of the mains power rectifier, internal DC link capacitors).

Note: For the operation of the VSC variable speed drive, the application of main chokes is not necessary.

However, we recommend using a mains choke if the electrical supply system's quality is not known:

- Large voltage peaks (i.e., when switching large loads directly)
- Correction systems (without series inductors)
- Power supplied via conductor bar or slip ring systems (i.e., overhead cranes)

While planning the project, consider that a mains choke is only assigned to a single variable speed drive for decoupling.

When using an adapting transformer (assigned to a single variable speed drive), a main choke is not necessary.

Mains chokes are designed based on the mains-side input current (I_{LN}) of the variable speed drive.

Note: When the variable speed drive is running at its rated current limit, the mains choke with a u_K value of around 4 % will cause the variable speed drive's maximum possible output voltage U_2 to be reduced to about 96 % of the mains voltage U_{LN}.

Note: For the rated mains contactors for VSC variable speed drives, please refer to **Page 31**.

Radio interference suppression filter

VSC12xxx**F**…, VSC32xxx**F**…, and VSC34xxx**F**… variable speed drives feature an internal radio interference suppression filter. When combined with a motor cable that is screened and earthed 360° on both ends, they make it possible to comply with the stringent EMC limits for conducted interference corresponding to category C in the 1st environment (IEC/EN 61800-3). This requires installation in accordance with EMC requirements, as well as not exceeding permissible motor cable lengths.

- 1 m for category C1 in the 1st environment (only VSC12…),
- 5 m for category C2 in the 1st and 2nd environment,
- 25 m for category C3 in the 2nd environment.

Note: VSC32… and VSC34… three-phase variable speed drives can be operated within category C1 in the 1st environment only if an external radio interference suppression filter is used.

Longer motor cable lengths can be used if additional external radio interference suppression filters (DX-EMC…) are used.

Note: For the rated radio interference suppression filters for VSC variable speed drives, please refer to **Page 31**.

Note: The unscreened cable length between the radio interference suppression filter and the variable speed drive should not exceed 300 mm (maximum of 500 mm depending on the setup inside the metal-enclosed control panel).

Additional measures used to reduce EMC limits and use longer motor cable lengths are possible in combination with motor chokes and sine filters.

Note: In the case of power drive systems (PDS) with variable speed drives, electromagnetic compatibility (EMC) measures must already be taken into account during the engineering stage, as making changes during assembly and installation and retroactively fixing things will be more expensive.

Braking resistances

In certain operating states, the motor may run as a generator in certain applications (regenerative braking operation).

Examples include:

- Lowering in hoisting gear and conveyor applications
- Controlled speed reduction in the case of large load inertias (flywheels)
- A fast speed reduction in dynamic travel drives

When the motor operates as a generator, its braking energy will be fed into the variable speed drive's DC link via the inverter. DC link voltage U_{DC} will be increased as a result. If the voltage value is too high, the DA1 variable speed drive will disable its inverter, after which the motor will coast uncontrolled. If there is a braking chopper and a connected braking resistance R_B, the braking energy fed back into the variable speed drive can be dissipated in order to limit the DC link voltage.

VSC…BA… variable speed drives (frame sizes FS2, FS3, and FS4) feature an integrated braking chopper. The brake resistors are connected to the internal braking transistor with terminals DC+ and BR so that they will be connected in parallel to the DC link. In addition to this, the braking chopper must be enabled using parameter P-34 (= 1 or = 2).
The braking chopper will be switched on automatically if the braking energy being fed back causes the DC link voltage to increase to the switch-on voltage's magnitude.

Table 11. Braking resistances

Device series	Mains connection	Voltage class	Braking chopper on	Braking chopper off
VSC12…	Single-phase	230 V	390 V	378 V
VSC32…	Three-phase	230 V	390 V	378 V
VSC34…	Three-phase	400 V	780 V	756 V

For example, in the case of VSC34… variable speed drives, the braking chopper will be switched on at a DC link voltage of approximately 780 Vdc and then back off at 756 Vdc. During this stage, the braking transistor and the brake resistor will be active continuously.

In the case of units with a frame size of FS2 or FS3, brake resistor DX-BR3-100 (P_D = 200 W) can be inserted underneath the heat sink. In addition, parameter P-34 must be set to a value of 1 in order to protect against thermal overloads (braking chopper activated with electronic overload protection).

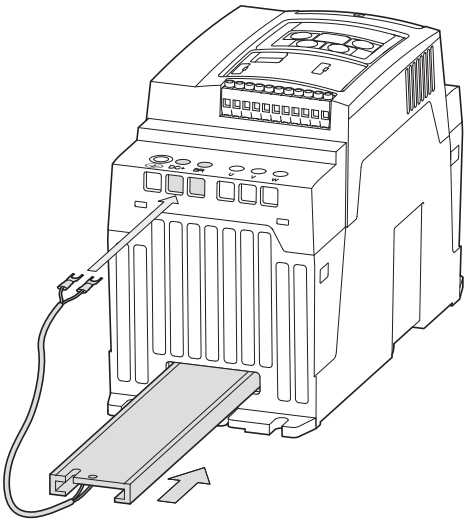


Figure 15. VSC variable speed drive with a frame size of FS2 and a DX-BR3-100 brake resistor

It is often difficult to specify a suitable brake resistor for specific applications. This is due to the fact that not all of the application conditions required for sizing will be available when the engineering stage starts. Because of this, and as a simplification, brake resistors are instead usually classified for two load groups:

- **Low duty**: Low load with short braking duration and low duty factor (up to about 25 %), i.e., for horizontal conveyors and handling equipment for bulk cargo and general cargo, end carriages, sliding doors, and turbomachinery (centrifugal pumps, fans).
- **High duty**: High load with long braking duration and high duty factor (at least 30 %), i.e., for elevators, downhill conveyors, winders, centrifuges, flywheel motors, and large fans.

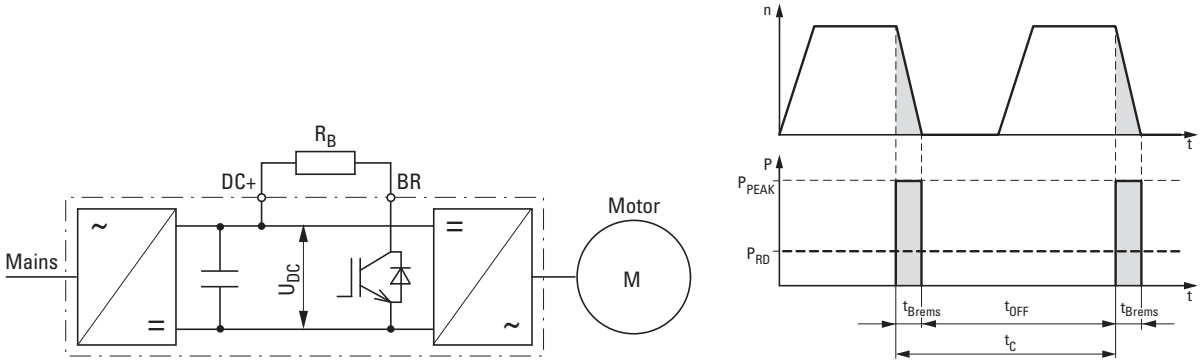


Figure 16. Braking cycle, fast motor stop with external brake resistor

Selecting brake resistors

Brake resistors are selected based on continuous power dissipation P_{DB} and maximum peak pulse power P_{Peak}. The brake resistor must be adequate for both powers.

The maximum pulse power is defined by the braking torque – kinetic energy W_{kin} during braking – that is fed back by the motor during braking. A simplified method that can be used is to take the variable speed drive's braking power P_{max} or the rated motor output and use it as peak pulse power P_{Peak} for sizing purposes, since the mechanical braking power will be reduced by the motor's and inverter's efficiency.

$$P_{Peak} \sim P_{max} = \frac{1}{2} \times \frac{W_{kin}}{t_{Braking}}$$

The required rated power / continuous rating for braking resistance P_{DB} is calculated using braking energy W_{kin} and cycle time t_C:

$$P_{DB} = \frac{W_{kin}}{t_C}$$

If the kinetic energy is not known, you will need the ratio of braking time $t_{Braking}$ to cycle time t_C:

$$DF[\%] = \frac{t_{Braking}}{t_C} \times 100\ \%$$

The required continuous rating for a duty factor of 10% (= DF[%]), for example, can be calculated as follows:

$$P_{DB} = P_{Peak} \times 10\ \%$$

This means that the brake resistor's continuous rating P_{DB} will always be lower than maximum pulse power P_{Peak} by the DF[%] factor.

Resistance R_B must be at least as high as the breaking transistor's minimum permissible resistance R_{min}.

Note: Use brake resistors with the recommended R_{Brec} resistance values for the VSC variable speed drives' ratings.

Note: For the rated braking resistances for VSC variable speed drives, please refer to **Page 31**.

Motor chokes

It is recommended to use a motor choke if using long cable lengths and/or connecting several motors in parallel. The motor reactor is in the output of the variable speed drive. Its rated operational current must always be greater than/equal to the rated operational current of variable speed drive.

For VSC variable speed drives, it is recommended to use a motor choke for motor cable lengths of 100 meters or more. Doing so may result in the following improvements:

- Longer maximum permissible screened motor cable length, up to 200 m,
- Current smoothing and du/dt value (kV/µs) attenuation, providing additional protection for the winding insulation inside the motor,
- Motor noise and heat build-up will be reduced.

Note: Take into account the maximum permissible motor cable lengths for the relevant EMC interference category.

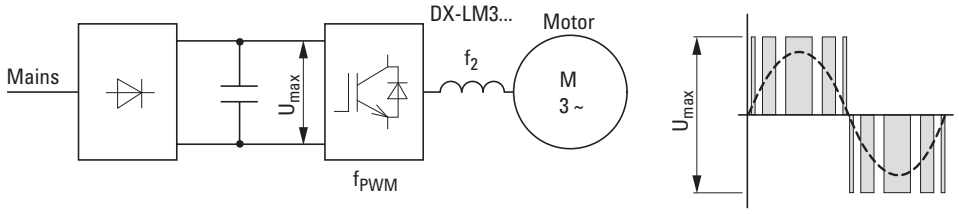


Figure 17. DX-LM3… rated operational data:
U_{max} = 750 V, f_2 = 0 - 400 Hz, f_{PWM} = 8 - 32 kHz (P-17 setting on VSC)

It is also recommended to use a motor choke at the variable speed drive's output if several motors with identical or different rated operational data are being run in parallel (V/Hz control only). In this case, the motor choke will compensate for the total resistance and total inductance decreases caused by the parallel circuit and will attenuate the cables' higher stray capacitance.

For the rated motor chokes for VSC variable speed drives, please refer to **Page 31**.

For more information and technical data on DX-LM3… motor chokes, please refer to instruction leaflet IL009060003Z

Sine filter

Sine filters are connected between a variable speed drive's output and the motor. The voltage output by a sine filter will be virtually sinusoidal, ensuring that:

- Conducted and radiated emissions will be reduced (EMC)
- Irritating noise levels and motor losses will be reduced
- Potential insulation damage will be minimized, extending the motor's life as a result

Note: Sine filters require for the variable speed drive to modulate the output voltage with V/Hz control.

In order to meet this requirement, parameter P-60 on VSC variable speed drives needs to be set to a value of 1 (this is the default setting).

Note: When there is a load-dependent or thermal overload, VSC variable speed drives will automatically reduce the carrier frequency (f_{PWM}) to a minimum value of 8 kHz (double modulation, effective rms value of 4 kHz)

Note: When used with a DX-SIN3… sine filter, the minimum permissible carrier frequency (f_{PWM}) on the VSC variable speed drive must be set to 8 kHz using parameter P-17.

Note: For the rated sine filters DX-SIN3… for VSC variable speed drives, please refer to "Sine filter" on **Page 34**.

Switching to the output side

Typical applications for switching at the VSC variable speed drive's output include:

- Cases in which a bypass circuit is implemented.
- Cases in which it must be possible to switch on various motors as necessary.
- Cases in which several motors are connected in parallel and need to be switched individually.
- Cases in which the motor must be de-energized quickly in the event of an emergency switching off (safety shutdown).

When an individual motor is switched off, the inverter needs to be disabled first (the FWD/REV enable signal must be switched off) before the contacts (contactor, switch-disconnector) on the variable speed drive's output side are opened.

Notice

Switching off during operation in vector mode (P-60 = 0 / 2 / 3 / 4) is not permissible and may result in damage to the switching device and the variable speed drive.

In cases in which the output is switched to a running motor, parameter P-33 must have a value of 1 (flying restart circuit enabled). When this condition is met, the VSC variable speed drive will be automatically synchronized with the running motor with the enable signal (FWD/REV).

Contactors

The contactors on the output side of VSC variable speed drives need to be sized based on utilization category AC-3 (IEC/EN 60947-4-1) for the assigned rated motor current and the corresponding rated operating voltage.

When a motor is being switched off, the VSC variable speed drive's output (inverter) must be disabled (the FWD/REV enable signal must be switched off) before the contacts are opened.

Notice

Switching off during operation in vector mode (P-60 = 0 / 2 / 3 / 4) is not permissible and may result in damage to the contactor and the variable speed drive.

Note: Vacuum contactors should not be used at a variable speed drive's output, as they are not suitable for switching at low frequencies.

Switch-disconnectors

Switch-disconnectors are used as repair and maintenance switches in industrial, trade, and building service management applications. At the output of variable speed drives, they are primarily used to locally switch off motors (pumps, fans) that pose a risk of unintended starting during maintenance or repairs. In order to provide greater safety, these switch-disconnectors can be locked out with the use of padlocks, meaning they have characteristics comparable to those of main switches as defined in EN 60204.

The switch-disconnectors on the output side of VSC variable speed drives need to be sized based on utilization category AC-23A (IEC/EN 60947-3) for the assigned rated motor current and the corresponding rated operating voltage.

When a motor is being switched off, the VSC variable speed drive's output (inverter) must be disabled (the FWD/REV enable signal must be switched off) before the contacts are opened.

Notice

Switching off during operation in vector mode (P-60 = 0 / 2 / 3 / 4) is not permissible and may result in damage to the switch-disconnector and the variable speed drive.

Bypass circuit

⚠ WARNING

Never connect the VSC variable speed drive's output terminals U, V, and W to the power feed system (L1, L2, L3). Connecting the mains voltage to the output terminals can result in the variable speed drive being irreparably damaged.

If a bypass is required, use mechanically linked switches or contactors or electrically interlocked contactors in order to ensure that the motor terminals will not be simultaneously connected to the mains connection and to the variable speed drive's output terminals.

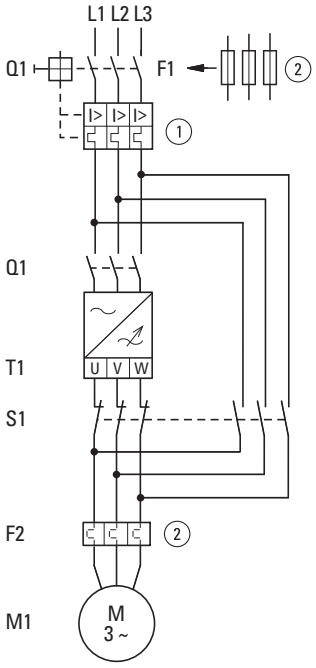


Figure 18. Bypass motor control (example)

① Q1 Thermal overload and short-circuit protection
② F1 Fuse and F2 overload relay (alternative to ①)
Q1 Mains contactor
T1 VSC variable speed drive
S1 Interlocked switching between variable speed drive and bypass
F2 Motor protection (overload relay, alternative to ①)
M1 Three-phase motor

When the motor is being switched off, the output (U, V, W) of variable speed drive T1 must be disabled (the FWD/REV enable signal must be switched off) before the contacts at S1 are opened.

Notice

Switching off during operation in vector mode (P-60 = 0 / 2 / 3 / 4) is not permissible and may result in damage to the switching device and the variable speed drive.

Connecting Motors in Parallel

Note: If multiple motors are connected in parallel, the total of their motor currents must be lower than the VSC variable speed drive's rated operational current.

Connecting motors in parallel will reduce the load resistance at the variable speed drive's output. This will cause the total stator inductance to decrease and the cables' stray capacitance to increase, resulting in greater harmonic distortion when compared to a single-motor circuit.
In order to reduce the amount of current distortion, it is recommended to use a motor choke or a sine filter at the variable speed drive's output when there are three motors or more.

Note: When running multiple motors in parallel with a single variable speed drive, the individual motors' outputs should not be more than three output classes apart.

Note: If several motors are being run in parallel, you will not be able to use the variable speed drive's electronic motor protection. As a result, each individual motor must be protected with thermistors and/or an overload relay.

Notice

If multiple motors are being run simultaneously using a single variable speed drive, make sure to size the individual motors' contactors as required for utilization category AC-3.The motor contactors must be selected according to the rated operational currents of the motors that will be connected.

Note: The total of the motor currents in operation, plus, for example, the inrush current of a motor being added, must be less than the rated operational current of the variable speed drive.

In applications with motors that will be connected and disconnected, we recommend using a motor choke or a sine filter.

Note: Connecting multiple motors in parallel requires for the variable speed drive to modulate the output voltage with V/Hz control. In order to meet this requirement, parameter P-60 on VSC variable speed drives needs to be set to a value of 1 (= default setting).

Note: When using vector mode (P-60 = 0), two motors with identical output classes can be connected (i.e., calendar drive).

Note: When using vector mode with P-60 = 2, 3 or 4, it is not permissible to run multiple motors connected in parallel!

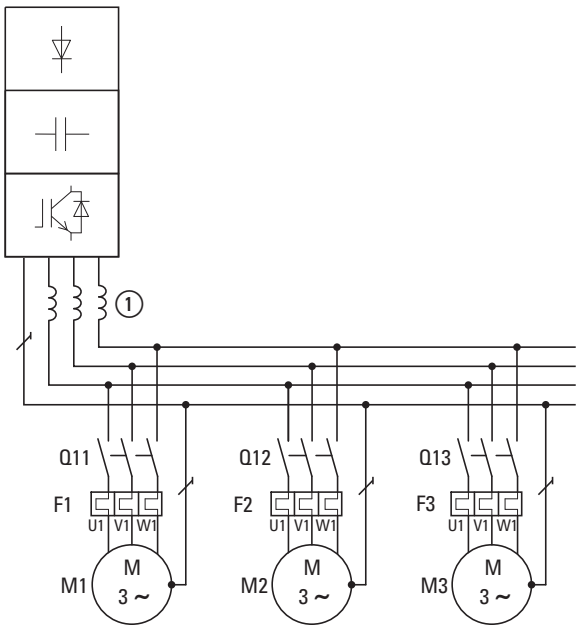


Figure 19. Example: Parallel connection of several motors to one variable speed drive

1. Motor choke (DX-LM3…) or sine filter (DX-SIN3…)

   Q11, Q12, Q13, …: Motor protection (utilization category AC-3)

   F1, F2, F3, …: Overload relay (bimetallic relay or PKE)

Three-phase motors

VSC variable speed drives can be used to drive the following three-phase AC motors with sensorless control:

- Three-phase asynchronous motor (DAM),
- Permanent magnet motor (PM),
- Brushless DC motors (BLDC)
- Synchronous reluctance motor (SynRM).

When used with their default settings, VSC variable speed drives are configured for V/Hz modulation for the rated motor output of a three-phase asynchronous motor, i.e., this is the intended application for "out-of-the-box operation" without configuring any parameters.

Note: Vector mode, as well as running PM, BLDC, or SyncRM motors, will need for parameters P-60 and P-61 on VSC variable speed drives to be configured accordingly.

Motor Selection

Note: Check whether the VSC variable speed drive you selected and the AC motor you will be using are compatible with each other as per the corresponding voltage (mains and motor voltage) and rated operational current.

Note: Configurations such as the ones used in outrunner motors and slip-ring motors also fall under the three-phase asynchronous motor category (which in turn is also referred to as the "squirrel-cage rotor" or "standard motor" category). These motors can also be run with VSC variable speed drives, but will normally require additional engineering, modifying the various parameters, and detailed information from the motor manufacturer.

Note: General recommendations for motor selection:

- Only use motors that have insulation class F (maximum steady state temperature of 155 °C) at least.
- Choose 4 pole motors preferably (synchronous speed: 1500 min^{-1} at 50 Hz and 1800 min^{-1} at 60 Hz).
- Take the operating conditions into account for S1 operation (IEC 60034-1).
- Do not oversize the motor, i.e., the motor should not be more than one rating level higher than the rated motor output.
- In the case of undersized motors, the motor output for continuous operation should not be more than one rating level lower than the rated rating level (in order to ensure that the motor will be protected).
- When running tests or commissioning a system with significantly lower motor outputs, the motor's rated operational current must be adjusted using parameter P-08 ("rated motor current").

Circuit types with three-phase motors

A three-phase motor's stator winding can be connected in a star connection or delta circuit as per the mains voltage (U_{LN} = output voltage U_2) and the rated operational data on the motor's nameplate (rating plate).

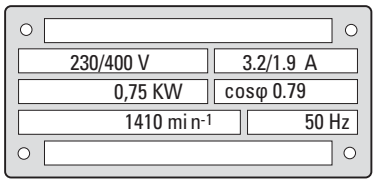


Figure 20. Example of a nameplate (rating plate) for a three-phase asynchronous motor

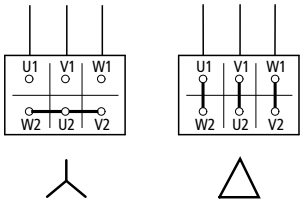


Figure 21. Configuration types: Star-connected circuit (left), Delta circuit (right)

Examples based on figures 20 and 21

Motor in star connection,
mains voltage: three-phase 400 V; output voltage: three-phase 400 V

→ VSC342D2…

Motor in delta circuit,
mains voltage: single-phase 230 V; output voltage: three-phase 230 V

→ VSC124D3…

Table 12. Motor connection

VSC variable speed drive	According to IEC	According to UL
U	U1 (-U2)	T1 (-T4)
V	V1 (-V2)	T2 (-T5)
C0	W1 (-W2)	T3 (-T6)

Permanent magnet motor (PM motor),

PM motors are three-phase motors that are excited by permanent magnets and have a speed that is directly proportional to the supply frequency. Together with a high-pole-count, three-phase stator winding, the permanent magnets on the rotor make it possible to produce large torques at low speeds, which in turn makes it possible to forgo the use of a gearbox in many applications.

By combining high efficiency and good power factor characteristics with a lightweight and compact construction, PM motors make for a compelling choice when compared to asynchronous motors. Accordingly, these high-efficiency motors are primarily found in roller and press drives, agitator and mill drives, drives for extruder screws, and drives used by the crane industry for a variety of applications.

Note: In order to use vector control with permanent magnet motors, the values for parameters P-60, P-61, and P-62 on VSC variable speed drives need to be changed:

- Change the value for P-60 to 2 ("PM motor speed control").
- Change the value for P-61 to 1 ("Motor identification").
  Automatic autotune to determine the motor parameters when the motor is stationary.
- P-62 ("MSC gain"). Adjust the gain factor for the speed controller.

Brushless DC motors (BLDC motors)

Contrary to what their name might seem to imply, brushless DC motors (BLDC, also referred to as "EC motors") do not have the same configuration as a DC motor, but are instead put together the same way as three-phase synchronous motors. The three-phase AC field coil in brushless DC motors generates a rotating magnetic field that pulls the permanently excited rotor along. When using vector control, the rotor position is determined based on the back-EMF generated in the stator's coils. This means that the variable speed drive's output voltage must always be live in all three phases (block voltage control), even when the rotor is stationary. If this condition is met, short current pulses will be generated when the system is stationary – these pulses will not move the motor, but they will have an effect on the rotor's magnetic field.

The control response for BLDC motors is to a large extent the same as that for a shunt DC motor. BLDC motors are primarily used in drive systems for machine tools, servo drives in conveyor systems, and compressors and metering pumps.

Note: In order to use vector control with brushless DC motors, the values for parameters P-60, P-61, and P-62 on VSC variable speed drives need to be changed:

- Change the value for P-60 to 3 ("Brushless DC motor speed control").
- Change the value for P-61 to 1 ("Motor identification").
  Automatic autotune to determine the motor parameters when the motor is stationary.
- P-62 ("MSC gain"). Adjust the gain factor for the speed controller.

Synchronous reluctance motor (SynRM)

Synchronous reluctance motors have the same configuration as a three-phase asynchronous motor. In order to prevent eddy currents, their rotor is made of a soft magnetic material such as electrical steel, and in general terms can have one of two different sheet cross-sections.

In the case of reluctance motors intended to be run as grid-connected systems, the rotor additionally features a rotor cage (similar to that used in asynchronous motors). This cage makes it possible for the motor to start asynchronously on the grid until it synchronizes ("falls into step") to it and is able to follow the rotating field.

In the case of reluctance motors with a rotor that features salient poles with flux directing sections and flux barrier sections, a variable speed drive with sensorless vector control is required (VSC). This combination makes it possible to have a rotor speed that is synchronous with the rotating field and achieve optimum operation even when there are load changes. The losses in the rotor will be practically negligible within this context. Synchronous reluctance motors have better efficiency than conventional asynchronous motors and, in contrast to them, can meet the requirements for the IE4 international efficiency class. Synchronous reluctance motors are primarily used in turbomachinery (rotating equipment) in process engineering, where they are used to drive pumps, fans, compressors, and turbines, as well as mixers, centrifuges, and conveyor systems.

Note: In order to use vector control with synchronous reluctance motors, the values for parameters P-60, P-61, and P-62 on VSC variable speed drives need to be changed:

- Change the value for P-60 to 4 ("SyncRel motor speed control").
- Change the value for P-61 to 1 ("Motor identification").
  Automatic autotune to determine the motor parameters when the motor is stationary.
- P-62 ("MSC gain"). Adjust the gain factor for the speed controller.

Single-phase AC motors

It is strictly prohibited to use the VSC variable speed drives described in this manual to run single-phase AC motors (induction motors), single-phase asynchronous motors (capacitor motors), shaded-pole motors, etc.

There are other VSC variable speed drive models designed for use with these motors: VSCS1… and VSCS2… with IP20 and IP66 degrees of protection.

Note: For more information on how to run single-phase AC motors using the VSC variable speed drive, please refer to Application Note, "VSC Variable Speed Drives – Operating Single Phase Motors".

Connecting EX motors

The following aspects must be taken into account when connecting hazardous location motors:

- A VSC variable speed drive can be installed in an explosion-proof enclosure within the hazardous location or in a control panel outside the hazardous location.
- All applicable industry-specific and country-specific regulations for hazardous locations (ATEX 100a) must be complied with.
- The specifications and instructions provided by the motor's manufacturer with regard to operation with a variable speed drive—i.e., whether motor reactors (dV/dt limiting) or sine filters are required—must be taken into account.
- Temperature sensors in the motor windings (thermistor, Thermo-Click) must not be connected directly to the variable speed drive, but instead must be connected through a relay approved for the hazardous location (i.e., EMT6).

Installation

Introduction

This chapter provides a description of the installation and the electrical connections for the variable speed drive DC 1 series.

Note: While installing and/or assembling the variable speed drive, cover all ventilation slots in order to ensure that no foreign bodies can enter the device.

Note: Perform all installation work with the specified tools and without the use of excessive force.

Note: For more information on how to install VSC variable speed drives with the various available degrees of protection and frame sizes, please refer to the instruction leaflets.

Mounting position

VSC variable speed drives have a conformal coating on their printed circuit boards (coated boards) that provides enhanced protection from moisture and soiling.

VSC variable speed drives are available with two enclosure versions:

- IP20/NEMA 0 degree of protection: for use in control panels.
- IP66/NEMA 4X protection type: This enclosure version protects against moisture and dust and is designed for use in harsh conditions.

Without the required additional measures, using the device in the following environments is strictly prohibited:

- Explosion-proof Ranges
- Environments with damaging substances:
  - Oils and acids
  - Gases and fumes
  - Dust
  - Radiated noise
- Environments with mechanical vibration and impact loads that go beyond the requirements in EN 50178.
- Areas in which the variable speed drive takes care of safety functions that must guarantee machine and personnel protection.

Mounting

The engineering instructions in this section are meant to show how to install the device in a suitable enclosure for devices with degree of protection IP20 in compliance with standard EN 60529 and/or any other applicable local regulations.

- The enclosures must be made of a material with high thermal conductivity.
- If a control panel with ventilation openings is used, the openings must be located above and below the variable speed drive in order to allow for proper air circulation. Air should be delivered from the bottom and conveyed outwards through the top.
- If the environment outside the control panel contains dirt particles (i.e., dust), a suitable particle filter must be placed on the ventilation openings and forced ventilation must be used.The filters must be maintained and cleaned if necessary.
- An appropriate enclosed control panel (without ventilation openings) must be used in environments containing large percentages or amounts of humidity, salt, or chemicals.

Note: Install the VSC variable speed drive only on a nonflammable mounting base (i.e., on a metal plate).

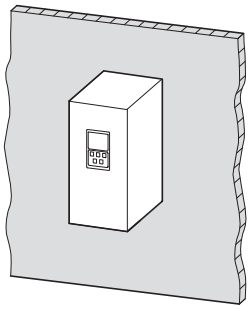


Figure 22. Surface mounting on metal plate

IP66 VSC variable speed drives must be installed as required by the local conditions for this degree of protection.

Mounting position

VSC series variable speed drives are designed to be mounted vertically. The maximum permissible inclination is 30°.

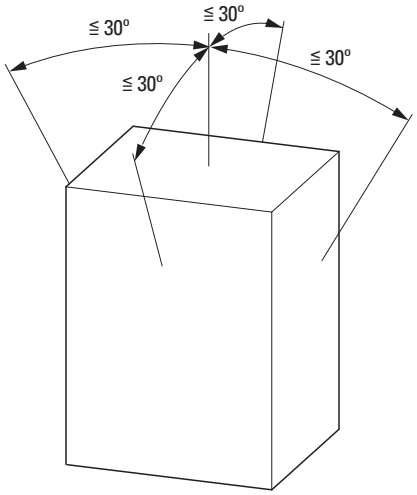


Figure 23. Mounting position

Cooling measures

To ensure that there is sufficient air circulation, appropriate thermal clearances must be maintained, with these clearances depending on the size of the specific variable speed drive.

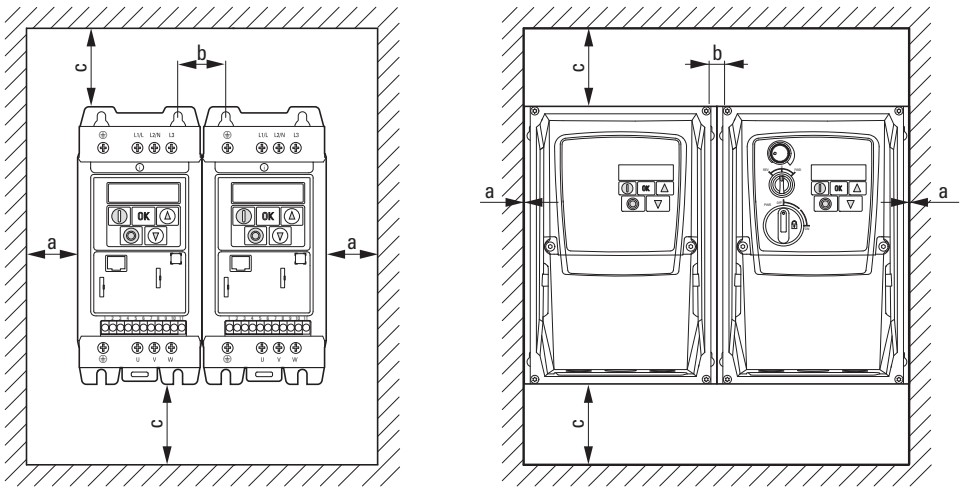


Figure 24. Clearances for air cooling (left: IP20; right: IP66)

Note: The variable speed drives can be mounted side by side without any lateral clearance between them.

When variable speed drives with internal fans are installed vertically over each other, an air baffle must be placed between the devices. Failure to do so may expose the device on top to a thermal overload caused by the guided air flow (device fan).

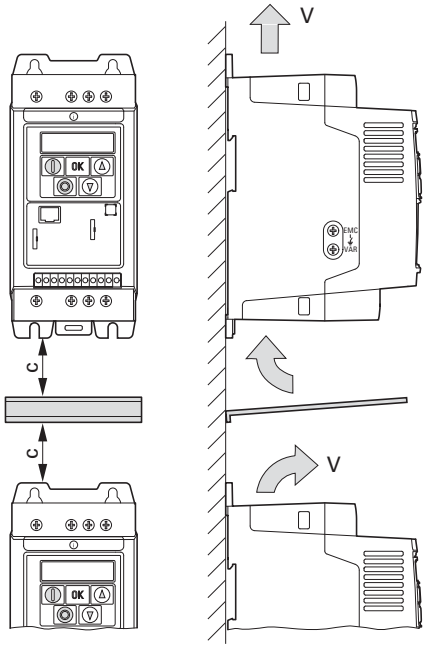


Figure 25. Deflector due to increased circulation caused by device fan

Note: Devices with high magnetic fields (i.e., reactors or transformers) should not be installed close to the variable speed drive.

Table 13. Recommended values for minimum clearances and required cooling air (see fig. 24, 25)

	a		b		c		Airflow ①	
Size	**mm**	**in**	**mm**	**in**	**mm**	**in**	**m^3/h**	**ft^3/min**
For degree of protection IP20								
FS1	50	1.97	33	1.3	50	1.97	18.69	11
FS2	50	1.97	46	1.81	75	2.95	37.38	22
FS3 ②	50	1.97	52	2.05	100	3.94	101.94	60
FS4	50	1.97	52	2.05	100	3.94	203.88	120
For degree of protection IP66								
FS1	10	0.39	12.5	0.49	200	7.87	—	—
FS2	10	0.39	12.0	0.47	200	7.87	—	—
FS3 ②	10	0.39	13.0	0.51	200	7.87	—	—

Notes

① ft^3/min = CFM (cubic foot per minute)

② For UL conformity, the maximum permissible ambient air temperature over a period of 24 hours is limited to +45 °C for the VSC127D0…, VSC32011…, and VSC32018… variable speed drives.

The values specified in **Table 13** are recommended values for an ambient temperature of up to +50 °C with an IP20 degree of protection or +40 °C with an IP66 degree of protection, an installation altitude of up to 1000 m, and a switching frequency of up to 8 kHz.

Note: Typical heat loss makes up about 3% of the operational load conditions.

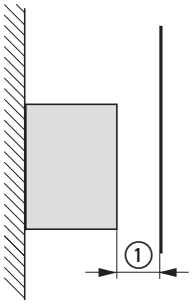


Figure 26. Minimum required clearance ① in front of the variable speed drive when installed in an enclosure (control panel)

Size with IP20 degree of protection	Minimum clearance ①
FS1, …, FS4	≥ 15 mm (≥ 0.59 inch)
FS1, …, FS4 with DX-NET-ETHERNET2-2	≥ 50 mm (≥ 1.97 inch)

Fixing

All VSC variable speed drive frame sizes can be mounted with screws. Moreover, frame sizes FS1 to FS3 with an IP20 degree of protection can be mounted on a mounting rail as well.

Note: Dimension and weight specifications for the VSC variable speed drive can be found in the "Dimensions" on **Page 129**.

Fixing with screws

Note: Use screws with a washer and split washer with the permissible tightening torque in order to protect the enclosure and safely and reliably mount the device.

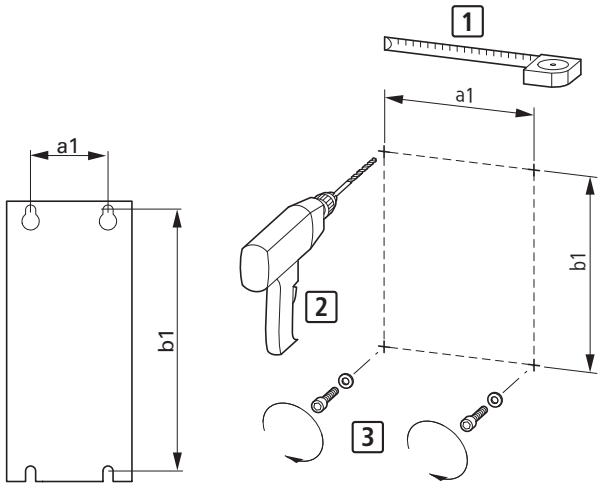


Figure 27. Mounting dimensions

First fit the screws at the specified positions, mount the variable speed drive and then fully tighten all screws.

Table 14. Installation dimensions, screws, tightening torques

Size	Degree of protection		a1		b1		Screw		Tightening torque	
FS	IP	NEMA	mm	in	mm	in	Quantity	Size	N/m	lb-in
FS1	IP20	NEMA 0	50	1.97	170	6.69	4	M4	1	8.85
FS1	IP66_x	NEMA 4X	184.5	5.85	189	7.44	4	M4	1.2–1.5	10.62–13.27
FS2	IP20	NEMA 0	75	2.95	215	8.46	4	M4	1	8.85
FS2	IP66_x	NEMA 4X	176	6.93	200	7.87	4	M4	1.2–1.5	10.62–13.27
FS3	IP20	NEMA 0	100	3.94	255	10.04	4	M4	1	8.85
FS3	IP66_x	NEMA 4X	198	7.78	252	9.9	4	M4	1.2–1.5	10.62–13.27
FS4	IP20	NEMA 0	125	4.92	400	15.75	4	M6	4	35.4

Note

① 1 in = 1" = 25.4 mm; 1 mm = 0.0394 in.

Fixing on a mounting rail

As an alternative to screw fixing, VSC variable speed drives with sizes FS1, FS2 and FS3 and a degree of protection of IP20 can also be mounted on a mounting rail as per IEC/EN 60715.

Note: If you use EMC mounting adapters (DX-EMC-MNT-…), use a tall mounting rail (15 mm) preferably.

