

M-Max™ Frequency Inverter



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Original Operating Instructions

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 German manual.

1st published 2009, edition date 06/09,

2nd edition 04/10,

3rd edition 01/12,

See revision protocol in the "About this manual" chapter

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Production: DHW

Translation: globaldocs GmbH

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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.

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0 About This Manual

This manual contains special information required for the correct selection and connection a frequency inverter and its configuration to your specific requirements using the parameters. The information given refers to the stated hardware and software versions. The manual describes all sizes of the M-Max device series. The differences and special characteristics of each rating level and size are listed accordingly.

0.1 List of revisions

The following significant amendments have been introduced since previous issues:

Publication date	Seite	Key word	New	Modification	omitted
04/10	All	Completely revised for the second upgrade of the MMX	✓		
01/12	All	Completely revised for the extended ratings to 18.5 kW (400 V).	✓		

0.2 Target group

The content of the manual is written for engineers and electricians. A specialist knowledge of electrical engineering and fundamental technical principles is needed for commissioning.

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.

0.3 Writing conventions

The symbols used in this manual have the following meanings:

▶ indicates actions to be taken.

→ Indicates useful tips.

NOTICE

Warns about the possibility of material damage.



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.

For greater clarity, the name of the current chapter and the name of the current section are shown in the page header.



In order to make it easier to understand some of the figures included in this manual, the housing of the frequency inverter, as well as other safety-relevant parts, have been left out. However, it is important to note that the frequency inverter must always be operated with its housing placed properly, 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.



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

www.moeller.net → Support → Download Center

0.4 Abbreviations and Symbols

The abbreviations and symbols used in this manual have the following meanings:

EMC	Electromagnetic compatibility
FS	Frame Size
FWD	Forward run (clockwise rotating field)
GND	Ground, 0 V potential
IGBT	Insulated-gate bipolar transistor
LCD	Liquid Crystal Display
PDS	Power Drives System
PES	EMC connection to PE for shielded lines
PNU	Parameter number
REV	Reverse run (anticlockwise rotation field active)
UL	Underwriters Laboratories

M-Max™ frequency inverters are divided into three voltage categories:

- 100 V (MMX11)
- 200 V (MMX12..., MMX32...)
- 400 V (MMX34...)

0.5 Mains supply voltages

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

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

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

The wide tolerance range of frequency inverter M-Max™ takes into account a permissible voltage drop of an additional 4 % ($U_{LN} - 14\%$) in load networks, while, in the 400 V category, it takes into account the North American line voltage of 480 V +10 % (60 Hz).

The permissible connection voltages for the M-Max™ series are listed in the Technical Specifications section in the appendix.

The rated operational data of the mains voltage is always based on the mains frequencies 50/60 Hz (50 Hz -10 % - 60 Hz +10 %).

0.6 Units of Measurement

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

Table 1: Unit conversion examples

Designation	US-American value	SI value	Conversion value	US-American designation
Length	1 inch (")	25.4 mm	0.0394	inch
Merit	1 HP = 1.014 PS	0.7457 kW	1.341	horsepower
Torque	1 lbf in	0.113 Nm	8.851	pound-force inches
Temperature	1 °F (T _F)	-17.222 °C (T _C)	$T_F = T_C \times 9/5 + 32$	Fahrenheit
Speed	1 rpm	1 min ⁻¹	1	Revolutions per minute
Weight	1 lb	0.4536 kg	2.205	pound

1 M-Max™ Series

1.1 System overview

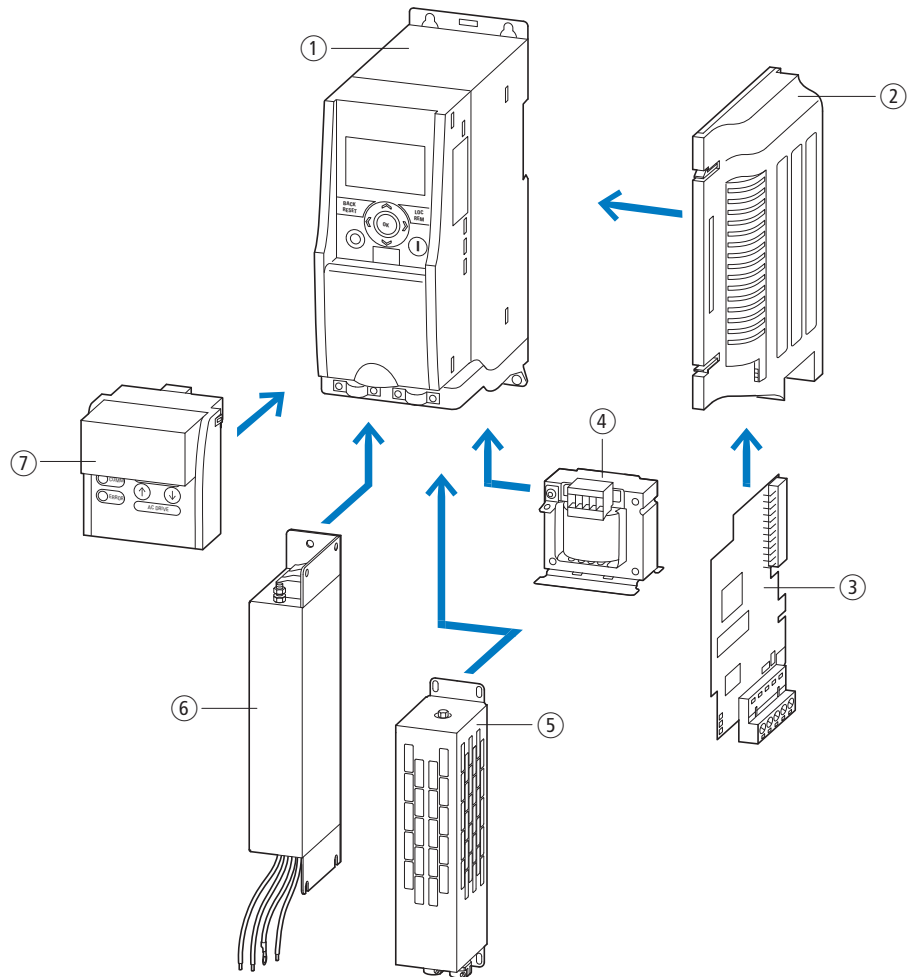


Figure 1: System overview

- ① Frequency inverters MMX-...
- ② MMX-NET-XA, MMX-NET-XB mounting frame for fieldbus connection
- ③ Fieldbus connection
CANopen XMX-NET-CO-A
PROFIBUS DP with XMX-NET-PS-A screw terminals
PROFIBUS DP with XMX-NET-PD-A Sub-D plug
- ④ Mains choke DEX-LN..., motor reactor DEX-LM3..., sinusoidal filter SFB400...
- ⑤ BR... braking resistance
- ⑥ MMX-COM-PC communication module, MMX-KEY-9 external keypad
- ⑦ external interference suppression filters for MMX...NO-0

1.2 Checking the Delivery



Before opening the packaging go over the nameplate on the packaging and check for whether the delivered frequency inverter is the same part no. as the one you ordered.

M-MAX™ frequency inverters have been carefully packaged and prepared for delivery. The devices should be shipped only in their original packaging with suitable transportation materials. Please take note of the labels and instructions on the packaging, as well as of those meant for the unpacked device.

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

The packaging must contain the following parts:

- a M-Max™ frequency inverter,
- an accessory kit for EMC-suitable installation
- instructional leaflet IL04020006Z (FS1, FS2 and FS3) and IL04020007Z (FS4 and FS5),
- a data carrier (CD-ROM) with documentation for M-Max™.

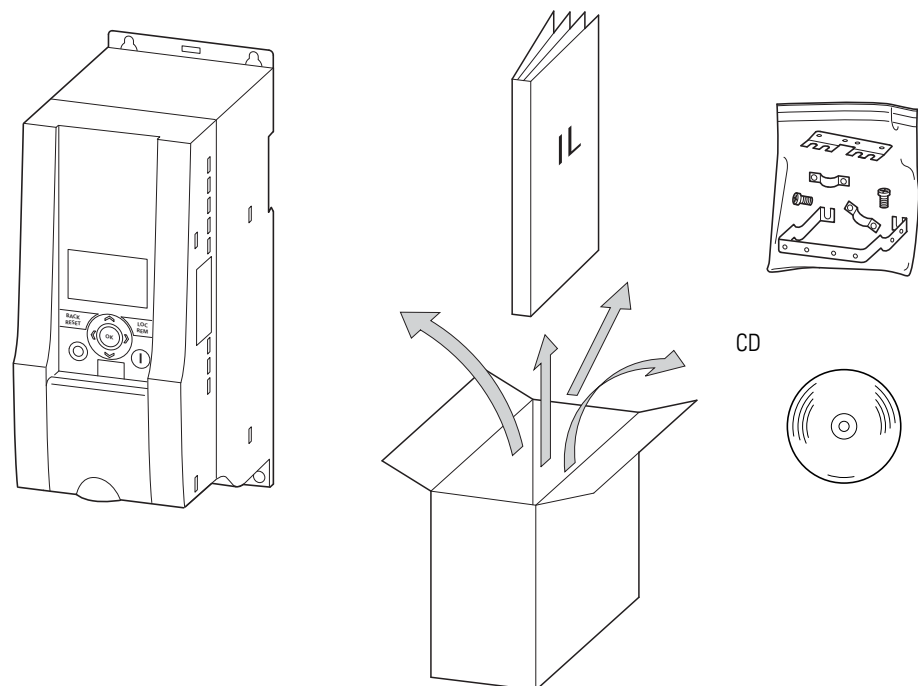



Figure 2: Equipment supplied

1.3 Rated data

1.3.1 Rating plate

The device specific rated operational data of the frequency inverter M-Max™ is shown on the nameplate on the side of the device and on the rear of the control signal terminal cover.

