PowerXL™

DA1
Variabe Frequency Drives

Installation Manual

Powering Business Worldwide

All proprietary names and product designations are brand names or trademarks registered to the relevant title holders.

Break-Down Service
Please call your local representative:
http://eaton.com/moeller/aftersales
or
Hotline After Sales Service:
+49 (0) 180 5 223822 (de, en)
AfterSalesEGBonn@eaton.com

For customers in US/Canada contact:

EatonCare Customer Support Center

Call the EatonCare Support Center if you need assistance with placing an order, stock availability or proof of shipment, expediting an existing order, emergency shipments, product price information, returns other than warranty returns, and information on local distributors or sales offices.

Voice: 877-ETN-CARE (386-2273) (8:00 a.m. – 6:00 p.m. EST)
After-Hours Emergency: 800-543-7038 (6:00 p.m. – 8:00 a.m. EST)

Drives Technical Resource Center

Voice: 877-ETN-CARE (386-2273) option 2, option 6
(8:00 a.m. – 5:00 p.m. Central Time U.S. [UTC-6])
email: TRCDrives@Eaton.com
www.eaton.com/drives

Original operating manual
The German-language edition of this document is the original operating manual.

Translation of the original operating manual
All editions of this document other than those in German language are translations of the original operating manual.

1st published 2012, edition date 10/2012
2nd edition 2016, edition date 01/2016
3rd edition 2016, edition date 11/2016
4th edition 2018, edition date 08/2018

See revision protocol in the "About this manual" chapter.

Authors: Jörg Randermann, Philipp Hergarten, Sven Stahlmann
Redaction: René Wiegand

Danger!
Dangerous electrical voltage!

Before commencing the installation

- Disconnect the power supply of the device.
- Ensure that devices cannot be accidentally restarted.
- Verify isolation from the supply.
- Earth and short circuit the device.
- Cover or enclose any adjacent live components.
- Follow the engineering instructions (AWA/IL) for the device concerned.
- Only suitably qualified personnel in accordance with EN 50110-1/-2 (VDE 0105 Part 100) may work on this device/system.
- Before installation and before touching the device ensure that you are free of electrostatic charge.
- The functional earth (FE, PES) must be connected to the protective earth (PE) or the potential equalisation. The system installer is responsible for implementing this connection.
- Connecting cables and signal lines should be installed so that inductive or capacitive interference does not impair the automation functions.
- Install automation devices and related operating elements in such a way that they are well protected against unintentional operation.
- Suitable safety hardware and software measures should be implemented for the I/O interface so that an open circuit on the signal side does not result in undefined states in the automation devices.
- Ensure a reliable electrical isolation of the extra-low voltage of the 24 V supply. Only use power supply units complying with IEC 60364-4-41 (VDE 0100 Part 410) or HD384.4.41 S2.
- Deviations of the mains voltage from the rated value must not exceed the tolerance limits given in the specifications, otherwise this may cause malfunction and dangerous operation.
- Emergency stop devices complying with IEC/EN 60204-1 must be effective in all operating modes of the automation devices. Unlatching the emergency-stop devices must not cause a restart.
- Devices that are designed for mounting in housings or control cabinets must only be operated and controlled after they have been installed and with the housing closed. Desktop or portable units must only be operated and controlled in enclosed housings.
- Measures should be taken to ensure the proper restart of programs interrupted after a voltage dip or failure. This should not cause dangerous operating states even for a short time. If necessary, emergency-stop devices should be implemented.
- Wherever faults in the automation system may cause injury or material damage, external measures must be implemented to ensure a safe operating state in the event of a fault or malfunction (for example, by means of separate limit switches, mechanical interlocks etc.).
- Depending on their degree of protection, frequency inverters may contain live bright metal parts, moving or rotating components or hot surfaces during and immediately after operation.
- Removal of the required covers, improper installation or incorrect operation of motor or frequency inverter may cause the failure of the device and may lead to serious injury or damage.
- The applicable national accident prevention and safety regulations apply to all work carried on live frequency inverters.
- The electrical installation must be carried out in accordance with the relevant regulations (e. g. with regard to cable cross sections, fuses, PE).
- Transport, installation, commissioning and maintenance work must be carried out only by qualified personnel (IEC 60364, HD 384 and national occupational safety regulations).
- Installations containing frequency inverters must be provided with additional monitoring and protective devices in accordance with the applicable safety regulations. Modifications to the frequency inverters using the operating software are permitted.
- All covers and doors must be kept closed during operation.
- To reduce the hazards for people or equipment, the user must include in the machine design measures that restrict the consequences of a malfunction or failure of the drive (increased motor speed or sudden standstill of motor). These measures include:
  - Other independent devices for monitoring safety-related variables (speed, travel, end positions etc.).
  - Electrical or non-electrical system-wide measures (electrical or mechanical interlocks).
  - Never touch live parts or cable connections of the frequency inverter after it has been disconnected from the power supply. Due to the charge in the capacitors, these parts may still be live after disconnection. Fit appropriate warning signs.

Table of contents

0 About This Manual

This manual (08/18 MN04020005Z-EN) contains specific information designed to enable you to select and connect a DA1 variable frequency drive. It covers all DA1 frame sizes.

Differences and special characteristics of each rating level and frame size are listed accordingly. Accessories that can be used to modify the DA1 variable frequency drive according to your specific needs will be listed where applicable.

"Parameter manual"
A separate manual – MN04020006Z-EN ("Parameter Manual") – goes over how to configure the parameters for DA1 variable frequency drives and provides application examples as well.

This manual is available on the Eaton website at:

http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/Kundensupport/DownloadCenter/index.htm

→ Customer Support → Download Center – Documentation

Enter "MN04020006Z" in the **Quick Search** field and click on **Search**.

0.1 Target group

The content of the MN04020005Z-EN manual is written 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 fundamentals and that you are familiar with handling electrical systems and machines, as well as with reading technical drawings.

CAUTION

Installation requires a qualified electrician

0.2 Change protocol

The following significant amendments have been introduced since previous issues:

Publication date	Page	Keyword	new	modified	deleted
08/18	14	Assembly instruction IL040049ZU for devices with IP20 protection and frame size FS4 and FS5	✓		
	19	new types (“Features” table)		✓	
	25	Sizes FS4 and FS5 with IP20 protection	✓		
	39	Fan replacement with sizes FS4 and FS5	✓		
	62	Sine wave filters		✓	
	94	EMC screws		✓	
	106	Stripping lengths and tightening torques		✓	
	121	Configuration of the control signal terminals (terminals 1 and 3)		✓	
	122 ff.	Block diagrams		✓	
	142	Parameters with Error no. 51		✓	
	143 ff.	Specifications		✓	
	158	Dimensions with sizes FS4 and FS5	✓		
	195	List of accessories		✓	
11/16	75	P1-12 = 12			✓
01/16	–	This manual splits into two manuals, the installation section (= MN04020005Z-EN) and the parameter section (= MN04020006Z-EN) as well as revised in general		✓	
	various	Output expansion up to 250 kW (400 V)	✓		
	various	Rated operating voltages up to 600 V	✓		
	68	STO function (Safe Torque Off)	✓		
10/12		First edition			

0.3 Writing conventions

Symbols with the following meaning are used in this manual:

▶ Indicates instructions to be followed.

0.3.1 Hazard warnings of material damages

WARNING

Warns about the possibility of material damage.

0.3.2 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.

0.3.3 Tips

Indicates useful tips.

In order to make it easier to understand some of the figures included in this manual, the variable frequency drive housing, as well as other safety-relevant parts, have been left out. However, it is important to note that the variable frequency 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.

0.4 Documents with additional information

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

www.eaton.eu/powerxl

as well as

http://www.eaton.de/EN/EatonDE/ProdukteundLoesungen/Electrical/Kundensupport/DownloadCenter/index.htm

→ Customer Support → Download Center – Documentation

In the **Quick Search** box, enter the document name ("MN04020005", for the existing manual example).

0.5 Abbreviations

The following abbreviations are used in this manual.

DS	Default setting
EMC	Electromagnetic compatibility
FE	Functional earth
FS	Frame size
FWD	Forward run (clockwise rotating field)
GND	Ground (0-V-potential)
IGBT	Insulated gate bipolar transistor
LED	Light Emitting Diode
OLED	Organic Light Emitting Diode
PC	Personal Computer
PDS	Power Drive System
PE	Protective earth ⏚
PES	EMC connection to PE for screened cables
PNU	Parameter Number
REV	Reverse run (anticlockwise rotation field active)
SCCR	Short Circuit Current Rating
UL	Underwriters Laboratories

0.6 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 (e. g. 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 (e. g. 230 V, 400 V).

In star networks (e. g. in North America), the rated operating voltage at the transfer point of the utility companies is higher than in the consumer network.
Example: 240 V → 230 V, 480 V → 460 V, 600 V → 575 V.

The broad tolerance range of the DA1 variable frequency drive observes a permitted voltage drop of 10 % (i. e. U_{LN} - 10 %) and in the 400-V category, the North American mains voltage of 480 V + 10 % (60 Hz).

The permissible power supplies for the DA1 series are listed in the technical data section in the appendix.

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

0.7 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

Name	US-American designation	US-American value	SI value	Conversion value
Length	inch	1 in (")	25.4 mm	0.0394
Power	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)	$T_F = T_C \times 9/5 + 32$
Speed	Revolutions per minute	1 rpm	1 min^{-1}	1
Weight	pound	1 lb	0.4536 kg	2.205
Flow rate	cubic feet per minute	1 cfm	1.698 m^3/min	0.5889

1 DA1 device series

1.1 Introduction

Due to their comprehensive functionality and high reliability, PowerXL™ DA1 variable frequency drives are ideal for sophisticated applications involving synchronous or asynchronous three-phase motors.

In fact, DA1 variable frequency drives are characterized by innovative technology and unrivaled reliability that meet the needs of the machine and system-building industry and enable companies to optimize their production and manufacturing processes.

All DA1 variable frequency drives feature an internal brake chopper.

In addition, devices belonging to the 230 V (DA1-32…) and 400 V (DA1-34…) voltage categories come with an integrated radio interference suppression filter (EMC).

The devices' printed circuit boards are coated in order to provide greater protection against environmental factors.

DA1 devices are characterized by compact and rugged construction, are available in seven frame sizes (FS2 to FS8), and are designed for the following motor ratings:

- 0.75 (for 230 V) to 11 kW (for 400 V and 500 V) with IP20 protection with a 7-segment display,
- 0.75 kW (for 230 V) to 7.5 kW (for 400 V and 500 V) with IP66 protection and an OLED display – also available in a version with a mains switch and controls for local control,
- 5.5 kW (for 230 V) to 90 kW (for 500 V) and 132 kW (for 400 V) with an OLED display in sizes FS4, FS5, FS6 and FS7 with internal DC link choke,
- 200 kW to 250 kW (for 400 V) with IP20 protection and an OLED display (frame size FS8).

1.2 System overview

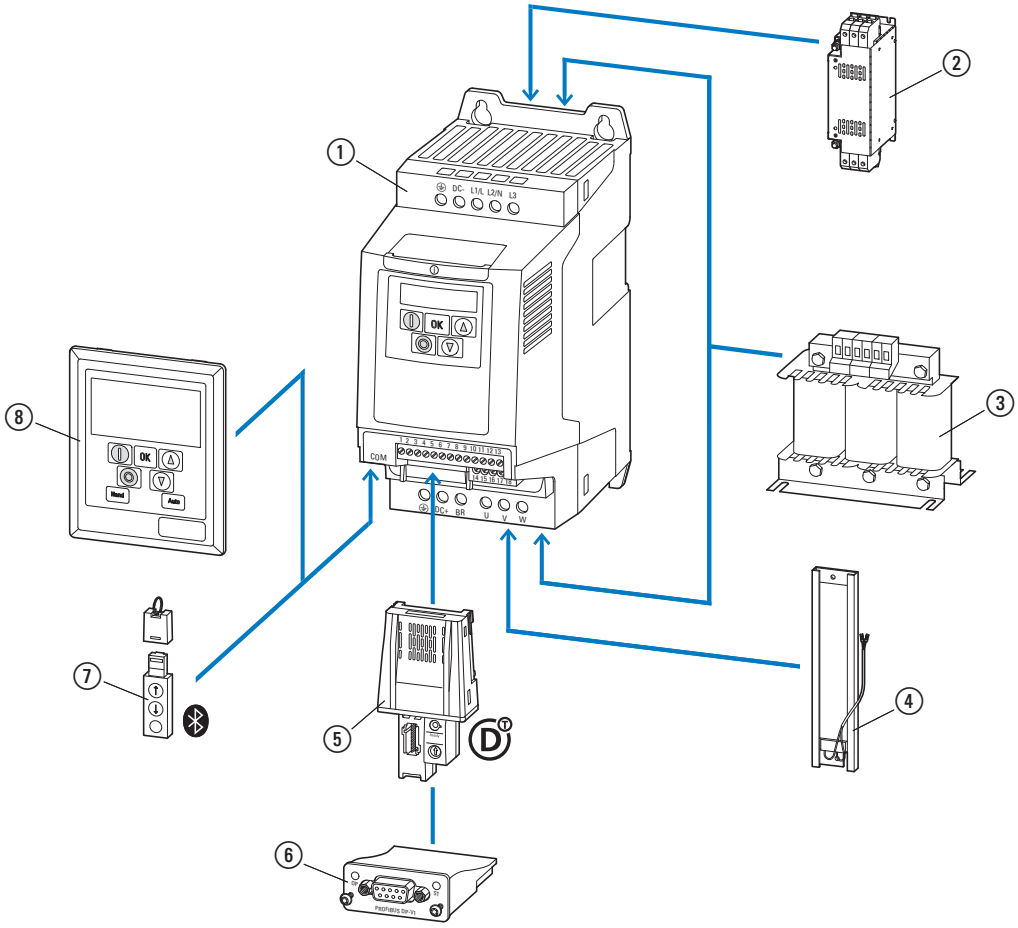


Figure 1: System overview (example: frame size FS2, IP20 protection)

① DA1-… variable frequency drives
② Mains choke DX-LN…, motor choke DX-LM3-…,
DX-SIN3-…sine wave filter, DX-SIN3-…-A all-pole sine wave filter
③ DX-BR… braking resistor
④ DX-NET… fieldbus connection and DXA-EXT… expansion group
⑤ DX-COM-STICK3 communication module and accessories (e. g. DX-CBL-… connection cable)
⑥ DX-KEY-…keypad (external)

1.3 Checking the delivery

→ Before opening the package, please check its rating plate to make sure that you have received the correct variable frequency drive.

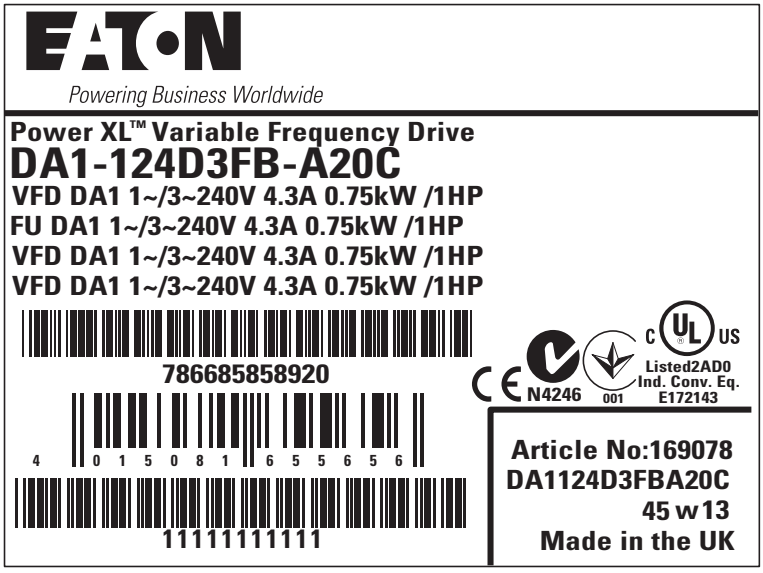


Figure 2: Label (example) on packaging

The sample label shown in figure 2 indicates that the package contains a DA1 variable frequency drive with the following characteristics:

- Single-phase mains connection: 230 V (200 - 240 V ±10 %)
- Rated current: 4.3 A
- rated motor output: 0.75 kW/1 HP (for 230 V)

The DA1 series variable frequency 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 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:

- DA1 series variable frequency drive,
- installation instructions
  - IL04020010Z for devices with IP20 protection with frame size FS2, FS3
  - IL040049ZU for devices with IP20 protection with frame size FS4, FS5
  - IL04020012Z for devices with IP20 protection with frame size FS8
  - IL04020011Z for devices with IP55 protection with frame size FS4, FS5, FS6, FS7
  - IL04020015Z for devices with IP66 protection with frame size FS2, FS3

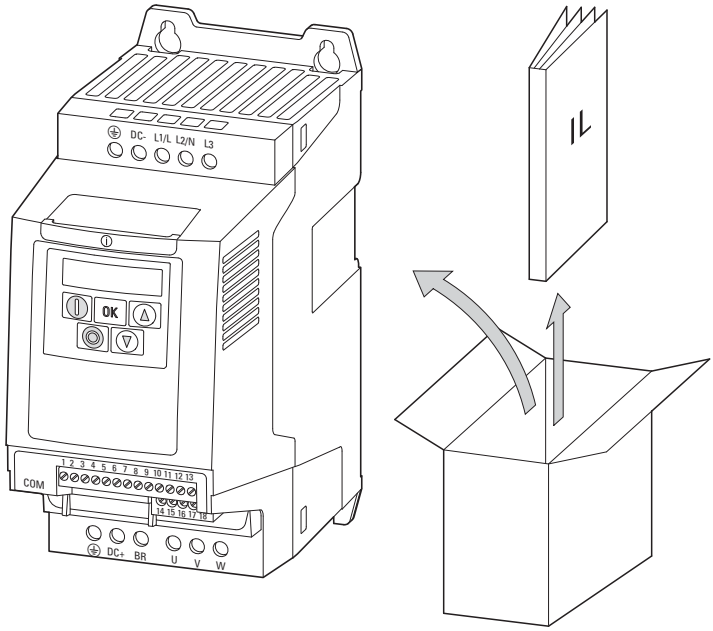


Figure 3: Equipment supplied (example: frame size FS2, IP20 protection)

1.4 Rated operational data

1.4.1 Rated operational data on the rating plate

The device-specific rated operational data for the DA1 variable frequency drive is listed on the rating plate of the device.

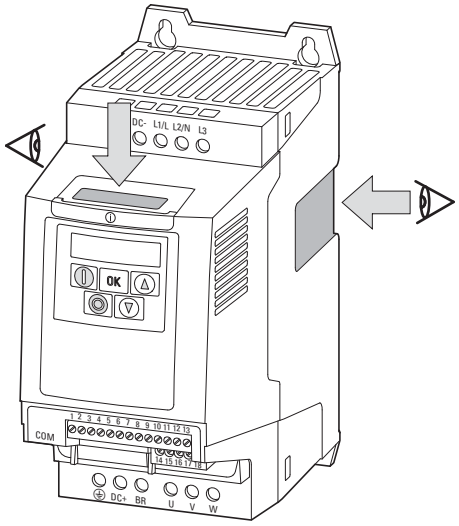


Figure 4: Rating plate on the device (example: frame size FS2, IP20 protection)

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

DA1
PowerXL™
Variable Frequency Drive
IP20

DA1-124D3FB-A20C

→ DA1 - MN04020005Z...
Article-No: 169152
Style-No: DA1124D3FBA20C

Input : 200-240V +/-10%, 50/60Hz, 1 phase, 11A (pk)
Output: 0-250V, 4.3A, 0.75kW/1.0HP, 3 phase, 0-500Hz
Serial No.: 57227302045

CAUTION
Power down for 5 mins before removing cover
Read User guide before installation or servicing

www.eaton.eu/documentation
Max Amb. 50°C
Made in UK

S/Ware : 1.20
08112013

c UL us
Listed340B
Ind. Conv. Eq.
E172143
N4246

Figure 5: Rating plate ① (on the side)

DA1-124D3FB-A20C **Art.No: 169152**
I/P: 200-240 V +/-10 %, 50/60 Hz, 1 ph 11 A (pk)
O/P: 0-250 V, 4.3 A, 0.75 kW/1.0 HP, 3 ph, 0-500 Hz
Serial No.: 57227302045 **S/Ware: 0.00**

Figure 6: Rating plate ② (on the front)

The inscription of the rating plate (from → figure 5) has the following meaning (example):

Inscription	**Meaning**
DA1-124D3FB-A20C	Part no.: DA1 = DA1 series variable frequency drive 1 = Single-phase mains connection / three-phase motor connection 2 = Mains voltage category 230 V 4D3 = 4.3 A rated operational current (4-decimal point-1, output current) F = Integrated radio interference suppression filter B = Integrated brake chopper A = LED display (7-segment text display) 20 = IP20 protection C = PCB protection (coated board)
Input	Rated operational data of mains connection: Single-phase AC voltage (U_e 1~ AC) Voltage 200 - 240 V, frequency 50/60 Hz, input phase current (11 A)
Output	Load side (motor) rated operational data: Three-phase AC voltage (0 - U_e) output phase current (4.3 A), Output frequency (0 - 500 Hz) Rated motor output: 0.75 kW at 230 V/1 HP at 230 V for a four-pole, internally or surface-cooled three-phase motor (1500 min^{-1} at 50 Hz/1800 rpm at 60 Hz)
Serial No.:	Serial number
IP20	Housing protection type: IP20, UL (cUL) Open type
S/Ware	Software version (1.20)
08112013	Manufacturing date: 11/8/2013
Max. Amb. 50 °C	Maximum permissible ambient air temperature (50 °C)
→ 	Frequency converters are electrical equipment. Read the manual (in this case MN04020005Z-EN) before making any electrical connections and commissioning.

1.4.2 Catalog number selection

The catalog number selection/part no. for DA1 variable frequency drives is subdivided into three groups

Series – Power section – Model

The following figure shows it in greater detail:

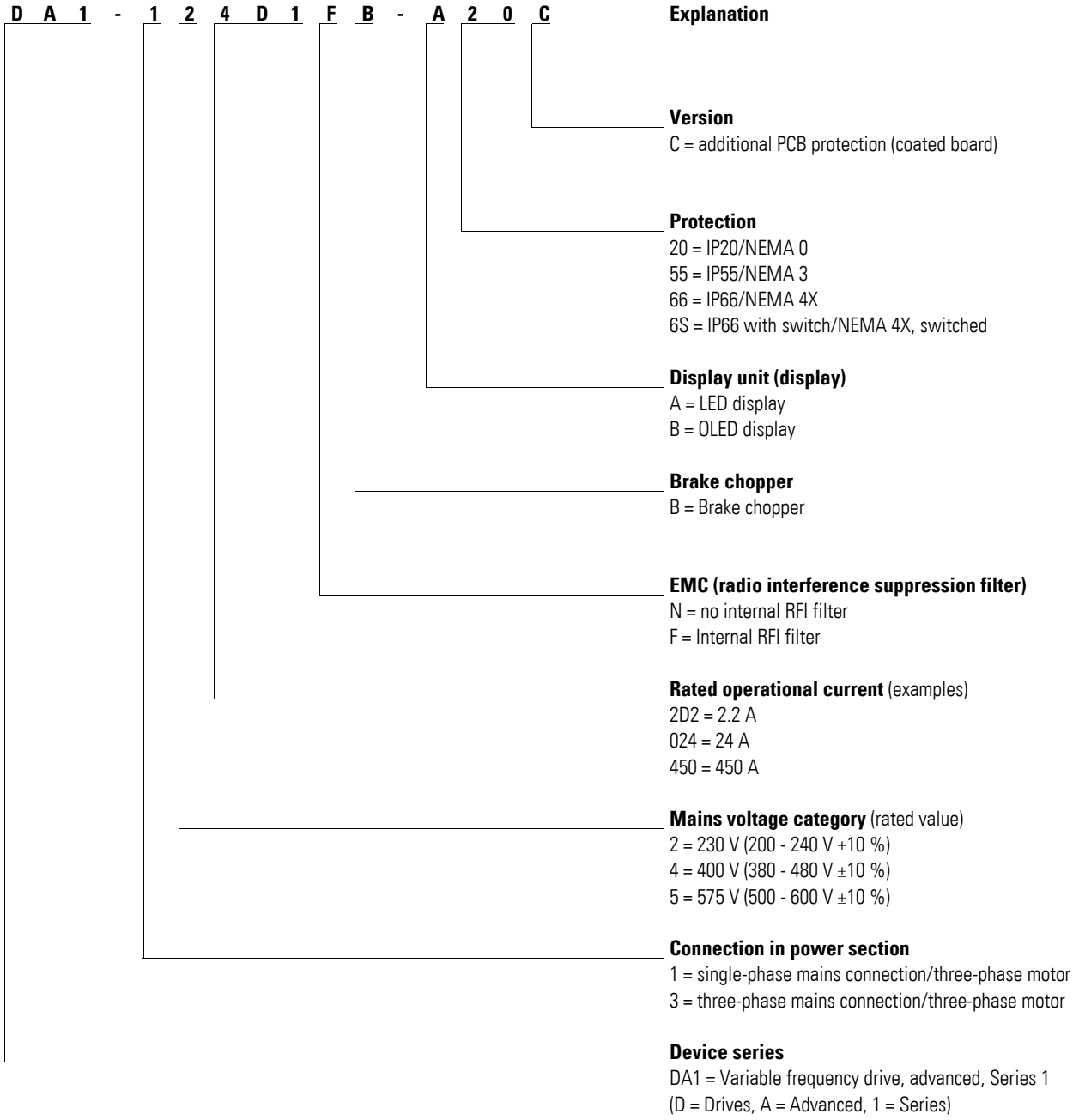


Figure 7: Catalog number selection

Catalog number examples

Inscription	Meaning
DA1-124D3FB-A20C	DA1 = DA1 series variable frequency drive 1 = Single-phase main terminal 2 = Mains voltage category: 230 V (200 V- 240 V ±10 %) 4D3 = rated operational current: 4.3 A N = Internal radio interference suppression filter B = Internal brake chopper A = LED display 20 = IP20 protection C = PCB protection (coated board)
DA1-327D0FB-A20C	DA1 = DA1 series variable frequency drive 3 = Three-phase main terminal 2 = Mains voltage category: 230 V (200 V- 240 V ±10 %) 7D0 = rated operational current: 7.0 A N = Internal radio interference suppression filter B = Internal brake chopper A = LED display 20 = IP20 protection C = PCB protection (coated board)
DA1-34014FB-B66C	DA1 = DA1 series variable frequency drive 3 = Three-phase main terminal 4 = Mains voltage category: 400 V (380 V - 480 V ±10 %) 014 = rated operational current: 14 A N = Internal radio interference suppression filter B = Internal brake chopper B = OLED display 66 = IP66 protection C = PCB protection (coated board)
DA1-35043NB-B55C	DA1= DA1 series variable frequency drive 3 = Three-phase main terminal 5 = Mains voltage category: 575 V (500 V - 600 V ±10 %) 043 = rated operational current: 43 A N = No internal radio interference suppression filter[1)] B = Internal brake chopper B = OLED display 55 = IP55 protection C = PCB protection (coated board)

1) See following note

→ For DA1-35…**N**B-… devices, an external radio interference suppression filter is required for operation as per IEC/EN 61800-3.

1.4.3 Features

Mains supply voltage: 1 AC 230 V
Motor connection voltage: 3 AC 230 V, 50/60 Hz

Type	Rated operational current	Rated motor power (induction motor)		Display (operating unit)	Local controls	Radio interference filter	DC link choke	Protection	Frame size	Brake Chopper
	I_e	P[1] (230 V, 50 Hz)	P[2] (220 - 240 V, 60 Hz)					IP	FS	
	A	kW	HP							
DA1-124D3FB-A20C	4.3	0.75	1	LED	–	✓	–	IP20	FS2	✓
DA1-124D3FB-B66C	4.3	0.75	1	OLED	–	✓	–	IP66	FS2	✓
DA1-124D3FB-B6SC	4.3	0.75	1	OLED	✓	✓	–	IP66	FS2	✓
DA1-127D0FB-A20C	7	1.5	2	LED	–	✓	–	IP20	FS2	✓
DA1-127D0FB-B66C	7	1.5	2	OLED	–	✓	–	IP66	FS2	✓
DA1-127D0FB-B6SC	7	1.5	2	OLED	✓	✓	–	IP66	FS2	✓
DA1-12011FB-A20C	10.5	2.2	3	LED	–	✓	–	IP20	FS2	✓
DA1-12011FB-B66C	10.5	2.2	3	OLED	–	✓	–	IP66	FS2	✓
DA1-12011FB-B6SC	10.5	2.2	3	OLED	✓	✓	–	IP66	FS2	✓

1) As per IEC standards
2) Quote from "Power Conversion Equipment - UL 508C, May 3, 2002".

Mains supply voltage: 3 AC 230 V, 50/60 Hz
Motor supply voltage: 3 AC 230 V, 50/60 Hz

Type	Rated operational current	Rated motor power (induction motor)		Display (operating unit)	Local controls	Radio interference filter	DC link choke	Protection	Frame size	Brake Chopper
	I_e	P[1] (230 V, 50 Hz)	P[2] (220 - 240 V, 60 Hz)					IP	FS	
	A	kW	HP							
DA1-324D3FB-A20C	4.3	0.75	1	LED	–	✓	–	IP20	FS2	✓
DA1-324D3FB-B66C	4.3	0.75	1	OLED	–	✓	–	IP66	FS2	✓
DA1-324D3FB-B6SC	4.3	0.75	1	OLED	✓	✓	–	IP66	FS2	✓
DA1-327D0FB-A20C	7	1.5	2	LED	–	✓	–	IP20	FS2	✓
DA1-327D0FB-B66C	7	1.5	2	OLED	–	✓	–	IP66	FS2	✓
DA1-327D0FB-B6SC	7	1.5	2	OLED	✓	✓	–	IP66	FS2	✓
DA1-32011FB-A20C	10.5	2.2	3	LED	–	✓	–	IP20	FS2	✓
DA1-32011FB-B66C	10.5	2.2	3	OLED	–	✓	–	IP66	FS2	✓
DA1-32011FB-B6SC	10.5	2.2	3	OLED	✓	✓	–	IP66	FS2	✓
DA1-32018FB-A20C	18	4	5	LED	–	✓	–	IP20	FS3	✓
DA1-32018FB-B66C	18	4	5	OLED	–	✓	–	IP66	FS3	✓
DA1-32018FB-B6SC	18	4	5	OLED	✓	✓	–	IP66	FS3	✓
DA1-32024FB-A20C	24	5.5	7.5	LED	–	✓	–	IP20	FS3	✓
DA1-32024FB-B55C	24	5.5	7.5	OLED	–	✓	–	IP55	FS4	✓
DA1-32030FB-B20C	30	7.5	10	OLED	–	✓	–	IP20	FS4	✓
DA1-32030FB-B55C	30	7.5	10	OLED	–	✓	–	IP55	FS4	✓
DA1-32046FB-B20C	46	11	15	OLED	–	✓	–	IP20	FS4	✓
DA1-32046FB-B55C	46	11	15	OLED	–	✓	–	IP55	FS4	✓
DA1-32060FB-B20C	61	15	20	OLED	–	✓	✓	IP20	FS5	✓
DA1-32061FB-B55C	61	15	20	OLED	–	✓	✓	IP55	FS5	✓
DA1-32072FB-B20C	72	18.5	25	OLED	–	✓	✓	IP20	FS5	✓
DA1-32072FB-B55C	72	18.5	25	OLED	–	✓	✓	IP55	FS5	✓
DA1-32090FB-B55C	90	22	30	OLED	–	✓	✓	IP55	FS6	✓
DA1-32110FB-B55C	110	30	40	OLED	–	✓	✓	IP55	FS6	✓
DA1-32150FB-B55C	150	37	50	OLED	–	✓	✓	IP55	FS6	✓
DA1-32180FB-B55C	180	45	60	OLED	–	✓	✓	IP55	FS6	✓
DA1-32202FB-B55C	202	55	75	OLED	–	✓	✓	IP55	FS7	✓
DA1-32248FB-B55C	248	75	100	OLED	–	✓	✓	IP55	FS7	✓

1) As per IEC standards
2) Quote from "Power Conversion Equipment - UL 508C, May 3, 2002".

Mains supply voltage: 3 AC 400 V, 50 Hz/480 V, 60 Hz
Motor supply voltage: 3 AC 400 V, 50 Hz/440 - 480 V, 60 Hz

Type	Rated operational current	Rated motor power (induction motor)[1]		Display	Local controls	Radio interference filter	DC link choke	Protection	Frame size	Brake Chopper
	I_e	P[1)] (400 V, 50 Hz)	P[2)] (440 - 480 V, 60 Hz)					IP	FS	
	A	kW	HP							
DA1-342D2FB-A20C	2.2	0.75	1	LED	–	✓	–	IP20	FS2	✓
DA1-342D2FB-B66C	2.2	0.75	1	OLED	–	✓	–	IP66	FS2	✓
DA1-342D2FB-B6SC	2.2	0.75	1	OLED	✓	✓	–	IP66	FS2	✓
DA1-344D1FB-A20C	4.1	1.5	2	LED	–	✓	–	IP20	FS2	✓
DA1-344D1FB-B66C	4.1	1.5	2	OLED	–	✓	–	IP66	FS2	✓
DA1-344D1FB-B6SC	4.1	1.5	2	OLED	✓	✓	–	IP66	FS2	✓
DA1-345D8FB-A20C	5.8	2.2	3	LED	–	✓	–	IP20	FS2	✓
DA1-345D8FB-B66C	5.8	2.2	3	OLED	–	✓	–	IP66	FS2	✓
DA1-345D8FB-B6SC	5.8	2.2	3	OLED	✓	✓	–	IP66	FS2	✓
DA1-349D5FB-A20C	9.5	4	5	LED	–	✓	–	IP20	FS2	✓
DA1-349D5FB-B66C	9.5	4	5	OLED	–	✓	–	IP66	FS2	✓
DA1-349D5FB-B6SC	9.5	4	5	OLED	✓	✓	–	IP66	FS2	✓
DA1-34014FB-A20C	14	5.5	7.5	LED	–	✓	–	IP20	FS3	✓
DA1-34014FB-B66C	14	5.5	7.5	OLED	–	✓	–	IP66	FS3	✓
DA1-34014FB-B6SC	14	5.5	7.5	OLED	✓	✓	–	IP66	FS3	✓
DA1-34018FB-A20C	18	7.5	10	LED	–	✓	–	IP20	FS3	✓
DA1-34018FB-B66C	18	7.5	10	OLED	–	✓	–	IP66	FS3	✓
DA1-34018FB-B6SC	18	7.5	10	OLED	✓	✓	–	IP66	FS3	✓
DA1-34024FB-A20C	24	11	15	LED	–	✓	–	IP20	FS3	✓
DA1-34024FB-B55C	24	11	15	OLED	–	✓	–	IP55	FS4	✓
DA1-34030FB-B20C	30	15	20	OLED	–	✓	–	IP20	FS4	✓
DA1-34030FB-B55C	30	15	20	OLED	–	✓	–	IP55	FS4	✓
DA1-34039FB-B20C	39	18.5	25	OLED	–	✓	–	IP20	FS4	✓
DA1-34039FB-B55C	39	18.5	25	OLED	–	✓	–	IP55	FS4	✓
DA1-34046FB-B20C	46	22	30	OLED	–	✓	–	IP20	FS4	✓
DA1-34046FB-B55C	46	22	30	OLED	–	✓	–	IP55	FS4	✓
DA1-34061FB-B20C	61	30	40	OLED	–	✓	✓	IP20	FS5	✓
DA1-34061FB-B55C	61	30	40	OLED	–	✓	✓	IP55	FS5	✓
DA1-34072FB-B20C	72	37	50	OLED	–	✓	✓	IP20	FS5	✓
DA1-34072FB-B55C	72	37	50	OLED	–	✓	✓	IP55	FS5	✓
DA1-34090FB-B55C	90	45	60	OLED	–	✓	✓	IP55	FS6	✓

Type	Rated operational current	Rated motor power (induction motor)[1]		Display	Local controls	Radio interference filter	DC link choke	Protection	Frame size	Brake Chopper
	I_e	P[1] (400 V, 50 Hz)	P[2] (440 - 480 V, 60 Hz)					IP	FS	
	A	kW	HP							
DA1-34110FB-B55C	110	55	75	OLED	–	✓	✓	IP55	FS6	✓
DA1-34150FB-B55C	150	75	100	OLED	–	✓	✓	IP55	FS6	✓
DA1-34180FB-B55C	180	90	125	OLED	–	✓	✓	IP55	FS6	✓
DA1-34202FB-B55C	202	110	150	OLED	–	✓	✓	IP55	FS7	✓
DA1-34240FB-B55C	240	132	200	OLED	–	✓	✓	IP55	FS7	✓
DA1-34302FB-B55C	302	160	250	OLED	–	✓	✓	IP55	FS7	✓
DA1-34370FB-B20C[3]	370	200	300	OLED	–	✓	–	IP20	FS8	✓
DA1-34450FB-B20C[3]	450	250	350	OLED	–	✓	–	IP20	FS8	✓

1) As per IEC standards
2) Quote from "Power Conversion Equipment - UL 508C, May 3, 2002".
3) If it is not guaranteed that the system percentage impedance is greater than or equal to 1 %, a mains choke must be connected. Your u_K value should fall between 1 and 4 %.

Examples:
DA1-34370FB-B20C → DX-LN3-370
DA1-34450FB-B20C → DX-LN3-450

Mains supply voltage: 3 AC 500 V, 50 Hz/575 V, 60 Hz
Motor supply voltage: 3 AC 500 V, 50 Hz/550 - 600 V, 60 Hz

Type	Rated operational current	Rated motor power (induction motor)		Display	Local controls	Radio interference filter	DC link choke	Protection	Frame size	Brake Chopper
	I_e	P (500 V, 50 Hz)	P[1] (550 - 600 V, 60 Hz)					IP	FS	
	A	kW	HP							
DA1-352D1NB-A20C	2.1	0.75	1	LED	–	–	–	IP20	FS2	✓
DA1-352D1NB-B66C	2.1	0.75	1	OLED	–	–	–	IP66	FS2	✓
DA1-352D1NB-B6SC	2.1	0.75	1	OLED	✓	–	–	IP66	FS2	✓
DA1-353D1NB-A20C	3.1	1.5	2	LED	–	–	–	IP20	FS2	✓
DA1-353D1NB-B66C	3.1	1.5	2	OLED	–	–	–	IP66	FS2	✓
DA1-353D1NB-B6SC	3.1	1.5	2	OLED	✓	–	–	IP66	FS2	✓
DA1-354D1NB-A20C	4.1	2.2	3	LED	–	–	–	IP20	FS2	✓
DA1-354D1NB-B66C	4.1	2.2	3	OLED	–	–	–	IP66	FS2	✓
DA1-354D1NB-B6SC	4.1	2.2	3	OLED	✓	–	–	IP66	FS2	✓
DA1-356D5NB-A20C	6.5	4	5	LED	–	–	–	IP20	FS2	✓
DA1-356D5NB-B66C	6.5	4	5	OLED	–	–	–	IP66	FS2	✓
DA1-356D5NB-B6SC	6.5	4	5	OLED	✓	–	–	IP66	FS2	✓
DA1-359D0NB-A20C	9	5.5	7.5	LED	–	–	–	IP20	FS2	✓
DA1-359D0NB-B66C	9	5.5	7.5	OLED	–	–	–	IP66	FS2	✓
DA1-359D0NB-B6SC	9	5.5	7.5	OLED	✓	–	–	IP66	FS2	✓
DA1-35012NB-A20C	12	7.5	10	LED	–	–	–	IP20	FS3	✓
DA1-35012NB-B66C	12	7.5	10	OLED	–	–	–	IP66	FS3	✓
DA1-35012NB-B6SC	12	7.5	10	OLED	✓	–	–	IP66	FS3	✓
DA1-35017NB-A20C	17	11	15	LED	–	–	–	IP20	FS3	✓
DA1-35017NB-B66C	17	11	15	OLED	–	–	–	IP66	FS3	✓
DA1-35017NB-B6SC	17	11	15	OLED	✓	–	–	IP66	FS3	✓
DA1-35022NB-A20C	22	15	20	LED	–	–	–	IP20	FS3	✓
DA1-35022NB-B55C	22	15	20	OLED	–	–	–	IP55	FS4	✓
DA1-35028NB-B20C	28	18.5	25	OLED	–	–	–	IP20	FS4	✓
DA1-35028NB-B55C	28	18.5	25	OLED	–	–	–	IP55	FS4	✓
DA1-35034NB-B20C	34	22	30	OLED	–	–	–	IP20	FS4	✓
DA1-35034NB-B55C	34	22	30	OLED	–	–	–	IP55	FS4	✓
DA1-35043NB-B20C	43	30	40	OLED	–	–	✓	IP20	FS5	✓
DA1-35043NB-B55C	43	30	40	OLED	–	–	✓	IP55	FS5	✓
DA1-35054NB-B20C	54	37	50	OLED	–	–	✓	IP20	FS5	✓
DA1-35054NB-B55C	54	37	50	OLED	–	–	✓	IP55	FS5	✓
DA1-35065NB-B20C	65	45	60	OLED	–	–	✓	IP20	FS5	✓
DA1-35065NB-B55C	65	45	60	OLED	–	–	✓	IP55	FS5	✓

Type	Rated operational current	Rated motor power (induction motor)		Display	Local controls	Radio interference filter	DC link choke	Protection	Frame size	Brake Chopper
	I_e	P (500 V, 50 Hz)	P[1] (550 - 600 V, 60 Hz)					IP	FS	
	A	kW	HP							
DA1-35078NB-B55C	78	55	75	OLED	–	–	✓	IP55	FS6	✓
DA1-35105NB-B55C	105	75	100	OLED	–	–	✓	IP55	FS7	✓
DA1-35130NB-B55C	130	90	125	OLED	–	–	✓	IP55	FS6	✓
DA1-35150NB-B55C	150	110	150	OLED	–	–	✓	IP55	FS7	✓

1) Quote from "Power Conversion Equipment - UL 508C, May 3, 2002".

1.5 Designation

1.5.1 IP20 protection IP20 (FS2, FS3, FS4, FS5)

The following drawing serves as an example showing the designations used for the elements in DA1 variable frequency drives with a frame size of FS2 and IP20 protection.

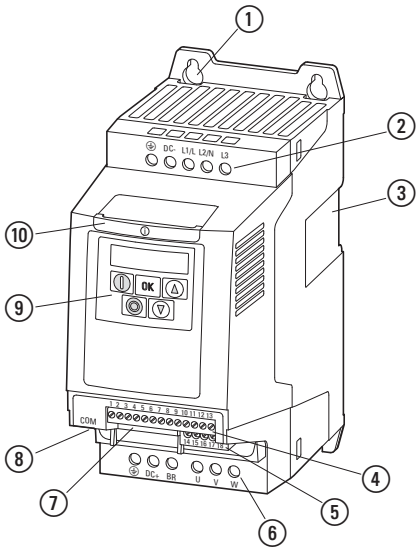


Figure 8: DA1 designations (here: FS2, IP20)

① Fixing holes (screw fastening)
② Connection terminals in power section (mains side)
③ Cutout for mounting on mounting rail
④ Control signal terminals (plug-in)
⑤ Relay terminals (plug-in)
⑥ Connection terminals in power section (motor feeder)
⑦ Slot for fieldbus connection or expansion module
⑧ Communication interface (RJ45)
⑨ Keypad with 5 control buttons and LED display
⑩ Info card

1.5.2 IP20 protection (FS8)

The following drawing serves as an example showing the designations used for the elements in DA1 variable frequency drives with a frame size of FS8 and IP20 protection.

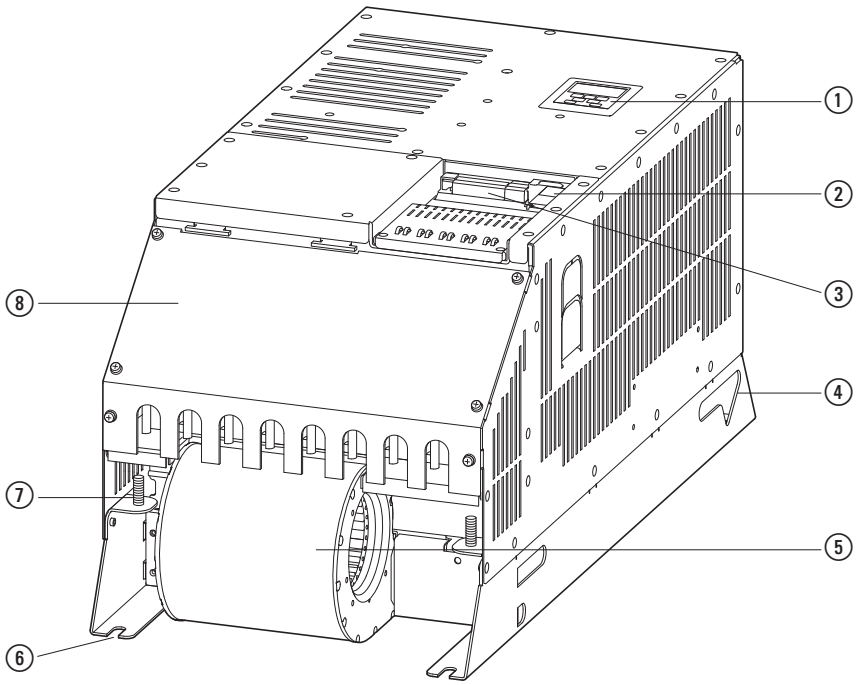


Figure 9: DA1 designations (here: FS8, IP20)

1. Operating unit with 5 control buttons and OLED display
2. Slot for fieldbus connection or expansion module
3. Control signal terminals and relay terminals (plug-in)
4. Eyebolts
5. Device fan
6. Fixing holes
7. PE terminal bolt
8. Enclosure cover for the connection terminals in the power section

The info cards are located at the back of the enclosure cover.