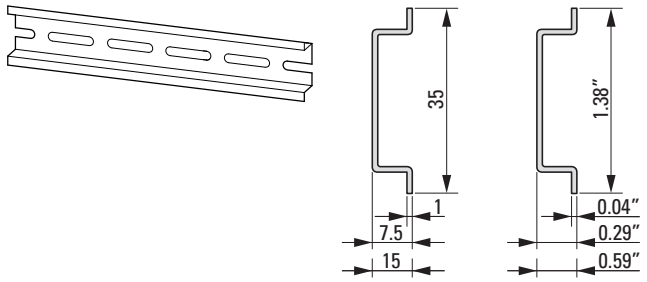


Figure 28. Mounting rail conforming with IEC/EN 60715

Note: If you use EMC mounting adapters (DX-EMC-MNT-…), use a tall mounting rail (15 mm) preferably.

To do this, place the variable speed drive on the mounting rail from above [1] and press it down until it snaps into place [2].

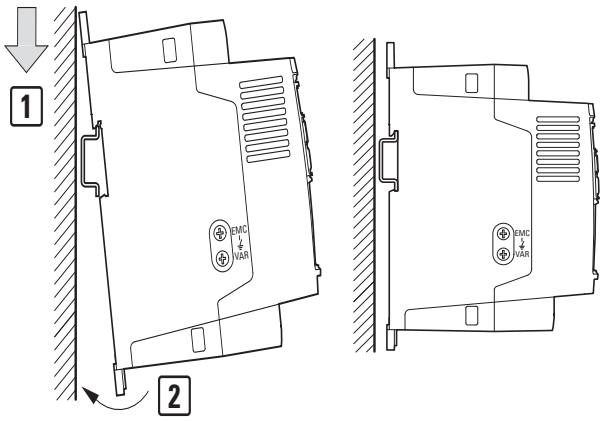


Figure 29. Fixing on a mounting rail

Dismantling from mounting rails

To remove the device, push down the spring-loaded clip. A cutout marked on the lower edge of the device is provided for this purpose. A flat-bladed screwdriver (blade width 5 mm) is recommended for pushing down the clip.

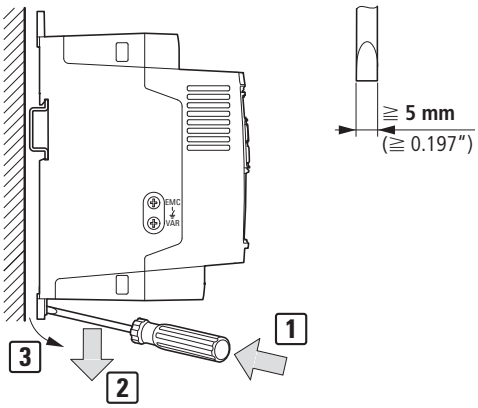


Figure 30. Dismantling from mounting rails

IP66 / NEMA4X degree of protection

IP66 VSC variable speed drives are available in two versions:

- VSC…A66N: Activation via control signal terminals
- VSC…A6SN: Controlled with controls on the front and/or control signal terminals

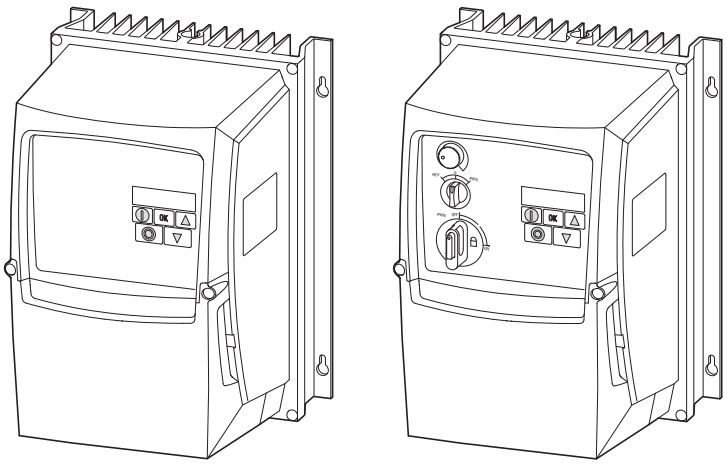


Figure 31. IP66 variants

The units must be mounted, with four screws and in a vertical position, on a wall or panel that is made of nonflammable material and is stable enough to hold the variable speed drive's weight.

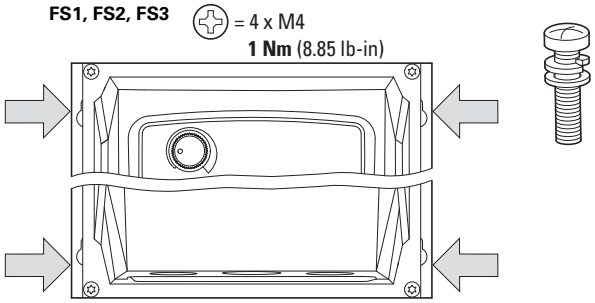


Figure 32. Openings for fixing screws

On the VSC…A6SN version, the main disconnect switch can be locked in the OFF position with a standard padlock.

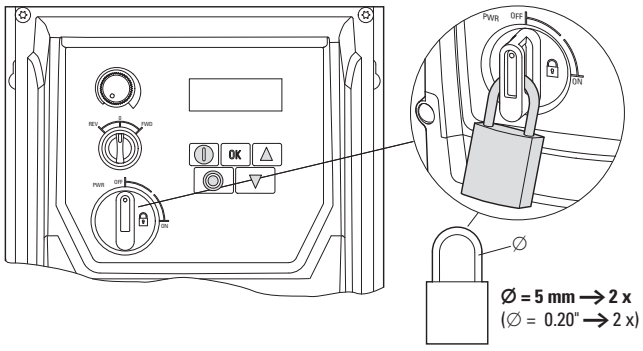


Figure 33. VSC…A6SN with padlock

Push on the center of the switch in order to open the opening for the padlock.

EMC installation

The responsibility to comply with the legally stipulated limit values and thus the provision of electromagnetic compatibility is the responsibility of the end user or system operator. This operator must also take measures to minimize or remove emission in the environment concerned. He must also utilize means to increase the interference immunity of the devices of the system.

Note: In a magnet system (PDS) with variable speed drives, you should take measures for electromagnetic compatibility (EMC) while doing your engineering, since changes or improvements to the installation site, which are required in the installation or while mounting, are normally associated with additional higher costs as well.

The technology and system of a variable speed drive cause the flow of high frequency leakage current during operation. Because of this, all earthing elements must be low-impedance elements connected in such a way as to establish an electrical contact across a large surface area.

With leakage currents greater than 3.5 mA, in accordance with VDE 0160 or EN 60335, either

- the cable cross-section of the protective conductor must be ≥ 10 mm^2,
- the protective conductor must be open-circuit monitored, or
- the second protective conductor must be fitted.

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

- installation of the variable speed drive in a metallically conductive housing
  with a good connection to ground,
- screened motor cables (short cables).

Note: Ground all conductive components and housings in a drive system using as short a line as possible with the greatest possible cross-section (Cu-braid).

EMC measures in the control panel

In order to have an installation that meets EMC requirements, make sure to connect all the metallic parts in the devices and in the control panel to each other across a large area and in a way that will make it possible to conduct high frequencies. Mounting plates and control panel doors should be connected to the panel by means of short drain wires with an electrical contact established across a large surface area.

- Do not make connections to painted surfaces (electrolytic oxidation, yellow chromated).
- Install the variable speed drive as directly as possible (without spacers) on a metal plate (mounting plate).
- Route mains and motor cables in the control cabinet as close to the ground potential as possible. This is because free moving cables act as antennas.
- If routed in parallel, cables carrying high frequencies (i.e., screened motor cables) and clean cables (i.e., mains supply cable, control and signal cables) should be installed at a distance of at least 100 mm from each other in order to avoid electromagnetic interference. You should also use separate cable entries if there is a great difference in voltage potentials. If control cables and power cables need to cross, they should always do so at a right angle (90°).

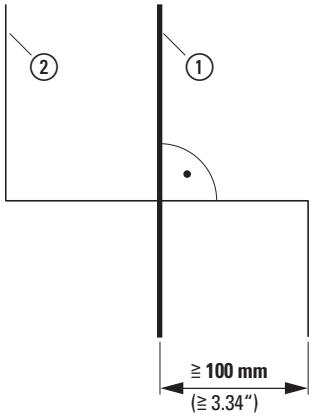


Figure 34. Cable routing

Note: Do not route the control and signal cables ② in the same conduit as the power cables ①.

Analog signal cables (measured values, setpoints, and correction values) must be routed inside screened conduit.

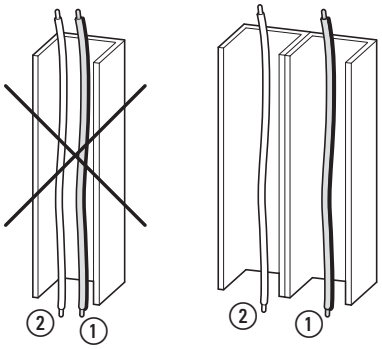


Figure 35. Separate routing

① Power cable: mains voltage, motor connection
② Control and signal lines, fieldbus connections

Earthing

The protective earth (PE) in the control panel should be connected from the mains supply to a central earth point (mounting plate, system earth). The PE conductor's cross-sectional area must be at least as large as that of the incoming mains supply cable. If there are leakage currents greater than 3.5 mA, the PE conductor must have a minimum cross-sectional area of 10 mm^2.

Every variable speed drive must be individually connected to the power supply system's protective earth directly at the location of installation (system earthing). This protective earth must not pass through any other devices.

All protective conductors should be routed in a star topology starting from the central earth point, and all of the magnet system's conductive components (i.e., variable speed drive, sine filter) should be connected.

The earth-fault loop impedance must comply with all locally applicable industrial safety regulations. In order to meet UL requirements, UL-listed ring cable lugs must be used for all earth wiring connections.

Note: Avoid ground loops when installing multiple variable speed drives in one control panel. Make sure that all metallic devices that are to be grounded have a broad area connection with the mounting plate.

Protective earth

This refers to the legally required protective earth for a variable speed drive. An earthing terminal on the variable speed drive, or the system earth, must be connected to a neighboring steel element in the building (beam, ceiling joist), an earth electrode in the ground, or a mains earth bus. The earth points must meet the requirements set forth by the applicable national and local industrial safety regulations and/or regulations for electrical systems.

Motor earthing

The motor earthing must be connected to one of the earthing terminals on the variable speed drive, as well as to the central earth point on the power drive system (PDS). Earth connections to a neighboring steel element in the building (i.e., beam, ceiling joist), a ground rod in the ground, or a mains earth bus must meet the requirements set forth in the applicable national and regional industrial safety regulations and/or regulations for electrical systems.

Earth-fault protection

A fault current to earth can be produced by variable speed drives due to their system characteristics. VSC series variable speed drives have been designed in such a way that the smallest possible fault current will be produced in compliance with standards applicable worldwide. In the case of devices powered with a three-phase supply (VSC3…), this fault current must be monitored by an AC/DC-sensitive type B residual current device (RCD).

Internal filters (EMC and VAR screws)

FS1 to FS3 VSC variable speed drives with an IP20 degree of protection feature two screws on the left side that are labeled EMC and VAR.

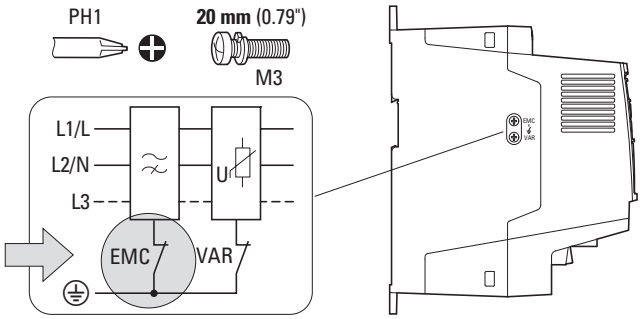


Figure 36. EMC and VAR screw

In the case of units with a frame size of FS4, there will be two screws labeled EMC: one next to the main terminals and another one next to the motor terminals.

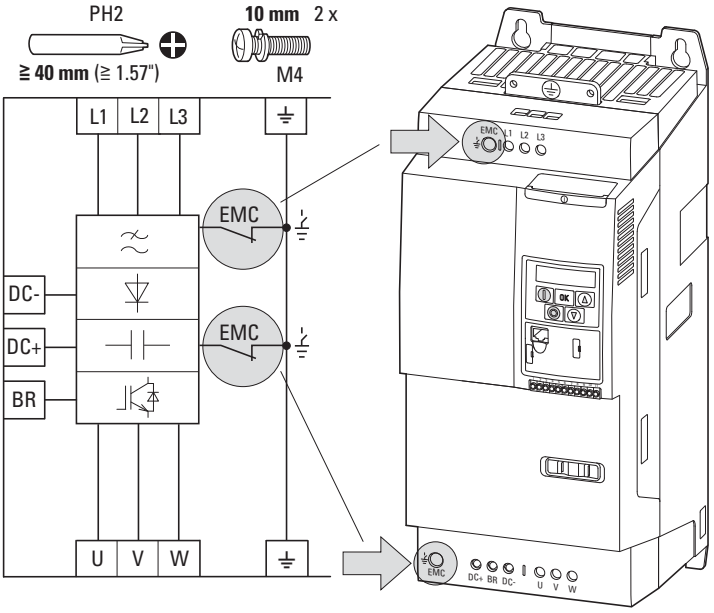


Figure 37. Two EMC screws on devices with a frame size of FS4

EMC screw

Notice

The screw labeled EMC must not be manipulated as long as the variable speed drive is connected to the mains or there is a DC link voltage.

Note: The EMC screw galvanically connects the EMC filter's mains-side capacitors to the earthing (PE). The screw must be screwed in all the way to the stop (factory setting) in order for the variable speed drive to comply with EMC standards.

In the case of units with a frame size of FS4, the DC link filter (Y class capacitors) is galvanically connected to the earthing (PE) via the two EMC screws (motor connection side).

Notice

In the case of units with a frame size of FS4, both EMC screws must be either installed or removed, i.e., it is not permissible for one of them to remain installed while the other one is removed.

Due to their system characteristics, variable speed drives with an internal EMC filter will produce a larger fault current to earth than devices without a filter. For applications in which this larger leakage current may cause malfunction messages or disconnections (residual current device), the EMC filter's internal protective earth can be disconnected (remove the EMC screw to do this).

Local EMC regulations must be taken into account when doing so. If necessary, a specific low-leakage-current EMC filter (DX-EMC...-L) must be connected upstream.
In connections to isolated power sources (IT networks), the EMC and VAR screw should be removed. The earth fault monitors required for IT networks must be suitable for operation with power electronic devices (IEC 61557-8).

VAR screw

VSC variable speed drives with a frame size of FS1 to FS3 and an IP20 degree of protection are equipped with an overvoltage filter for the input supply voltage. This overvoltage filter is designed to protect the devices from noise pulses and high voltage magnitudes in the mains voltage. Pulse spikes are typically caused by lightning strikes or by switching operations in other high-power devices on the same supply.

If high potential tests are performed on a system, these overvoltage protection components may cause the system to fail the test. In order to make it possible to perform this type of hipot tests, the overvoltage protection components can be disconnected by removing the VAR screw. The screw must be screwed back in after the high potential tests are performed and the test must then be repeated. The system must then fail the test, indicating that the overvoltage protection components have been reconnected.

Note: The screw labeled VAR (**Figure 36** on **Page 47**) must not be manipulated as long as the variable speed drive is connected to the mains or there is a DC link voltage.

Screen earth kit

Cables that are not screened work like antennas (sending, receiving).

Note: For a proper EMC connection, cables emitting interference (i.e., motor cables) and susceptible cables (analog signal and measured values) must be screened and laid separately from each other.

The effectiveness of the cable screen depends on a good screen connection and a low screen impedance.

Note: Use only screens with tinned or nickel-plated copper braiding. Screens made of steel braids or metal conduits are either not suitable or suitable only to a limited extent (depending on the EMC environment).

Note: Control and signal lines (analog, digital) should always be grounded on one end, in the immediate vicinity of the supply voltage source (PES).

EMC cable brackets

Frame-size-specific DX-EMC-MNT-… cable brackets can be used to easily route and secure cables in the connection area of a VSC variable speed drive with a frame size of FS1 to FS3 and an IP20 degree of protection. These cable brackets are mounted on the variable speed drive's mains connection side (DX-EMC-MNT-…**N**) and motor side (DX-EMC-MNT-…**M**) using the corresponding mounting holes, and are then connected to the drive's earthing.

The cable brackets' integrated hole pattern (M4 screw tread) makes it possible to secure the cables being connected and relieve any strain on them by using the corresponding gland plates. It also makes it possible to have a good 360° EMC connection (PES) in the case of screened cables.

These cable brackets are made of galvanized sheet steel.

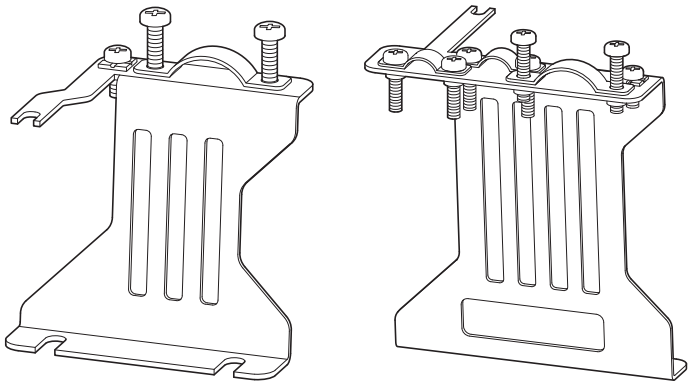


Figure 38. DX-EMC-MNT-...N (left), net and DX-EMC-MNT-...M (right), motor, cable brackets

Table 15. Cable brackets

Cable bracket	Size VSC in IP20	Gland plates	
		Quantity	Designation
DX-EMC-MNT-1N	FS1	1	Mains connection
DX-EMC-MNT-1M	FS1	2	Control cables, motor connection
DX-EMC-MNT-2N	FS2	1	Mains connection
DX-EMC-MNT-2M	FS2	3	Control cables, motor connection, external braking resistance
DX-EMC-MNT-3N	FS3	1	Mains connection
DX-EMC-MNT-3M	FS3	3	Control cables, motor connection, external braking resistance

Note: We recommend connecting the DX-EMC-MNT-… cable brackets to the variable speed drive before installing it.

Note: DX-EMC-MNT-… EMC cable brackets are sold as individual units. There are different brackets for each VSC variable speed drive size (FS1 to FS3).

Note: The gland plates and their fixing screws are included in the equipment supplied with the cable brackets.

Connection example

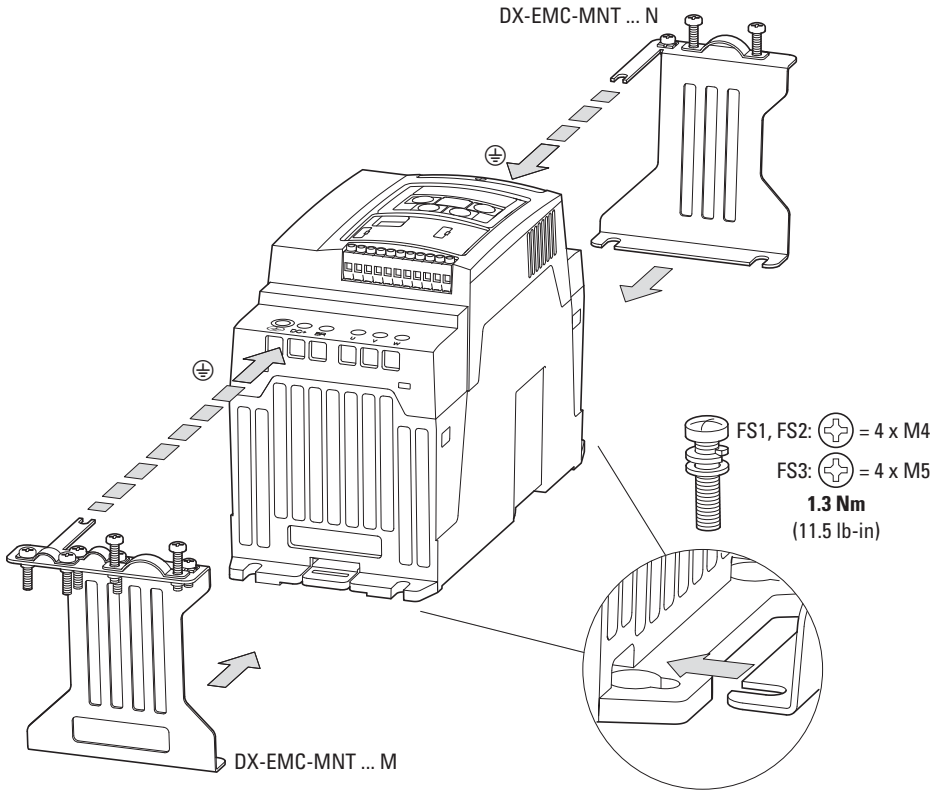


Figure 39. EMC cable brackets (example: FS2 frame size)

General installation diagram

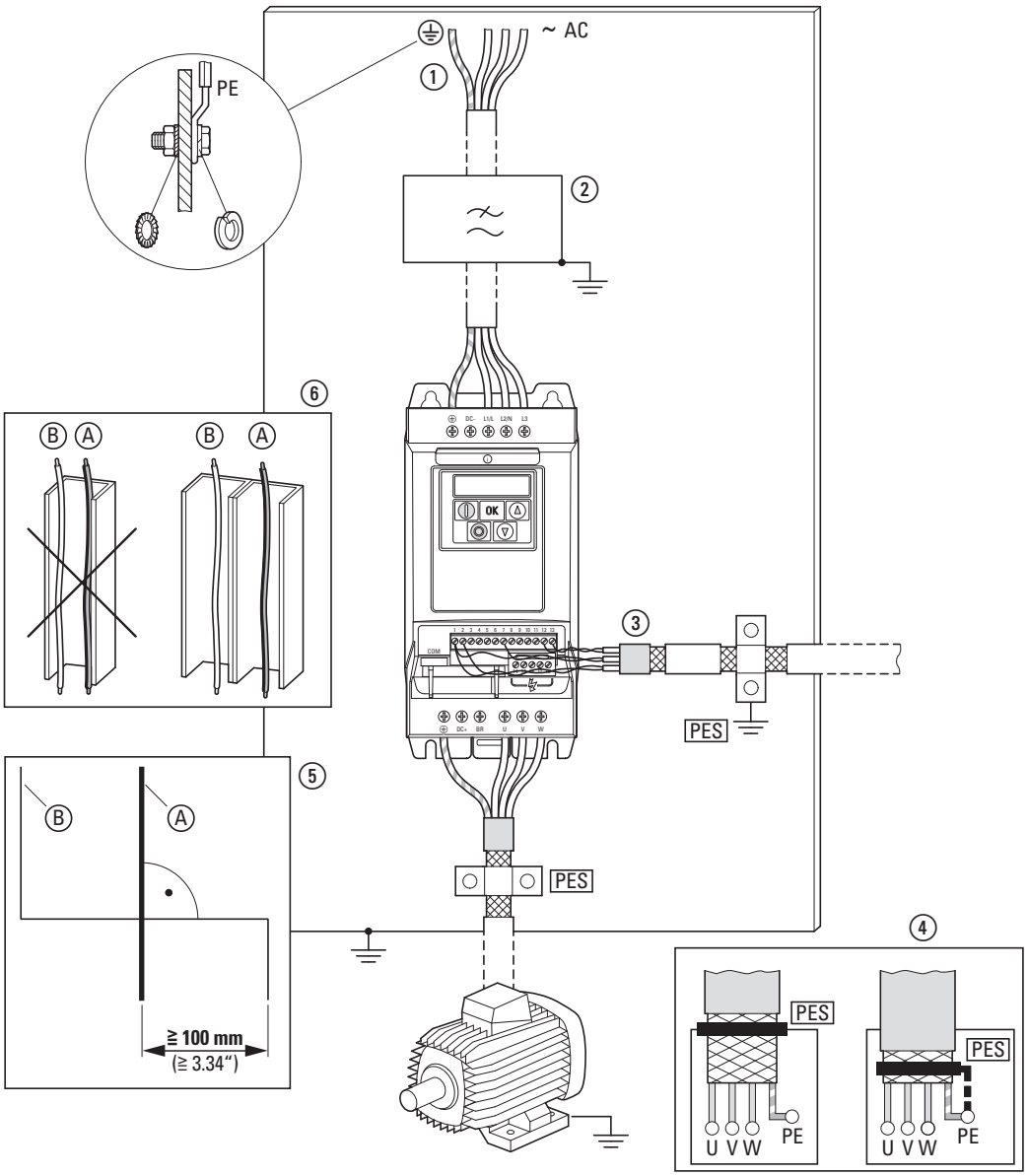


Figure 40. EMC installation

① Mains connection: Supply voltage, central earthing connection for control panel and machine

② External radio interference suppression filter: Optional DX-EMC… radio interference suppression filter for longer motor cables or use in a different EMC environment

③ Control connection: Connection for the digital and analog control cables and communication via RJ45 plug-in connection

④ Motor connection: Connection (PES) between the screened motor cable and the motor's terminal box, made according to EMC requirements, with metal cable gland or with gland plate in the terminal box.

⑤ Cable routing: Power cables (A) and control cables (B) spatially routed separately from each other. If different potential levels need to cross, they should do so at a right angle as far as possible.

⑥ Cable routing: Do not route power cables and control cables parallel to each other in a single cable duct. If they need to be routed in parallel, they should be in separate metal cable ducts (in order to meet EMC requirements).

Electrical Installation

⚠ CAUTION

Carry out wiring work only after the variable speed drive has been correctly mounted and secured.

⚠ DANGER

Electric shock hazard–risk of injuries!

Carry out wiring work only if the unit is de-energized.

Notice

Fire hazard!

Only use cables, circuit-breakers, and contactors that feature the indicated permissible nominal current value.

Notice

On VSC variable speed drives, earth leakage currents can be greater than 3.5 mA (AC). Accordingly, as per IEC/EN 61800-5-1, an additional protective conductor must be connected or the protective conductor's cross-sectional area must be at least 10 mm^2.

⚠ DANGER

The components in the variable speed drive's power section remain energized up to five (5) minutes after the supply voltage has been switched off (intermediate circuit capacitor discharging time).

Pay attention to hazard warnings!

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

Connection to power section

The connection to the power section is normally made via the connection terminals:

- L1/L, L2/N, L3, PE for the mains-side supply voltage. The phase sequence does not matter.
- DC+, DC-, PE for DC link coupling or if the device is being supplied with DC voltage
- U, V, W, PE for the connection to the motor
- BR, DC+, PE for an external brake resistor

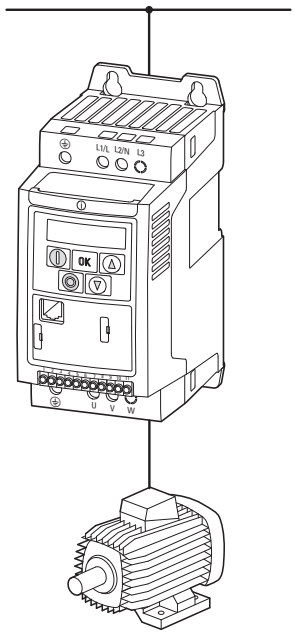


Figure 41. Connection in power section (schematic)

The number and the arrangement of the connection terminals used depend on the variable speed drive's size and model.

Notice

The variable speed drive must always be connected with ground potential via a grounding conductor (PE).

Terminals in power section for units with IP20 degree of protection

Table 16. Terminals (IP20)

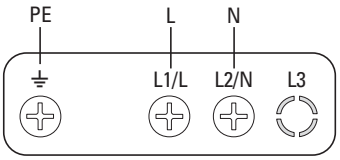
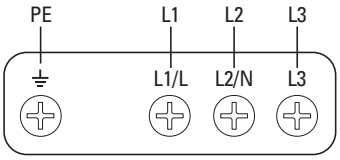
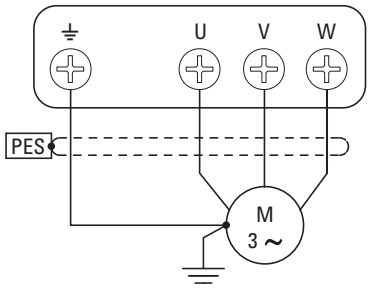
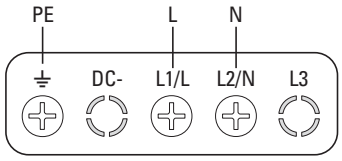
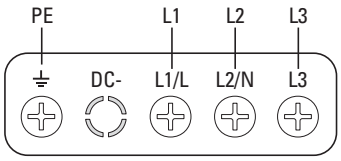
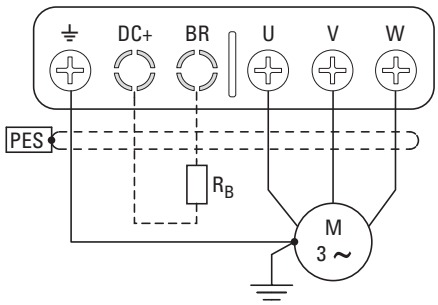
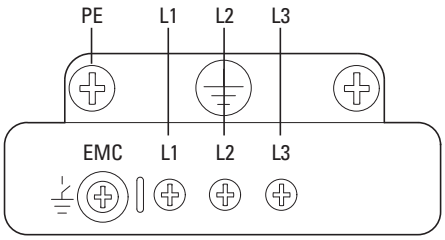
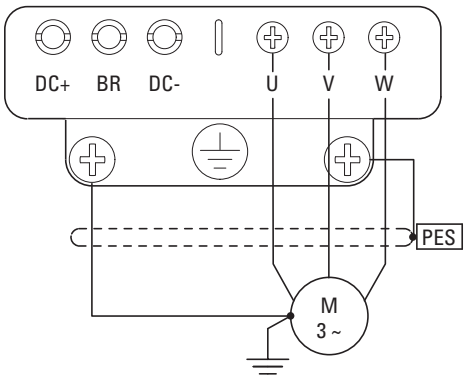
Size	Connection terminals	Description
FS1		Connection with single-phase supply voltage: • VSC1D… (115 V) • VSC12… (230 V) **Note:** Connection to terminal L3 not permissible!
		Connection with three-phase supply voltage: • VSC32… (230 V) • VSC34… (400 V, 480 V)
		Motor connection for three-phase motors: • VSC1D… (230 V) • VSC12… (230 V) • VSC32… (230 V) • VSC34… (400 V, 460 V)

Table 16. Terminals (IP20), continued

Size	Connection terminals	Description
FS2, FS3		Connection with single-phase supply voltage (115 V, 230 V): • VSC1D… (115 V) • VSC12… (230 V) **Note:** Connection to terminal L3 not permissible! **DC-**: Negative DC link connection if using an external DC power supply or DC link coupling. The terminal's plastic cover can be removed if necessary.
		Connection with three-phase supply voltage: • VSC32… (230 V) • VSC34… (400 V, 480 V) **Note: DC-**: Negative DC link connection if using an external DC power supply or DC link coupling. The terminal's plastic cover can be removed if necessary.
		Motor connection for three-phase motors: • VSC1D… (230 V) • VSC12… (230 V) • VSC32… (230 V) • VSC34… (400 V, 460 V) **Note: DC+**: Positive DC link connection if using an external DC power supply, DC link coupling, or braking chopper. The terminal's plastic cover can be removed if necessary. **BR**: Terminal for brake resistor (braking chopper output). The terminal's plastic cover can be removed if necessary.
FS4		Connection with three-phase supply voltage: • VSC32… (230 V) • VSC34… (400 V, 480 V)
		Motor connection for three-phase motors: • VSC32… (230 V) • VSC34… (400 V, 480 V) **Note: DC+, DC-**: DC link connection if using an external DC power supply or DC link coupling. The terminals' plastic cover can be removed if necessary. **DC+, BR**: Connection for external brake resistors (BR = braking chopper output). The terminals' plastic cover can be removed if necessary.

Terminals in power section for units with IP66 degree of protection

On units with an IP66 degree of protection, the connection area is located behind the lower enclosure cover.

To open the cover, release the two latches by turning them counterclockwise (90 degrees) so that they are in a vertical position [1]. Once the latches are released, you can lift the cover off [2].

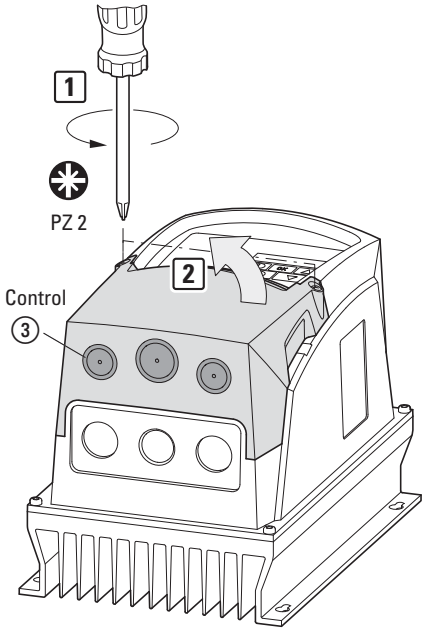


Figure 42. Removing the lower housing cover

Table 17. Terminals (IP66)

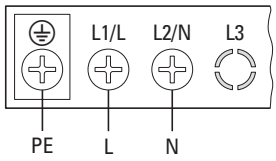
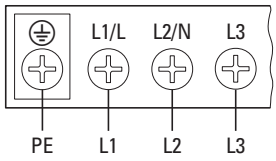
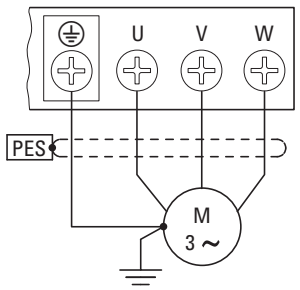
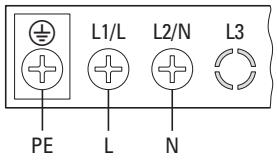
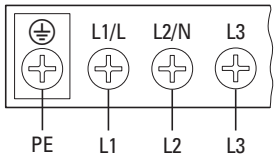
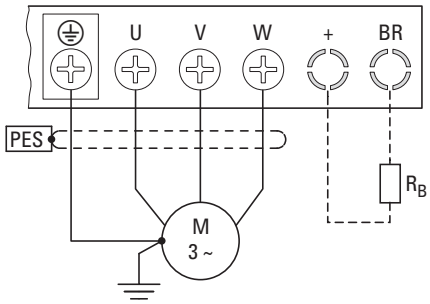
Size	Connection terminals	Description
FS1		Connection with single-phase supply voltage: • VSC1D… (115 V) • VSC12… (230 V) **Note:** Connection to terminal L3 not permissible!
		Connection with three-phase supply voltage: • VSC32… (230 V) • VSC34… (400 V, 480 V)
		Motor connection for three-phase motors: • VSC1D… (230 V) • VSC12… (230 V) • VSC32… (230 V) • VSC34… (400 V, 460 V)

Table 17. Terminals (IP66), continued

Size	Connection terminals	Description
FS2, FS3		Connection with single-phase supply voltage (115 V, 230 V): • VSC1D… (115 V) • VSC12… (230 V) **Note:** Connection to terminal L3 not permissible!
		Connection with three-phase supply voltage: • VSC32… (230 V) • VSC34… (400 V, 480 V)
		Motor connection for three-phase motors: • VSC1D… (230 V) • VSC12… (230 V) • VSC32… (230 V) • VSC34… (400 V, 460 V) **Note: +, BR**: Connection for external brake resistors (**BR** = Output Brake Chopper). The terminals' plastic cover can be removed if necessary. Terminal **+** has the same function as terminal **DC+** in devices with an IP20 degree of protection.

Stripping lengths and tightening torques

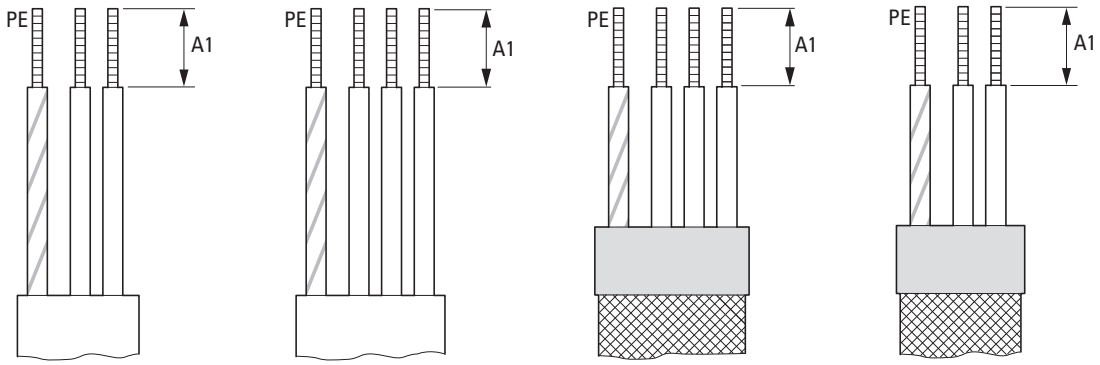


Figure 43. Stripping lengths in the power section

Mains = Electrical power network (supply voltage)

Motor = Motor connection

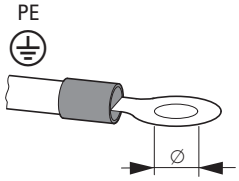
DC link = Internal DC link (DC link coupling)

Brake Resistor = Braking resistance (connection to brake chopper)

Table 18. Terminal capacities and tightening torques

	A1		Maximum terminal capacity		Tightening torque	
Size	**mm**	**in**	**mm²**	**AWG**	**N/m**	**lb-in**
FS1	8	0.3	8	8	1	8.85
FS2	10	0.39	8	8	1	8.85
FS3	10	0.39	8	8	1	8.85
FS4	10–11	0.39–0.43	16	5	2.1	19

PE connection: Ring terminal with a diameter of 0.25 in (6.3 mm)



Connecting the motor cable

The screened cables between the variable speed drive and the motor should be as short as possible.