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

Inscription	Importance
MMX34AA3D3F0-0	Part no.: MMX = frequency inverter of the M-Max™ series 3 = Three-phase power connection 4 = 400 V voltage category AA = Instance (Software version A and alphanumerical display) 3D3 = 3.3 A rated operational current (3-decimal-3) F = Integrated radio interference filter 0 = IP20 protection type 0 = No integrated optional assembly
Input	Power connection rating: Three-phase AC voltage (U_e 3- AC), 380 - 480 V voltage, 50/60 Hz frequency, input phase current (4.0 A).
Output	Load side (motor) rating: Three-phase AC voltage (0 - U_e), output phase current (3.3 A), output frequency (0 - 320 Hz)
Power	Assigned motor rating. 1.1 kW at 400 V/1.5 HP at 460 V for a four-pole internally-cooled or surface-cooled alternating current three-phase asynchronous motor. (1500 min ⁻¹ at 50 Hz/ 1800 rpm at 60 Hz)
S/N	Serial number
	Frequency inverter is an electrical apparatus. Read the manual (in this case MN04020001Z) before making any electrical connections and commissioning.
IP 20/Open part no.	Protection type of the housing: IP 20, UL (cUL) Open part no.
12W10	Production Date Week 12 of 2010.

1 M-Max™ Series

1.3 Rated data

1.3.2 catalog number selection

The catalog number selection and the part no. of the M-MAX™ frequency inverter series are in the following order:

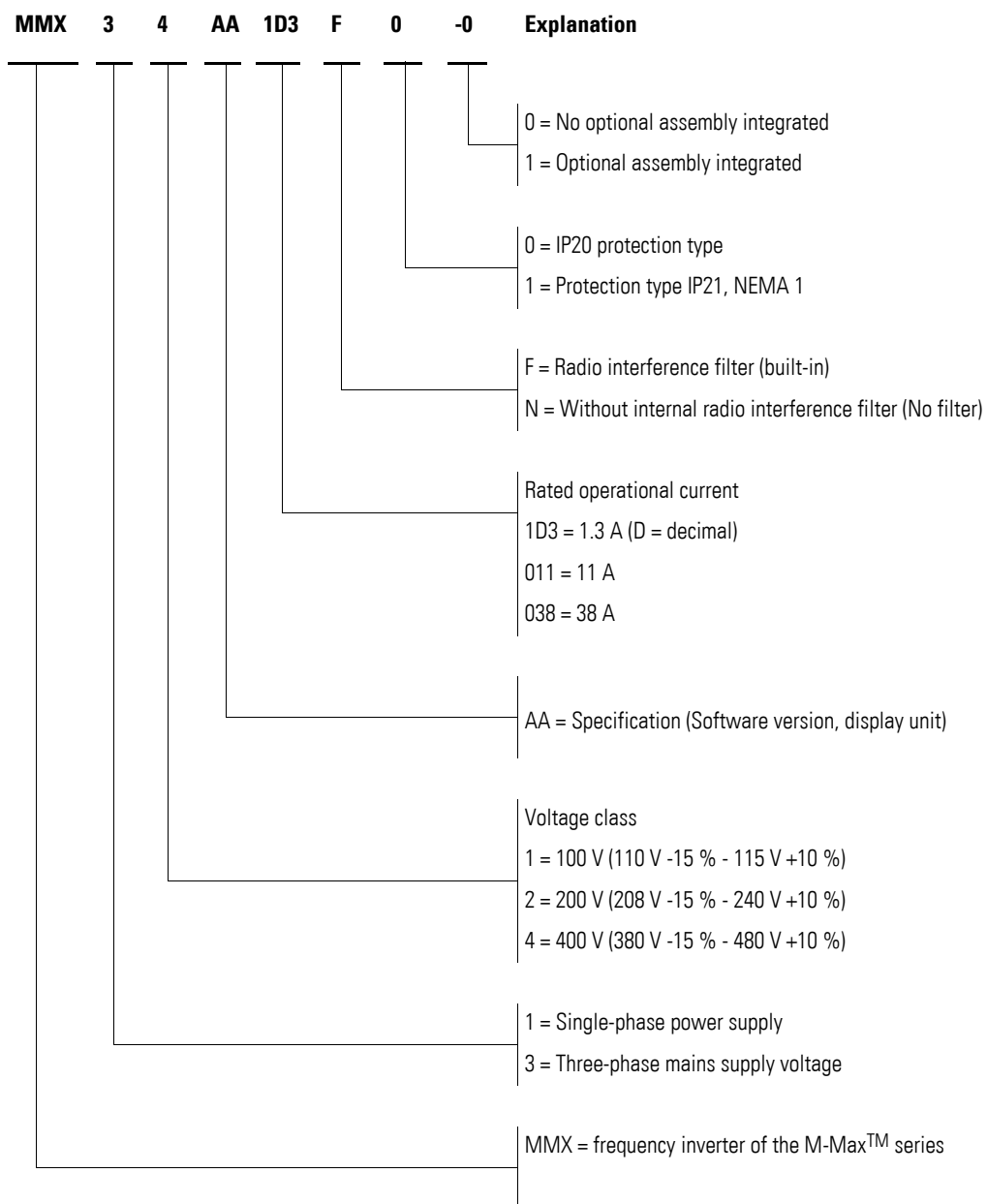


Figure 3: catalog number selection of the M-Max™ frequency inverters

Examples

Inscription	Importance
MMX11AA2D8N0-0	MMX = frequency inverter of the M-Max™ series: 1 = Single-phase power supply 1 = Rated operating voltage 115 V AA = Type of software version and display unit 2D8 = 2.8 A (rated operational current) N = No integrated interference filter (No filter) 0 = IP20 protection type 0 = No integrated optional assembly
MMX12AA1D7F0-0	MMX = frequency inverter of the M-Max™ series: 1 = Single-phase power supply 2 = Rated operating voltage 230 V AA = Type of software version and display unit 1D7 = 1.7 A (rated operational current) F = Integrated radio interference filter 0 = IP20 protection type -0 = No integrated optional assembly
MMX32AA2D4N0-0	MMX = frequency inverter of the M-Max™ series: 3 = Three-phase mains supply voltage 2 = Rated operating voltage 230 V AA = Type of software version and display unit 2D4 = 2.4 A (rated operational current) N = No integrated interference filter (No filter) 0 = IP20 protection type 0 = No integrated optional assembly
MMX34AA012F0-0	MMX = frequency inverter of the M-Max™ series: 3 = Three-phase mains supply voltage 4 = Rated operating voltage 400 V AA = Type of software version and display unit 012 = 12 A (rated operational current) F = Integrated radio interference filter 0 = IP20 protection type -0 = No integrated optional assembly
MMX34AA5D6N0-0	MMX = frequency inverter of the M-Max™ series: 3 = Three-phase mains supply voltage 4 = Rated operating voltage 400 V AA = Type of software version and display unit 5D6 = 5.6 A (rated operational current) N = No integrated interference filter (No filter) 0 = IP20 protection type -0 = No integrated optional assembly



MMX11: The mains voltage of 115 V is raised to 230 V (output voltage) through an internal voltage double connection.



MMX... N...: An externally fitted interference filter is required for operation in accordance with IEC/EN 61800-3.

Example: MMX34AA5D6N0-0.

Assigned interference suppression filter: MMX-LZ3-009 (three-phase interference funk-interference filter up to 9 A, size FS2)