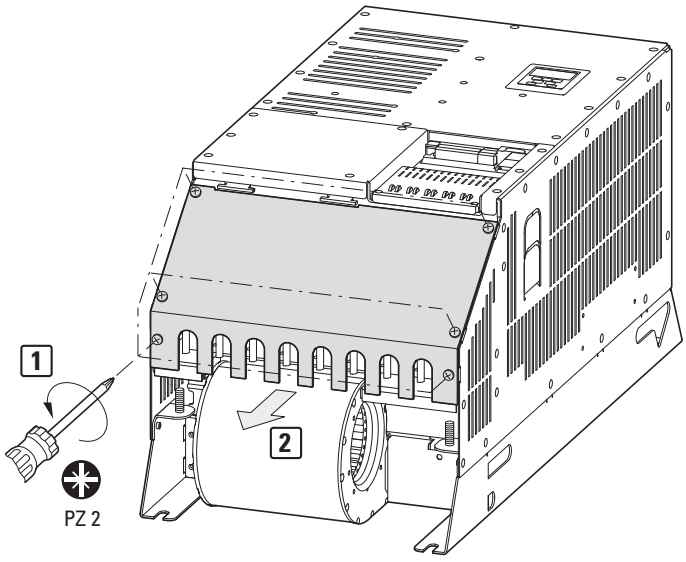


Figure 10: Info cards (back of enclosure cover ⑧)

1.5.3 IP55 protection IP55 (FS4, FS5, FS6, FS7)

The following drawing serves as an example showing the designations used for the elements in DA1 variable frequency drives with a frame size of FS4 and IP55 protection.

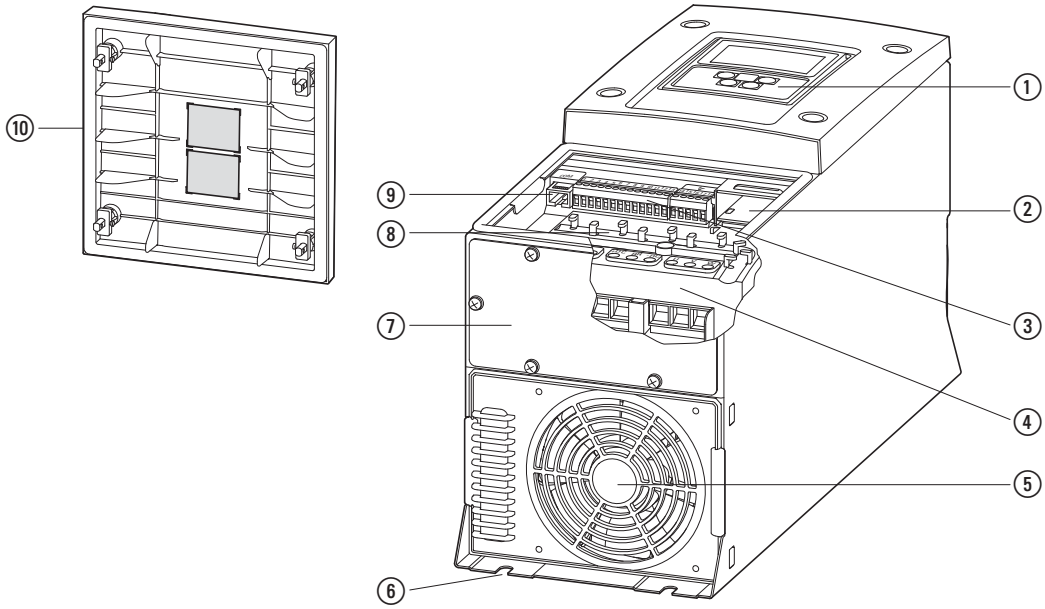


Figure 11: DA1 designations (here: FS4, IP55)

① Operating unit with 5 control buttons and OLED display
② Slot for fieldbus connection or expansion module
③ Control signal terminals and relay terminals (plug-in)
④ Connection terminals in power section
⑤ Device fan
⑥ Fixing holes
⑦ Blanking plate for installing cable glands for IP55 protection (without blanking plate: IP40 protection)
⑧ Retainer for the control section connection cables
⑨ Communication interface (RJ45)
⑩ Enclosure cover (connection terminals)

The info card is located inside the lower enclosure cover ⑩ (removed in the figure above).

Blanking plate

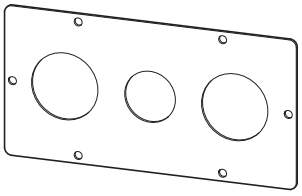


Figure 12: Blanking plate with holes for cable glands (FS4, FS5)

→ The equipment supplied with frame sizes FS4 and FS5 includes an additional blanking plate ⑦ that already has holes for the cable glands.

1.5.4 IP66 protection (FS2, FS3)

The following drawing serves as an example showing the designation used for the elements in DA1 variable frequency drives with a frame size of FS2 and IP66 protection.

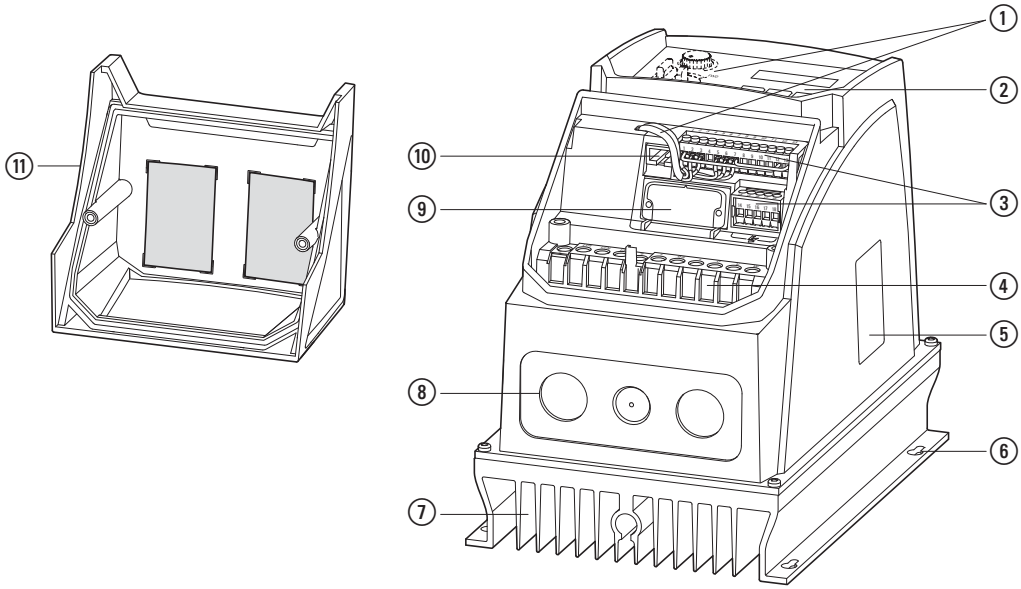


Figure 13: DA1 designation (here: FS2, IP66)

① Local controls on DA1-…-B6SC
② Operating unit with 5 control buttons and OLED display
③ Control and relay terminals (plug-in)
④ Connection terminals in power section grommet for EMC cable gland
⑤ Rating plate
⑥ Fixing holes
⑦ Heat sink
⑧ Connection terminals in power section and grommet for cable gland
⑨ Slot for fieldbus connection or expansion module
⑩ Communication interface (RJ45)
⑪ Cover

The info cards ⑪ are located inside the lower enclosure cover, which features three knockouts for cable glands to the control section.

1.6 Voltage classes

DA1 variable frequency drives are divided into three voltage categories:

- 200 V: 200 – 240 V ±10 % → DA1-**12**…, DA1-**32**…
- 400 V: 380 - 480 V ±10 % → DA1-**34**…
- 575 V: 500 - 600 V ±10 % → DA1-**35**…

1.6.1 DA1-12…

- DA1-**12**…
  - Single-phase mains connection, rated operating voltage 230 V
  - U_{LN} = 1~, 200 - 240 V ±10 %, 50/60 Hz
  - I_e = 4.3 - 11 A
  - Motor: 0.75 - 2.2 kW (230 V, 50 Hz), 1 - 3 HP (230 V, 60 Hz)

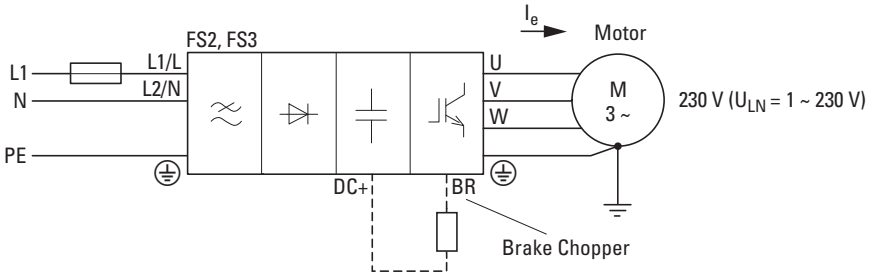


Figure 14: DA1-12…FB-…

1.6.2 DA1-32…

- DA1-**32**…
  - Three-phase power supply, rated operating voltage 230 V
  - U_{LN} = 3~, 200 - 240 V ±10 %, 50/60 Hz
  - I_e = 4.3 - 46 A
  - Motor: 0.75 - 11 kW (230 V, 50 Hz), 1 - 15 HP (230 V, 60 Hz)

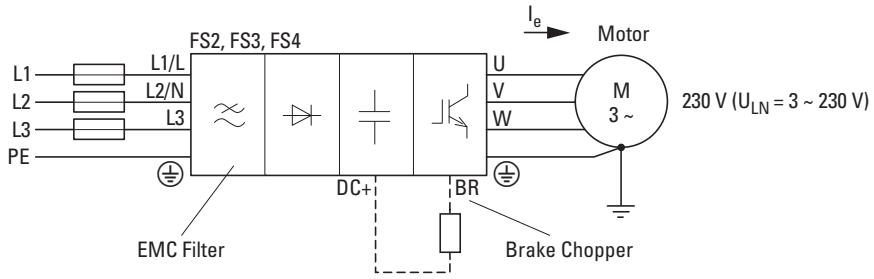


Figure 15: DA1-32…FB-…

- DA1-**32**…
  - Three-phase power supply, rated operating voltage 230 V
  - U_{LN} = 3~, 200 - 240 V ±10 %, 50/60 Hz
  - I_e = 61 - 248 A
  - Motor: 15 - 75 kW (230V, 50 Hz), 20 - 100 HP (230 V, 60 Hz)

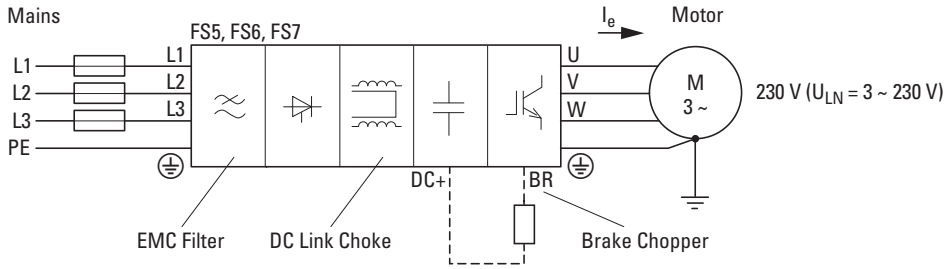


Figure 16: DA1-32…FB-B55C with DC link choke

1.6.3 DA1-34…

- DA1-**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 (400V, 50 Hz), 1 - 30 HP (460 V, 60 Hz)

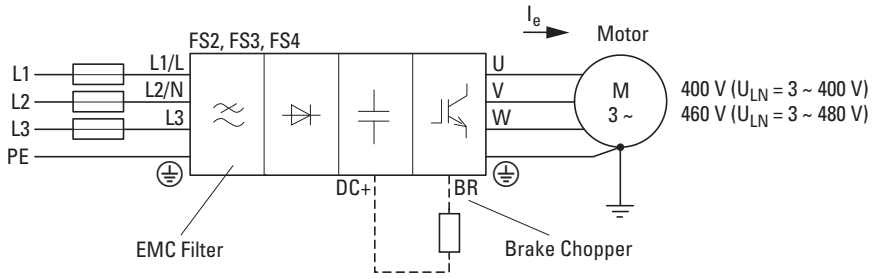


Figure 17: DA1-34…FB-…

- DA1-**34**…
  - Three-phase power supply, rated operating voltage 400/480 V
  - U_{LN} = 3~, 380 - 480 V ±10 %, 50/60 Hz
  - I_e = 61 - 302 A
  - Motor: 30 - 160 kW (230 V, 50 Hz), 40 - 250 HP (460 V, 60 Hz)

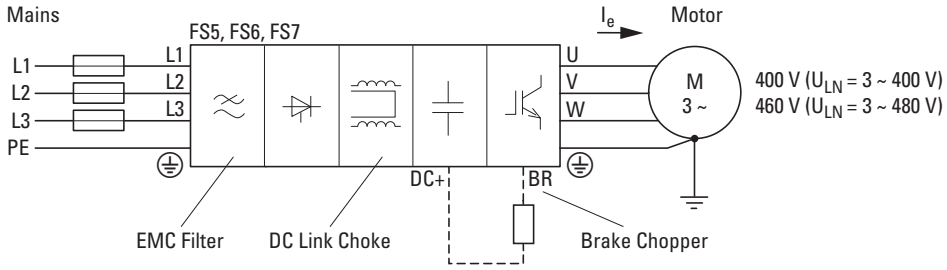


Figure 18: DA1-34…FB-… with DC link choke

- DA1-**34**…
  - Three-phase power supply, rated operating voltage 400/480 V
  - U_{LN} = 3~, 380 - 480 V ±10 %, 50/60 Hz
  - I_e = 370 - 450 A
  - Motor: 200 - 250 kW (400 V, 50 Hz), 300 - 350 HP (460 V, 60 Hz)

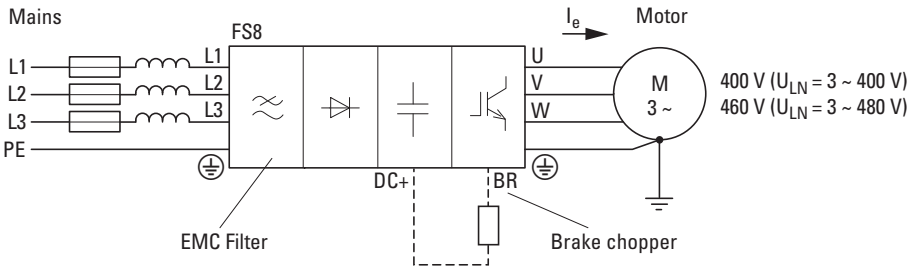


Figure 19: DA1-34…FB-B20C (external mains choke required)

1.6.4 DA1-35…

- DA1-**35**…
  - Three-phase power supply, rated operating voltage 500/575 V
  - U_{LN} = 3~, 500 - 600 V ±10 %, 50/60 Hz
  - I_e = 2.1 - 34 A
  - Motor: 1.1 - 22 kW (500 V, 50 Hz), 1.5 - 30 HP (575 V, 60 Hz)

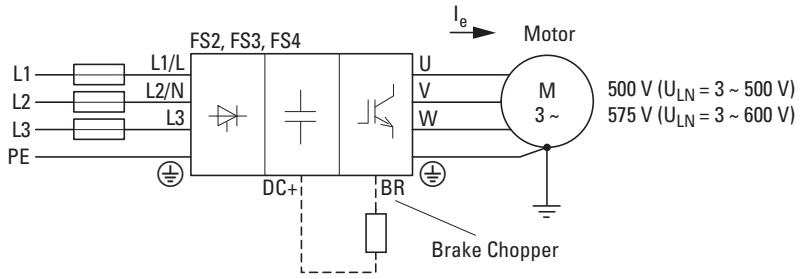


Figure 20: DA1-35…NB-… (without radio interference suppression filter)

- DA1-**35**…
  - Three-phase power supply, rated operating voltage 500/575 V
  - U_{LN} = 3~, 500 - 600 V ±10 %, 50/60 Hz
  - I_e = 43 - 150 A
  - Motor: 30 - 110 kW (500 V, 50 Hz), 40 - 150 HP (575 V, 60 Hz)

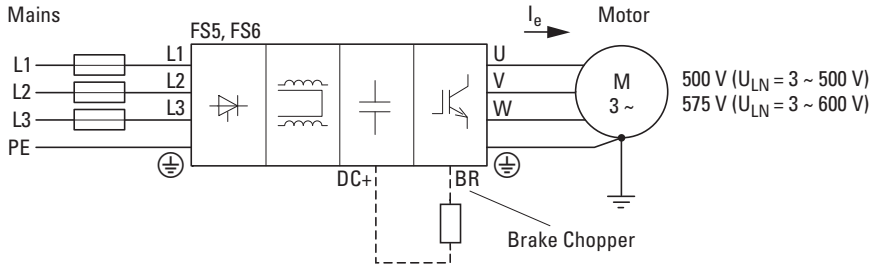


Figure 21: DA1-34…NB-B55C with DC link choke
(without radio interference suppression filter)

1.7 Selection criteria

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

Thevariable frequency drive's rated output current I_e must be greater than or equal to the rated motor current.

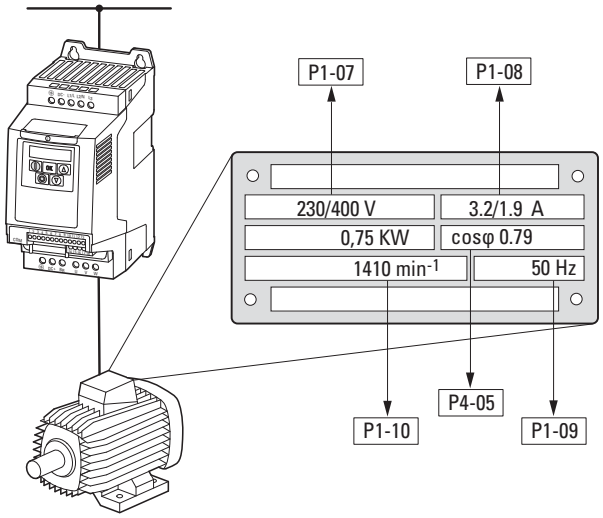


Figure 22: Selection criteria – Rating plate data

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

- Mains voltage = motor supply voltage (e. g. 3~ 400 V),
- Type and characteristics of motor (e. g., three-phase asynchronous motor),
- The rated motor current (recommended value – depends on the motor's configuration and on the power supply),
- Ambient conditions: ambient temperature, control cabinet installation with IP20 protection or direct local installation with IP66 protection.

Example based on figure 22

- Mains voltage: 3~ 400 V, 50 Hz
- Star connection (400 V)
- Rated Current: 1.9 A (400 V)
- Control panel installation→ IP20 protection
- Max. ambient temperature 50 °C without derating, IP20

→ variable frequency drive to be selected: DA1-342D2FB-B20C

- DA1-**34**…: 3-phase mains terminal, rated operating voltage: 400 V
- DA1-…**2D2**…: 2.2 A – The variable frequency drive's rated operational current (output current) guarantees that the motor will be supplied with the required rated operational current (1.9 A).

Whenconnecting multiple motors in parallel to the output of a frequency inverter , the motor currents are added geometrically – separated by the active and reactive current components.

Accordingly, when selecting a variable frequency drive, make sure to size it in such a way that it will be able to supply the total resulting current. It may be necessary to install motor chokes or sine wave filters between the variable frequency drive and the motor in order to dampen and compensate for varying current values.

1.8 Output reduction (derating)

Derating the DA1 variable frequency 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 DA1 variable frequency drive if the drive will be run outside these conditions:

Derating for ambient temperature

Enclosure version for IP protection	Maximum ambient temperature without derating	Derate	Maximum permissible ambient air temperature
IP20	50°C	None	50°C
IP40[1)]	40°C	None	40°C
IP55	40°C	1.5% per K	50°C
IP66	40°C	2.5% per K	50°C

Derating for installation altitude

Enclosure version for IP protection	Maximum height without derating	Derate	Maximum permissible altitude as per IEC (UL)
IP20, IP40[1)], IP55, IP66	1000 m	1% per 100 m	4000 m (2000 m)

Derating for switching frequency

Enclosure version for IP protection	Switching frequency (P2-24), setting (audible)[2)]					
	4 kHz	8 kHz	12 kHz	16 kHz	24 kHz	32 kHz
IP20	None	None	20%	30%	40%	50%
IP40[1)]	None	None	10%	15 %	25 %	Do not set
IP55	None	10 %	10%	15%	25%	Do not set
IP66	None	10%	25%	35%	50%	50%

1) DA1 variable frequency drive with IP55 enclosure and connection area open from below (without blanking plate and cable glands).

2) The pulse frequency's effective rms value will be approximately half the value set with parameter P2-24 (double modulation).

→ For more information on the subject of "derating", please refer to application note AP040039EN.
You can find the document on the Internet under the following address:
https://es-assets.eaton.com/DRIVES/POWERXL/01_APPLICATION_NOTE/English/DA1/AP040039EN_DA1_Derating.pdf

Examples showing how to apply derating factors

4 kW Motor (400 V, 8.5 A), installation altitude 2,000 m above sea level, ambient temperature 42 °C, switching frequency 12 kHz.

a)
Selected frequency inverter: DA1-349D5FB-A20C:
Rated operational current 9.5 A, switching frequency 8 kHz (factory setting).

Required derating factors:

- for the 12 kHz switching frequency: **20 %**
- for installation altitude 2,000 m: **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 42 °C ambient temperature: **None**
  (not needed for DA1-349D5FB-A20C, IP20 degree of protection)

9.5 A - 20 % - 10 % = (9.5 x 0.8 x 0.9) A = **6.84 A**

The DA1's permissible continuous rated operational current of 6.84 is lower than the motor's required rated operational current (8.5 A). Reducing the pulse frequency to 8 kHz will make it possible to operate the motor continuously at an altitude of 2,000 m (9.5 A - 10 % 8.55 A).

→ Use a variable frequency 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)
Selected frequency inverter: DA1-34014FB-B55C:
Rated operational current 14 A.

Required derating factors:

- for the 12 kHz switching frequency: **10 %**
- for installation altitude 2,000 m: **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 ambient temperature 42 °C: **3 %**
  (1.5 % per Kelvin, 42 °C - 40 °C = 2 K, IP55 protection rating).

14 A - 10 % - 10 % - 3 % = (14 x 0.9 x 0.9 x 0.97) A = approx. **11 A**

The DA1-34014FB-B55C variable frequency drive meets the necessary operating conditions.

1.9 Proper use

The DA1 variable frequency 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 DA1 variable frequency drives are not domestic appliances. They are designed for industrial use as system components only.

If the variable frequency drive is installed in a machine, it is prohibited to put it into operation until it has been determined that the corresponding machine meets the safety and protection requirements set forth in the Machinery Safety Directive 2006/42/EC (e. g., by complying with EN 60204). The user is responsible for ensuring the machine application's compliance with EC Directives.

The CE labels applied to the DA1 variable frequency drives confirm that when the typical drive connection is applied, devices comply with the Low Voltage and Electromagnetic Compatibility Directives of the European Union (Directives 2006/95/EC, EMC 2004/108/EC and ROHS 2011/65/EU).

In the described system configurations, DA1 variable frequency drives are suitable for use in public and non-public networks.

A DA1 variable frequency drive can be connected to IT networks (networks without a ground potential link) only under certain conditions, because filter capacitors within the device connect the network to the ground potential (housing).
With non-grounded networks, this can lead to hazardous situations or damage to the device (insulation monitoring is required).

You must not connect the output (terminals U, V, W) of the DA1 variable frequency drive to:

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

Always observe the technical data and connection conditions! For additional information, refer to the equipment rating plate or label at the variable frequency drive and the documentation. Any other usage constitutes improper use.

1.10 Maintenance and inspection

DA1 variable frequency drives are maintenance-free, provided that the general rating data, as well as the technical data for the specific models in use, is observed. Please note, however, that external influences may effect the operation and lifespan of a DA1 variable frequency drive.

Because of this, we recommend inspecting the devices on a regular basis and carrying out the following maintenance activities at the specified intervals.

Table 2: Recommended maintenance

Maintenance measures	Maintenance interval
Clean cooling vents	If necessary
Check that the fan is working properly	6 - 24 months (depending on the environment)
Check the filters in the control panel door (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 shielding connection (EMC)	According to the manufacturer's specifications, no later than 5 years
Charge capacitors	12 months (→ section 1.12, "Charging the internal DC link capacitors")

There are no plans for replacing or repairing individual components of DA1 variable frequency drives.

If the variable frequency drive DA1 in sizes FS2 or FS3 (IP20, IP66) is damaged or destroyed due to external influences, a repair is not possible. For sizes FS4 to FS8 a conditional repair is possible by qualified and certified workshops (→ section 1.13, "Service and warranty").

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

1.10.1 Replacement of the device fan for sizes FS4 and FS5 (IP20)

With the DA1 frequency inverters in sizes FS4 and FS5, the installed device fan can be replaced.
The fan is inserted and can be removed from the bottom of the device.

In frame size FS4

▶ Remove the fan cover (①, ②).

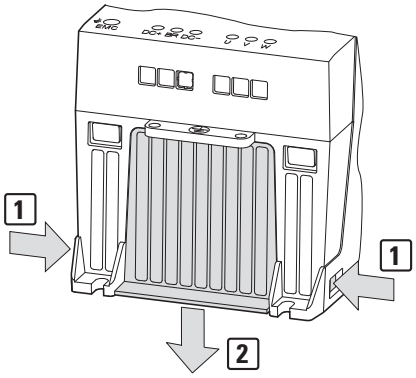


Figure 23: Remove fan cover

▶ Release the plug connection (③, ④) and slide out the fan (⑤, ⑥).

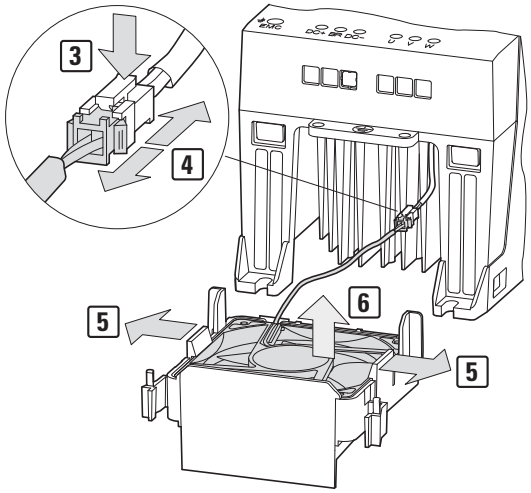


Figure 24: Release the plug connection

▶ Replace the fan and use the new one. Reattach the plug connection (⑧).

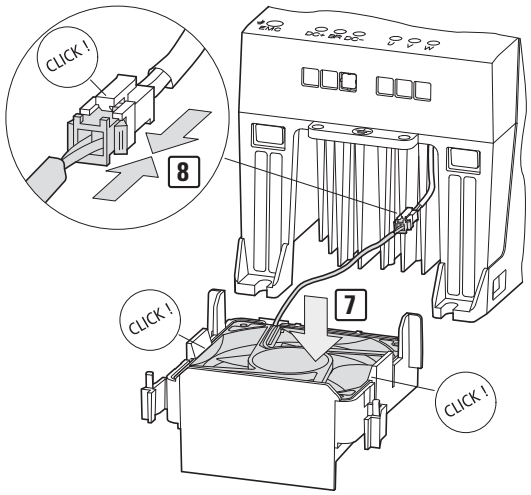


Figure 25: Reinsertion of the fan

▶ Reinsert the fan cover.

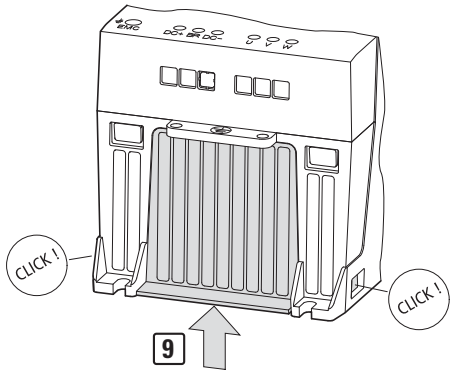


Figure 26: Reinsert the fan cover

In size FS5

▶ Remove the fan cover using a wrench.

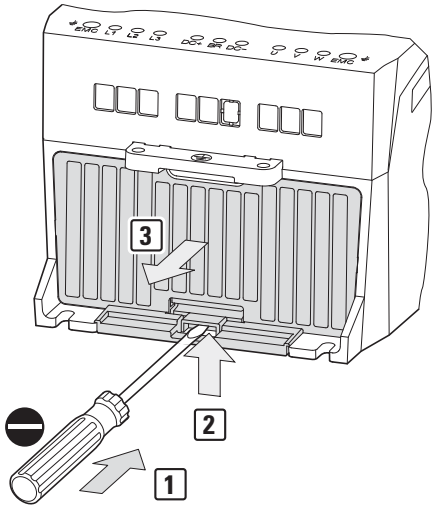


Figure 27: Remove fan cover

Slide the fan forwards (④) and release the plug connection (⑤, ⑥).

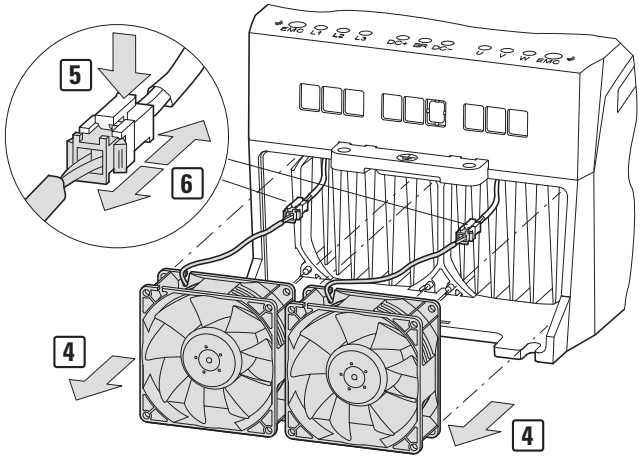


Figure 28: Remove fan

▶ Replace the fan and insert the new one as shown.

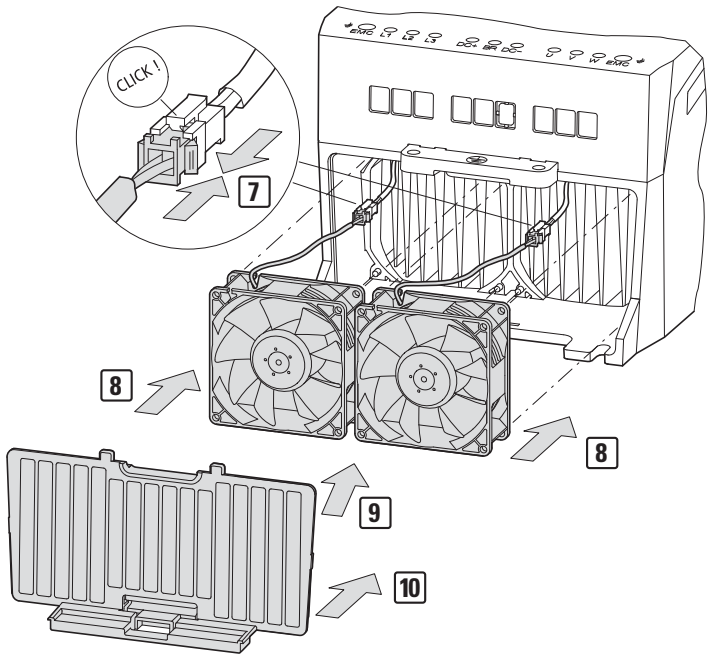


Figure 29: Reinsert the fan

1.11 Storage

If the DA1 variable frequency drive is stored before use, suitable ambient conditions must be ensured at the site of storage:

- Storage temperature: -40 - +60 °C,
- relative average air humidity: < 95 %, non-condensing (EN 50178),
- To prevent damage to the variable frequency drive's internal DC link capacitors, it is recommended that the variable frequency drive is not stored for more than 12 months
  (→ section 1.12, “Charging the internal DC link capacitors”).

1.12 Charging the internal DC link capacitors

After long storage times or long down times without a power supply (> 12 months), the capacitors in the internal DC link mustundergo controlled recharging, in order to avoid damage. To do this, the DA1 variable frequency drive must be supplied with power, with a controlled DC power supply unit, via two mains connection terminals (e.g. 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 frequency 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} ~ 1.41 x U_e) and applied for one hour at least (regeneration time).

- DA1-12…, DA1-32…: approx. 324 V DC at U_e = 230 V AC
- DA1-34…: approx. 560 V DC at U_e = 400 V AC
- DA1-35…: approx. 705 V DC at U_e = 500 V AC

1.13 Service and warranty

In the unlikely event that you have a problem with your DA1 variable frequency drive, please contact your local sales office.

When you call, have the following data ready:

- the detailed type description of the variable frequency drive (see rating plate),
- the date of purchase,
- a detailed description of the problem which has occurred with the variable frequency drive.

If some of the information printed on the rating plate is not legible, please state only the data which are clearly legible.

Information concerning the guarantee can be found in the Terms and Conditions of Eaton Industries GmbH.

Break-Down Service

Please contact your local office:

http://www.eaton.eu/aftersales

or

After Sales Service Hotline

+49 (0) 180 5 223822 (de, en)

AfterSalesEGBonn@eaton.com

2 Engineering

2.1 Introduction

This chapter describes the most important features in the energy circuit of a drive 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 DA1 variable frequency 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 that will not be covered by the warranty.

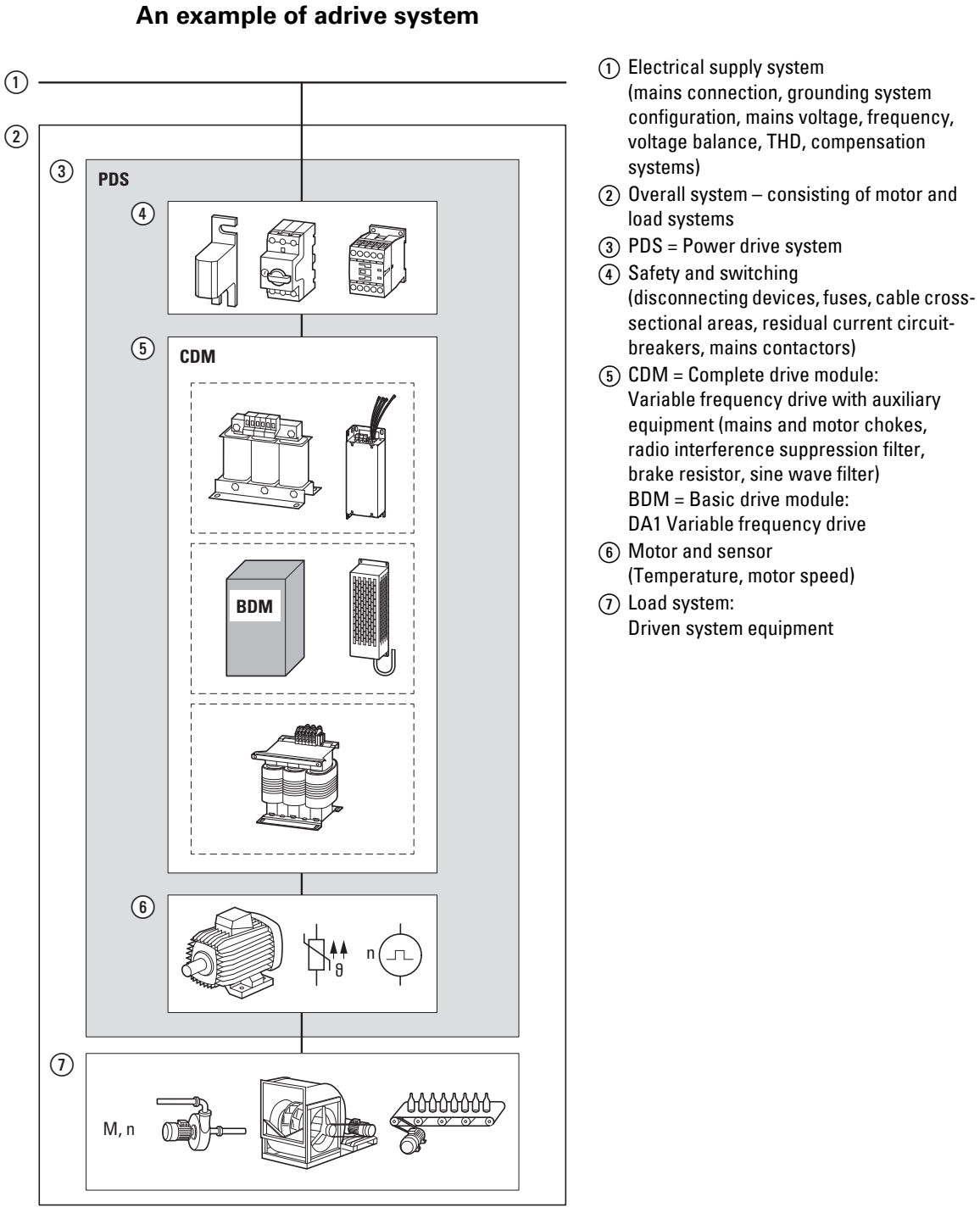


Figure 30: Drive system example (overall system as its own system or as part of a larger system)

2.2 Electrical power network

2.2.1 Mains connection and configuration

DA1 variable frequency drives can be connected to and run on all earthed groundAC supply systems (TN-S, TN-C, TT grounding systems; please refer to IEC 60364) without any limitations.

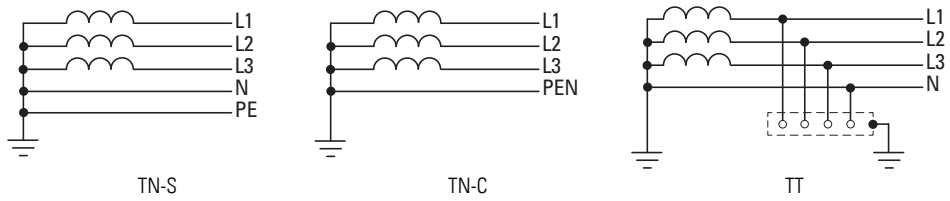


Figure 31: AC supply systems with earthed neutral

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

The connection and operation of variable frequency 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).

The connection to IT networks is permitted only in sizes FS2 and FS3 in IP20 protection with an unscrewed VAR and EMC screw.

WARNING

With an unscrewed VAR screw, the variable frequency drive is no longer protected from transistor overvoltage.

→ Operation on non-earthed networks (IT) requires the use of suitable insulation monitoring relays (e. g. pulse-code measurement method).

→ In networks with an earthed phase conductor, the maximum phase-earth voltage must not exceed 300 V AC.

DA1-…-A20C variable frequency drives with an FS2 or FS3 frame size can be connected to corner-grounded systems or IT grounding systems (not grounded, insulated). The internal radio interference suppression filter must be disabled in these cases.

Generally speaking, measures designed to ensure electromagnetic compatibility are required in drive systems in order to ensure compliance with the applicable regulations in the EMC and Low Voltage Directives.

Good earthing measures are a prerequisite for the effective use of further measures, such as a screen earth kit or filters. Without corresponding grounding measures, further steps are superfluous.

DA1-35… (500 - 600 V) devices do not feature a radio interference suppression filter and can be connected to corner-grounded systems and IT grounding systems.

2.2.2 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 range of the DA1 variable frequency drive observes both the European (EU: U_{LN} = 230 V/400 V, 50 Hz) and the American (USA: U_{LN} = 240 V/480 V, 60 Hz) standard voltages in this case:

- 230 V, 50 Hz (EU) and 240 V, 60 Hz (USA) at DA1-12…, DA1-32…
  200 V -10 % - 240 V +10 % (180 V -0 % - 264 V +0 %)
- 400 V, 50 Hz (EU) and 480 V, 60 Hz (USA) at DA1-34…
  380 V -10 % - 480 V +10 % (342 V -0 % - 528 V +0 %)
- 500 V, 50 Hz (EU) and 575 V, 60 Hz (USA) at DA1-35…
  500 V -10 % - 600 V +10 % (450 V -0 % - 660 V +0 %)

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

2.2.3 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 frequency drive's rectifier bridge converter to be loaded unevenly, resulting in premature diode failure.

→ In the project planning for the connection of three-phase supplied variable frequency drives (DA1-3…), consider onlyAC 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 suitable main choke is recommended.

2.2.4 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.

→ In order to reduce the THD value (up to 30 %, it is recommended to use a DX-LN… mains choke

→ FS5, FS6, and FS7 DA1 variable frequency drives feature chokes in their DC link. Using mains chokes in order to reduce current harmonics is not necessary in this case.

→ Only for FS8 DA1 variable frequency drives:
DA1-34370FB-B20C, DA-34450FB-B20C

If it is not guaranteed that the system percentage impedance is greater than or equal 1 %, a mains choke must be connected. Your u_K value should fall between 1 % and 4 %.

Examples:

DA1-34370FB-B20C → DX-LN3-370
DA1-34450FB-B20C → DX-LN3-450

2.2.5 Reactive power compensation devices

Compensation on the power supply side is not required for the variable frequency drives of the DA1 series. From the AC power supply network they take only very little reactive power of the fundamental harmonics (cos φ ~ 0.98).

In the AC supply system 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 frequency drives to AC supply systems with undefined circumstances, consider using mains chokes.

2.3 Safety and switching

2.3.1 Disconnecting device

Install a manual disconnecting device between the mains connection and the DA1 variable frequency 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.

2.3.2 Fuses

The DA1 variable frequency drive and the corresponding supply cables must be protected from thermal overload and short-circuits.

The fuse ratings and cable cross-sectional areas (wire gages) for the connection on the mains side will depend on the DA1 variable frequency drive's input current I_{LN}.

For the recommended fuse sizing and assignments, please refer to → section 6.5, "Fuses", page 165.

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

2.3.3 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.

> *WARNING*
> 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.

→ section 6.2, "Specific rated operational data", page 148 defines the leakage currents for the individual models.

→ section 3.5, "EMC installation", page 91 defines 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 a US installation, UL-tested fuses, fuse bases and cables (AWG) must exclusively be used.
The approved cables must have heat-resistance of 70 °C (158 °F) and often require installation in a metallic protective tube (see the local regulations).

For the rated cable cross-sectional areas for DA1 variable frequency drives, please refer to the technical data chapter in → section 6.4, "Cable cross-sections", page 162.

2.3.4 Residual current device (RCD)

When using variable frequency drives (DA1-3…) that work with a three-phase power supply (L1, L2, L3), make sure to use type B AC/DC sensitive residual current devices exclusively.

With a single-phase power supply (L, N) (DA1-12…), you may use type F and type B residual current devices (RCD).

> *WARNING*
>
> Residual-current devices (RCD) may be installed between the supply system (AC mains supply) and the DA1 variable frequency drive only – they must never be installed in the motor output.

The leakage currents' magnitudewill generally depend on:

- the length of the motor cable,
- the shielding of the motor cable,
- the magnitude of the switching frequency (switching frequency of the inverter),
- the implementation of the filter measures,
- the grounding measures at the site of the motor.

Other protective measures against direct and indirect contact can be used for DA1 variable frequency drives, including isolating them from the supply system with the use of a transformer.

2.3.5 Mains contactors

The mains contactor enables operational switching on and off of the supply voltage for the variable frequency 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 DA1 variable frequency drive for utilization category AC-1 (IEC 60947) and the ambient air temperature at the location of use.

→ The mains contactors listed here are based on the variable frequency drive's rated input-side mains current I_{LN} without an external mains choke.
These are selected based on thermal current $I_{th} = I_e$ (AC-1) at the indicated ambient temperature.

WARNING

Push-to-run operation is not permissible via the mains contactor (Pause time ≧ 30 s between switching off and on).

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

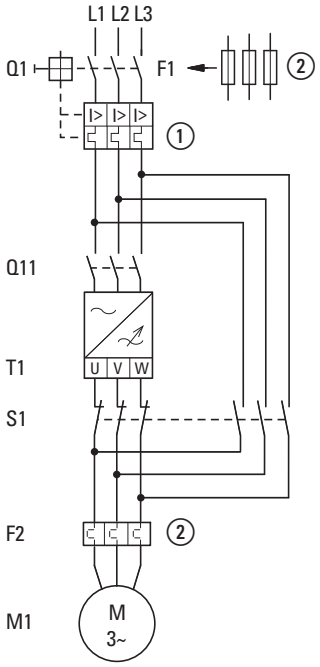
→ For the rated mains contactors for DA1 variable frequency drives, please refer to the technical data chapter
in→ section 6.6, "Mains contactors", page 169.