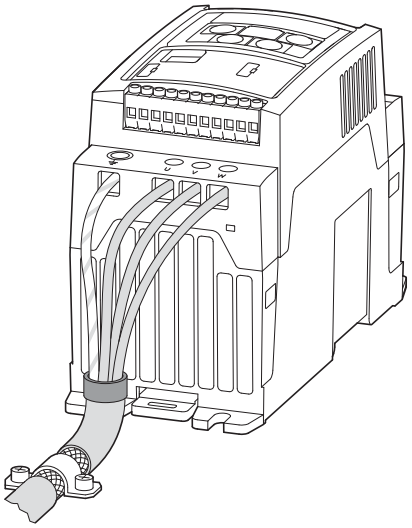


Figure 44. Connection on motor side

- Connect the screening, on both sides and across a large area (360° overlap), to the protective earth (PE) ⏚.The power screening's protective earth (PES) connection should be in the immediate proximity of the variable speed drive.and directly on the motor terminal box.
- Prevent the screen earth kit from becoming unbraided, i.e., by pushing the separated plastic covering over the end of the shielding or with a rubber grommet on the end of the shielding. Terminate the cable screen across a large area at the end (PES). Alternatively, you can twist the screen braid and connect it to the protective earth with a cable lug. In order to prevent EMC interference, this twisted screen connection should be as short as possible (recommended value for the twisted cable screen: $b \geq 1/5\ a$).

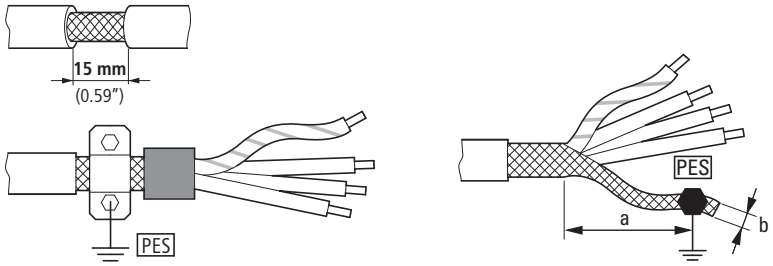


Figure 45. Screened connection cable in motor circuit

Screened, four-wire cable is recommended for the motor cables. The green-yellow conductor in these cables must be used to connect the motor's and variable speed drive's PE terminals, minimizing the loads on the cable screen (high equalizing currents).

The following figure shows the construction of a four-wire, screened motor line (recommended specifications).

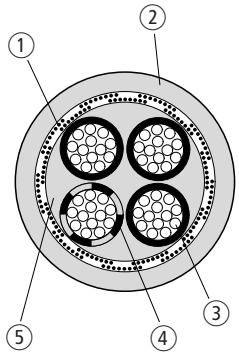


Figure 46. Four-core, screened motor supply cable

① Cu shield braid
② PVC outer casing
③ Flexible wire (copper strands)
④ PVC core insulation, 3 x black, 1 x green–yellow
⑤ Textile and PVC fillers

If there are additional subassemblies in a motor feeder (such as motor contactors, overload relays, motor chokes, sine filters or terminals), the shielding of the motor cable can be interrupted close to these subassemblies and connected to the mounting plate (PES) with a large area connection. Free or non-shielded connection cables should not be any longer than about 300 mm (max. 500 mm).

Note: In the case of units with a frame size of FS1, FS2, or FS3, the screened motor cable can also be connected using an EMC cable bracket (DX-EMC-MNT…M) refer to **Page 49**.

Cable glands IP66

In the case of units with an IP66 degree of protection, a total of six cable glands can be installed. The lower section will come with two knockouts for cable glands that have already been removed and that are intended for the connections in the power section (Mains ①, Motor ②). Meanwhile, the center knockout in the lower section, which will not yet have been removed, is intended for an external brake resistor. In addition, the upper enclosure cover will feature three additional knockouts for routing control and bus cables. If necessary, the corresponding plastic covers can be removed (Control ③).

Note: Make sure not to damage any terminal box parts on the inside when breaking through the plastic covers.

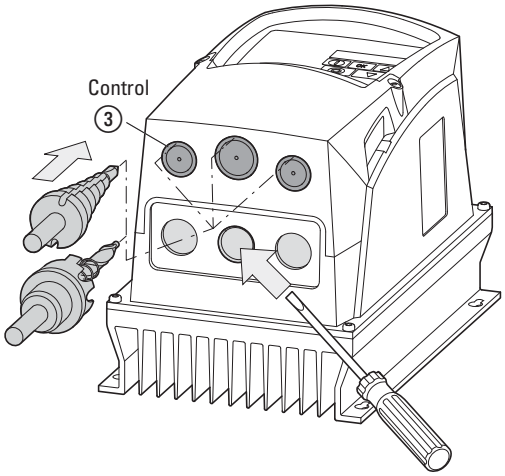


Figure 47. Punching out the knockouts (Example)

Insert a plastic gland into the knockout on the left—which could already have been punched out at the factory—in order to thread in the power supply cord. Due to EMC reasons, you should use an metallic EMC cable gland in the knockout on the right in order to connect the motor cable screen across a large area and ground it.

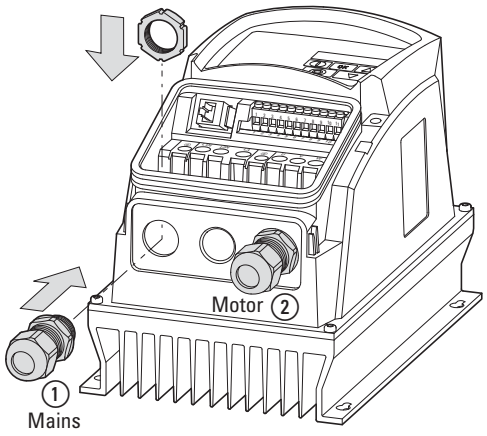


Figure 48. Installing the cable glands

Note: Make sure that the cable glands have at least an IP66 degree of protection.

Table 19. Cable glands that can be used (figures 47, 48)

Range	Size	Hole size	PG-gland	Metric gland
Control section	FS1	2 x 22 mm	2 x PG 13.5	2 x M20
Control ③	FS2		1 x PG 16	1 x M25
	FS3			
Power section	FS1	3x22mm	3 x PG 13.5	3 x M20
Mains ①	FS2	1x22mm	1 x PG 13.5	1 x M20
Motor ②	FS3	2x25mm	2 x PG 16	2 x M25

The EMC cable gland must be earthed properly—i.e., with a metal lock nut that is then connected to the PE terminal.

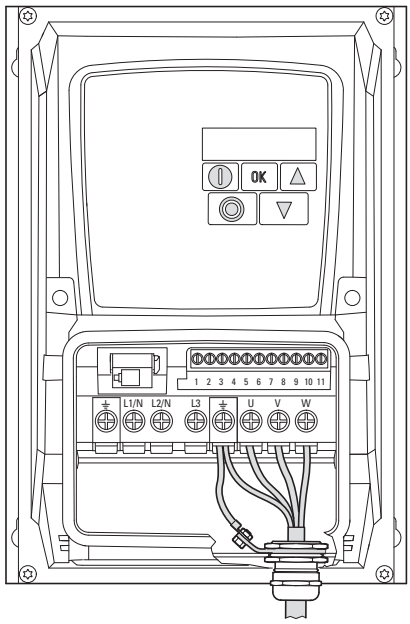


Figure 49. Grounding the EMC cable gland

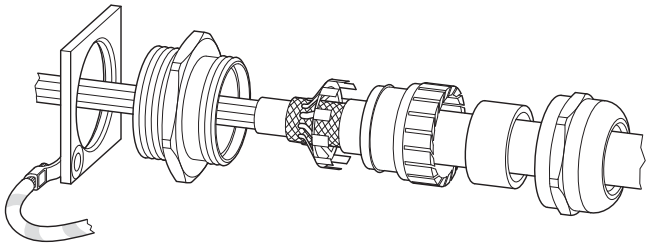


Figure 50. Example: diagram of EMC gland assembly

Connection on control section

The connection to the control section is made using the plug-in connection terminals:

- Terminals 1, 5, 7, 9: Control voltage output (+24V, +10V, 0V),
- Terminals 2, 3, 4, 6: for digital and analog input signals
- Terminal 8: for a digital or analog output signal
- Terminals 10, 11: for a potential-free relay output

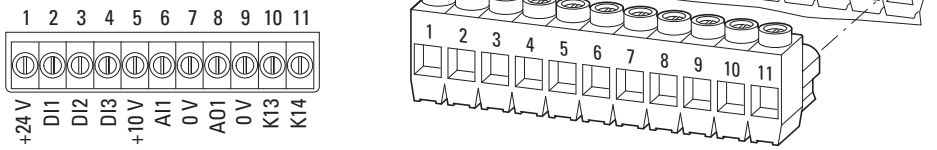


Figure 51. Control signal terminal layout and factory designations

ESD measures

Note: Discharge yourself on a grounded surface before touching the control terminals and the circuit board to prevent damage through electrostatic discharge.

Notice

Do not connect an external voltage source to control signal terminal 1 (+24 V)!

⚠ DANGER

Before touching or handling the wired control signal terminals, check to make sure that the terminals (terminals 10 and 11) are de-energized.

Note: The relay contact (terminals 10, 11) may be wired to a higher-level control circuit that has a dangerous voltage (i.e., 110 Vac, 230 Vac) even when the variable speed drive is de-energized.

Note: When using more than one control voltage, we recommend using separate cables.

Example: 24 Vdc at control signal terminals 1, 2, 3, 4, 6, and 8 and 110 or 230 Vac at control signal terminals 10 and 11.

Terminal capacities and stripping lengths

The terminal capacities and stripping lengths are listed in the following table.

Table 20. Control signal terminal sizes and designs

mm^2	mm^2	AWG	mm	in	N/m	ft-lbs	mm
0.2–2.5	0.2–1.5	24–12	5	0.2	0.5	0.42	0.4 x 2.5

Control signal terminal connection information and functions

The functions that are set in the ex-factory and the electrical connection data of all control signal terminals are listed in the following table.

Table 21. Factory-set functions of the control signal terminal

Connection terminal		Signal	Description	Default Setting
1	+24 V	Control voltage for DI1–DI4, output (+24 V)	Maximum load 100 mA, Reference potential 0 V **Notice:** Do not connect an external voltage source!	—
2	DI1	Digital Input 1	+8 to +30 V (High, R_i > 6 kΩ)	Start enable FWD
3	DI2	Digital input 2	+8 to +30 V (High, R_i > 6 kΩ)	Start enable REV
4	DI3 AI2	Digital Input 3 Analog Input 2	Digital: +8 to +30 V (high) Analog: 0 to +10 V (R_i > 72 kΩ) 0/4 to 20 mA (R_B = 500 Ω) Can be switched with parameter P-16 1–10 kΩ	Fixed frequency FF1
5	+10 V	Reference voltage, Output (+10 V)	Maximum load: 10 mA Reference potential: 0 V	—
6	AI1 DI4	Analog Input 1 Digital Input 4	Analog: 0 to +10 V (R_i > 72 kΩ) 0/4 to 20 mA (R_B = 500 Ω) Can be switched with parameter P-16 1–10 kΩ Digital: +8 to +30 V (high)	Frequency Reference (fixed frequency)
7	0 V	Reference potential	0 V = connection terminal 9	—
8	AO1 DO1	Analog output 1 Digital output 1	Analog: 0 to +10 V, maximum 20 mA Can be switched with parameter P-25 Digital: 0 to +24 V	Output Frequency
9	0 V	Reference potential	0 V = connection terminal 7	—
10	K13	Relay 1, N/O	Maximum switching load: 250 Vac / 6 A or 30 Vdc / 5 A	RUN
11	K14	Relay 1, N/O	Maximum switching load: 250 Vac / 6 A or 30 Vdc / 5 A	RUN

Note: The control terminals' functions and electrical parameters can be changed with Parameter,

- Expansion modules DXC-EXT-… (refer to "DXC-EXT-2RO output expansion" on **Page 138** and "DXC-EXT-2RO1AO output expansion" on **Page 140**).

Connection example

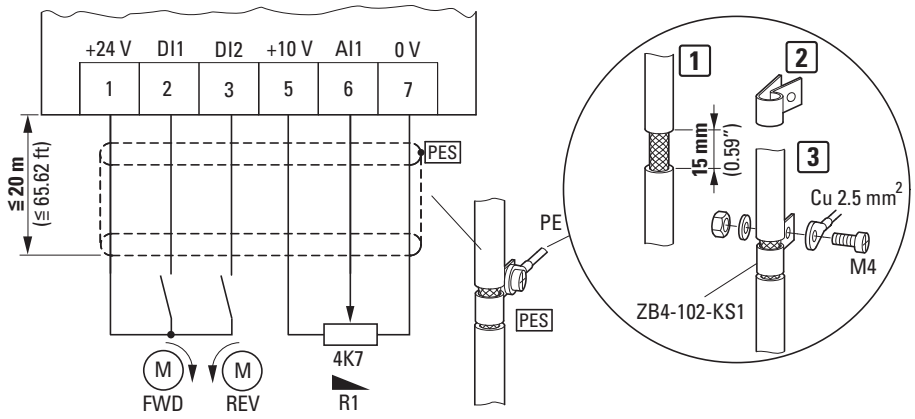


Figure 52. Simple connection example

- Two operating directions:
  - FWD = clockwise rotating field
  - REV = counterclockwise rotating field
- R1: External reference value potentiometer, frequency reference value 0 - f_{max} (P-01)

The control cables should be screened and twisted for the external connection. The screening is applied on one side in the proximity of the variable speed drive (PES).

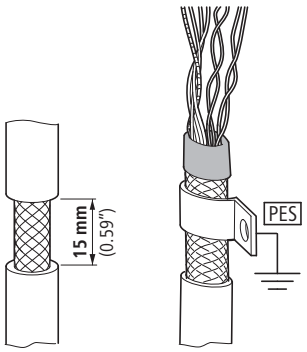


Figure 53. Screen termination at one end (PES) close to the variable speed drive

Alternatively, in addition to the broad area gland plate, you can twist the screen braid at the end and connect to the protective earth with a cable lug. To prevent EMC disturbance, this twisted shielding connection should be made as short as possible.

Prevent the screen from becoming unbraided at the other end of the control cable, i.e., by using a rubber grommet. The screen braid must not make any connection with the protective ground here because this would cause problems with an interference loop.

Control signal terminals

The VSC variable speed drive has four control inputs (control terminals 2, 3, 4, and 6). Two of these are parameterizable as digital control inputs; while the others can be set to work as digital or analog control inputs.

The variable speed drive comes with the following default setting:

- Control signal terminal 2 as digital input 1 (DI1)
- Control signal terminal 3 as digital input 2 (DI2)
- Control signal terminal 4 as digital input 3 (DI3)
- Control signal terminal 6 as analog input 1 (AI1)

Control signal terminal 8 can be used as a digital or as an analog output.It is used as an analog output (AO) in the default configuration that comes with the variable speed drive when it is delivered.

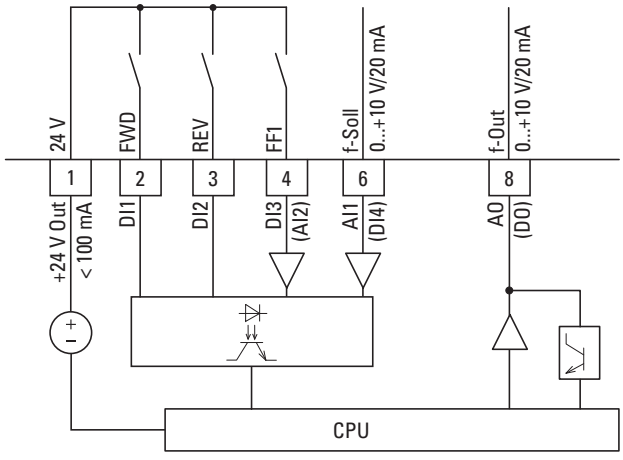


Figure 54. Control signal terminals (D = digital / A = analog)

Digital input signals

Control terminals 2, 3, 4, and 6 all have the same function and mode of operation as digital inputs (DI1 to DI4).

A logic level of +24 V (positive logic) is used:

- 8–30 V = High (logic "1")
- 0–4 V = Low (logic "0")

The internal control voltage from control signal terminal 1 (+24 V, maximum 100 mA) or an external voltage source (+24 V) can be used for this. The permissible residual ripple must be less than ±5 % ≥ U_a/U_a.

Note: If you use an external voltage source, make sure to connect the 0-V potentials of the external voltage source to the 0-V potentials of the variable speed drive.

Note: Control terminals 7 and 9 are the common 0 V reference potential for all analog and digital input signals.

Optional modules DXC-EXT-IO110 and DXC-EXT-IO230 can be used to optically isolate the digital inputs (DI1 to DI4) and integrate them directly into control circuits with 110 V / 230 V. Values of 80 to 110/230 Vac will be recognized as a high signal, refer to "DXC-EXT-IO… coupling module"on **Page 136**.

Digital output (transistor)

When using the device's default configuration, control signal terminal 8 will be configured as an analog output (AO). It can be set to work as a digital output instead (DO) with parameter P-25:

Table 22. Control signal terminal 8 (DO)

P-25	Signal 1 = High (+24 V)	Description
0	RUN	Enable (FWD/REV)
1	Ready	Ready for operation. No fault signal
2	Actual value = Setpoint value	The output frequency (f-Out) or speed is equal to the setpoint value (REF).
3	Error (Fault)	Fault (not ready).
4	f-Out ≥ P-19	The output frequency (f-Out) is greater than or equal to the value set in P-19 (RO1 upper limit).
5	I-Out ≥ P-19	The output current (I-Out) is greater than or equal to the value set in P-19 (RO1 upper limit).
6	f-Out < P-19	The output frequency (f-Out) is less than the value set in P-19 (RO1 upper limit).
7	I-Out < P-19	The output current (I-Out) is less than the value set in P-19 (RO1 upper limit).
10	Not Enable	No enable signal (FWD/REV)
11	Actual value ≠ Setpoint value	The output frequency (f-Out) / speed is not equal to the setpoint value (REF).

Digital output DO: Accuracy ≥ 1% relative to maximum value.

Transistor output DO uses control signal terminal 8 to switch the device's internal control voltage (+24 V) as a digital signal (1 = High). The maximum permissible load current is 20 mA.

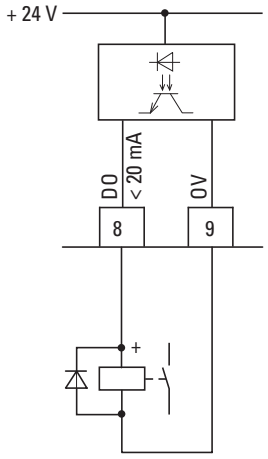


Figure 55. Connecting example (interposing relay with free-wheel diode ETS4-VS3)

Note: Control terminals 7 and 9 are the common 0 V reference potential for all analog and digital input signals.

Analog input signals

Depending on how parameters P-12 and P-15 are set, control terminals 4 (AI2) and 6 (AI1) can be connected to analog signals.

Table 23. Control signal terminal 6 (AI1)

P-16	Signal	Description
0	0 to +10 V	Frequency reference value / Speed reference value. Manipulated variable range from minimum (P-02) to maximum (P-01) value. Default settings.
1	–10–0 to +10 V	Frequency reference value/speed reference value with operating direction change based on the setpoint polarity
2	0–20 mA	Current signal
3	4–20 mA	Current signal with open-circuit monitoring (< 3 mA) → Shutdown with fault message.
4	4–20 mA	Current signal with open-circuit monitoring (< 3 mA) → **No** shutdown if a fault is detected Operation will continue with fixed frequency/fixed speed 1 (P-20)
5	20–4 mA	Inverted current signal with open-circuit monitoring (< 3 mA) → Shutdown with fault message
6	20–4 mA	Inverted current signal with open-circuit monitoring (< 3 mA) → **No** shutdown if a fault is detected Operation will continue with fixed frequency/fixed speed 1 (P-20)
7	+10–0 V	Inverted voltage signal

Analog input AI1: Resolution: 12-bit, response time: < 16 ms.

Table 24. Control signal terminal 4 (AI2)

P-25	Signal (0 to +10 V)	Description
0	0 to +10 V	Voltage signal
1	0–20 mA	Current signal
2	4–20 mA	Current signal with open-circuit monitoring (< 3 mA) → Shutdown with fault message.
3	4–20 mA	Current signal with open-circuit monitoring (< 3 mA) → **No** shutdown if a fault is detected Operation will continue with fixed frequency/fixed speed 1 (P-20)
4	20–4 mA	Inverted current signal with open-circuit monitoring (< 3 mA) → Shutdown with fault message
5	20–4 mA	Inverted current signal with open-circuit monitoring (< 3 mA) → **No** shutdown if a fault is detected Operation will continue with fixed frequency/fixed speed 1 (P-20)
6	Ptc-th	Thermistor connection (refer to **Page 69**)

Analog input AI2: Resolution: 12-bit, response time: < 16 ms.
The way control terminal 4 works (DI3 AI2) can be changed with P-15 = 4 and P-12 = 6.

Note: Control terminals 7 and 9 are the common 0 V reference potential for all analog and digital input signals.

Analog output signal

When the device is used with its default settings, there will be an analog voltage signal (0–10 V) available at control signal terminal 8. This value will correspond to 0 to 100% of P-01 (maximum frequency / speed). The output can handle a maximum load of 20 mA. Parameter P-25 is used to configure whether this output signal will be provided at the terminal:

Table 25. Control signal terminal 8 (AO)

P-25	Signal 1 = High (+24 V)	Description
8	f-Out	Output frequency (f-Out) / speed 0–100 % of P-01 Resolution: 0.1 Hz
9	I-Out	Output current (I-Out) / motor current 0–100 % of P-08 Resolution: 0.1 A
12	P-Out	Output power (P-Out) 0–200% relative to the VSC's rated motor output

Analog output AO: Accuracy ≥ 1% relative to maximum value; resolution: 10-bit

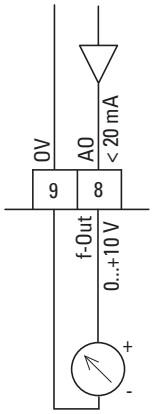


Figure 56. Analog output (AO) (connecting example)

Note: Control terminals 7 and 9 are the common 0 V reference potential for all analog and digital input signals.

Relay contact

Control signal terminals 10 and 11 are connected to the VSC variable speed drive's internal relay contact (N/O) in a potential-free manner.

The relay function can be configured with parameter P-18:

Table 26. Control signal terminals 10 and 11 (RO1)

P-18	Contact closed	Description
0	RUN	Enable (FWD/REV) Default Setting
1	Ready	Ready for operation. No fault signal
2	Actual value = Setpoint value	The output frequency (f-Out) / speed is equal to the setpoint value (REF).
3	Error (Fault)	Fault (not ready)
4	f-Out ≥ P-19	The output frequency (f-Out) is greater than or equal to the value set in P-19 (RO1 upper limit).
5	I-Out ≥ P-19	The output current (I-Out) is greater than or equal to the value set in P-19 (RO1 upper limit).
6	f-Out < P-19	The output frequency (f-Out) is less than the value set in P-19 (RO1 upper limit).
7	I-Out < P-19	The output current (I-Out) is less than the value set in P-19 (RO1 upper limit).
8	Not Enable	No enable signal (FWD/REV)
9	Actual value ≠ Setpoint value	The output frequency (f-Out) / speed is not equal to the setpoint value (REF).
10	AI2 > P-19	The analog signal at control signal terminal 4 (AI2) is greater than the value set in P-19 (RO1 upper limit).
11	Ready-to-RUN	Ready for operation. The enable signal (ENA) is present and there is no fault signal present.

Parameter P-19 (RO1 upper limit) contains the limit used in P-18 (4, 5, 6, 7, 10) for relay RO1 (control signal terminal 10/11) or in P-25 (4, 5, 6, 7) for digital output DO (control signal terminal 8).

The electrical connection specifications for control terminals 10 and 11 are:

- 250 Vac, max. 6 A
- 30 Vdc, max. 5 A

We recommend connecting the loads connected to the relay contact as follows:

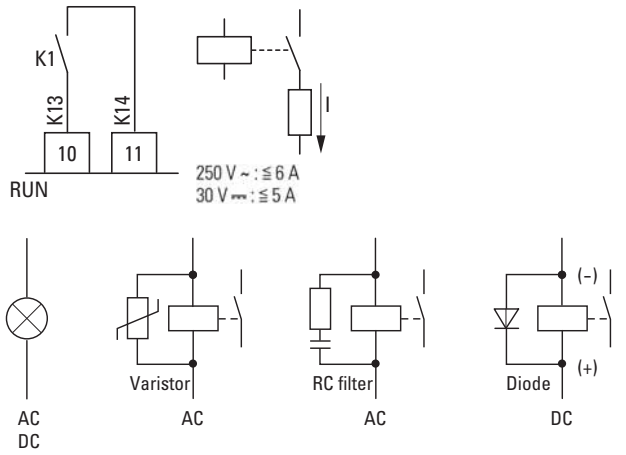


Figure 57. Connection examples with suppressor circuit

RJ45 interface

The RJ45 port located in the front (IP20) or under the connection terminal cover (IP66) can be used to directly connect the device to communication modules and fieldbus connections.

The internal RS-485 connection transmits Modbus RTU and CANopen data.

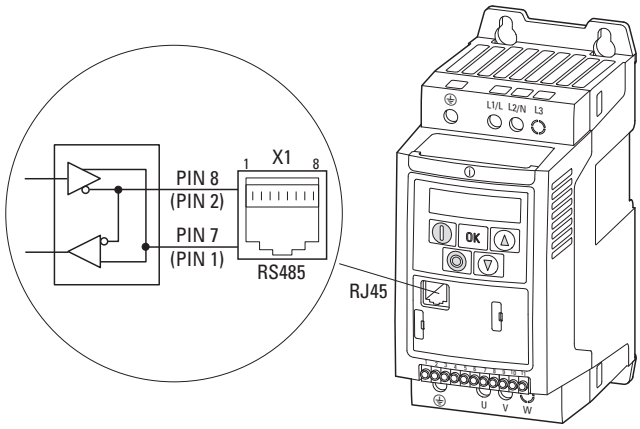


Figure 58. RJ45 interface

Table 27. Configuration of the RJ45 interface

Pin	Meaning
1	CANopen -
2	CANopen +
3	0 V
4	OP-Bus -
5	OP-Bus +
6	+24V
7	Modbus RTU (A), RS485-
8	Modbus RTU (B), RS485+

Note: VSC variable speed drives do not have an internal bus termination resistor. Use EASY-NT-R if necessary.

Control signal terminals IP66

In the case of VSC variable speed drives with an IP66 degree of protection, the plug-in control signal terminals are located under the terminal cover. In version VSC…A6SN, the local controls will already be connected.

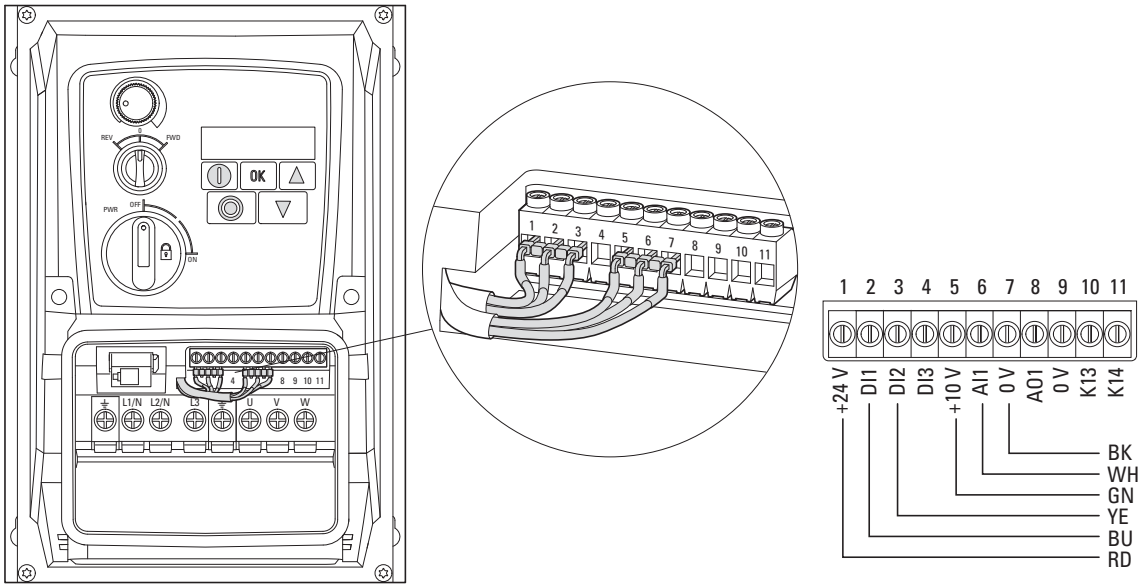


Figure 59. VSC…A6S… (connection wired at the factory)

When supplied, the control signal terminals will be connected as follows:

Table 28. Configuration of the control signal terminals

Terminal	Color	Function
1	RD (red)	+24 V to FWD/REV selector switch
2	BU (blue)	From selector switch = FWD
3	YE (yellow)	From selector switch = REV
5	GN (green)	+10 V to potentiometer
6	WH (white)	From potentiometer = f-Set
7	BK (black)	0 V to potentiometer

When the device is set to its default settings, the setpoint value can be set using the potentiometer. Meanwhile, the REV – 0 – FWD selector switch can be used to set the drive's operating direction (counterclockwise rotating field mode – STOP – clockwise rotating field mode).

Thermistor connection

Motor thermistors and motor thermal switches (Thermoclick) can be connected to control signal terminal 4 (DI3 = digital input 3) in order to provide protection against thermal motor overloads. In this case, parameter P-15 must be used to select the EXTFLT (external fault) setting for DI3, and parameter P-47 must be set to a value of 6 (Ptc-th).

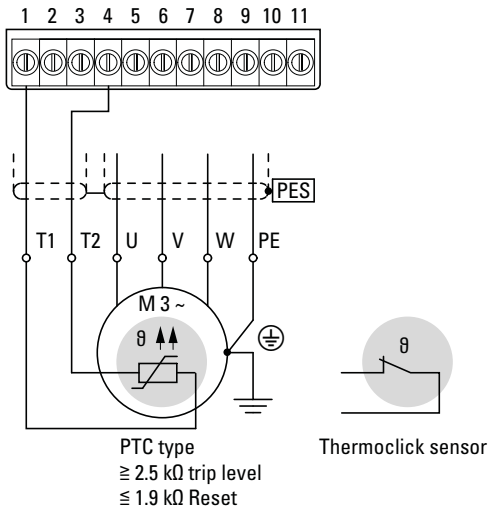


Figure 60. Thermistor connection

The thermistors and thermal switches used must be PTC-type units (PTC characteristic, positive temperature coefficient). The tripping range must fall within a resistance value range of approximately 2.5–3 kΩ, while the reset range must fall within a range of 1.9–1 kΩ.

Block diagrams

The following block diagrams show all the connection terminals on a VSC variable speed drive and their functions when in their default settings.

VSC1D…

Mains voltage U_{LN}: single-phase, 110 (–10 %)–115 (+10 %) V, 50/60 Hz

Motor Voltage U_2: 3-phase, $U_2 = 2 \times U_{LN}$ (voltage doubling), 0–50/60 Hz (max. 500 Hz)

Size: FS1 and FS2 with IP20 degree of protection

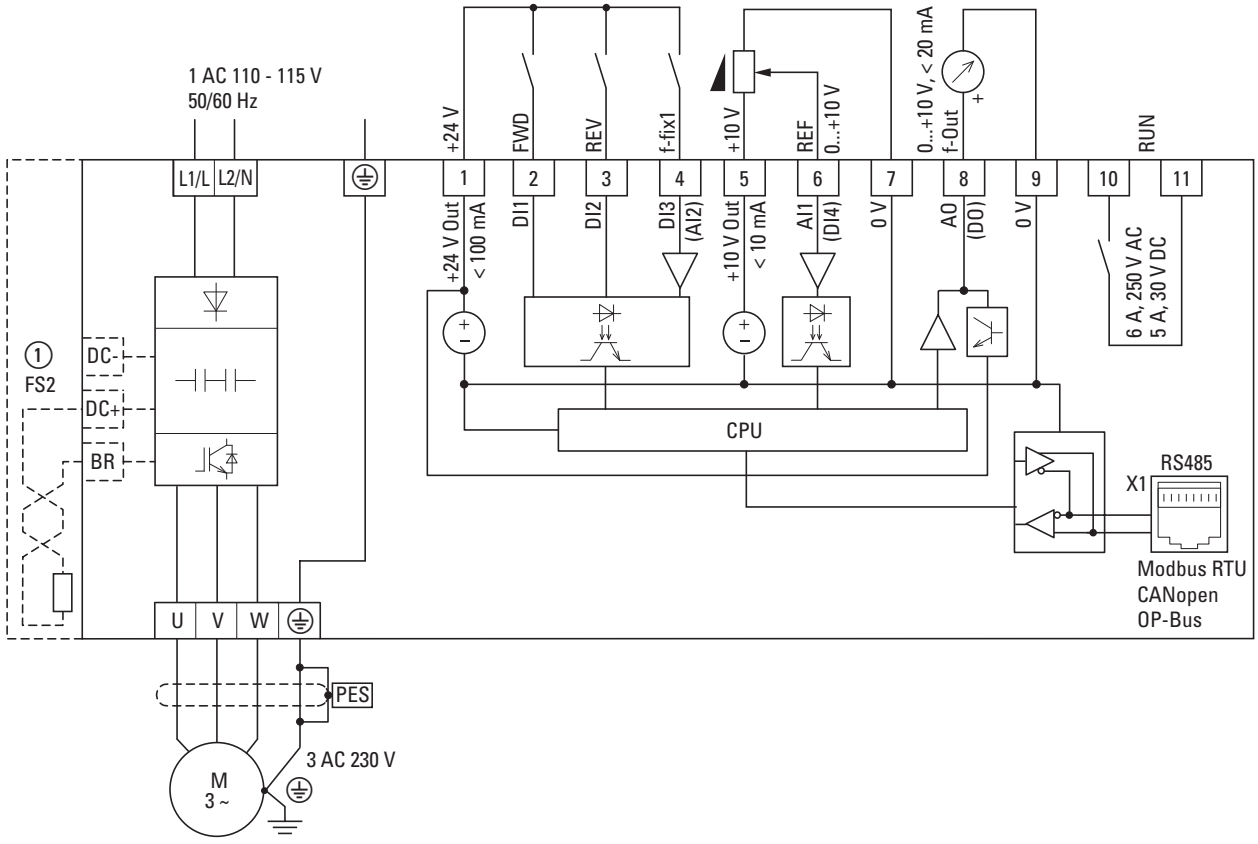


Figure 61. Block diagram VSC1D…Nx-…

VSC1D… variable speed drives feature a voltage doubler in their internal DC link. When there is a connected voltage of 1 AC 110 - 115 V, a motor voltage of up to 3 AC 230 V will be output.

① Devices with a frame size of FS2 allow for DC link coupling (DC+, DC-) and connecting brake resistors (DC+, BR).

Brake resistor DX-BR3-100 can be inserted underneath the heat sink into the enclosure and electronically protected against overloads (P-34 = 1).

Note: VSC1D… variable speed drives do not feature an internal radio interference suppression filter. An external radio interference suppression filter is required for operation as per EN 61800-3, refer to "Radio interference suppression filter" on **Page 31**.

VSC12...

Mains voltage U_{LN}: single-phase, 200 (–10 %)–240 (+10 %) V, 50/60 Hz

Motor voltage U_2: 3-phase, $U_2 = U_{LN}$, 0–50/60 Hz (max. 500 Hz)

Size: FS1, FS2 and FS3 with IP20 degree of protection

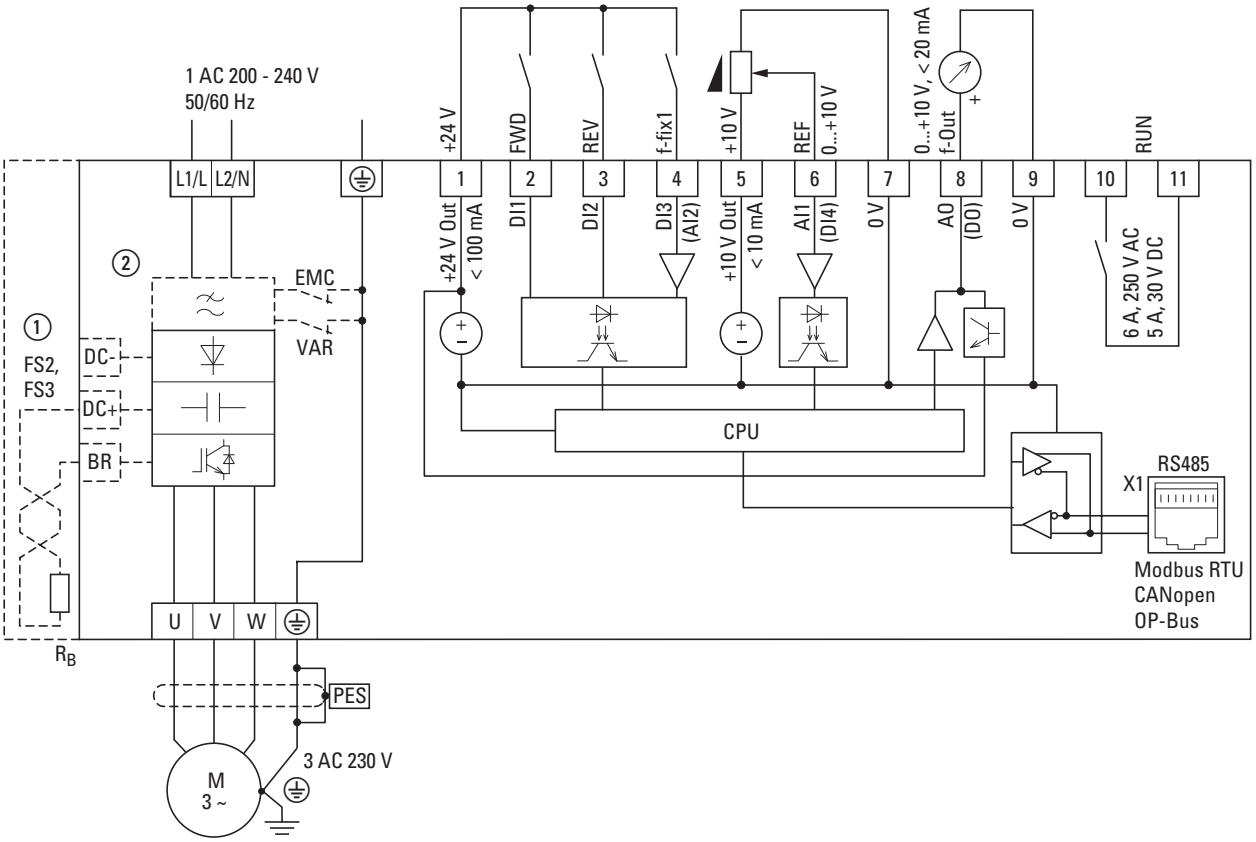


Figure 62. Block diagram VSC12...