1 M-Max™ Series

1.3 Rated data

1.3.3 General rated operational data

Technical Data	Symbols used in technical data and formulae	Material Type	Value
General			
Standards			EMV: IEC/EN 61800-3, IEC/EN 6100-3-12 (size FS4, FS5) Safety: IEC/EN61800-5, UL508C
Certifications and manufacturer's declarations on conformity			EMC: CE, CB, c-Tick Safety: CE, CB, UL, cUL
Production quality			RoHS, ISO 9001
Climatic proofing	ρ_w	%	< 95, average relative humidity (RH), non-condensing (EN50178)
Air quality			
Chemical vapors			IEC721-3-3: Device in operation, Class 3C2
Mechanical particles			IEC721-3-3: Device in operation, Class 3S2
Ambient air temperature			
Operation	θ	°C	-10 - +40 (+50) ¹⁾
Storage	θ	°C	-40 - +70
Altitude	H	m	0 - 1000 m above sea level, 100 % maximum ambient air temperature during operation +50 °C, over 1000 m above sea level with 1 % derating per 100 m, maximum 2000 m
Mounting position			vertical ±90°, frame sizes FS1, FS2 and FS3, vertical ±30°, frame sizes FS4 and FS5
Protection type			IP20, frame sizes FS1, FS2 and FS3 IP21/NEMA1 with optional accessories (MMX-IP21-FS...) for frame sizes FS1, FS2 and FS3, IP21/NEMA1, frame size FS4, and FS5
Busbar tag shroud			BGV A3 (VBG4, finger and back-of-hand proof)
Pollution degree			PD2
Mechanical shock resistance			IEC 68-2-27 Storage and transport: 15 g, 11 ms (in the packaging) UPS drop test (for applicable UPS weights)
Vibration			EN 60068-2-6 3 – 150 Hz, oscillation amplitude 1 mm (Peak) at 3 – 15.8 Hz, maximum acceleration amplitude 1 g at 15.8 – 150 Hz
Power section			
Radio interference level and motor cable length			C1: in 1st environment (residential area with commercial utilization) only with calibrated RFI filters C2: in 1st environment (residential area with commercial utilization) C3: in 2nd environment (industrial)
MMX...N...			No radio interference class
MMX...N... with external RFI filter (MMX-LZ...) in frame sizes FS1, FS2 and FS3			C1, C2, C3 with calibrated RFI filter according to pulse frequency and motor cable length (→ Page 168)
MMX...F...			C2 in 1st environment, max 3 m (frame size FS1, FS2, FS3), max. 15 m (frame size FS4, FS5) C3 in 2nd environment, max. 30 m (size FS1, FS2, FS3), max. 50 m (sizes FS4, FS5 with internal DC reactor)
Maximum motor cable length			30 m, frame sizes FS1, FS2, FS3 50 m, frame sizes FS4, FS5

Technical Data	Symbols used in technical data and formulae	Material Type	Value
Rated operational voltage	f_{LN}	Hz	at 50/60
MMX11	U_e	V AC	1 ~ 115 (110 -15 % - 120 + 10 %)
MMX12	U_e	V AC	1 ~ 230 (208 -15 % - 240 + 10 %)
MMX32	U_e	V AC	3 ~ 230 (208 -15 % - 240 + 10 %)
MMX34	U_e	V AC	3 ~ 400 (380 -15 % - 480 + 10 %)
Mains network configuration (AC power supply network)			Center-point grounded star network (TN-S network) Phase grounded AC networks are not permitted.
Mains switch-on frequency			Maximum one time per minute
Total harmonic distortion (without choke)	THD	%	> 120
Short-circuit current	I_K	kA	maximum < 50 MMX...N...in frame size FS4 (without internal DC choke) < 2.3 kA MMX...N...in frame size FS5 (without internal DC choke) < 3.8 kA
Mains frequency	f_{LN}	Hz	50/60, (45 - 66 Hz \pm 0 %)
Pulse frequency (switching frequency of the inverter)	f_{PWM}	kHz	1.5 - 16 (DS: 6 kHz) ¹⁾
Operation Mode			V/f characteristic control (DS), speed control with slip compensation
Output voltage	U_2	V	3 AC 230 (MMX11), 3 AC U_e (MMX12, MMX32, MMX34)
Output Frequency	f_2	Hz	0 - 320 (DS: 0 - 50 Hz)
Frequency resolution (setpoint value)	I	Hz	0.01
Rated operational current	I/I_e	%	100 % continuous current at maximum +50 °C ambient temperature
Overload current	I/I_e	%	150 for 60 s every 600 s
Starting current	I/I_e	%	200 for 2 s every 20 s
Braking torque	M_B/M_N	%	\leq 30 for all sizes up to maximum 100 % M_N from frame size FS2 with MMX32... and MMX34... with external braking resistor
Control section			
Control voltage (output)	U_c	V DC	24, max. 50 mA
Reference voltage (output)	U_s	V DC	10, max. 10 mA
Input, digital, parameterizable			6 x, max. +30 V DC, $R_i > 12 \text{ k}\Omega$
Permitted residual ripple with external control voltage (+24 V)			max. 5 % $\Delta U_a/U_a$
Input, analog, parameterizable, selection via microswitches			2 x 0 (2) - +10 VDC, $R_i > 200 \text{ k}\Omega$ or 0 (4) - 20 mA, $R_B \sim 200 \Omega$
Resolution		Bit	10
Output, analog, parameterizable			1 x 0 (2) - 10 V, max. 10 mA
Resolution		Bit	10
Output, digital, parameterizable			1 x Transistor: 48 V DC, max. 50 mA
Output relay, parameterizable			1 x N/O contact: 250 V AC, maximum 2 A or 250 V DC, maximum 0.4 A
Output relay, parameterizable			1 x Changeover contact: 250 V AC, maximum 2 A or 250 V DC, maximum 0.4 A
Serial interface			RS485/Modbus RTU

1) +50 °C with lateral clearance of $\geq 20 \text{ mm}$ and reduced pulse frequency $\leq 4 \text{ kHz}$.
MMX34AA014... is only permissible for a maximum ambient temperature of +40 °C at a max. pulse frequency of $\leq 4 \text{ kHz}$.

1 M-Max™ Series

1.3 Rated data

1.3.4 Technical Data

Part no.	Rated operational current	Overload current (150 %)	Assigned motor power				Frame Size
	I_e	I_{e150}	P (230 V, 50 Hz)		P (230 V, 60 Hz)		
	[A]	[A]	[kW]	[A] ¹⁾	[HP]	[A] ¹⁾	
Mains supply voltage: 1 AC 115 V, 50/60 Hz (94 - 132 V ±0 %, 45 - 66 Hz ±0 %)							
Note: The mains voltage of 115 V is raised to 230 V (output voltage) through an internal voltage double connection.							
MMX11AA1D7...	1.7	2.6	0.25	1.4	1/3 ²⁾	1.5 ²⁾	FS2
MMX11AA2D4...	2.4	3.6	0.37	2	1/2	2.2	FS2
MMX11AA2D8...	2.8	4.2	0.55	2.7	1/2	2.2	FS2
MMX11AA3D7...	3.7	5.6	0.75	3.2	3/4	3.2	FS2
MMX11AA4D8...	4.8	7.2	1.1	4.6	1	4.2	FS3
Mains supply voltage: 1 AC 230 V, 50/60 Hz (177 - 264 V ±0 %, 45 - 66 Hz ±0 %)							
MMX12AA1D7...	1.7	2.6	0.25	1.4	1/3 ²⁾	1.5 ²⁾	FS1
MMX12AA2D4...	2.4	3.6	0.37	2	1/2	2.2	FS1
MMX12AA2D8...	2.8	4.2	0.55	2.7	1/2	2.2	FS1
MMX12AA3D7...	3.7	5.6	0.75	3.2	3/4	3.2	FS2
MMX12AA4D8...	4.8	7.2	1.1	4.6	1	4.2	FS2
MMX12AA7D0...	7	10.5	1.5	6.3	2	6.8	FS2
MMX12AA9D6...	9.6	14.4	2.2	8.7	3	9.6	FS3
Mains supply voltage: 3 AC 230 V, 50/60 Hz (177 - 264 V ±0 %, 45 - 66 Hz ±0 %)							
MMX32AA1D7...	1.7	2.6	0.25	1.4	1/3 ²⁾	1.5 ²⁾	FS1
MMX32AA2D4...	2.4	3.6	0.37	2	1/2	2.2	FS1
MMX32AA2D8...	2.8	4.2	0.55	2.7	1/2	2.2	FS1
MMX32AA3D7...	3.7	5.6	0.75	3.2	3/4	3.2	FS2
MMX32AA4D8...	4.8	7.2	1.1	4.6	1	4.2	FS2
MMX32AA7D0...	7	10.5	1.5	6.3	2	6.8	FS2
MMX32AA011...	11	16.5	2.2	8.7	3	9.6	FS3
MMX32AA012...	12	18.8	3	11.5	3	9.6	FS4
MMX32AA017...	17	26.3	4	14.8	5	15.2	FS4
MMX32AA025...	25	37.5	5.5	19.6	7.5	22	FS4
MMX32AA031...	31	46.5	7.5	26.4	10	28	FS5
MMX32AA038...	38	57	11	38	10	28	FS5

1) Rated motor currents for normal four-pole internally and surface-cooled three-phase asynchronous motors (1500 min⁻¹ at 50 Hz, 1800 min⁻¹ at 60 Hz).

2) Calculated motor output (no standard value).

Part no.	Rated operational current	Overload current (150 %)	Assigned motor power				Frame Size
	I_e	I_{150}	P (400 V, 50 Hz)		P (460 V, 60 Hz)		
	[A]	[A]	[kW]	[A] ¹⁾	[HP]	[A] ¹⁾	
Mains supply voltage: 3AC 400 V, 50/60 Hz (323 - 528 V ±0 %, 45 - 66 Hz ±0 %)							
MMX34AA1D3...	1.3	2	0.37	1.1	1/2	1.1	FS1
MMX34AA1D9...	1.9	2.9	0.55	1.5	3/4	1.6	FS1
MMX34AA2D4...	2.4	3.6	0.75	1.9	1	2.1	FS1
MMX34AA3D3...	3.3	5	1.1	2.6	1-1/2	3	FS2
MMX34AA4D3...	4.3	6.5	1.5	3.6	2	3.4	FS2
MMX34AA5D6...	5.6	8.4	2.2	5	3	4.8	FS2
MMX34AA7D6...	7.6	11.4	3	6.6	4 ²⁾	6.4 ²⁾	FS3
MMX34AA9D0...	9	13.5	4	8.5	5	7.6	FS3
MMX34AA012...	12	18	5.5	11.3	7-1/2	11	FS3
MMX34AA014...	14	21	5.5	11.3	10	14	FS3
MMX34AA016...	16	24	7.5	15.2	10	14	FS4
MMX34AA023...	23	34.5	11	21.7	15	21	FS4
MMX34AA031...	31	46.5	15	29.3	20	27	FS4
MMX34AA038...	38	57	18.5	36	25	34	FS5

1) Rated motor currents for normal four-pole internally and surface-cooled three-phase asynchronous motors (1500 min⁻¹ at 50 Hz, 1800 min⁻¹ at 60 Hz).