2.3.6 Using abypass connection

WARNING

Never connect the DA1 variable frequency drive's output terminals U, V, and W to the feed-in system (L1, L2, L3)! Connecting the mains voltage to the output terminals can result in the variable frequency 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 frequency drive's output terminals.



① Q1 thermal overload and short-circuit protection
② F1 fuse and F2 overload relay (alternative to ①)
Q1 Mains contactor
T1 DA1 variable frequency drive
S1 Interlocked switching between variable frequency drive and bypass
F2 Motor protection (overload relay, alternative to ①)
M1 Three-phase motor

Figure 32: Bypass motor control (example)

2.4 Mains chokes

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

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

→ It is not necessary to use mains chokes in order to run the DA1 variable frequency drive. However, we recommend using a mains choke if the electrical supply system's quality is not known.

While planning the project, consider that a mains choke is only assigned to a single variable frequency drive for decoupling. When using an adapting transformer (assigned to a single variable frequency drive), a mains choke is not necessary. Mains chokes are designed based on the mains-side input current I_{LN} of the variable frequency drive.

→ FS5, FS6, and FS7 DA1 variable frequency drives feature mains chokes in their DC link. Using chokes in order to reduce current harmonics is not necessary in this case.

→ Only for FS8 DA1 variable frequency drives:
DA1-34370FB-B20C, DA-34450FB-B20C
If it is not guaranteed that the system percentage impedance is greater than or equal to 1 %, a mains choke must be connected. Your u_K value should fall between 1 % and 4 %.
Examples:
DA1-34370FB-B20C → DX-LN3-370
DA1-34450FB-B20C → DX-LN3-450

→ When the variable frequency drive is operating at its rated current limit, the mains choke, with a u_K-value of approx. 4 %, causes a reduction of the variable frequency drive's greatest possible output voltage (U_2) to approx. 96 % of the mains voltage (U_{LN}) .

→ For the rated mains contactors for DA1 variable frequency drives, please refer to the technical data chapter in → section 6.7, "Mains chokes", page 173.

→ For more information and technical data on DX-LN… mains chokes, please refer to instruction leaflet IL00906003Z.

2.5 Radio interference suppression filter

DA1-12…FB-…, DA1-32…FB-…, and DA1-34…FB-… variable frequency drives feature an internal radio interference suppression filter.
Combined with a 360 degrees shielded motor conductor grounded on both sides, this ensures compliance with the EMC limit value in Category C1, First Environment (IEC/EN61800-3). This requires installation in accordance with EMC requirements, as well as not exceeding permissible motor cable lengths.

The standard motor cable lengths are as follows:

- 1 m in Category C1 in First Environment
- 5 m in Category C2 in First and Second Environment
- 25 m in Category C3 in Second Environment

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

For more information, please refer to the following tables.

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

DA1-35…NB-… devices do not feature an internal radio interference suppression filter. DX-EMC34… radio interference suppression filters can be connected upstream in order to run these devices on a three-phase mains voltage of 500 V.

Please enquire for radio interference suppression filters for higher mains voltages.

In the case of power drive systems (PDS) with variable frequency 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.

The maximum unscreened cable length between the radio interference suppression filter and the variable frequency drive should not exceed 300 to 500 mm (depending on the DA1 variable frequency drive's frame size).

For the rated radio interference suppression filters for DA1 variable frequency drives, please refer to the technical data chapter in→ section 6.8, “Radio interference suppression filter”, page 177.

2.6 Brake resistors

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 frequency drive's DC link via the inverter. TheDC link voltage U_{DC} will be increased as a result. If the voltage value is too high, the DA1 variable frequency drive will disable its inverter, If the voltage value is too high, the DA1 variable frequency drive will disable its inverter, after which the motor will coast uncontrolled.

DA1-…B-… variable frequency drives 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 P1-05 (= 2 or = 3). 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.

Device series	Power supply	Voltage class	Brake chopper on	Brake chopper off
DA1-12…	Single-phase	230 V	390 V	378 V
DA1-32…	3-phase	230 V	390 V	378 V
DA1-34…	3-phase	400 V	780 V	756 V
DA1-35…	3-phase	575 V	975 V	945 V

For example, in the case of DA1-34… variable frequency drives, the brake chopper will be switched on at a DC link voltage of approximately 780 V DC and then back off at 756 V DC. During this stage, the braking transistor and the brake resistor will be active continuously. To protect against thermal overload, under parameter P6-19, the resistance value R_B and under parameter P6-20 rated output P_{DB} of the braking resistance can be set.

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 %), e.g., 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 %), e.g., for elevators, downhill conveyors, winders, centrifuges, flywheel motors, and large fans.

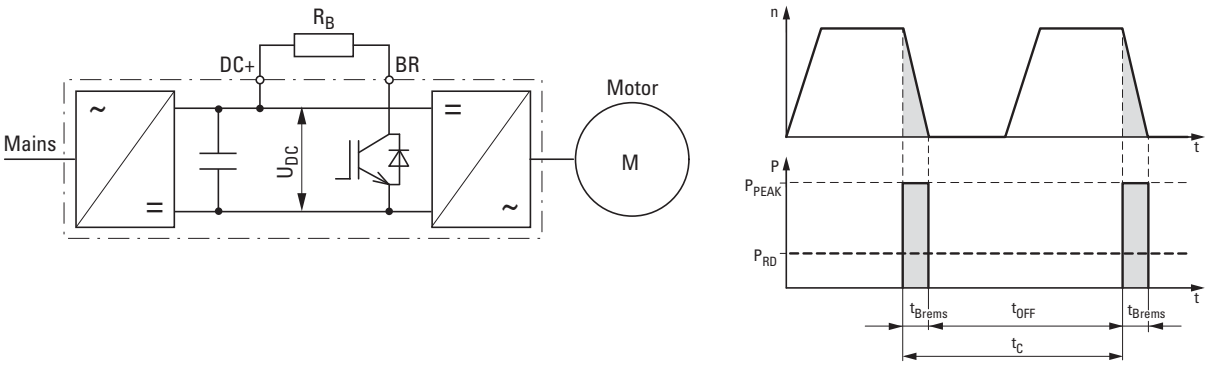


Figure 33: Braking cycle, fast motor stop with external brake resistor

Selecting brake resistors

The selection of brake resistors takes place according to the occurring sustained power loss P_{DB} and the maximum impulse peak output P_{Peak}. The brake resistor must be appropriate for both outputs.

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. In the simplified procedure, as a guideline value for dimensioning for the impulse peak output P_{Peak}, the braking output P_{max} of the variable frequency drive or the rated motor output can be used, as the mechanical braking output is reduced by the efficiency level of the motor and the inverter.

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

The required rated output and continuous rating of the braking resistance P_{DB} is calculated from the braking energy W_{kin} and the cycle time$_C$:

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

If the kinetic energy is not known, the percentage ratio of braking time $t_{braking}$ and cycle time t_C is required:

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

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

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

The continuous rating P_{DB} of the braking resistance is therefore always the factor of the duty cycle DF [%] less than the maximum impulse output P_{Peak}.

The resistance value R_B must be at least as much as the minimum permitted resistance value R_{min} of the brake transistor.

→ Use brake resistors with the recommended R_{Brec} resistance values for the DA1 variable frequency drives' ratings.

→ For the rated brake resistors for DA1 variable frequency drives, please refer to the technical data chapter in

2.7 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 frequency drive. Its rated operational current must always be greater than/equal to the rated operational current of variable frequency drive.

For DA1 variable frequency drives, it is recommended to use a motor choke for motor cable lengths of 50 meters or more. Doing so may result in the following improvements:

- Longer maximum permissible screened motor cable length, up to 200 m,
  Longer maximum permissible motor cable length without screening, up to 300 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.

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

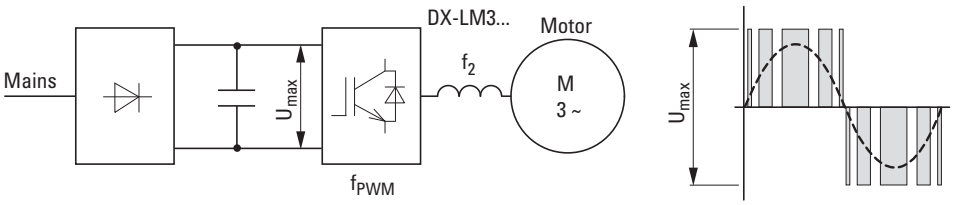


Figure 34: Measurement data DX-LM3…:
U_{max} = 750 V, f_2 = 0 - 400 Hz, f_{PWM} = 8 - 24 kHz (setting P2-24 with DA1)

It is also recommended to use a motor choke at the variable frequency 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 DA1 variable frequency drives, please refer to the technical data chapter in→ section 6.10, "Motor chokes", page 189.

→ For more information and technical data on DX-LM3… motor chokes, please refer to instruction leaflet IL00906003Z.

2.8 Sine wave filters

TheDX-SIN3… sine wave filter removes high-frequency components from the variable frequency drive's output voltage (U_2). This reduces the conducted and radiated emission. The output voltage of the sine wave filter reaches a sinusoidal shape with a lower overlapped output ripple.
The distortion factor of the sine wave voltage is typically 5 % to 10 %. This reduces the noise generation and losses in the motor.

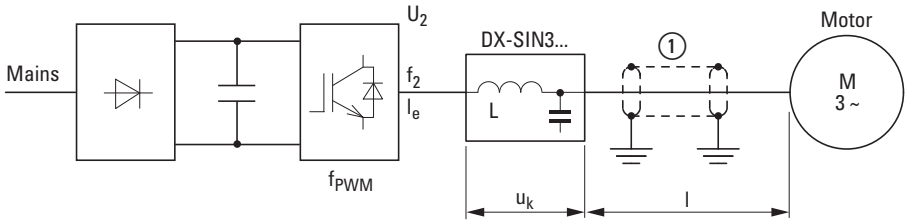


Figure 35:Maximum permissible motor cable lengths

① **Screened motor cable:** $U_2 \leqq 230$ V → l ≦ 200 m; $U_2 \leqq 500$ V → l ≦ 150 m
unscreened motor cable: $U_2 \leqq 230$ V → l ≦ 300 m; $U_2 \leqq 500$ V → l ≦ 200 m

→ The DX-SIN3… sine wave filters are not permitted to be operated with a lower frequency than the switching frequency stated on the sine wave filter .
For this, the P6-02 parameter ("auto-temperature-management") needs to be set to the double value of the switching frequency set on the sine wave filter.

Permissible switching frequencies (P2-24) for DA1 with DX-SIN3…: 1 ≙ 8 kHz; 2 ≙12 kHz

For the DA1 variable frequency drive, the set value with the double-modulation procedure is the double value of the effective value in the sine wave filter (1 ≙ 8 kHz → 4 kHz; 2 ≙ 12 kHz → 6 kHz).

→ For the rated sine wave filters for DA1 variable frequency drives, please refer to the technical data chapter in→ section 6.11, "Sine filters", page 191.

2.9 Three-phase motor

2.9.1 Motor selection

Check whether the DA1 variable frequency drive you selected and the rated AC motor you will be using are compatible with each other as per the corresponding voltage (mains and motor voltage) and rated operational current.

Please note the following general recommendations for the motor selection:

- Use three-phase induction motors with squirrel-cage rotors and surface cooling – also referred to as three-phase asynchronous motors or standard motors. Other types of motors, such as external rotor motors, wound rotor motors, reluctance motors, permanent magnet motors, synchronous motors, and servomotors can also be run with DA1 variable frequency drives, but will normally require additional engineering, modifying the various parameters, and detailed information from the motor manufacturer.
- Only use motors of at least class F temperature rating (155 °C maximum constant temperature).
- Choose 4-pole motors where possible (with synchronous speeds of: 1500 min^{-1} at 50 Hz or 1800 min^{-1} at 60 Hz).
- Please observe the operating conditions 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.
- With undersizing, the motor output may only be one output level less than the allocated output level (to ensure the motor protection). With significantly smaller motor output, the "frequency control U/f)" operating mode must be set (P4-01 = 2).

2.9.2 Circuit types withthree-phase motors

Based on the mains voltage ($_{LN}$ = output voltage U_2) and the rated data on the motor's nameplate (rating plate), the stator winding of a three-phase motor can be configured as a star or delta circuit.

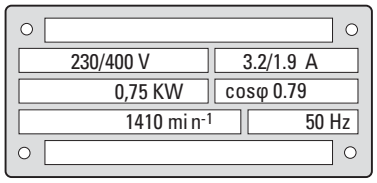


Figure 36: Example of a motor rating plate

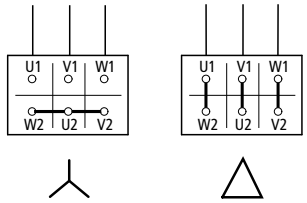


Figure 37: Configuration types:Star-connected circuit (left), Delta circuit (right)

Examples based on figures36and 37

Motor with star circuit configuration:
Mains voltage: 3~ 400 V; Output voltage: 3~ 400 V

→ DA1-342D2…

Motor with delta circuit configuration:
Mains voltage: 1~ 230 V; Output voltage: 3~ 230 V

→ DA1-124D3…

Motor connection

DA1 variable frequency drives	as per IEC	as per UL
U	U1 (-U2)	T1 (-T4)
V	V1 (-V2)	T2 (-T5)
W	W1 (-W2)	T3 (-T6)

2.9.3 Connecting Motors in Parallel

When in V/Hz control mode (default setting, P4-01 = 2), DA1 variable frequency drives can be used to run multiple motors simultaneously.

→ If multiple motors are connected in parallel, the totalof their motor currents must be lower than the DA1 variable frequency drive's rated operational current.

Connecting motors in parallel will reduce the load resistance at the variable frequency drive's output. This will cause the total stator inductance to decrease and the cables' stray capacitance to increase. As a result of this, the current distortion becomes greater compared to the single motor connection.
In order to reduce the current distortion, a motor choke or sine wave filter should be installed in the output of the variable frequency inverter (→ figure 38).

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

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

Within a frequency range of 20 to 120 Hz, the PKE electronic motor-protective circuit-breaker can be used for motor protection at a DA1 variable frequency drive's output as well.

CAUTION

For the parallel operation of several motors on one DA1 variable frequency drive, the contactors of the individual motors must be designed according to utilization category AC-3.
The selection of the motor contactors occurs according to the rated operational current of the motor to be switched.

→ The total of the motor currents in operation, plus one motor's inrush current, must be less than the rated operational current of the variable frequency drive.

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

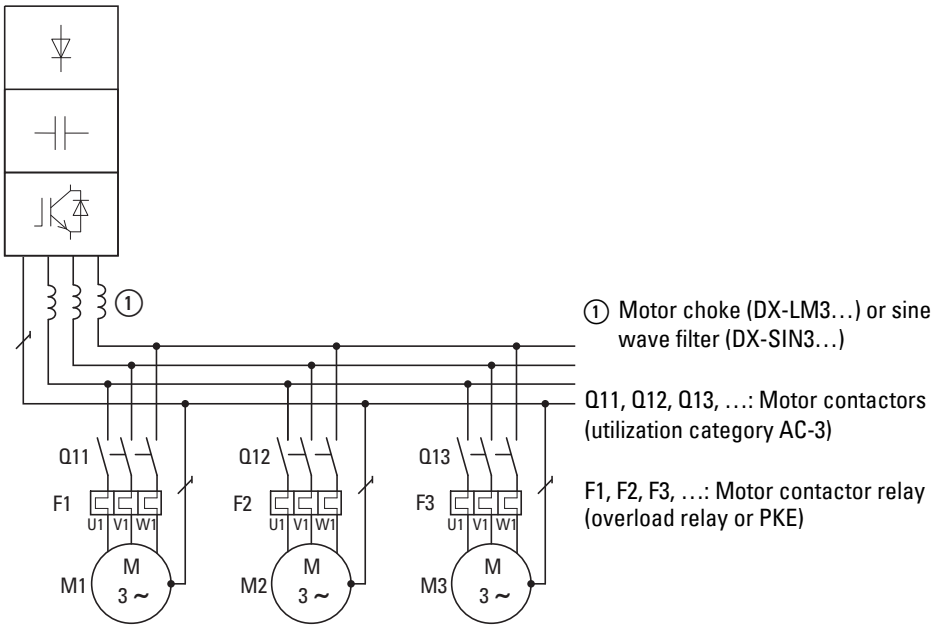


Figure 38: Example: Parallel connection of several motors to one variable frequency drive

2.9.4 Single-phase ACmotors

It is not permitted to run DA1 variable frequency drives with single-phase AC motors (induction motors), single-phase asynchronous motors (capacitor motors), shaded-pole motors, etc.

2.9.5 Connecting EX motors

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

- A DA1 variable frequency drive can be installed in an Ex-area or in a control cabinet outside of the Ex area.
- 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 frequency drive – e.g., whether motor reactors (dV/dt limiting) or sine wave filters are required – must be taken into account.
- Temperature monitors in the motor windings (thermistor, Thermo-Click) must not be connected directly to the variable frequency drive, but instead must be connected through a relay approved for the hazardous location (e.g. EMT6).

2.9.6 Synchronous, reluctance, and PM motors

DA1 variable frequency drives can be used to run premium efficiency three-phase motors, such as:

- Efficiency classes IE3 and IE4
  according to IEC/EN 60034-30, EU No. 4/2014,
- Permanent magnet motors (PM motor),
- Synchronous reluctance motors (SynRM),
- Brushless DC motors.

These motor technologies have comparable efficiencies at their rated operating point and identical efficiency classes, but also have significant differences when it comes to their startup behavior and partial-load operation.

The rating plate details, e.g. 315 V, R_{20*} = 2.1 Ω, L* = 20 mH and U_{Pol} = 195 V/1000 min^{-1} also differ significantly from the usual details.

For information on and examples for permanent magnet and brushless DC-motors, please refer to application note AP040051EN.

2.10 STO function

2.10.1 Overview

DA1 variable frequency drives include theSTO function (STO =Safe Torque Off) as part of their standard range of functionalities. This function meets the requirements for variable-speed drive systems defined in Part 5-2 of the IEC 61800 standard and ensures that torque-generating energy is no longer able to act on the motor shaft and that unintended starting is prevented. Moreover, this state is monitored internally in the drive.

The STO function can be used anywhere where the corresponding motor will come to a stop by itself in a sufficiently short amount of time as a result of the corresponding load torque or friction, as well as in cases in which coasting has no safety implications.

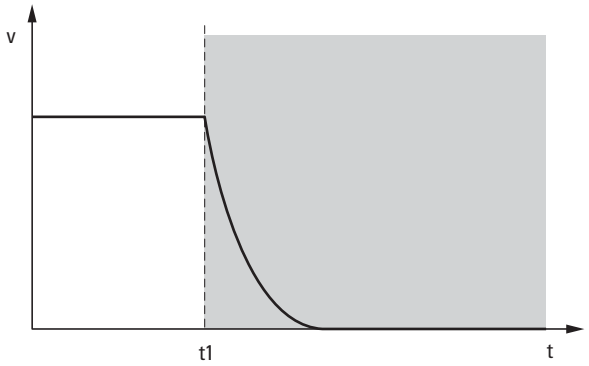


Figure 39: STO conforming to Stop Category 0

This safety function corresponds to uncontrolled stopping as defined in IEC 60204-1, Stop Category 0.
It can be used if it is necessary to switch off the power in order to prevent unexpected starts.

Additional measures (such as mechanical brakes) may be required in order to prevent hazards in which external factors are involved (e. g., suspended loads falling down).

Application examples can be found in the Eaton safety manual PU05907001Z.

You can find the safety manual as a PDF document on the Eaton website at the following address:
http://www.eaton.eu/Europe/Electrical/CustomerSupport/TechnicalLiterature/SafetyManual/index.htm

CAUTION

When used in conjunction with permanent magnet motors and in the unlikely event of multiple output semiconductors (IGBTs) failing, having the STO function activated may result in a motor shaft rotational movement of 180 degrees/p = Number of motor pole pairs).

DANGER

The STO function is an electronic mechanism that does not provide sufficient protection against electric shock. Additional potential isolation measures may be accordingly required (e. g., switch-disconnector).

2.10.2 TÜV certification

DA1 variable frequency drives with a TÜV logo on their nameplate feature an STO function that complies with the following standards:

Standard	Classification
EN 61800-5-2:2007	Type 2: "Safely switched-off moment"
EN ISO 13849-1:2006	PL d
EN 61508 (Part 1 to 7)	SIL 2
EN60204-1	Stop category 0: "Uncontrolled stopping by means of immediately cutting the power supply to the machine drive elements"
EN 62061	SIL CL 2

The following information and descriptions for the STO function are translations of the original description in English (TÜV specification).

2.10.3 Specification of the safety relay

Safety component monitoring requires an approvedsafety relay.

When used together with a DA1 variable frequency drive, the following minimum requirements must be met for the STO function:

Standard requirement	SIL 2 or PL d SC 3 or better with interlocked opposing contacts
Number of output contacts	Two independent
Rated switching voltage	30 V DC
Current carrying capacity	100 mA (minimum)

2.10.4 STO-compatible installation

DANGER

Make sure to use proper earthing and select cables based on local regulations or standards.

The variable frequency drive may have a leakage current greater than 3.5 mA AC or 10 mA DC. In addition, the grounding cable must be sized for the maximum mains fault current, which is normally limited by fuses or miniature circuit-breakers. Appropriately sized fuses or miniature circuit-breakers should be installed at the mains supply for the variable frequency drive in line with local regulations or standards.

DANGER

The "STO wiring" must be protected against unintended short-circuits and unintended tampering and modifications.
It must be ensured that the "STO input signal" (control signal terminals 12/13) has a safe operating state.

CAUTION

Variable frequency drives with IP 20 protection that are used in environments with a pollution degree of 2 must be installed in a control panel with IP 54 protection or better.

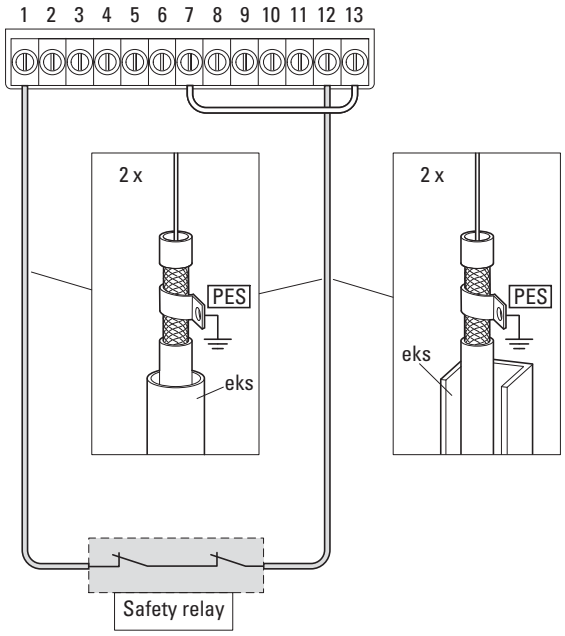
→ In order to prevent damage to the variable frequency drive, the devices should remain in their original packaging until right before they are installed.
They must be stored in a dry and clean area with a temperature range of -40 °C to 60 °C.

→ The conductor cross-section used for the STO installation should be between 0.05 and 2.5 mm^2 (AWG 30-12).
The length of the cable connected to the control signal terminals should not exceed 25 meters.

In addition to the wiring guidelines for an installation meeting EMC requirements (→ section 3.5, "EMC installation", page 91), the following requirements must be observed as well for the "STO wiring":

- The STO-compatible installation must be protected against short-circuits and tampering. The cables in the STO circuit can be mechanically protected with a closed cable duct or with a conduit (eks = ground and short-circuit-safe installation).
- The 24-V-DC power supply of the STO inputs can occur from the internal 24-V-DC voltage of the DA1 variable frequency drive or from an external 24-V-DC power source (External Power Supply).
  The DA1 variable frequency drive should be wired as described below.

2.10.4.1 STO installation with internal DA1 supply voltage (24 V DC)



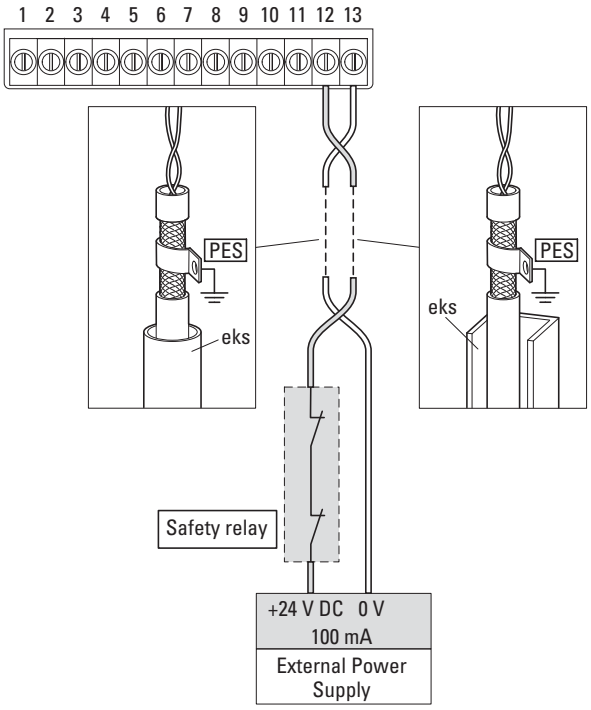
Control signal terminals

1:	24 V DC, output, max. 100 mA
7 or 9:	0 V
12:	STO+, logical high signal, input = 18 - 30 V DC from the safety controller
13:	STO-, 0-V connection to internal control voltage (terminal 7 or 9)

Figure 40: STO installation with internal control voltage

The connecting cable from control signal terminal 1 (+24 V) to the safety relay's contact and the connecting cable from the safety relay's contact to control signal terminal 12 (STO+) must be wired individually and installed separately (eks, separate mechanical protection with two closed cable ducts or two conduits). These two separately wired single cables must be screened, and the corresponding cable screen must be earthed (PES).

2.10.4.2 STO installation with external DA1 supply voltage (24 V DC)



Control signal terminals

12: STO+, logical high signal, input = 18 - 30 V DC

13: STO-, 0-V connection to internal control voltage (terminal 7 or 9)

Figure 41: STO installation with external control voltage

Both of the connecting cables, from the external power supply and the safety relay, to the control signal terminals 12 (STO+) and 13 (STO-) must be twisted cables.
These twisted cables must be installed in an enclosed cable duct or installation pipe (eks) and shielded and the shielding braid must be grounded (PES).

The external control voltage should meet the following specifications:

Rated control voltage	24 V DC
Voltage for the logical STO high signal	18 - 30 V DC
Current carrying capacity	100 mA

2.10.5 STO function pick-up time

The total pick-up time for the STO function is the time that elapses from the moment a safety-related event occurs on the system's components (aggregate) to the moment a safe state is reached (in this case: Stop category 0 as defined in IEC 60204-1):

- The pick-up time from the moment the STO inputs (control signal terminals 12 and 13) become de-energized to the moment when the outputs in the power section (U, V, W) are in a state in which no torque is produced in the motor (STO function activated) is less than 1 ms.
- The pick-up time from the moment the STO inputs (control signal terminals 12 and 13) become de-energized to the moment the STO monitoring status changes is less than 20 ms.
- The pick-up time from the moment a fault is detected in the STO circuit to the moment $5E\,o\text{-}F$ is signaled (fault indicator, digital output) is less than 20 ms.

2.10.6 STO function parameters

The STO function is always activated and enabled in DA1 variable frequency drives – regardless of the operating mode or of parameter changes made by the user.

During normal operation (supply voltage present), there are various options for monitoring the STO inputs' (control signal terminals 12 and 13) state.

If the STO inputs are de-energized:

- The corresponding operating unit will display $I\,nH\,ib\,iE$).
  Exception: If the DA1 variable frequency drive detects a fault, the corresponding fault code will be displayed (not: $I\,nH\,ib\,iE$).
- Relay RO1 will be switched off if parameter P2-15 is set to 13 (changeover contact: 14-16 = open, 14-15 = closed),
- Relay RO2 will be switched off if parameter P2-18 is set to 13 (N/O: 17-18 = open).

Table 3: STO-relevant parameters

PNU	Modbus ID	Access right		Name	Value	Description	DS
		RUN/ STOP	ro/rw				
P2-15	237	RUN	rw	RO1 function	0 - 13	Selection of the function of output relay RO1 Possible values: • **0**: RUN, Enable (FWD/REV) • **1**: READY, variable frequency drive ready for operation • **2**: Speed = speed setpoint value • **3**: Speed > 0 • **4**: Speed ≧ Limit: ON: ≧ P2-16; OFF: < P2-17 • **5**: Motor Current ≧ limit: ON: ≧ P2-16; OFF: < P2-17 • **6**: Speed ≧ Limit: ON: ≧ P2-16; OFF: < P2-17 • **7**: Analog input AI2 ≧ Limit: ON: > P2-16; OFF: < P2-17 • **8**: Reserved • **9**: Reserved • **9**: Reserved • **10**: Reserved • **11**: Reserved • **12**: Reserved • **13**: STO (STO = Safe Torque OFF) Status	1
P2-18	240	RUN	rw	RO2 function	0 - 13	Selection of the function of output relay RO2 Possible values: • **0**: RUN, Enable (FWD/REV) • **1**: READY, variable frequency drive ready for operation • **2**: Speed = speed setpoint value • **3**: Speed > 0 • **4**: Speed ≧ Limit: ON: ≧ P2-19; OFF: < P2-20 • **5**: Motor Current ≧ limit: ON: ≧ P2-19; OFF: < P2-20 • **6**: Speed ≧ Limit: ON: ≧ P2-19; OFF: < P2-20 • **7**: Analog input AI2 ≧ Limit: ON: > P2-19; OFF: < P2-20 • **8**: Control for the external brake of a hoist. (Enables the operating mode for hoists). ON: output frequency ≧ P2-07 with START (FWD/REV) command present. OFF: Output frequency ≦ P2-08 with START (FWD/REV) command not present. • **9**: Reserved • **9**: Reserved • **10**: Reserved • **11**: Reserved • **12**: Reserved • **13**: STO (STO = Safe Torque OFF) Status	0

PNU	Modbus ID	Access right		Name	Value	Description	DS
		RUN/ STOP	ro/rw				
P2-36	258	RUN	rw	Start Mode	Edge-r Auto-0 … Auto-5	Defines the behavior of the drive relating to the enable digital input and also configures automatic restart after a failure. Possible values: • **0**: Edge-r: If the enable signal is already active before the supply voltage is switched on or before a RESET, the drive will not start. A rising edge is required for starting. • **1**: Auto-0: If the enable signal is already active before the supply voltage is switched on or before a RESET, the drive will start automatically. • **2**, …,**6**: Auto-1, …, Auto-5: Following a trip, the drive will make up to 5 attempts to restart at intervals according to P6-03. As long as the supply voltage is not switched off, the counter content remains. The number of start attempts is counted. If the drive fails to start automatically on the last attempt, it will be switched off with a fault message, after which a manual RESET will be required. **Caution:** An automatic restart is possible only when the control commands are given via terminals (P1-12 = 0, and P1-12 = 11 when, after a communication loss, the control is toggled to the terminals). **Observe the following warning!**	Auto-0

DANGER

For the automatic start mode (Auto-0 to Auto-5), personnel protection and the implications for the drive system must be specifically noted.

2.10.7 Error messages

The following table lists the error messages relevant to the STO function, as well as potential causes and fixes.

Table 4: Error messages

Display[1]	Error code[2] Modbus RTU [hex]	Name	Potential causes and fixes
PS-trP	05	Power section fault	• Error message from the power section's output • Check the connection to the motor (short-circuit, earth fault). • Disconnect the cable from terminals U, V, W. If the fault message cannot be reset, please contact your nearest Eaton representative.
Sto-F	29	Internal STO circuit fault	Please contact your nearest Eaton representative.

1) Display = Error code on the 7-digital display assembly or on the optional DX-KEY-LED2 keypad
2) Modbus RTU [hex] = Hexadecimal fault code via Modbus

2.10.8 STO function checklist

A drive's STO function should always be checked before initial commissioning, after maintenance, and at regular maintenance intervals. This check should include the following tests:

No.	Activity	Note
1	The STO inputs (control signal terminals 12, 13) are de-energized. With motor standstill and a stop command on the DA1 variable frequency drives, *InHibit* is displayed (locked state).	
2	The STO inputs (control signal terminals 12, 13) are de-energized and the DA1 variable frequency drive receives a start command (depending on the selected mode in P1-13, DI Config Select). *InHibit* is displayed (locked state). The motor does not start.	
3	The STO inputs (control signal terminals 12, 13) are supplied with 24 V DC and the DA1 variable frequency drive receives a start command (depending on the selected mode in P1-13, DI Config Select). The motor starts normally and is controlled by the DA1 variable frequency drive.	
4	The motor is running while being controlled by the DA1 variable frequency drive and an STO input (control signal terminal 12 or 13) is de-energized. *InHibit* is displayed and the motor coasts.	

2.10.9 Regular maintenance

The STO function should always be included in a scheduled maintenance process (at least once per year) so that the function will be tested on a regular basis to make sure it is intact and complete – especially after changes are made to the safety system and after repairs are made.

During the corresponding inspection and testing, the variable frequency drive's installation and operating environment must be checked:

- The ambient temperature must fall within the admissible range.
- The heat sink and fan must be free of dust and other foreign particles. The fan must be able to rotate freely.
- The enclosure in which the variable frequency drive is installed must be free of dust and condensation.
- The enclosure fan and air filter must provide the required airflow.
- All electrical connections must be checked:
  The screw terminals must be properly tightened and the power cables must not show any signs of heat damage.

2.10.10 "Safe stop"function

The purpose of the STO function is to prevent the drive from enabling the motor to produce a torque when there is no input signal at terminals 12 and 13. This makes it possible to integrate the drive into a complete safety system in which the "safe stop" function needs to be fully implemented.

DANGER

The STO function cannot prevent unexpected restarting or automatic restarting (if the corresponding parameters are configured for this type of restarting).
Accordingly, it must not be used to perform maintenance or cleaning work on the machine.

The STO function eliminates the need to use electro-mechanical contactors with self-monitoring auxiliary contacts in order to implement safety functions.

DANGER

In certain applications, additional measuring and monitoring equipment may be needed in order to meet the requirements for the system's safety function.
The STO function does not include motor braking, and the DA1 variable frequency drive's braking function cannot be considered a fail-safe method by itself.
If a motor braking function is required, an appropriate safety relay and/or a mechanical braking system or a similar method must be used.

The STO function that is integrated into the DA1 variable frequency drive fulfills the definition of "safe stop" according to IEC 61800-5-2 and corresponds to a non-controlled hold in accordance with category 0 (emergency-stop) of the IEC 60204-1 norm. This means that the motor runs down (coasts), if the STO function is activated. The method used for stopping must be appropriate for the system being driven by the motor.

The STO function is approved for use as a fail-safe method even in cases in which the STO signal is not present and a single fault has occurred in the drive. The drive was accordingly tested in accordance with the following safety standards:

	SIL (Safety Integrity Level)	**PFH_d**(Probability of dangerous Failures per Hour)	**SFF (%)** (Safe Failure Fraction)	**Lifetime assumed**
EN 61800-5-2	2	1.23E-09 1/h (0.12 % SIL 2)	50	20 Yrs
	PL(Performance Level)	**CCF (%)**(Common Cause Failure)		
EN ISO 13849-1	PL d	1		
	SIL CL			
EN 62061	SIL CL 2			

The values provided here can only be ensured if the DA1 variable frequency drive is installed in an environment that stays within the permissible limits:

- Ambient temperature range: -10 to +50 °C, taking into account any limits that depend on frame size and protection.
- Maximum altitude for rated operation: 1000 m above sea level, with altitude derating of 1 % for every 100 m above 1000 m (up to max. 4000 m for IEC / 2000 m for UL)
- Relative humidity: < 95 % (non-condensing). The DA1 variable frequency drive must always be free of frost and moisture.

3 Installation

3.1 Introduction

This chapter provides a description of the mounting and the electrical connection for the DA1 variable frequency drive.

→ While mounting and/or assembling the variable frequency drive, cover all ventilation slots in order to ensure that no foreign bodies can enter the device.

→ Perform all installation work only with the specified appropriate tools and without the use of force .

→ For information on how to install DA1 variable frequency drives with the various enclosure versions, please refer to the following instruction leaflets:

- IL04020010Z (IP20 in FS2, FS3)
- IP040049ZU (IP20 in FS4, FS5)
- IL04020012Z (IP20 in FS8)
- IL04020011Z (IP55 in FS4, …, FS7)
- IL04020015Z (IP66 in FS2, FS3)

3.2 Installation position

DA1 variable frequency drives are available in three enclosure versions:

- IP20/NEMA 0 protection for use in control panels,
- IP55/NEMA 12 protection,
- IP66/NEMA 4X protection.

The IP55 and IP66 enclosure versions provide protection against moisture and dust, allowing for use under harsh conditions in indoor environments.

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

- Explosion-proof areas
- 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 of EN 50178.
- Areas in which the variable frequency drive takes care of safety functions that must guarantee machine and personnel protection.

3.3 Assembly

The installation guidance provided here takes into account building the devices into suitable housings with protection rating IP20 and IP55 in accordance with the EN 60529 standard or other essential provisions that apply regionally.

- 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 frequency 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 (e. g., 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.

→ Install the DA1 variable frequency drive only on a nonflammable mounting base (e.g., on a metal plate).

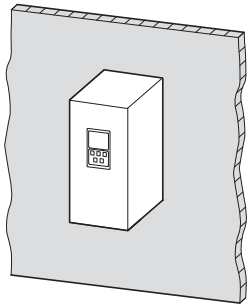


Figure 42: Surface mounting on metal plate

IP66 DA1 variable frequency drives must be installed as required by the local conditions for this protection.

3.3.1 Position of installation

The DA1 device series variable frequency drives are installed vertically. The maximum permitted tilt is 30°.

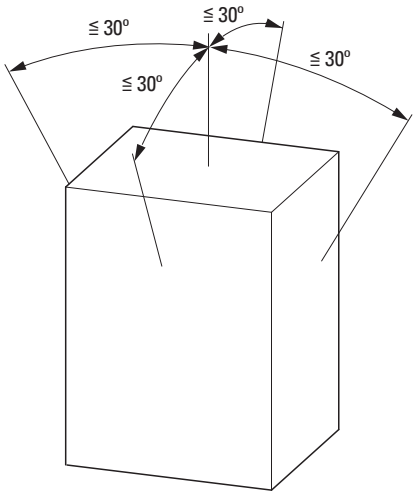


Figure 43: Position of installation

3.3.2 Cooling measures

In order to guarantee sufficientair circulation, enough thermal clearance must be ensured according to the frame size (rating) of the frequency inverter.

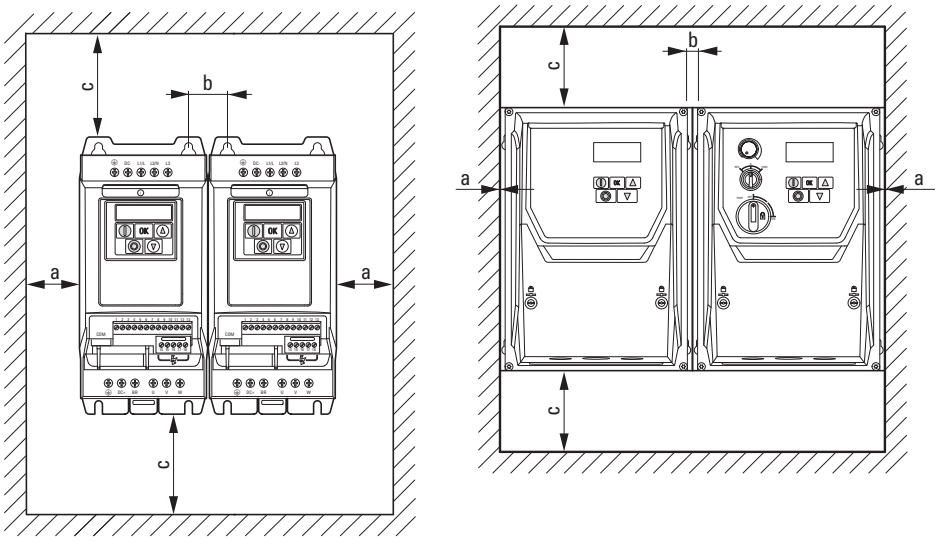


Figure 44: Clearances forair cooling (left: IP20; right: IP66)

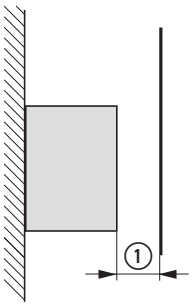
The variable frequency drives can be mounted side by side without any lateral clearance between them.

Table 5: Minimum clearances and required cooling airflow

Frame size (protection)	a		b		c		Required airflow	
	mm	in	mm	in	mm	in	m^3/h	cfm
FS2 (IP20)	50	1.97	31	1.22	75	2.95	70	41
FS2 (IP66)	0	0	12	0.47	150	5.91	0	0
FS3 (IP20)	50	1.97	31	1.22	100	3.94	190	112
FS3 (IP66)	0	0	13	0.51	150	5.91	0	0
FS4 (IP20)	25	0.98	70	2.76	200	7.87	105	62
FS4 (IP55)	10	0.39	71	2.8	200	7.87	425	250
FS5 (IP20)	25	0.98	70	2.76	200	7.87	177	104
FS5 (IP55)	10	0.39	70	2.76	200	7.87	425	250
FS6 (IP55)	10	0.39	140	5.52	200	7.87	650	383
FS7 (IP55)	10	0.39	140	5.52	200	7.87	650	383
FS8 (IP20)	50	1.97	162	6.38	350	13.78	825	485

The values in table5 are recommended values for an ambient air temperature of +50 °C for IP20 and +40 °C for IP55 and +40 °C in frame size FS8 (IP20), an installation altitude of up to 1000 m and a switching frequency of up to 8 kHz.

→ Typicalheat loss makes up about 3 % of the operational load conditions.



Frame size	Minimum clearance ①
FS2, …, FS7	≧ 15 mm (≧ 0.59 in)
FS8	≧ 50 mm (≧ 1.97 in)

Figure 45: Minimum required clearance ① in front of the variable frequency drive when installed in an enclosure (control panel)

→ Please ensure that the installation makes it possible to properly open and close the control signal terminal enclosure.

When variable frequency 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).

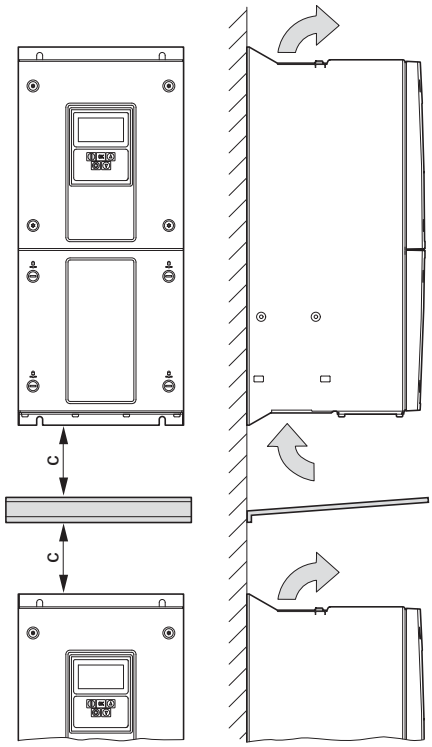


Figure 46: Deflector due to increased circulation caused by device fan

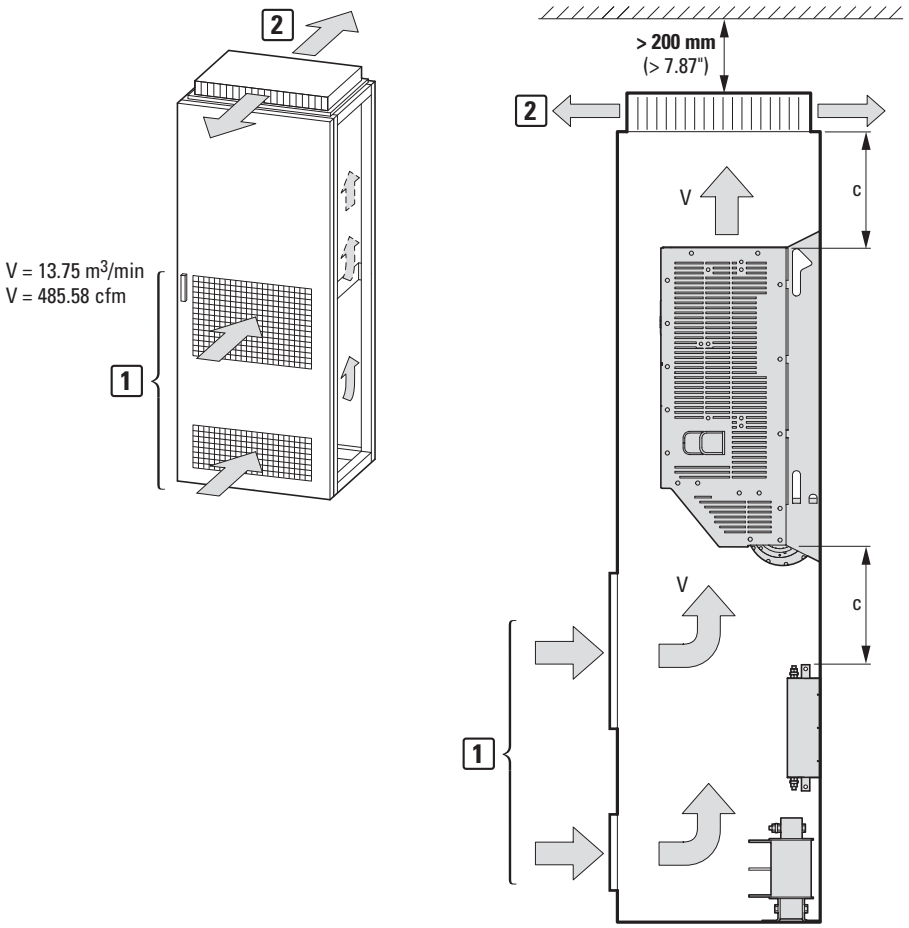


Figure 47: Air circulation in frame size FS8

There must be enough clearance above and in front of the control panel in order to ensure that there will be adequate cooling and space for any required maintenance work. The required volume of cooling air [1] and the required cooling air temperature must ensure that the variable frequency drive's maximum permissible ambient temperature will not be exceeded.