Variable speed drive with single-phase supply system voltage and three-phase motor connection.

① Devices with a frame size of FS2 or FS3 allow for DC link coupling (DC+, DC-) and connecting brake resistors (DC+, BR).

Brake resistor DX-BR3-100 can be inserted underneath the heat sink into the enclosure and electronically protected against overloads (P-34 = 1).

② VSC12xxx**N**...: without radio interference suppression filter
VSC12xxx**F**...: with built-in radio interference suppression filter

VSC32..., VSC34... (in FS1, FS2, FS3)

Mains voltage U_{LN}:

VSC32...: 3-phase, 200 (–10 %)–240 (+10 %) V, 50/60 Hz

VSC34...: 3-phase, 380 (–10 %)–480 (+10 %) V, 50/60 Hz

Motor voltage U_2: 3-phase, $U_2 = U_{LN}$, 0–50/60 Hz (max. 500 Hz)

Size: FS1, FS2 and FS3 with IP20 degree of protection

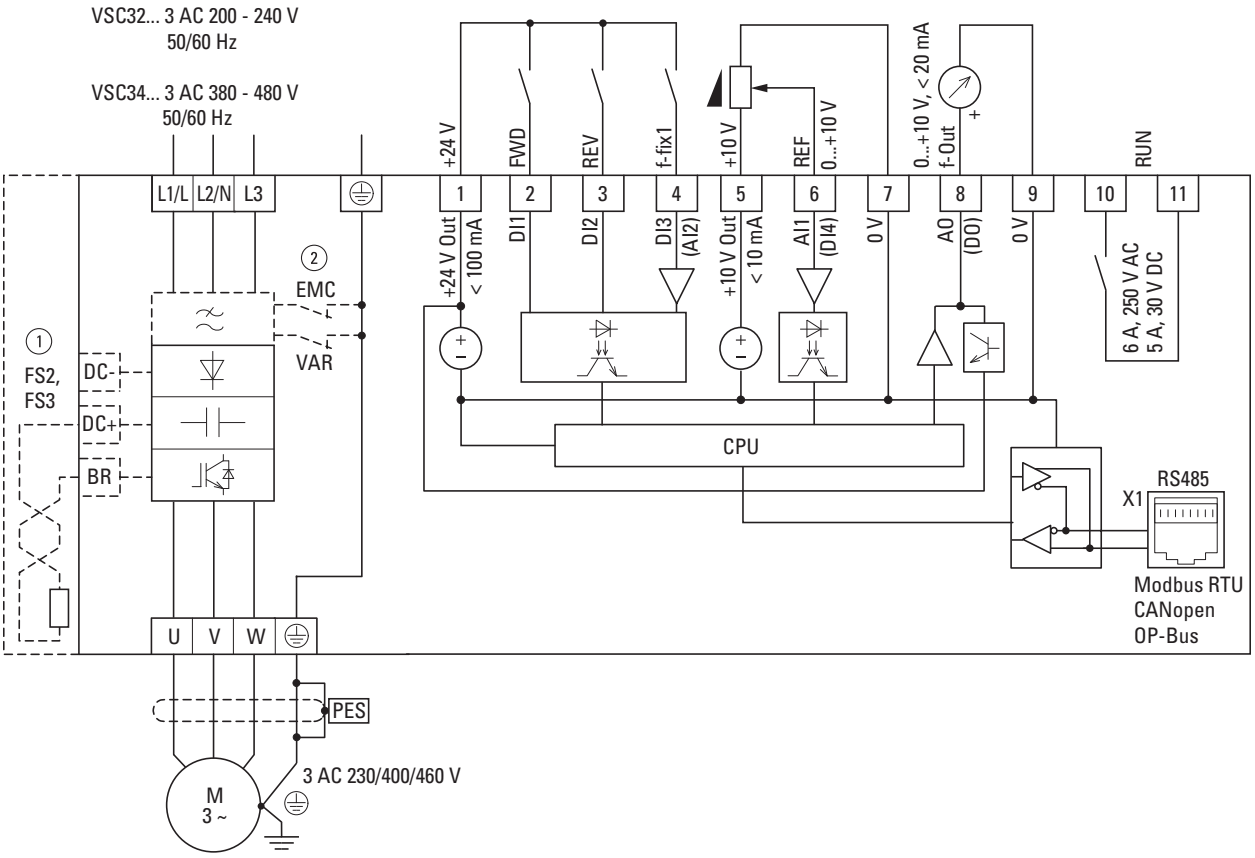


Figure 63. Block diagram VSC32... and VSC34... in frame sizes FS1, FS2 and FS3

Variable speed drive with three-phase mains supply voltage and three-phase motor connection.

① Devices with a frame size of FS2 or FS3 allow for DC link coupling (DC+, DC-) and connecting brake resistors (DC+, BR).

Brake resistor DX-BR3-100 can be inserted underneath the heat sink into the enclosure and electronically protected against overloads (P-34 = 1).

② VSC32xxx**N**..., VSC34xxx**N**...: without radio interference suppression filter
VSC32xxx**F**..., VSC34xxx**F**...: with built-in radio interference suppression filter

VSC32…, VSC34… (in FS4)

Mains voltage U_{LN}:

VSC32…: 3-phase, 200 (–10 %)–240 (+10 %) V, 50/60 Hz

VSC34…: 3-phase, 380 (–10 %)–480 (+10 %) V, 50/60 Hz

Motor voltage U_2: 3-phase, $U_2 = U_{LN}$, 0–50/60 Hz (max. 500 Hz)

Size: FS4 with IP20 degree of protection

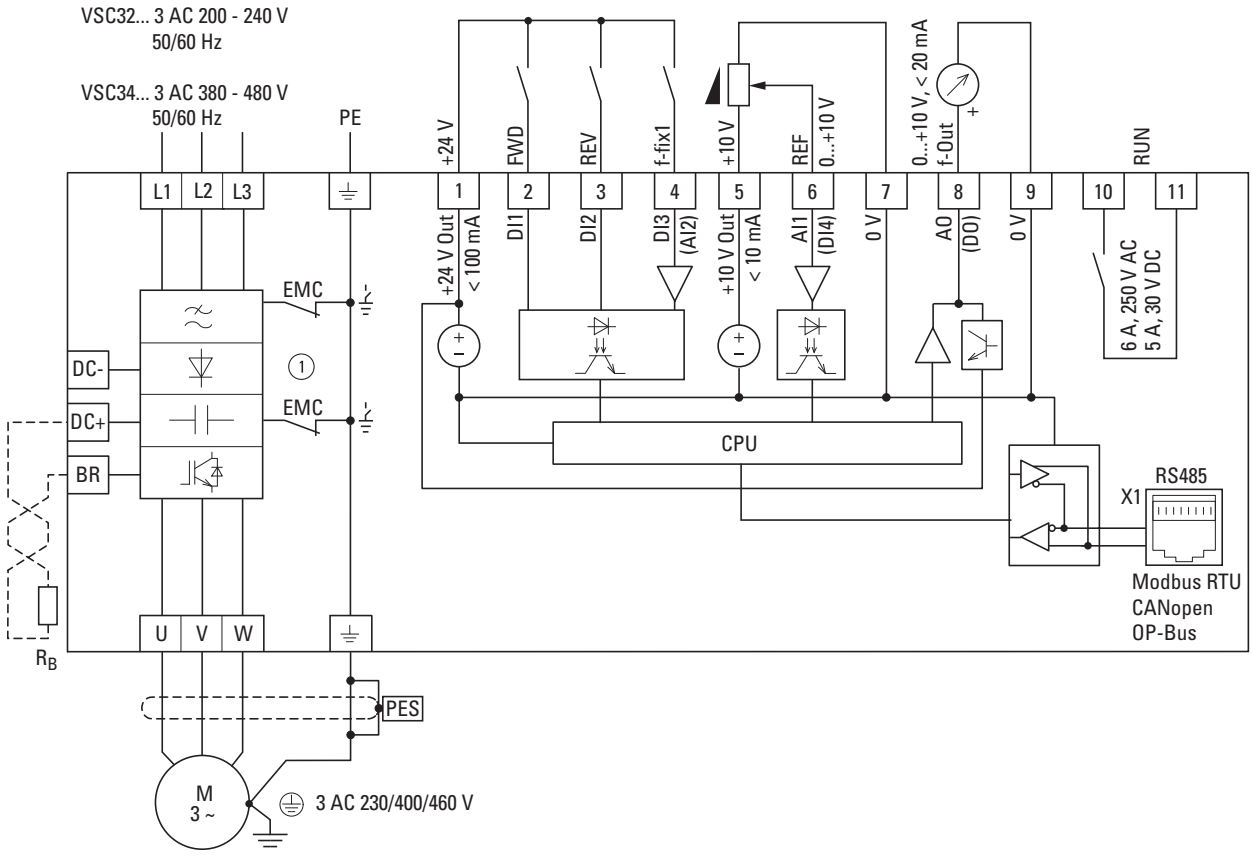


Figure 64. Block diagram VSC32… and VSC34… in frame size FS4

Variable speed drive with three-phase mains supply voltage and three-phase motor connection.

① The two EMC screws connect the mains-side capacitors in the internal radio interference suppression filter and the Y class capacitors to the earthing (PE).

VSC1D…NxA6S…

Mains voltage U_{LN}: single-phase, 110 (–10 %)–115 (+10 %) V, 50/60 Hz

Motor Voltage U_2: 3-phase, $U_2 = 2 \times U_{LN}$ (voltage doubling), 0–50/60 Hz (max. 500 Hz)

Size: FS1 and FS2 with IP66 degree of protection

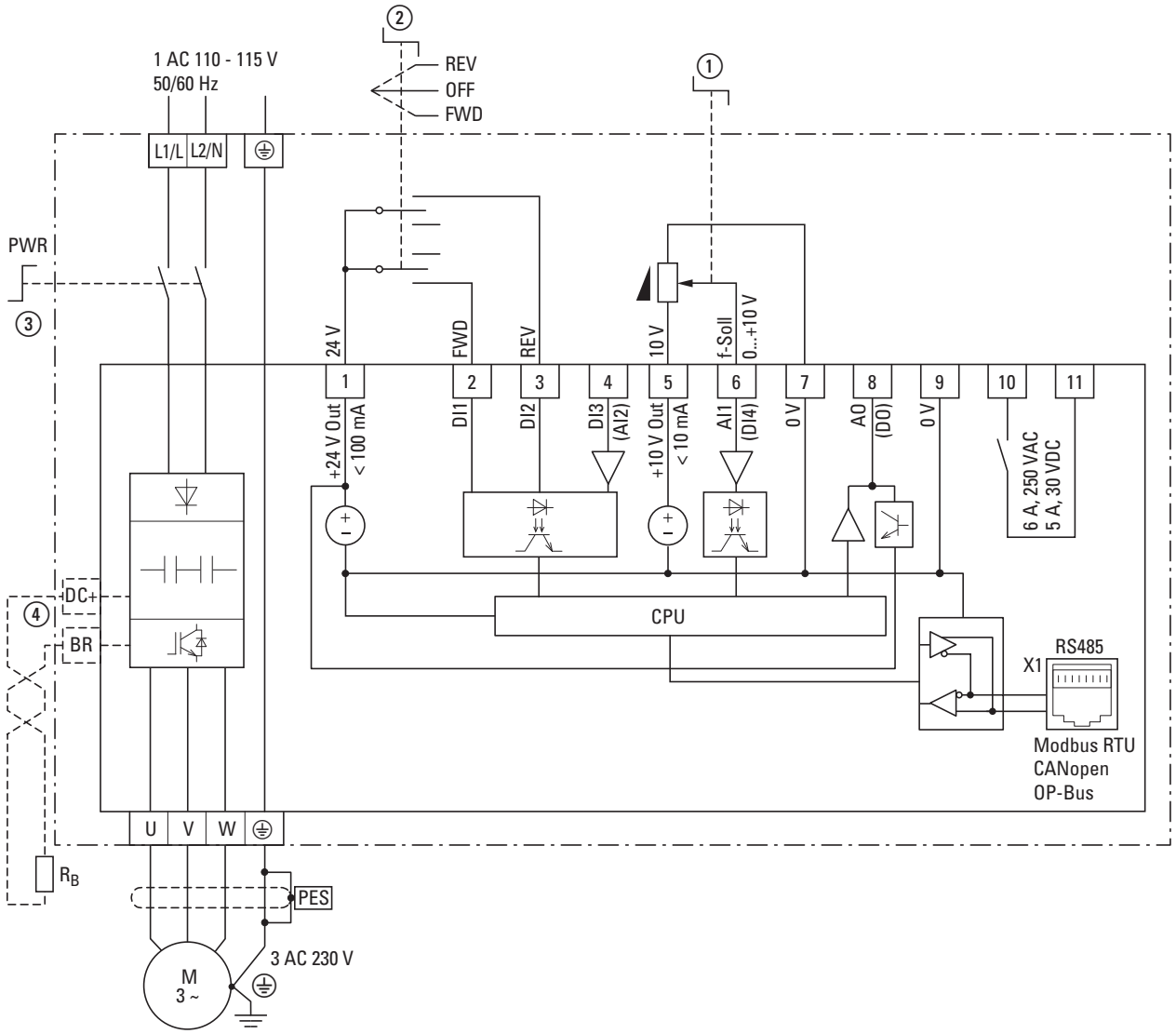


Figure 65. Block diagram VSC1D…NxA6S…

VSC1D…NxA6S… variable speed drives with an IP66 degree of protection and local controls feature a voltage doubler in their internal DC link.

When there is a power supply of 1 AC 110 - 115 V, a motor voltage of up to 3 AC 230 V will be output.

① Reference value potentiometer (0–f_{max})

② Operating direction selector switch (FWD = Clockwise rotating field, REV = Counterclockwise rotating field)

③ Mains transfer switch (PWR = Power)

④ External brake resistors can be connected to devices with a frame size of FS2 or bigger.

Note: VSC1D variable speed drives do not have an internal radio interference suppression filter.

An external radio interference suppression filter is required for operation as per EN 61800-3, refer to "Radio interference suppression filter", on **Page 31**.

An external radio interference suppression filter should be installed in the immediate proximity of the variable speed drive. In order to have an IP66 degree of protection, DX-EMC… radio interference suppression filters must be installed inside an enclosure (IP66). In this case, the connection to the variable speed drive will require a screened cable with a screen braid that is terminated at both ends to the protective earth (PES) across a large area.

VSC1D…NxA66…

Mains voltage U_{LN}: single-phase, 110 (–10 %)–115 (+10 %) V, 50/60 Hz

Motor Voltage U_2: 3-phase, $U_2 = 2 \times U_{LN}$ (voltage doubling), 0–50/60 Hz (max. 500 Hz)

Size: FS1 and FS2 with IP66 degree of protection

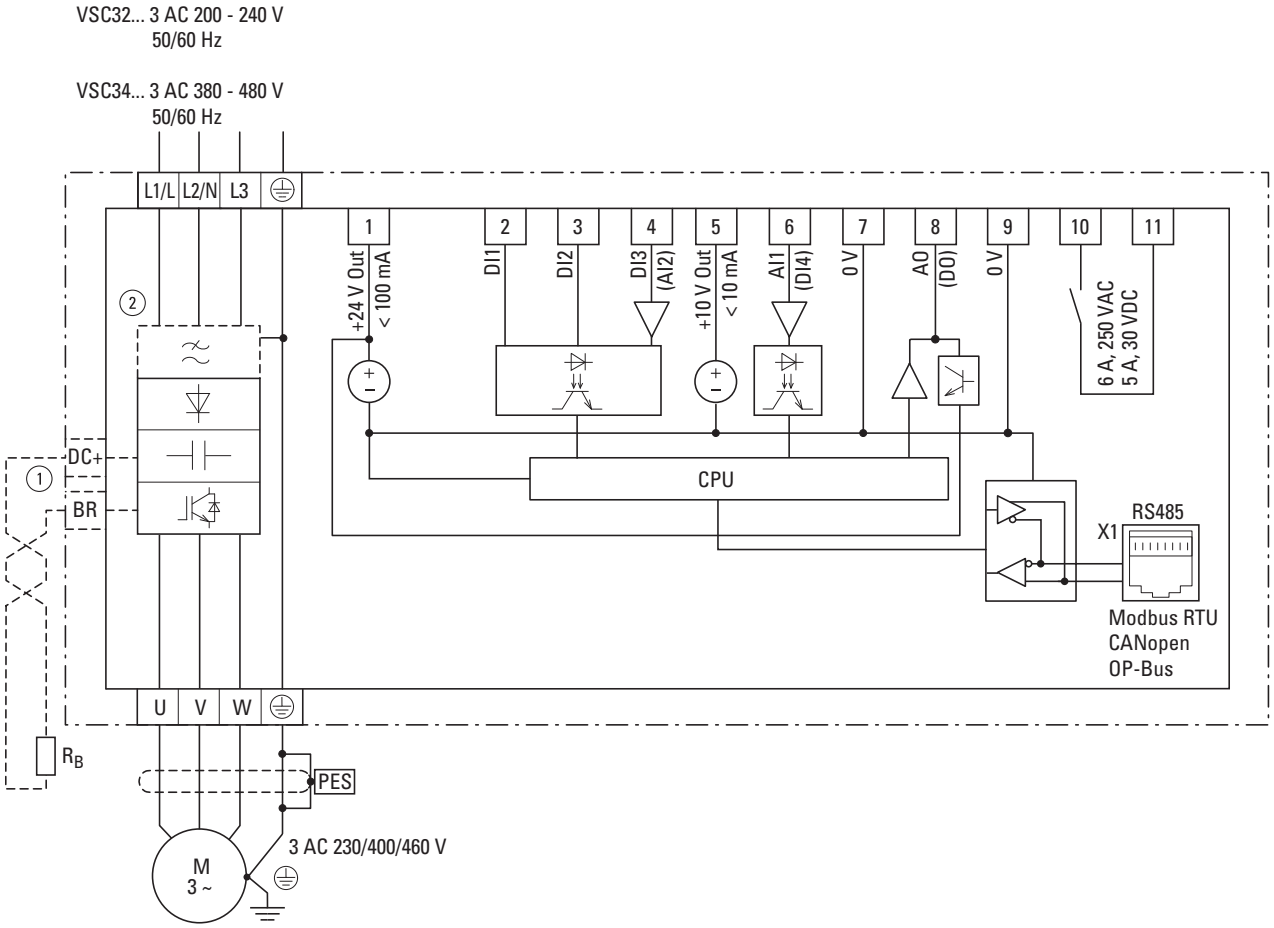


Figure 66. Block diagram VSC1D…NxA66…

When there is a power supply of 1 AC 110 - 115 V, a motor voltage of up to 3 AC 230 V will be output.

External braking resistances can be connected to devices with a size of FS2 or bigger.

① Frame size FS2 with connection for external brake resistor

② VSC12xxx**N**…: without radio interference suppression filter
VSC12xxx**F**…: with built-in radio interference suppression filter

Note: VSC1D variable speed drives do not have an internal radio interference suppression filter. An external radio interference suppression filter is required for operation as per EN 61800-3, refer to "Radio interference suppression filter" on **Page 31**.

VSC12…A6S…

Mains voltage U_{LN}: single-phase, 200 (–10 %)–240 (+10 %) V, 50/60 Hz

Motor voltage U_2: 3-phase, $U_2 = U_{LN}$, 0–50/60 Hz (max. 500 Hz)

Size: FS1, FS2 and FS3 with IP66 degree of protection

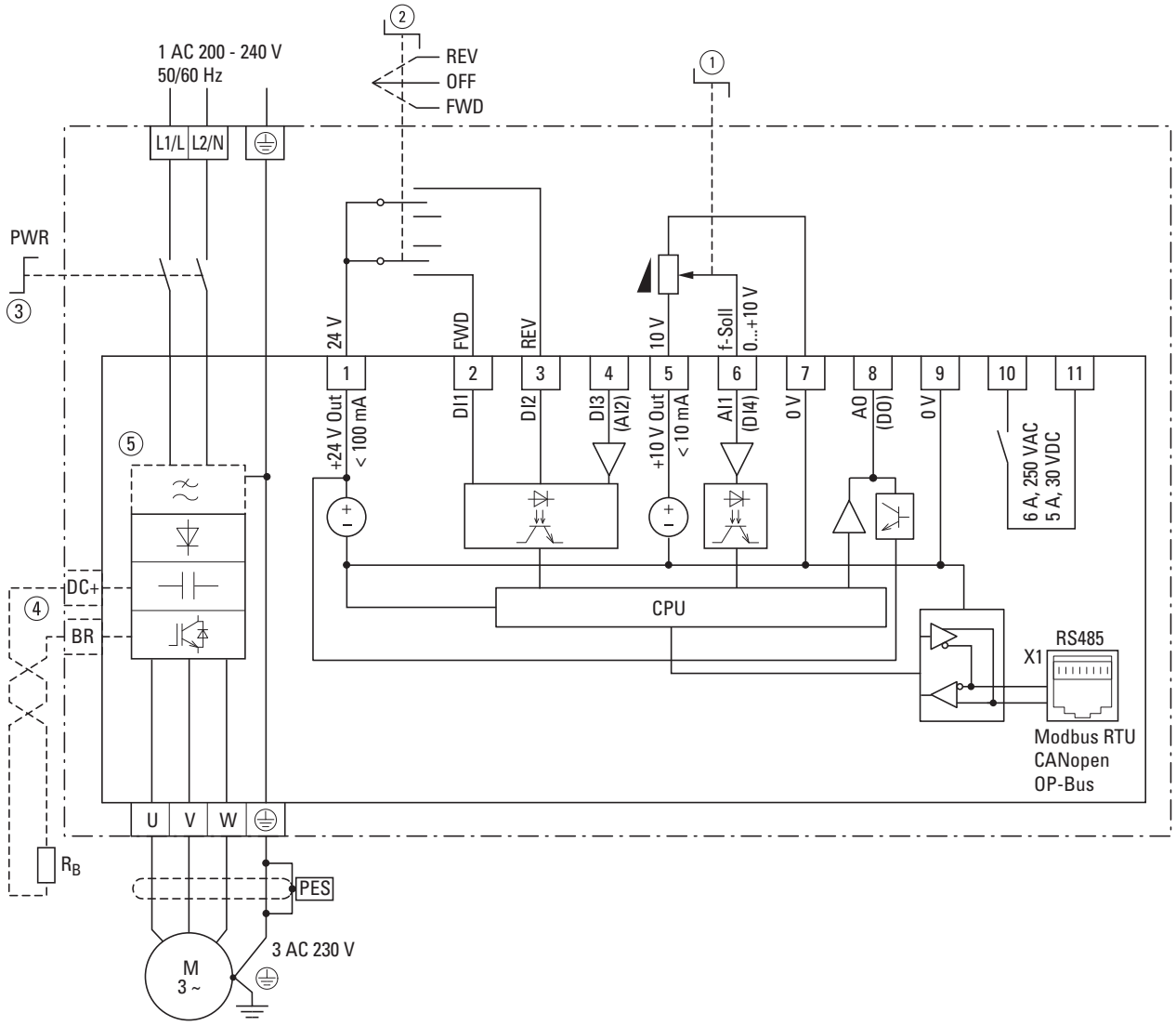


Figure 67. Block diagram VSC12…A6S…

Variable speed drive with IP66 degree of protection, local controls, single-phase mains supply voltage, and three-phase motor connection.

① Reference value potentiometer (0–f_{max})
② Operating direction selector switch
(FWD = Clockwise rotating field, REV = Counterclockwise rotating field)
③ Mains transfer switch (PWR = Power)
④ Frame sizes FS2 and FS3 with connection for external brake resistors
⑤ VSC12xxx**N**…: without radio interference suppression filter
VSC12xxx**F**…: with built-in radio interference suppression filter

VSC12…A66…

Mains voltage U_{LN}: single-phase, 200 (–10 %)–240 (+10 %) V, 50/60 Hz

Motor voltage U_2: 3-phase, $U_2 = U_{LN}$, 0–50/60 Hz (max. 500 Hz)

Size: FS1, FS2 and FS3 with IP66 degree of protection

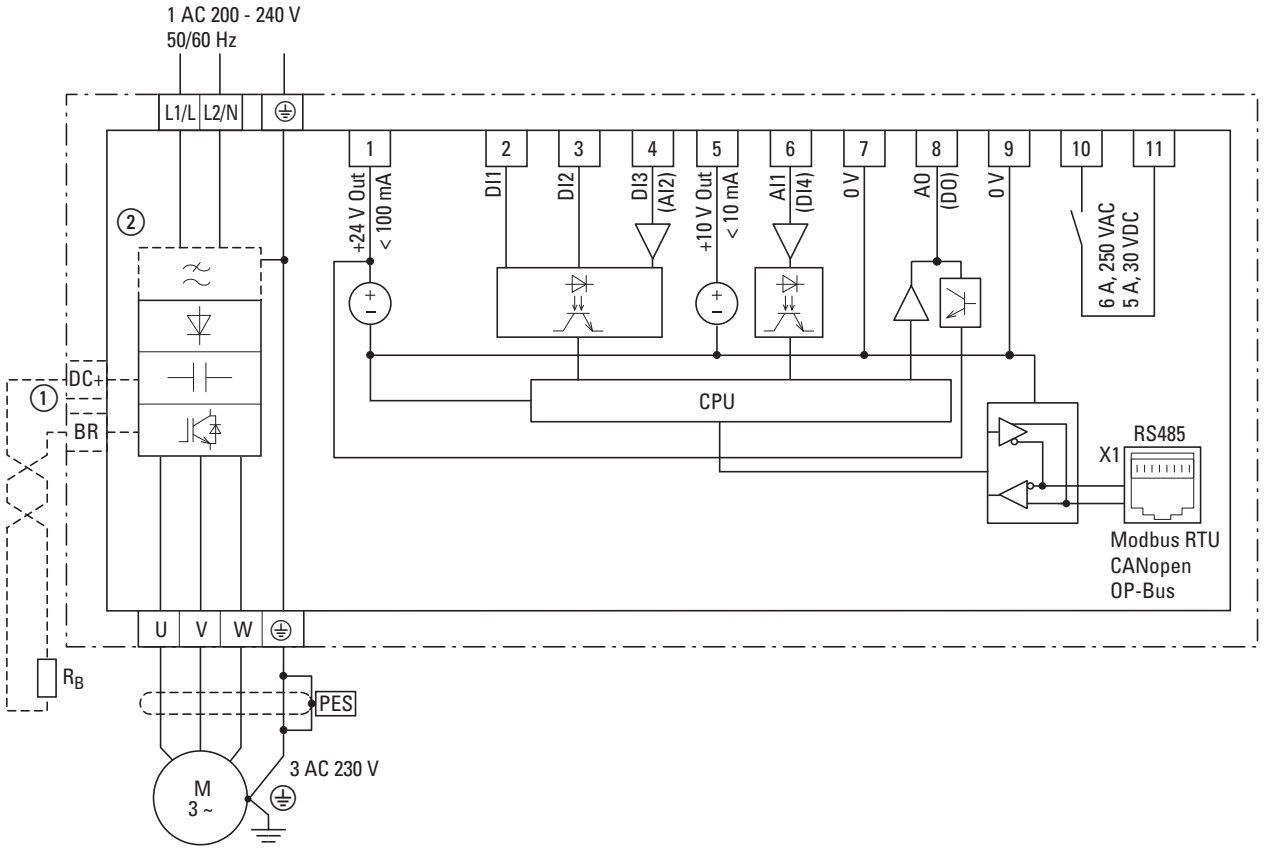


Figure 68. Block diagram VSC12…A66…

Variable speed drive with IP66 degree of protection, local controls, single-phase mains supply voltage, and three-phase motor connection.

① Frame sizes FS2 and FS3 with connection for external brake resistors

② VSC12xxx**N**…: without radio interference suppression filter
VSC12xxx**F**…: with built-in radio interference suppression filter

VSC32…A6S…, VSC34…A6S…

Mains voltage U_{LN}:

VSC32…: 3-phase, 200 (–10 %)–240 (+10 %) V, 50/60 Hz

VSC34…: 3-phase, 380 (–10 %)–480 (+10 %) V, 50/60 Hz

Motor voltage U_2: 3-phase, $U_2 = U_{LN}$, 0–50/60 Hz (max. 500 Hz)

Size: FS1, FS2 and FS3 with IP66 degree of protection

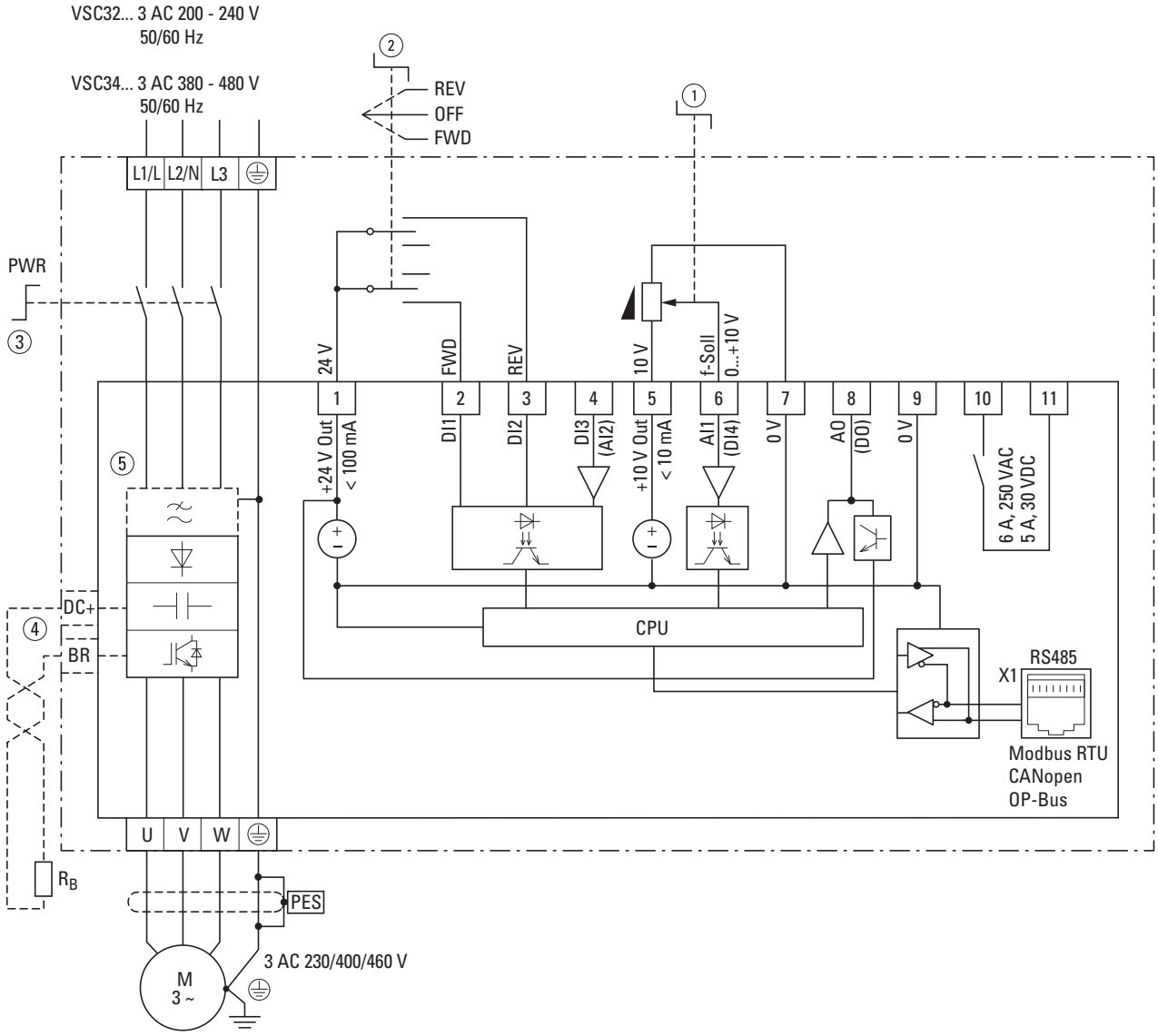


Figure 69. Block diagram VSC32…A6S…, VSC34…A6S…

Variable speed drive with IP66 degree of protection, local controls, three-phase mains supply voltage, and three-phase motor connection.

① Reference value potentiometer (0–f_{max})
② Operating direction (FWD = Clockwise rotating field, REV = Counterclockwise rotating field)
③ Mains transfer switch (PWR = Power)
④ Frame sizes FS2 and FS3 with connection for external brake resistors
⑤ VSC12xxx**N**…: without radio interference suppression filter
VSC12xxx**F**…: with built-in radio interference suppression filter

VSC32…A66…, VSC34…A66…

Mains voltage U_{LN}:

VSC32…: 3-phase, 200 (–10 %)–240 (+10 %) V, 50/60 Hz

VSC34…: 3-phase, 380 (–10 %)–480 (+10 %) V, 50/60 Hz

Motor voltage U_2: 3-phase, $U_2 = U_{LN}$, 0–50/60 Hz (max. 500 Hz)

Size: FS4 with IP20 degree of protection

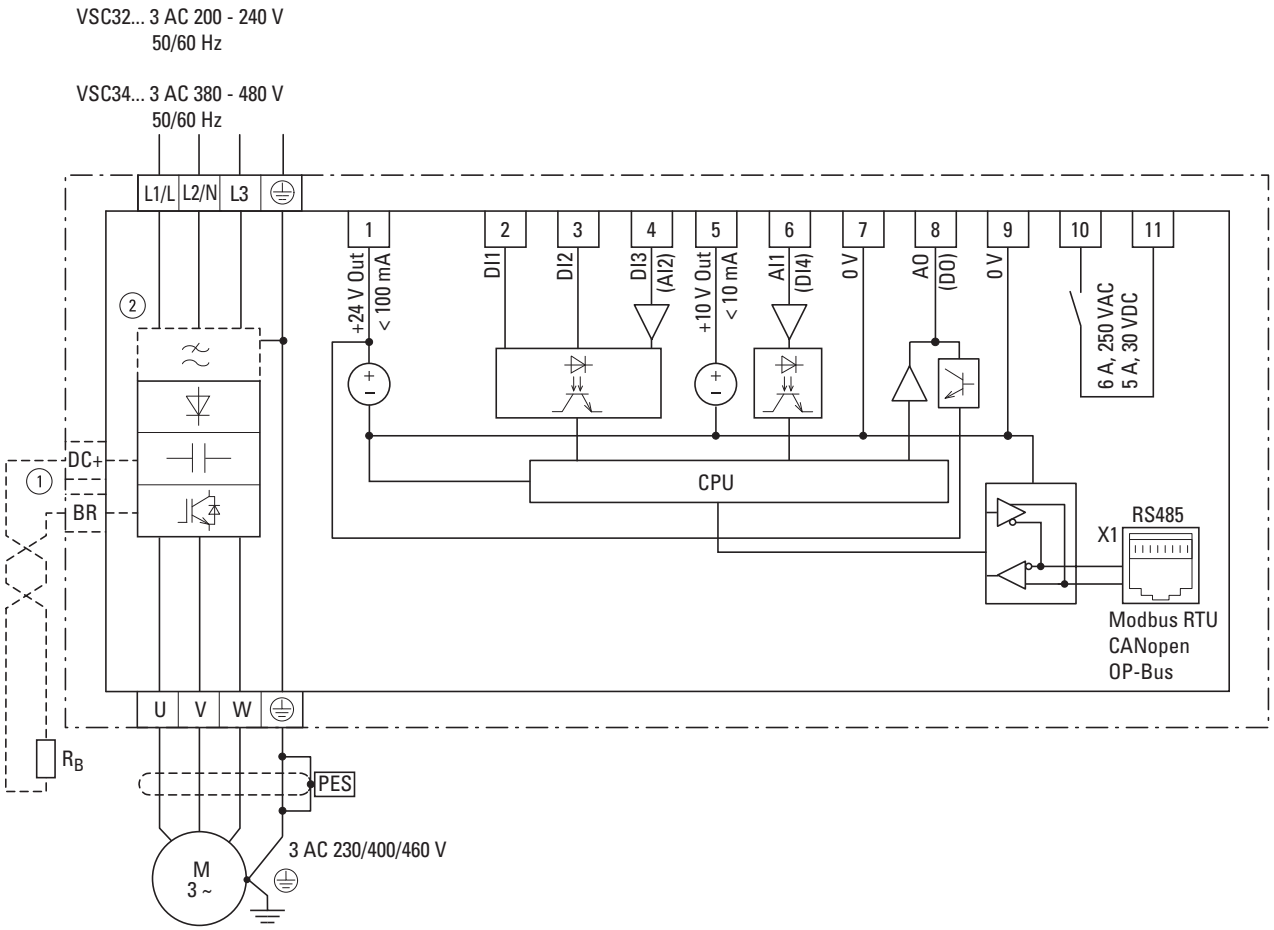


Figure 70. Block diagram VSC32…A66…, VSC34…A66…

① Frame sizes FS2 and FS3 with connection for external brake resistors

② VSC32xxx**N**…: without radio interference suppression filter
VSC32xxx**F**…: with built-in radio interference suppression filter

Insulation testing

The variable speed drive of the VSC series are tested, delivered and require no additional testing.

⚠ CAUTION

On the control signal and the connection terminals of the variable speed drive, no leakage resistance tests are to be performed with an insulation tester.