2) Calculated motor output (no standard value).

1 M-Max™ Series

1.4 Description of the M-Max™

1.4 Description of the M-Max™

The following drawings show examples of named elements of the M-Max™ frequency inverters in different frame sizes.

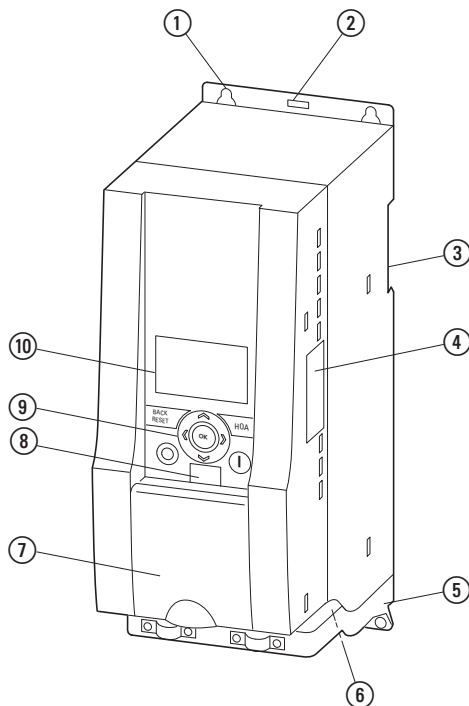


Figure 4: Elements of the M-Max™ for frame sizes FS1, FS2 and FS3

- ① Fixing holes (screw fastening)
- ② Release (dismantling from mounting rail)
- ③ Recess for mounting on mounting rail (DIN EN 50022-35)
- ④ Interface for field bus interface cards
- ⑤ EMC mounting accessories
- ⑥ Power section terminals
- ⑦ Cover flap of control signal terminals and microswitches
- ⑧ Interface for PC connection module MMX-COM-PC (Option)
- ⑨ Keypad with 9 control buttons
- ⑩ Display unit (LCD)

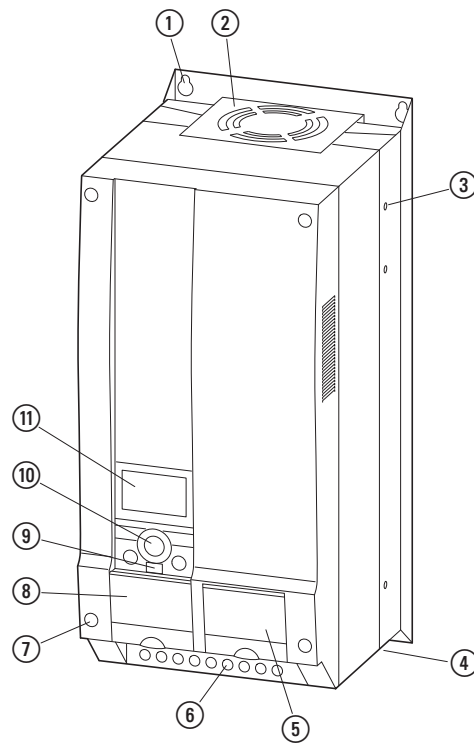


Figure 5: Elements of the M-Max™ for frame sizes FS4 and FS5 (example)

- ① Fixing holes (screw fastening)
- ② Device fans
- ③ Fixing holes for flange mounting (MMX-FLANGE-FS... option required)
- ④ EMC mounting accessories
- ⑤ Cover flap for connecting the field bus interface cards
- ⑥ Power section terminals
- ⑦ Screws for opening the enclosure covers
- ⑧ Cover flap of control signal terminals and microswitches
- ⑨ Interface for PC connection module MMX-COM-PC (Option)
- ⑩ Keypad with 9 control buttons
- ⑪ Display unit (LCD)

1.5 Features

The M-Max™ frequency inverters convert the voltage and frequency of an existing AC network into a DC voltage. This DC voltage is used to generate a three-phase AC voltage with adjustable frequency and assigned amplitude values for the variable speed control of three-phase asynchronous motors.

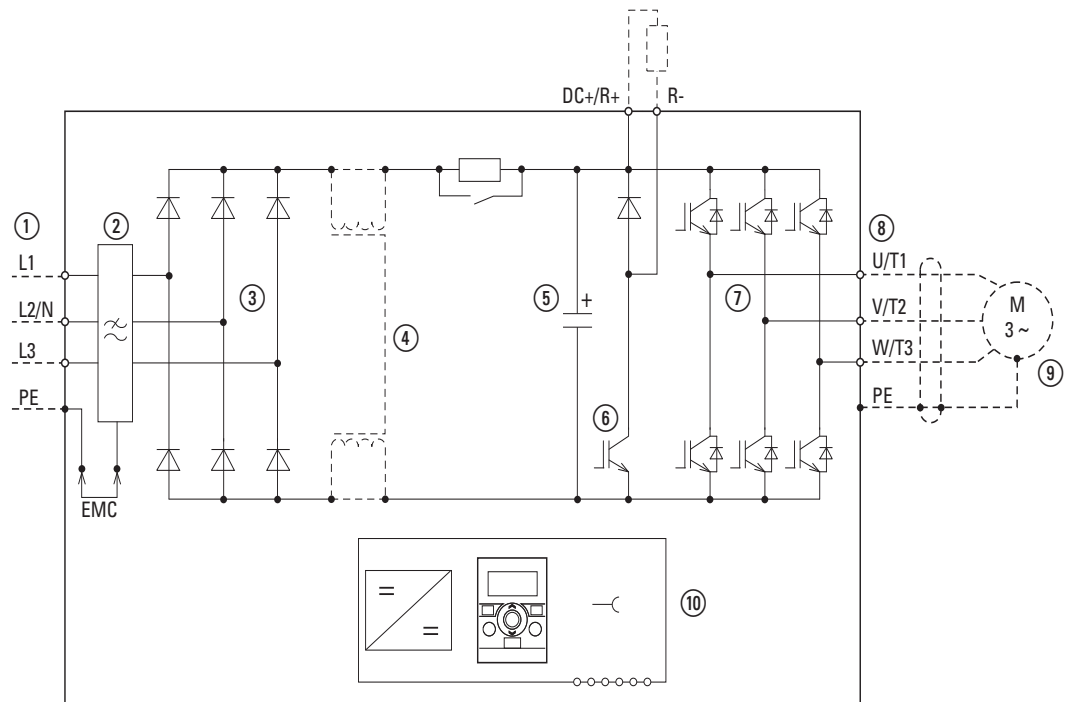


Figure 6: Block diagram, elements of the M-Max™ frequency inverters

- ① Supply L1, L2/N, L3, PE, mains supply voltage $U_{LN} = U_e$ at 50/60 Hz:
 MMX11: 100 V class, single-phase mains connection (1 AC 120 V),
 MMX12: 200 V class, single-phase mains connection (1 AC 230 V/240 V),
 MMX32: 200 V class, three-phase mains connection (3 AC 230 V/240 V),
 MMX34: 400 V class, three-phase mains connection (3 AC 400 V/480 V).
- ② Internal RFI filter (MMX...F...), category C2 and C3, in accordance with IEC/EN 61800-3. EMC connection of the internal RFI filter with PE.
- ③ Rectifier bridge, single phase (MMX1...) or three-phase (MMX3...), converts the AC voltage of the electrical network into DC voltage.
- ④ DC choke, DC link choke (only for MMX32...F... and MMX34...F... in frame sizes FS4 and FS5)
- ⑤ DC link with charging resistor, capacitor and switching-mode power supply unit (SMPS = Switching-Mode Power Supply):
 DC link voltage U_{DC} : $U_{DC} = 1.41 \times U_{LN}$
- ⑥ Braking transistor: connections DC+/R+ and R- for external braking resistor (only for MMX32 and MMX34 from frame size FS2).
- ⑦ Inverter. The IGBT based inverter converts the DC voltage of the DC link (U_{DC}) into a three-phase AC voltage (U_2) with variable amplitude and frequency (f_2). Sinusoidal pulse width modulation (PWM) with V/f control can be switched to speed control with slip compensation.
- ⑧ Motor connection U/T1, V/T2, W/T3 with output voltage U_2 (0 to 100 % U_e) and output frequency f_2 (0 to 320 Hz)
 output current (I_2):
 MMX11: 1.7 A - 4.8 A,
 MMX12: 1.7 A - 9.6 A,
 MMX32: 1.7 A - 11 A,

MMX34: 1.3 A - 38 A.

100 % at an ambient temperature of +50 °C with an overload capacity of 150 % for 60 s every 600 s and a starting current of 200 % for 2 s every 20 s.