It must be possible for the hot exhaust air [2] to be channeled away unobstructed. Residual heat may cause the variable frequency drive's maximum permissible ambient temperature to be exceeded.

The heat dissipation of the variable frequency drive and of the rated accessories in the power path (mains choke, motor choke, sine filter) will vary significantly depending on the load, the output frequency, and the carrier frequency being used.

→ section 6.2, "Specific rated operational data", page 148 lists the variable frequency drives' heat dissipation at the rated operational current.

The following formula provides a good reference value for estimating heat dissipation at target conditions, and can be used to size cooling and ventilation equipment for electrical rooms:

$$P_{Loss}\ [kW] = P_{Motor}\ [kW] \times 0.025$$

3.3.3 Fixing

All DA1 variable frequency drive frame sizes can be mounted with screws.

Moreover, frame sizes FS2 and FS3 with IP20 protection can be mounted on a mounting rail as well.

→ Install the DA1 variable frequency drive only on a nonflammable mounting base (e. g., on a metal plate).

→ Dimension and weight specifications for the DA1 variable frequency drive can be found in the → section 6.3, “Dimensions and frame sizes”, page 158.

3.3.3.1 Fixing with screws

→ 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.

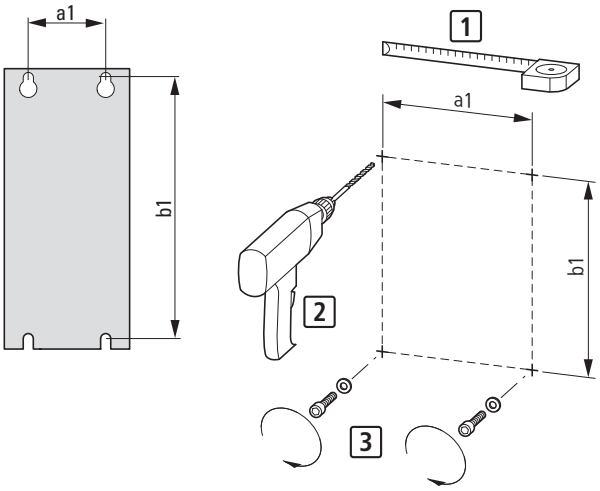


Figure 48: Mounting dimensions

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

Table 6: Mounting dimensions,screws, tightening torques

Frame size	protection		a1		b1		Screw		Tightening torque	
FS	IP	NEMA	mm	in	mm	in	Number	Size	Nm	lb-in
FS2	IP20	NEMA 0	75	2.95	215	8.46	4	M4	1	8.85
FS2	IP66	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	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	M8	2	18
FS4	IP55	NEMA 12	110	4.33	428	16.85	4	M8	4	35.4
FS5	IP20	NEMA 0	175	6.89	460	18.11	4	M8	4	35.4
FS5	IP55	NEMA 12	175	6.89	515	20.28	4	M8	15	132.76
FS6	IP55	NEMA 12	200	7.87	840	33.07	4	M10	20	177
FS7	IP55	NEMA 12	200	7.87	1255	44.41	4	M10	20	177
FS8	IP20	NEMA 0	420	16.54	942	37.09	4	M12	57	504.5

1 in = 1'' = 25.4 mm; 1 mm = 0.0394 in

3.3.3.2 Fixing on amounting rail

As an alternative to screw fixing, DA1 variable frequency drives (sizes FS2 and FS3) and IP20 protection can also be mounted on a mounting rail as per IEC/EN 60715.

→ Ifyou use EMC mounting adapters (DX-EMC-MNT-…), preferably use a tall mounting rail (15 mm).

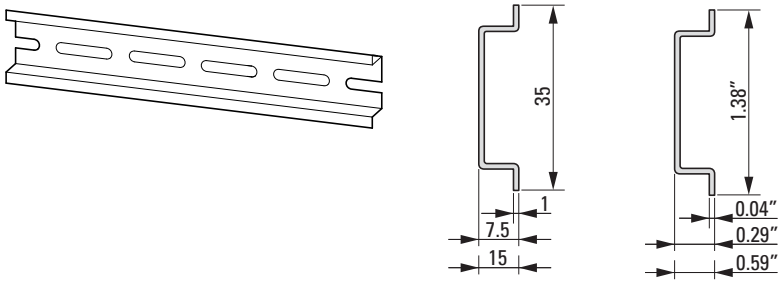


Figure 49: Mounting rail conforming with IEC/EN 60715

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

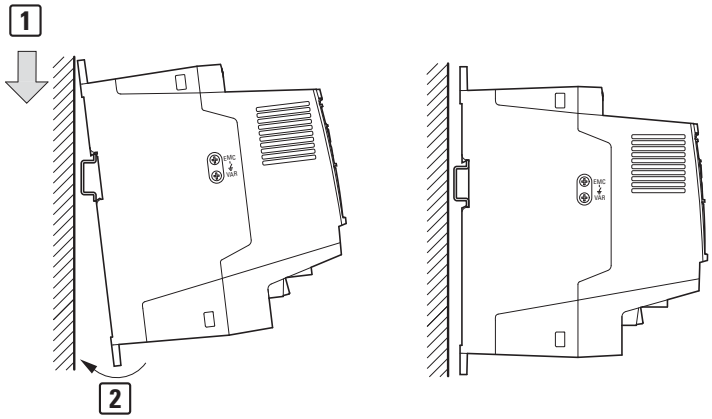


Figure 50: Fixing on mounting rails

Dismantling from mounting rails

▶ To remove the device, push down [2] on the clip being held by a spring force [1]. For this, there is a marked recess on the bottom edge of the device.
For unlocking, it is recommended that a screwdriver with a flat head (e. g. head width 5 mm) is used.

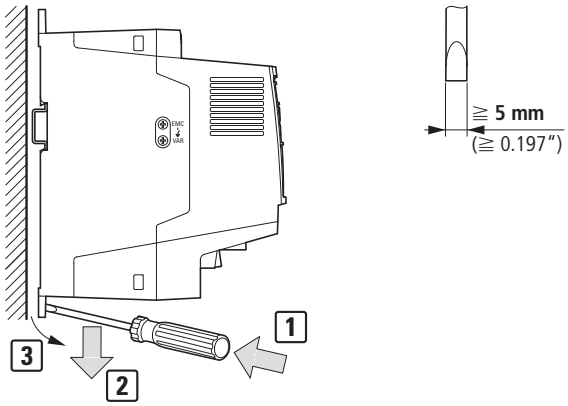


Figure 51: Dismantling from mounting rails

▶ Now pull the lower edge away from the mounting surface (forwards) [3] before lifting the variable frequency drive off the mounting rail.

3.3.4 Control panel installation

If the DA1 variable frequency drive is installed into a control cabinet, ensure that it is installed with structural stability.
It is preferable to install it on a rear wall. Moreover, the top of the cabinet should be fastened to the wall and the two front corners should be fastened to the floor.

If the cabinet is set up in a freestanding configuration, all four corners must be fastened to the floor.

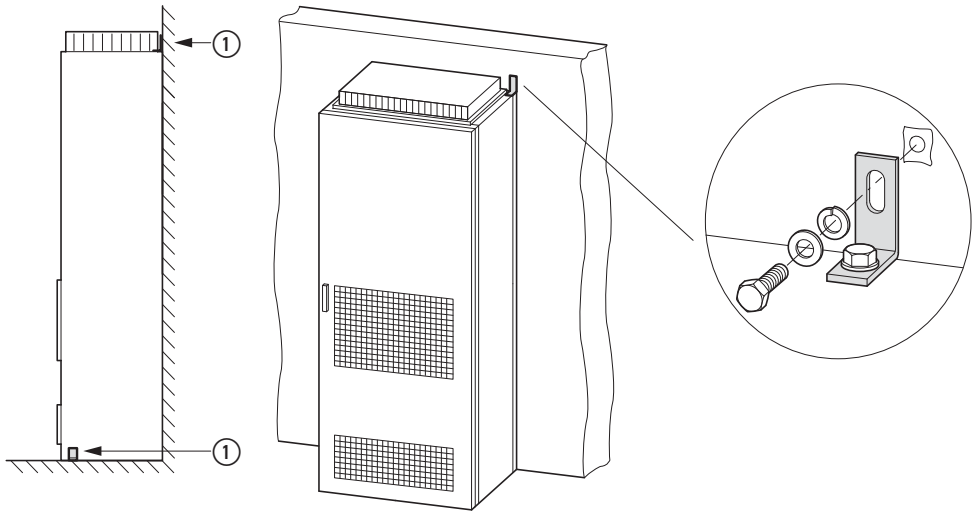


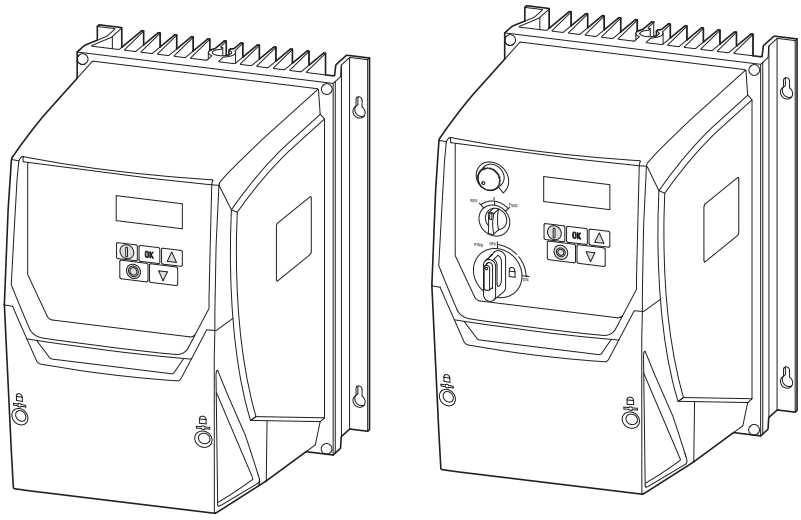
Figure 52: Stable control panel setup

→ Heavy accessories such as motor chokes and sine wave filters should always be installed on the control panel's base plate.

3.4 IP66/NEMA4X protection

IP66 DA1 variable frequency drives are available in two versions:

- DA1-…-A**66C**: Controlled via control signal terminals
- DA1-…-A**6SC**: Controlled with controls on the front and/or control signal terminals



DA1-…-A66C DA1-…-A6SC

Figure 53: 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 frequency drive's weight.

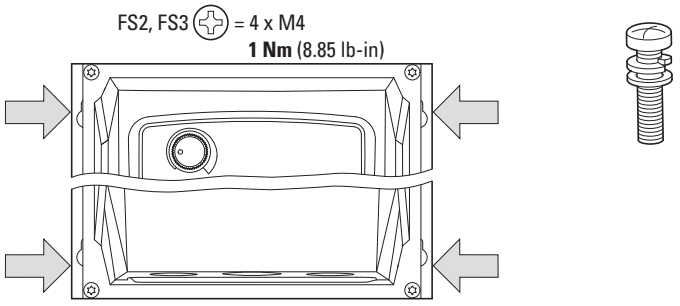


Figure 54: Openings for fixing screws

On the DA1-…-A6SC version, the main disconnect switch can be locked in the OFF position with a standard padlock.

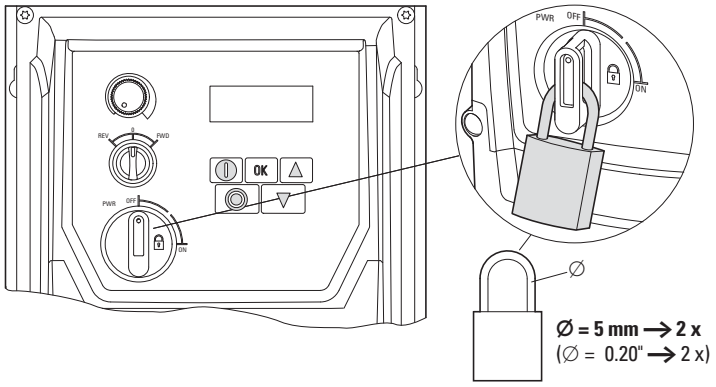


Figure 55: DA1-…-A6SC with padlock

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

3.5 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. They must also utilize means to increase the interference immunity of the devices of the system.

In a power drive system (PDS) with variable frequency 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 frequency 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
- a second protective conductor must be fitted.

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

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

Ground all conductive components and enclosures in a drive system with the shortest possible cable with the largest possible diameter (Cu-braid).

3.5.1 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 HF braids with an electrical contact established across a large surface area.

Do not make connections to painted surfaces (electrolytic oxidation, yellow chromated).

Install the variable frequency 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 (e. g., screened motor cables) and clean cables (e. g., 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 right angles (90°).

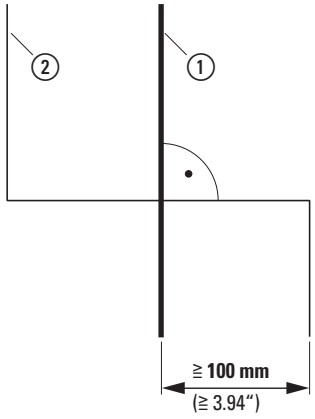


Figure 56: Cable routing

Never lay control or signal cables ② in the same duct as power cables ①.
Analog signal cables (measured values, setpoints, and correction values) must be routed inside shielded conduits.

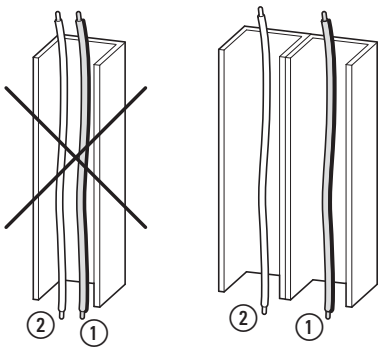


Figure 57: Separate cable routing

① Cable routing: Mains voltage, motor connection
② Control and signal lines, fieldbus connections

3.5.2 Grounding

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.

Every variable frequency 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 drive's system's conductive components (e. g., variable frequency drive, sine wave filter) should be connected.

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

Avoid ground loops when installing multiple variable frequency drives in a single control cabinet. Make sure that all metallic devices that are to be grounded have a broad area connection with the mounting plate.

3.5.2.1 Protective earth

This refers to the legally required protective earth for a variable frequency drive. An earthing terminal on the variable frequency 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.

3.5.2.2 Motor earthing

The motor earth must be connected to one of the earthing terminals on the variable frequency drive and to a neighboring steel element in the building (beam, ceiling joist), an earth electrode in the ground, or a mains earth bus.

3.5.2.3 Earth-fault protection

A fault current to earth can be produced by variable frequency drives due to their system characteristics. DA1 series variable frequency 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 (DA1-3…), this fault current must be monitored by a residual current device (RCD, type B).

3.5.3 Internal filters (EMC and VAR screws)

3.5.3.1 EMC screws

The DA1 variable frequency drives in sizes FS2 and FS3 have two screws on the left-hand side in protection rating IP20, which are marked with EMC and VAR; in sizes FS4 and FS5, these screws are on the front.

The EMC screws are found only in devices with an internal RFI filter in sizes FS2 to FS5 with IP20 protection.

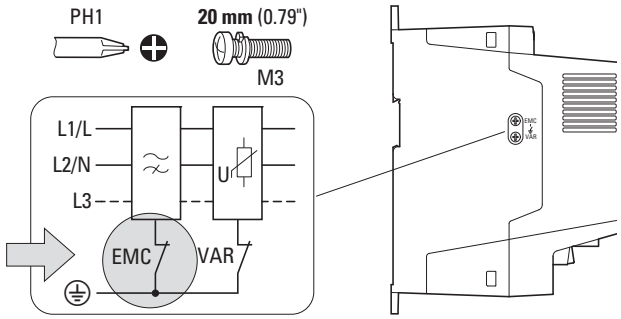


Figure 58: EMC and VAR screw

WARNING

The screw labeled EMC must not be adjusted as long as the variable frequency drive is connected to the mains.

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

Due to their system characteristics, variable frequency 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).

The local EMC regulations must be taken into consideration for this.

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).

3.5.4 VAR screw

DA1 series variable frequency drives are equipped with an overvoltage filter for the input supply voltage that is designed to protect the devices from noise pulses 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-voltage 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 high-voltage tests, the overvoltage protection components can be disconnected by removing the VAR screw. The screw must be screwed back in after the high-voltage 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.

→ The VAR screw is found only in devices in sizes FS2 and FS3 with IP20 protection.

WARNING

The screw labeled VAR (→ figure 58, page 94) must not be adjusted as long as the variable frequency drive is connected to the mains.

3.5.5 Shielding

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

→ For a proper EMC connection, cables emitting interference (e. g., 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.

→ Use only screens with tinned or nickel-plated copper braiding. Braided steel shields are unsuitable.

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

3.5.6 EMC cable brackets

The DX-EMC-MNT-... cable brackets enable the cable routing and cable catch in the connection area of the DA1 variable frequency drive in sizes FS2 and FS3 of protection type IP20. The cable brackets are installed on the mains connection side (DX-EMC-MNT-…N) and the motor side (DX-EMC-MNT-…M) of the variable frequency drive above the mounting holes and connected to the ground connection ⏚ of the variable frequency drive.

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

These cable brackets are made of galvanized sheet steel.

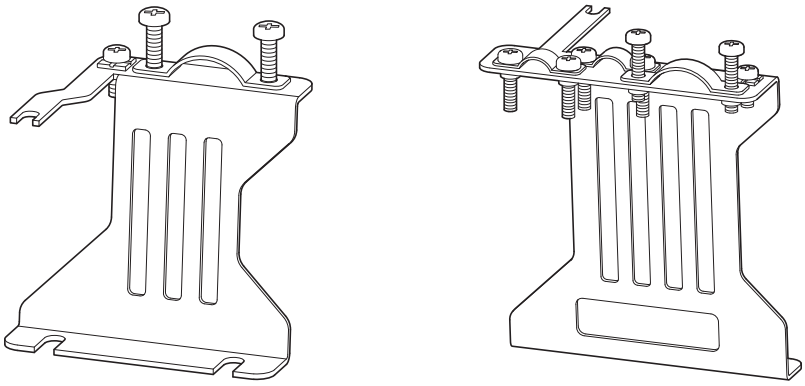


Figure 59: DX-EMC-MNT-...N (left), mains and DX-EMC-MNT-...M (right), motor, cable brackets

→ For more information and technical data on DX-EMC-MNT-… EMC cable brackets, please refer to instructional leaflet IL040010ZU.

→ DX-EMC-MNT-… EMC cable brackets are sold as individual units. There are different brackets for each DA1 variable frequency drive frame sizes (FS2 and FS3).
Thecable clamps and their fixing screws are included in the equipment supplied with the cable brackets.

Cable bracket	Frame size DA1	Cable clamps Number / designation
DX-EMC-MNT-2N	FS2	1/Mains connection
DX-EMC-MNT-2M	FS2	3/control cables, motor connection, external braking resistor
DX-EMC-MNT-3N	FS3	1/Mains connection
DX-EMC-MNT-3M	FS3	3/control cables, motor connection, external braking resistor

3.5.7 General installation diagram

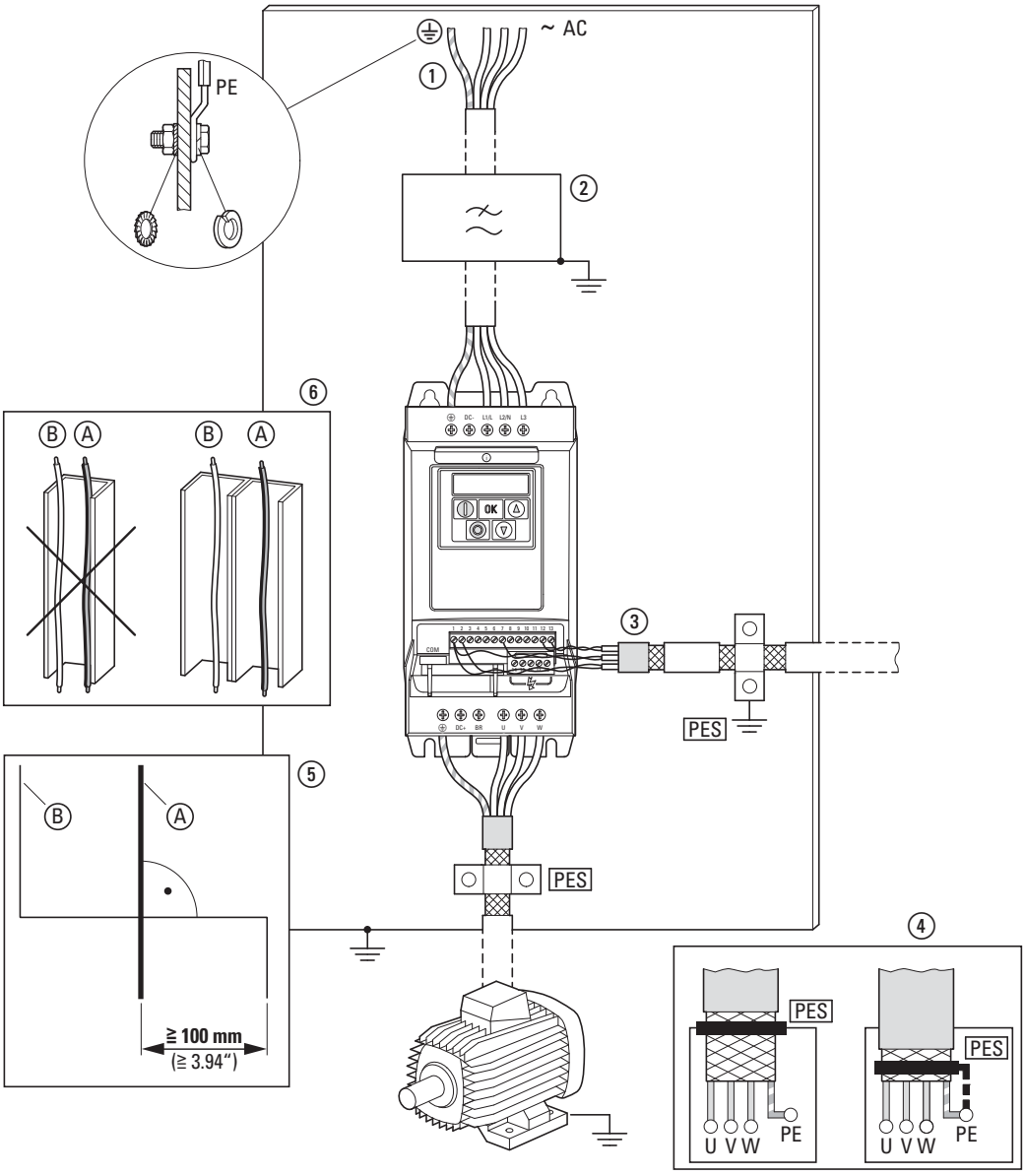


Figure 60: EMC installation

① Mains connection: Supply voltage, central earthing connection for control panel and machine
② External radio interference suppression filter: Optional external radio interference suppression DX-EMC… radio interference suppression filter for longer motor cables or use in a different EMC environment
③ Control connection: Connecting the digital and analog control lines, STO function and communicating through an RS45 plug-in connection
④ Motor connection: EMC 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 right angles 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).

3.6 Electrical Installation

CAUTION

Carry out wiring work only after the variable frequency 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.

WARNING

Fire hazard!
Use only those cables, circuit-breakers, and contactors that feature the indicated permissible nominal current value.

WARNING

The ground leakage currents in the DA1 variable frequency drives can be greater than 3.5 mA (AC).
According to product standard IEC/EN 61800-5-1, an additional grounding conductor must be connected or the existing grounding conductor must have a cross-section of at least 10 mm^2.

DANGER

The components in the variable frequency 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!

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

3.6.1 Connection to thepower 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 is not relevant for sizes FS2 to FS7.
  Pay attention to the phase sequence for frame size FS8!
- DC+ (or +), DC- (or -), PE for DC link coupling or if the device is being supplied with DC voltage
- U, V, W, PE for the input wiring to the motor
- BR, DC+ (or +), PE for an external braking resistor
- DC+ (or +) or DC- (or -), PE for connecting all-pole sine filters

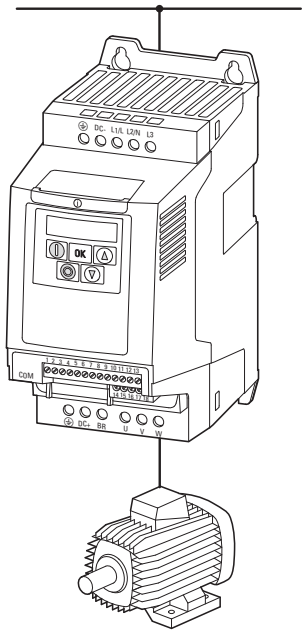


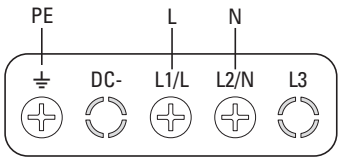
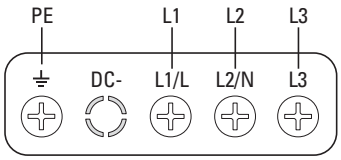
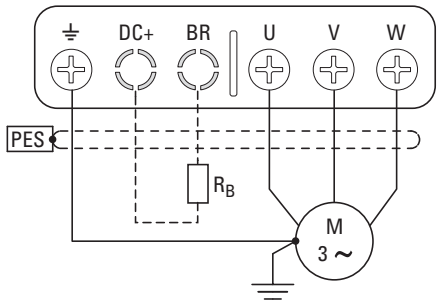
Figure 61: Connection to power section (schematic)

The number and the arrangement of the connection terminals used depend on the DA1 variable frequency drive's frame size and model.

> *WARNING*
>
> The variable frequency drive must always be connected with ground potential via a grounding conductor (PE).

3.6.1.1 Connection terminals on frame sizes FS2 and FS3 with IP20

Table 7: Connection terminals (FS2, FS3)

Connection terminals	Description
	Connection with single-phase supply voltage (230 V): • DA1-12… (200 - 240 V)
	Connection with three-phase supply voltage: • DA1-32… (200 - 240 V) • DA1-34… (380 - 400 V) • DA1-35… (500 - 600 V)
	Motor connection for three-phase motors: (motor voltage = supply voltage) • DA1-12… • DA1-32… • DA1-34… • DA1-35… optional: internal or external braking resistor (R_B)

→ DC+ and DC- for DC link coupling or if the device is being supplied with DC voltage.
To do this, the terminal screw cover needs to be knocked out.

3.6.1.2 Connection for frame sizes FS4 to FS7 with IP55

On enclosures with IP55 protection (frame sizes FS4 to FS7), the connection area will be located behind the lower enclosure cover.

Sizes FS4 and FS5

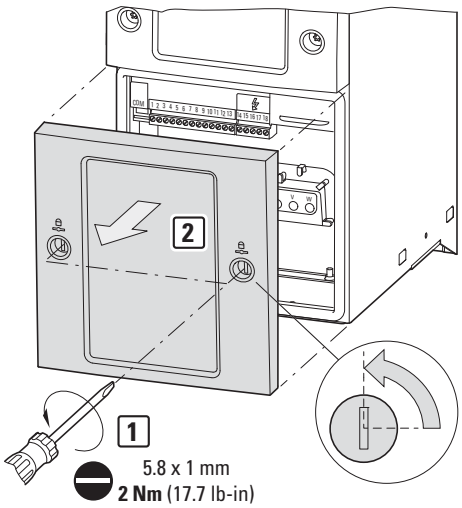


Figure 62: Removing the cover

Release the latches by turning them counterclockwise (90 degrees) so that they are in a vertical position [1] and lift the cover off forwards [2].

Sizes FS6 and FS7

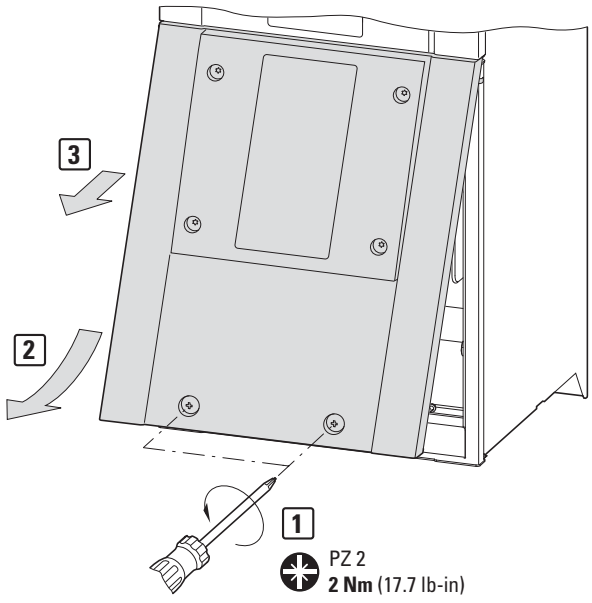


Figure 63: Removing the cover

Unscrew the two screws at the bottom [1], lift the cover from the bottom [2], and then remove it forwards

→ The upper edge of this cover is inserted into the upper enclosure cover from below.

The connection cables need to be brought in from below. To do this on these frame sizes (FS4 to FS7), the cover at the bottom (above the device fan) needs to be removed.

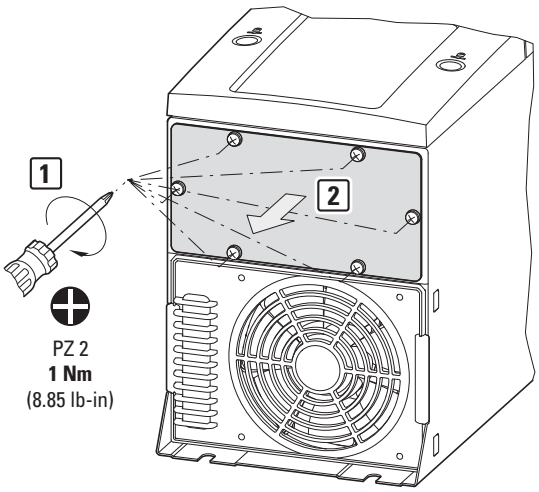


Figure 64: Remove the blanking plate

Unscrew the screws (six pcs./eight pcs.) [1] and remove the blanking plate [2].

Table 8: Connection terminals (FS4, FS5)

Description		
Connection with three-phase supply voltage: • DA1-32… (200 - 240 V) • DA1-34… (380 - 480 V) • DA1-35… (500 - 600 V)	optional: internal or external braking resistor (R_B)	Connection for three-phase motors (motor voltage = supply voltage)

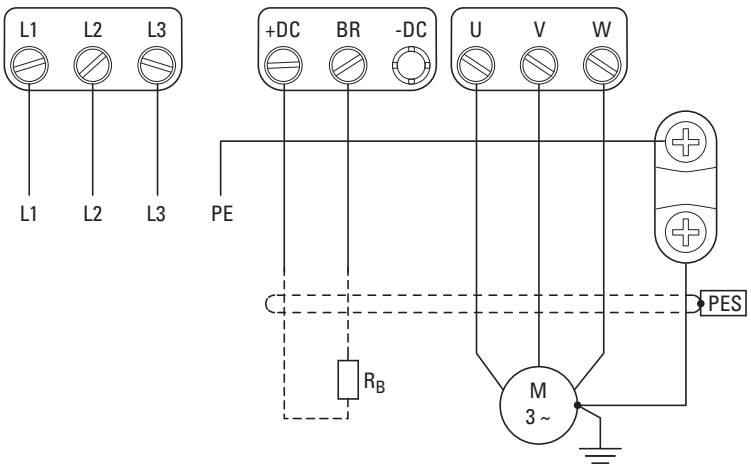


Figure 65: Connection terminals for sizes FS4 and FS5

PE earthing connection with ring cable lugs on the right side.

Terminals +DC and -DC have the same function as terminals DC+ and DC-.

Table 9: Terminal bolt (FS6, FS7)

Description		
Connection with three-phase supply voltage: • DA1-32… (200 - 240 V) • DA1-34… (380 - 480 V) • DA1-35… (500 - 600 V)	optional: External braking resistor (R_B)	Connection for three-phase motors (motor voltage = supply voltage)

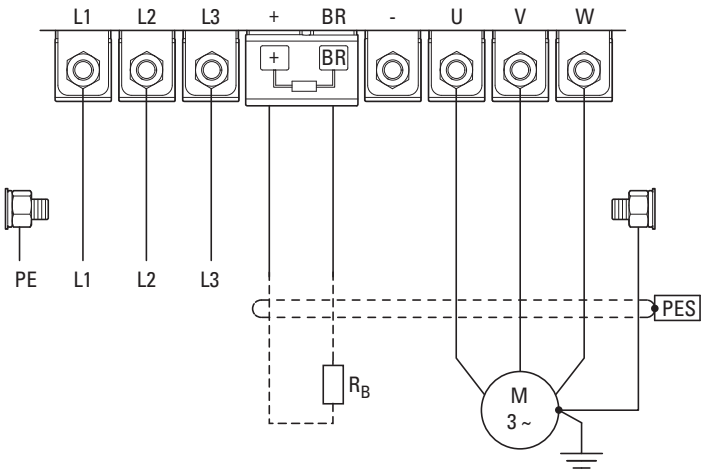


Figure 66: Connection terminal bolts for sizes FS6 and FS7

The PE earthing connection is made with ring cable lugs and the bolts on the left and right sides of the enclosure.

The terminal bolts for an external brake resistor are located under the cover marked with + and BR.

Stud terminal + has the same function as terminal DC+.

If the device is installed in a control panel, the lower blanking plate and the front enclosure cover must not be installed. Without the cover, the DA1 variable frequency drive will have IP40 protection.

3.6.1.3 Terminal bolts on frame size FS8 (IP20)

On FS8 DA1 variable frequency drives, the connection area inside the power section will be covered by a blanking plate at the bottom of the enclosure. In order to open it, you will need to unscrew six screws [1].

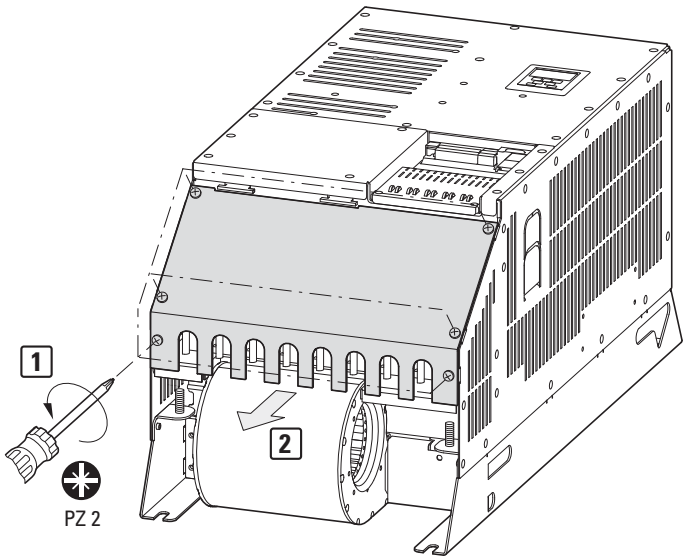


Figure 67: Remove the blanking plate

Table 10: Terminal bolts (FS8)

Description		
Connection with three-phase supply voltage: • DA1-34… (380 - 480 V)	optional: External braking resistor (R_B)	Connection for three-phase motors (motor voltage = supply voltage)

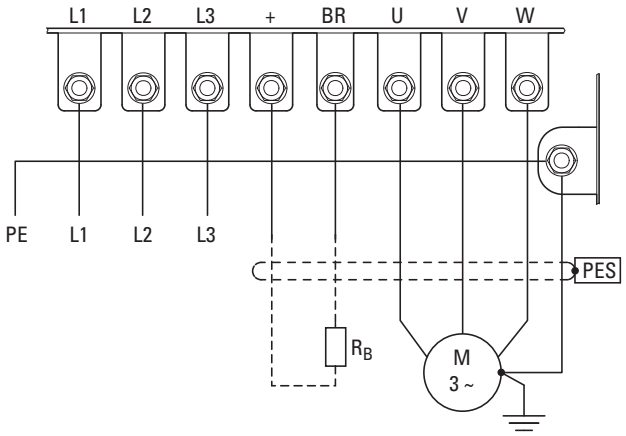
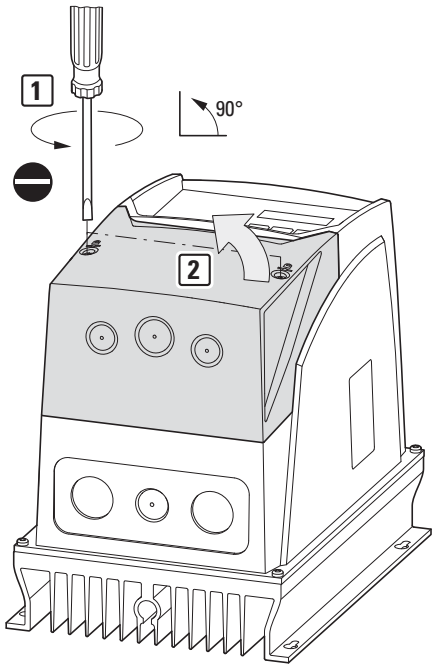


Figure 68: Terminal bolts on frame size FS8

The PE earthing connection is made with ring cable lugs and the bolts on the right side.

→ Stud terminal + has the same function as terminal DC+.

3.6.1.4 Connection terminals on frame sizes FS2 and FS3 with IP66

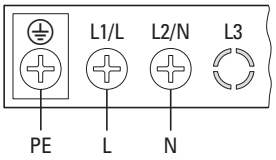
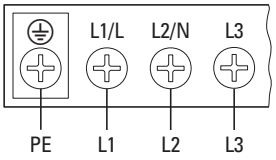
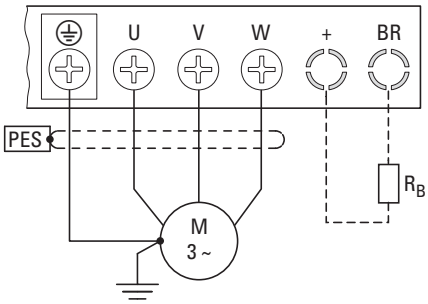


On FS2 and FS3 frame sizes with IP66 protection, the connection area is located behind the lower enclosure cover.
To open the cover, release the two latches by turning them counterclockwise (90 degrees) so that they are in a vertical position [1].

Once the latches are released, you can lift the cover off forwards [2].

Figure 69: Remove enclosure cover (IP66)

Table 11: Connection terminals (FS2, FS3)

Connection terminals	Description
	Connection with single-phase supply voltage • DA1-12… (200 - 240 V)
	Connection with three-phase supply voltage: • DA1-32… (200 -240 V) • DA1-34… (380 - 480 V) • DA1-35… (500 - 600 V)
	Motor connection for three-phase motors: (motor voltage = supply voltage) optional: External braking resistor (R_B)

→ Terminal + has the same function as terminal DC+.

3.6.1.5 Stripping lengths and tightening torques

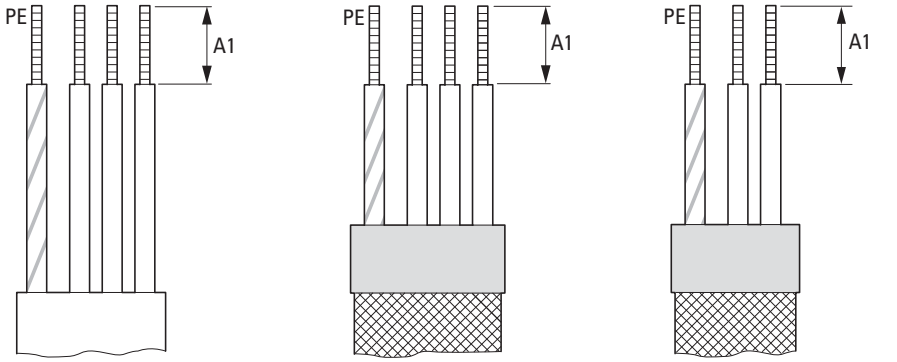


Figure 70: Connection cables

Mains = Electrical supply system (mains voltage),
Motor = Motor connection,
DC-Link = internal DC link,
Brake Resistor = Braking resistor

Table 12: Stripping lengths in the power section

Frame size (protection)	A1 mm (in)	Tightening torque Nm (lb-in)
FS2 (IP20)	8 (0.3)	1 (8.85)
FS3 (IP20)	8 (0.3)	1 (8.85)
FS2 (IP66)	10 (0.39)	1.5 (15)
FS3 (IP66)	10 (0.39)	1.5 (15)
FS4 (IP20)	15, space unit = ring cable lug, ∅ M6	2 (18)
FS4 (IP55)	15, space unit = ring-cable lug	4 (35.4)
FS5 (IP20)	15, space unit = ring-cable lug, ∅ M8	4 (35.4)
FS5 (IP55)	15, space unit = ring-cable lug	15 (98.2)
FS6	Ring-cable lug	20 (177)
FS7	Ring-cable lug	20 (177)
FS8	Ring-cable lug	57 (504.5)

3.6.1.6 Connecting the motor cable

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

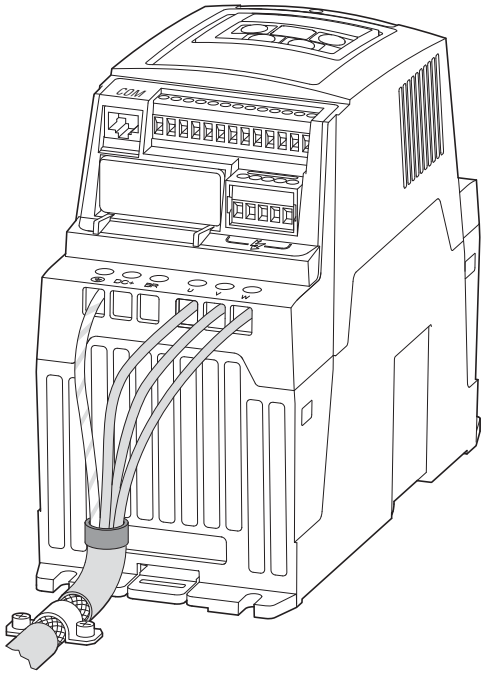


Figure 71: Connection on motor side

- 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 frequency drive and directly on the motor terminal box.
- Prevent the screen earth kit from unbraiding, i.e. by pushing the separate plastic covering over the end of the screen or by inserting a rubber grommet on the end of the screen. Connect the screen braid onto the end across a large area (PES).
  Alternatively, you can twist the screen braid and connect it to the protective earth using 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 ≧ 1/5 a).

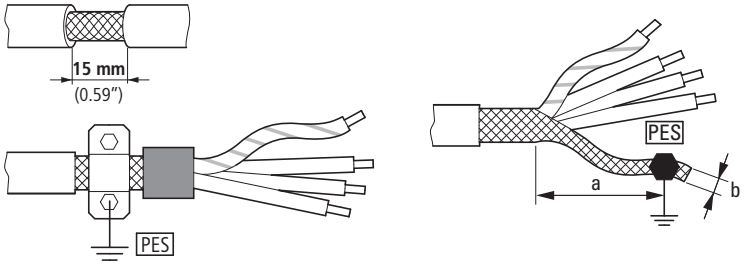


Figure 72: Screened connection cable in motor circuit

Screened, four-wire cable is recommended for the motor cables. The green-yellow line of this cable connects the protective ground connections from the motor and the variable frequency drive and therefore minimizes the equalizing current loads on the screen braid.

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

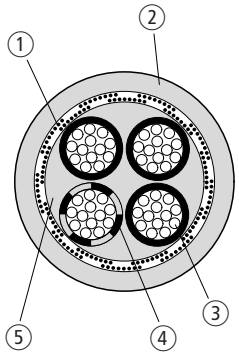


Figure 73: Four-core, screened motor supply cable

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

If there are additional subassemblies in a motor feeder (such as motor contactors, overload relays, motor chokes, sine wave 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.

3.6.1.7 Cable glands on IP55 and IP66

In the case of applications requiring a variable frequency drive to be installed inside buildings or systems but outside a control panel, cable glands can be used with DA1 variable frequency drives with IP55 or IP66 protection in order to establish an optimal connection.