⚠ CAUTION

Wait at least 5 minutes after switching the supply voltage off before you disconnect one of the connection terminals (L1/L, L2/N, L3, DC-, DC+, BR) of the variable speed drive.

If insulation testing is required in the power circuit of the PDS, you must consider the following measures.

Testing the motor cable insulation

- Disconnect the motor cable from the connection terminals U, V and W of the variable speed drive and from the motor (U, V, W). Measure the insulation resistance of the motor cable between the individual phase conductors and between the phase conductor and the grounding conductor.

The insulation resistance must be greater than 1 MΩ.

Testing the mains cable insulation

- Disconnect the power cable from the mains supply network and from the connection terminals 1/L, L2/N and L3 of the variable speed drive. Measure the insulation resistance of the mains cable between the individual phase conductors and between each phase conductor and the protective conductor.

The insulation resistance must be greater than 1 MΩ.

Testing the motor insulation

- Disconnect the motor cable from the motor (U, V, W) and open the bridge circuits (star or delta) in the motor terminal box. Measure the individual motor windings' insulation resistance. The measurement voltage must at least match the rated operating voltage of the motor but is not to exceed 1000 V.

The insulation resistance must be greater than 1 MΩ.

Note: Consider the notes from the motor manufacturer in testing the insulation resistance.

Protection against electric shock

Ensuring protection against electric shock when using DA1 variable speed drives, as per IEC/EN 61800-5-1

Manufacturer's declaration for the initial verification as per IEC/HD 60364-6 (DIN VDE 0100-600 (VDE 0100-600)) and for periodic testing as per EN 50110-1 (DIN VDE 0105-100 (VDE 0105-100))

Fault protection in accordance with IEC/HD 60364-4-41 (DIN VDE 0100-410 (VDE 0100-410)) for the output-side circuits of the aforementioned apparatus is guaranteed provided that the following requirements are met:

- The installation instructions in this documentation have been observed.
- The applicable standards in the IEC/HD 60364 (DIN VDE 0100 (VDE 0100) series have been observed.
- The continuity of all associated protective conductors and equipotential bonding conductors, including the corresponding connection points, has been ensured.

Provided that the above requirements are met, the aforementioned apparatus meets the requirements in IEC/HD 60364-4-41 (DIN VDE 0100-410 (VDE 0100-410):2007-06, section 411.3.2.5) when using the "automatic power supply shutdown" protective measure.

The note is based on the following information:

In the event of a short-circuit with negligible impedance to a protective conductor or to earth, the aforementioned apparatus will reduce the output voltage within a time as required in table 41.1 or within 5 seconds – depending on the applicable scenario – as per IEC/HD 60364-41 (DIN VDE 0100-410; VDE 0100-410):2007-06).

Operational

Checklist for commissioning

Before placing the frequency converter into operation, use the checklist below to make sure that all the following requirements are met:

Table 29. Checklist

No.	Activity	Note
1	Mounting and wiring have been carried out in accordance with the corresponding instruction leaflet	
2	All wiring and line section leftovers, as well as all the tools used, have been removed from the variable speed drive's proximity.	
3	All connection terminals in the power section and in the control section were tightened with the specified torque.	
4	The lines connected to the output terminals (U, V, W, DC+, DC-, BR) of the variable speed drive are **not** short-circuited and are **not** connected to earth (PE).	
5	The variable speed drive has been earthed properly (PE).	
6	All electrical connections in the power section (L1/L, L2/N, L3, U, V, W, DC+, DC-, BR, PE) have been connected properly while taking into account the degree of protection and have been dimensioned in line with the corresponding requirements.	
7	Each single phase of the supply voltage (L or L1, L2, L3) is protected with a fuse.	
8	The variable speed drive and the motor are adapted to the mains voltage. (Refer to "Rated operational data on the nameplate" on **Page 6**, connection type (star, delta) of the motor tested).	
9	The quality and volume of cooling air are in line with the environmental conditions required for the variable speed drive and the motor.	
10	All connected control cables comply with the corresponding stop conditions (i.e., switch in OFF position and setpoint value = zero).	
11	The parameters that were preset at the factory have been checked with the list of parameters.	
12	The effective direction of a coupled machine will allow the motor to start.	
13	All emergency switching off functions and safety functions are in an appropriate condition.	

Operational hazard warnings

Please observe the following notes.

⚠ DANGER

Commissioning is only to be completed by qualified technicians.

⚠ DANGER

Hazardous voltage!

The safety instructions on pages I and II must be followed.

⚠ DANGER

The components in the variable speed drive's power section are energized if the supply voltage (mains voltage) is connected. For instance: L1/L, L2/N, L3, DC+, DC-, BR, U/T1, V/T2, W/T3 power terminals.

The control signal terminals are isolated from the line power potential.

There can be a dangerous voltage on the relay terminals (10, 11) even if the variable speed drive is not being supplied with line voltage (i.e., integration of relay contacts in control systems with voltage > 48 Vac / 60 Vdc).

⚠ DANGER

The components in the variable speed drive's power section remain energized up to five (5) minutes after the supply voltage has been switched off (intermediate circuit capacitor discharging time).

Pay attention to hazard warnings!

⚠ DANGER

Following a shutdown (fault, mains voltage off), the motor can start automatically (when the supply voltage is switched back on) if the automatic restart function has been enabled (→ parameters P-31).

Notice

Any contactors and switching devices on the line side are not to be opened during motor operation. Inching operation using the mains contactor is not permitted.

Contactors and switchgear (repair and maintenance switches) on the motor side must not be opened while the motor is in operation.

Inching operation of the motor with contactors and switching devices in the output of the variable speed drive is not permissible.

Notice

Make sure that there is no danger in starting the motor. Disconnect the driven machine if there is a danger in an incorrect operating state.

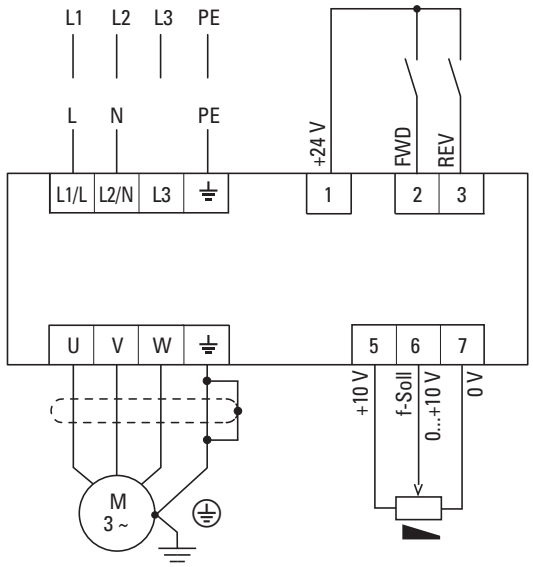
Note: If motors are to be operated with frequencies higher than the standard 50 or 60 Hz, then these operating ranges must be approved by the motor manufacturer. The motors could be damaged otherwise.

Commissioning with control signal terminals (default settings)

VSC variable speed drives come pre-configured for their rated mains voltage and motor output. Once the corresponding motor and mains voltage are connected, these drives allow for direct operation via their control signal terminals.

Simplified connecting example

VSC with IP20 degree of protection



Terminal	Designation	
L1/L	Single-phase mains connection (VSC1D…, VSC12…)	Three-phase mains connection (VSC32…, VSC34…)
L2/N		
L3	—	
⏚	Ground connection	
1	Control voltage +24 V (output, maximum 100 mA)	
2	FWD, Start release clockwise rotating field	
3	REV, Start release left rotating field	
U	Connection for three-phase ac motor (three-phase motor)	
V		
CO		
⏚		
5	Reference voltage +10 V (Output, maximum 10 mA)	
6	Frequency reference value f-Set (Input 0 – +10 V)	
7	Reference potential (0 V)	

The potentiometer should have a fixed resistance (connection to control terminals 5 and 7) of at least 1 kΩ and up to a maximum of 10 kΩ. A standard fixed resistance of 4.7 kΩ is recommended.

Note: Make sure that the enable contacts (FWD/REV) are open before switching on the mains voltage.

When the specified supply voltage is applied at the mains connection terminals (L1/L, L2/N, L3), the switched-mode power supply unit (SMPS) in the internal DC link will be used to generate the control voltage and light up the 7-segment LED display (STOP). At this point, the variable speed drive will be ready for operation (correct operating status) and in Stop mode. The start enable signal is sent by activating one of the digital inputs with +24 V:

- Terminal 1: FWD = Clockwise rotating field (Forward Run)
- Terminal 2: REV = Counterclockwise rotating field (Reverse Run)

The FWD and REV control commands are interlocked (exclusive OR) and require a rising voltage edge.

The frequency is shown with a minus sign with a start release with a left rotating field (REV).

- You can now set the output frequency (0 - 50 Hz) and, as a result, the speed of the connected three-phase motor (0 - n_{Motor}), by using the potentiometer via terminal 6 (0 - +10 V proportional voltage signal). Output frequency changes will be delayed based on the specified acceleration and deceleration times. When using the device's default settings, these times will be set to 5 seconds.

The acceleration and deceleration ramps specify the time change for the output frequency: from 0 to f_{max} (WE = 50 Hz) or from f_{max} back to 0.

Figure 71 shows an example illustrating the time response when a RUN enable signal (FWD or REV) is switched on while the maximum setpoint voltage (+10 V) is being applied at control signal terminal 6. The speed of the motor follows the output frequency, depending on the load torque and moment of inertia (slip), from zero to n_{max}.

The acceleration time is set in parameter P-03.

If the enable signal (FWD or REV) is switched off during operation, the inverter will be disabled immediately (STOP) and the output frequency will be set to zero. This will cause the motor to coast to a stop—see ① below.

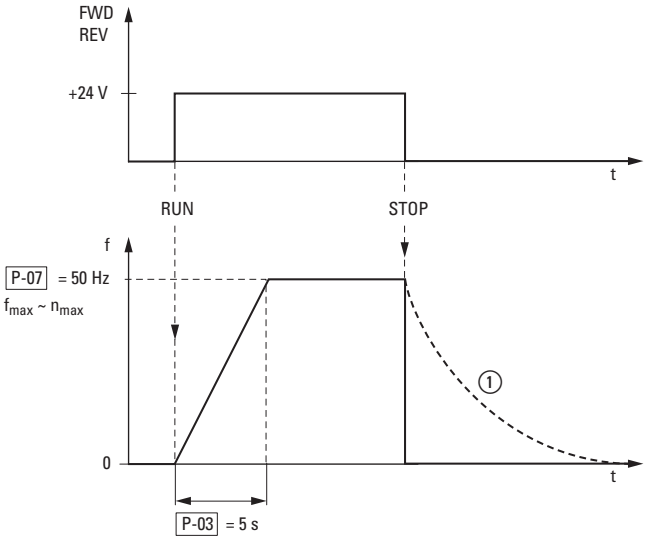


Figure 71. Start-Stop command with maximum reference voltage, acceleration ramp 5 s

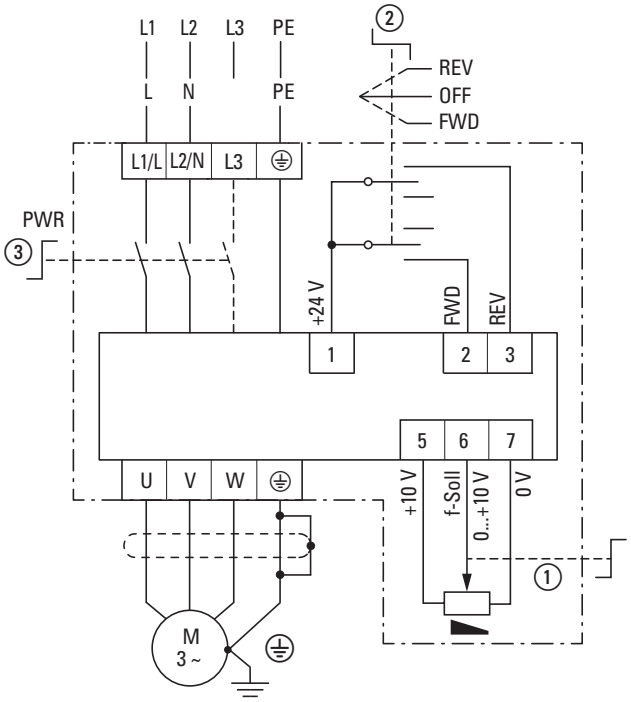
Commissioning with local controls

VSC…A6S… variable speed drives with local controls are configured and wired at the factory. They can be started directly using the local controls when the rated motor output for the mains voltage is connected (see the connecting example below).

Note: Make sure that the switches ② and ③ are open before switching on the mains voltage.

Table 30. Simplified connecting example

VSC…A6SN



Terminal	designation	
PWR	Power ③	
L1/L	Single-phase mains connection (VSC1D…, VSC12…)	Three-phase mains connection (VSC32…, VSC34…)
L2/N		
L3	—	
⏚	Ground connection	
1	Control voltage +24 V (output, maximum 100 mA)	
2	FWD, Start release clockwise rotating field ②	
3	REV, Start release left rotating field ②	
U	Connection for three-phase ac motor (three-phase motor)	
V		
CO		
⏚		
5	Reference voltage +10 V (Output, maximum 10 mA)	
6	Frequency reference value f-Set (Input 0 – +10 V) ①	
7	Reference potential (0 V)	

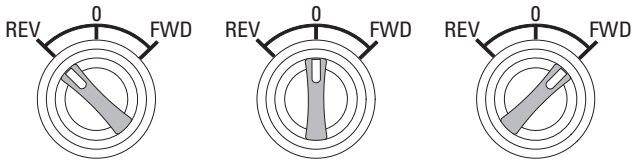
When the specified supply voltage is applied at the mains connection terminals (L1/L, L2/N, L3) and the main switch (PWR ③) on the mains side is switched on, the switched-mode power supply unit (SMPS) in the DC link will be used to generate the control voltage and the 7-segment LED display will light up (StoP). At this point, the variable speed drive will be ready for operation (correct operating status) and in Stop mode. The start enable signal can then be issued by selecting a rotating field direction ②:

- FWD = Clockwise rotating field (Forward Run)
- REV = Counterclockwise rotating field (Reverse Run)

At this point, the output frequency (0 - 50 Hz), and the speed of the connected three-phase motor (0 - n_{Motor}) as a result, can be adjusted by using the internal setpoint potentiometer ①. Output frequency changes will be delayed based on the specified acceleration and deceleration times. When using the device's default settings, these times will be set to 5 seconds.

Example

Table 31. Selector switch for VSC…A6S…

Switch position			Mode parameter		Description
			P-12	P-15	
Default Setting					
REV (Counterclockwise rotation field)	**STOP**	**FWD** (Clockwise rotation field)	0	5	Speed control with the setpoint potentiometer on the front ①
Only one operating direction					
STOP	**STOP**	**FWD** (Clockwise rotation field)	0	0	Speed control with the setpoint potentiometer on the front ①
Application: Aeration/De-aeration					
REV (Counterclockwise rotating field) with fixed frequency	**STOP**	**FWD** (Clockwise rotating field) with potentiometer	0	5	**Requirement:** Control signal terminals 3 (DI2) and 4 (DI3) are connected with a jumper. A fan is used to supply and remove air, with the specific action depending on the operating direction being used. In one of these operating modes (i.e., supplying air, FWD via DI1), the fan speed can be variably adjusted by using the internal setpoint potentiometer ①. In the other (removing air, REV via DI2 and DI3), the fan is run with the speed configured as a set value in parameter P-20 (default setting = 15 Hz).

Handling the keypad

The keypad can be used to configure the VSC variable speed drive's parameters and monitor its operation.

Operating unit elements

The following figure shows the elements of the VSC variable speed drive integrated operating unit.

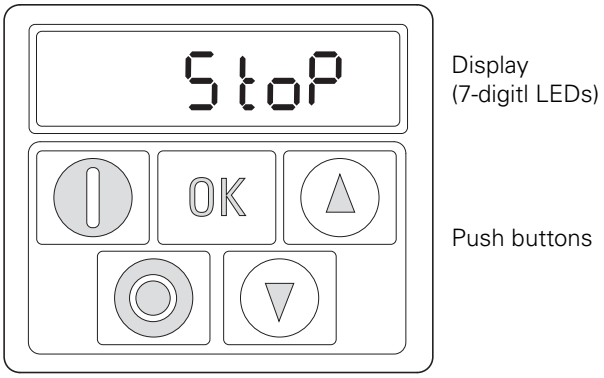


Figure 72. Operating unit view (example VSC…A20…)

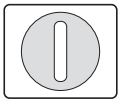
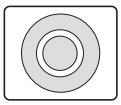
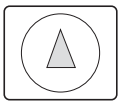
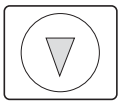
Note: On OLED displays, languages can be selected by pressing **START** + ▲ simultaneously.

Display: **Select Language**.

The display language can be changed with the ▲ and ▼ arrow keys. The selected language setting can then be saved by pressing the **OK** button.

Note: If you want to use the **START** and **STOP** buttons to control the VSC variable speed drive, the corresponding setting needs to be enabled in parameter P-12 ("Local process data source") regardless of which keypad type or model is being used (integrated DX-KEY-LED2 or external DX-KEY-OLED)

Table 32. Keypad buttons

Button	Attribute ID	Explanation
	**OK**	Navigating in parameter mode Opens and closes the parameter interface (press the button and hold it down for more than two seconds) Saves parameter changes Changes the value being displayed: A, rpm, etc. (real-time information)
	**START**	Starts the variable speed drive ① Changes the operating direction ② if the motor is running
	**STOP**	Stops the variable speed drive ① Reset – Resetting after fault message
	**UP**	Increases the speed ① Increment numeric value or parameter number
	**DOWN**	Decreases the speed ① Decrement numeric value or parameter number

① P-12 = 1 (one operating direction) or P-12 = 2 (two operating directions);
The operating direction will be reversed when the START button is pressed
② Only if P-12 = 2

Parameter structure

Table 33. Parameter groups

Parameter group	Value range	Part no.	Access rights
Display values	P00-01–P00-20	VSC…	ro
	P00-21–P00-50	VSC	ro
Basis parameters	P-01 – P-14	VSC…	rw
Expansion	P-15 – P-55	VSC…	rw
Expansion, version 1	P-60 – P-68	VSC	rw

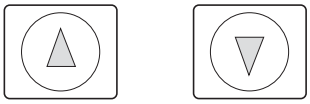
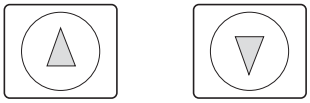
Parameter P-14 is used to control access to all parameter groups:

- P-14 = P-37 (default setting: 101): enables access to the extended parameter set (up to P-55 and up to P00-20)
- P-14 = P-37 + 100 (default setting: 201): enables access to the extended parameter set for version 1 (up to P-68 and up to P00-50)

Keypad usage examples

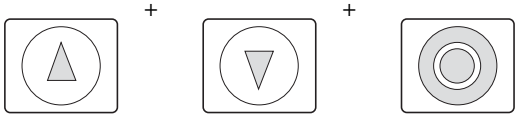
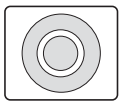
Adjust parameters

Table 34. Modify parameters

Commands	Description
	Press the **OK** button and hold it down for two seconds in order to access the parameter interface. → The display will show the parameter that was last used.
	Use the ▲ and ▼ buttons to select a parameter.
	Press the **OK** button. The value of the selected parameter can be changed.
	Use the ▲ and ▼ buttons to change the parameter's value.
	Press the **OK** button to confirm the parameter value change. As soon as the parameter is displayed, the value will have been saved. Press the **OK** button and hold it down for two seconds in order to exit the parameter interface (display: "Stop").

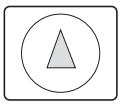
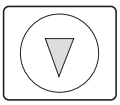
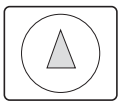
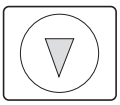
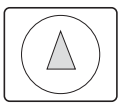
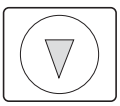
Resetting parameters (RESET)

Table 35. Resetting parameters (RESET)

Commands	Description
Reset to default settings	
	Press the ▲ and ▼ and STOP buttons and hold them down for two seconds. → **All parameters will be restored to their default settings.** The display will show P-dEF.
Resetting after a fault	
	Press the **STOP** button to reset a fault message. The display will show StoP.

Extended parameter set

Table 36. Enabling and disabling access to the extended parameter set

Commands	Description
Enabling access to the extended parameter set	
	Press the **OK** button and hold it down for two seconds in order to access the parameter interface The display will show the parameter that was last used.
 	Use the ▲ and ▼ buttons to select parameter P-14
	Press the **OK** button.
 	Use the ▲ and ▼ buttons to enter the password set with P-37 (default setting: 101)
	Press the **OK** button to confirm The extended parameter set (parameters > P-14 and display values P00-…) will now be available.
Disabling access to the extended parameter set	
 	Use the ▲ and ▼ buttons to set a value for P-14 that does not match the password (P-37).
	Press the **OK** button to confirm Only the “basic parameters”, P-01 to P-14, will be accessible now.

Note: The extended parameter set (default setting for P-37 = 101) contains parameters P-01 to P-55.

Additional parameters P-60 to P-68 can be configured for specific applications. The corresponding password is 201 in parameter P-37 (value of P37 + 100).

Help leaflets

VSC variable speed drives come with two help cards that show the most important control connections and parameters. This makes it possible to quickly and easily commission the drives with their default settings when using the rated motor output ("out-of-the-box operation").

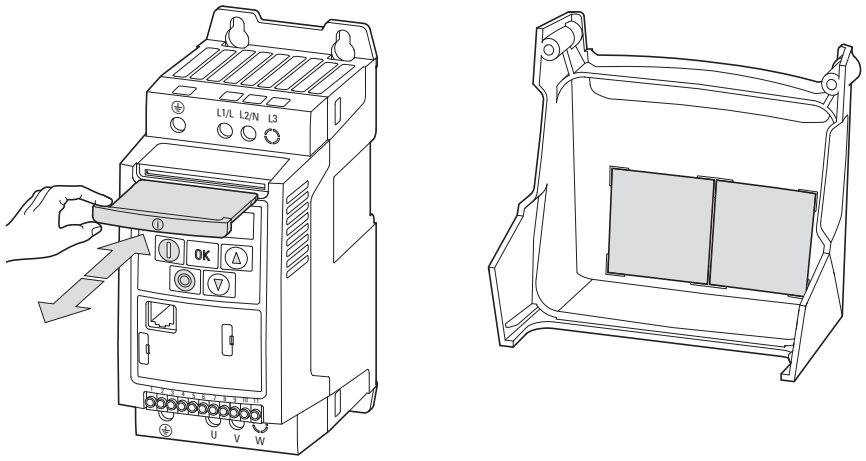


Figure 73. Help cards in units with an IP20 (left) or IP66 (right) degree of protection

In the case of devices with an IP20 degree of protection, the help cards will be inserted in place above the keypad. In the case of devices with an IP66 degree of protection, they will be found on the inside of the terminal cover.

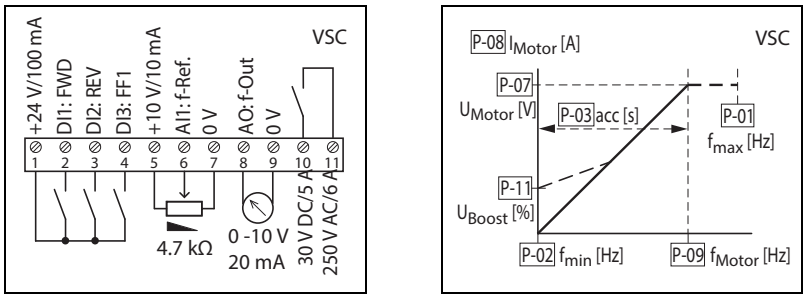


Figure 74. Help cards

Table 37. Control connections with default settings (help card)

Control signal terminal	Signal	Description	
1	+24 V	Control Voltage	Output voltage
2	DI1	Digital Input 1	FWD = clockwise rotating field enable (U → V → W)
3	DI2	Digital input 2	REV = counterclockwise rotating field enable (W → V → U)
4	DI3	Digital Input 3	FF1 = Switch from analog setpoint AI1 (control signal terminal 6) to fixed frequency value f-Fix1 in parameter P-20 (15 Hz)
5	+10V	Reference voltage	Output voltage
6	AI1	Analog Input 1	Reference voltage: 0–10 V = 0–50 Hz (Rotating field frequency)
7	0 V	Reference potential	for +24 V and + 10 V, 0 V = Control signal terminal 9
8	AO	Analog output	Frequency actual value: 0–50 Hz = 0–10 V (output voltage)
9	0 V	Reference potential	for +24 V and + 10 V, 0 V = Control signal terminal 7
10	relay	Contact N/O	RUN = Run signal (operating signal); closed when there is an enable signal at DI1 or DI2.
11			

Note: When the active enable signal (FWD or REV) is switched off, the motor will coast to a stop with the default settings.

Table 38. Default settings for basic parameters (help card)

Mode parameter	Designation	Description		
P-01	f_{max}	f-max	Hz	Maximum output frequency; can be set to any value between f-min (P-02) and the motor's rated frequency (P-09); maximum setting: 5 x P-09
P-02	f_{min}	Min Frequency	Hz	Minimum output frequency, can be set to any value between 0 and f-max (P-01)
P-03	acc	t-acc	s	Acceleration time from stop to rated frequency (P-09).
P-07	U_{Motor}	Motor Nom Voltage	V	Defined rated motor voltage at rated frequency (P-09) = Mains voltage (U_{LN})
P-08	I_{Motor}	Motor Nom Current	A	Rated operational current for the VSC variable speed drive. The motor protection function can be adjusted to match the motor being used by setting this parameter to the rated motor current (see **Figure 75**).
P-09	f_{Motor}	Motor Nom Frequency	f	Rated motor frequency (50 Hz) at the rated motor voltage (P-07)
P-11	V_{Boost}	V-Boost	%	Voltage is used to increase the applied motor voltage at low output frequency, in order to improve low speed and starting torque.

When the VSC variable speed drive is used with its default settings, parameter P-08 will show the drive's rated operational current. The motor protection function can be adjusted to match the motor being used by changing this value to the rated motor current. If the motor current exceeds the value set in P-08, the dots on the display (I x t) will flash to indicate that there is an overload. If this overload is present for a prolonged period of time, the VSC variable speed drive will switch off the output in order to protect the motor, and the display will show I.t-trP in order to indicate this. At this point, the motor will coast to a stop.

The computed value for the thermal motor model may be saved depending on how parameter P-51 has been configured.

Table 39. Thermal memory (T-Memory Enable)

P-51	Storage function	Description
0	OFF	The computed thermal model for the motor will be deleted when the supply voltage is switched off (= default setting).
1	ON	The computed thermal model for the motor will be automatically saved when the supply voltage is switched off and used again when the supply voltage is switched back on.

Example of a motor rating plate

VSC3402D3… variable speed drive (rated operational current of 2.3 A) for three-phase mains connection with a voltage of 400 V.

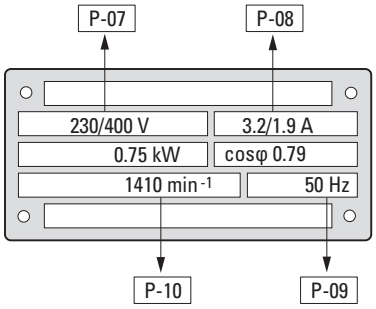


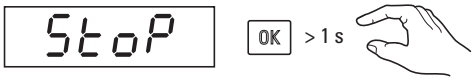
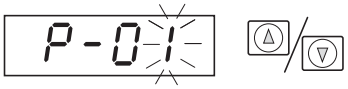
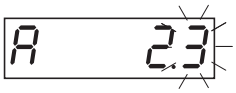
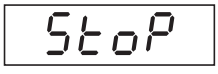
Figure 75. Motor rating plate, P-08 = 1.9 A at 400 V

Note: This motor needs to be connected with a star configuration.

Example (adjust the motor protection function)

The following example shows how to adjust the motor protection function:

Table 40. Adjust motor protection function

View	Explanation
	Operating state Stop Press the **OK** button and hold it down for about two seconds.
	Use the ▲ (Up) or ▼ (Down) arrow key to select parameter P-08.
	Press the **OK** button to confirm.
	The rated operational current (2.3 A) for the VSC342D3 variable speed drive will be displayed.
	Press the ▼ (Down) arrow key four times in order to set the appropriate rated motor current (1.9 A with 400 V). The motor protection function will be adjusted so as to match the motor being used
	Press the **OK** button and hold it down for about two seconds to confirm.

Control signal terminals

Correspondence between inputs/outputs and terminals

Table 41. Input/output and terminals correspondence

Input/Output	Terminals
Entries	
DigIN: 1	Terminal 2
DI2	Terminal 3
DI3/AI2	Terminal 4
DI4/AI1	Terminal 6
Outputs	
AO1/DO1	Terminal 8
RO1 (relay, N/O)	Terminals 10/11

Parameter P-15 can be used to select the configuration for the control signal terminals. More specifically, you can select predefined terminal configurations by setting P-15 to a value between 0 and 13.

The setting (digital/analog) for terminals 4 and 6 will be configured automatically based on the value set for P-15.

The following abbreviations are used throughout this document:

Table 42. Abbreviations

Abbreviation	Significance
AI1 REF	Analog input AI1 (terminal 6) Used as a speed setpoint input. • P-16: configuration (voltage input, current input etc.) • P-35: scaling • P-39: offset
AI2 REF	Analog input AI2 (terminal 4) Used as a speed setpoint input. • P-47: configuration (voltage input, current input etc.)
DIR	Used to select an operating direction Used together with the START command. • Low = Forward (FWD) • High = Counterclockwise operation (REV) • Hint: If there is a wire breakage and the REV operating direction is selected, this will cause the drive to reverse! Alternative: Use configuration with FWD/REV.
DOWN	Used to reduce the speed if a digital setpoint value is selected (P-12 = 1 or = 2). Used together with the UP command.
ENA	variable speed drive enable signal A start signal (START, FWD, REV) is additionally required for starting. If ENA is removed, the drive will coast.
EXTFLT	Ext Fault/Warning Can be used to integrate an external signal into the variable speed drive's fault messages. During operation, there must be a high-level signal at the terminal. If the unit detects a low-level signal instead, the drive will be switched off and display E-trip as a fault message.
FWD	Used to start the drive in the forward direction (FWD = Forward) If a high-level signal is applied at the corresponding terminal, the drive will accelerate with the selected ramp. Removing the signal will cause the drive to stop. In this case, the specific way in which it stops will depend on the value set for P1-05 (stop mode). Once the variable speed drive stops, it will be locked. In applications with two operating directions, the reverse direction can be selected with REV. FWD and REV are XOR'd. If both signals are applied simultaneously, the drive will ramp down to zero with the quick stop ramp (P-24).
INV	Used to reverse the operating direction The operating direction will be reversed as per the configured ramps: Low = do not reverse, High = invert

Table 42. Abbreviations, continued

Abbreviation	Significance
Pulse FWD (NO) Pulse REV (NO) Pulse STOP (NC)	Pulse control Used to control the drive like a latching reversing contactor circuit. The Pulse STOP signal must always be present when operating the drive. If the signal is not present, it will not be possible to start the drive / the drive will ramp down to zero. To start, all that is required is a pulse via the FWD (forward) or REV (reverse) signal. The FWD and REV signals do not need to be continuously applied during operation.
REV	Used to start the drive in the reverse direction (REV = Reverse) If a high-level signal is applied at the corresponding terminal, the drive will accelerate with the selected ramp. Removing the signal will cause the drive to stop. In this case, the specific way in which it stops will depend on the value set for P-05 (stop mode). Once the variable speed drive stops, it will be locked. In applications with two operating directions, the forward direction is selected with FWD. FWD and REV are XOR'd. If both signals are applied simultaneously, the drive will ramp down to zero with the quick stop ramp (P-24).
Select AI1 REF/AI2 REF	Used to select between the analog setpoint values on AI1 (terminal 6) and AI2 (terminal 4) • AI1 = Low • AI2 = High
Select AI1 REF/f-Fix	Used to select between the analog speed reference value at analog input 1 (AI1 = terminal 6) and a fixed frequency. The fixed frequency itself is selected with the Select f-Fix Bit0, Select f-Fix Bit1, Select f-Fix Bit2 commands. • Low = analog setpoint value • High = fixed frequency
Select AI1 REF/f-Fix1	Used to select between the analog speed reference value at analog input 1 (AI1 = terminal 6) and fixed frequency 1 (f-Fix1), which is set with P-20. • Low = analog setpoint value • High = Preset Speed 1
Select AI1 REF/f-Fix2	Used to select between the analog speed reference value at analog input 1 (AI1 = terminal 6) and the fixed frequency (f-Fix2) set with P-21. • Low = Analog setpoint value • High = f-Fix2
Select BUS REF/AI1 REF	Used to select between setpoint values • Low = Speed reference value from bus • High = AI1
Select BUS REF/DIG REF	Used to select between setpoint values • Low = Speed reference value from bus • High = fixed frequency The fixed frequency itself is selected with the Select f-Fix Bit0, Select f-Fix Bit1 commands.
Select BUS REF/f-Fix1	Used to select between the setpoint value from the bus and fixed frequency 1 (f-Fix1), which is set with P-20 • Low = Speed reference value from bus • High = Preset Speed 1
Select BUS REF/f-Fix4	Used to select between the setpoint value from the bus and fixed frequency 4 (f-Fix4), which is set with P-23 • Low = Setpoint value from bus • High = f-Fix4
Select DIG REF/AI1 REF	Used to select between the digital speed reference value, set with the keypad or with the UP and DOWN commands, and analog setpoint value AI1 REF (terminal 6) • Low = digital setpoint value • High = AI1
Select DIG REF/f-Fix1	Used to select between the digital speed reference value, set with the keypad or with the UP and DOWN commands, and fixed frequency 1 (f-Fix1) set with P-20. • Low = digital setpoint value • High = Preset Speed 1
Select DIG REF/f-Fix4	Used to select between the digital speed reference value (set with the keypad or with the UP and DOWN commands) and fixed frequency 4 (f-Fix4), which is set with P-23 • Low = Digital setpoint value • High = f-Fix4

Table 42. Abbreviations, continued

Abbreviation	Significance
Select f-Fix Bit0/f-Fix Bit1	Used to select a fixed frequency with digital commands Fixed frequencies f-Fix1, …, f-Fix4 are defined with parameters P-20 up to P-23. **Fixed frequency** / **Bit 1** / **Bit 0** f-Fix1 (P-20) / 0 / 0 f-Fix2 (P-21) / 0 / 1 f-Fix3 (P-22) / 1 / 0 f-Fix4 (P-23) / 1 / 1 0 = Low 1 = High
Select f-Fix/BUS REF	Used to select between a fixed frequency and the setpoint value from the bus. • Low = Fixed frequency • High = Setpoint value from bus
Select f-Fix/DIG REF	Used to select between a fixed frequency and the digital setpoint value, which is set with the keypad or with the UP and DOWN commands. • Low = Fixed frequency • High = Digital setpoint value
Select f-Fix/f-max	Used to select between a fixed frequency and the maximum speed set with P-01. • Low = Fixed frequency • High = maximum speed • The fixed frequency itself is selected with the Select f-Fix Bit0 or Select f-Fix Bit1 commands.
Select f-Fix2/f-Fix4	Used to select between f-Fix2 and f-Fix4 • Low = f-Fix2 • High = f-Fix4
Select f-Fix4/AI1 REF	Used to select between f-Fix4 and the analog setpoint value (terminal 6) • Low = f-Fix4 • High = Analog setpoint value
Select f-Fix4/BUS REF	Used to select between fixed frequency f-Fix4 (P-23) and the setpoint value from the bus • Low = f-Fix4 • High = Setpoint value from bus
Select f-Fix4/DIG REF	Used to select between fixed frequency f-Fix4 (P-23) and the digital setpoint value, which is set with the keypad or with the UP and DOWN commands • Low = f-Fix4 • High = Digital setpoint value
Select f-Fix4/f-Fix2	Used to select between f-Fix4 and f-Fix2 • Low = f-Fix4 • High = f-Fix2
Select f-Fix4/PI REF	Used to select between fixed frequency 4 (f-Fix4) and the setpoint value from the PI controller's output • Low = f-Fix4 • High = Setpoint value from PI controller output
Select Fire Mode/Normal OP	The fire mode function allows the variable speed drive to keep running in emergency situations until it is no longer able to work. When this mode is selected, drive fault signals will be ignored. • Low = Fire mode • High = Normal mode
Select PI REF/AI1 REF	Used to select between setpoint values • Low = setpoint from the PI controller's output • High = AI1
Select PI REF/f-Fix1	Used to select between setpoint values • Low = setpoint from the PI controller's output • High = f-Fix1, set with P-20
Select t-dec/t-Quick-dec	This command must be present (there must be a high-level signal at the corresponding terminal) in order to be able to run the variable speed drive. If the signal is removed (low level), the unit will immediately do a quick stop with the ramp defined in P-24.

Table 42. Abbreviations, continued

Abbreviation	Significance
START	Used to start/stop the drive If a high-level signal is applied at the corresponding terminal, the drive will accelerate with the selected ramp. Removing the signal will cause the drive to stop. In this case, the specific way in which it stops will depend on the value set for P-05 (stop mode). Once the variable speed drive stops, it will be locked. In applications with two operating directions, the directions are selected using the DIR and INV commands.
START INV	In applications in which the keypad is used to set a setpoint value: When the START command is issued, the drive will start running in the operating direction that was last selected. If START INV is used to start the drive, the drive will run in the opposite direction.
UP	Used to increase the speed if a digital setpoint is selected (P-12 = 1 or = 2). Used together with the DOWN command.