- ⑨ Three-phase asynchronous motor, variable speed control of three-phase asynchronous motor for assigned motor shaft power values (P_2):
MMX11: 0.25 - 1.1 kW (230 V, 50 Hz) or 0.33 - 1 HP (230 V, 60 Hz),
MMX12: 0.25 - 2.2 kW (230 V, 50 Hz) or 0.25 - 3 HP (230 V, 60 Hz),
MMX32: 0.25 - 11 kW (230 V, 50 Hz) or 0.25 - 10 HP (230 V, 60 Hz),
MMX34: 0.37 - 18.5 kW (400 V, 50 Hz) or 0.5 - 25 HP (460 V, 60 Hz).
- ⑩ Keypad with control buttons, LCD display, control voltage, control signal terminals, microswitches and interface for the PC interface card (Option).

1.6 Selection criteria

Select the frequency inverter ③ according to the supply voltage U_{LN} of the supply system ① and the rated current of the assigned motor ②. The circuit type (Δ / Υ) of the motor must be selected according to the supply voltage ①. The rated output current I_e of the frequency inverter must be greater than or equal to the rated motor current.

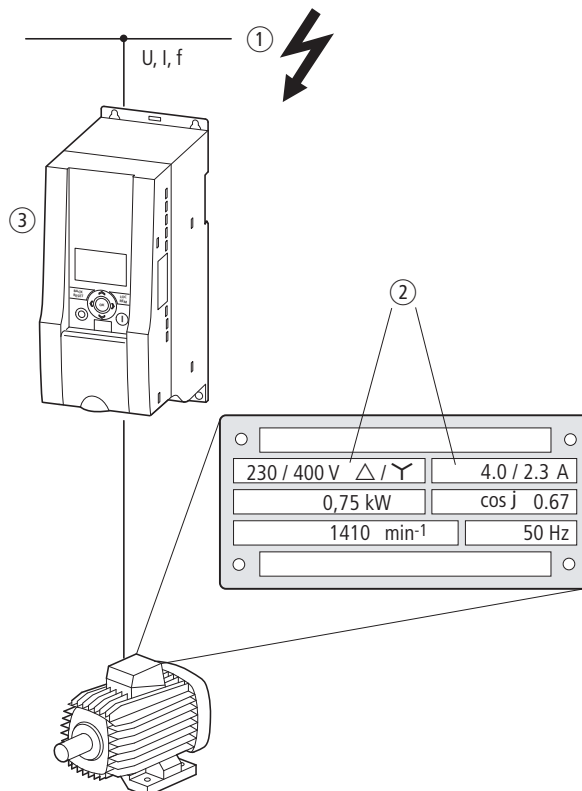


Figure 7: Selection criteria

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

- Type of motor (three-phase asynchronous motor)
- Mains voltage = rated operating voltage of the motor (e.g. 3 AC ~ 400 V),
- Rated motor current (guide value, dependent on the circuit type and the supply voltage)

1 M-Max™ Series

1.6 Selection criteria

- Load torque (quadratic, constant),
- Starting torque,
- Ambient air temperature (rated value +40 °C).



When connecting multiple motors in parallel to the output of a frequency inverter, the motor currents are added geometrically – separated by effective and idle current components. When you select a frequency inverter, make sure that it can supply the total resulting current. If necessary, for dampening and compensating the deviating current values, motor reactors or sinusoidal filters must be connected between the frequency inverter and the motor.

The parallel connection of multiple motors in the output of the frequency inverter is only permitted with U/f-characteristic curve control.



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

Switching in the output of the frequency inverter is only permitted with U/f-characteristic curve control.



The speed control with slip compensation (P11.8) increases the drive dynamics and optimizes the output. For this the frequency inverter processes all motor data in an electrical image.



The speed control operating mode (P11.8) must only be used with single drives (one motor at the output of the frequency inverter). The rated current of the motor must be assigned to the rated operational current of the frequency inverter (same rating).

1.7 Proper use

The M-MAX™ frequency inverters are not domestic appliances. They are designed only for industrial use as system components.

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

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

The CE markings on the M-MAX™ frequency inverter confirm that, when used in a typical drive configuration, the apparatus complies with the European Low Voltage Directive (LVD) and the EMC Directives (Directive 73/23/EEC, as amended by 93/68/EEC and Directive 89/336/EEC, as amended by 93/68/EEC).

In the described system configurations, M-MAX™ frequency inverters are suitable for use in public and non-public networks.

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



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

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

Observe the technical data and connection requirements. For additional information, refer to the equipment nameplate or label at the frequency inverter and the documentation.

Any other usage constitutes improper use.

1.8 Maintenance and inspection

Provided that the general rating data (→ Section “1.3.1 Rating plate”, Page 14) and the special technical data (→ Section “8.1 Special technical data” in the Appendix) of the ratings concerned are observed, the M-Max™ frequency inverters are maintenance free. However, external influences may affect the function and the lifespan of the M-Max™ frequency inverter. We therefore recommend that the devices are checked regularly and the following maintenance measures are carried out at the specified intervals.

Maintenance measures	Maintenance interval
Clean cooling vents (cooling slits)	Please enquire
Check the fan function	6 - 24 months (depending on the environment)
Filter in the switching cabinet doors (see manufacturer specifications)	6 - 24 months (depending on the environment)
Check the tightening torques of the terminals (control signal terminals, power terminals)	Regularly
Check connection terminals and all metallic surfaces for corrosion	6 - 24 months; when stored, no more than 12 months later (depending on the environment)
Charge capacitors	12 months, → Section “1.10 Charging DC link capacitors”
Motor cables and shield connection (EMC)	According to manufacturer specifications, no later than 5 years

There are no plans for replacing or repairing individual components of M-Max™ frequency inverters.

If the M-Max™ frequency inverter is damaged by external influences, repair is not possible. Dispose of the device in accordance with the respectively applicable environmental laws and provisions for the disposal of electrical or electronic devices.

1.9 Storage

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

- Storage temperature: -40 - +70 °C,
- Relative average air humidity: < 95 %, non condensing (EN 50178),
- To prevent damage to the RASP DC link capacitors, storage times longer than 12 months are not recommended (→ Section “1.10 Charging DC link capacitors”).

1.10 Charging DC link capacitors

After long storage times or long down times without a power supply (> 12 months), the capacitors in the internal DC link must undergo controlled recharging, in order to avoid damage.

For this the M-Max™ frequency inverters must be fed with a regulated DC power supply unit via two mains connection terminals (e.g. L1, L2/N). To avoid any possible excessive leakage currents from the capacitors, the inrush current should be limited to around 300 to 800 mA (depending on the rating). In this case, the frequency inverter must not be enabled (no start signal). The DC voltage must then be set to the values of the corresponding DC link voltage ($U_{DC} \sim 1.41 \times U_e$) and fed for at least one hour (regeneration time).

- MMX12, MMX32 about 324 V DC at $U_e = 230$ V AC
- MMX34 about 560 V DC at $U_e = 400$ V AC.



MMX11: Due to the internal voltage doubler circuit, the capacitors cannot be recharged via the connection terminals. Contact your local sales partner.

1.11 Service and warranty

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

When you call, have the following data ready:

- the exact frequency inverter part no. (see nameplate),
- the date of purchase,
- a detailed description of the problem which has occurred with the frequency inverter.

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

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

24-hour hotline: +49 (0)1805 223 822

E-Mail: AfterSalesEGBonn@eaton.com

1 M-Max™ Series

1.11 Service and warranty

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.

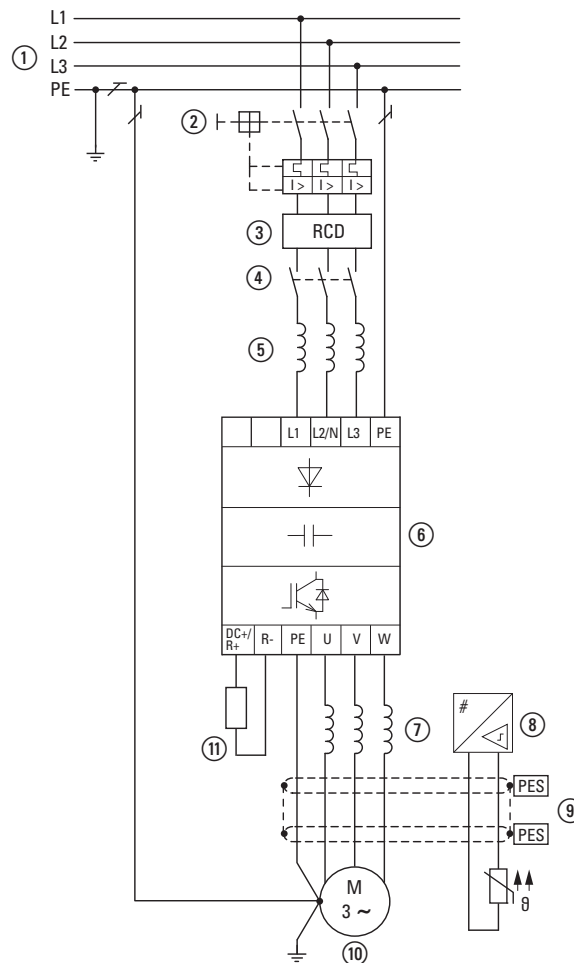


Figure 8: Drive system (PDS)

- ① Network configuration, mains voltage, mains frequency, interaction with p.f. correction systems
- ② Fuses and cable cross-sections, cable protection
- ③ Protection of persons and domestic animals with residual-current protective devices
- ④ Mains contactor
- ⑤ Main choke, radio interference suppression filter, mains filters
- ⑥ Frequency inverter: mounting, installation; power connection; EMC measures; circuit examples
- ⑦ Motor reactor, du/dt filter, sine-wave filter
- ⑧ Motor protection; Thermistor overload relay for machine protection
- ⑨ Cable lengths, motor cables, shielding (EMC)
- ⑩ Motor and application, parallel operation of multiple motors on a frequency inverter, bypass circuit; DC braking
- ⑪ Braking resistance; dynamic braking

2.2 Electrical power network

2.2.1 Mains connection and configuration

The frequency inverters of the M-Max™ series can be connected and operated with all control-point grounded AC power networks (see IEC 60364 for more information in this regard).