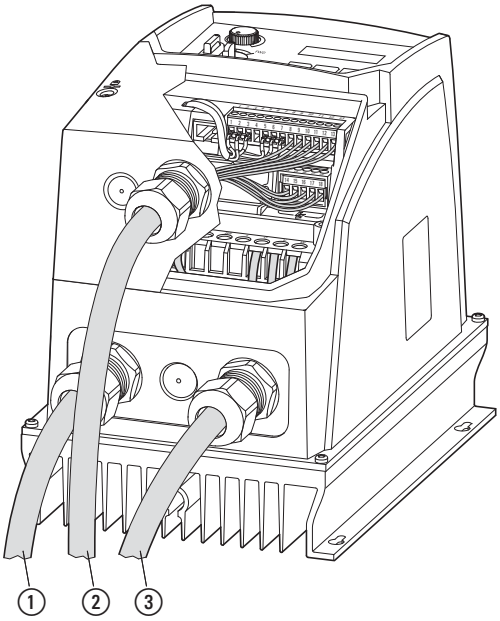


Figure 74: Openings with cable glands (IP66)

① Mains connection (supply voltage)
② Control and signal cables
③ Motor connection (screened cable with metal cable gland)

The lower metal section already comes with openings for the cable glands to the power section.

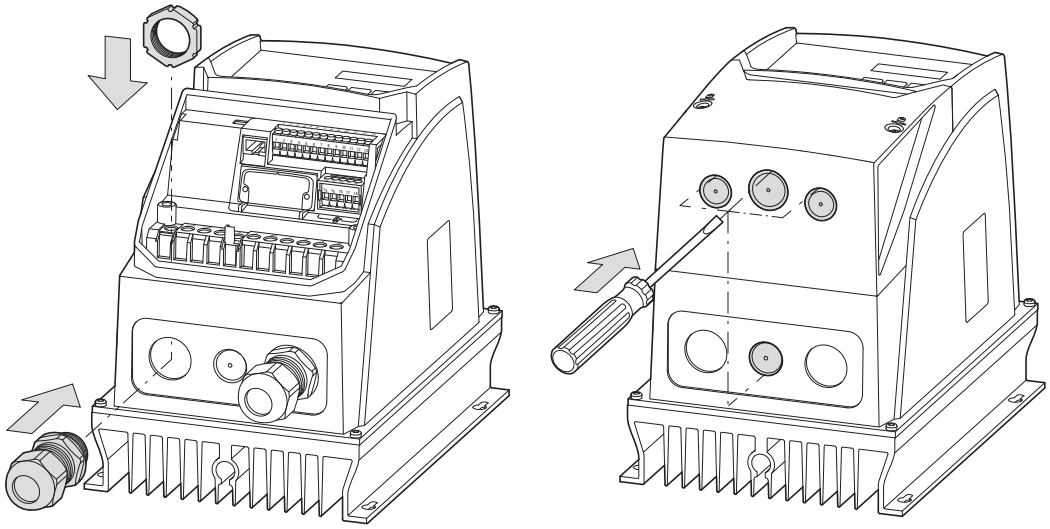


Figure 75: Openings for cable glands with IP66 protection

Table 13: Openings (FS2, FS3)

Frame size	Control section	Power section	Metric gland for hole size
FS2	2 x 21 mm 1 x 25.5 mm	3 x 21 mm	M20 with 21 mm M25 with 25.5 mm
FS3	2 x 21 mm 1 x 25.5 mm	1 x 21 mm 1 x 25.5 mm (open)	M20 with 21 mm M25 with 25.5 mm

→ Make sure that the cable glands have at least IP66 protection.

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

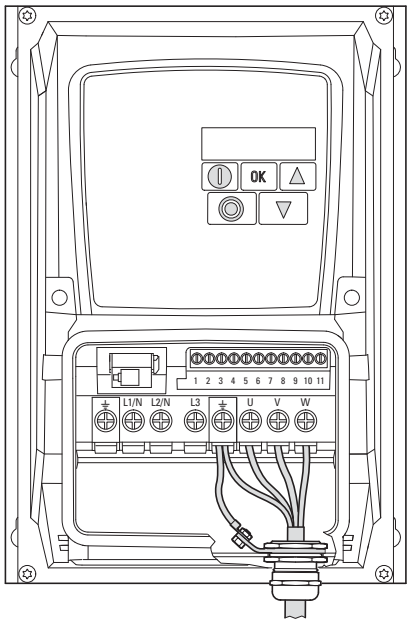


Figure 76: Grounding the EMC cable gland (IP66)

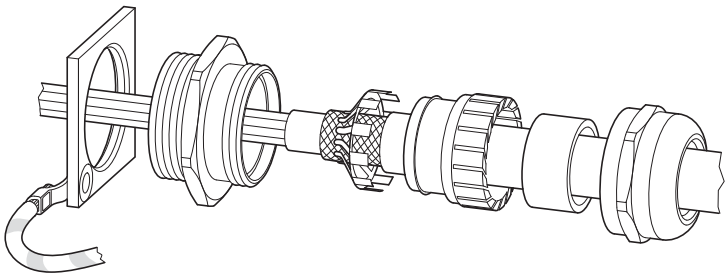


Figure 77: Set-up (example) of the EMC cable gland

In devices with IP55 protection (frame sizes FS4 to FS7), the blanking plates (→ figure 78) have three locating points for individual diameters for cable ducts. In order to have an installation that meets EMC requirements, the metal stud on this blanking plate must be connected to the enclosure's PE/earthing connection.

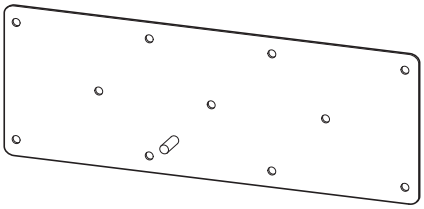


Figure 78: Blanking plate (FS6, FS7) with locating points and earthing stud

→ On frame sizes FS4 and FS5, the equipment supplied includes a second blanking plate with three openings in addition to the solid blanking plate that comes already installed.

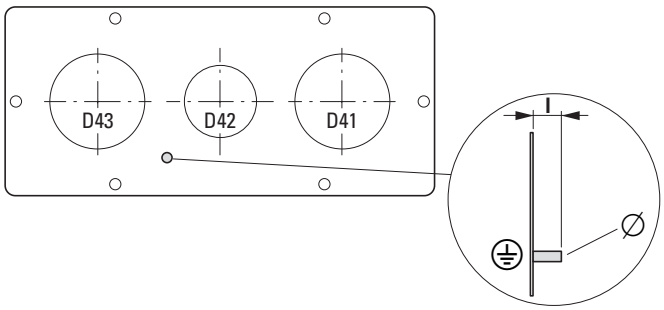


Figure 79: Blanking plate with openings and earthing stud (FS4, FS5)

Table 14: Openings (FS4, FS5)

Frame size	D41 mm (in)	D42 mm (in)	D43 mm (in)	l mm (in)	∅
FS4	40.5 (1.59) M40	25.5 (1) M25	40.5 (1.59) M40	10 (0.35)	M4
FS5	50.5 (1.99) M50	25.5 (1) M25	50.5 (1.99) M50	18 (0.71)	M6

3.6.2 Connection to control section

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

- Terminals 1, 5, 7, 9: for the internal power supply,
- Terminals 2, 3, 4, 6, 10: for digital and analog input signals,
- Terminals 8, 11: for a digital or analog output signal,
- Terminals 14, 15, 16, 17, 18: for dry relay outputs,
- Terminals 12, 13: for the STO inputs.

The 13- and 5-pole control signal terminals can be plugged in.
In IP20 protection (FS2, FS3, FS8), the control signal terminals are mounted on the front; in IP55 (FS4, …, FS7) and IP66 protection, they are mounted under the enclosure cover.

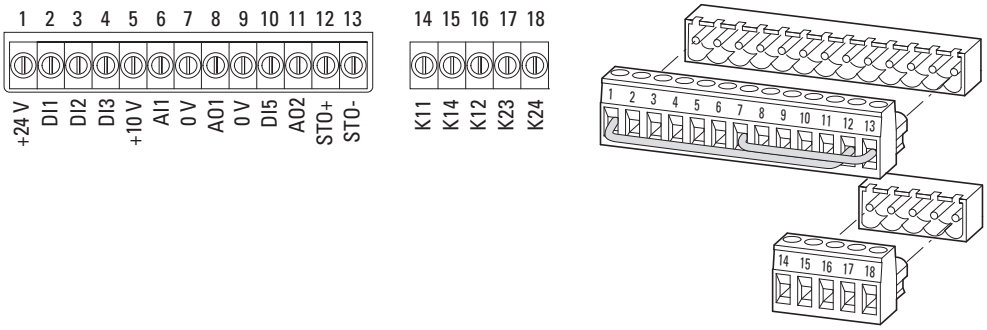


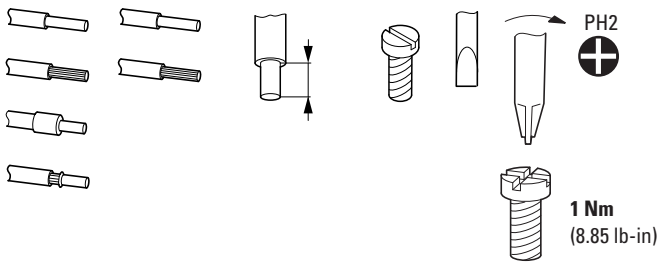
Figure 80: Plug-in control signal terminal designations

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

3.6.2.1 Terminal capacities

The connection terminals' layout depends on the frame size of the power section. The cross-sections to be used in the connections and the tightening torques for screws are listed in the following.

Table 15: Control signal terminal dimensions



Frame size	mm²	AWG	mm	in	Nm	mm
FS2, …, FS8	0.2 - 2.5	24 - 12	8	0.31	0.5	0.6 x 3.5

3.6.2.2 Connection data and functions

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

Table 16: Factory-set functions of the control terminals

Terminal		Signal	Description	Default settings
1	+24 V	Control voltage for DI1 - DI5, output (+24 V)	Maximum load 100 mA, Reference potential 0 V	(= Input for external control voltage, +24 V DC, reference potential at terminal 7 or terminal 9)
2	DI1	Digital Input 1	8 - +30 V (High, R_i > 6 kΩ)	FWD (clockwise rotating field enable)
3	DI2	Digital Input 2	8 - +30 V (High, R_i > 6 kΩ)	REV (anticlockwise rotating field enable)
4	DI3	Digital Input 3	8 - +30 V (High, R_i > 6 kΩ)	Select AI1 REF/f-Fix (Switch-over of the setpoint source from Analog input 1 to fixed frequency)
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 - +10 V (R_i > 72 kΩ) 0/4 - 20 mA (R_B = 500 Ω) switchable using parameter P2-30 • digital: 8 - 30 V (High)	Select f-Fix Bit0 (Selection of the frequency setpoint values of Bit0: f-Fix1 = 5 Hz (P2-01))
7	0 V	Reference potential	0 V = connection terminal 9	–
8	AO1 DO1	Analog output 1 Digital output 1	• Analog: 0 - +10 V maximum 20 mA switchable via parameter P2-11 • digital: 0 - +24 V	Output frequency f-Out (P2-11 = 8, ADO1 function & mode)
9	0 V	Reference potential	0 V = connection terminal 7	–
10	DI5 AI2	Digital Input 5 Analog Input 2	• digital: 8 - 30 V (High) • Analog: 0 - +10 V (R_i > 72 kΩ) 0/4 - 20 mA (R_B = 500 Ω) switchable using parameter P2-33	Select f-Fix Bit0
11	AO2 DO2	Analog output 2 Digital output 2	• Analog: 0 - +10 V maximum 20 mA switchable via parameter P2-13 • digital: 0 - +24 V	Output current A-Out (P2-13 = 9, ADO2 function & mode)
12	STO+	Safe Torque Off +	Enable = +24 V	→ section 2.10, "STO function", page 68
13	STO-	Safe Torque Off -	Enable = 0 V	
14	K11	Relay 1, changeover contact	Maximum switching load: 250 V AC/6 A or 30 V DC/5 A	(common connection for N/C and N/O)
15	K14	Relay 1, N/O (changeover contact)	Maximum switching load: 250 V AC/6 A or 30 V DC/5 A	Closed = No error message
16	K12	Relay 1, N/C (changeover contact)		Closed = No 24 V control voltage or error message (Error)
17	K23	Relay 2, N/O	Maximum switching load: 250 V AC/6 A or 30 V DC/5 A	Closed = RUN operating signal
18	K24	Relay 2, N/O		

1) Configurable function: Manual MN04020006Z-EN describes the functions and modes for the configurable control signal terminals.

3.6.2.3 STO terminals

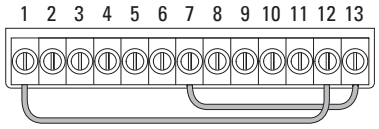


Figure 81: STO control signal terminals (direct enable)

Control signal terminal 12 (STO+) must always be connected to +24 V and control signal terminal 13 (STO-) must always be connected to 0 V (reference point for +24 V)!

Without the connection of a power supply (24 V DC) to control signal terminals 12 and 13, the control section and the inverter will remain blocked. An *Inh ibt* (Inhibit = block) message is displayed.

3.6.2.4 Connection example

The control cables should be screened and twisted. The screen is applied on one side in the proximity of the variable frequency drive (PES).

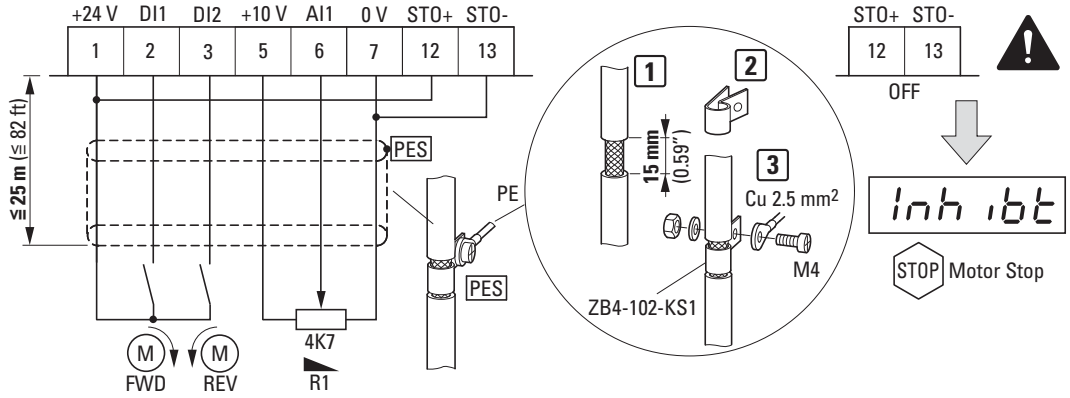


Figure 82: Simple connection example

Prevent the shielding from unbraiding, i.e. by pushing the separate plastic covering over the end of the screen or by pushing a rubber grommet on the end of the screen.

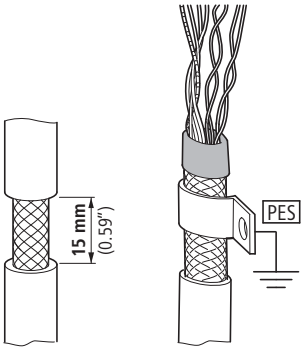


Figure 83: Preventing the screen from becoming unbraided

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

Prevent the screen from becoming unbraided at the other end of the control cable, e.g. 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.

3.6.2.5 Digital input signals

Control signal terminals 2, 3, 4, 6 and 10 all have the same function and mode of operation as digital inputs (DI1 to DI5).

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

- 8 - +30 V = High (logic "1")
- 0 - +4 V = Low (logic "0")
- Typical input current: ~ 4 mA
- Signal common 0 V (control signal terminal 7 or 9)

The internal control voltage from control signal terminal 1 (+24 V) or an external voltage source (+24 V) can be used for this.

By default (with the unit as supplied), the control signal terminals for the digital input signals will be assigned as follows:

- Control signal terminal 2 as digital input 1 (DI1) = FWD (clockwise rotating field enable signal)
- Control signal terminal 3 as digital input 2 (DI2) = REV (counterclockwise rotating field enable signal)
- Control signal terminal 4 as digital input 3 (DI3) = Switch-over from f-setpoint to fixed frequency (f-Fix1, f-Fix2),
- Control signal terminal 6 as analog input 1 (AI1) = analog setpoint value f-setpoint,
- Control signal terminal 10 as digital input 5 (DI5), switchable between f-Fix1 and f-Fix2.

→ The setting (digital/analog) for terminals 6 and 10 will be configured automatically based on the function selection with parameter P1-13.

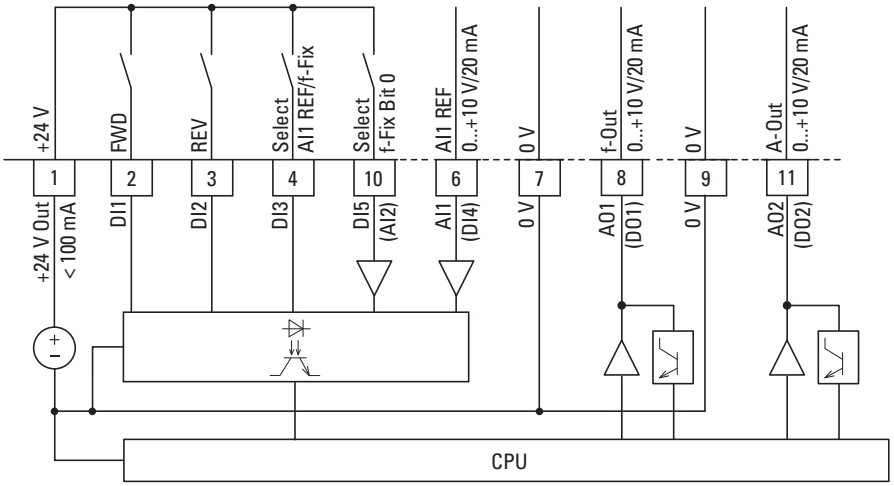


Figure 84: Control signal terminals (digital / analog)

3.6.2.6 Analog input signals

Depending on how parameters P1-12 and P1-13 are set, control signal terminals 6 (AI1) and 10 (AI2) can be connected to analog signals (→ figure 84):

- 0 - +10 V
- 0 - 10 V with scaling and operating direction change
- 0 - 20 mA
- 4 - 20 mA or 20 - 4 mA with cable breakage monitoring (< 3 mA)

→ Control signal terminals 7 and 9 are the common 0 V reference potential for all analog and digital signals.

3.6.2.7 Analog output signal

Analog signals are available at control signal terminals 8 and 11 (→ figure 84). These outputs can handle a maximum load of 20 mA. The output signals can be selected using parameters P2-11 (AO1) and P2-13 (AO2). Parameters P2-12 (AO1) and P2-14 (AO2) are used to configure the formats for the analog inputs:

Parameter value	Output signal
0	0 - 10 V
1	10 - 0 V
2	0 - 20 mA
3	20 - 0 mA
4	4 - 20 mA
5	20 - 4 m A

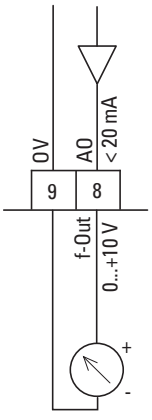


Figure 85: Analog output (AO)

→ Control signal terminals 7 and 9 are the common 0 V reference potential for all analog and digital signals.

By default, the speed/frequency (AO1) and the output current (AO2) will be displayed.

3.6.2.8 Digital output (Transistor)

Control signal terminals 8 and 11 (→ figure 84) are configured as analog outputs (AO) by default. Parameters P2-11 and P2-13 can be used to configure them as digital outputs (DO) instead.

The Transistor outputs DO1 (terminal 8) and DO2 (terminal 11) switch the device-internal control voltage (+24 V) as a digital signal.
The maximum permitted load current is 20 mA.

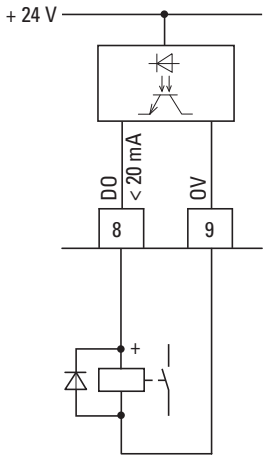


Figure 86: Connection example (coupling relay with free-wheeling diode:ETS4-VS3; article no. 083094)

→ Control signal terminals 7 and 9 are the common 0 V reference potential for all analog and digital signals.

3.6.2.9 Relay output

DA1 variable frequency drives feature two relays with dry contacts.

Relay K1:
control signal terminals 14 (change-over), 15 (closer) and 16 (opener)
Default setting: 1 = Standby/error (Error)

Relay K2:
control signal terminals 17 and 18 (closer)
Default setting: 0 = Drive running (RUN)

The relay function can be configured using parameters P2-15 and P2-18.

The electrical connection specifications for control signal terminals or relay contacts are:

- 250 V AC, maximum 6 A
- 30 V DC, maximum 5 A

We recommend connecting any connected loads as follows:

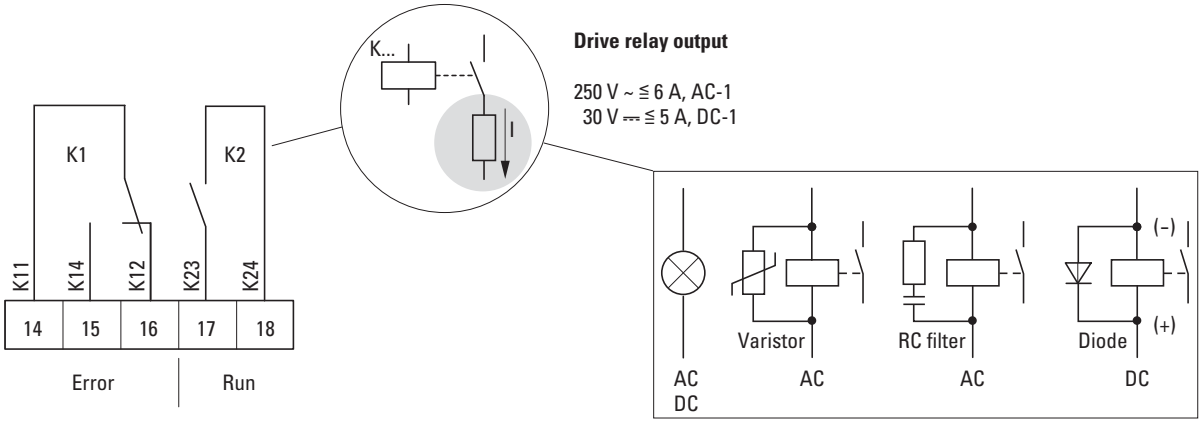


Figure 87: Connection examples with suppressor circuit

3.6.2.10 External control voltage

An external power supply unit can be used to supply the DA1 variable frequency drive's control section with 24 V DC.

DA1	External control voltage
Terminal 1	+24 V
Terminal 7, 9	0 V

The external control voltage (+24 V) should be able to handle a load of at least 100 mA.
The residual ripple of this external control voltage must be less than ±5 % $\Delta U_a/U_a$.

If the control section is powered with an external power supply unit, the control section, the control signal terminals, and the RJ45 interface will be active.

You will be able to do the following:

- Change parameters (but not save them)
- Read readings and error registers
- Address and read parameters via the RJ45 interface, the drivesConnect parameter configuration program, field buses, and SmartWire-DT
- Control level functions are controlled without the power section being powered.
- A fieldbus communication is maintained, even if there is no power supply.

3.6.2.11 RJ 45 interface

The RJ45 interface of the DA1 allows a direct connection to communication assemblies and fieldbus switch-ons.

The internal RS485 switch-on transfer Modbus RTU and CANopen and can also communicate via OP-Bus with other PowerXL components.

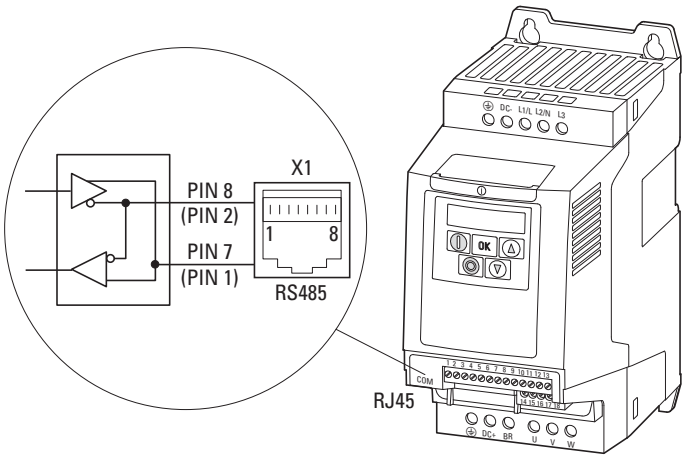


Figure 88: RJ45 interface (example: location on FS2 frame size)

DA1 variable frequency drives have no internal bus termination resistor. – Use EASY-NT-R if necessary.

3.6.2.12 IP66, control signal terminals (DA1-…-A6SC)

On DA1 variable frequency drives with IP66 protection and local controls (DA1-…A6SC), the control signal terminals will be partially wired.

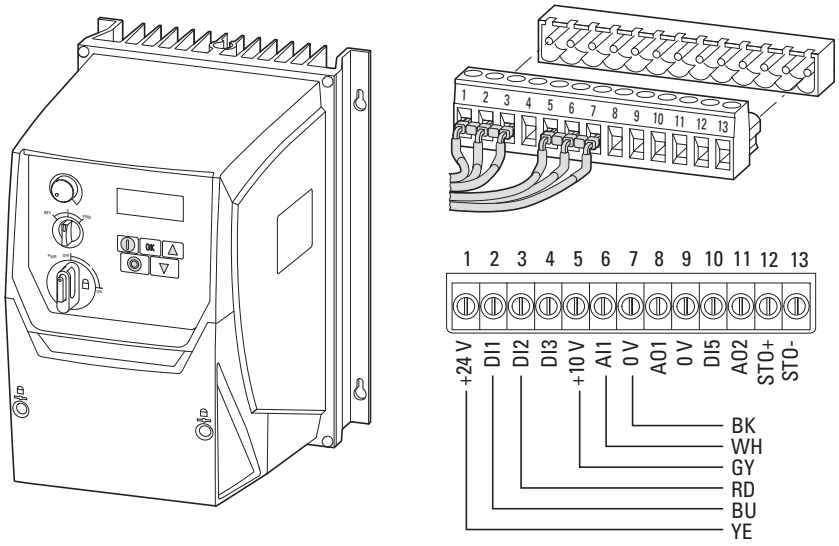


Figure 89: DA1-…-A6SC (factory connection)

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

Table 17: 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	GY (gray)	+10 V to potentiometer
6	WH (white)	From potentiometer = f-Set
7	BK (black)	From potentiometer = 0 V

→ For the enable signal for operation, you will also need to install an insulated wire jumper from terminal 1 to terminal 12 (STO+) and a link from terminal 13 (STO-) to terminal 9 or 7 (→ figure 80, page 112).

3.7 Block diagrams

The following block diagrams show all the connection terminals on a DA1 variable frequency drive and their functions when in their default settings.

An external 24 V power supply can be connected to control signal terminals 1 (+24 V) and 7 or 9 (0 V).

3.7.1 DA1-…-A20C

Type	Mains		Motor	
	Voltage U_{LN}	Frequency f_{LN}	Voltage U_2	Frequency f_2
DA1-12-…-A20C	1~ 200 V (-10%) - 240 V (+10%)	50/60 Hz	3~ 230 V	0 - 500 Hz
DA1-32-…-A20C	3~ 200 V (-10%) - 240 V (+10%)	50/60 Hz	3~ 230 V	0 - 500 Hz
DA1-34-…-A20C	3~ 380 V (-10%) - 480 V (+10%)	50/60 Hz	3~ 400 V/ 460 V	0 - 500 Hz
DA1-35-…-A20C	3~ 500 V (-10%) - 600 V (+10%)	50/60 Hz	3~ 500 V/ 575 V	0 - 500 Hz

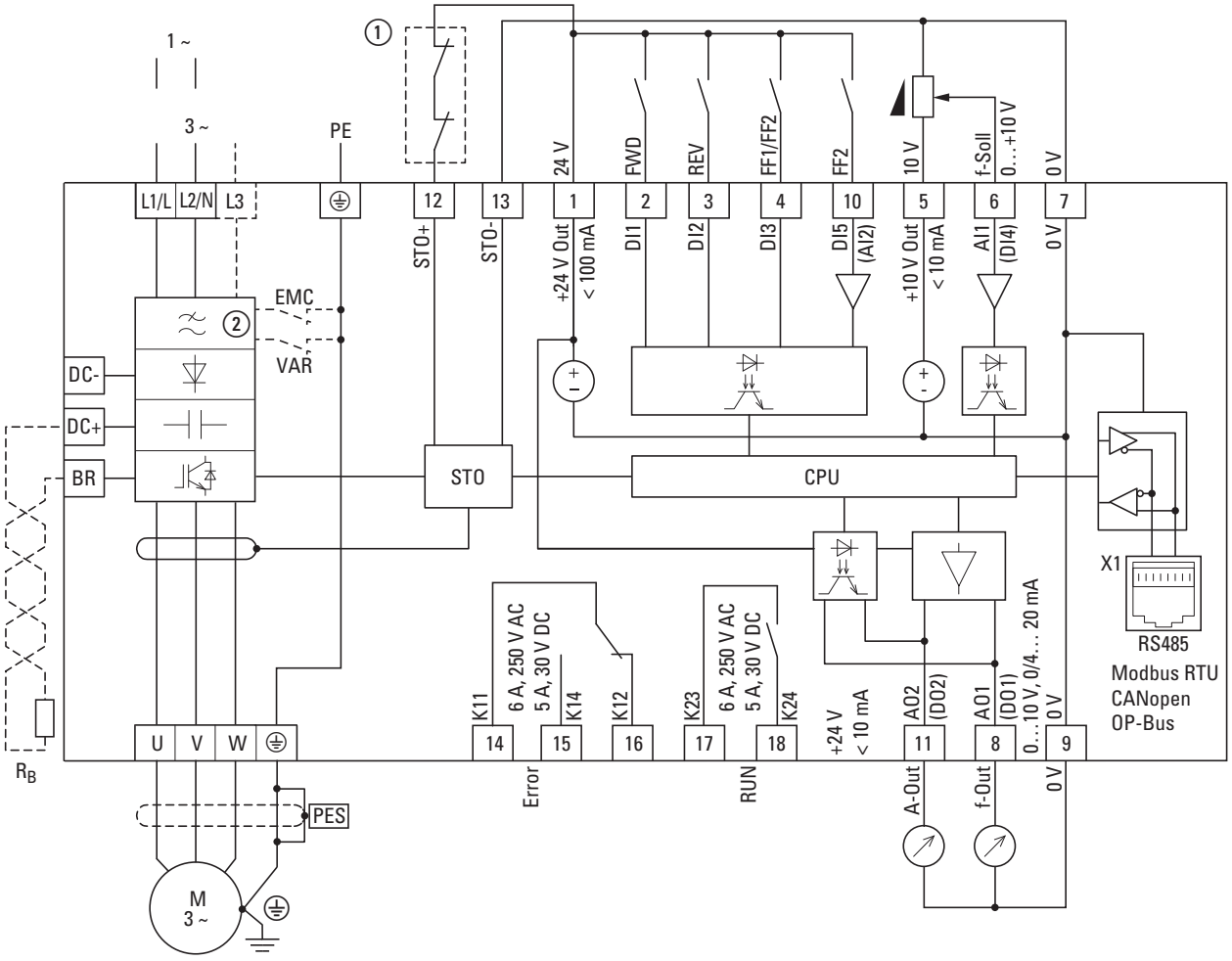


Figure 90: DA1- A20C block diagram in frame sizes FS2 and FS3

① Relay: Safe Torque Off (STO), SIL 2 (EN 61800-5-2)

② The RFI filter is not contained in the DA1-35-…-B6XC device.

→ The STO connection must be made by the user.

→ The VAR screw cannot be disabled with devices in sizes FS4 and FS5.

3.7.2 DA1-…-B55C

Type	Mains		Motor	
	Voltage U_{LN}	Frequency f_{LN}	Voltage U_2	Frequency f_2
DA1-32-…-B55C	3~ 200 V (-10%) - 240 V (+10%)	50/60 Hz	3~ 230 V	0 - 500 Hz
DA1-34-…-B55C	3~ 380 V (-10%) - 480 V (+10%)	50/60 Hz	3~ 400 V/ 460 V	0 - 500 Hz
DA1-35-…-B55C	3~ 500 V (-10%) - 600 V (+10%)	50/60 Hz	3~ 500 V/ 575 V	0 - 500 Hz

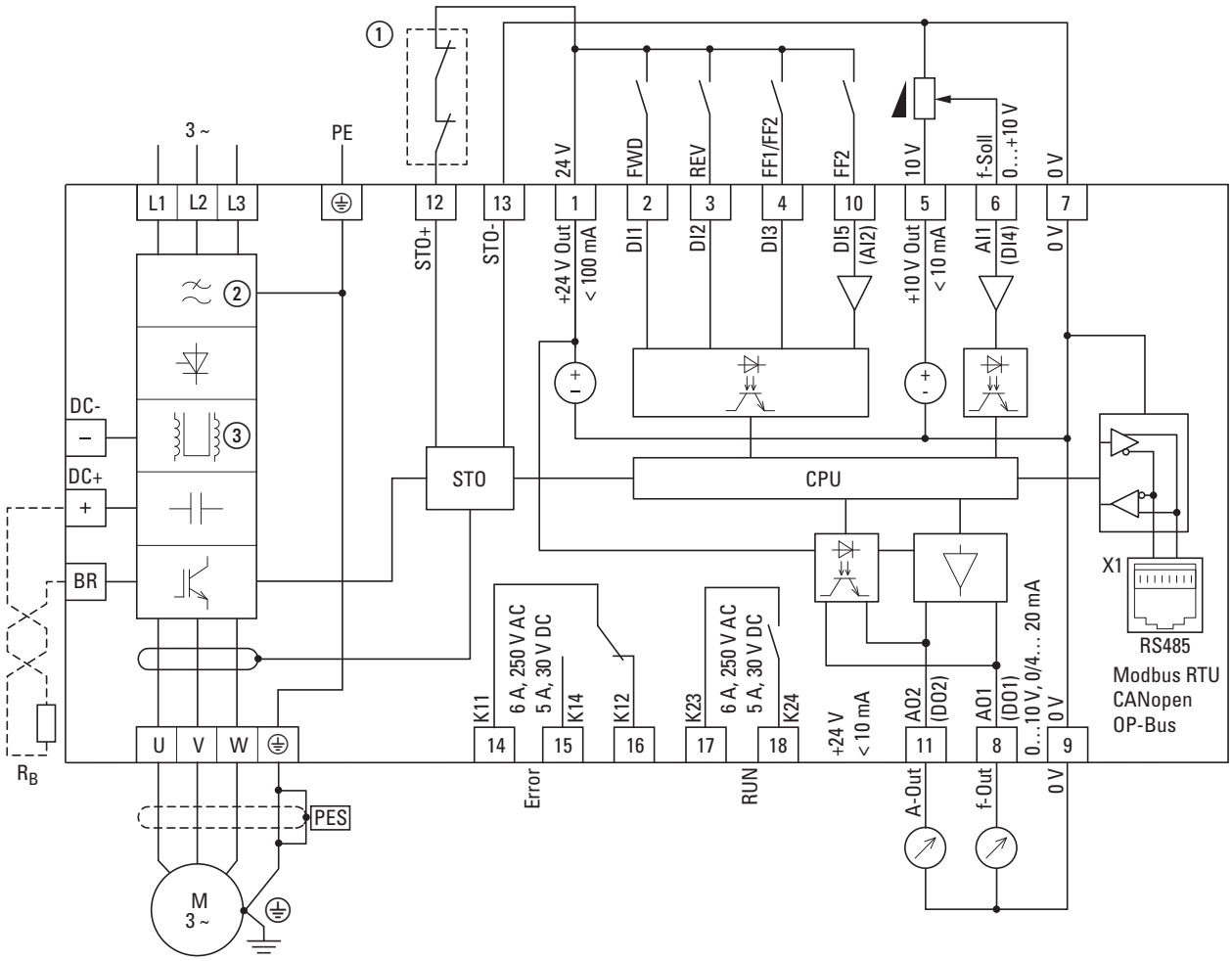


Figure 91: DA1-…-B55C block diagram

① Direct enable of the STO function or relay: Safe Torque Off (STO), SIL 2 (EN 61800-5-2)

② The RFI filter is not contained in the DA1-35-…-B6XC device.

③ A DC link choke is contained in sizes FS5, FS6, FS7.

→ The STO connection must be made by the user.

→ The VAR screw cannot be disabled with devices in sizes FS4, FS5, FS6 and FS7.

3.7.3 DA1-34370…, DA1-34450…

Type	Mains		Motor	
	Voltage U_{LN}	Frequency f_{LN}	Voltage U_2	Frequency f_2
DA1-34…	3~ 380 V (-10%) - 480 V (+10%)	50/60 Hz	3~ 400 V/ 460 V	0 - 500 Hz

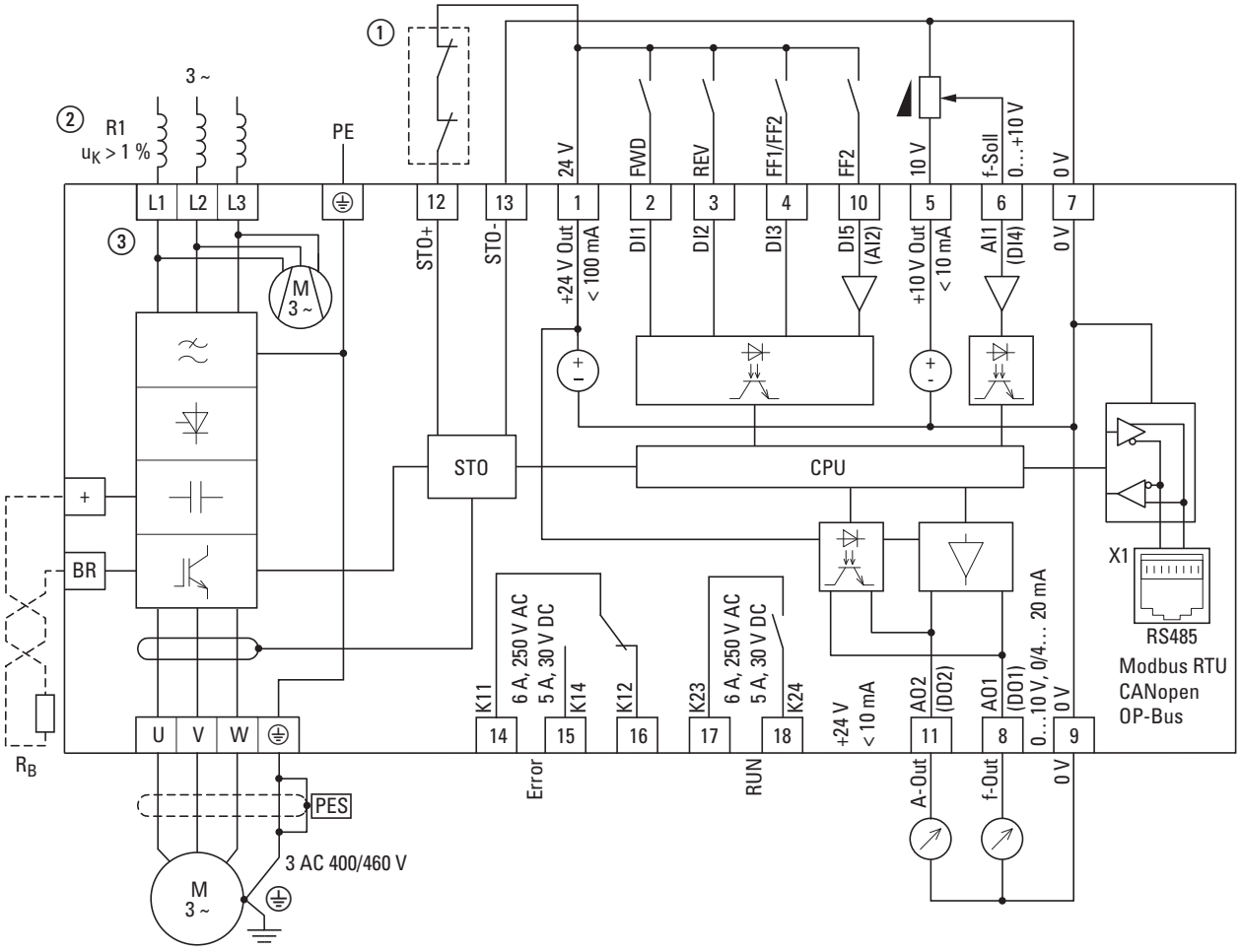


Figure 92: DA1-34… block diagram in size FS8

① Relay: Safe Torque Off (STO), SIL 2 (EN 61800-5-2)

② If there is no guarantee that the system percentage impedance is greater than or equal to 1 %, a mains choke must be connected. Your u_K value should fall between 1 % and 4%.

③ Check phase sequence L1–L2–L3 (rotary field direction). With an incorrect phase sequence, the error message *FAn-F* is displayed.

→ The STO connection must be made by the user.

→ The VAR screw cannot be disabled with devices in sizes FS8.

3.7.4 DA1-…-B6SC

Type	Mains		Motor	
	Voltage U_{LN}	Frequency f_{LN}	Voltage U_2	Frequency f_2
DA1-12-…-B6SC	1~ 200 V (-10%) - 240 V (+10%)	50/60 Hz	3~ 230 V	0 - 500 Hz
DA1-32-…-B6SC	3~ 200 V (-10%) - 240 V (+10%)	50/60 Hz	3~ 230 V	0 - 500 Hz
DA1-34-…-B6SC	3~ 380 V (-10%) - 480 V (+10%)	50/60 Hz	3~ 400 V/ 460 V	0 - 500 Hz
DA1-35-…-B6SC	3~ 500 V (-10%) - 600 V (+10%)	50/60 Hz	3~ 500 V/ 575 V	0 - 500 Hz

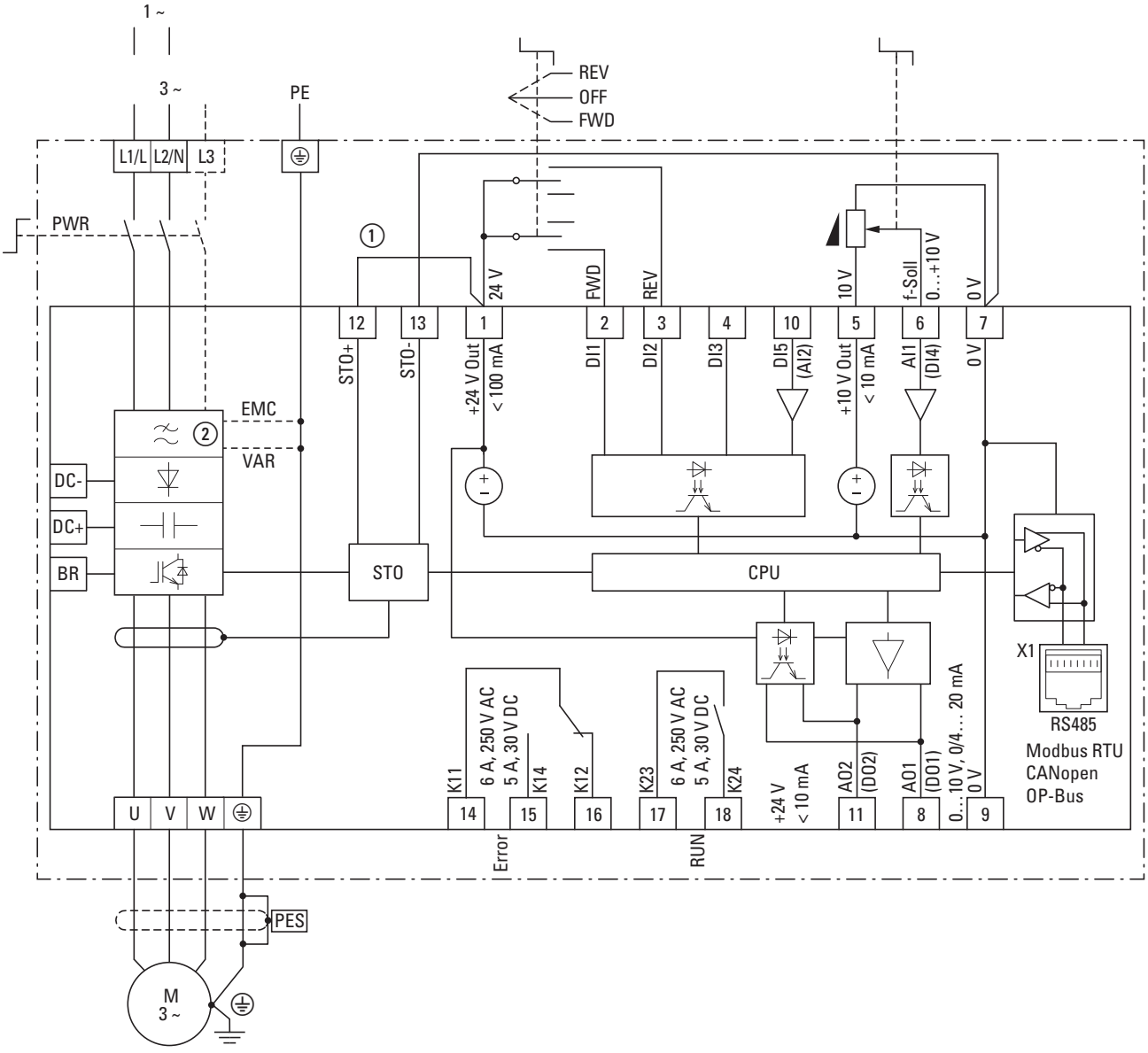


Figure 93: DA1-…-B6SC block diagram

① Direct enable of the STO function or relay: Safe Torque Off (STO), SIL 2 (EN 61800-5-2) as in → figure 91, page 124

② The RFI filter is not contained in the DA1-35-…-B6XC device.