Configuration of the control signal terminals

P-12 = 0: Terminal-based operation

Table 43. P-12 = 0: Terminal-based operation

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	START	DIR	Select AI1 REF/f-Fix1	AI1 REF
1	FWD	Select AI1 REF/f-Fix	Select f-Fix Bit0	AI1 REF
2	FWD	Select f-Fix Bit0	Select f-Fix Bit1	Select f-Fix/f-max
3	FWD	Select AI1 REF/f-Fix1	EXTFLT	AI1 REF
4	FWD	Select AI1 REF/AI2 REF	AI2 REF	AI1 REF
5	FWD	REV	Select AI1 REF/f-Fix1	AI1 REF
6	START	DIR	EXTFLT	AI1 REF
7	FWD	REV	EXTFLT	AI1 REF
8	START	DIR	Select f-Fix Bit0	Select f-Fix Bit1
9	FWD	REV	Select f-Fix Bit0	Select f-Fix Bit1
10	Pulse FWD (NO)	Pulse STOP (NC)	Select AI1 REF/f-Fix1	AI1 REF
11	Pulse FWD (NO)	Pulse STOP (NC)	Pulse REV (NO)	AI1 REF
12	FWD	Select t-dec/t-QuickDec	Select AI1 REF/f-Fix1	AI1 REF
13	FWD	Select f-Fix Bit0	EXTFLT	Select f-Fix Bit1
14	Pulse FWD (NO)	Pulse STOP (NC)	Pulse REV (NO)	Select DIG REF/f-Fix1
15	FWD	Select f-Fix4/AI1 REF	Select Fire Mode/Normal OP	AI1 REF
16	FWD	Select f-Fix4/f-Fix2	Select Fire Mode/Normal OP	DIR
17	FWD	Select f-Fix Bit0	Select Fire Mode/Normal OP	Select f-Fix Bit1

The setpoint and the control commands are set/issued via terminals.

P-12 = 1: digital setpoint value, 1 operating direction

Table 44. P-12 = 1: digital setpoint value, 1 operating direction

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	START	UP	DOWN	DIR
1	Not permissible			
2	FWD	UP	DOWN	Select DIG REF/f-Fix1
3	FWD	UP	EXTFLT	DOWN
4	START	UP	Select DIG REF/AI1 REF	AI1 REF
5	Not permissible			
6	START	DIR	EXTFLT	Select DIG REF/f-Fix1
7	FWD	REV	EXTFLT	Select DIG REF/f-Fix1
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	FWD	No function	EXTFLT	No function
14	Not permissible			
15	FWD	Select f-Fix/DIG REF	Select Fire Mode/Normal OP	Select f-Fix4/f-Fix2
16	FWD	Select f-Fix4/DIG REF	Select Fire Mode/Normal OP	DIR
17	FWD	Select DIG REF/f-Fix4	Select Fire Mode/Normal OP	DIR

The setpoint value is set using the keypad = digital setpoint value. The arrow buttons are used to adjust the setpoint value.

P-12 = 2: digital setpoint value, 2 operating directions

Table 45. P-12 = 2: digital setpoint value, 2 operating directions

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	START	UP	DOWN	DIR
1	Not permissible			
2	FWD	UP	DOWN	Select DIG REF/f-Fix1
3	FWD	UP	EXTFLT	DOWN
4	START	UP	Select DIG REF/AI1 REF	AI1 REF
5	Not permissible			
6	START	DIR	EXTFLT	Select DIG REF/f-Fix1
7	FWD	REV	EXTFLT	Select DIG REF/f-Fix1
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	FWD	No function	EXTFLT	No function
14	Not permissible			
15	FWD	Select f-Fix/DIG REF	Select Fire Mode/Normal OP	Select f-Fix4/f-Fix2
16	FWD	Select f-Fix4/DIG REF	Select Fire Mode/Normal OP	DIR
17	FWD	Select DIG REF/f-Fix4	Select Fire Mode/Normal OP	DIR

The setpoint value is set using the keypad = digital setpoint value. The arrow buttons are used to adjust the setpoint value.

P-12 = 2: If the motor is running, pressing the green button again will reverse the operating direction. The last operating direction will be stored when the unit is switched off.

P-12 = 3: Control via Modbus with internal acceleration and deceleration ramps

Table 46. P-12 = 3: Control via Modbus with internal acceleration and deceleration ramps

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	START	No function	No function	No function
1	Not permissible			
2	Not permissible			
3	START	Select BUS REF/f-Fix1	EXTFLT	No function
4	Not permissible			
5	Not permissible			
6	START	Select BUS REF/AI1 REF	EXTFLT	AI1 REF
7	START	Select BUS REF/DIG REF	EXTFLT	No function
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	START	No function	EXTFLT	No function
14	Not permissible			
15	FWD	Select f-Fix/BUS REF	Select Fire Mode/Normal OP	Select f-Fix4/f-Fix2
16	FWD	Select f-Fix4/BUS REF	Select Fire Mode/Normal OP	No function
17	FWD	Select DIG REF/f-Fix4	Select Fire Mode/Normal OP	No function

P-12 = 4: Control via Modbus, ramps via Modbus

Table 47. P-12 = 4: Control via Modbus, ramps via Modbus

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	START	No function	No function	No function
1	Not permissible			
2	Not permissible			
3	START	Select BUS REF/f-Fix1	EXTFLT	No function
4	Not permissible			
5	Not permissible			
6	START	Select BUS REF/AI1 REF	EXTFLT	AI1 REF
7	START	Select BUS REF/DIG REF	EXTFLT	No function
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	START	No function	EXTFLT	No function
14	Not permissible			
15	FWD	Select f-Fix/BUS REF	Select Fire Mode/Normal OP	Select f-Fix4/f-Fix2
16	FWD	Select f-Fix4/BUS REF	Select Fire Mode/Normal OP	No function
17	FWD	Select DIG REF/f-Fix4	Select Fire Mode/Normal OP	No function

P-12 = 5: PI controller

Table 48. P-12 = 5: PI controller

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	FWD	Select PI REF/f-Fix1	PI feedback	No function
1		Select PI REF/AI1 REF	PI feedback	AI1 REF
2	Not permissible			
3	FWD	Select PI REF/f-Fix1	EXTFLT	PI feedback
4	Not permissible			
5	Not permissible			
6	Not permissible			
7	Not permissible			
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	Not permissible			
14	Not permissible			
15	FWD	Select f-Fix4/PI REF	Select Fire Mode/Normal OP	No function
16 ①	FWD	Select f-Fix4/f-Fix2	Select Fire Mode/Normal OP	No function
17 ①	FWD	Select f-Fix2/f-Fix4	Select Fire Mode/Normal OP	No function

① If P-15 = 16 or 17, the fixed frequencies will only be enabled in fire mode.

P-12 = 6: PI controller with AI1 totaling

Table 49. P-12 = 6: PI controller with AI1 totaling

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	FWD	Select PI REF/f-Fix1	PI feedback	No function
1		Select PI REF/AI1 REF	PI feedback	AI1 REF
2	Not permissible			
3	FWD	Select PI REF/f-Fix1	EXTFLT	PI feedback
4	Not permissible			
5	Not permissible			
6	Not permissible			
7	Not permissible			
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	Not permissible			
14	Not permissible			
15	FWD	Select f-Fix4/PI REF	Select Fire Mode/Normal OP	No function
16 ①	FWD	Select f-Fix4/f-Fix2	Select Fire Mode/Normal OP	No function
17 ①	FWD	Select f-Fix2/f-Fix4	Select Fire Mode/Normal OP	No function

① If P-15 = 16 or 17, the fixed frequencies will only be enabled in fire mode.

P-12 = 7: Control via CAN with internal acceleration and deceleration ramps

Table 50. P-12 = 7: Control via CAN with internal acceleration and deceleration ramps

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	START	No function	No function	No function
1	Not permissible			
2	Not permissible			
3	START	Select BUS REF/f-Fix1	EXTFLT	No function
4	Not permissible			
5	Not permissible			
6	START	Select BUS REF/AI1 REF	EXTFLT	AI1 REF
7	START	Select BUS REF/DIG REF	EXTFLT	No function
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	START	No function	EXTFLT	No function
14	Not permissible			
15	FWD	Select f-Fix/BUS REF	Select Fire Mode/Normal OP	Select f-Fix4/f-Fix2
16	FWD	Select f-Fix4/BUS REF	Select Fire Mode/Normal OP	No function
17	FWD	Select BUS REF/f-Fix4	Select Fire Mode/Normal OP	No function

P-12 = 8: Control via CAN, ramps via Modbus

Table 51. P-12 = 8: Control via CAN, ramps via Modbus

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	START	No function	No function	No function
1	Not permissible			
2	Not permissible			
3	START	Select BUS REF/f-Fix1	EXTFLT	No function
4	Not permissible			
5	Not permissible			
6	START	Select BUS REF/AI1 REF	EXTFLT	AI1 REF
7	START	Select BUS REF/DIG REF	EXTFLT	No function
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	START	No function	EXTFLT	No function
14	Not permissible			
15	FWD	Select f-Fix/BUS REF	Select Fire Mode/Normal OP	Select f-Fix4/f-Fix2
16	FWD	Select f-Fix4/BUS REF	Select Fire Mode/Normal OP	No function
17	FWD	Select BUS REF/f-Fix4	Select Fire Mode/Normal OP	No function

P-12 = 9: SWD control + setpoint value

Table 52. P-12 = 9: SWD control + setpoint value

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	ENA	No function	No function	No function
1	Not permissible			
2	Not permissible			
3	Not permissible			
4	Not permissible			
5	Not permissible			
6	Not permissible			
7	Not permissible			
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	ENA	No function	EXTFLT	No function
14	Not permissible			
15 ①	ENA	No function	Select Fire Mode/Normal OP	No function
16 ②	ENA	Select AI1/f-Fix2	Select Fire Mode/Normal OP	AI1 REF
17	ENA	Select f-Fix Bit0	Select Fire Mode/Normal OP	Select f-Fix Bit1

① If P-15 = 15 and fire mode is active, the drive will run with fixed frequency 4 (f-Fix4), which is set with P-13.
② If P-15 = 16, the setpoint value selection will be independent from fire mode.

P-12 = 10: SWD control

Table 53. P-12 = 10: SWD control

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	FWD	No function	Select AI1 REF/f-Fix1	AI1 REF
1	FWD	Select AI1 REF/f-Fix	Select f-Fix Bit0	AI1 REF
2	FWD	Select f-Fix Bit0	Select f-Fix Bit1	Select f-Fix/f-max
3	FWD	Select AI1 REF/f-Fix1	EXTFLT	AI1 REF
4	FWD	Select AI2 REF/AI1 REF	AI2 REF	AI1 REF
5	Not permissible			
6	FWD	No function	EXTFLT	AI1 REF
7	Not permissible			
8	START	DIR	Select f-Fix Bit0	Select f-Fix Bit1
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	START	No function	EXTFLT	No function
14	Not permissible			
15 ①	ENA	No function	Select Fire Mode/Normal OP	No function
16 ②	ENA	Select AI1/f-Fix2	Select Fire Mode/Normal OP	AI1 REF
17	ENA	Select f-Fix Bit0	Select Fire Mode/Normal OP	Select f-Fix Bit1

① If P-15 = 15 and fire mode is active, the drive will run with fixed frequency 4 (f-Fix4), which is set with P-13.
② If P-15 = 16, the setpoint value selection will be independent from fire mode.

P-12 = 11: SWD setpoint value

Table 54. P-12 = 11: SWD setpoint value

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	ENA	No function	No function	No function
1	Not permissible			
2	Not permissible			
3	Not permissible			
4	Not permissible			
5	Not permissible			
6	Not permissible			
7	Not permissible			
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	ENA	No function	EXTFLT	No function
14	Not permissible			
15 ①	ENA	No function	Select Fire Mode/Normal OP	No function
16 ②	ENA	Select AI1/f-Fix2	Select Fire Mode/Normal OP	AI1 REF
17	ENA	Select f-Fix Bit0	Select Fire Mode/Normal OP	Select f-Fix Bit1

① If P-15 = 15 and fire mode is active, the drive will run with fixed frequency 4 (f-Fix4), which is set with P-13.
② If P-15 = 16, the setpoint value selection will be independent from fire mode.

P-12 = 12: SWD control + setpoint value, auto

Table 55. P-12 = 12: SWD control + setpoint value, auto

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	ENA	No function	No function	No function
1	Not permissible			
2	Not permissible			
3	Not permissible			
4	Not permissible			
5	Not permissible			
6	Not permissible			
7	Not permissible			
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	ENA	No function	EXTFLT	No function
14	Not permissible			
15 ①	ENA	No function	Select Fire Mode/Normal OP	No function
16 ②	ENA	Select AI1/f-Fix2	Select Fire Mode/Normal OP	AI1 REF
17	ENA	Select f-Fix Bit0	Select Fire Mode/Normal OP	Select f-Fix Bit1

① If P-15 = 15 and fire mode is active, the drive will run with fixed frequency 4 (f-Fix4), which is set with P-13.
② If P-15 = 16, the setpoint value selection will be independent from fire mode.

P-12 = 13: SWD control + setpoint value, DI ENA

Table 56. P-12 = 13: SWD control + setpoint value, DI ENA

P-15	DI1 (terminal 2)	DI2 (terminal 3)	DI3/AI2 (terminal 4)	DI4/AI1 (terminal 6)
0	ENA	No function	No function	No function
1	Not permissible			
2	Not permissible			
3	Not permissible			
4	Not permissible			
5	Not permissible			
6	Not permissible			
7	Not permissible			
8	Not permissible			
9	Not permissible			
10	Not permissible			
11	Not permissible			
12	Not permissible			
13	ENA	No function	EXTFLT	No function
14	Not permissible			
15 ①	ENA	No function	Select Fire Mode/Normal OP	No function
16 ②	ENA	Select AI1/f-Fix2	Select Fire Mode/Normal OP	AI1 REF
17	ENA	Select f-Fix Bit0	Select Fire Mode/Normal OP	Select f-Fix Bit1

① If P-15 = 15 and fire mode is active, the drive will run with fixed frequency 4 (f-Fix4), which is set with P-13.
② If P-15 = 16, the setpoint value selection will be independent from fire mode.

Messages

List of messages

Table 57. Messages

Message	Possible causes and fixes
StOP	Ready to start. There is no drive enable signal present. There are no fault messages present.
P-dEf	The parameters' default settings have been loaded.
O-I	Overcurrent at variable speed drive output Occurs right after switching on the unit: • Check the cable connection between the variable speed drive and the motor • Check the motor for shorted turns and ground faults • Occurs when starting the motor: • Check whether the motor can rotate freely and make sure that it is not being blocked mechanically. • Motor with mechanical brake: Check whether the brake is being applied. • Check the connection configuration (star/delta) • Check to make sure that the correct rated motor current has been entered in P-08 • Increase the acceleration ramp time (t-acc, P-03) if necessary. • Reduce the voltage boost with P-11. • Occurs during operation at a constant speed: • Check whether the motor is overloaded. • Occurs during acceleration/deceleration: • The ramp times are too short and require too much power. If P-03 / P-04 cannot be increased, a larger device may be required.
I.t-trP	Motor overload. The thermal protection mechanism has tripped as a result of the device being run above the rated motor current set with P-08 longer than a specific time. • Check to make sure that the rated motor current has been entered in P-08. • Check the motor's connection configuration (i.e., start/delta) • If the decimal points on the display flash during operation, this means that the unit is being run in its overload range (> P-08). In this case, use P-03 to make the acceleration ramp longer or reduce the load. • Check whether the motor is being blocked mechanically or whether there are any additional loads.
OI-b	Excessively high braking current • Check the brake resistor and its wiring for short-circuits and ground faults. • Make sure that the braking resistance value is not lower than the minimum permissible braking resistance.
OL-br	Thermal overload on brake resistor. The drive has been switched off in order to prevent the brake resistor from being thermally destroyed. This message will only be output if P-34 = 1 ("braking chopper") • Make the P-04 and P-24 ramp times longer in order to have less frequent braking. • Reduce the load's inertia (if possible). • If the protection achieved with P-34 = 1 is not adequate for the brake resistor being used: • Provide external protection for the brake resistor and set P-34 to a value of 2.
PS-trp	Overcurrent (Hardware) • Check the wiring to the motor and the motor itself for short-circuits and ground faults. • Disconnect the motor cable from the variable speed drive and switch the variable speed drive back on. • If the fault message still appears, the device needs to be replaced. Before commissioning the new device, check the system for short-circuits or ground faults that could have caused the device to fail.
O.Volt	Overvoltage in DC link • Check to make sure that the supply voltage falls within the range for which the variable speed drive is sized. • If the error occurs during deceleration or stopping: • Make the deceleration ramp (P-04/P-24) longer or use the brake resistor and activate the braking chopper with P-34 (only on devices with frame size FS2, FS3, or FS4).
VVolt	Undervoltage in DC link **Hint:** Generally, this message will appear when the supply voltage is switched off on the device and the DC link voltage dies away. In this case, there is no fault. If the message appears during operation: • Check whether the power supply voltage is too low. • Check all components/devices in the variable speed drive's feeder circuit (circuit-breaker, contactor, choke, etc.) to make sure they are connected properly and have an adequate contact resistance.

Table 57. Messages, continued

Message	Possible causes and fixes
O-t	Overtemperature at heat sink. The drive is too hot. • Check to make sure that the variable speed drive is being operated within the ambient temperature range specified for it (IP20 devices: max. 50 °C; IP66 devices: max. 40 °C). • Make sure that cooling air can circulate freely (clearances to neighboring devices above and below the variable speed drive). • Improve the ventilation in the control cabinet if necessary. The device's vents must not be obstructed, i.e., by dirt or as a result of devices being installed too close to each other.
V-t	Under-temperature. The message will appear if the ambient temperature falls below -10 °C. In order to be able to start the drive, the temperature must be higher than this.
th-f(t	Malfunctioning heat sink thermistor. • Please contact your nearest Johnson Controls sales branch.
E-trip	External fault (at digital input 3, terminal 4). There must be a high-level signal at this input in order to be able to run the variable speed drive. If a thermistor is connected to terminal 4: • Check whether the motor is too hot.
SC-trp	Serial communication lost • Check to make sure that the connection to other variable speed drives and external modules is set up and working correctly: every module on the bus must have its own address. There must not be two or more modules with the exact same address!
P-LOss	Incoming power phase failure (only for devices with a three-phase power supply)
SPIn-F	Speed detection before switching (on the running motor) unsuccessful.
dAtA-F	Error in internal memory. The parameters have not been saved and the default settings have been loaded. Change the parameter values (again) and save them once more. If the message appears again, please contact your nearest Johnson Controls sales branch.
4-20 F	The analog input's input current does not fall within the specified range. • Check the setting in P-16 for AI1 and P-47 for AI2 • In the case of 4-20mA: • Check the setpoint connection for wire breakage
SC-FLt	Internal error • Please contact your nearest Johnson Controls sales branch
FAVLty	Internal error • Please contact your nearest Johnson Controls sales branch

Messages after a data transfer with a DX-COM-STICK2

Table 58. Possible messages after a data transfer

View	Description
PASS-r	Parameter transfer to DX-COM-STICK2 was successful
OS-Loc	DX-COM-STICK2 locked. In order to transfer data, check the switch position on the side.
FAiL-r	Error while attempting to read the parameters from the variable speed drive.
PASS-t	Parameter transfer to variable speed drive successful.
FAiL-P	The parameter set stored in the DX-COM-STICK2 is for a different rating (different motor current, motor output, etc.) than that of the connected variable speed drive.
Fail-t	Error when attempting to copy parameter set to variable speed drive
no-dAt	No data found in DX-COM-STICK2.
dr-Loc	Parameter set in variable speed drive locked. Unlock variable speed drive first.
dr-rVn	The variable speed drive has an enable signal and cannot take new parameters. Stop the variable speed drive.
tyPE-E	The parameter set stored in the DX-COM-STICK2 does not match the variable speed drive. Only transfers from the variable speed drive to the DX-COM-STICK2 are possible.
tyPE-F	The DX-COM-STICK2 is not compatible with the variable speed drive.

Operating status indicators

The six flashing dots on the seven-segment display are used to indicate various operating statuses.

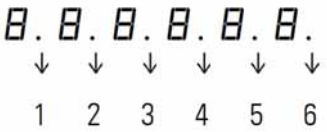


Table 59. Operating status indicators

Number(s)	Behavior	Significance
1, 2, 3, 4, 5, 6	Flash synchronously	Overload The current exceeds the value set with P-08.
1, 6	Flash in an alternating pattern	Power outage or power supply switched off
1	Flashes	Fire Mode enabled

Error messages

Introduction

VSC series variable speed drives come with several internal monitoring functions. When a deviation from the correct operating state is detected, an error message will be displayed; in the drive's default settings, the relay contact will open (control terminals 10 and 11).

Fault history

The most recent four error messages will be stored in the order in which they occurred (with the most recent one in the first place). Error messages can be read from the display-parameter P00-13.

Acknowledge error message (Reset)

To acknowledge and reset the current error message, you can either switch off the supply voltage or press the STOP pushbutton. Error messages (a maximum of four) are stored in parameter P00-13. Error messages can also be reset with a new start signal (new rising edge) at control signal terminal 2 (DI1) or 3 (DI2).

Fault log

The fault log (P00-13) stores the most recent four error messages in the order in which they occurred. The most recent error message will always be shown as the first value when P00-13 is accessed.

To see the remaining error messages one after the other, press the ▲ (Up) button. Their order will be indicated by the number of flashing dots on the 7-segment digital display assembly.

Note: The values in the fault log (P00-13) will not be deleted if the variable speed drive is reset to its default settings!

Note: In order to view parameter P00-13, you will first need to enable access to the extended parameter set: P-14 = P-37 (default setting: 101)

Fault list

The following table shows the failure codes, the possible causes and indicates corrective measures.

Table 60. Error messages list

Message	Error no. [dec]	Possible causes and fixes
Stop	—	Ready to start. There is no drive enable signal present. There are no error messages present.
OI-b	01	Excessively high braking current Check the brake resistor and its wiring for short-circuits and ground faults. Make sure that the braking resistance value is not lower than the minimum permissible braking resistance.
OL-br	02	Thermal overload on brake resistor The drive has been switched off in order to prevent the brake resistor from being thermally destroyed. Make the P1-04 and P2-25 ramp times longer in order to have less frequent braking. Reduce the load's inertia, if possible.
O-I	03	Overcurrent at variable speed drive output Occurs right after switching on the unit: Check the cable connection between inverter and motor. Check the motor for shorted turns and ground faults. Occurs when starting the motor: Check whether the motor can rotate freely and make sure that it is not being blocked mechanically. Motor with mechanical brake: Check whether the brake is being applied. Check the connection configuration (star/delta). Check to make sure that the motor data was entered correctly in P1-07, P1-08, and P1-09. In vector control mode (P4-01 = 0 or 1): Check to make sure that the cos φ (P4-05) value was entered correctly and that a motor identification run was performed correctly. Increase the acceleration ramp time (t-acc, P1-03) if necessary. In speed control mode (P4-01 = 2): Reduce the voltage boost with P1-11. Occurs during operation at a constant speed: Check whether the motor is overloaded. Occurs during acceleration/deceleration: The ramp times are too short and require too much power. If P-03/P-04 cannot be increased, a larger device may be required.
I.t-trP	04	Motor overload. The thermal protection mechanism has tripped as a result of the device being run above the rated motor current set with P1-08 longer than a specific time. Check to make sure that the motor data was entered correctly in P1-07, P1-08, and P1-09. In vector control mode (P4-01 = 0 or 1): Check to make sure that the cos φ (P4-05) value was entered correctly and that a motor identification run was performed correctly. Check the motor's connection configuration (i.e., start/delta) If the decimal points on the display flash during operation, this means that the unit is being run in its overload range (> P1-08).In this case, use P1-03 to make the acceleration ramp longer or reduce the load. Make sure that the motor is not being mechanically blocked and that there are no additional loads on the motor.
PS-trp	05	Overcurrent (Hardware) Check the wiring to the motor and the motor itself for short-circuits and ground faults. Disconnect the motor cable from the variable speed drive and switch the variable speed drive back on. If the error message still appears, the device needs to be replaced. Before commissioning the new device, check the system for short-circuits or ground faults that could have caused the device to fail.

Table 60. Error messages list, continued

Message	Error no. [dec]	Possible causes and fixes
O.Volt	06	Overvoltage in DC link The DC-Link Voltage value can be viewed using parameter P0-20. P0-36 contains a fault register with the last values before the unit was switched off (scan time: 256 ms). Check to make sure that the supply voltage falls within the range for which the variable speed drive is sized. If the fault occurs during deceleration or stopping: Make the deceleration ramp (P1-04/P2-25) longer or use the brake resistor. In vector control mode (P4-01 = 0 or = 1): Reduce the speed controller's gain (P4-03). If using the PID controller: Reduce P3-11 (PID1 fault ramp) to ensure that the ramps are active.
V.Volt	07	Undervoltage in DC link **Note:** Generally, this message will appear when the supply voltage is switched off on the device and the DC link voltage dies away. In this case, there is no fault. If the message appears during operation: Check whether the power supply voltage is too low. Check all components/devices in the variable speed drive's feeder circuit (circuit-breaker, contactor, choke, etc.) to make sure they are connected properly and have an adequate contact resistance.
O-t	08	Overtemperature at heat sink. The drive is too hot. The heat sink temperature can be viewed by using P0-21. P0-38 contains a fault register with the last values before the unit was switched off (scan time: 30 s). Check to make sure that the variable speed drive is being operated within the ambient temperature range specified for it. (IP20 devices: max. 50 °C; IP66 devices: max. 40 °C). Check to make sure that the device fan is running. Make sure that cooling air can circulate freely (clearances to neighboring devices above and below the variable speed drive). Improve the control cabinet's ventilation if necessary: The device's vents must not be obstructed, i.e., by dirt or as a result of devices being installed too close to each other. Reduce the switching frequency with P2-24. Reduce the load, if possible.
V-t	09	Under-temperature The message will appear if the ambient temperature falls below –10 °C. In order to be able to start the drive, the temperature must be higher than this.
P-dEf	10	The parameters' default settings have been loaded. Press the STOP button: You will be able to reconfigure the drive after doing so.
E-trip	11	External fault (at digital input 5, terminal 10, if P1-13 = 6/7/16/17). There must be a high-level signal at this input in order to be able to run the variable speed drive. If a thermistor is connected to terminal 10, check whether the motor is too hot.
P-LOss	14	Incoming power phase failure (only for devices with a three-phase power supply)
th-f(t	16	Malfunctioning heat sink thermistor. Please contact your nearest Johnson Controls sales branch.
dAtA-F	17	Error in internal memory. The parameters have not been saved and the default settings have been loaded. Change the parameter values (again) and save them once more. If the message appears again, please contact your nearest Johnson Controls sales branch.
4-20 F	18	The analog input's input current does not fall within the specified range. Check the setting in P2-30 for AI1 (terminal 6) and P2-33 for AI2 (terminal 10). In the case of 4-20 mA: Check the setpoint connection for wire breakage.

Fault diagnostics

The number of critical faults and specific malfunctions will be logged for diagnostic purposes. The corresponding values can be read by accessing the display parameters (Refer to "Parameter structure" on **Page 88**). Please note that these values cannot be edited or deleted.

Table 61. Critical faults and specific malfunctions

Mode parameter	Designation	Description
P00-33	O-I	Number of overcurrent signals at the variable speed drive's output **Critical fault!**
P00-34	O Volts	Number of overvoltage signals in the internal DC link **Critical fault!**
P00-35	V-volts	Number of undervoltage signals in the internal DC link **Critical fault!**
P00-36	O-temp	Hours with overtemperature at heat sink **Critical fault!**
P00-37	b O-I	Number of overcurrent signals from braking chopper **Critical fault!**
P00-38	O-hEAt	Number of overtemperature signals from control section **Critical fault!**
P00-39	—	Modbus—Number of communication errors
P00-40	—	CANopen—Number of communication errors
P00-41	—	I/O processor—Number of communication errors
P00-42	—	Microprocessor in power section—number of communication errors

Technical Data

General rating data

Technical data	Symbol	Unit	Value
General			
Standards			EMC: EN 61800-3:2004+A1-2012 Radio interference: EN 55011: 2010 Security: EN 61800-5: 2007 Degree of protection: EN 60529: 1992 Soiling: IEC 721-3-3
Certifications and manufacturer's declarations on conformity			CE, UL, cUL, c-Tick, UkrSEPRO, Gost-R
Production quality			RoHS, ISO 9001
Climatic proofing	ρ_W	%	< 95 %, average relative humidity (RH), noncondensing (EN 50178)
Ambient air temperature			
Operational			
IP20 (NEMA 0)	θ	°C	–10 to +50 without derating –10 to +45 for VSC12011… and VSC32011…, for UL compliance over a period of 24 hours
IP66 (NEMA 4X)	θ	°C	–10 to +40 without derating **Note:** Operation within a temperature range of 40 to 50 °C does not conform to UL listing.
Storage	θ	°C	–40 to +60 (frost-free and condensation-free)
Pollution degree			Non-conductive dust permissible
Transport			Class 1C2 (chemical gases), Class 1S2 (solid particles)
Storage			Class 2C2 (chemical gases), Class 2S2 (solid particles)
Operational			Class 3C2 (chemical gases), Class 3S2 (solid particles)
Vibration level (not evaluated during operation)			
Shock test			
Pulse shape			Half sinus
Top acceleration			15 g
Time Window			11 ms
Vibration test			
Frequency range	f	Hz	10–150 10–57.55: 0.15 mm peak-peak 57.55–150: 1 g Top acceleration
Vibration evaluation			1 octave/minute
MTBF (mean time between failures)		Years	157
Electrostatic discharge (ESD, EN 61000-4-2:2009	U	kV	±4, contact discharge ±8, air discharge
Fast transient burst (EFT/B, EN 61000-4-4: 2004)	U	kV	±1, at 5 kHz, control signal terminal ±2, at 5 kHz, motor connection terminals, single-phase mains connection terminals ±4, at 5 kHz, three-phase mains connection terminals

Technical data	Symbol	Unit	Value
Overvoltage (surge, EN 61000-4-5: 2006)			
110–115 V, 200–240 V	U	kV	±1, phase to phase/neutral conductor ±2, phase/neutral conductor to earth
380–480 V	U	kV	±2, phase to phase ±4, phase to earth
Electric strength (flash, EN 61800-5-1: 2007)			
110–115 V, 200–240 V	U	kV	1.5
380–480 V	U	kV	2.5
Radio interference class (EMC)			
Maximum screened motor cable length with integrated radio interference suppression filter			
Category C1	I	mA	1, only for VSC122D3F… to VSC12011F….(FS1, FS2)
Category C2	I	mA	5
Category C3	I	mA	25
Mounting position			vertical
Altitude	h	mA	0–1000 above sea level, > 1000 with 1% load current reduction every 100 m, maximum 2000 with UL approval, maximum 4000 without UL approval
Degree of protection			IP20 (NEMA 0) / IP66 (NEMA 4X)
Protection against contact			BGV A3 (VBG4, finger- and back-of-hand proof)
Main circuit / power section			
Feeder unit			
Rated operating voltage			
VSC1D…	U_e	V	1~ 110 (110 V –10 %–115 V +10 %, → U_2 = 230 V)
VSC12…	U_e	V	1~ 230 (200 V –10 %–240 V +10 %)
VSC32…	U_e	V	3~ 230 (200 V –10 %–240 V +10 %)
VSC34…	U_e	V	3~ 400 (380 V –10 %–480 V +10 %)
Single-phase power supply with VSC3… units			When powered with a single-phase power supply, variable speed drives from the VSC32… and VSC34... series can be operated with a maximum of 50% of the rated operational current (I_e).
Mains frequency	f	Hz	50/60 ±10 %
Phase Imbalance		%	max. 3
Maximum short-circuit current (supply voltage)	SCCR	kA	100
Mains switch-on frequency			Maximum of one time every 30 seconds
Mains network configuration (AC supply system)			TN and TT network with directly earthed neutral point. IT earthing systems with PCM insulation monitoring relays only. Operation on phase-earthed networks is only permissible up to a maximum phase-earth voltage of 300 Vac.
Inrush current	I	A	< I_{LN}

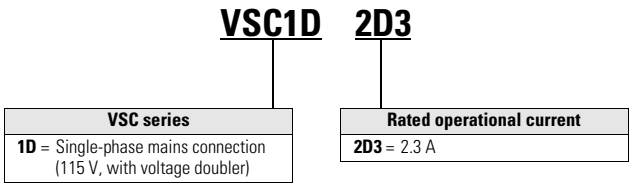
Technical data	Symbol	Unit	Value
Motor feeder			
Output voltage			
VSC1D…	U_2	V	3~ 0–2 x U_e (voltage doubler)
VSC12…, VSC32…, VSC34…	U_2	V	3~ 0–U_e
Assigned motor output			
at 230 V, 50 Hz	P	kW	0.37–4
at 400 V, 50 Hz	P	kW	0.75–22
Output Frequency			
Range, parameterizable	f_2	Hz	0–50/60 (max. 500 Hz)
resolution		Hz	0.1
Rated operation current	I_e	A	IP20: 2.3–46 IP66: 2.3–24
Overload current for 60 s every 600 s	i_l	%	150
Overload current for 3.75 s every 600 s	i_l	%	175
Switching frequency (double modulation)	f_{PWM}	kHz	max. 32
Operating mode			
V/Hz control (speed accuracy)			±20 %, with slip compensation
Vector control (static speed accuracy)			±0.033 % ±1% load range: 0–100%
Torque response time	t_r	ms	1–8
Torque linearity			±5% (10–90% of speed variable range, 20–100% of torque load range)
Response time (enable IGBT)	t_r	ms	< 10
DC braking			
Time before start	t	s	0–25, in the event of a stop
Motor pick-up control function (for catching spinning motors)			all frame sizes
Brake chopper			only for sizes FS2 to FS4
Braking current during continuous operation		%	100 (I_e)
Maximum braking current		%	150 for 60 s

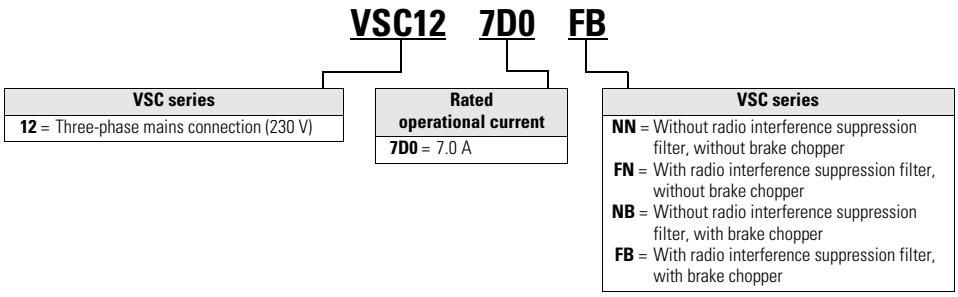
Technical data	Symbol	Unit	Value
Control section			
Control voltage			
Output voltage (control signal terminal 1)	U_C	Vdc	24
Load rating (control signal terminal 1)	I_1	mA	100
Reference voltage (control signal terminal 5)	U_S	Vdc	10
Load rating (control signal terminal 5)	I_5	mA	10
Digital Input (DI)			
Quantity			2–4
Logic (level)			increase (NPN)
Response time	t_r	ms	< 8
Input voltage range High (1)	U_C	Vdc	8–30
Input voltage range Low (0)	U_C	Vdc	0–4
Analog Input (AI)			
Quantity			0–2
Resolution			12-bits
Accuracy		%	< 1 to the final value
Response time	t_r	ms	< 16
Input voltage range	U_S	V	0–10, DC (R_i ~ 72 kΩ)
Input current range	I_S	mA	0/4–20 (R_B ~ 500 Ω)
Relay output (RO1)			
Quantity			1 relay
Relay contact			N.O.
Switching capacity			
AC	I	A	6 (250 Vac)
DC	I	A	5 (30 Vac)
Digital Output (DO)			
Quantity			0–1
Output voltage	U_{Out}	V	+24
Load rating (control signal terminal 8)	I_8	mA	20 max.
Analog Output (AO)			
Quantity			0–1
Output voltage	U_{Out}	V	0 to +10
Output current (control signal terminal 8)	I_8	mA	0–20, 4–20
Load rating (control signal terminal 8)	I_8	mA	20 max.
Resolution		Bit	10
Accuracy		%	< 1 to the final value
Interface (RJ45)			OP bus, Modbus RTU, CANopen, RS485
Response time (after valid command)	t_r	ms	<8 (Modbus, CANopen) <8 (OP bus: Master Subordinate, 60 ms cycle)

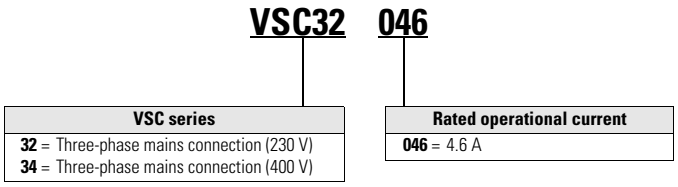
Specific rated operational data

The following tables list the specific rated operational data for the individual VSC series based on the corresponding rated operational current.