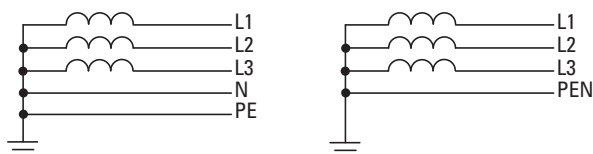


Figure 9: AC power networks with earthed center point (TN/TT networks)



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

The connection and operation of frequency inverters 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.

If the M-Max™ frequency inverters are connected to an asymmetrically grounded network or to an IT network (non grounded, insulated), the internal interference suppression filter must be disconnected (unscrew the screw marked EMC, → Chapter 3 "Installation", page 53).

The required filtering for electromagnetic compatibility (EMC) is then no longer present.



Measures for electromagnetic compatibility are mandatory in a magnet system, to meet the legal standards for EMC- and low-voltage regulations.

Good grounding measures are a prerequisite for the effective insert of further measures such as screen earth kit or filters here. Without respective grounding measures, further steps are superfluous.

2.2.2 Mains voltage and frequency

The standardized rated operating voltages (IEC 60038, VDE017-1) for power suppliers (EVU) guarantee the following conditions at the transition points:

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

The broad tolerance band of the M-MaxTM frequency inverter considers the rated value for

European as (EU: $U_{LN} = 230\text{ V}/400\text{ V}$, 50 Hz) and

American as (USA: $U_{LN} = 240\text{ V}/480\text{ V}$, 60 Hz) standard voltages:

- 120 V, 50/60 Hz at MMX11
- 230 V, 50 Hz (EU) and 240 V, 60 Hz (USA) at MMX12 und MMX32,
- 400 V, 50 Hz (EU) and 480 V, 60 Hz (USA) at MMX34...

For the bottom voltage value, the permitted voltage drop of 4 % in the consumer circuits is also taken into account, therefore a total of $U_{LN} - 14\%$.

- 100 V device class (MMX11):
110 V -15 % - 120 V +10 % (94 V -0 % - 132 V +0 %)
- 200-V device class (MMX12, MMX32):
208 V - 15 % - 240 V + +10 % (177 V - 0 % - 264 V + 0 %)
- 400-V device class (MMX34):
380 V - 15 % - 480 V + +10 % (323 V - 0 % - 528 V + 0 %)

The permitted frequency range is 50/60 Hz here (45 Hz - 0 % - 66 Hz + 0 %).

2.2.3 Voltage balance

Because of the uneven loading on the conductor and with the direct connection of greater power ratings, deviations from the ideal voltage form and unsymmetrical voltages can be caused in three-phase AC power networks. These asymmetric divergences in the mains voltage can lead to different loading of the diodes in mains rectifiers with three-phase supplied frequency inverters and as a result, to an advance failure of this diode.



In the project planning for the connection of three-phase supplied frequency inverters (MMX32, MMX34), consider only AC power networks that handle permitted asymmetric divergences in the mains voltage $\leq +3\%$.

If this condition is not fulfilled, or symmetry at the connection location is not known, the use of an assigned main choke is recommended (see "Appendix", Section "Mains chokes", Page 247).

2.2.4 THD (Total Harmonic Distortion)

Non-linear consumers (loads) in an AC supply system produce harmonic voltages that result in harmonic currents. These harmonic currents at the inductive and capacitive reactances of the mains supply system produce additional voltage drops with different values which are then overlaid on the sinusoidal mains voltage and result in distortions. In supply systems, this form of "noise" can give rise to problems in an installation if the sum of the harmonics exceeds certain limit values.

Non-linear consumers (harmonics producers) include for example:

- Induction and arc furnaces / welding devices
- Current converters, rectifiers and inverters, soft starters, frequency inverters,
- Switched-mode power supply units (computers, monitors, lighting), uninterruptible power supply (UPS)

The THD value or total harmonic distortion is defined in IEC/EN61800-3 as the ratio of the rms of all harmonic components to the rms value of the fundamental harmonic. For example, for the current:

$$\text{THD} = \frac{\sqrt{\sum_{n=2}^{\infty} I_n^2}}{I_1}$$

I_1 is the rms value of the fundamental harmonic current and n the order number of a harmonic with its own frequency which is an integer multiple of the fundamental harmonic (Fourier analysis). Example: 5th harmonic of a mains frequency of 50 Hz → 5 x 50 Hz = 250 Hz.

The THD value of the harmonic distortion is stated in relation to the rms value of the total signal as a percentage. On a frequency inverter, the total harmonic distortion is around 120 %.

A mains choke (such as 4 % uk) on the supply side of the frequency inverter enables the THD value with a single-phase supply (B2 diode rectifier bridge) to be reduced to around 80 % and with a three-phase supply (B6 diode rectifier bridge) to around 50 %. The supply quality is thus improved and the mains supply distortion is reduced. This improves the power factor.

A DC choke in the DC link of the frequency inverter enables the THD value to be reduced to around 40 %. This complex and costly solution is required for frequency inverters with a rated input current that exceeds 16 A in a single phase, and is up to 75 A per phase, and which is intended for connection to public low-voltage AC supply systems (IEC/EN 61000-3-12). The PCC (Point of Common Coupling) in the public low-voltage supply network (→ Figure 10, page 36) is the measuring point for the total harmonic distortion (THD).

2.2.5 Idle power compensation devices

Compensation on the power supply side is not required for the frequency inverters of the M-MAX™ series. From the AC power supply network they only take on very little reactive power of the fundamental harmonics ($\cos \varphi \sim 0.98$).



In the AC power networks with non-choked idle current compensation devices, current deviations can enable parallel resonance and undefinable circumstances.

In the project planning for the connection of frequency inverters to AC power networks with undefined circumstances, consider using main chokes.

2.2.6 Mains chokes

A mains reactor (also called commutation inductors) increases the inductance of the power supply line. This extends the current flow period and dampens mains deviations.

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

Towards the frequency inverter, the mains reactors dampen the interference from the supply network. This increases the withstand voltage of the frequency inverter and lengthens the lifespan (diodes of the mains power rectifier, intermediate circuit capacitors).



For the operation of the M-MAX™ frequency inverter, the application of main chokes is not necessary.

We do recommend however that an upstream mains reactor is used since the network quality is not known in most cases. While planning the project, consider that a mains reactor is only assigned to a single frequency inverter for isolation. Using a large mains reactor for multiple small frequency inverters should therefore be avoided if at all possible.

When using an adapting transformer (assigned to a single frequency inverter), a main choke is not necessary.

Mains reactors are designed based on the mains-side input current (I_{LN}) of the frequency inverter. Mains chokes and the assignment to M-MAX™ frequency inverters are explained in the appendix.

2 Engineering

2.3 Safety and switching

2.2.7 DC chokes

DC chokes are connected in the DC link circuit of the frequency inverter. They smooth the residual ripple of the rectified mains voltage and reduce the total harmonic distortion (THD) to around 40 %.

The DC chokes are factory fitted in frame sizes FS4 and FS5 of the MMX...F... frequency inverters. With the other versions (MMX...N...) and designs, retrofitting the chokes or the use of an external connection is not possible.

2.3 Safety and switching

2.3.1 Fuses and cable cross-sections

The fuses and wire cross-sections allocated for power-side connections depend on the rated mains current I_{LN} of the frequency inverter (without mains reactor).

NOTICE

When selecting the cable cross-section, take the voltage drop under load conditions into account.

The consideration of other standards (e.g. VDE 0113 or VDE 0289) is the responsibility of the user.

The recommended fuses and their assignment to the frequency inverters are listed in Page 229 the appendix.

The national and regional standards (for example VDE 0113, EN 60204) must be observed and the necessary approvals (for example UL) at the site of installation must be fulfilled. The permissible copper cables must have a heat resistance of +60/75 °C.

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

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

The leakage currents for the individual performance variables are listed in the appendix on Page 201 ff.

NOTICE

The specified minimum PE conductor cross-sections (EN 50178, VDE 0160) must be maintained.

A completely (360°) screened low impedance cable on the motor side is required. The length of the motor cable depends on the RFI class and the environment and must not exceed 50 m for the M-Max™.



Choose the cross-section of the PE conductor in the motor lines at least as large as the cross-section of the phase lines (U, V, W).