→ The STO connection must be made by the user.

3.8 Insulation testing

The variable frequency drive of the DA1 series are tested, delivered and require no additional testing.

CAUTION

No leakage resistance tests are to be performed with an insulation tester on the control signal and the connection terminals of the variable frequency drive.

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 frequency 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 frequency drive and from the motor (U, V, W).
  Measure the insulation resistance of the motor 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 mains cable insulation

- Disconnect the mains cable from the power supply network and from connection terminals L1/L, L2/N and L3 of the variable frequency 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

- Separate the motor cable from the motor (U, V, W) and open the bridge circuit (star or delta) in the motor terminal box.
  Measure the insulation resistance of the individual motor windings. 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.

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

3.9 Protection against electric shock

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

Manufacturer's declaration for the initial verification as per IEC/HD 60364-6

Fault protection as per IEC/HD 60364-4-41 (DIN VDE 0100-410 (VDE 0100-410)) for the circuit on the output side of the aforementioned equipment is ensured based on the following requirements:

- 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 ground, the aforementioned equipment reduces the output voltage within the times as per Table 41.1 or otherwise within 5 seconds – whichever applies – in accordance with IEC/HD 60364-41 (DIN VDE 0100-410; VDE 0100-410):2007-06).

4 Operation

4.1 Checklist for commissioning

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

No.	Activity	Note
1	Mounting and wiring have been carried out in accordance with the corresponding instructional leaflet (→ IL04020010Z, IL040049ZU, IL04020012Z, IL04020011Z, IL04020015Z).	
2	Potential wiring and line section leftovers, as well as all the tools used, have been removed from the variable frequency drive's proximity.	
3	All terminals in the power section and in the control section have been tightened with the specified torque.	
4	The lines connected to the output terminals of the variable frequency drive (U/T1, V/T2, W/T3, DC+, DC-, BR) are**not** short-circuited and **not connected** to ground (PE).	
5	The variable frequency drive has been grounded 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 protection level and have been dimensioned in line with the corresponding requirements. The device fan in frame size FS8 requires a connection with the correct phase sequence (L1–L2–L3). – check the direction of the airflow.	
7	Each individual phase of the supply voltage (L or L1, L2, L3) is protected with a fuse.	
8	The variable frequency drive and the motor are matched to the mains voltage. (→ section 1.4.1, "Rated operational data on the rating plate", page 15, 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 frequency drive and the motor.	
10	All connected control cables comply with the corresponding stop conditions (e.g., 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 (→ section 2.10, "STO function", page 68) are in an appropriate condition.	

4.2 Operational hazard warnings

Please observe the following notes.

DANGER

Commissioning is to be completed by qualified technicians only.

DANGER

Dangerous electrical voltage!

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

DANGER

The components in the variable frequency 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 mains voltage. There can be a dangerous voltage on the relay terminals (10, 11) even if the variable frequency drive is not being supplied with mains voltage (e.g., integration of relay contacts in control systems with voltage > 48 V AC/60 V DC).

DANGER

The components in the variable frequency drive's power section remain energized up to five 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 P2-36).

WARNING

Any contactors and switching devices on the mains side are not to be opened during motor operation.
Push-to-run 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.
Push-to-run operation of the motor with contactors and switching devices in the output of the variable frequency drive is not permissible.

WARNING

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

→ 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.

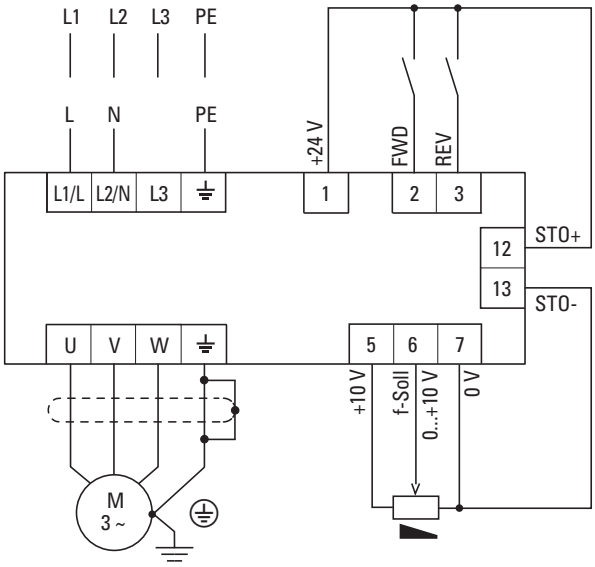
4.3 Commissioning with control signal terminals (default settings)

The controls on DA1 variable frequency drives are pre-wired at the factory; however, the STO inputs need to be wired. After the mains voltage and the rated motor are connected, the DA1 variable frequency drive can be started with the local controls (see following connection example).

→ You can skip this section if you want to set up the parameters directly for optimal operation of the variable frequency drive based on the motor data (rating plate) and the application.

The following shows a simplified connecting example of a connection with default settings.

Connection example for three-phase motor



Connection example for three-phase motor	Terminal	Name	
	L1/L	Single-phase mains connection (DA1-12…)	Three-phase mains connection(DA1-3…)
	L2/N		
	L3	–	
	⏚	Ground connection	
	1	Control voltage +24 V (output, maximum 100 mA)	
	2	FWD, Start enable clockwise rotating field	
	3	REV, Start enable left rotating field	
	U	Connection for three-phase ac motor (three-phase motor)	
	V		
	W		
	⏚		
	5	Control voltage +10 V (output, maximum 10 mA)	
	6	Frequency reference value f-Set (Input 0 – +10 V)	
	7	Reference potential (0 V)	
	12	Safe Torque Off +	
	13	Safe Torque Off -	

▶ For simple commissioning with the preset default settings, connect the variable frequency drive as shown in the connection example above.

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

Make sure that the enable contacts (FWD/REV) are open and the STO is connected correctly before switching on the mains voltage.

→ If the connections for the setpoint value potentiometer cannot be clearly allocated with terminals 5, 6 and 7, you should set the potentiometer to about 50 % before giving the start enable (FWD/REV) for the first time.

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 DC link will be used to generate the control voltage and light up the 7-segment LED display (STOP).

At this point, the variable frequency drive will be ready for operation (correct operating status) and in Stop mode.

The start enable is done by actuating one of the digital inputs with +24 V:

- Terminal 2: FWD = Clockwise rotating field (Forward Run)
- Terminal 3: 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 for 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). The output frequency will then be changed after a delay according to the specified acceleration and deceleration times. In the default settings, these times are set to 5 seconds each, from frame size FS4, they are set to 10 seconds each.

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

If the release signal (FWD, REV) is switched off during operation, the inverter is blocked immediately (STOP) and the output frequency is set to 0.
The motor runs down unguided (see ① in figure 94).
The acceleration time is set in parameter P1-03.

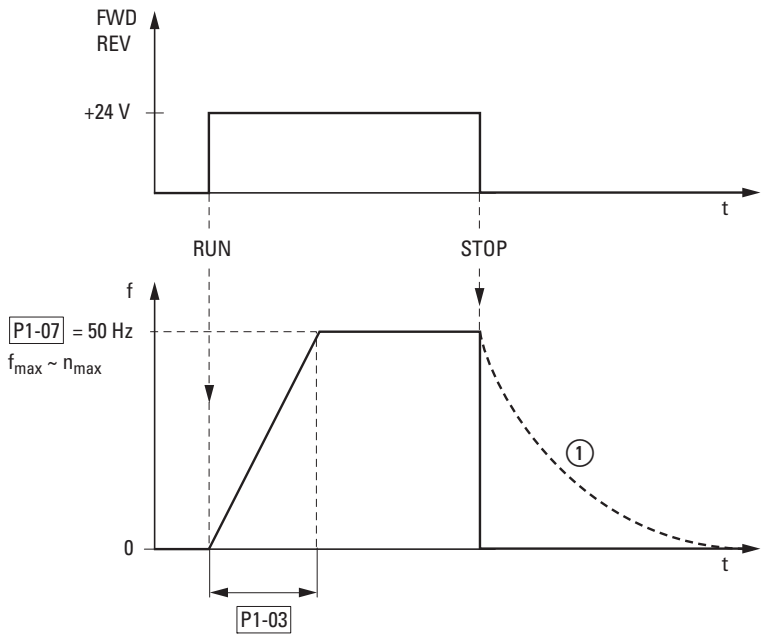


Figure 94: Start-Stop command with maximum reference voltage

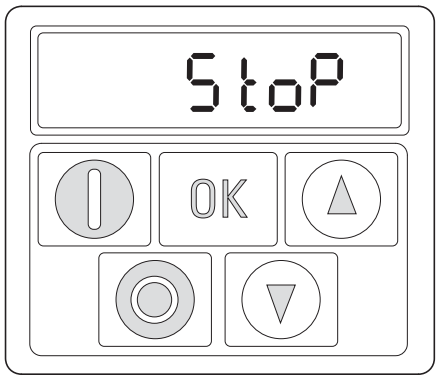
4.4 Using the operating unit

The operating unit can be used to configure the DA1 variable frequency drive's parameters and monitor its operation.

→ The configuration of the individual parameters is described in the manual MN04020006Z, "DA1 Variable Frequency Drive DA1 – Parameter Manual".

4.4.1 Operating unit elements

The following figure shows the elements of the DA1 variable frequency drive integrated operating unit.



Display (7-segment LEDs)

Pushbuttons

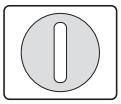
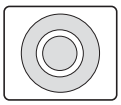
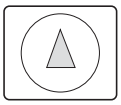
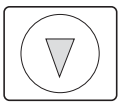
Figure 95: Operating unit view (example DA1-…-A20C)

→ The integrated operating unit on DA1-…-A20C devices and the (optional) external DX-KEY-LED2 keypad feature a six-digit 7-segment LED display.
Meanwhile, DA1-…-B20C, DA1-…-B55C devices and the (optional) external DX-KEY-OLED operating unit feature a multi-language clear text display (OLED = organic light-emitting diode display). The function keys work in the exact same way.
With the external DX-KEY-OLED operating unit, two additional keys (**Hand**, **Auto**) are available. By default, these buttons do not do anything, and can be configured (freely) only in the PLC editor.

→ 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.

→ The **START**, **STOP**, **UP** keys and **DOWN** must be activated in parameter P1-12 (local process data source).

Table 18: Keypad elements – Buttons

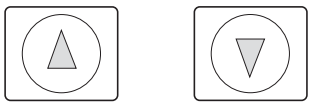
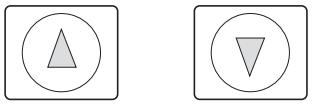
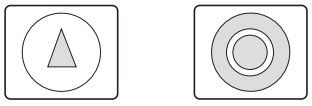
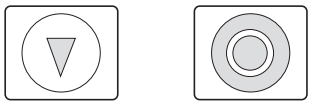
Button	Command	Explanation
	**OK**	• Navigating in parameter mode • Opens and closes the parameter interface(press the button and hold it down for more than two seconds) • Saves parameter changes • Changes the value being displayed: A, rpm, etc. (real-time information)
	**START**	• Starts the variable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

Notes:

1) P1-12 = 1 (one operating direction) or P1-12= 2 (two operating directions); The operating direction will be reversed when the START button is pressed
2) Only if P1-12 = 2

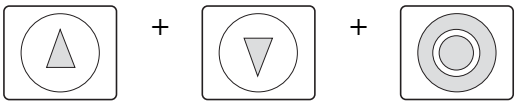
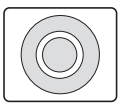
4.4.2 Setting parameters

Table 19: 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).
	**Switching between two parameter groups** The parameters are in sequential order. This means: Moving forward from the last parameter in a parameter group will take you to the first parameter in the next parameter group and the other way around. **Note:** To access the extended parameter groups, you will need to enter the corresponding password in parameter P1-14 (default passwords: level 2 = 101, level 3 = 201). Press the ▲ and **STOP** buttons to jump to the first parameter in the next parameter group.
	Press the ▼ and **STOP** buttons to jump to the first parameter in the previous parameter group.

4.4.3 Resetting Parameters (RESET)

Table 20: 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 showP-dEF.
Resetting after an error	
	Press the **STOP** button to reset after an error message. The display will show StoP.

5 Error messages

5.1 Introduction

The DA1 variable frequency drives have several internal monitoring functions.
When a discrepancy from the proper operating conditions is detected, an error message is displayed; the factory settings cause the relay contact to open (control signal terminals 14 and 15).

5.1.1 Error messages

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). The error messages can be read under monitor parameter P0-13.
The values are not deleted when there is a reset to factory settings !

5.1.2 Acknowledge error (Reset)

To acknowledge and reset the current error message, you can either switch off the supply voltage or press the STOP pushbutton. Error messages can also be reset with an additional positive edge at control signal terminal 2 (DI1) or 3 (DI2) (new start signal).

If parameter P2-36 is set from 2 (Auto-1) to 6 (Auto-5), the variable frequency drive tries to restart automatically up to five times.

5.1.3 Error list

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

Table 21: List of error messages

Message	Error no.	Possible cause and remedy
StoP	–	Ready to start. There is no drive enable signal present. There is no error message present.
Inh ibt	–	STO inputs (terminals 12 and/or 13) de-energized • Safety relay switched off • Voltage source overloaded Consequence: The drive is disabled.
no-FLt	00	Shown for P0-13 if there are no messages in the error register.
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 resistor value is not lower than the minimum permissible braking resistor value.
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 frequency drive output Occurs right after switching on the unit: • Check the cable connection between the inverter 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 this has been triggered. • 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 mode (P4-01 = 0 or 1): Check whether the value cos φ (P4-05) has been entered correctly and a motor identification run has been successfully performed. • Increase the acceleration ramp time (t-acc, P1-03) if necessary. • With speed control (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.

Message	Error no.	Possible cause and remedy
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 mode (P4-01 = 0 or 1): Check whether the value cos φ (P4-05) has been entered correctly and a motor identification run has been successfully performed. • Check the motor's connection configuration (e. g., 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 frequency drive and switch the variable frequency 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.
O.Volt	06	Overvoltage in DC link The DC link voltage value can be viewed using parameter P0-20. P0 contains an error register with the last values before the unit was switched off -36 (scan time: 256 ms). • Check to make sure that the supply voltage falls within the range for which the variable frequency drive is sized. • If the error occurs during deceleration or stopping: Extend delay ramp (P1-04/P2-25) or use a brake resistor. • In vector mode (P4-01 = 0 or = 1): Reduce the speed controller's amplification (P4-03). • When using the PID controller: By reducing P3-11 (PID1 error ramp), ensure that the ramps are active.
U.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 has dropped. 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 frequency drive's feeder circuit (circuit-breaker, contactor, choke, etc.) to make sure they are connected properly and have the correct contact resistance.

Message	Error no.	Possible cause and remedy
O-t	08	Over-temperature at heat sink. The drive is too hot. The heat sink temperature can be viewed by using P0-21. P0-38 contains an error register with the last values before the unit was switched off (scan time: 30 s). • Check to make sure that the variable frequency 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 frequency drive). • Improve the ventilation in the control cabinet if necessary: The ventilation vent on the device must not be blocked, e.g., by dirt or due to devices being installed too closely together. • Reduce the switching frequency with P2-24. • If possible reduce the load.
U-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: The drive can then be reconfigured:
E-tr iP	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 frequency drive. • If a thermistor is connected to terminal 10, check whether the motor is too hot.
SC-0bS	12	Communication fault with an external operating unit or with a PC. • Check connections.
FLt-dc	13	Excessively high ripple on DC link voltage The DC link voltage ripple can be viewed using P0-16. P0 contains an error register with the last values before the unit was switched off -37 (scan time: 20 ms). • Check to make sure that all the mains supply phases are present and that their voltage balance falls within the permissible tolerance range (3 %). • If possible reduce the load. • If the fault persists, please contact your nearest Eaton sales branch.
P-LOSS	14	Incoming power phase failure (only for devices with a three-phase power supply)
h O-I	15	Overcurrent at output • See Error no. 03.
th-FLt	16	Malfunctioning heat sink thermistor. • Please contact your nearest Eaton 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 Eaton 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 4-20mA: Check setpoint value connection for wire breakage.
dAtA-E	19	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 Eaton sales branch.

Message	Error no.	Possible cause and remedy
U-dEF	20	The customer's settings for the parameters have been imported. • Press the STOP button.
F-PtC	21	Motor PTC thermistor over-temperature
FAn-F	22	The device's internal fan is experiencing a fault For frame size FS8: Incorrect rotation direction of the device fan • Check the supply voltage phase sequence (L1–L2–L3).
O-hEAt	23	The measured ambient temperature exceeds the specified value. • Check the device's internal fan. • Make sure that the required clearance around the device is being maintained and that cooling air can flow through the vents on the device unimpeded. • Reduce the switching frequency with P2-24. • If possible: Reduce load.
O-torq	24	Maximum permissible torque exceeded. • If possible: Reduce the load or increase acceleration time t-acc.
U-torq	25	Only active if brake control is enabled in hoisting gear mode (P2-18= 8). The torque produced before the hoisting gear's mechanical brake is enabled falls below the set threshold.
OUt-F	26	Device output fault • Please contact your nearest Eaton sales branch.
Sto-F	29	Internal STO circuit fault • Please contact your nearest Eaton sales branch.
Enc-01	30	No communication between the encoder module and the variable frequency drive. • Check to make sure that the module is correctly plugged in and secured.
Enc-02 SP-Err	31	The calculated motor speed is different from the measured motor speed. • Check the encoder connection, including the corresponding shielding. • Increase the value of P6-07 if necessary.
Enc-03	32	The motor speed and the PPR value entered in P6-06 do not match. The PPR value in P6-06 must be at least 60. • Check the speed entered in P1-10.
Enc-04	33	Channel A fault: Usually a bad connection. • Check wiring.
Enc-05	34	Channel B fault Usually a bad connection. • Check wiring.
Enc-06	35	Error on channels A and B Usually a bad connection. • Check wiring.
AtF-01	40	Motor identification failed: The measured stator resistance varies between the phases. • Make sure that the motor is connected properly and working correctly. • Check the motor windings to make sure they have the same resistance values.
AtF-02	41	Motor identification failed: The measured stator resistance is too large. • Make sure that the motor is connected properly and working correctly. • Check to make sure that the device's rated output matches the motor's rated output. The difference should not exceed one full output class.

Message	Error no.	Possible cause and remedy
AtF-03	42	Motor identification failed: The measured motor inductance is too low. • Make sure that the motor is connected properly and working correctly.
AtF-04	43	Motor identification failed: The measured motor inductance is too high. • Make sure that the motor is connected properly and working correctly. • Check to make sure that the device's rated output matches the motor's rated output. The difference should not exceed one full output class.
AtF-05	44	Motor identification failed: The measured motor parameters do not match. • Make sure that the motor is connected properly and working correctly. • Check to make sure that the device's rated output matches the motor's rated output. The difference should not exceed one full output class.
OUt-Ph	49	A phase in the motor cable is not connected or is broken.
Sc-F01	50	No valid Modbus frame was received within the time specified in P5-06. • Check to make sure that the network master is working correctly. • Check connecting cables. • Increase the value of P5-06 to an acceptable value.
Sc-F02	51	No valid CANopen frame was received within the time specified in P5-05. • Check to make sure that the network master is working correctly. • Check connecting cables. • Increase the value of P5-05 to an acceptable value.
Sc-F03	52	Communications between the device and the plugged-in field bus option have dropped out. • Check to make sure that the module is installed properly.
Sc-F04	53	Communications between the device and the plugged-in I/O expansion have dropped out. • Check to make sure that the module is installed properly.
OF-01	60	No internal connection to an optional card
OF-02	61	Optional module in undefined operating state
PLC-01	70	Non-supported function block from function block editor
PLC-02	71	Program from function block editor is too big
PLC-03	72	Division by zero
PLC-04	73	Lower limit is higher than upper limit
PLC-05	74	Overflow table Function block editor

6 Specifications

6.1 General rating data

Specifications	Symbol	Unit	Value
General			
Standards			EMC: EN 61800-3:2004+A1-2012 Radio frequency interference: EN 55011: 2010 Safety: EN 61800-5 : 2007 Protection type: EN 60529: 1992 **Note:** DA1-35 … series devices are not covered by the EU-EMC Directive declaration of conformity.
Certifications and manufacturer's declarations on conformity			CE, UL, cUL, c-Tick, UkrSEPRO, Gost-R **Note:** At the time of writing frame size FS8 is not UL or cUL Certification.
Production quality			RoHS, ISO 9001
Climatic proofing	ρ_w	%	< 95 %, mean relative humidity (RH), non-condensing (EN 50178)
Ambient temperature range			
Operation			
IP20 (NEMA 0)	ϑ	°C	-10 - +50 (frost-free and condensation-free)
IP55 (NEMA 3)	ϑ	°C	-10 - +40, with derating of 1.5 % pro °C above 40 °C on rated operational current I_e **Note:** Operation within a temperature range of 40 to 50 °C does not conform to UL Certification.
IP66 (NEMA 4X)	ϑ	°C	-10 - +40, with derating of 2.5 % pro °C above 40 °C on rated operational current I_e **Note:** Operation within a temperature range of 40 to 50 °C does not conform to UL Certification.
Storage	ϑ	°C	-40 - +60
$MTTF_d$		Years	4525
MTBF		Years	50
PFH_D			1.23 - 09 1/h (0.12 % SIL)
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

Specifications	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, 500 - 600 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, 500 - 600 V	U	kV	2.5
Radio interference class (EMC)			
Category and maximum screened motor cable length with integrated radio interference suppression filter			
C1	l	m	1
C2	l	m	5
C3	l	m	25
Installation position			Vertical
Installation altitude	h	m	0 - 1,000 above sea level, > 1,000 with 1 % load current reduction every 100 m, maximum 2,000 with UL approval, maximum 4,000 without UL approval
Protection type			IP20 (NEMA 0) IP55 (NEMA 3) IP66 (NEMA 4X)
Fan (built-in)			Yes
Busbar tag shroud			BGV A3 (VBG4, finger and back-of-hand proof)
Main circuit / power section			
Power supply			
Rated operating voltage			
DA1-12…	U_e	V	1~ 230 (200 V -10 % - 240 V +10 %)
DA1-32…	U_e	V	3~ 230 (200 V -10 % - 240 V +10 %)
DA1-34…	U_e	V	3~ 400 (380 V -10 % - 480 V +10 %)
DA1-35…	U_e	V	3~ 575 (500 V - 10 % - 600 V +10 %)
Mains frequency	f	Hz	50/60 ±10 %
Phase imbalance		%	max. 3
Maximum short-circuit current (supply voltage)	SCCR	kA	100 (according to IEC 60439-1)
Mains switch-on frequency			Maximum of once 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 V AC.

Specifications	Symbol	Unit	Value
Motor feeder			
Output voltage			
DA1-12…, DA1-32…, DA1-34…, DA1-35…	U_2	V	3~ 0 - U_e
rated motor power			
at 230 V, 50 Hz	P	kW	0.75 - 75
at 400 V, 50 Hz	P	kW	0.75 - 250
at 500 V, 60 Hz	P	kW	0.75 - 110
Output frequency			
Range, parameterizable	f_2	Hz	0 - 50/60 (max. 500 Hz)
Resolution	Δf	Hz	0.1
Rated operating current	I_e	A	IP20: 4.3 - 72 / 370 - 450 IP55: 24 -302 IP66: 4.3 -18
Overload current for 60 s every 600 s	I_L	%	150
Starting current for 4 s every 40 s	I_L	%	200
Motor cable length			
screened	l	m	100
unscreened	l	m	150
with motor choke	Δl	%	100 (increased maximum cable length)
Switching frequency (pulse frequency)	f_{PWM}	kHz	4 - 32 (double modulation) / 2 - 16 (effective) Maximum value depends on rating
Operating mode			V/Hz control, slip compensation, vector control
SLV, max. Speed error	Δn	%	±0.5
DC-braking			
Time before starting	t	s	0 - 25, in the event of a stop
Motor pick-up control function			Yes
Brake chopper			Yes
Braking current during continuous operation	I_{BR}	%	100 (I_e)
Maximum braking current	I_{BRmax}	%	150 for 60 s

Specifications	Symbol	Unit	Value
Control section			
Connection cross section (clampable)	A	mm^2	0.05 - 2.5 (30 - 12 AWG)
Control voltage			
Output voltage (control terminal 1)	U_C	V DC	24
Input voltage (control terminal 1)	U_C	V DC	18 - 30
Load rating (control terminal 1), maximum	I	mA	100
Reference voltage (control terminal 5)	U_S	V DC	10
Load rating (control terminal 5), maximum	I	mA	10
Digital input (DI)			
Number (configurable)			3 - 5
Logic (level)			Positive
Reaction time	t	ms	< 4
Input voltage range High (1)	U_C	V DC	8 - 30
Input voltage range Low (0)	U_C	V DC	0 - 4
Analogue input (AI)			
Number (configurable)			0 - 2
Resolution			12 Bit
Accuracy		%	< 1 full scale
Reaction time	t	ms	< 4
Input voltage range	U_{Ref}	V	0/-10 - +10, DC (R_i ~ 72 kΩ)
Input current range	I	mA	0/4 - 20 (R_B ~ 500 Ω)
Setpoint potentiometer (recomm. fixed resistance)	R	kΩ	1 -10
Relay output (K)			
Number of relays (contacts)			2 (1 N/O/1 changeover contact)
Switching capacity			
AC	I	A	6 (250 V)
DC	I	A	5 (30 V)
Digital/analog output (DO/AO)			
Number			2 (digital/analog)
Output voltage			
DO	U_{Out}	V DC	+24
AO	U_{Out}	V DC	0/-10 - +10
DO current carrying capacity	I_{out}	mA	< 20
AO resolution			12 Bit
Interface (RJ45)			OP bus, Modbus RTU, CANopen, (RS485)

Specifications	Symbol	Unit	Value
STO (Safe Torque Off)			
Voltage	U	V DC	+24 (18 - 30)
Current	I	mA	100
SIL category			2
PL			d

6.2 Specific rated operational data

6.2.1 DA1-12… series

Size		Symbol	Unit	4D3	7D0	011
Rated operational current		I_e	A	4.3	7.0	10.5
Overload current for 60 s every 600 s		I_L	A	6.45	10.5	15.75
Apparent power at rated operation [1]	230 V	S	kVA	1.71	2.79	4.18
	240 V	S	kVA	1.79	2.91	4.36
Rated motor output	230 V	P	kW	0.75	1.5	2.2
	230 V	P	HP	1	2	3
Power input side (primary side):						
Number of phases				single-phase or two-phase		
Rated voltage		U_{LN}	V	200 - 10 % - 240 + 10 %, 50/60 Hz (180 - 264 V ±0 %, 48 - 62 Hz ±0 %)		
Input current (phase current)		I_{LN}	A	8.5	15.2	19.5
Minimum braking resistor		R_B	Ω	100	50	35
Switching frequency (pulse frequency)						
Factory default setting		f_{PWM}	kHz	16	16	16
Settings range		f_{PWM}	kHz	4 - 32	4 - 32	4 - 32
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	2.49	2.49	2.49
Efficiency		η		0.94	0.96	0.95
Heat dissipation at I_e		P_V	W	45.75	63	103.4
Frame size				FS2	FS2	FS2

6.2.2 DA1-32… series

Size		Symbol	Unit	4D3	7D0	011	018	024	024
Rated operational current		I_e	A	4.3	7.0	10.5	18	24	24
Overload current for 60 s every 600 s		I_L	A	6.45	10.5	15.75	27	36	36
Apparent power at rated operation	230 V	S	kVA	1.71	2.79	4.18	7.17	9.56	9.56
	240 V	S	kVA	1.79	2.91	4.36	7.48	9.98	9.98
Rated motor output	230 V	P	kW	0.75	1.5	2.2	4.0	5.5	5.5
	230 V	P	HP	1	2	3	5	7.5	7.5
Power input side (primary side):									
Number of phases				three-phase					
Rated voltage		U_{LN}	V	200 V - 10 % - 240 V +10 %, 50/60 Hz (180 - 264 V ±0 %, 48 - 62 Hz ±0 %)					
Input current (phase current)		I_{LN}	A	5.1	8.3	12.6	21.6	29.1	29.1
Minimum braking resistor		R_B	Ω	100	50	35	20	20	20
Switching frequency (pulse frequency)									
Factory default setting		f_{PWM}	kHz	16	16	16	16	16	16
Settings range		f_{PWM}	kHz	4 - 32	4 - 32	4 - 32	4 - 32	4 -16	4 - 16
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	1.73	1.73	1.73	0.93	0.93	1.42
Efficiency		η		0.95	0.96	0.96	0.96	0.97	0.97
Heat dissipation at I_e		P_V	W	39.75	61.5	90.2	160	170.5	170.5
Frame size				FS2	FS2	FS2	FS3	FS3	FS4

DA1-32… series Size		Symbol	Unit	030	046	061	072	090	110
Rated operational current		I_e	A	30	46	61	72	90	110
Overload current for 60 s every 600 s at 50 °C		I_L	A	58.5	69	91.5	108	135	165
Apparent power at rated operation	230 V	S	kVA	15.5	18.3	24.3	28.7	35.9	43.8
	240 V	S	kVA	16.2	19.1	25.4	29.9	37.4	45.7
Rated motor output	230 V	P	kW	7.5	11	15	18.5	22	30
	230 V	P	HP	10	15	20	25	30	40
Power input side (primary side):									
Number of phases				three-phase					
Rated voltage		U_{LN}	V	200 V - 10 % - 240 V +10 %, 50/60 Hz (180 - 264 V ±0 %, 48 - 62 Hz ±0 %)					
Input current (phase current)		I_{LN}	A	36.4	55.8	70.2	82.9	103.6	126.7
Minimum braking resistor		R_B	Ω	22	22	12	12	6	6
Switching frequency									
Factory default setting		f_{PWM}	kHz	8	8	8	8	8	4
Settings range		f_{PWM}	kHz	4 - 24	4 - 24	4 - 24	4 - 24	4 -24	4 - 16
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	1.42	1.42	0.28	0.28	1.54	1.54
Efficiency		η		0.97 (IP55) 0.96 (IP20)	0.97	0.97	0.97	0.97	0.97
Heat dissipation at I_e		P_V	W	187.5 (IP55) 410 (IP20)	264	345	518	550	720
Frame size				FS4	FS4	FS5	FS5	FS6	FS6

DA1-32… series Size		Symbol	Unit	150	180	202	248
Rated operational current		I_e	A	150	180	202	248
Overload current for 60 s every 600 s		I_L	A	225	270	303	372
Apparent power at rated operation	230 V	S	kVA	59.8	71.7	80.5	98.8
	240 V	S	kVA	62.4	74.8	84	103.1
Rated motor output	230 V	P	kW	37	45	55	75
	230 V	P	HP	50	60	75	100
Power input side (primary side):							
Number of phases				three-phase			
Rated voltage		U_{LN}	V	200 V - 10 % - 240 V +10 %, 50/60 Hz (180 - 264 V ±0 %, 48 - 62 Hz ±0 %)			
Input current (phase current)		I_{LN}	A	172.7	183.3	205.7	255.5
Minimum braking resistor		R_B	Ω	6	6	6	6
Switching frequency (pulse frequency)							
Factory default setting		f_{PWM}	kHz	4	4	4	4
Settings range		f_{PWM}	kHz	4 - 12	4 - 8	4 - 16	4 - 12
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	1.54	1.54	2.74	2.74
Efficiency		η		0.97	0.98	0.98	0.98
Heat dissipation at I_e		P_V	W	814	945	1100	1425
Frame size				FS6	FS6	FS7	FS7

6.2.3 DA1-34… series

Size		Symbol	Unit	2D2	4D1	5D8	9D5	014	018	024
Rated operational current		I_e	A	2.2	4.1	5.8	9.5	14	18	24
Overload current for 60 s every 600 s		I_L	A	3.3	6.15	8.7	14.25	21	27	36
Apparent power at rated operation	400 V	S	kVA	1.52	2.84	4.02	6.58	9.7	12.5	16.6
	480 V	S	kVA	1.83	3.41	4.8	7.9	11.6	15	20
Rated motor output	400 V	P	kW	0.75	1.5	2.2	4.0	5.5	7.5	11
	460 V	P	HP	1	2	3	5	7.5	10	15
Power input side (primary side):										
Number of phases				three-phase						
Rated 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	2.4	5.1	7.5	11.2	19	22	28.9
Minimum braking resistor		R_B	Ω	400	200	150	100	75	50	40
Switching frequency (pulse frequency)										
Factory default setting		f_{PWM}	kHz	8	8	8	8	8	8	8
Settings range		f_{PWM}	kHz	4 - 32	4 - 32	4 - 32	4 - 32	4 -24	4 - 24	4 - 16
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	4.65	4.65	4.65	4.65	1.55	1.55	1.55
Efficiency		η		0.92	0.95	0.95	0.96	0.96	0.97	0.97
Heat dissipation at I_e		P_V	W	63.75	76.5	101.2	136	209	300	297
Frame size				FS2	FS2	FS2	FS2	FS3	FS3	FS3

DA1-34… series Size		Symbol	Unit	024	030	039	046	061	072	090
Rated operational current		I_e	A	24	30	39	46	61	72	90
Overload current for 60 s every 600 s		I_L	A	36	45	58.5	69	91.5	108	135
Apparent power at rated operation	400 V	S	kVA	16.6	20.8	27	31.9	42.3	49.9	62.4
	480 V	S	kVA	20	24.9	32.4	38.2	50.7	59.9	74.8
Rated motor output	400 V	P	kW	11	15	18.5	22	30	37	45
	460 V	P	HP	15	20	25	30	40	50	60
Power input side (primary side):										
Number of phases					three-phase					
Rated 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	28.9	37.2	47	52.4	66.1	77.3	92.2
Minimum braking resistor		R_B	Ω	40	22	22	22	12	12	6
Switching frequency (pulse frequency)										
Factory default setting		f_{PWM}	kHz	8	8	8	8	8	8	4
Settings range		f_{PWM}	kHz	4 - 16	4 - 24	4 - 24	4 - 24	4 - 24	4 -24	4 - 16
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	2.47	2.47	2.47	2.47	0.49	0.49	2.68
Efficiency		η		0.97	0.97	0.97	0.97	0.97	0.97	0.97
Heat dissipation at I_e		P_V	W	297	375	444	506	840	925	1080
Frame size				FS4	FS4	FS4	FS4	FS5	FS5	FS6

DA1-34… series											
Size		**Symbol**	**Unit**	**110**	**150**	**180**	**202**	**240**	**302**	**370**	**450**
Rated operational current		I_e	A	110	150	180	202	240	302	370	456
Overload current for 60 s every 600 s		I_L	A	165	225	270	303	360	453	555	675
Apparent power at rated operation	400 V	S	kVA	76.2	104	125	140	166	209	256	311
	480 V	S	kVA	91.5	125	150	168	200	251	307	332
Rated motor output	400 V	P	kW	55	75	90	110	132	160	200	250
	460 V	P	HP	75	120	150	175	200	250	300	350
Power input side (primary side):											
Number of phases				three-phase							
Rated 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	112.5	153.2	183.7	217	256	302	370	450
Minimum braking resistor		R_B	Ω	6	6	6	6	6	6	2	2
Switching frequency (pulse frequency)											
Factory default setting		f_{PWM}	kHz	4	4	4	4	4	4	4	4
Settings range		f_{PWM}	kHz	4 - 16	4 - 12	4 - 8	4 - 16	4 - 12	4 - 8	4 - 8	4 - 8
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	2.68	2.68	2.68	4.75	4.75	4.75	–	–
Efficiency		η		0.98	0.98	0.98	0.98	0.98	0.98	–	–
Heat dissipation at I_e		P_V	W	1210	1575	1800	2090	2375	3040	4000	5000
Frame size				FS6	FS6	FS6	FS7	FS7	FS7	FS8	FS8

6.2.4 DA1-35… series

DA1-35… devices are not covered by the declaration of conformity.
Additional radio interference suppression filters are required for compliance.

Size		Symbol	Unit	2D1	3D1	4D1	6D5	9D0	012
Rated operational current		I_e	A	2.1	3.1	4.1	6.5	9	12
Overload current for 60 s every 600 s at 50 °C		I_L	A	3.15	4.65	6.15	9.75	13.5	18
Apparent power at rated operation	500 V	S	kVA	1.6	2.1	2.4	4.3	6	7.5
	600 V	S	kVA	2	2.5	2.9	5.1	7.3	9
Rated motor output	500 V	P	kW	0.75	1.5	2.2	4	5.5	7.5
	575 V	P	HP	1	2	3	5	7.5	10
Power input side (primary side):									
Number of phases				three-phase					
Rated voltage		U_{LN}	V	500 V -10 % - 600 V +10 %, 50/60 Hz					
Input current (phase current)		I_{LN}	A	2.5	3.7	4.9	7.8	10.8	14.4
Minimum braking resistor		R_B	Ω	50	50	50	50	50	40
Switching frequency (pulse frequency)									
Factory default setting		f_{PWM}	kHz	8	8	8	8	8	8
Settings range		f_{PWM}	kHz	4 - 24	4 - 24	4 - 24	4 - 24	4 - 24	4 - 24
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	–	–	–	–	–	–
Efficiency		η		0.97	0.97	0.97	0.97	0.97	0.97
Heat dissipation at I_e		P_V	W	22.5	45	66	120	165	225
Frame size				FS2	FS2	FS2	FS2	FS2	FS3

DA1-35… series									
Size		**Symbol**	**Unit**	**017**	**022**	**022**	**028**	**034**	**043**
Rated operational current		I_e	A	17	22	22	28	34	43
Overload current for 60 s every 600 s		I_L	A	25.5	33	33	42	51	64.5
Apparent power at rated operation	500 V	S	kVA	10.4	12.7	12.7	16	19.5	24.4
	600 V	S	kVA	12.5	15.2	15.5	19.3	23.4	29.3
Rated motor output	500 V	P	kW	11	15	15	18.5	22	30
	575 V	P	HP	15	20	20	25	30	40
Power input side (primary side):									
Number of phases				three-phase					
Rated voltage		U_{LN}	V	500 V -10 % - 600 V +10 %, 50/60 Hz					
Input current (phase current)		I_{LN}	A	20.6	26.7	26.7	34	41.2	53
Minimum braking resistor		R_B	Ω	40	40	22	22	22	22
Switching frequency (pulse frequency)									
Factory default setting		f_{PWM}	kHz	8	8	8	8	8	8
Settings range		f_{PWM}	kHz	24	24	24	24	24	24
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	–	–	–	–	–	–
Efficiency		η		0.97	0.97	0.97	0.97	0.97	0.97
Heat dissipation at I_e		P_V	W	330	450	450	555	660	850
Frame size				FS3	FS3	FS4	FS4	FS4	FS4

DA1-35… series Size		Symbol	Unit	054	065	078	105	130	150
Rated operational current		I_e	A	54	65	78	105	130	150
Overload current for 60 s every 600 s		I_L	A	81	97.5	117	157.5	195	225
Apparent power at rated operation	500 V	S	kVA	29.7	35.2	45.2	60.5	71.5	79.1
	600 V	S	kVA	35.6	42.2	54.3	72.6	85.9	95
Rated motor output	500 V	P	kW	37	45	55	75	90	110
	575 V	P	HP	50	60	75	100	125	150
Power input side (primary side):									
Number of phases				three-phase					
Rated voltage		U_{LN}	V	500 V -10 % - 600 V +10 %, 50/60 Hz					
Input current (phase current)		I_{LN}	A	62.2	75.8	90.9	108.2	162	187
Minimum braking resistor		R_B	Ω	12	12	6	6	6	6
Switching frequency (pulse frequency)									
Factory default setting		f_{PWM}	kHz	8	8	4	4	4	4
Settings range		f_{PWM}	kHz	4 - 24	4 - 24	4 -16	4 - 16	4 - 12	4 - 12
Maximum leakage current to earth (PE), without motor		I_{PE}	mA	–	–	–	–	–	–
Efficiency		η		0.97	0.97	0.97	0.97	0.97	0.97
Heat dissipation at I_e		P_V	W	1110	1350	1650	2250	2700	3300
Frame size				FS5	FS5	FS6	FS6	FS6	FS6

6.3 Dimensions and frame sizes

6.3.1 Frame sizes FS2, FS3, FS4 and FS5 for IP20

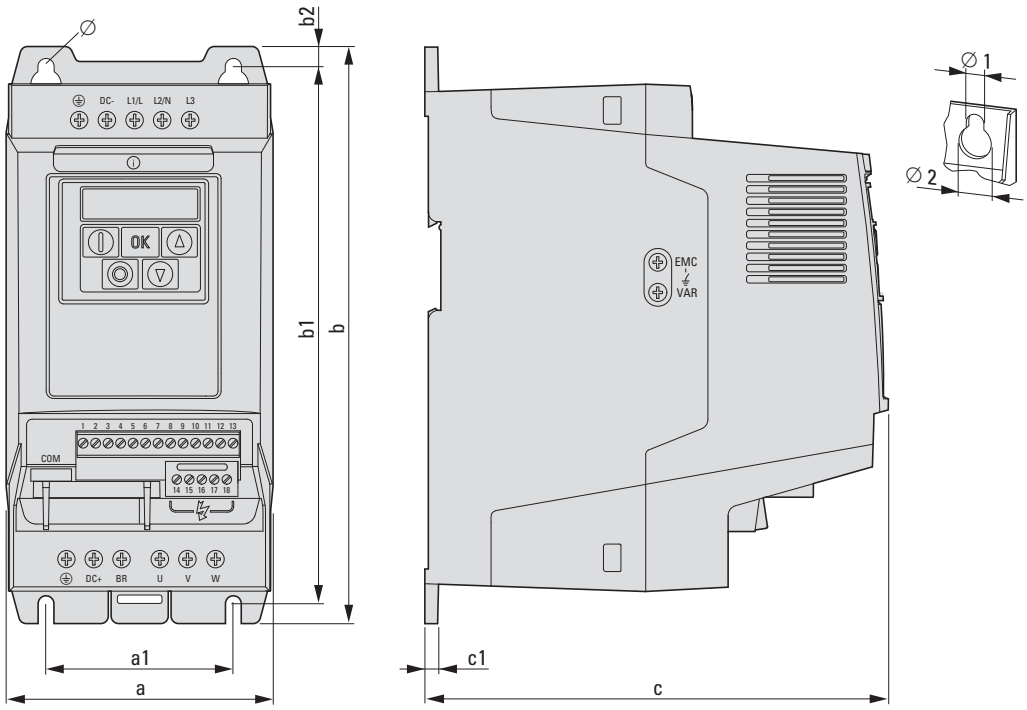


Figure 96: Frame sizes FS2; FS3, FS4 and FS5 for IP20 (NEMA 0)

Table 22: Dimensions and weights for sizes FS2, FS3, FS4 and FS5 for IP20 (NEMA 0)

Frame size	a [mm] (in)	a1 [mm] (in)	b [mm] (in)	b1 [mm] (in)	b2 [mm] (in)	c [mm] (in)	c1 [mm] (in)	Ø1 [mm] (in)	Ø2 [mm] (in)	m [kg] (lbs)
FS2	107 (4.2)	75 (3)	231 (9.1)	215 (8.5)	8 0.31	186 (7.3)	5 (0.2)	6.5 (0.26)	12.2 (0.48)	1.8 (3.97)
FS3	131 (5.2)	100 (3.9)	273 (10.8)	255 (10)	8.5 0.33	204 (8)	5 (0.2)	6.5 (0.26)	12.2 (0.48)	3.5 (7.72)
FS4	173 (6.81)	125 (4.92)	419 (16.5)	400 (15.75)	10 (0.39)	241 (9.49)	5 (0.2)	8 (0.31)	15 (0.59)	9.2 (20.3)
FS5	234 (9.21)	175 (6.89)	485 (19.09)	460 (18.11)	13 (0.51)	261 (10.28)	5 (0.2)	8 (0.31)	18 (0.71)	18.2 (40.1)