Examples







VSC1D… device series

Variable speed drives with voltage doubler

U_{LN} = 2 x U_2: 115 V → 230 V

Table 62. VSC1D… device series

Size	Symbol	Unit	2D3	4D3	5D8
Rated operational current	I_e	A	2.3	4.3	5.8
Overload current for 60 s every 600 s	i_I	A	3.45	6.45	8.7
Overload current for 3.75 s every 600 s	i_I	A	4.03	7.53	10.15
Apparent power at rated operation ① 230 V	S	kVA	0.92	1.71	2.31
Assigned motor power					
at 230 V, 50 Hz	P	kW	0.37	0.75	1.1
at 220–240 V, 60 Hz	P	hp	0.5	1	1.5
Power side (primary side):					
Number of phases			Single-phase or two-phase		
Rated operating voltage	U_{LN}	V	110 (–10 %)–115 (+10 %) 48–62 Hz 99–126 ±0 %		
Input current (phase current)	I_{LN}	A	7.8	15.8	21.9
Minimum braking resistance	R_B	Ω	—	—	100
Switching frequency (pulse frequency)					
Default Setting	f_{PWM}	kHz	8	8	8
Setting range	f_{PWM}	kHz	4–32	4–32	4–32
Voltage Boost (U_{Boost}/U_{LN})					
Default Setting		%	3	3	2.5
Max Value		%	25	25	20
Maximum leakage current to earth (touch current), at U_{LN}: 120 V, without motor	I_{Touch}	mA	4.8	4.8	4.8
Efficiency	η		0.95	0.95	0.95
Heat dissipation					
At I_e (150%)	P_V	CO	18.5	37.5	44
During no-load running, standby (locked, without fan)	P_V	CO	3.07	3.07	4.51
fan, built-in			—	✔ ①	✔ ①
Size			FS1	FS1	FS2

① Not with IP66 degree of protection

VSC12… device series

Table 63. VSC12… device series

Size	Symbol	Unit	2D3	4D3	7D0NN 7D0FN	7D0NB 7D0FB	011	015
Rated operational current	I_e	A	2.3	4.3	7	7	10.5	15
Overload current for 60 s every 600 s	i_I	A	3.45	6.45	10.5	10.5	15.75	22.5
Overload current for 3.75 s every 600 s	i_I	A	4.03	7.53	12.25	12.25	18.38	26.25
Apparent power at rated operation 230 V	S	kVA	0.92	1.71	2.79	2.79	4.18	5.98
Apparent power at rated operation 240 V	S	kVA	0.96	1.79	2.91	2.91	4.36	6.24
Assigned motor power								
at 230 V, 50 Hz	P	kW	0.37	0.75	1.5	1.5	2.2	4
at 220–240 V, 60 Hz	P	hp	0.5	1	2	2	3	5
Power side (primary side):								
Number of phases			single-phase or two-phase					
Rated operating voltage	U_{LN}	V	200–10 %–240 + 10 %, 50/60 Hz 180–264 ±0 %, 48–62 Hz ±0 %					
Input current (phase current)	I_{LN}	A	3.7	7.5	12.9	12.9	19.2	29.2
Minimum braking resistance	R_B	Ω	—	—	—	100	50	25
Switching frequency (pulse frequency)								
Default Setting	f_{PWM}	kHz	8	8	8	8	8	8
Setting range	f_{PWM}	kHz	4–32	4–32	4–32	4–32	4 -32	4–24
Voltage Boost (U_{Boost}/U_{LN})								
Default Setting		%	3	3	3	2.5	2.5	2
Max Value		%	25	25	25	20	20	15
Maximum leakage current to earth (PE), at U_{LN}: 240 V, without motor	I_{PE}	mA	4.8	4.8	4.8	4.8	4.8	4.7
Efficiency	η		0.95	0.94	0.96	0.96	0.95	0.96
Heat dissipation								
At I_e (150%)	P_V	CO	18.5	45.75	63	63	103.4	160
During no-load running, standby (locked, without fan)	P_V	CO	3.07	3.07	3.07	4.51	4.51	5.16
fan, built-in			—	✔	✔	✔	✔	✔
Size			FS1	FS1	FS1	FS2	FS2	FS3

VSC32… device series

Table 64. VSC32… device series

Size	Symbol	Unit	2D3	4D3	7D0NN	7D0NB 7D0FB
Rated operational current	I_e	A	2.3	4.3	7	7
Overload current for 60 s every 600 s	i_I	A	3.45	6.45	10.5	10.5
Overload current for 3.75 s every 600 s	i_I	A	4.03	7.53	12.25	12.25
Apparent power at rated operation 230 V	S	kVA	0.92	1.71	2.79	2.79
Apparent power at rated operation 240 V	S	kVA	0.96	1.79	2.91	2.91
Assigned motor power						
at 230 V, 50 Hz	P	kW	0.37	0.75	1.5	1.5
at 220–240 V, 60 Hz	P	hp	0.5	1	2	2
Power side (primary side):						
Number of phases			3	3	3	3
Rated operating voltage	U_{LN}	V	200–10 %–240 + 10 %, 50/60 Hz 180–264 ±0 %, 48–62 Hz ±0 %			
Input current (phase current)	I_{LN}	A	3.4	5.6	9.5	8.9
Minimum braking resistance	R_B	Ω	—	—	—	100
Switching frequency (pulse frequency)						
Default Setting	f_{PWM}	kHz	16	16	16	16
Setting range	f_{PWM}	kHz	4–32	4–32	4–32	4–32
Voltage Boost (U_{Boost}/U_{LN})						
Default Setting		%	3	3	3	2.5
Max Value		%	25	25	25	20
Maximum leakage current to earth (touch current), at U_{LN}: 240 V, without motor	I_{Touch}	mA	7.5	7.5	7.5	7.2
Efficiency	η		0.96	0.95	0.96	0.96
Heat dissipation						
At I_e (150%)	P_V	CO	14.8	39.75	61.5	61.5
During no-load running, standby (locked, without fan)	P_V	CO	3.07	3.07	3.07	4.51
fan, built-in			✔	✔	✔	✔
Size			FS1	FS1	FS1	FS2

Table 64. VSC32… device series, continued

Size	Symbol	Unit	011	018	024	030	046
Rated operational current	I_e	A	10.5	18	24	30	46
Overload current for 60 s every 600 s	i_I	A	15.75	27	36	45	69
Overload current for 3.75 s every 600 s	i_I	A	18.38	31.5	42	52.5	80.5
Apparent power at rated operation 230 V	S	kVA	4.18	7.17	9.55	11.94	18.30
Apparent power at rated operation 240 V	S	kVA	4.36	7.48	9.96	12.46	19.10
Assigned motor power							
at 230 V, 50 Hz	P	kW	2.2	4	5.5	7.5	11
at 220–240 V, 60 Hz	P	hp	3	5	7.5	10	15
Power side (primary side):							
Number of phases			3	3	3	3	3
Rated operating voltage	U_{LN}	V	200–10 %–264 + 10 %, 50/60 Hz 180–264 ±0 %, 48–62 Hz ±0 %				
Input current (phase current)	I_{LN}	A	12.1	20.9	26.4	33.3	50.1
Minimum braking resistance	R_B	Ω	50	25	20	15	10
Switching frequency (pulse frequency)							
Default Setting	f_{PWM}	kHz	16	8	8	8	8
Setting range	f_{PWM}	kHz	4–32	4–24	4–24	4–24	4–24
Voltage Boost (U_{Boost}/U_{LN})							
Default Setting		%	2.5	2	2	1.5	1.5
Max Value		%	20	15	15	10	10
Maximum leakage current to earth (touch current), at U_{LN}: 240 V, without motor	I_{Touch}	mA	7.2	6.8	6.8	6.9	6.9
Efficiency	η		0.96	0.96	0.97	0.97	0.96
Heat dissipation							
At I_e (150%)	P_V	CO	90.2	160	223	304	446
During no-load running, standby (locked, without fan)	P_V	CO	4.51	5.16	5.16	7.54	7.54
fan, built-in			✔	✔	✔	✔	✔
Size			FS2	FS3	FS3	FS4	FS4

VSC34… device series

Table 65. VSC34… device series

Size	Symbol	Unit	2D2	4D1NN 4D1FN	4D1NB 4D1FB	5D8	9D5
Rated operational current	I_e	A	2.2	4.1	4.1	5.8	9.5
Overload current for 60 s every 600 s	i_I	A	3.3	6.15	6.15	8.7	14.25
Overload current for 3.75 s every 600 s	i_I	A	3.85	7.18	7.18	10.15	16.63
Apparent power at rated operation 230 V	S	kVA	1.52	2.84	2.84	4.02	6.58
Apparent power at rated operation 240 V	S	kVA	1.83	3.41	3.41	4.82	7.9
Assigned motor power							
at 230 V, 50 Hz	P	kW	0.75	1.5	1.5	2.2	4
at 220–240 V, 60 Hz	P	hp	1	2	2	3	5
Power side (primary side):							
Number of phases			3	3	3	3	3
Rated operating voltage	U_{LN}	V	380 V–10 %–480 V + 10 %, 50/60 Hz 342–528 V ±0 %, 48–62 Hz ±0 %				
Input current (phase current)	I_{LN}	A	3.5	5.6	5.6	7.5	11.5
Minimum braking resistance	R_B	Ω	—	—	250	200	120
Switching frequency (pulse frequency)							
Default Setting	f_{PWM}	kHz	16	16	16	16	16
Setting range	f_{PWM}	kHz	4–32	4–32	4–32	4–32	4–32
Voltage Boost (U_{Boost}/U_{LN})							
Default Setting		%	3	3	2.5	2.5	2.5
Max Value		%	25	25	20	20	20
Maximum leakage current to earth (touch current), at U_{LN}: 400 V, without motor	I_{Touch}	mA	13	13	12.6	12.6	12.6
Efficiency	η		0.92	0.95	0.95	0.95	0.97
Heat dissipation							
At I_e (150%)	P_V	CO	33.75	66.5	66.5	101.2	136
During no-load running, standby (locked, without fan)	P_V	CO	4.55	4.55	6.44	6.44	6.44
fan, built-in			✔	✔	✔	✔	✔
Size			FS1	FS1	FS2	FS2	FS2

Table 65. VSC34… device series, continued

Size	Symbol	Unit	014	018	024	030	039	046
Rated operational current	I_e	A	14	18	24	30	39	46
Overload current for 60 s every 600 s	i_I	A	21	27	36	45	58.5	69
Overload current for 3.75 s every 600 s	i_I	A	24.5	31.5	42	52.5	68.25	80.5
Apparent power at rated operation 230 V	S	kVA	9.67	12.47	16.63	20.76	26.99	31.83
Apparent power at rated operation 240 V	S	kVA	11.64	14.96	19.95	24.91	32.39	38.20
Assigned motor power								
at 230 V, 50 Hz	P	kW	5.5	7.5	11	15	18.5	22
at 220–240 V, 60 Hz	P	hp	7.5	10	15	20	25	30
Power side (primary side):								
Number of phases			3	3	3	3	3	3
Rated operating voltage	U_{LN}	V	380 V–10 %–480 V + 10 %, 50/60 Hz 342–528 V ±0 %, 48–62 Hz ±0 %					
Input current (phase current)	I_{LN}	A	17.2	21.2	27.5	34.2	44.1	51.9
Minimum braking resistance	R_B	Ω	100	80	50	30	22	22
Switching frequency (pulse frequency)								
Default Setting	f_{PWM}	kHz	8	8	8	8	8	8
Setting range	f_{PWM}	kHz	4–24	4–24	4–24	4–24	4–24	4–24
Voltage Boost (U_{Boost}/U_{LN})								
Default Setting		%	2	2	2	2	1.5	1.5
Max Value		%	15	15	15	10	10	10
Maximum leakage current to earth (touch current), at U_{LN}: 400 V, without motor	I_{Touch}	mA	12.7	12.7	12.7	12.9	12.9	12.9
Efficiency	η		0.96	0.97	0.97	0.97	0.97	0.96
Heat dissipation								
At I_e (150%)	P_V	CO	223	304	446	607	728	801
During no-load running, standby (locked, without fan)	P_V	CO	6.42	6.42	6.52	14.6	14.6	14.6
fan, built-in			✔	✔	✔	✔	✔	✔
Size			FS3	FS3	FS3	FS4	FS4	FS4

Dimensions

Sizes FS1 to FS3 in IP20

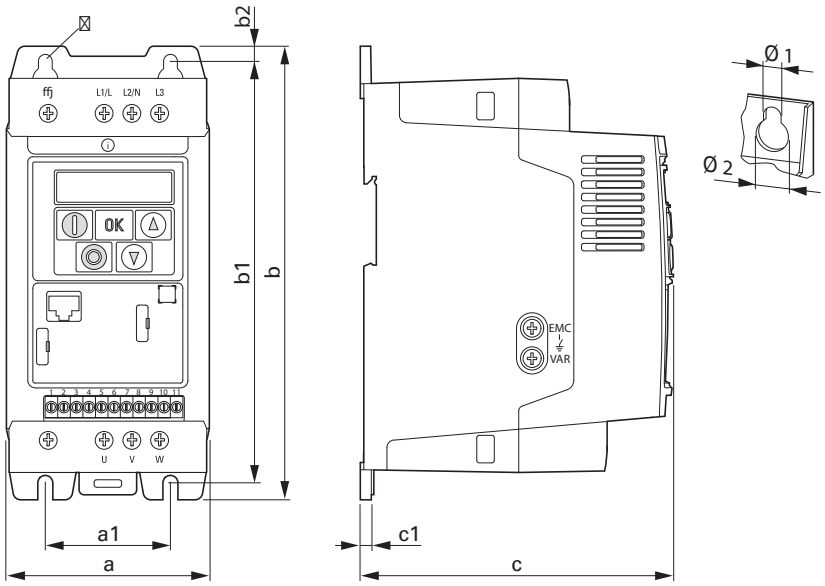


Figure 76. Dimensions for VSC with IP20 degree of protection (NEMA 0)

Table 66. Dimensions, weights, and sizes for IP20

Size	a	a1	b	b1	b2	c	c1	Ø1	Ø2	m
	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	kg (lbs)
FS1	81 (3.19)	50 (1.97)	184 (7.24)	170 (6.69)	7 (0.28)	124 (4.88)	4 (0.16)	6 (0.25)	12 (0.47)	1.1 (2.4)
FS2	107 (4.21)	75 (2.95)	231 (9.09)	215 (8.46)	8 (0.31)	152 (5.98)	5 (0.2)	6 (0.25)	12 (0.47)	2.6 (5.7)
FS3	131 (5.16)	100 (3.94)	273 (10.75)	255 (10.04)	8.5 (0.33)	175 (6.89)	5 (0.2)	6 (0.25)	12 (0.47)	4 (8.8)

1 in = 1" = 25.4 mm, 1 mm = 0.0394 in

Size FS4 in IP20

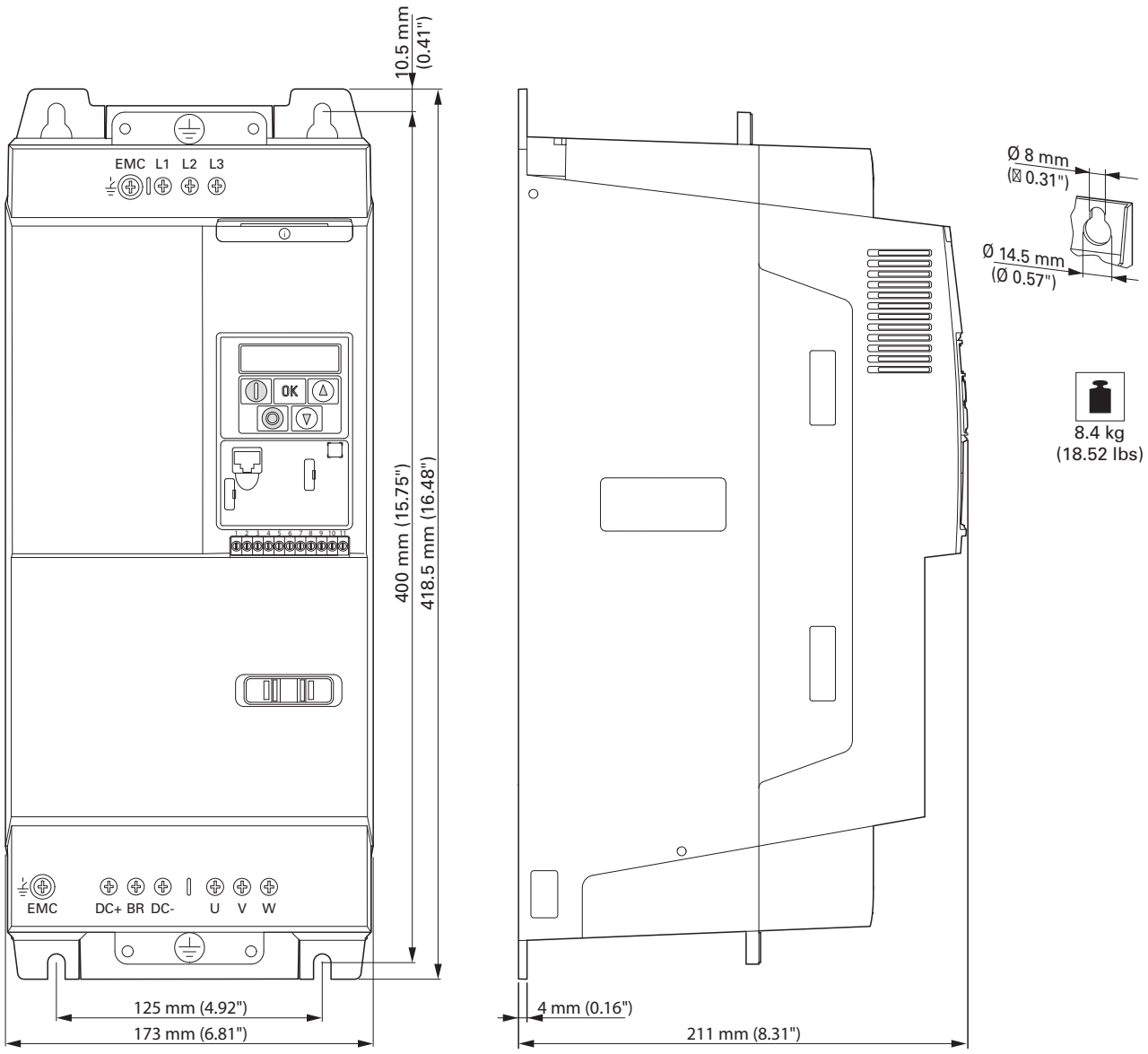


Figure 77. Dimensions and weight for VSC with frame size of FS4 and IP20 (NEMA 0) degree of protection

Sizes FS1 to FS3 in IP66

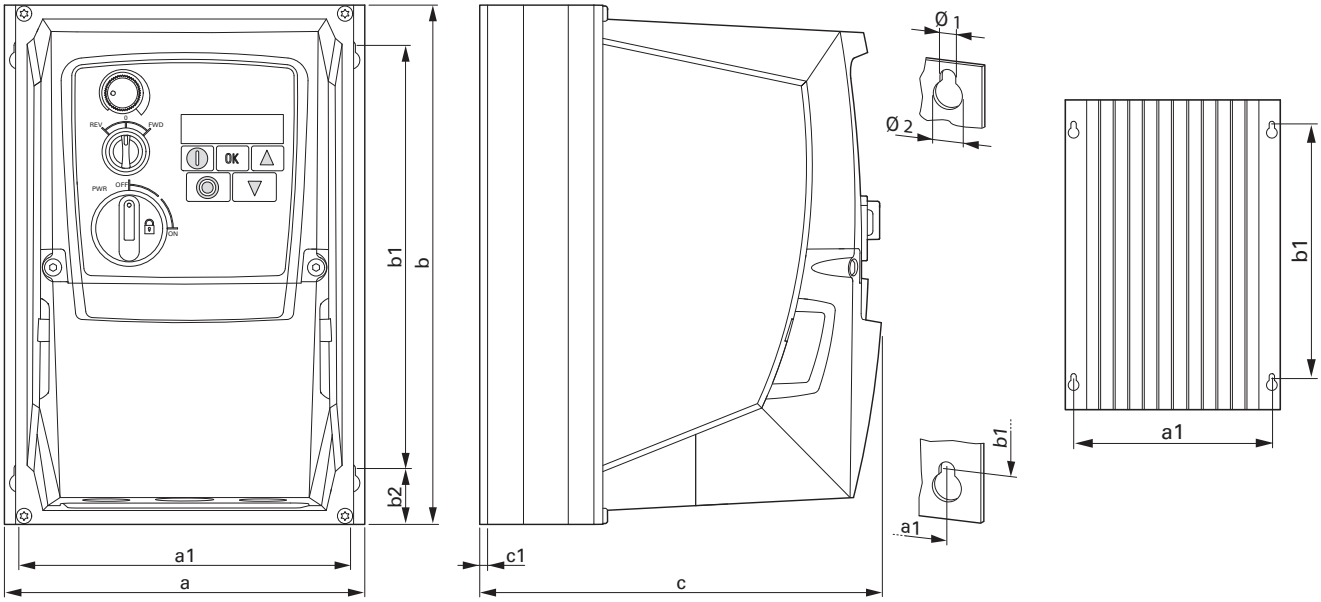


Figure 78. Dimensions for VSC with IP66 degree of protection (NEMA 4X)

Table 67. Dimensions, weights, and sizes for IP66

Size	a	a1	b	b1	b2	c	c1	Ø1	Ø2	m
	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	mm (in)	kg (lbs)
FS1	161 (6.34)	148.5 (5.85)	232 (9.13)	189 (7.44)	25 (0.98)	184 (7.24)	3.5 (0.14)	4 (0.15)	8 (0.31)	2.8 (6.17)
FS2	188 (7.4)	176 (6.93)	257 (10.12)	200 (7.87)	28 (1.1)	192 (7.56)	3.5 (0.14)	4.2 (0.16)	8.5 (0.33)	5 (11.02)
FS3	210 (8.27)	197.5 (7.78)	310 (12.2)	252 (9.92)	33 (1.3)	240 (9.45)	3.5 (0.14)	4.2 (0.16)	8.5 (0.33)	8.2 (18.08)

1 in = 1" = 25.4 mm, 1 mm = 0.0394 in.

Cable cross-sections

The "Maximum terminal capacity" specification indicates the maximum possible sizes that can be connected to the power terminals. The cross-sectional areas and gauges that should be used for the power supply and motor connections are recommendations for the corresponding frame sizes and ratings and are provided as examples.

Note: Use the general installation instructions and local conditions as a basis when selecting terminal capacities.

Table 68. Cable cross-sections

		Maximum terminal capacity		Input current I_{LN}	Cross-sectional area/gauge that should be used for the power supply (L1/L, L2/N, L3, PE)		Output current (rated operational current) I_e	Cross-sectional area/gauge that should be used for the motor connection (U, V, W, PE)	
Device Type	**Size**	**mm^2**	**AWG/kcmil ①**	**A**	**mm^2**	**AWG/kcmil ①**	**A**	**mm^2**	**AWG/kcmil ①**
Mains voltage 115 V Supply voltage (50/60 Hz) U_{LN} 110 (–10 %)–115 (+10 %) V U_e 115 Vac, single-phase / U_2 230 Vac, three-phase (internal voltage doubler)									
VSC1D2D3…	FS1	8	8	7.8	2.5	14	2.3	1.5	14
VSC1D4D3…	FS1	8	8	15.8	4	10	4.3	1.5	14
VSC1D5D8…	FS2	8	8	21.9	6	8	5.8	1.5	14
Mains voltage 230 V Supply voltage (50/60 Hz) U_{LN} 200 (–10 %)–240 (+10 %) V U_e 230 Vac, single-phase / U_2 230 Vac, three-phase									
VSC122D3…	FS1	8	8	3.7	1.5	14	2.3	1.5	14
VSC124D3…	FS1	8	8	7.5	1.5	14	4.3	1.5	14
VSC127D0NN…	FS1	8	8	12.9	2.5	12	7	1.5	14
VSC127D0FN…	FS1	8	8	12.9	2.5	12	7	1.5	14
VSC127D0NB…	FS2	8	8	12.9	2.5	12	7	1.5	14
VSC127D0FB…	FS2	8	8	12.9	2.5	12	7	1.5	14
VSC12011…	FS2	8	8	19.2	4	10	10.5	1.5	14
VSC12015…	FS3	8	8	29.2	4	8	15.3	2.5	12

① AWG = American wire gauge
kcmil = Thousands of circular mils (1 kcmil = 0.5067 mm^2)

Table 68. Cable cross-sections, continued

		Maximum terminal capacity		Input current I_{LN}	Cross-sectional area/gauge that should be used for the power supply (L1/L, L2/N, L3, PE)		Output current (rated operational current) I_e	Cross-sectional area/gauge that should be used for the motor connection (U, V, W, PE)	
Device Type	**Size**	**mm^2**	**AWG/kcmil ①**	**A**	**mm^2**	**AWG/kcmil ①**	**A**	**mm^2**	**AWG/kcmil ①**
Mains voltage 230 V Supply voltage (50/60 Hz) U_{LN} 200 (–10 %)–240 (+10 %) V U_e 230 Vac, three-phase / U_2 230 Vac, three-phase									
VSC322D3…	FS1	8	8	3.4	1.5	14	2.3	1.5	14
VSC324D3…	FS1	8	8	5.6	1.5	14	4.3	1.5	14
VSC327D0NN…	FS1	8	8	9.5	1.5	14	7	1.5	14
VSC327D0NB…	FS2	8	8	8.9	1.5	14	7	1.5	14
VSC327D0FB…	FS2	8	8	8.9	1.5	14	7	1.5	14
VSC32011…	FS2	8	8	12.1	2.5	12	10.5	1.5	14
VSC32018…	FS3	8	8	20.9	6	10	18	2.5	10
VSC32024…	FS3	8	8	26.4	10	8	24	4	10
VSC32030…	FS4	16	5	33.3	16	8	30	6	8
VSC32046…	FS4	16	5	50.1	16	6	46	10	6
Mains voltage 400 V Supply voltage (50/60 Hz) U_{LN} 380 (–10 %)–480 (+10 %) V U_e 400 Vac, three-phase / U_2 400 Vac, three-phase									
VSC342D2…	FS1	8	8	3.5	1.5	14	2.2	1.5	14
VSC344D1NN…	FS1	8	8	5.6	1.5	14	4.1	1.5	14
VSC344D1FN…	FS1	8	8	5.6	1.5	14	4.1	1.5	14
VSC344D1NB…	FS2	8	8	5.6	1.5	14	4.1	1.5	14
VSC344D1FB…	FS2	8	8	5.6	1.5	14	4.1	1.5	14
VSC345D8…	FS2	8	8	7.5	1.5	14	5.8	1.5	14
VSC349D5…	FS2	8	8	11.5	2.5	12	9.5	1.5	14
VSC34014…	FS3	8	8	17.2	4	10	14	1.5	14
VSC34018…	FS3	8	8	21.2	4	10	18	2.5	10
VSC34024…	FS3	8	8	27.5	8	8	24	4	10
VSC34030…	FS4	16	5	34.2	16	8	30	6	8
VSC34039…	FS4	16	5	44.1	16	6	39	10	8
VSC34046…	FS4	16	5	51.9	16	5	46	10	6

① AWG = American wire gauge
kcmil = Thousands of circular mils (1 kcmil = 0.5067 mm^2)

Fuses

The fuses listed below are examples and can be used without additional measures. If you use other circuit-breakers and/or fuses, make sure to take their protection characteristic and operational voltage into account. When using other circuit-breakers, it may be necessary to also use fuses depending on the circuit-breaker's model, design, and settings. There may also be limitations concerning the short-circuit capacity and the supply network's characteristic, and these must also be taken into account when selecting circuit-breakers and/or fuses.

Table 69. Protective devices

Symbol	Description
	**Fuse Class J** Rated operating voltage: 600 Vac Switching capacity: 300 kA

Table 70. Specified fuses

	Input current	Fuse or miniature circuit-breaker	
		IEC	
	I_{LN}	(Type B or gG)	UL (Class J) ①
Device type	**A**	**A**	**A**
Mains voltage 115 V Supply voltage (50/60 Hz) U_{LN} 110 (–10 %)–115 (+10 %) V U_e 115 Vac, single-phase / U_2 230 Vac, three-phase (internal voltage doubler)			
VSC1D2D3…	7.8	10	10
VSC1D4D3…	15.8	25	20
VSC1D5D8…	21.9	32	30
Mains voltage 230 V Supply voltage (50/60 Hz) U_{LN} 200 (–10 %)–240 (+10 %) V U_e 230 Vac, single-phase / U_2 230 Vac, three-phase			
VSC122D3…	3.7	10	6
VSC124D3…	7.5	10	10
VSC127D0NN…	12.9	16	17.5
VSC127D0FN…	12.9	16	17.5
VSC127D0NB…	12.9	16	17.5
VSC127D0FB…	12.9	16	17.5
VSC12011…	19.2	25	25
VSC12015…	29.2	40	40
Mains voltage 230 V Supply voltage (50/60 Hz) U_{LN} 200 (–10 %)–240 (+10 %) V U_e 230 Vac, three-phase / U_2 230 Vac, three-phase			
VSC322D3…	3.4	6	6
VSC324D3…	5.6	10	10
VSC327D0NN…	9.5	16	15
VSC327D0NB…	8.9	16	15
VSC327D0FB…	8.9	16	15
VSC32011…	12.1	16	17.5
VSC32018…	20.9	32	30
VSC32024…	26.4	40	35
VSC32030…	33.3	40	45
VSC32046…	50.1	63	70
Mains voltage 400 V Supply voltage (50/60 Hz) U_{LN} 380 (–10 %)–480 (+10 %) V U_e 400 Vac, three-phase / U_2 400 Vac, three-phase			
VSC342D2…	3.5	6	6
VSC344D1NN…	5.6	10	10
VSC344D1FN…	5.6	10	10
VSC344D1NB…	5.6	10	10
VSC344D1FB…	5.6	10	10
VSC345D8…	7.5	16	10
VSC349D5…	11.5	16	15
VSC34014…	17.2	25	25
VSC34018…	21.2	32	30
VSC34024…	27.5	40	35
VSC34030…	34.2	40	45
VSC34039…	44.1	50	60
VSC34046…	51.9	63	70

① Maximum supply short-circuit current: 100 kA rms (AC).

Accessories

Device-specific DXC… accessories, as well as the general accessories from the Series III (DX…) system, are available for VSC variable speed drives.

Device-specific accessories

DCX… device-specific accessories are connected directly to the plug-in control signal terminals on VSC variable speed drives, making it easy to expand the drives' functionality.

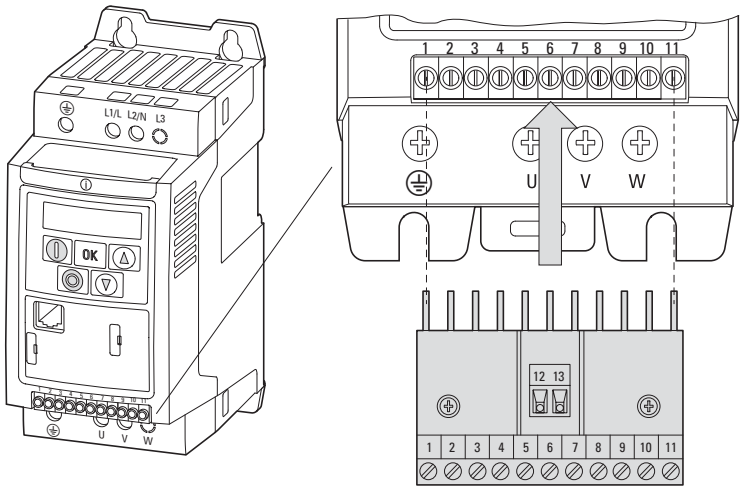


Figure 79. Connecting DXC… to the control signal terminals on the VSC

Note: The control terminals on the VSC variable speed drive are plug-in terminals. They can be screwed onto the expansion module in order to cover the pins (protection against contact).

DXC-EXT-IO… coupling module

Coupling modules DXC-EXT-IO110 and DXC-EXT-IO230 can be used to integrate the digital inputs on VSC variable speed drives directly into circuits with 110 Vac / 230 Vac. In the actual coupling mode, the inputs (connection terminals 1 to 4 and 12 and 13) are galvanically isolated from the variable speed drive's digital inputs (DI1 to DI4).

Note: For more information on the coupling modules and on output expansions, please refer to Application Note AP040032 (VSC, I/O Configuration).

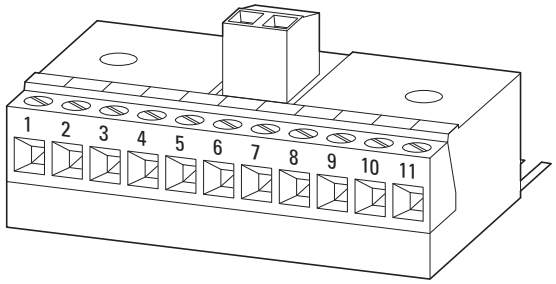


Figure 80. DXC-EXT-IO110 and DXC-EXT-IO230

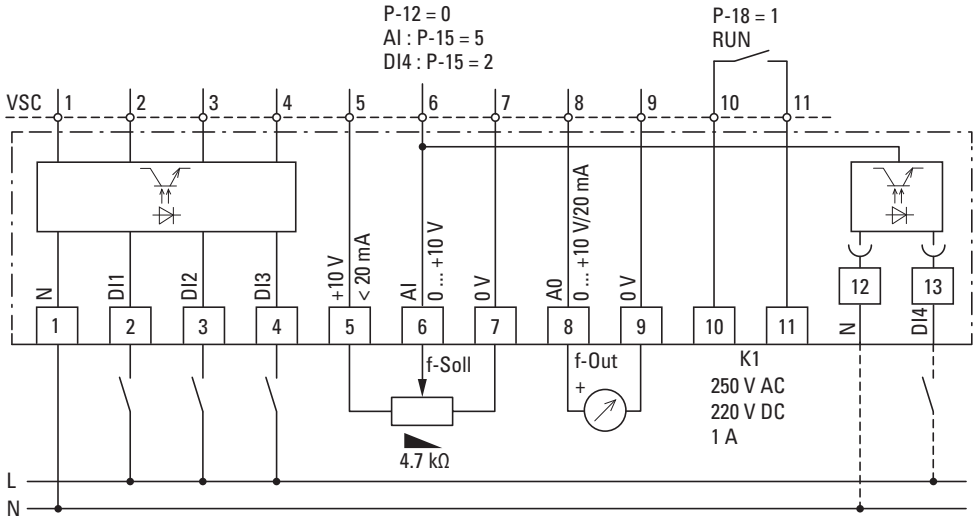


Figure 81. Block diagram DXC-EXT-IO110 and DXC-EXT-IO230

Parameters:

P-12 = 0 Terminal mode (WE)

P-15 = 5 WE = The analog value on terminal 6 will be used as the frequency reference value (AI)

P-15 = 2 Terminal 12 and 13 digital input active (DI4)

P-18 = 0 RUN (WE)

Table 71. Specific technical data DXC-EXT-IO…

Technical data	Unit	Value
Input voltage		
DXC-EXT-IO110	V	100–10 %–120 + 10 %, 50/60 Hz (90–132 ± 0 %, 48–62 Hz ± 0 Hz)
DXC-EXT-IO230	V	200–10 %–240 + 10 %, 50/60 Hz (180–264 ± 0 %, 48–62 Hz ± 0 Hz)
High signal		
DXC-EXT-IO110	V	80–250, $R_i \approx 68\ k\Omega$
DXC-EXT-IO230	V	80–250, $R_i \approx 68\ k\Omega$
Degree of protection (without the connection pins being covered by the VSC's control signal terminal block)		IP00

Note: For detailed instructions on how to install the expansion modules, please refer to instruction leaflet IL04012016Z.

Notice

Internal relay K1 is looped with the expansion module, meaning it can only conduct a lower current (≤ 1 A).

⚠ DANGER

Dangerous voltage!

Expansion modules DXC-EXT-IO110 and DXC-EXT-IO230 must not be placed into operation until all mounting and installation work has been completed. Any other use will be considered to be an inappropriate use.

DXC-EXT-2RO output expansion

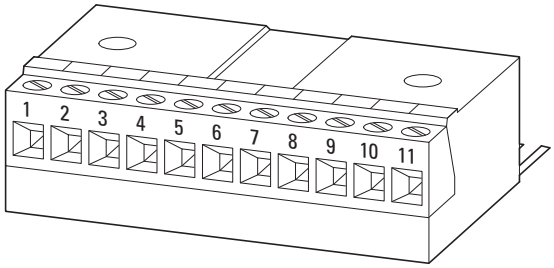


Figure 82. DXC-EXT-2RO

Expansion module DXC-EXT-2RO can be used to convert digital output DO1 (control signal terminals 8 and 9) on VSC variable speed drives to a potential-free contact relay output K2 (N/O). When this option is used, the variable speed drive will have two potential-free relay outputs available and will be able to switch voltages of up to 250 Vac and 220 Vdc.

Table 72. Specific technical data DX-EXT-2RO

Technical data	Unit	Value
Relay switching voltage		
K1 (control signal terminals 10, 11)	V	250 Vac / 230 Vdc
K2 (control signal terminals 8, 9)	V	250 Vac / 220 Vdc
Relay switching current		
K1 (control signal terminals 10, 11)	V	≤ 1
K2 (control signal terminals 8, 9)	V	≤ 1
Operating temperature	°C	–10 to +50
Degree of protection (without the connection pins being covered by the VSC's control signal terminal block)		IP00

Note: For detailed instructions on how to install the module, please refer to instruction leaflet IL04012015Z.

Notice

Internal relay K1 is looped with the expansion module, meaning it can only conduct a lower current (≤ 1 A).

⚠ DANGER

Dangerous voltage!

Expansion module DXC-EXT-2RO1AO must not be placed into operation until all mounting and installation work has been completed. Any other use will be considered to be an inappropriate use.

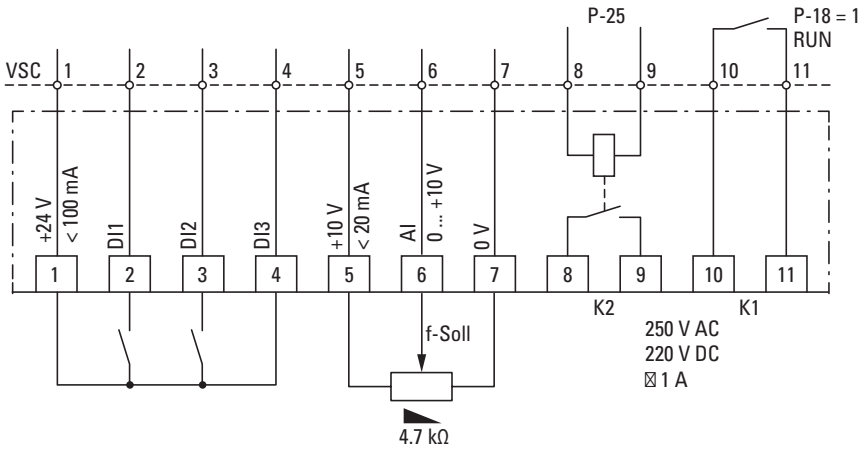


Figure 83. Block diagram DXC-EXT-2RO

Parameter definition

The K1 relay output's function can be configured using parameter P-18 (default setting = 1: RUN). Meanwhile, the new K2 relay output's function can be configured using parameter P-25 (default setting = Analog output AO1).