2.3.2 Residual-current device

RCD (Residual Current Device): Residual current device, residual current circuit breaker (FI circuit breaker)

Residual current circuit breakers protect persons and animals from the existence (not the origination) of impermissibly high touch voltages. They prevent dangerous, in cases deadly injuries caused by electrical accidents and also serve as fire prevention.



DANGER

With frequency inverters, only AC/DC sensitive residual current circuit breakers (RCD type B) are to be used (EN 50178, IEC 755).

Identification on the residual current devices

AC/DC sensitive (RCD, part no. B)



Frequency inverters work internally with rectified AC currents. If an error occurs, the DC currents can block an RCD circuit breaker of type A from triggering and therefore disable the protective functionality.

NOTICE

Residual current circuit breakers (RCD) are only to be installed between the AC power supply network and the frequency inverter.

Safety-relevant leakage currents can occur while handling and when operating the frequency inverter, if the frequency inverter is not earthed (because of a fault).

Leakage currents to ground are mainly caused by foreign capacities with frequency inverters; between the motor phases and the shielding of the motor cable and via the Y-capacitors of the noise filter. The size of the leakage current is mainly dependent upon the:

- length of the motor cable,
- shielding of the motor cable,
- height of the pulse frequency (switching frequency of the inverter),
- type of RFI filter,
- Grounding measures at the site of the motor.

2 Engineering

2.3 Safety and switching



The leakage current to ground is greater than 3.5 mA with a frequency inverter. Based on the requirements of EN 50178, an increased ground (PE) has to be connected. The cable cross-section must be at least 10 mm² or consist of two separately connected ground cables.



As long as you use residual current circuit breakers, they must be suitable for:

- the protection of installations with DC current component in case of fault scenario (RCD type B),
- high leakage currents (300 mA),
- brief discharges of pulse current spikes.

2.3.3 Mains contactor

The mains contactor enables an operational switching on and off of the supply voltage for the frequency inverter and switching off in case of a fault.

The mains contactor is designed based on the mains-side input current (I_{LN}) of the frequency inverter and the consumption category AC-1 (IEC 60947).

Mains contactors and the assignment to M-MAXTM frequency inverters are explained in the appendix.



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

The maximum permitted operating frequency of the mains voltage with the M-MAXTM frequency inverter is one time per minute (normal operation).

2.4 EMC compliance

Electrical components in a system (machine) have a reciprocal effect on each other. Each device not only emits interference but is also affected by it. The interference can be produced by galvanic, capacitive and/or inductive sources or by electromagnetic radiation. In practice, the limit between line-conducted interference and emitted interference is around 30 MHz. Above 30 MHz, cables and conductors act like antennas that radiate electromagnetic waves.

Electromagnetic compatibility (EMC) for frequency controlled drives (variable speed drives) is implemented in accordance with product standard IEC/EN 61800-3. This includes the complete power drive system (PDS), from the mains supply to the motor, including all components, as well as cables, → Figure 8, page 27. This type of drive system can consist of several individual drives.

The generic standards of the individual components in a PDS compliant with IEC/EN 61800-3 do not apply. These component manufacturers, however, must offer solutions that ensure standards-compliant use.

In Europe, maintaining the EMC Directive is mandatory.

A declaration of conformity (CE) refers always to a "typical" magnet system (PDS). The responsibility to comply with the legally stipulated limit values and thus the provision of electromagnetic compatibility is ultimately the responsibility of the end user or system operator. This operator must also take measures to minimize or remove emission in the environment concerned (→ Figure 10). He must also utilize means to increase the interference immunity of the devices of the system.

With their high interference immunity up to category C3, M-Max™ frequency inverters are ideal for use in harsh industrial networks (2nd environment).

The MMX...-F... version (with integrated RFI filter) makes it possible to comply with the stringent limit values for conducted emission for category C2 in the 1st environment. This requires a correct EMC installation (→ Page 51) and the observance of the permissible motor cable lengths and the maximum switching frequency (f_{PWM}) of the inverter.

Type MMX...-N... frequency inverters can comply with the limit values of category C1 in environment 1 when used in conjunction with an assigned external interference suppression filter (→ Chapter 8 "Appendix", Page 236).

The required EMC measures should be taken into account in the engineering phase. Improvements and modifications during mounting and installation or even at the installation site involve additional and even considerably higher costs.

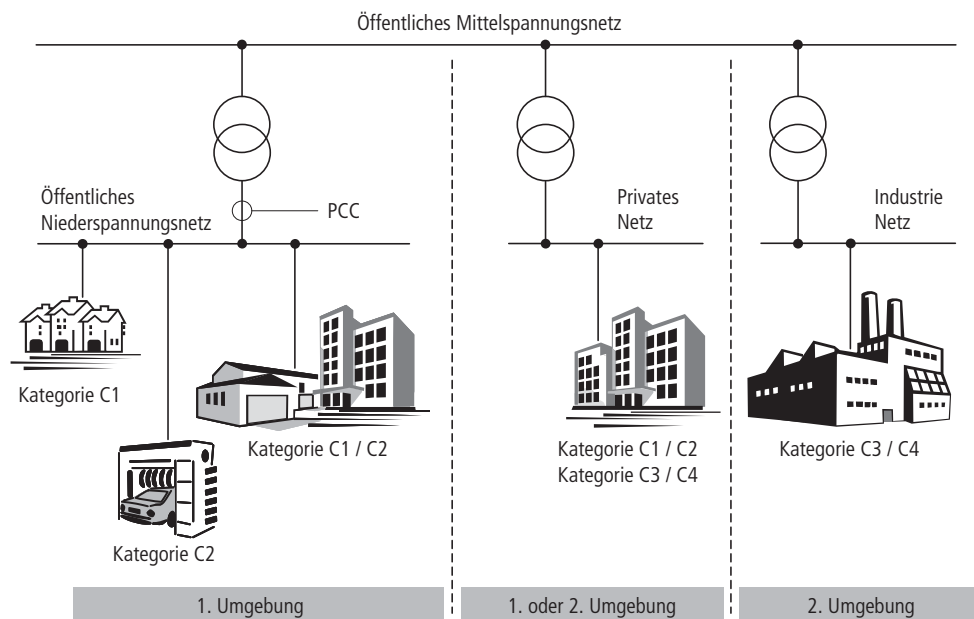


Figure 10: EMC environment and category

2.5 Motor and Application

2.5.1 Motor selection

General recommendations for motor selection:

- Use three-phase powered asynchronous motors with short-circuit rotors and surface cooling, also called asynchronous motors or standard motors for the frequency-controlled drive system (PDS). Other specifications such as external rotor motors, slip-ring motors, reluctance motors, synchronous or servo motors can also be run with a frequency inverter but normally require additional planning and discussion with the motor manufacturer.
- Use only motors with at least heat class F (155 °C maximum steady state temperature).
- 4-pole motors are preferred (synchronous speed: 1500 min⁻¹ at 50 Hz or 1800 min⁻¹ at 60 Hz).
- Take the operating conditions into account for S1 operation (IEC 60034-1).
- When operating multiple motors in parallel on one frequency inverter, the motor output should not be more than three power classes apart.
- Ensure that the motor is not overdimensioned.
If a motor in speed control mode is underdimensioned, the motor rating must only be one rating level lower.

2.5.2 Connecting motors in parallel

The M-Max™ frequency inverters allow parallel operation of several motors in U/f control mode:

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

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

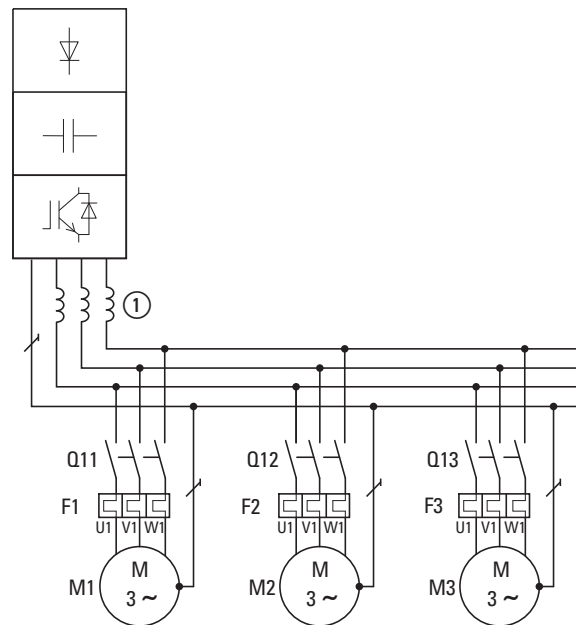


Figure 11: Parallel connection of several motors to one frequency inverter

NOTICE

If you are connecting multiple motors on one frequency inverter, you must design the contactors for the individual motors according to utilization category AC-3. Selecting the motor contactor is done according to the rated operational current of the motor to be connected.

Connecting motors in parallel reduces the load resistance at the frequency inverter output. The total stator inductance is lower and the leakage capacity of the lines greater. As a result, the current distortion is greater than in a single-motor circuit. To reduce the current distortion, you should use motor reactors (see ① in Figure 11) in the output of the frequency inverter (→ Section "8.11 motor reactor", page 250).

- ➔ The current consumption of all motors connected in parallel must not exceed the frequency inverter's rated output current I_{2N} .
- ➔ Electronic motor protection can not be used when operating the frequency inverter with several parallel connected motors. You must, however, protect each motor with thermistors and/or overload relays.
- ➔ The use of motor protective circuit breaker at the frequency inverter's output can lead to nuisance tripping.