1 in = 1'' = 25.4 mm, 1 mm = 0.0394 in

6.3.2 Sizes FS4 to FS7 for IP55

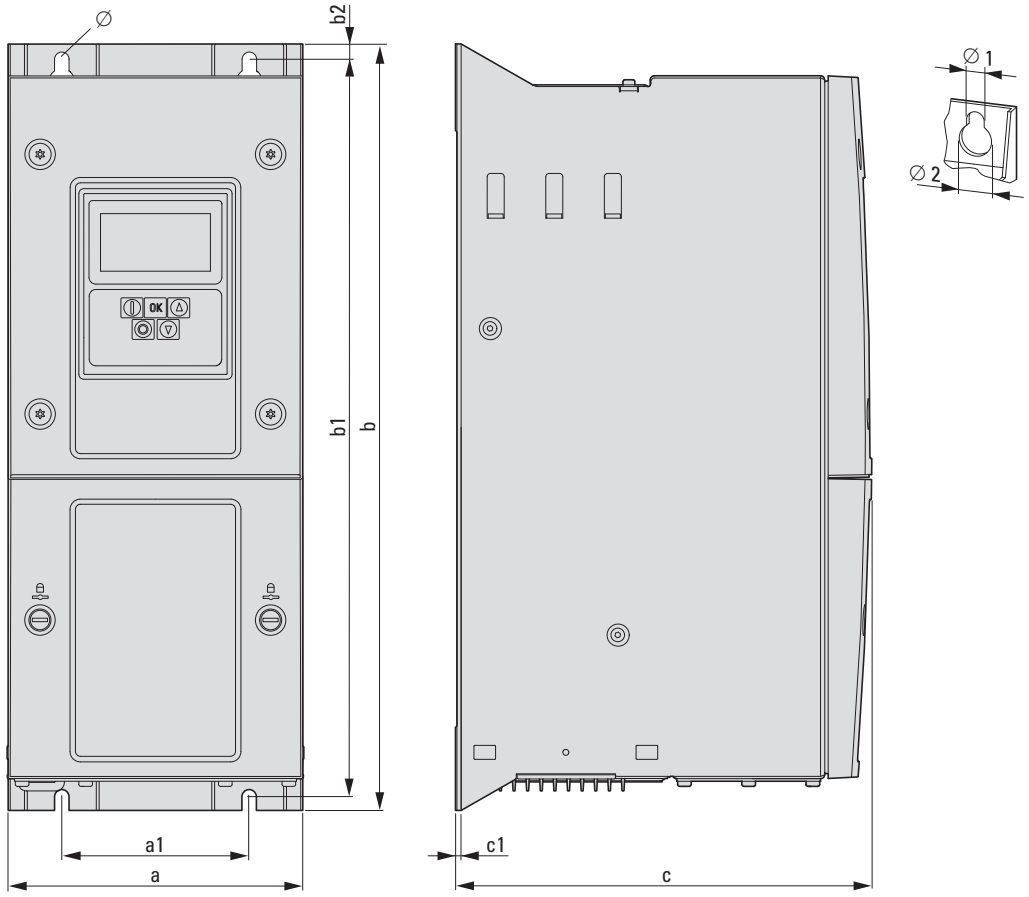


Figure 97: Sizes FS4 to FS7 for IP55 (NEMA 12)

Table 23: Dimensions and weights for sizes FS4 to FS7 for IP55 (NEMA 12)

Frame size	a [mm] (in)	a1 [mm] (in)	b [mm] (in)	b1 [mm] (in)	b2 [mm] (in)	c [mm] (in)	c1 [mm] (in)	Ø1 [mm] (in)	Ø2 [mm] (in)	m [kg] (lbs)
FS4	171 (6.7)	110 (175)	450 (17.7)	433 (17.1)	9 (0.35)	240 (9.7)	2 (0.79)	8 (0.32)	15 (0.59)	11.5 (25.35)
FS5	235 (9.3)	175 (6.9)	540 (21.3)	520 (20.5)	12 (0.47)	270 (10)	2 (0.79)	8 (0.32)	15 (0.59)	22.5 (49.60)
FS6	330 (13)	200 (7.9)	865 (34.1)	840 (33.1)	15 (0.59)	313.5 (12.4)	2 (0.79)	11 (0.43)	22 (0.87)	50 (110.23)
FS7	330 (14.2)	200 (7.9)	1280 (50.4)	1255 (49.5)	15 (0.59)	341 (13.4)	2 (0.79)	11 (0.43)	22 (0.87)	80 (176.37)

1 in = 1'' = 25.4 mm, 1 mm = 0.0394 in

6.3.3 Size FS8 for IP20

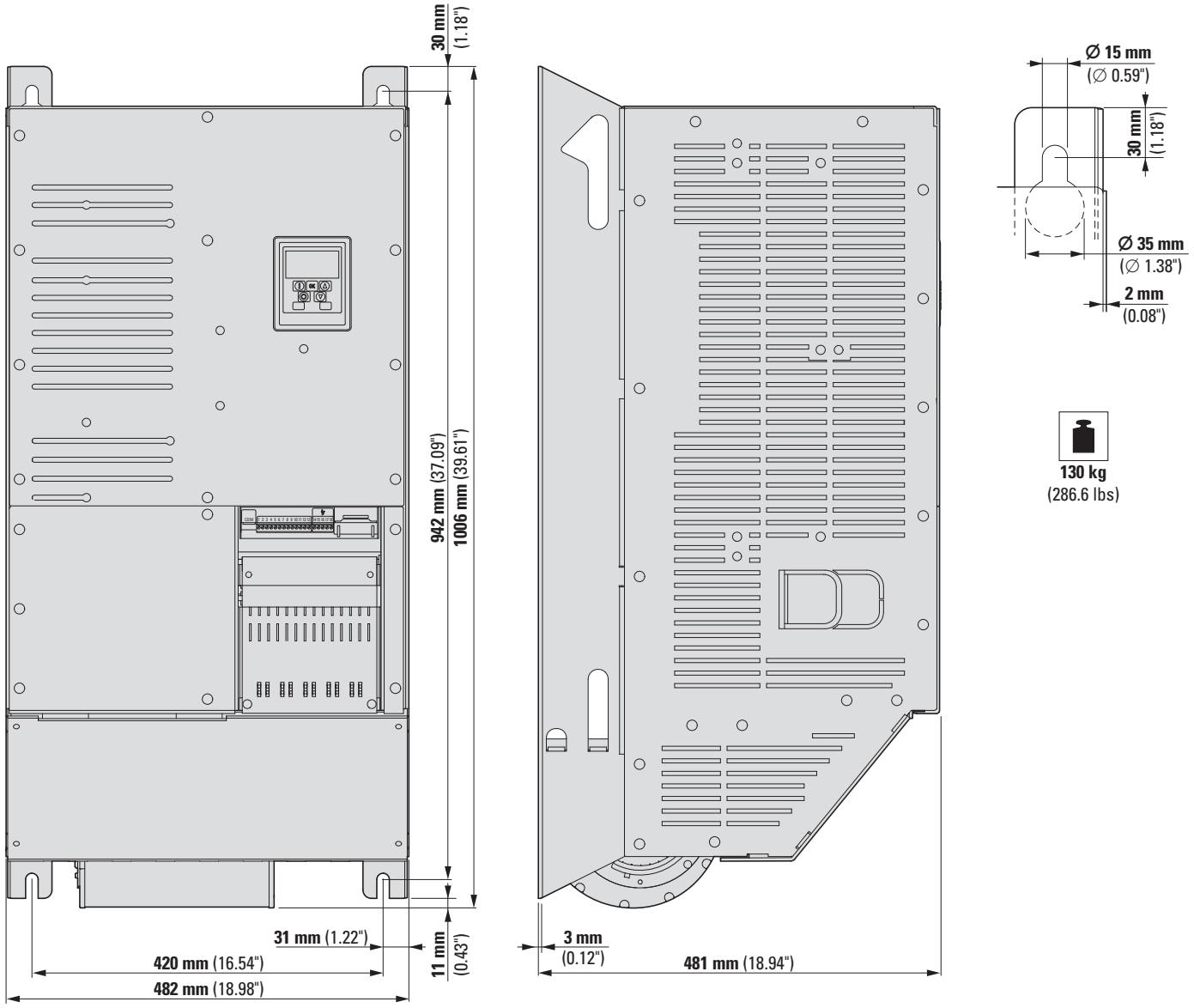


Figure 98: Size FS8 for IP20 (NEMA 0)

Table 24: Dimensions and weights for size FS8 for IP20 (NEMA 0)

Frame size	a [mm] (in)	a1 [mm] (in)	b [mm] (in)	b1 [mm] (in)	b2 [mm] (in)	c [mm] (in)	c1 [mm] (in)	Ø1 [mm] (in)	Ø2 [mm] (in)	m [kg] (lbs)
FS8	480 (18.9)	420 (16.5)	995 (39.2)	944 (37.2)	30 (1.18)	481 (18.9)	3 (0.12)	15 (0.59)	35 (1.38)	130 (286.6)

1 in = 1'' = 25.4 mm, 1 mm = 0.0394 in

6.3.4 Sizes FS2 and FS3 for IP66

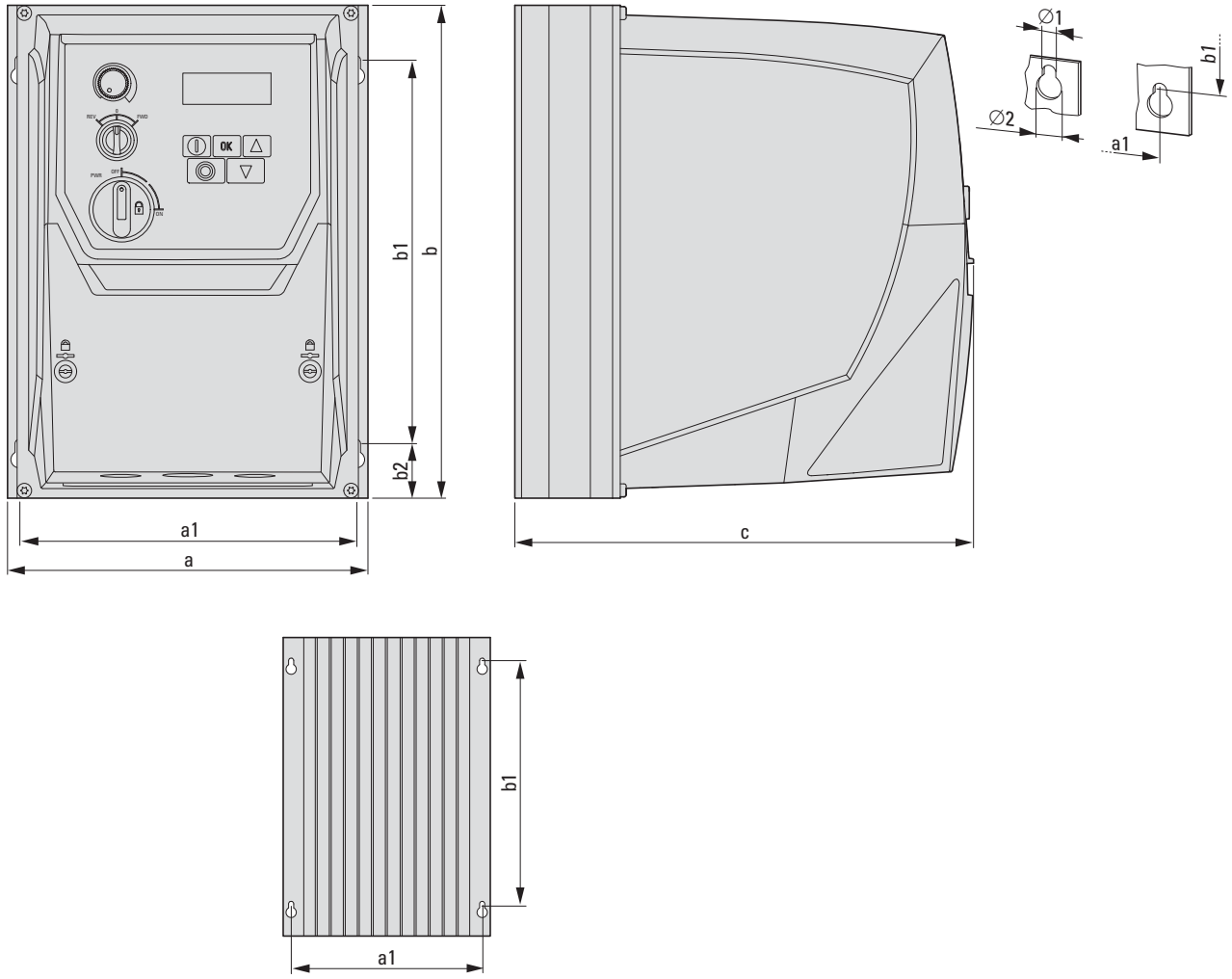


Figure 99: Sizes FS2 and FS3 for IP66 (NEMA 4X)

Table 25: Dimensions and weights for sizes FS2 and FS3 for IP66 (NEMA 4X)

Frame size	a [mm] (in)	a1 [mm] (in)	b [mm] (in)	b1 [mm] (in)	b2 [mm] (in)	c [mm] (in)	c1 [mm] (in)	Ø1 [mm] (in)	Ø2 [mm] (in)	m [kg] (lbs)
FS2	188 (7.4)	176 (6.93)	257 (10.12)	200 (7.87)	20 (0.79)	239.3 (9.43)	3.5 (0.14)	4.2 (0.16)	8.5 (0.33)	4.8 (10.6)
FS3	211 (8.29)	198 (7.78)	310 (12.2)	252 (9.9)	25 (0.98)	266.3 (10.49)	3.5 (0.14)	4.2 (0.16)	8.5 (0.33)	7.3 (16.1)

1 in = 1'' = 25.4 mm, 1 mm = 0.0394 in

6.4 Cable cross-sections

Table 26: Cable cross-sections – voltage class 230 V

Device type	Frame size	Input current	Maximum terminal capacity		Output current	Maximum motor cable length	
		A	mm²	AWG	A	m	ft
Voltage class: 230 V Mains voltage (50/60 Hz) U_{LN} 200 (-10%) - 240 (+10 %) V U_e 230 V AC, single-phase / U_2 230 V AC, 3-phase							
DA1-124D3…	FS2	8.5	8	8	4.3	100	330
DA1-127D0…	FS2	15.2	8	8	7	100	330
DA1-12011…	FS2	19.5	8	8	10.5	100	330
Voltage class: 230 V Mains voltage (50/60 Hz) U_{LN} 200 (-10%) – 240 (+10%) V U_e 230 V AC, 3-phase / U_2 230 V AC, 3-phase							
DA1-324D3…	FS2	5.1	8	8	4.3	100	330
DA1-327D0…	FS2	8.3	8	8	7	100	330
DA1-32011…	FS2	12.6	8	8	10.5	100	330
DA1-32018…	FS3	21.6	8	8	18	100	330
DA1-32024FB-A20C	FS3	29.1	8	8	24	100	330
DA1-32024FB-B55C	FS4	29.1	16	5	25	100	330
DA1-32030FB-B20C	FS4	36.4	16	5	30	100	330
DA1-32030FB-B55C	FS4	36.4	16	5	30	100	330
DA1-32046FB-B20C	FS4	55.8	16	5	46	100	330
DA1-32046FB-B55C	FS4	55.8	16	5	46	100	330
DA1-32060FB-B20C	FS5	63.9	35	2	61	100	330
DA1-32061FB-B55C	FS5	70.2	35	2	61	100	330
DA1-32072FB-B20C	FS5	74	35	2	72	100	330
DA1-32072FB-B55C	FS5	82.9	35	2	72	100	330
DA1-32090FB-B55C	FS6	103.6	150	300MCM	90	100	330
DA1-32110FB-B55C	FS6	126.7	150	300MCM	110	100	330
DA1-32150FB-B55C	FS6	172.7	150	300MCM	150	100	330
DA1-32180FB-B55C	FS6	183.3	150	300MCM	180	100	330
DA1-32202FB-B55C	FS7	205.7	150	300MCM	202	100	330
DA1-32248FB-B55C	FS7	255.5	150	300MCM	248	100	330

Table 27: Cable cross-sections – voltage class 400 V

Device type	Frame size	Input current	Maximum terminal capacity		Output current	Maximum motor cable length	
		A	mm²	AWG	A	m	ft
Voltage class: 400 V Mains voltage (50/60 Hz) U_{LN} 380 (-10%) – 480 (+10%) V U_e 400 V AC, 3-phase / U_2 400 V AC, 3-phase							
DA1-342D2…	FS2	2.4	8	8	2.2	100	330
DA1-344D1…	FS2	5.1	8	8	4.1	100	330
DA1-345D8…	FS2	7.5	8	8	5.8	100	330
DA1-349D5…	FS2	11.2	8	8	9.5	100	330
DA1-34014…	FS3	19	8	8	14	100	330
DA1-34018…	FS3	21	8	8	18	100	330
DA1-34024FB-A20C	FS3	28.9	8	8	24	100	330
DA1-34024FB-B55C	FS4	28.9	16	5	24	100	330
DA1-34030FB-B20C	FS4	37.2	16	5	30	100	330
DA1-34030FB-B55C	FS4	37.2	16	5	30	100	330
DA1-34039FB-B20C	FS4	47	16	5	39	100	330
DA1-34039FB-B55C	FS4	47	16	5	39	100	330
DA1-34046FB-B20C	FS4	52.4	16	5	46	100	330
DA1-34046FB-B55C	FS4	52.4	16	5	46	100	330
DA1-34061FB-B20C	FS5	66.1	35	2	61	100	330
DA1-34061FB-B55C	FS5	63.8	35	2	61	100	330
DA1-34072FB-B20C	FS5	77.3	35	2	72	100	330
DA1-34072FB-B55C	FS5	76.4	35	2	72	100	330
DA1-34090FB-B55C	FS6	92.2	150	300MCM	90	100	330
DA1-34110FB-B55C	FS6	112.5	150	300MCM	110	100	330
DA1-34150FB-B55C	FS6	153.2	150	300MCM	150	100	330
DA1-34180FB-B55C	FS6	183.7	150	300MCM	180	100	330
DA1-34202FB-B55C	FS7	217	150	300MCM	202	100	330
DA1-34240FB-B55C	FS7	256	150	300MCM	240	100	330
DA1-34302FB-B55C	FS7	302	150	300MCM	302	100	330
DA1-34370FB-B55C	FS8	370	240	450MCM	370	100	330
DA1-34450FB-B55C	FS8	450	240	450MCM	450	100	330

Table 28: Cable cross-sections – voltage class 575 V

Device type	Frame size	Input current	Maximum terminal capacity		Output current	Maximum motor cable length	
		A	mm²	AWG	A	m	ft
Voltage class: 575 V Mains voltage (50/60 Hz) U_{LN} 500 (-10%) - 600 (+10 %) V U_e 575 V AC, 3-phase / U_2 575 V AC, 3-phase							
DA1-352D1NB-…	FS2	2.5	8	8	2.1	100	330
DA1-353D1NB-…	FS2	3.7	8	8	3.1	100	330
DA1-354D1NB-…	FS2	4.9	8	8	4.1	100	330
DA1-356D5NB-…	FS2	7.8	8	8	6.5	100	330
DA1-359D0NB-…	FS2	10.8	8	8	9	100	330
DA1-35012NB-…	FS3	14.4	8	8	12	100	330
DA1-35017NB-…	FS3	20.6	8	8	17	100	330
DA1-35022NB-A20C	FS3	26.7	8	8	22	100	330
DA1-35022NB-B55C	FS4	26.7	16	5	22	100	330
DA1-35028NB-B20C	FS4	34	16	5	28	100	330
DA1-35028NB-B55C	FS4	34	16	5	28	100	330
DA1-35034NB-B20C	FS4	41.2	16	5	34	100	330
DA1-35034NB-B55C	FS4	41.2	16	5	34	100	330
DA1-35041NB-B20C	FS5	53	35	2	43	100	330
DA1-35043NB-B55C	FS4	53	16	5	43	100	330
DA1-35054NB-B20C	FS5	59.5	35	2	54	100	330
DA1-35054NB-B55C	FS5	62.2	35	2	54	100	330
DA1-35065NB-B20C	FS5	70.4	35	2	65	100	330
DA1-35065NB-B55C	FS5	75.8	35	2	65	100	330
DA1-35078NB-B55N	FS6	90.9	150	300MCM	78	100	330
DA1-35105NB-B55N	FS6	108.2	150	300MCM	105	100	330
DA1-35130NB-B55N	FS6	162	150	300MCM	130	100	330
DA1-35150NB-B55N	FS6	187	150	300MCM	150	100	330

6.5 Fuses

The Eaton circuit-breakers and 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 characteristics and operational voltages into account. When using other circuit-breakers, it may be necessary to use fuses as well, 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 29: Safety features

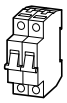
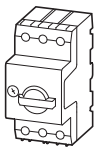
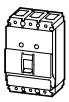
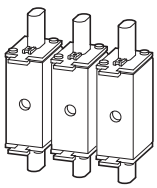
Symbol	Description
① 	**Circuit-breaker** FAZ-B…/1N: 1-pole + N FAZ-B…/2: 2-pole FAZ-B…/3: 3-pole Rated operating voltage: 230/400 V AC Switching capacity: 15 kA
② 	**Motor protection switch** PKM0…, PKZM4…: 3-pole Rated operating voltage: 690 V AC Switching capacity: • PKM0: 150 kA to 12 A and 50 kA to 32 A • PKZM4: 50 kA
③ 	**Circuit breaker** NZMC…: 3-pole Rated operating voltage: 690 V AC Switching capacity: 36 kA
④ 	**Fuse** Rated operating voltage: 500 V AC Switching capacity: 50 kA Frame size: DII, E27 / DIII, E33 Fuse base: S27… / S33…
⑤ 	**Fuse Class J** Rated operating voltage: 600 V AC Switching capacity: 300 kA Fuse bases: • up to 30 A: J60030… • 35 - 60 A: J60060… • 70 - 100 A: JM60100… • 110 - 200 A: JM60200… • 225 - 400 A: JM60400… • 450 - 600 A: JM60600…
⑥ 	**Fuse gG** Rated operating voltage: • 400 V AC (NHG…B-400) • 500 V AC (NHG…B) • 660 V AC (NHG…B-660) • 690 V AC (NHG…B-690) Switching capacity: 120 kA Size NHG…: 000 to 3 Fuse bases: NH fuse base (SD = 1-pole, TD = 3-pole)

Table 30: Specified fuses – voltage class 230 V

	Input current	Fuse or miniature circuit-breaker					
	I_{LN}	IEC (Type B or gG)				UL (Class CC or J)	
Device type	**A**	**A**	**Eaton type**			**A**	**Eaton type**
Voltage class: 230 V Mains voltage (50/60 Hz) U_{LN} 200 (-10%) - 240 (+10 %) V U_e 230 V AC, single-phase / U_2 230 V AC, 3-phase							
			①	②, 2-phase	④		⑤
DA1-124D3…	8.5	10	FAZ-B10/1N	FAZ-B10/2	Z-DII/SE-10A/GG	15	LPJ-15SP
DA1-127D0…	15.2	25	FAZ-B25/1N	FAZ-B25/2	Z-DII/SE-25A/GG	20	LPJ-20SP
DA1-12011…	19.5	25	FAZ-B25/1N	FAZ-B25/2	Z-DII/SE-25A/GG	25	LPJ-25SP
Voltage class: 230 V Mains voltage (50/60 Hz) U_{LN} 200 (-10%) – 240 (+10%) V U_e 230 V AC, 3-phase / U_2 230 V AC, 3-phase							
			①	②, ③	④, ⑥		⑤
DA1-324D3…	5.1	10	FAZ-B10/3	PKM0-10	Z-DII/SE-10A/GG	10	LPJ-10SP
DA1-327D0…	8.3	10	FAZ-B10/3	PKM0-10	Z-DII/SE-10A/GG	15	LPJ-15SP
DA1-32011…	12.6	16	FAZ-B16/3	PKM0-16	Z-DII/SE-16A/GG	17.5	LPJ-17,5SP
DA1-32018…	21.6	25	FAZ-B25/3	PKM0-25	Z-DII/SE-25A/GG	30	LPJ-30SP
DA1-32024FB-A20C	29.1	40	FAZ-B40/3	PKZM4-40	Z-DII/SE-40A/GG	40	LPJ-40SP
DA1-32024FB-B55C	29.1	40	FAZ-B40/3	PKZM4-40	Z-DII/SE-40A/GG	40	LPJ-40SP
DA1-32030FB-B20C	36.4	50	FAZ-B50/3	PKZM4-50	Z-DII/SE-50A/GG	50	LPJ-50SP
DA1-32030FB-B55C	36.4	50	FAZ-B50/3	PKZM4-50	Z-DII/SE-50A/GG	50	LPJ-50SP
DA1-32046FB-B20C	55.8	63	FAZ-B63/3	NZMC1-S80	Z-DII/SE-63A/GG	70	LPJ-70SP
DA1-32046FB-B55C	55.8	63	FAZ-B63/3	NZMC1-S80	Z-DII/SE-63A/GG	70	LPJ-70SP
DA1-32060FB-B20C	63.9	80	–	NZMC1-S80	80NHG000B-400	70	LPJ-70SP
DA1-32061FB-B55C	70.2	80	–	NZMC1-S80	80NHG000B-400	90	LPJ-90SP
DA1-32072FB-B20C	74	80	–	NZMC1-S80	80NHG000B-400	90	LPJ-90SP
DA1-32072FB-B55C	82.9	100	–	NZMC1-S100	100HG000B-400	110	LPJ-110SP
DA1-32090FB-B55C	103.6	125	–	NZMC2-S125	125NHG00B-400	150	LPJ-150SP
DA1-32110FB-B55C	126.7	160	–	NZMC2-S160	160NHG00B-400	175	LPJ-175SP
DA1-32150FB-B55C	172.7	200	–	NZMC2-S200	250NHG1B-400	225	LPJ-225SP
DA1-32180FB-B55C	183.3	250	–	NZMC3-S250	250NHG1B-400	250	LPJ-250SP
DA1-32202FB-B55C	205.7	250	–	NZMC3-S250	250NHG1B-400	300	LPJ-300SP
DA1-32248FB-B55C	255.5	315	–	NZMC3-S400	315NHG2B-400	350	LPJ-350SP

Note: The numbers ①, ②, ③, ④, ⑤, ⑥ refer to the graphics in table 29.

Table 31: Specified fuses – voltage class 400 V

	Input current	Fuse or miniature circuit-breaker					
	I_{LN}	IEC (Type B or gG)				UL (Class CC or J)	
Device type	**A**	**A**	**Eaton type**			**A**	**Eaton type**
Voltage class: 400 V Mains voltage (50/60 Hz) U_{LN} 380 (-10%) - 480 (+10 %) V U_e 400 V AC, 3-phase / U_2 400 V AC, 3-phase							
			①, max. 400 V	②, ③	④, ⑥		⑤
DA1-342D2…	2.4	10	FAZ-B10/3	PKM0-10	Z-DII/SE-10A/GG	6	LPJ-6SP
DA1-344D1…	5.1	10	FAZ-B10/3	PKM0-10	Z-DII/SE-10A/GG	10	LPJ-10SP
DA1-345D8…	7.5	10	FAZ-B10/3	PKM0-10	Z-DII/SE-10A/GG	10	LPJ-10SP
DA1-349D5…	11.2	16	FAZ-B16/3	PKM0-16	Z-DII/SE-16A/GG	15	LPJ-15SP
DA1-34014…	19	25	FAZ-B25/3	PKM0-25	Z-DII/SE-25A/GG	25	LPJ-25SP
DA1-34018…	21	25	FAZ-B25/3	PKM0-25	Z-DII/SE-25A/GG	30	LPJ-30SP
DA1-34024FB-A20C	28.9	40	FAZ-B40/3	PKZM4-40	Z-DII/SE-40A/GG	40	LPJ-40SP
DA1-34024FB-B55C	28.9	40	FAZ-B40/3	PKZM4-40	Z-DII/SE-40A/GG	40	LPJ-40SP
DA1-34030FB-B20C	37.2	50	FAZ-B50/3	PKZM4-50	Z-DII/SE-50A/GG	50	LPJ-50SP
DA1-34030FB-B55C	37.2	50	FAZ-B50/3	PKZM4-50	Z-DII/SE-50A/GG	50	LPJ-50SP
DA1-34039FB-B20C	47	63	FAZ-B63/3	PKZM4-58	Z-DII/SE-63A/GG	60	LPJ-60SP
DA1-34039FB-B55C	47	63	FAZ-B63/3	PKZM4-58	Z-DII/SE-63A/GG	60	LPJ-60SP
DA1-34046FB-B20C	52.4	63	FAZ-B63/3	PKZM4-58	Z-DII/SE-63A/GG	70	LPJ-70SP
DA1-34046FB-B55C	52.4	63	FAZ-B63/3	PKZM4-58	Z-DII/SE-63A/GG	70	LPJ-70SP
DA1-34061FB-B20C	66.1	80	–	NZMC1-S80	80NHG000B-400	80	LPJ-80SP
DA1-34061FB-B55C	63.8	80	–	NZMC1-S80	80NHG000B-400	80	LPJ-80SP
DA1-34072FB-B20C	77.3	100	–	NZMC1-S100	80NHG000B-400	100	LPJ-100SP
DA1-34072FB-B55C	76.4	100	–	NZMC1-S100	80NHG000B-400	100	LPJ-100SP
DA1-34090FB-B55C	92.2	125	–	NZMC2-S125	100HG000B-400	125	LPJ-125SP
DA1-34110FB-B55C	112.5	125	–	NZMC2-S125	125NHG00B-400	150	LPJ-150SP
DA1-34150FB-B55C	153.2	200	–	NZMC2-S200	160NHG00B-400	200	LPJ-200SP
DA1-34180FB-B55C	183.7	250	–	NZMC3-S250	250NHG1B-400	250	LPJ-250SP
DA1-34202FB-B55C	217	250	–	NZMC3-S250	250NHG1B-400	300	LPJ-300SP
DA1-34240FB-B55C	256	315	–	NZMC3-S320	315NHG2B-400	350	LPJ-350SP
DA1-34302FB-B55C	302	400	–	NZMC3-S400	315NHG2B-400	400	LPJ-400SP
DA1-34370FB-B55C	370	500	–	NZMC3-S500	400NHG2B-400	500	LPJ-500SP
DA1-34450FB-B55C	450	500	–	NZMC3-S500	500NHG3B-400	600	LPJ-600SP

Note: The numbers ①, ②, ③, ④, ⑤, ⑥ refer to the graphics in table 29.

Table 32: Specified fuses – voltage class 575 V

	Input current	Fuse or miniature circuit-breaker					
	I_{LN}	IEC (Type B or gG)				UL (Class CC or J)	
Device type	**A**	**A**	**Eaton type**			**A**	**Eaton type**
Voltage class: 575 V Mains voltage (50/60 Hz) U_{LN} 500 (-10%) - 600 (+10 %) V U_e 575 V AC, 3-phase / U_2 575 V AC, 3-phase							
			②, ③	⑥, max. 500 V	⑥		⑤
DA1-352D1NB-…	2.5	10	PKM0-10	10NHG000B	10NHG000B-690	6	LPJ-6SP
DA1-353D1NB-…	3.7	10	PKM0-10	10NHG000B	10NHG000B-690	6	LPJ-6SP
DA1-354D1NB-…	4.9	10	PKM0-10	10NHG000B	10NHG000B-690	10	LPJ-10SP
DA1-356D5NB-…	7.8	10	PKM0-10	10NHG000B	10NHG000B-690	10	LPJ-10SP
DA1-359D0NB-…	10.8	16	PKM0-16	16NHG000B	16NHG000B-690	15	LPJ-15SP
DA1-35012NB-…	14.4	16	PKM0-16	16NHG000B	16NHG000B-690	20	LPJ-20SP
DA1-35017NB-…	20.6	25	PKM0-25	25NHG000B	25NHG000B-690	30	LPJ-30SP
DA1-35022NB-A20C	26.7	32	PKM0-32	32NHG000B	32NHG000B-690	35	LPJ-35SP
DA1-35022NB-B55C	26.7	32	PKM0-32	32NHG000B	32NHG000B-690	35	LPJ-35SP
DA1-35028NB-B20C	34	40	PKZM4-40	40NHG000B	40NHG000B-690	45	LPJ-45SP
DA1-35028NB-B55C	34	40	PKZM4-40	40NHG000B	40NHG000B-690	45	LPJ-45SP
DA1-35034NB-B20C	41.2	50	PKZM4-50	50NHG000B	50NHG000B-690	60	LPJ-60SP
DA1-35034NB-B55C	41.2	50	PKZM4-50	50NHG000B	50NHG000B-690	60	LPJ-60SP
DA1-35041NB-B20C	53	63	PKZM4-58	63NHG000B	63NHG000B-690	70	LPJ-70SP
DA1-35043NB-B55C	53	63	PKZM4-58	63NHG000B	63NHG000B-690	70	LPJ-70SP
DA1-35054NB-B20C	59.5	80	NZMC1-S80	80NHG000B	80NHG000B-690	80	LPJ-80SP
DA1-35054NB-B55C	62.2	80	NZMC1-S80	80NHG000B	80NHG000B-690	80	LPJ-80SP
DA1-35065NB-B20C	70.4	100	NZMC1-S100	100NHG000B	100NHG000B-690	100	LPJ-100SP
DA1-35065NB-B55C	75.8	100	NZMC1-S100	100NHG000B	100NHG000B-690	100	LPJ-100SP
DA1-35078NB-B55N	90.9	125	NZMC2-S125	125NHG000B	125NHG000B-690	125	LPJ-125SP
DA1-35105NB-B55N	108.2	125	NZMC2-S125	125NHG000B	125NHG000B-690	150	LPJ-150SP
DA1-35130NB-B55N	162	160	NZMC2-S160	160NHG000B	160NHG000B-690	175	LPJ-175SP
DA1-35150NB-B55N	187	200	NZMC2-S200	200NHG1B	200NHG1B-690	200	LPJ-200SP

Note: The numbers ①, ②, ③, ④, ⑤, ⑥ refer to the graphics in table 29.

6.6 Mains contactors

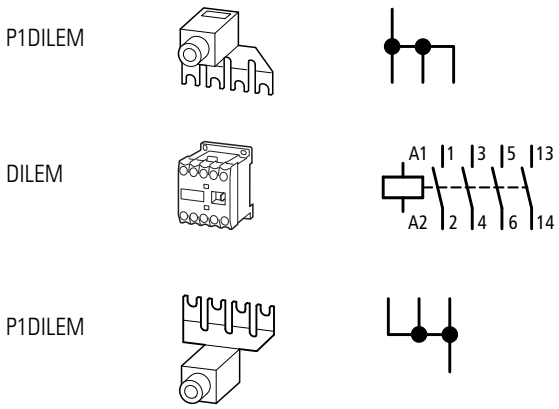


Figure 100: Mains contactor with single-phase connection (DA1-12…)

Table 33: Mains contactors – DA1 voltage class 230 V (single-phase)

Device type	Frame size	Input current	Output current	Mains contactors (thermal AC1 current)			
		A	A	Type max 50°C and IEC	A	Type max. 40°C and UL	A
Voltage class: 230 V Mains voltage (50/60 Hz) U_{LN} 200 (-10%) - 240 (+10 %) V U_e 230 V AC, single-phase / U_2 230 V AC, 3-phase							
DA1-124D3…	FS2	8.5	4.3	DILEM-…+P1DILEM	50	DILEM-…+P1DILEM	50
DA1-127D0…	FS2	15.2	7	DILEM-…+P1DILEM	50	DILEM-…+P1DILEM	50
DA1-12011…	FS2	19.5	10.5	DILEM-…+P1DILEM	50	DILEM-…+P1DILEM	50

Table 34: Mains contactors – DA1 voltage class 230 V (3-phase)

Device type	Frame size	Input current	Output current	Mains contactors (thermal AC1 current)			
		A	A	Type max 50°C and IEC	A	Type max. 40°C and UL	A
Voltage class: 230 V Mains voltage (50/60 Hz) U_{LN} 200 (-10%) - 240 (+10 %) V U_e 230 V AC, 3-phase / U_2 230 V AC, 3-phase							
DA1-324D3…	FS2	5.1	4.3	DILEM-…	20	DILEM-…	20
DA1-327D0…	FS2	8.3	7	DILEM-…	20	DILEM-…	20
DA1-32011…	FS2	12.6	10.5	DILEM-…	20	DILEM-…	20
DA1-32018…	FS3	21.6	18	DILM17	38	DILM17	40
DA1-32024FB-A20C	FS3	29.1	24	DILM17	38	DILM17	40
DA1-32024FB-B55C	FS4	29.1	25	DILM17	38	DILM17	40
DA1-32030FB-B20C	FS4	36.4	30	DILM17	38	DILM17	40
DA1-32030FB-B55C	FS4	36.4	30	DILM17	38	DILM17	40
DA1-32046FB-B20C	FS4	55.8	46	DILM40	57	DILM40	60
DA1-32046FB-B55C	FS4	55.8	46	DILM40	57	DILM40	60
DA1-32060FB-B20C	FS5	63.9	61	DILM50	71	DILM50	80
DA1-32061FB-B55C	FS5	70.2	61	DILM50	71	DILM50	80
DA1-32072FB-B20C	FS5	74	72	DILM65	88	DILM50	80
DA1-32072FB-B55C	FS5	82.9	72	DILM65	88	DILM65	98
DA1-32090FB-B55C	FS6	103.6	90	DILM95	125	DILM80	110
DA1-32110FB-B55C	FS6	126.7	110	DILM115	142	DILM95	130
DA1-32150FB-B55C	FS6	172.7	150	DILM150	180	DILM150	190
DA1-32180FB-B55C	FS6	183.3	180	DILM170	200	DILM150	190
DA1-32202FB-B55C	FS7	205.7	202	DILM185A	301	DILM170	225
DA1-32248FB-B55C	FS7	255.5	248	DILM185A	301	DILM185A	337

Table 35: Mains contactor – DA1 voltage class 400 V

Device type	Frame size	Input current	Output current	Mains contactors (thermal AC1 current)			
		A	A	Type max 50°C and IEC	A	Type max. 40°C and UL	A
Voltage class: 400 V Mains voltage (50/60 Hz) U_{LN} 380 (-10%) - 480 (+10 %) V U_e 400 V AC, 3-phase / U_2 400 V AC, 3-phase							
DA1-342D2…	FS2	2.4	2.2	DILEM-…	20	DILEM-…	20
DA1-344D1…	FS2	5.1	4.1	DILEM-…	20	DILEM-…	20
DA1-345D8…	FS2	7.5	5.8	DILEM-…	20	DILEM-…	20
DA1-349D5…	FS2	11.2	9.5	DILEM-…	20	DILEM-…	20
DA1-34014…	FS3	19	14	DILEM-…	20	DILEM-…	20
DA1-34018…	FS3	21	18	DILM7	21	DILM7	22
DA1-34024FB-A20C	FS3	28.9	24	DILM17	38	DILM17	40
DA1-34024FB-B55C	FS4	28.9	24	DILM17	38	DILM17	40
DA1-34030FB-B20C	FS4	37.2	30	DILM17	38	DILM17	40
DA1-34030FB-B55C	FS4	37.2	30	DILM17	38	DILM17	40
DA1-34039FB-B20C	FS4	47	39	DILM40	57	DILM40	60
DA1-34039FB-B55C	FS4	47	39	DILM40	57	DILM40	60
DA1-34046FB-B20C	FS4	52.4	46	DILM40	57	DILM40	60
DA1-34046FB-B55C	FS4	52.4	46	DILM40	57	DILM40	60
DA1-34061FB-B20C	FS5	66.1	61	DILM50	71	DILM50	80
DA1-34061FB-B55C	FS5	63.8	61	DILM50	71	DILM50	80
DA1-34072FB-B20C	FS5	77.3	72	DILM65	88	DILM50	80
DA1-34072FB-B55C	FS5	76.4	72	DILM65	88	DILM50	80
DA1-34090FB-B55C	FS6	92.2	90	DILM80	98	DILM65	98
DA1-34110FB-B55C	FS6	112.5	110	DILM95	125	DILM95	130
DA1-34150FB-B55C	FS6	153.2	150	DILM150	180	DILM115	160
DA1-34180FB-B55C	FS6	183.7	180	DILM170	200	DILM150	190
DA1-34202FB-B55C	FS7	217	202	DILM185A	301	DILM170	225
DA1-34240FB-B55C	FS7	256	240	DILM185A	301	DILM185A	337
DA1-34302FB-B55C	FS7	302	302	DILM225A	310	DILM185A	337
DA1-34370FB-B55C	FS8	370	370	DILM300A	385	DILM250	400
DA1-34450FB-B55C	FS8	450	450	DILM400	548	DILM400	612

Table 36: Mains contactor – DA1 voltage class 575 V

Device type	Frame size	Input current	Output current	Mains contactors (thermal AC1 current)			
		A	A	Type max 50°C and IEC	A	Type max. 40°C and UL	A
Voltage class: 575 V Mains voltage (50/60 Hz) U_{LN} 500 (-10%) - 600 (+10 %) V U_e 575 V AC, 3-phase / U_2 575 V AC, 3-phase							
DA1-352D1NB-…	FS2	2.5	2.1	DILEM-…	20	DILEM-…	20
DA1-353D1NB-…	FS2	3.7	3.1	DILEM-…	20	DILEM-…	20
DA1-354D1NB-…	FS2	4.9	4.1	DILEM-…	20	DILEM-…	20
DA1-356D5NB-…	FS2	7.8	6.5	DILEM-…	20	DILEM-…	20
DA1-359D0NB-…	FS2	10.8	9	DILEM-…	20	DILEM-…	20
DA1-35012NB-…	FS3	14.4	12	DILEM-…	20	DILEM-…	20
DA1-35017NB-…	FS3	20.6	17	DILM7	21	DILM7	22
DA1-35022NB-A20C	FS3	26.7	22	DILM17	38	DILM17	40
DA1-35022NB-B55C	FS4	26.7	22	DILM17	38	DILM17	40
DA1-35028NB-B20C	FS4	34	28	DILM17	38	DILM17	40
DA1-35028NB-B55C	FS4	34	28	DILM17	38	DILM17	40
DA1-35034NB-B20C	FS4	41.2	34	DILM25	43	DILM25	45
DA1-35034NB-B55C	FS4	41.2	34	DILM25	43	DILM25	45
DA1-35041NB-B20C	FS5	53	43	DILM40	57	DILM40	60
DA1-35043NB-B55C	FS4	53	43	DILM40	57	DILM40	60
DA1-35054NB-B20C	FS5	59.5	54	DILM50	71	DILM40	60
DA1-35054NB-B55C	FS5	62.2	54	DILM50	71	DILM50	80
DA1-35065NB-B20C	FS5	70.4	65	DILM50	71	DILM50	80
DA1-35065NB-B55C	FS5	75.8	65	DILM65	88	DILM50	80
DA1-35078NB-B55N	FS6	90.9	78	DILM80	98	DILM65	98
DA1-35105NB-B55N	FS6	108.2	105	DILM95	125	DILM80	110
DA1-35130NB-B55N	FS6	162	130	DILM150	162	DILM150	190
DA1-35150NB-B55N	FS6	187	150	DILM170	200	DILM150	190

→ Specifications on the mains contactors can be found in the main catalog HPL, “Contactors DILEM and DILM”.