Note: Parameter P-25 must be set to a value between 0 and 7 in order for the output to function as a digital output.

If the parameter is set to a value greater than 7, relay output K2 will not work properly.

DXC-EXT-2RO1AO output expansion

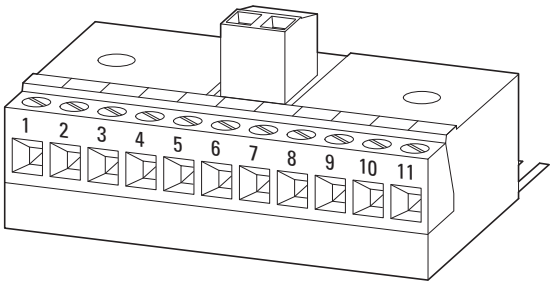


Figure 84. DXC-EXT-2RO1AO

Expansion module DXC-EXT-2RO1AO was developed with HVac applications in mind. It can switch the "Drive running" and "Shutdown due to fault" messages with two separate relays (K1, K2).

Table 73. Specific technical data DXC-EXT-2RO1AO

Technical data	Unit	Value
Output switching voltage		
K1 (control signal terminals 12, 13)	V	250 Vac / 230 Vdc
K2 (control signal terminals 10, 11)	V	250 Vac / 220 Vdc
AO	V	0–10 Vdc
Relay switching current		
K1 (control signal terminals 12, 13)	A	≤ 1
K2 (control signal terminals 10, 11)	A	≤ 1
AO	mA	< 20
Operating temperature	°C	–10 to +50
Degree of protection (without the connection pins being covered by the VSC's control signal terminal block)		IP00

Note: For detailed instructions on how to install the module, please refer to instruction leaflet IL04012014Z.

Notice

Internal relay K1 is looped with the expansion module, meaning it can only conduct a lower current (≤ 1 A).

⚠ DANGER

Dangerous voltage!

Expansion module DXC-EXT-2RO1AO must not be placed into operation until all mounting and installation work has been completed. Any other use will be considered to be an inappropriate use.

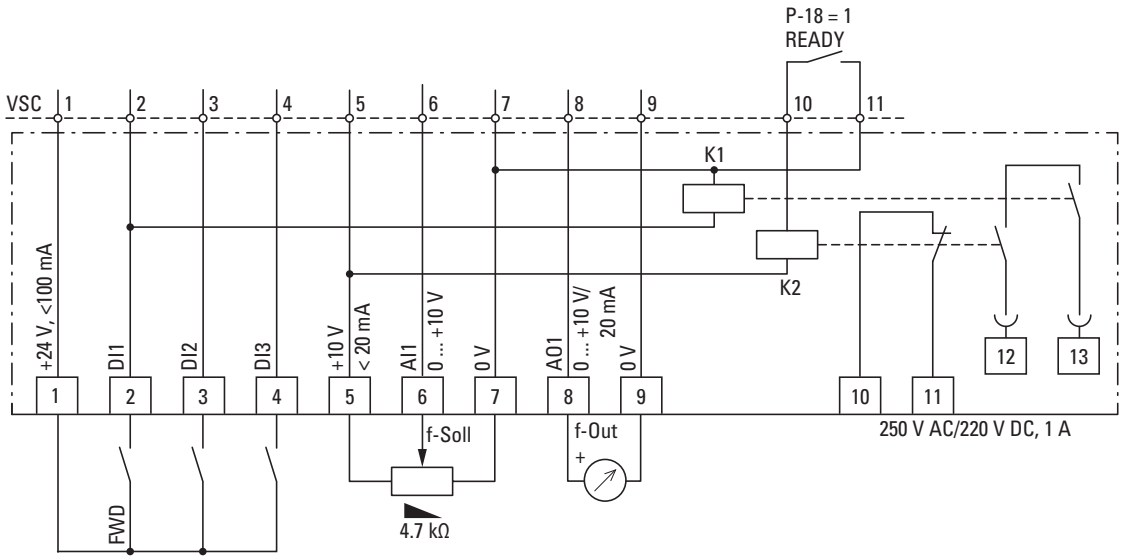


Figure 85. Block diagram DXC-EXT-2RO1AO

Parameter definition

P-18 = 1: READY, variable speed drive ready for operation

Typical operating mode (DXC-EXT-2RO1AO control signal terminals):

- 12/13 closed → There is an enable signal for operation (FWD), READY and RUN messages: Green indicator light, for example
- 10/11 closed → Error message (not READY): Red indicator light, for example

Note: P-18 can also be used to select other operating messages for the VSC variable speed drive's internal relay (RO1) ("Parameter Manual" MN040022EN).

DXC-EXT-LOCSIM simulator

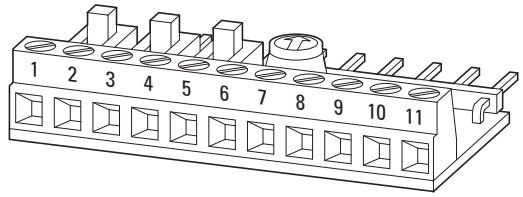


Figure 86. DXC-EXT-LOCSIM

DXC-EXT-LOCSIM is a simple commissioning and test simulator for VSC variable speed drives.

Three microswitches and a PCB mount potentiometer make it possible to easily put the variable speed drive into operation "out of the box" based on the corresponding help cards when using the drive's default settings. Refer to "Help leaflets" on **Page 91**.

Note: For detailed instructions on how to install the module, please refer to instruction leaflet IL04012019Z.

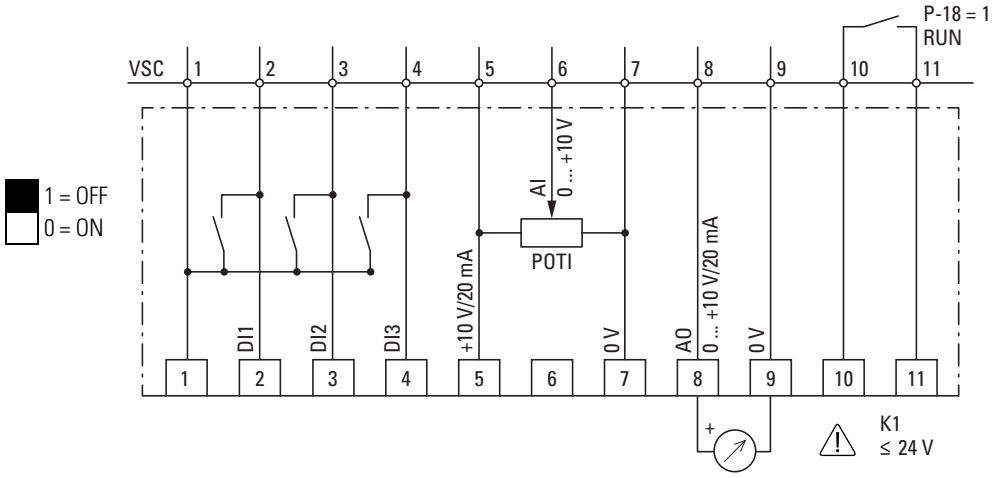


Figure 87. Block diagram DXC-EXT-LOCSIM simulator

The three microswitches can be used to directly drive (from left to right) the three digital inputs DI1, DI2, and DI3 with the internal control voltage (24 Vdc). Meanwhile, the POTI PCB mount potentiometer can be turned clockwise to sets the frequency reference value (0–50 Hz).

The analog output signal from AO (0–10 Vdc) will be available at control signal terminals 8 and 9 as per the output frequency (0–50 Hz).

Notice

Manual operation!

As per IEC 60449, only extra-low voltage should be connected to internal relay K1 via control signal terminals 10 and 11 (≤ 50 Vac, ≤ 120 Vdc).

General accessories (list)

Table 74. Series III accessories

Part no.	Description	Document
DX-KEY-LED2 DX-KEY-OLED	External keypad	AP040022, IL04012020Z
DX-NET-SWD1	Interface card for connecting to a SmartWire-DT network	MN04012009Z, IL04012025Z
DX-COM-STICK2	Parameter copying stick for establishing a Bluetooth connection to PC software	MN040003, IL04012021Z
DX-COM-PCKIT	Wired communication between variable speed drive and PC	MN040003, IL04012022Z
DX-CBL-PC1M5	Wired communication between variable speed drive and PC	MN040003
DX-SPL-R145-2SL1PL	RJ45, 8-pin, splitter, 2 sockets, 1 plug on short connection cable	IL04012023Z
DX-SPL-RJ45-3SL	RJ45, 8-pin, splitter, 3 sockets	IL04012023Z
DX-SPL-RJ45	RJ45, 8-pin, splitter, 2 sockets, 1 plug	IL 040026ZU
DX-SPL-RJ45-TERM	RJ45, 8-pin, splitter, 1 socket, 1 plug, integrated bus termination resistor for CANopen and Modbus	IL 040026ZU
drivesConnect	PC parameter configuration software for variable speed drives, with integrated oscilloscope function, drive control function, and function block creation for DA1	MN040003

Note: If you intend to use an external keypad and/or a parameter copying stick with a VSC- variable speed drive, please note that only models DX-KEY-LED**2** and DX-COM-STICK**2** will work.

DX-KEY-OLED can be used, but requires an update first.

Parameters

The following tables use a number of acronyms. These acronyms are defined below:

Abbreviation	Meaning
Min. value	Minimum value
Max. value	Maximum value
WE	Default setting (the parameter's value when using the device's factory settings)

Note: None of the parameters in parameter group 0 can be modified by the user, i.e., they are read-only parameters.

"Monitor" parameter group

Table 75. "Monitor" parameter group

Parameter	Designation	Min. value	Max. value	Description
P00-01	Analog Input1	0	100 %	Analog Input 1 Level of the signal applied to analog input 1 after scaling and offsets have been applied.
P00-02	Analog Input2	0	100 %	Analog Input 2 Level of the signal applied to analog input 2 after scaling and offsets have been applied.
P00-03	Frequency Reference	-P-01	P-01	Frequency Reference in Hz. Will be calculated into rpm when motor data are available. Value of the drive internal digital reference.
P00-04	DI1 Status	0	1	Status of the Digital Inputs Status of the digital inputs starting on the left hand side with digital input 1 etc.
	DI2 Status	0	1	
	DI3 Status	0	1	
	DI4 Status	0	1	
	DI5 Status	0	1	
P00-05	PID1 Output	0	100 %	PI(D) controller 1 Output
P00-06	DC-Link Voltage Ripple	0	1000 V	DC-Link Voltage Ripple
P00-07	Motor Voltage	0 V	600 Vac	Instantaneous output voltage
P00-08	DC-Link Voltage	0 V	1000 Vdc	Instantaneous DC Link Voltage
P00-09	Heatsink Temperature	–20 °C	100 °C	Instantaneous Heatsink Temperature
P00-10	t-Run	0 h	99999 h	Total operating time of the drive since the date of manufacture
P00-11	t-Run since Trip	0 h	65000 h	Total operating time of the drive since the last trip occurred
P00-12	t-Run since Trip	0h	65000 h	Total operating time of the drive since the last trip occurred Displayed in hours, minutes and seconds. Pressing the UP key on the drive keypad will change the display from "hours" to "minutes and seconds".
P00-13	Last Fault1 PDP	–	–	last fault

Table 75. "Monitor" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description
P00-14	t-HoursRun Enable	0	65000 h	Total operating time of the drive since the last drive ENABLE signal was applied. Displayed in hours, minutes and seconds. Pressing the UP key on the drive keypad will change the display from "hours" to "minutes and seconds".
P00-15	DC-Link0 Log	0 V	1000 Vdc	DC link voltage log Recording of the most recent 8 samples of the DC bus voltage prior to a drive trip condition occurring. The sample interval is 256 ms. Scan time: 256 ms
P00-16	Heatsink0 Log	- 20 °C	120 °C	Heatsink temperature log Recording of the most recent 8 samples of the heatsink temperature prior to a drive trip condition occurring. The sample interval is 500 ms.
P00-17	MotorCurrent0 Log	0 A	$2 \cdot I_e$	Motor current log Recording of the most recent 8 samples of the Motor current prior to a drive trip condition occurring. The sample interval is 256ms.
P00-18	DC-Link V-Ripple0 Log	0 V	1000 V	DC bus Voltage Ripple Log
P00-19	AmbientTemp0 Log	–20 °C	120 °C	Internal Ambient Temperature Log
P00-20	T-Controlboard	–80 °C	120 °C	Internal ambient temperature of the device, measured on the control board
P00-21	Input Data1 Value			Input Data 1, Value
	Input Data2 Value			Input Data 2, Value
	Input Data3 Value			Input Data 3, Value
	Input Data4 Value			Input Data 4, Value
P00-22	Output Data1 Value			Output Data 1, Value
	Output Data2 Value			Output Data 2, Value
	Output Data3 Value			Output Data 3, Value
	Output Data4 Value			Output Data 4, Value
P00-23	t-Run IGBT in OT	0 h	65000 h	Time elapsed, in which the drive has operated with a high heatsink temperature
P00-24	t-Run PCB in OT	0 h	65000 h	Time elapsed, in which the drive has operated with a high temperature at the PCBs (ambient temperature)
P00-25	Motor Speed	-P-01	P-01	Motorspeed (calculated or measured)
P00-26	MWh Meter	—	—	Energy Consumption MWh Meter (not resettable)
P00-27	Fan Runtime	0 h	65000 h	Run time of the integrated fan (not resettable)
P00-28	System Version			System version
P00-29	NoOfInputPhases			Number of input phases
	FrameSize			Frame Size
	kW/HP			Motor Power
	Power@Ue			Device Power at Device Voltage Rating
	Device Voltage			Device Voltage Rating
	DeviceType			Device Type
P00-30	Serial Number			Serial Number of the device

Table 75. "Monitor" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description
P00-31	Magnetizing current I_q	0 A	100.0 A	Calculated Magnetizing Current
P00-31	Torque current I_d	0 A	100.0 A	Calculated Torque producing Current
P00-32	Switching Frequency	4 kHz	32 kHz	Power stage switching frequency. Higher frequency reduces the audible "ringing" noise from the motor, and improves the output current waveform, at the expense of increased heat losses within the drive.
P00-33	FaultCounter Overcurrent	0	65535	Counts, how often "Overcurrent" occurred
P00-34	FaultCounter DC-Overvoltage	0	65535	Counts, how often "DC-Overvoltage" occurred
P00-35	FaultCounter DC-Undervoltage	0	65535	Counts, how often "DC-Undervoltage" occurred
P00-36	FaultCounter Overtemperature Heatsink	0	65535	Counts, how often "Overtemperature Heatsink" occurred
P00-37	FaultCounter Overcurrent Brake Chopper	0	65535	Counts, how often "Overcurrent Brake Chopper" occurred
P00-38	FaultCounter Overtemperature Ambient	0	65535	Counts, how often "Overtemperature Ambient" occurred
P00-39	FaultCounter Communication Loss	0	65535	Counts, how often "Communication Loss" occurred
P00-40	FaultCounter CANopen COM Loss	0	65535	Counts, how often "CANopen COM Loss" occurred
P00-41	FaultCounter Internal Fault (IO)	0	65535	Counts, how often "Internal Fault (IO)" occurred
P00-42	FaultCounter Internal Fault (DSP)	0	65535	Counts, how often "Internal Fault (DSP)" occurred
P00-43	t-PowerOn			Total time for which the drive was powered up since the day of manufacture.
P00-44	n/a			
P00-45	n/a			
P00-46	n/a			
P00-47	t-FireMode Active			Run time in Fire Mode
P00-47	FaultCounter Fire detected			Counts, how often "Fire detected" occurred
P00-48	ScopeChannel1			
P00-48	ScopeChannel2			
P00-49	ScopeChannel3			
P00-49	ScopeChannel4			
P00-50	System Software Version			System Software Version
P00-50	Application Software Version			I/O Controller / Application SW Version

"Basic" parameter group

Table 76. "Basic" parameter group

Parameter	Designation	Min. value	Max. value	Description	DS
P-01	f-max	0.0 Hz	5 x P-09	Sets the upper limit for the speed of the motor. This can be set to any value between "f-min" and 5x the "motor nom frequency". When "Motor Nom Frequency" (P-09) is changed, P-01 is set to the value of P-09. "Motor Nom Speed" (P-10) = 0, the maximum speed limit will be displayed in Hz. "Motor Nom Speed" (P-10) > 0, the maximum speed limit will be displayed in rpm.	50.0 hz
P-02	f-min	0.0 Hz	P-01	Sets the lower limit for the speed of the motor This can be set to any value between 0 and "f-max" (P-01). When "Motor Nom Frequency" (P-09) is changed, P-01 is set to zero. "Motor Nom Speed" (P-10) = 0, the minimum speed limit will be displayed in Hz. "Motor Nom Speed" (P-10) > 0, the minimum speed limit will be displayed in rpm.	0.0 Hz
P-03	t-acc	0.00 s	600 s	Sets the acceleration ramp time in seconds. The time interval set in "t-acc" represents the time taken to accelerate from zero to "Motor Nom Frequency" (P-09).	5.0 s
P-04	t-dec	0.00 s	600 s	Sets the deceleration ramp time in seconds. The time interval set in "t-dec" represents the time taken to decelerate from "Motor Nom Frequency" (P-09) to zero.	5.0 s
P-05	Stop Mode	0	3	Determines the action taken by the drive in the event of the drive enable signal being removed. 0: Ramping. When the enable signal is removed, the drive will ramp to stop, with the rate controlled by "t-dec" (P-04). 1: Coasting. When the enable signal is removed, the drive output is immediately disabled, and the motor will coast (freewheel) to stop. 2: Ramping. When the enable signal is removed, the drive will ramp to stop, with the rate controlled by "t-dec" (P-04). If the mains supply is lost the drive will ramp to stop using the deceleration ramp set by P-24. Condition: P-24 is set to a time which is shorter than the one for discharging the DC link. Otherwise the drive will trip due to "under voltage". 3: AC flux braking. When stopping the drive, AC flux braking is used to reduce the stopping time.	1
P-06	EnergyOptimizer	0	1	When energy optimization is activated, the motor voltage is dynamically varied, dependent on load. This results in reduced voltage being applied to the motor on light load, significantly reduce energy consumption. This mode of operation is less suitable for dynamic applications where the load conditions can suddenly increase significantly.	0

Table 76. "Basic" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description	DS
P-07	Motor Nom Voltage	0 / 20 V	U_e	Defines the Motor rated voltage. When the output frequency is greater than the "Motor Nom Frequency" (P-09), the output voltage is controlled at the level set with "Motor Nom Voltage" (P-07).	U_e
P-08	Motor Nom Current	0.25 I_e–I_e	I_e	Motor rated current. By setting the "Motor Nom Current" in the drive, the motor overload protection is configured to match the motor rating. When the measured motor current exceeds "Motor Nom Current", the decimal points on the drive display will flash to indicate an overload condition. If this condition persists, the drive will eventually trip, displaying I.t-trP, preventing thermal overload of the motor.	I_e
P-09	Motor Nom Frequency	25 Hz	500 Hz	The rated frequency of the motor. This is the frequency at which "Motor Nom Voltage" is applied to the motor. Below this frequency, the applied motor voltage will be reduced. Above this frequency the voltage remains limited to "Motor Nom Voltage" **Hint:** If the value for P-09 is changed, the following parameters will be reset to their default settings: P-01 f-max P-02 f-min P-10 Motor Nom Speed P-20 f-Fix1 P-21 f-Fix2 P-22 f-Fix3 P-23 f-Fix4	50 Hz
P-10	Motor Nom Speed	0 / 200 rpm	30000 rpm	Motor rated speed. P-10 = 0: the speed of the motor will be displayed in Hz. P-10 > 0: the speed related parameters (f-max, f-min etc.) will be displayed in rpm. The slip compensation is also activated, where the shaft speed of the motor is maintained under varying load conditions by compensating for the load-dependent slip of the motor. If "Motor Nom Speed" = motor synchronous speed (e.g. 3000 rpm for a 2-pole 50Hz motor), the speed can be displayed in rpm without activating the slip compensation.	0 rpm
P-11	V-Boost	0.0 % U_e	f (FS) FS1: 25 % U_e FS2: 20 % U_e FS3: 15 % U_e FS4: 10 % U_e	Voltage is used to increase the applied motor voltage at low output frequency, in order to improve low speed and starting torque. Excessive voltage boost levels may result in increased motor current and temperature, and forced ventilation may be required.	f (FS) FS1: 3 % U_e FS2: 2.5 % U_e FS3: 2 % U_e FS4: 1.5 % U_e

Table 76. "Basic" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description	DS
P-12	Local ProcessData Source	0	13	Local Configuration of Command and Reference Sources 0: Terminal Control. The drive responds directly to signals applied to the control terminals. 1: Uni-directional Keypad Control. The drive can be controlled in the forward direction only using an internal/external or remote Keypad 2: Bi-directional Keypad Control. The drive can be controlled in the forward and reverse directions using an internal/external or remote Keypad. Pressing the keypad START button toggles between forward and reverse. 3: Modbus Control. Control via Modbus RTU communication. 4: Modbus Control. Ramp times via Modbus 5: PI controller with external actual value 6: PI controller with external actual value and totalized value of AI1 7: CANOpen (internal ramp times) 8: CANOpen (CANOpen ramp times) 9: SmartWire Device Control and speed ref. 10: SmartWire Device Control and terminal speed ref. 11: Terminal Control and SmartWire Device speed ref. 12: SmartWire Device Control and speed ref. Reverts to terminal control when communication is lost. 13: SmartWire Device Control and speed ref. Digital input sets enable.	0
P-13	Application Mode Macro	0	2	Influences multiple parameter values inside the drive and combines them to an application specific configuration. 0: Industrial mode (constant torque, no spin start) 1: Pump mode (variable torque for induction motors, no spin start) 2: Fan mode (variable torque for induction motors, spin start)	
P-14	Password	0	65535	Entry of the password to get access to the extended parameter set. The value to be put in is determined by P-37 (default: 101). Access to Level 2 (extended → P-01 to P-59 and P00-01 to P00-30): P-37 Access to Level 3 (advanced → P-01 to P-68 and P00-01 to P00-50): P-37 + 100	0

"Extended" parameter group

Table 77. "Extended" parameter group

Parameter	Designation	Min. value	Max. value	Description	DS
P-15	DI Config Select	0	17	Configuration of digital inputs with a fix set of combinations The setting of P-15 determines the input configuration depending on P-12. Configuration in terminal mode (P-12 = 0): Possible configurations, refer to **Page 97**	5
P-16	AI1 Signal Range	0	7	Configures the Analog input 1 for the selected signal source type. 0: 0–10 V 1: bipolar 0–10 V 2: 0–20 mA 3: t 4–20 mA (Trips in case of wire break) 4: r 4–20 mA (Ramps to f-fix1 (P-20) in case of wire break) 5: t 20–4 mA (Trips in case of wire break) 6: r 20–4 mA (Ramps to f-fix1 (P-20) in case of wire break) 7: 10–0 V	0
P-17	Switching Frequency	0	f (I_e)	Power stage switching frequency. Higher frequency reduces the audible "ringing" noise from the motor, and improves the output current waveform, at the expense of increased heat losses within the drive. 0: 4 kHz 1: 8 kHz 2: 12 kHz 3: 16 kHz 4: 24 kHz 5: 32 kHz	f (I_e)
P-18	RO1 Function	0	11	Selection of the function of output relay RO1 0: RUN, enable (FWD/REV) 1: READY, VSC ready for operation (The relay contact is closed when the drive is powered on and no trip condition is present) 2: Speed = speed reference value 3: Fault (VSC not ready) 4: Speed ≥ RO1 Upper Limit (P-19) 5: Motor current ≥ RO1 Upper Limit (P-19) 6: Speed < RO1 Upper Limit (P-19) 7: Motor current < RO1 Upper Limit (P-19) 8: Drive not enabled 9: Motor not at target speed 10: Analog Input AI2 > RO1 Upper Limit 11: READY. VSC ready for operation. The relay contact is closed when the drive is powered on and no trip condition is present. In addition the hardware enable signal (ENA) must be present at the terminal.	0
P-19	RO1 upper Limit	0.00 %	200.00 %	Switching ON threshold of relay RO1 with P-18 = 4…7, 10	100.00 %

Table 77. "Extended" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description	DS
P-20	f-Fix1	f-min	f-max	Preset Fixed Frequency 1 Value can be adjusted between f-min and f-max. Selection via a digital control signal. If P-09 is changed, the value is reset to default.	15.0 hz
P-21	f-Fix2	f-min	f-max	Preset Fixed Frequency 2 Value can be adjusted between f-min and f-max. Selection via a digital control signal. If P-09 is changed, the value is reset to default.	0.0 Hz
P-22	f-Fix3	f-min	f-max	Preset Fixed Frequency 3 Value can be adjusted between f-min and f-max. Selection via a digital control signal. If P-09 is changed, the value is reset to default.	0.0 Hz
P-23	f-Fix4	f-min	f-max	Preset Fixed Frequency 4 Value can be adjusted between f-min and f-max. Selection via a digital control signal. If P-09 is changed, the value is reset to default.	0.0 Hz
P-24	t-QuickDec	0.00 s	600.0 s	Quick Stop Ramp In default the second deceleration ramp is activated by applying voltage to DI1 and DI2 (terminals 2 and 3) at the same time.	0.00 s
P-25	AO1 Function	0	12	Select Signal to show on the analog output P-25 = 0–7, 10, 11 = digital output 0: RUN, enable (FWD/REV) 1: READY, VSC ready for operation 2: Speed = speed reference value 3: Fault (VSC not ready) 4: Speed ≥ RO1 Upper Limit (P-19) 5: Motor current ≥ RO1 Upper Limit (P-19) 6: Speed < RO1 Upper Limit (P-19) 7: Motor current < RO1 Upper Limit (P-19) 10: Drive not enabled 11: Speed not at reference value P-25 = 8, 9,12 = analog output 8: Output Frequency (0–100 % f-max (P-01)) 9: Motor current (0–200 % Motor Nom Current (P-08)) 12: Motor power	8
P-26	f-SkipBand1	0.0 Hz	f-max	Skip frequency band width Defines the frequency range around f-Skip1 in which the drive doesn't work in steady-state to avoid mechanical resonances in the application. During acceleration and deceleration this range is passed through by using the ramps set with P-03 and P-04.	0.0 Hz
P-27	f-Skip1	0.0 Hz	f-max	Centre point of the frequency band defined by f-Skip-Band1 in which the drive doesn't work in steady-state.	0.0 Hz
P-28	V-MidV/f	0 V	P-07	Voltage to shape V/f curve Defines the adjustment voltage at the frequency set in P-29.	0 V

Table 77. "Extended" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description	DS
P-29	f-MidV/f	0 Hz	P-09	Frequency to shape V/f curve Sets the frequency at which the adjustment voltage defined with P-28 is applied to the motor.	0 Hz
P-30	Start Mode	0	6	Defines the behavior of the drive relating to the enable digital input and also configures the automatic restart function. Edge-r: Following power on or reset, the drive will not start if a start signal (FWD/REV) is still present. To start VSC a rising edge is necessary. Auto-0: Following a power on or reset, the drive will automatically start if digital input 1 is closed. Auto-1 to 5: Following a trip, the drive will make up to 5 attempts to restart at 25 second intervals. The drive must be powered down to reset the counter. The number of restart attempts are counted, and if the drive fails to start on the final attempt, the drive will trip, and will require the user to manually reset the fault. **Attention:** An automatic restart is only possible when the control commands are given via terminals (P-12 = 0, P-12 = 11 and P-12 = 12 when, after a communication loss, the control is toggled to the terminals).	0
P-31	Digital Reference Reset Mode	0	7	Defines the behavior of the drive on START when used in Keypad control or when controlled with UP/DOWN commands via terminals. 0: Start at min speed 1: Start with latest speed before switching off 2: Start at min speed (Auto-r) 3: Start with latest speed before switching off (Auto-r) 4: Start with current running speed 5: Start with f-Fix4 6: Start with current running speed (Auto-r) 7: Start with f-Fix4 (Auto-r) Auto r: START and STOP button on the keypad are disabled. VSC starts with a START command at the terminals.	1
P-32	t-DCBrake@Stop	0.0 s	25.0 s	Duration of DC braking at Stop and before Start. Setting "0" disables DC braking. The braking level is set with P-68	0.0 s
	DCBrake	0	2	Sets the instances when DC braking is enabled. 0: DC braking on Stop 1: DC braking before Start 2: DC braking before Start and on Stop	0

Table 77. "Extended" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description	DS
P-33	Spin Start Enable	0	2	Spin Start Enable Enables spin start, where the drive starts from the detected motor speed. A short start delay is possible if the rotor is stationary. Recommended for applications where the motor spins when applying the FWD/REV signal to the drive (high inertia loads, fans …) 0: Spin start disabled 1: Spin start enabled 2: Spin start enabled on trip, brown our coast to stop (P-05 = 1) **Hint:** The setting of P-33 will be adopted at a change of P-13 (P-33 = 0 when P-13 = 0 or 1, P-33 = 2 when P-13 = 2)	0
P-34	Brake Chopper	0	4	Enable Brake Chopper Enables Brake Chopper on sizes FS2 up to FS4. Software protection can be selected for brake resistors with a 200 W rating. 0: Disabled 1: Enabled with software protection 2: Enabled without software protection 3: Enabled during speed reference change with software protection 4: Enabled during speed reference change without software protection **Remark:** This parameter can only be set to a value > 0 on drives sizes FS2 and FS3. Size FS1 does not have a brake chopper inside the drive.	0
P-35	AI1 Gain	0.00 %	2000.00 %	Scaling of the Analog Input 1 Output value = Input value * Scaling. Example: P-16 = 0 to 10 V, P-35 = 200 %: at 5 V the motor turns with max speed (P-01) (5 V * 200 % = 10 V) In subordinate mode (P-12 = 14) the subordinate speed is scaled with P-35.	100.00 %

Table 77. "Extended" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description	DS
P-36	RS485-0 Address	1	63		1
	RS485-0 Baudrate	0	6	RS485 Baudrate 2: 9.6 kBit/s 3: 19.2 kBit/s 4: 38.4 kBit/s 5: 57.6 kBit/s 6: 115.2 kBit/s	6
	Modbus RTU0 COM Timeout	0	8	Modbus RTU0 COM Timeout Time between a communication loss and the resulting action. Setting "0" disables the action after communications trip. t: indicates the drive will trip if time exceeded. r: indicates the drive will ramp to stop if time exceeded. 0: no action 1: t 30 ms 2: t 100 ms 3: t 1000 ms 4: t 3000 ms 5: r 30 ms 6: r 100 ms 7: r 1000 ms 8: r 3000 ms	4
P-37	Password Level2	0	9999	Defines the password which is used to get access to extended parameter set (Level 2). In addition, it also defines the password needed to get access to the advanced parameter set (P-37 + 100). Access via P-14.	101
P-38	Parameter Lock	0	1	Determines whether to lock the parameters 0: OFF. All parameters can be accessed and changed 1: ON. Parameter values can be displayed, but cannot be changed. If a remote keypad is connected, parameters cannot be accessed by the remote keypad if they are locked.	0
P-39	AI1 Offset	-500.00 %	500.00 %	Offset Analog Input 1 Resolution 0.1 %	0.00 %
P-40	Display Scale	0.000	16000 %	Scale factor display Customer specific scaling factor. With P-40 > 0 a "c" appears on the left hand side of the display. With P-10 = 0 the scaling factor is applied to the frequency, with P-10 > 0, to the speed. The value is displayed in real-time on the drives display.	0.000
	Display Scale Source	0	3	Source to Scale factor display Source of the displayed value 0: Motor speed 1: Motor current 2: Analog Input AI2 3: PI controller feedback	0

Table 77. "Extended" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description	DS
P-41	PID1 Kp	0.1	30	PI(D) controller proportional gain Higher values will result in a larger change at the frequency inverter output frequency as a response to small changes in the feedback. Too high value can cause instability	1
P-42	PID1 Ti	0.0 s	30.0 s	PI(D) controller integral time constant Higher values will result in a more damped response. Used in systems in which the overall process responds slowly.	1.0 s
P-43	PID1 Mode	0	1	PI(D) controller 1 mode 0: direct mode. This setting is used when an increase of the feedback signal should lead to a decrease of the motor speed. 1: inverse mode. If an increasing feedback signal should increase the speed of the motor, use inverse mode.	0
P-44	PID1 Set Point 1 Source	0	1	Defines the set point source 1 of controller 1 0: digital set point signal, set with P-45 1: analog input 1	0
P-45	PID1 Set Point Digital	0.00 %	100.00 %	Digital set point controller 1 Digital set point of the PI controller in case P44 = 0	0.00 %
P-46	PID1 Feedback 1 Source	0	5	Defines the feedback source 1 of controller 1 0: analog input 2 (AI2) 1: analog input 1 (AI1) 2: motor current 3: DC-link voltage 4: difference AI1–AI2 5: max value of AI1 and AI2	0
P-47	AI2 Signal Range	0	6	Configures the Analog input 2 for the selected signal source type. 0: 0–10 V 1: 0–20 mA 2: t 4–20 mA (Trips in case of wire break) 3: r 4–20 mA (Ramps to f-fix1 (P-20) in case of wire break) 4: t 20–4 mA (Trips in case of wire break) 5: r 20–4 mA (Ramps to f-fix1 (P-20) in case of wire break) 6: Ptc-th (connection of a thermistor for motor protection)	0
P-48	t-Standby	0.0 s	25.0 s	Time after which the drive changes to stand by mode (inverter output disabled) when running at min speed (f-min) 0: Standby mode disabled non-zero: enter standby mode after the time specified in this parameter. Operation automatically resumes as soon as the speed set point increases above P-02.	0.0 s

Table 77. "Extended" parameter group, continued

Parameter	Designation	Min. value	Max. value	Description	DS
P-49	PID1 WakeUpLevel	0.00 %	100.00 %	Wake-up level controller 1 Sets an error level (difference between the PID reference and feedback values) above which the PID controller will wake from Standby mode. Sets an error level (difference between PI set point and feedback values) above which the PI controller will wake from standby mode.	0.00 %
P-50	CAN0 Baudrate	0	3	CANopen Baudrate Sets the Baudrate in case CANopen is used 0: 125 kBit/s 1: 250 kBit/s 2: 500 kBit/s 3: 1000 kBit/s	2
P-51	T-Memory Enable	0	1	When enabled, the motor thermal memory retention function will save the calculated motor thermal history on drive power down, using this saved value as the starting value on next power up. If this function is disabled, the motor thermal history is reset to zero on every power up. 0: Thermal memory disabled 1: Thermal memory enabled	0
P-52	ParameterAccess	0	1	Parameter Access 0: All parameters can be changed by any source. 1: All parameters locked; can only be changed by the SWD Device.	0
P-53	Action@Communication Loss	0	4	Device reaction after occurring of "Communication Loss". Possibilities device dependent Drive reaction after SWD master communication loss. Master communication loss delay time is set by "Modbus RTU0 COM Timeout" (P-36) 0: No reaction, continue work 1: Set warning, continue work 2: stop (if ramp enabled) 3: quick stop 4: coast stop	0
P-54	RO1 Hysteresis	0.00 %	100.00 %	Hysteresis for relay output 1 This parameter defines a lower reaction threshold level in case P-18 is set to 4, …, 7. Threshold level = limit (P-19)—hysteresis (P-54) P-18 = 4 or 5: output will be logic 1 if the value ≥ limit, output will be logic 0 if value < level P-18 = 6 or 7: output will be logic 0 if the value ≥ limit, output will be logic 1 if value < level	0.00 %
P-55	RO1 Switch-On Delay	0.0 s	250.0 s	Delay time before the Relay switches from logic 0 to logic 1.	0.0 s
P-56	Reserved Parameter	0.0 s	250.0 s	Reserved Parameter	0.0 s
P-57	Reserved Parameter	0.0 s	250.0 s	Reserved Parameter	0.0 s
P-58	Reserved Parameter	0.0 s	250.0 s	Reserved Parameter	0.0 s
P-59	Reserved Parameter	0.0 s	250.0 s	Reserved Parameter	0.0 s

"Advanced" parameter group

Table 78. "Advanced" parameter group

Parameter	Designation	Min. value	Max. value	Description	DS
P-60	Motor Control Mode	0	4	Motor Control Mode An autotune must be performed if setting 2 up to 4 is used. It is recommended with setting 0 0: Speed Control with Torque Limit (vector) 1: Speed Control (V/f) 2: PM Motor Speed Control 3: Brushless DC Motor Speed Control 4: SyncRel Motor Speed Control	1
P-61	Motor Identification	0	1	Motor Identification When set to 1, the drive immediately carries out a non-rotating autotune to measure the motor parameters for optimum control and efficiency. Following completion of the autotune, the parameter automatically returns to 0.	0
P-62	MSC Gain	0.00 %	200.00 %	Speed controller Gain for Kp and Ti as combined value	50.00 %
P-63	I-CurrentLimit	0.10 %	175 %	Current limit in amperes x 10, one decimal place	150 %
P-64	Motor Stator Resistance R1	0.00 Ohm	655.35 Ohm	Stator resistance of the motor For induction and PM motors: phase to phase resistance value [Rs] in Ohms. This value is determined during the motor identification run.	$f(I_e)$
P-65	Motor Stator Inductance d-Axis	0.0 mH	6553.5 mH	Stator inductance of the motor, torque producing For induction motors: Phase to phase inductance value in Henry [H] For PM-Motors: phase d-axis inductance value [Lsd] in Henry [H]	$f(I_e)$
P-66	Motor Stator Inductance q-Axis	0.0 mH	6553.5 mH	Stator inductance of the motor, magnetizing For PM-Motors: phase d-axis inductance value [Lsd] in Henry [H]	$f(I_e)$
P-67	f-DCBrake@Stop	0.0 Hz	P-01	Output frequency in Hz at which DC braking starts during the deceleration phase. If "Stop Mode" is set to coasting, DC braking starts at stop command immediately.	0.0 Hz
P-68	DC-Brake Current	0.0 %	100.0 %	Amount of DC current as a percentage of the "Motor Nom Current" that is injected into the motor during DC braking.	20.0 %

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