6.7 Mains chokes

DX-LN1…

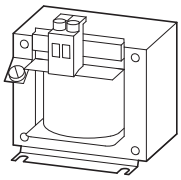


Figure 101:DEX-LN1… mains chokes (single-phase)

Table 37: Rated mains chokes – DA1 voltage class 230 V (single-phase)

Device type	Frame size	Input current	Mains choke U_{LN} max. 240 V +10% 50/60 Hz ±10 %	
		I_{LN}	max. 50 °C	
		A	Type	A
Voltage class: 230 V Mains voltage (50/60 Hz) U_{LN} 200 (-10%) - 240 (+10 %) V U_e 230 V AC, single-phase / U_2 230 V AC, 3-phase				
DA1-124D3FB-…	FS2	8.5	DX-LN1-013	13
DA1-127D0FB-…	FS2	15.2	DX-LN1-018	18
DA1-12011FB-…	FS2	19.5	DX-LN1-024	24

DX-LN3…

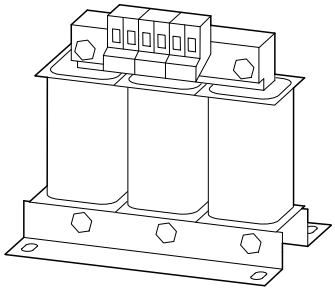


Figure 102:Mains chokes DEX-LN3… (3-phase)

Table 38: Rated mains chokes – DA1 voltage class 230 V (3-phase)

	Frame size	Input current	Mains choke U_{LN} max. 240 V +10% 50/60 Hz ±10 % max. 50°C	
Device type		**A**	**Type**	**A**
Voltage class: 230 V Mains voltage (50/60 Hz) U_{LN} 200 (-10%) - 240 (+10 %) V U_e 230 V AC, 3-phase / U_2 230 V AC, 3-phase				
DA1-324D3…	FS2	5.1	DX-LN3-006	6
DA1-327D0…	FS2	8.3	DX-LN3-010	10
DA1-32011…	FS2	12.6	DX-LN3-016	16
DA1-32018…	FS3	21.6	DX-LN3-025	25
DA1-32024FB-A20C	FS3	29.1	DX-LN3-040	40
DA1-32024FB-B55C	FS4	29.1	DX-LN3-040	40
DA1-32030FB-B20C	FS4	36.4	DX-LN3-040	40
DA1-32030FB-B55C	FS4	36.4	DX-LN3-040	40
DA1-32046FB-B20C	FS4	55.8	DX-LN3-060	60
DA1-32046FB-B55C	FS4	55.8	DX-LN3-060	60
DA1-32060FB-B20C	FS5	63.9	DX-LN3-080	80
DA1-32061FB-B55C	FS5	70.2	DX-LN3-080	80
DA1-32072FB-B20C	FS5	74	DX-LN3-080	80
DA1-32072FB-B55C	FS5	82.9	DX-LN3-100	100
DA1-32090FB-B55C	FS6	103.6	DX-LN3-120	120
DA1-32110FB-B55C	FS6	126.7	DX-LN3-160	160
DA1-32150FB-B55C	FS6	172.7	DX-LN3-200	200
DA1-32180FB-B55C	FS6	183.3	DX-LN3-200	200
DA1-32202FB-B55C	FS7	205.7	DX-LN3-250	250
DA1-32248FB-B55C	FS7	255.5	DX-LN3-300	300

Table 39: Rated mains chokes – DA1 voltage class 400 V (3-phase)

Device type	Frame size	Input current A	Mains choke U_{LN} max. 240 V +10% 50/60 Hz ±10 % max. 50°C Type	A
Voltage class: 400 V Mains voltage (50/60 Hz) U_{LN} 380 (-10%) - 480 (+10 %) V U_e 400 V AC, 3-phase / U_2 400 V AC, 3-phase				
DA1-342D2…	FS2	2.4	DX-LN3-004	3.9
DA1-344D1…	FS2	5.1	DX-LN3-006	6
DA1-345D8…	FS2	7.5	DX-LN3-010	10
DA1-349D5…	FS2	11.2	DX-LN3-016	16
DA1-34014…	FS3	19	DX-LN3-025	25
DA1-34018…	FS3	21	DX-LN3-025	25
DA1-34024FB-A20C	FS3	28.9	DX-LN3-040	40
DA1-34024FB-B55C	FS4	28.9	DX-LN3-040	40
DA1-34030FB-B20C	FS4	37.2	DX-LN3-040	40
DA1-34030FB-B55C	FS4	37.2	DX-LN3-040	40
DA1-34039FB-B20C	FS4	47	DX-LN3-050	50
DA1-34039FB-B55C	FS4	47	DX-LN3-050	50
DA1-34046FB-B20C	FS4	52.4	DX-LN3-060	60
DA1-34046FB-B55C	FS4	52.4	DX-LN3-060	60
DA1-34061FB-B20C	FS5	66.1	DX-LN3-080	80
DA1-34061FB-B55C	FS5	63.8	DX-LN3-080	80
DA1-34072FB-B20C	FS5	77.3	DX-LN3-080	80
DA1-34072FB-B55C	FS5	76.4	DX-LN3-080	80
DA1-34090FB-B55C	FS6	92.2	DX-LN3-100	100
DA1-34110FB-B55C	FS6	112.5	DX-LN3-120	120
DA1-34150FB-B55C	FS6	153.2	DX-LN3-160	160
DA1-34180FB-B55C	FS6	183.7	DX-LN3-200	200
DA1-34202FB-B55C	FS7	217	DX-LN3-250	250
DA1-34240FB-B55C	FS7	256	DX-LN3-300	300
DA1-34302FB-B55C	FS7	302	DX-LN3-303	303
DA1-34370FB-B55C	FS8	370	DX-LN3-370	370
DA1-34450FB-B55C	FS8	450	DX-LN3-450	450

Table 40: Rated mains chokes – DA1 voltage class 500 V (3-phase)

Device type	Frame size	Input current A	Mains choke U_{LN} max. 240 V +10% 50/60 Hz ±10 % max. 50°C Type	A
Voltage class: 500 V Mains voltage (50/60 Hz) U_{LN} 500 (-10%) - 600 (+10 %) V U_e 500 V AC, 3-phase / U_2 500 V AC, 3-phase				
DA1-352D1NB-…	FS2	2.5	DX-LN3-004	3.9
DA1-353D1NB-…	FS2	3.7	DX-LN3-004	3.9
DA1-354D1NB-…	FS2	4.9	DX-LN3-006	6
DA1-356D5NB-…	FS2	7.8	DX-LN3-010	10
DA1-359D0NB-…	FS2	10.8	DX-LN3-016	16
DA1-35012NB-…	FS3	14.4	DX-LN3-016	16
DA1-35017NB-…	FS3	20.6	DX-LN3-025	25
DA1-35022NB-A20C	FS3	26.7	DX-LN3-040	40
DA1-35022NB-B55C	FS4	26.7	DX-LN3-040	40
DA1-35028NB-B20C	FS4	34	DX-LN3-040	40
DA1-35028NB-B55C	FS4	34	DX-LN3-040	40
DA1-35034NB-B20C	FS4	41.2	DX-LN3-050	50
DA1-35034NB-B55C	FS4	41.2	DX-LN3-050	50
DA1-35041NB-B20C	FS5	53	DX-LN3-060	60
DA1-35043NB-B55C	FS4	53	DX-LN3-060	60
DA1-35054NB-B20C	FS5	59.5	DX-LN3-060	60
DA1-35054NB-B55C	FS5	62.2	DX-LN3-080	80
DA1-35065NB-B20C	FS5	70.4	DX-LN3-080	80
DA1-35065NB-B55C	FS5	75.8	DX-LN3-080	80
DA1-35078NB-B55N	FS6	90.9	DX-LN3-100	100
DA1-35105NB-B55N	FS6	108.2	DX-LN3-120	120
DA1-35130NB-B55N	FS6	162	DX-LN3-200	200
DA1-35150NB-B55N	FS6	187	DX-LN3-200	200

→ Please inquire about mains chokes for mains voltages > 500 V.

→ For more information and technical data on DX-LN… mains chokes, please refer to instruction leaflet IL00906003Z.

6.8 Radio interference suppression filter

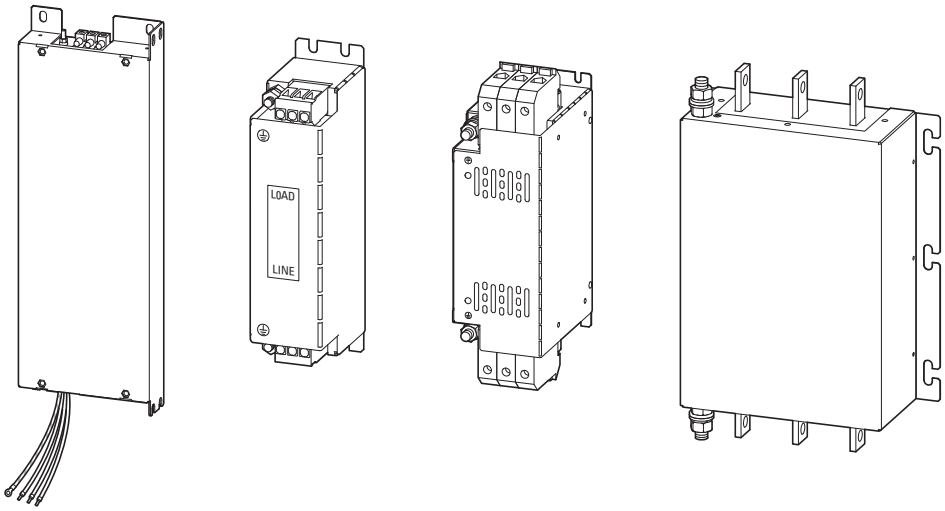


Figure 103: DX-EMC…-FS… (base-mounted filters with prefabricated connection cables) and DX-EMC… (side-mounting filters) external radio interference suppression filters

DX-EMC… external radio interference suppression filters should always be installed in the immediate proximity of the corresponding variable frequency drive. The connection cables between the radio interference suppression filter and the variable frequency drive should not be longer than 300 to 500 mm if they are installed without screening.

→ The DX-EMC… radio interference suppression filters with IP20 protection listed below are intended for installation in a control panel.

→ Sizes DX-EMC34-400… and DX-EMC34-750… have IP00 protection.

→ Please inquire about higher degrees of protection.

→ For more information and technical data on DX-EMC… radio interference suppression filters, please refer to the instruction leaflets IL04012017Z and IL04012018Z.

→ The maximum motor cable lengths for the C1, C2, and C3 interference categories listed below are standardized recommended values. They apply to the adjustable switching frequencies (f_{PWM}) of 4 to 16 kHz (parameter P2-24) in the corresponding ratings.

Voltage class: 230 V

Mains voltage (50/60 Hz) ULN 200 (-10%) - 240 (+10%) V

U_e 230 V AC, single-phase / U_2 230 V AC, 3-phase

Table 41: Rated radio interference suppression filter (single-phase)

Device type	Frame size	Input current	Radio interference filter	Rated operational current	Leakage current (IEC38 +10 %)	C1	C2	C3
		A	Type	A	A	m	m	m
DA1-124D3…	FS2	8.5	DX-EMC12-014-FS2	14	8	25	50	75
DA1-127D0…	FS2	15.2	DX-EMC12-014-FS2	14	8	25	50	75
DA1-12011…	FS2	19.5	DX-EMC12-025-FS2	25	8	25	75	100

→ DX-EMC…-**FS2**: Base-mounted filter for frame size FS2

Voltage class: 230 V

Mains voltage (50/60 Hz) U_{LN} 200 (-10%) - 240 (+10%) V

U_e 230 V AC, 3-phase / U_2 230 V AC, 3-phase

Table 42: Rated radio interference suppression filter (3-phase)

Device type	Frame size	Input current	Radio interference filter	Rated operational current	Leakage current (IEC38 +10 %)	C1	C2	C3
		A	Type	A	A	m	m	m
DA1-324D3…	FS2	5.1	DX-EMC34-016	16	21	25	50	75
			DX-EMC34-016-L	16	6	5	25	50
DA1-327D0…	FS2	8.3	DX-EMC34-016	16	21	25	50	75
			DX-EMC34-016-L	16	6	5	25	50
DA1-32011…	FS2	12.6	DX-EMC34-016	16	21	25	50	75
			DX-EMC34-016-L	16	6	5	25	50
DA1-32018…	FS3	21.6	DX-EMC34-030	30	29	25	50	75
			DX-EMC34-030-L	30	6.5	5	25	50
DA1-32024FB-A20C	FS3	29.1	DX-EMC34-030	30	29	25	50	75
			DX-EMC34-030-L	30	6.5	5	25	50
DA1-32024FB-B55C	FS4	29.1	DX-EMC34-030	30	29	25	50	75
			DX-EMC34-030-L	30	6.5	5	25	50
DA1-32030FB-B20C	FS4	36.4	DX-EMC34-042	42	30	25	50	75
			DX-EMC34-042-L	42	6.5	5	25	50
DA1-32030FB-B55C	FS4	36.4	DX-EMC34-042	42	30	25	50	75
			DX-EMC34-042-L	42	6.5	5	25	50
DA1-32046FB-B20C	FS4	55.8	DX-EMC34-075	75	22	25	50	75
			DX-EMC34-075-L	75	6.5	5	25	50
DA1-32046FB-B55C	FS4	55.8	DX-EMC34-075	75	22	25	50	75
			DX-EMC34-075-L	75	6.5	5	25	50
DA1-32060FB-B20C	FS5	63.9	DX-EMC34-075	75	22	25	50	75
			DX-EMC34-075-L	75	6.5	5	25	50
DA1-32061FB-B55C	FS5	70.2	DX-EMC34-075	75	22	25	50	75
			DX-EMC34-075-L	75	6.5	5	25	50
DA1-32072FB-B20C	FS5	74	DX-EMC34-075	75	22	25	50	75
			DX-EMC34-075-L	75	6.5	5	25	50
DA1-32072FB-B55C	FS5	82.9	DX-EMC34-100	100	30	25	50	75
			DX-EMC34-100-L	100	6.5	5	25	50
DA1-32090FB-B55C	FS6	103.6	DX-EMC34-130	130	22	25	50	75
			DX-EMC34-130-L	130	6.5	5	25	50
DA1-32110FB-B55C	FS6	126.7	DX-EMC34-130	130	22	25	50	75
			DX-EMC34-130-L	130	6.5	5	25	50

Device type	Frame size	Input current	Radio interference filter	Rated operational current	Leakage current (IEC38 +10 %)	C1	C2	C3
		A	Type	A	A	m	m	m
DA1-32150FB-B55C	FS6	172.7	DX-EMC34-180	180	31	25	50	75
			DX-EMC34-180-L	180	7	5	25	50
DA1-32180FB-B55C	FS6	183.3	DX-EMC34-250	250	37	25	50	75
			DX-EMC34-250-L	250	7	5	25	50
DA1-32202FB-B55C	FS7	205.7	DX-EMC34-250	250	37	25	50	75
			DX-EMC34-250-L	250	7	5	25	50
DA1-32248FB-B55C	FS7	255.5	DX-EMC34-400	400	60	5	25	50
			DX-EMC34-400-L	400	8	5	25	50

→ DX-EMC…-**FS**: DX-EMC…-FS: Base-mounted filter for the specified frame size
DX-EMC…-**L**: Low leakage current

Voltage class: 400 V

Mains voltage (50/60 Hz) U_{LN} 380 (-10%) - 480 (+10%) V

U_e 400 V AC, 3-phase / U_2 400 V AC, 3-phase

Table 43: Rated radio interference suppression filter (3-phase)

Device type	Frame size	Input current	Radio interference filter	Rated operational current	Leakage current (IEC38 +10 %)	C1	C2	C3
		A	Type	A	A	m	m	m
DA1-344D1…	FS2	5.1	DX-EMC34-016	16	21	25	50	75
			DX-EMC34-016-L	16	6	5	25	50
DA1-345D8…	FS2	7.5	DX-EMC34-016	16	21	25	50	75
			DX-EMC34-016-L	16	6	5	25	50
DA1-349D5…	FS2	11.2	DX-EMC34-016	16	21	25	50	75
			DX-EMC34-016-L	16	6	5	25	50
DA1-34014…	FS3	19	DX-EMC34-030	30	29	25	50	75
			DX-EMC34-030-L	30	6.5	5	25	50
DA1-34018…	FS3	21	DX-EMC34-030	30	29	25	50	75
			DX-EMC34-030-L	30	6.5	5	25	50
DA1-34024FB-A20C	FS3	28.9	DX-EMC34-030	30	29	25	50	75
			DX-EMC34-030-L	30	6.5	5	25	50
DA1-34024FB-B55C	FS4	28.9	DX-EMC34-030	30	29	25	50	75
			DX-EMC34-030-L	30	6.5	5	25	50
DA1-34030FB-B20C	FS4	37.2	DX-EMC34-042	42	30	25	50	75
			DX-EMC34-042-L	42	6.5	5	25	50
DA1-34030FB-B55C	FS4	37.2	DX-EMC34-042	42	30	25	50	75
			DX-EMC34-042-L	42	6.5	5	25	50
DA1-34039FB-B20C	FS4	47	DX-EMC34-055	55	30	25	50	75
			DX-EMC34-055-L	55	6.5	5	25	50
DA1-34039FB-B55C	FS4	47	DX-EMC34-055	55	30	25	50	75
			DX-EMC34-055-L	55	6.5	5	25	50
DA1-34046FB-B20C	FS4	52.4	DX-EMC34-055	55	30	25	50	75
			DX-EMC34-055-L	55	6.5	5	25	50
DA1-34046FB-B55C	FS4	52.4	DX-EMC34-055	55	30	25	50	75
			DX-EMC34-055-L	55	6.5	5	25	50
DA1-34061FB-B20C	FS5	66.1	DX-EMC34-075	75	22	25	50	75
			DX-EMC34-075-L	75	6.5	5	25	50
DA1-34061FB-B55C	FS5	63.8	DX-EMC34-075	75	22	25	50	75
			DX-EMC34-075-L	75	6.5	5	25	50
DA1-34072FB-B20C	FS5	77.3	DX-EMC34-100	100	30	25	50	75
			DX-EMC34-100-L	100	6.5	5	25	50

Device type	Frame size	Input current	Radio interference filter	Rated operational current	Leakage current (IEC38 +10 %)	C1	C2	C3
		A	Type	A	A	m	m	m
DA1-34072FB-B55C	FS5	76.4	DX-EMC34-100	100	30	25	50	75
			DX-EMC34-100-L	100	6.5	5	25	50
DA1-34090FB-B55C	FS6	92.2	DX-EMC34-100	100	30	25	50	75
			DX-EMC34-100-L	100	6.5	5	25	50
DA1-34110FB-B55C	FS6	112.5	DX-EMC34-130	130	22	25	50	75
			DX-EMC34-130-L	130	6.5	5	25	50
DA1-34150FB-B55C	FS6	153.2	DX-EMC34-180	180	31	25	50	75
			DX-EMC34-180-L	180	7	5	25	50
DA1-34180FB-B55C	FS6	183.7	DX-EMC34-250	250	37	25	50	75
			DX-EMC34-250-L	250	7	5	25	50
DA1-34202FB-B55C	FS7	217	DX-EMC34-250	250	37	25	50	75
			DX-EMC34-250-L	250	7	5	25	50
DA1-34240FB-B55C	FS7	256	DX-EMC34-400	400	60	5	25	50
			DX-EMC34-400-L	400	8	5	25	50
DA1-34302FB-B55C	FS7	302	DX-EMC34-400	400	60	5	25	50
			DX-EMC34-400-L	400	8	5	25	50
DA1-34370FB-B55C	FS8	370	DX-EMC34-400	400	60	5	25	50
			DX-EMC34-400-L	400	8	5	25	50
DA1-34450FB-B55C	FS8	450	DX-EMC34-750	750	60	5	25	50
			DX-EMC34-750-L	750	8	5	25	50

→ DX-EMC…-**FS**: Base-mounted filter for the specified frame size
DX-EMC…-**L**: Low leakage current

6.9 Braking resistors

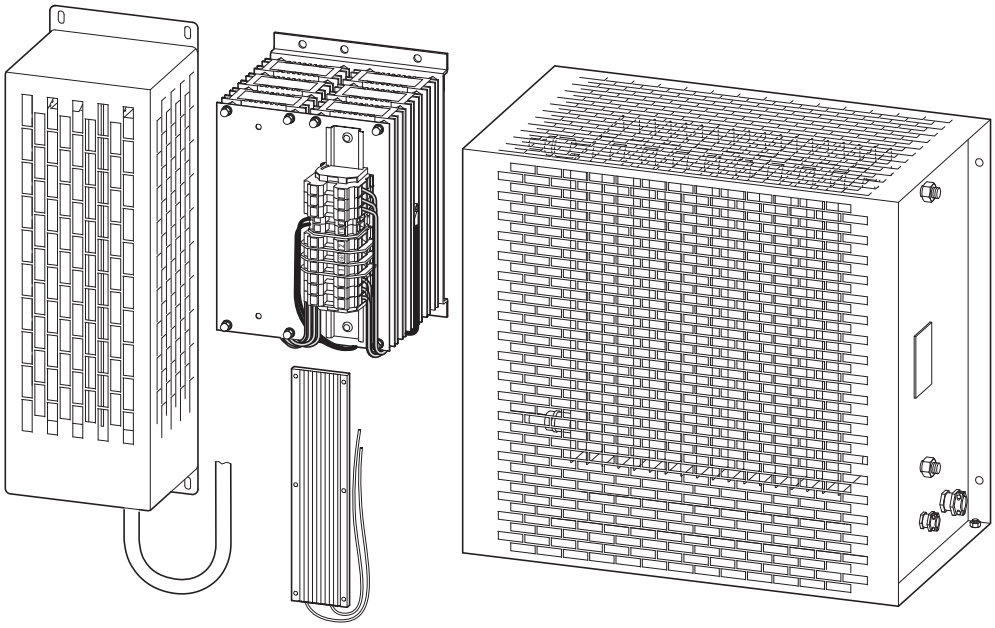


Figure 104: Examples of DX-BR… braking resistor designs

WARNING

The resistor value must not be less than the specified minimum resistance R_{Bmin}

CAUTION

Braking resistors get extremely hot during operation!

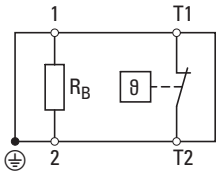
The following tables provide examples of DX-BR… braking resistors rated for individual DA1 variable frequency drives. They are specified according to the "High duty" and "Low duty" classification, for intermittent braking, with a cycle time t_C of 120 seconds, corresponding to a pulse power P_{Peak}, which corresponds to the maximum braking output P_{max} of the variable frequency drive with the rated motor output.

Load groups (simplified classification)

- **Low duty**: Low load with short braking duration and low duty factor (up to about 25 %, e.g., 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 %, e.g., for elevators, downhill conveyors, winders, centrifuges, flywheel motors, and large fans.

All braking resistors feature a temperature switch for protection against thermal overload.

This dry contact (N/C) can be directly integrated into the DA1 variable frequency drive's control section and work as an external fault message (control terminal 10, DI5, parameter P9-08 = 5).



Exception:

Resistors DX-BR3-100 and DX-BR5-33 do not feature a circuit-breaker. They are inserted into the corresponding recesses on the DA1 variable frequency drive's heat sinks (frame sizes FS2 and FS3 for IP20 and FS4 and FS5 for IP55) and are automatically protected against thermal overloads as a result (heat sink overtemperature, display: 0- t).

For more information and technical data on the DX-BR… braking resistors listed here, please refer to the corresponding instruction leaflet for the individual designs: IL04012024Z, IL04011ZU, IL04014ZU, IL04015ZU and IL04021ZU.

Table 44: Braking resistance – DA1 voltage class 230 V

Device type	Frame size	Resistor value			Braking resistance (Low duty)					Braking resistance (High duty)				
					Type					Type				
		R_{Bmin}	R_{Brec}	P_{max}		R_B	P_{DB}	ED	t_{Brake}		R_B	P_{DB}	ED	t_{Brake}
		Ω	Ω	kW		Ω	kW	%	s		Ω	kW	%	s
Voltage class: 230 V | Mains voltage (50/60 Hz) U_{LN} 200 (-10 %) - 240 (+10 %) V | U_e 230 V AC, single-phase / U_2 230 V AC, 3-phase														
DA1-124D3FB-A20C	FS2	25	100	0.75	DX-BR3-100	100	0.2	27	32	DX-BR100-240	100	0.24	32	38
DA1-127D0FB-A20C	FS2	25	50	1.5	DX-BR3-100	100	0.2	13	16	DX-BR050-600	50	0.6	40	48
DA1-12011FB-A20C	FS2	25	35	2.2	DX-BR3-100	100	0.2	9	11	DX-BR042-720	42	0.72	33	39
Voltage class: 230 V | Mains voltage (50/60 Hz) U_{LN} 200 (-10 %) - 240 (+10 %) V | U_e 230 V AC, 3-phase / U_2 230 V AC, 3-phase														
DA1-324D3FB-A20C	FS2	25	100	0.75	DX-BR3-100	100	0.2	27	32	DX-BR100-240	100	0.24	32	38
DA1-327D0FB-A20C	FS2	25	50	1.5	DX-BR3-100	100	0.2	13	16	DX-BR050-600	50	0.6	40	48
DA1-32011FB-A20C	FS2	25	35	2.2	DX-BR3-100	100	0.2	9	11	DX-BR042-720	42	0.72	33	39
DA1-32018FB-A20C	FS3	20	20	4	DX-BR5-33	33	0.5	13	15	DX-BR025-1440	25	1.44	36	43
DA1-32024FB-A20C	FS3	20	20	5.5	DX-BR5-33	33	0.5	9	11	DX-BR025-1920	25	1.92	35	42
DA1-32024FB-B55C	FS4	12	20	5.5	DX-BR5-33	33	0.5	9	11	DX-BR025-1920	25	1.92	35	42
DA1-32030FB-B55C	FS4	12	22	7.5	DX-025-1440	25	1.44	19	23	DX-027-2880	27	2.88	38	46
DA1-32046FB-B55C	FS4	12	22	11	DX-025-1440	25	1.44	13	16	DX-BR022-5K1	22	5.1	46	56
DA1-32061FB-B55C	FS5	6	12	15	2 // DX-025-1440	12.5	2.88	19	23	DX-BR012-5K1	12	5.1	34	41
DA1-32072FB-B55C	FS5	6	12	18.5	2 // DX-025-1440	12.5	2.88	16	19	DX-BR012-9K2	12	9.2	50	60
DA1-32090FB-B55C	FS6	6	6	22	2 // DX-BR025-1440	12.5	2.88	13	16	DX-BR012-9K2	12	9.2	42	50
DA1-32110FB-B55C	FS6	3	6	30	2 // DX-BR025-1440	12.5	2.88	10	12	DX-BR012-9K2	12	9.2	31	37
DA1-32150FB-B55C	FS6	3	6	37	DX-BR006-5K1	6	5.1	14	17	DX-BR006-18K1	6	18.1	49	59
DA1-32180FB-B55C	FS6	3	6	45	DX-BR006-5K1	6	5.1	11	14	DX-BR006-18K1	6	18.1	40	48
DA1-32202FB-B55C	FS7	3	6	55	DX-BR006-5K1	6	5.1	9	11	DX-BR006-18K1	6	18.1	33	39
DA1-32248FB-B55C	FS7	3	6	75	DX-BR006-9K2	6	9.2	12	15	DX-BR006-33K	6	33	44	53

2 // DX-BR… = Two units of this model connected in parallel | 2 & DX-BR… = Two units of this model connected in series
2 // 2 & DX-BR… = Four units of this model, two sets of two connected in parallel, and the resulting two parallel links connected in series with each other
Resistance values: R_{Bmin} = minimum permitted resistance value; R_{Brec} = recommended resistance value
P_{max} = Rated power for the low duty and high duty classification

Table 45: Braking resistance – DA1 voltage class 400 V

Device type	Frame size	Resistor value			Braking resistance (Low duty)					Braking resistance (High duty)				
					Type					Type				
		R_{Bmin}	R_{Brec}	P_{max}		R_B	P_{DB}	ED	t_{Brake}		R_B	P_{DB}	ED	t_{Brake}
		Ω	Ω	kW		Ω	kW	%	s		Ω	kW	%	s
Voltage class: 400 V | Mains voltage (50/60 Hz) U_{LN} 380 (-10 %) - 480 (+10 %) V | U_e 400 V AC, 3-phase / U_2 400 V AC, 3-phase														
DA1-342D2FB-A20C	FS2	50	400	0.75	DX-BR3-100	100	0.2	27	32	DX-BR400-400	400	0.4	53	64
DA1-344D1FB-A20C	FS2	50	200	1.5	DX-BR3-100	100	0.2	13	16	DX-BR216-600	216	0.6	40	48
DA1-345D8FB-A20C	FS2	50	150	2.2	DX-BR3-100	100	0.2	9	11	DX-BR150-0K8	150	0.8	36	44
DA1-349D5FB-A20C	FS2	50	100	4	DX-BR100-600	100	0.6	15	18	2 & DX-BR050-920	100	1.92	48	58
DA1-34014FB-A20C	FS3	40	75	5.5	DX-BR100-600	100	0.6	11	13	2 & DX-BR050-920	100	1.92	35	42
DA1-34018FB-A20C	FS3	40	50	7.5	DX-BR050-720	50	0.72	10	12	DX-BR050-2880	50	2.88	38	46
DA1-34024FB-A20C	FS3	40	40	11	DX-BR050-920	50	0.92	9	10	DX-BR047-5K1	47	5.1	46	56
DA1-34024FB-B55C	FS4	22	40	11	DX-BR050-920	50	0.96	9	10	DX-BR047-5K1	47	5.1	46	56
DA1-34030FB-B55C	FS4	22	22	15	DX-BR025-1440	25	1.44	10	12	DX-BR022-5K1	22	5.1	34	41
DA1-34039FB-B55C	FS4	22	22	18.5	DX-BR025-1920	25	1.92	10	12	DX-BR022-9K2	22	9.2	50	60
DA1-34046FB-B55C	FS4	22	22	22	DX-BR025-1920	25	1.92	9	10	DX-BR022-9K2	22	9.2	42	50
DA1-34061FB-B55C	FS5	12	12	30	2 // DX-BR025-1440	12.5	2.88	10	12	DX-BR012-9K2	12	9.2	31	37
DA1-34072FB-B55C	FS5	12	12	37	2 // DX-BR027-1920	12.5	3.84	10	12	DX-BR012-18K1	12	18.1	49	59
DA1-34090FB-B55C	FS6	6	6	45	DX-BR006-5K1	6	5.1	11	14	DX-BR006-18K1	6	18.1	40	48
DA1-34110FB-B55C	FS6	6	6	55	DX-BR006-9K2	6	9.2	17	20	DX-BR006-18K1	6	18.1	33	39
DA1-34150FB-B55C	FS6	6	6	75	DX-BR006-9K2	6	9.2	12	15	DX-BR006-33K3	6	33.3	44	53
DA1-34180FB-B55C	FS6	6	6	90	DX-BR006-9K2	6	9.2	10	12	DX-BR006-33K3	6	33.3	37	44
DA1-34202FB-B55C	FS7	6	6	110	DX-BR006-18K1	6	18.1	16	20	DX-BR012-18K1	6	36.2	33	39
DA1-34240FB-B55C	FS7	6	6	132	DX-BR006-18K1	6	18.1	14	16	4 // DX-BR006-18K1	6	72.4	55	66
DA1-34302FB-B55C	FS7	6	6	160	DX-BR006-18K1	6	18.1	11	14	4 // DX-BR006-18K1	6	72.4	45	54

Device type	Frame size	Resistor value			Braking resistance (Low duty)					Braking resistance (High duty)				
					Type					Type				
		R_{Bmin}	R_{Brec}	P_{max}		R_B	P_{DB}	ED	t_{Brake}		R_B	P_{DB}	ED	t_{Brake}
		Ω	Ω	kW		Ω	kW	%	s		Ω	kW	%	s
DA1-34370FB-B20C	FS8	2	2	200	DX-BR006-33K3	6	33.3	17	20	DX-BR002-102K4	2	102.4	51	61
DA1-34450FB-B20C	FS8	2	2	250	DX-BR006-33K3	6	33.3	13	16	DX-BR002-102K4	2	102.4	41	49

2 // DX-BR… = Two units of this model connected in parallel | 2 & DX-BR… = Two units of this model connected in series
2 // 2 & DX-BR… = Four units of this model, two sets of two connected in parallel, and the resulting two parallel links connected in series with each other
Resistance values: R_{Bmin} = minimum permitted resistance value; R_{Brec} = recommended resistance value
P_{max} = Rated power for the low duty and high duty classification

Table 46: Braking resistance – DA1 voltage class 575 V

Device type	Frame size	Resistor value			Braking resistance (Low duty)					Braking resistance (High duty)				
					Type					Type				
		R_{Bmin}	R_{Brec}	P_{max}		R_B	P_{DB}	ED	t_{Brake}		R_B	P_{RD}	ED	t_{Brake}
		Ω	Ω	kW		Ω	kW	%	s		Ω	kW	%	s
Voltage class: 575 V | Mains voltage (50/60 Hz) U_{LN} 500 (-10 %) - 600 (+10 %) V | U_e 575 V AC, 3-phase / U_2 575 V AC, 3-phase														
DA1-352D1NB-A20C	FS2	600	600	0.75	2 & DX-BR430-100	860	0.2	27	32	3 & DX-BR210-200	630	0.6	80	96
DA1-353D1NB-A20C	FS2	300	300	1.5	DX-BR400-0K4	400	0.4	27	32	2 & DX-BR150-0K5	300	1	67	80
DA1-354D1NB-A20C	FS2	200	200	2.2	DX-BR200-0K4	200	0.4	18	22	2 & DX-BR100-600	200	1.2	55	65
DA1-356D5NB-A20C	FS2	150	150	4	DX-BR150-0K5	150	0.5	13	15	2 & DX-BR075-1K1	150	2.2	55	66
DA1-359D0NB-A20C	FS2	100	100	5.5	DX-BR100-0K8	100	0.8	15	17	2 & DX-BR050-1440	100	2.88	52	63
DA1-35012NB-A20C	FS3	80	80	7.5	DX-BR100-920	100	0.96	13	15	2 & DX-BR050-1440	100	2.88	38	46
DA1-35017NB-A20C	FS3	50	50	11	DX-BR050-1440	50	1.44	13	16	2 & DX-BR025-1920	50	3.84	35	42
DA1-35022NB-A20C	FS3	33	33	15	DX-BR050-1440	50	1.44	10	12	DX-BR040-5K1	40	5.1	34	41
DA1-35022NB-B55C	FS4	33	33	15	DX-BR050-1440	50	1.44	10	12	DX-BR040-5K1	40	5.1	34	41
DA1-35028NB-B55C	FS4	33	33	18.5	DX-BR040-3K1	40	3.1	17	20	DX-BR047-9K2	47	9.2	50	60
DA1-35034NB-B55C	FS4	22	22	22	DX-BR022-3K1	22	3.1	14	17	DX-BR022-9K2	22	9.2	42	50
DA1-35043NB-B55C	FS5	16	16	30	DX-BR022-5K1	22	5.1	17	20	DX-BR022-9K2	22	9.2	31	37
DA1-35054NB-B55C	FS5	16	16	37	DX-BR022-5K1	22	5.1	14	17	2 & DX-BR012-9K2	24	18.4	50	60
DA1-35065NB-B55C	FS5	12	12	45	DX-BR012-5K1	12	5.1	11	14	DX-BR012-18K1	12	18.1	40	48
DA1-35078NB-B55C	FS6	12	12	55	DX-BR012-5K1	12	5.1	9	11	DX-BR012-18K1	12	18.1	33	39
DA1-35105NB-B55C	FS6	8	8	75	DX-BR012-9K2	12	9.2	12	15	2 & DX-BR006-18K1	12	36.2	48	58
DA1-35130NB-B55C	FS6	8	8	90	DX-BR012-9K2	12	9.2	10	12	2 & DX-BR006-18K1	12	36.2	40	48
DA1-35150NB-B55C	FS6	8	8	110	DX-BR012-9K2	12	9.2	8	10	2 & DX-BR006-18K1	12	36.2	33	39

2 & DX-BR… Two units of this model connected in series
Resistance values: R_{Bmin} = minimum permitted resistance value; R_{Brec} = recommended resistance value
P_{max} = Rated power for the low duty and high duty classification

6.10 Motor chokes

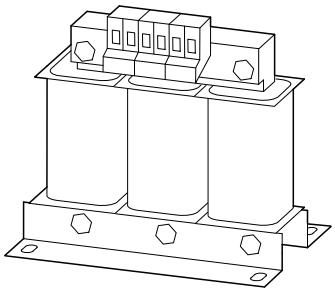


Figure 105: Motor choke DX-LM3…

Table 47: Motor chokes that should be used

Device type			Motor choke that should be used[1]	
				Rated operational current
DA1-12… DA1-32…	DA1-34…	DA1-35…[2]	Type	A
DA1-124D3…	DA1-342D2…	DA1-352D1…	DX-LM3-005	5
DA1-324D3…	DA1-344D1…	DA1-353D1…	DX-LM3-005	5
		DA1-354D1…	DX-LM3-005	5
DA1-127D0…	DA1-345D8…	DA1-356D5…	DX-LM3-008	8
DA1-327D0…			DX-LM3-008	8
DA1-12011…[3]	DA1-349D5…	DA1-359D0…	DX-LM3-011	11
DA1-32011…[3]			DX-LM3-011	11
	DA1-34014…	DA1-35012…	DX-LM3-016	16
DA1-32018..	DA1-34018…	DA1-35017…	DX-LM3-035	35
DA1-32024…	DA1-34024…	DA1-35022…	DX-LM3-035	35
DA1-32030…	DA1-34030…	DA1-35028…	DX-LM3-035	35
		DA1-35034…	DX-LM3-035	35
DA1-32046…	DA1-34039…	DA1-35043…	DX-LM3-050	50
	DA1-34046…		DX-LM3-050	50
DA1-32061…	DA1-34061…	DA1-35054…	DX-LM3-063	63
DA1-32072…	DA1-34072…	DA1-35065….	DX-LM3-080	80
		DA1-35078…	DX-LM3-080	80
DA1-32090…	DA1-34090…		DX-LM3-100	100
DA1-32110…	DA1-34110…	DA1-35105…	DX-LM3-150	150
DA1-32150…	DA1-34150…	DA1-35130…	DX-LM3-150	150
		DA1-35150…	DX-LM3-150	150
DA1-32180…	DA1-34180…		DX-LM3-180	180
DA1-32202…	DA1-34202…		DX-LM3-220	220
DA1-32248…	DA1-34240…		DX-LM3-260	260

Device type			Motor choke that should be used[1]	
				Rated operational current
DA1-12… DA1-32…	**DA1-34…**	**DA1-35…**[2]	**Type**	**A**
	DA1-34302…		DX-LM3-303	303
	DA1-34370…[4]		DX-LM3-370	370
	DA1-34450…[4]		DX-LM3-450	450

1) Maximum ambient temperature of 50 °C for the corresponding DA1 variable frequency drive with IP20 protection. For devices with IP55 protection: with a derating of 1.5 % per °C above 40 °C on rated operational current I_e of DA1 and DX-LM3…
2) DX-LM3… motor choke only for motor voltages (= mains voltages U_{LN}) of up to 500 V AC
3) Above 40 °C, use DX-LM3-016 motor choke
4) Above 40 °C, with a derating of 1.5 % on rated operational current I_e of DA1 and DX-LM3…

For more information and technical data on DX-LM3… motor chokes, please refer to instruction leaflet IL00906003Z.

6.11 Sine filters

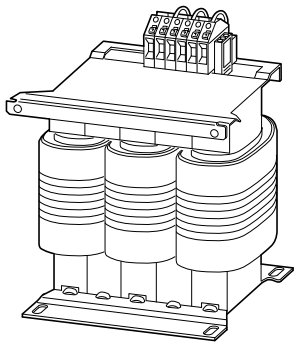


Figure 106:Sine filter DX-SIN3…

Sine filter DX-SIN3… should be operated only with fixed switching frequencies.
Accordingly, the switching frequency (P2-24) must be set to the value set in parameter P6-02 (auto temperature management) (P2-24 = P6-02).

Permissible switching frequencies for DA1 with DX-SIN3…:
1 ≙ 8 kHz; 2 ≙12 kHz

For the DA1 variable frequency drive, the set value with the double-modulation procedure is the double value of the effective value in the sine filter (1 ≙ 8 kHz → 4 kHz; 2 ≙ 12 kHz → 6 kHz).

Table 48: Assigned sine filters (degree of protection IP00)

Device type			**Assigned sine filter**[1] **rated frequency f_2 = 0 - 150 Hz**		
DA1-12… DA1-32…	**DA1-34…**	**DA1-35…**[2]	**Type**	**Rated operational current** **A**	**Voltage drop u_K at 400 V** **%**
–	DA1-342D2…	DA1-352D1…	DX-SIN3-004	4	k. A.
–	–	DA1-353D1…	DX-SIN3-004	4	k. A.
DA1-124D3…	DA1-344D1…	DA1-354D1…	DX-SIN3-010	10	7
DA1-127D0…	DA1-345D8…	DA1-356D5…	DX-SIN3-010	10	7
DA1-324D3…	DA1-349D5…	DA1-359D0…	DX-SIN3-010	10	7
DA1-327D0…	–	–	DX-SIN3-010	10	7
DA1-12011…[3]	DA1-34014…	DA1-35012…	DX-SIN3-016	16.5	7.5
DA1-32011…[3]	–	–	DX-SIN3-016	16.5	7.5
DA1-32018…	DA1-34018…	DA1-35017…	DX-SIN3-023	23.5	8
–	DA1-34024…	DA1-35022…	DX-SIN3-023	23.5	8
DA1-32024…	DA1-34030...	DA1-35028…	DX-SIN3-032	32	8.7
DA1-32030…	–	–	DX-SIN3-032	32	8.7
DA1-32046…	DA1-34039…	DA1-35034…	DX-SIN3-048	48	7.8
–	DA1-34046…	DA1-35041..	DX-SIN3-048	48	7.8
–	–	DA1-35043…	DX-SIN3-048	48	7.8
DA1-32060…	DA1-34061…	DA1-35054…	DX-SIN3-061	61	8.3
DA1-32061...	–	–	DX-SIN3-061	61	8.3
DA1-32072…	–	DA1-35065…	DX-SIN3-072	72	7.5
DA1-32090…	DA1-32072…	DA1-35078…	DX-SIN3-090	90	10
–	DA1-34090…	–	DX-SIN3-090	90	10
DA1-32110…	DA1-34110…	DA1-35105…	DX-SIN3-115	115	11
DA1-32150…	DA1-34150…	DA1-35130…	DX-SIN3-150	150	10.2
DA1-32180…	DA1-34180…	DA1-35150…	DX-SIN3-180	180	7.5
DA1-32202…	DA1-34202…	–	DX-SIN3-250	250	7.5
DA1-32248…	DA1-34240…	–	DX-SIN3-250	250	7.5
–	DA1-34302…	–	DX-SIN3-440	440	7.5
–	DA1-34370…	–	DX-SIN3-440	440	7.5
–	DA1-34450…	–	DX-SIN3-480	480	7

1) Maximum permissible ambient air temperature: + 50 °C; maximum permissible motor voltage U_{2max}: 520 V
2) Sine filter DX-SIN3… only for (= supply voltage U_{LN}) of up to 500 V AC
3) DA1-12011… and DA1-32011… for load currents (rated motor current) of up to 10 A

For more information and technical data on DX-SIN3… sine filters, please refer to instruction leaflet IL00906001Z.

6.12 All-pole sine filter

Please inquire for DX-SIN3-…-A all-pole sine filters for motor currents of up to 180 A.

All-pole sine filters make it possible to reduce differential-mode and common-mode interference at the variable frequency drive output when using extremely long motor cable lengths. This makes it possible to eliminate the bearing currents, caused by common-mode voltage, between the motor windings' neutral point and earth potential, extending the motor's lifespan.

DX-SIN3-…-A all-pole sine filters also require being connected to DC+ (or +) and DC- (or -) on the internal DC link in DA1 variable frequency drives.

They can be used

- for fixed switching frequencies ≧ 8 kHz (P2-24, double modulation),
- Output voltage U_{2max} to 500 V,
- Rotating field frequencies (f_2) of 0 to 60 Hz.

They make it possible to forego the use of screened motor cables.

DX-SIN3-…-A all-pole sine filters may be operated only with fixed switching frequencies.
Accordingly, the switching frequency (P2-24) must be set to the value set in parameter P6-02 (auto temperature management) (P2-24 = P6-02).

Permissible switching frequencies for DA1 with DX-SIN3…:
1 ≙ 8 kHz; 2 ≙12 kHz

For the DA1 variable frequency drive, the set value with the double-modulation procedure is the double value of the effective value in the sine filter (1 ≙ 8 kHz → 4 kHz; 2 ≙ 12 kHz → 6 kHz).

Table 49: Rated all-pole sine filters (IP20 protection)

Device type	**Rated sine filter[1], rated frequency f_2 = 0 - 150 Hz**		
DA1-34…	**Type**	**Rated operational current** **A**	**Voltage drop u_K at 400 V** **%**
DA1-342D2…	DX-SIN3-005-A	5	5
DA1-344D1…	DX-SIN3-005-A	5	5
DA1-345D8…	DX-SIN3-013-A	13	5
DA1-349D5…	DX-SIN3-013-A	13	5
DA1-34014…	DX-SIN3-024-A	24	5
DA1-34018…	DX-SIN3-024-A	24	5
DA1-34024…	DX-SIN3-024-A	24	5
DA1-34030…	DX-SIN3-046-A	46	5
DA1-34039…	DX-SIN3-046-A	46	5
DA1-34046…	DX-SIN3-046-A	46	5
DA1-34061…	DX-SIN3-062-A	62	5
DA1-34072…	DX-SIN3-075-A	75	5
DA1-34090…	DX-SIN3-150-A	150	5
DA1-34110…	DX-SIN3-150-A	150	5
DA1-34150…	DX-SIN3-150-A	150	5

7 Accessories

7.1 List of accessories

Type	Description	Document
DX-KEY-....	External operating panel	AP040022
DXA-EXT-3 RO	Adds three relay outputs	IL040006ZU
DXA-EXT-3DI1RO	Adds three digital inputs and one relay output	IL040007ZU
DXA-EXT-ENCOD	Dual-channel encoder module for using closed-loop vector control	AP040028DE
DX-NET-SWD1	Interface card for connecting to a SmartWire-DT network	MN04012009Z
DX-COM-STICK3-KIT	Parameter copying stick for establishing a Bluetooth connection to PC software, smartphone app	MN040003 IL040051ZU
DX-CBL-PC-3M0	Wired communication between DA1 and PC	MN040003 IL040025ZU
DX-SPL-R145-2SL1PL	RJ45, 8-pole, splitter, two sockets, one plug on short connection cable	IL04012023Z
DX-SPL-RJ45-3SL	RJ45, 8-pole, splitter, three sockets	IL04012023Z
DX-EMC-MNT...	EMC cable bracket. Can be used to route and secure cables in the connection area	IL040010ZU
drivesConnect	PC parameter configuration software for variable frequency drives, with integrated oscilloscope function, drive control function, and function block creation for DA1	MN040003

7 Accessories
7.1 List of accessories

Alphabetical index

T

U

V

W