2.5.3 Motor and circuit type

The motor's stator winding can be connected in a star or delta configuration in accordance with the rated operational data on the rating plate.

230 Δ / 400 Υ V		3.5 / 2 A
S1	0,75 kW	cos φ 0.79
1430 rpm		50 Hz

Figure 12: Example of a motor ratings plate

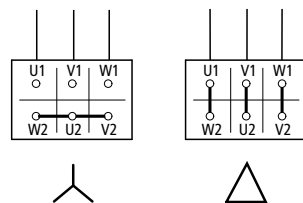


Figure 13: Circuit types: Star, Delta

The three-phase motor with the rating plate based on Figure 12, can be run in a star or delta connection.

The operational characteristic curve is determined by the ratio of motor voltage and motor frequency in this case.

2.5.3.1 87-Hz Characteristic curve

In the delta circuit with 400 V and 87 Hz, the motor in Figure 12 was released with 3 times-fold output (~ 1.3 kW).

Because of the higher thermal loading, only utilizing the next higher motor output according to the list (1.1 kW) is recommended. The motor (in this example) therefore still has 1.47-fold higher output compared with the listed output (0.75 kW).

With the 87-Hz characteristic curve, the motor also works in the range from 50 to 87 Hz with an unattenuated field. The pull-out torque remains at the same level as in mains operation with 50 Hz.

➔ The heat class of the motor must be at least F in 87-Hz operation.

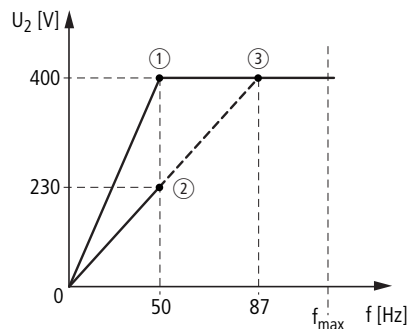


Figure 14: U/f characteristic curve

- ① Star connection: 400 V, 50 Hz
- ② Delta circuit: 230 V, 50 Hz
- ③ Delta connection: 400 V, 87 Hz

The following Table 2 shows the allocation of possible frequency inverters depending on the mains voltage and the type of circuit.

Table 2: Assignment of frequency inverters to example motor circuit (➔ Figure 14)

Frequency inverters	MMX12AA3D7...	MMX32AA3D7...	MMX34AA2D4...	MMX34AA4D3...
Rated operational current	3.7A	3.7A	2.4A	4.3A
Mains voltage	1 AC 230 V	3 AC 230 V	3 AC 400 V	3 AC 400 V
U/f-characteristic curve	②	②	①	③
Motor circuit	Delta (230 V)	Delta (230 V)	Star (400 V)	Delta (230 V)
Motor current	3.5A	3.5A	2.0A	3.5A
Motor voltage	3 AC 0 - 230 V	3 AC 0 - 230 V	3 AC 0 - 400 V	3 AC 0 - 400 V
Motor speed	1430 min ⁻¹	1430 min ⁻¹	1430 min ⁻¹	2474 min ⁻¹ 1)
Motor frequency	50 Hz	50 Hz	50 Hz	87 Hz ¹⁾

1) Note the permitted limit values of the motor!

2.5.4 Bypass operation

If you want to have the option of operating the motor with the frequency inverter or directly from the mains supply, the input branches must be interlocked mechanically.

NOTICE

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



CAUTION

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

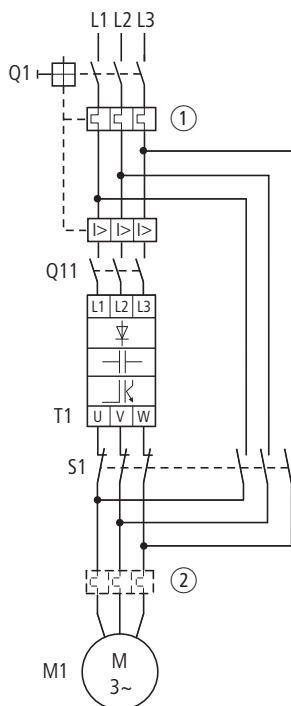


Figure 15: Bypass motor control (example)

NOTICE

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



Contactors and switches (S1) in the frequency inverter output and for the direct start must be designed based on utilization category AC-3 for the rated operational current of the motor.

Connecting EX motors

Note the following when connecting explosion-protected motors please:

- The frequency inverter must be installed outside the EX area.
- Note the branch- and country-specific standards for explosion-protected areas (ATEX 100a).
- Note the standards and information of the motor manufacturer regarding operation on frequency inverters - e.g. if motor reactors (du/dt-limiting) or sinus filters are specified.
- Temperature monitors in the motor windings (thermistor, thermo-Click) are not to be connected directly to frequency inverters but must be connected via an approved trigger apparatus for EX areas i.e. EMT6.

2.5.5 Sinusoidal filter

Sinusoidal filters are connected in the output of the frequency inverter. They allow the use of long motor cables with reduced conducted and radiated emission.

The upstream sinusoidal filter enables the reduction of losses and noise in the motor (→ Section "8.12 Sinusoidal filter", page 253).



Disadvantage. Sinusoidal filters have a system voltage drop of around 30 V per phase.

NOTICE

Sinusoidal filters must only be used with permanently set pulse frequencies.

2 Engineering

2.5 Motor and Application

3 Installation

3.1 Introduction

This chapter provides a description of the mounting and the electrical connection for the frequency inverter M-Max™ series.

- ➔ While mounting and/or assembling the frequency inverter, cover all ventilation slots in order to ensure that no foreign bodies can enter the device.
- ➔ Perform all installation work with the specified tools and without the use of excessive force.

3.2 Mounting

The mounting instructions given here take into account the installation in a control cabinet enclosure for devices with degree of protection IP 20.

In order to comply with the mounting requirements of NEMA 1 (IP 21), the optional housing accessories MMX-IP21-FS1, MMX-IP21-FS2 or MMX-IP21-FS3 must be used for frame sizes FS1, FS2 and FS3.

3.2.1 Mounting position

The M-Max frequency inverters are normally mounted vertically. The internal temperature controlled device fan allows a mounting inclination of up to 90° with frame sizes FS1, FS2 and FS3.

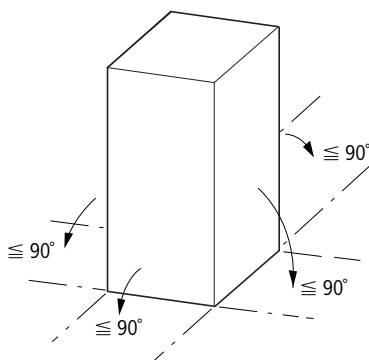


Figure 16: Mounting position FS1, FS2 and FS3

- ➔ A mounting that is turned by 180° (stood on its head) is not permissible.

3 Installation

3.2 Mounting

The maximum permissible inclination for frame sizes FS4 and FS5 is 30°.

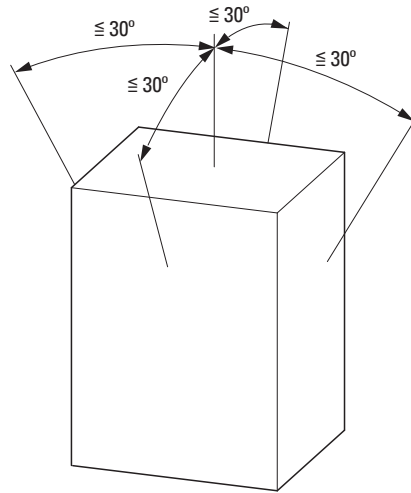


Figure 17: Mounting position FS4 and FS5

3.2.2 Cooling measures

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

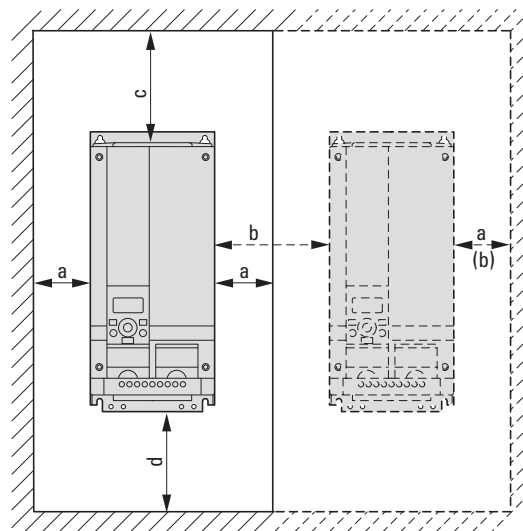


Figure 18: Space for air-cooling

Table 3: Minimum clearance and required cooling air

	a ¹⁾ [mm]	b ¹⁾ [mm]	c [mm]	d [mm]	e [mm]	V [m ³ /h]
FS1	20	20	100	50	15	10
FS2	20	20	100	50	15	10
FS3	20	20	100	50	15	30
FS4	20	20	100	100	20	45
FS5	20	20	120	100	20	75

1) With frame sizes FS1, FS2 and FS3 the side clearance can also be around 0 mm if the ambient air temperature does not exceed +40 °C and the pulse frequency (P11.9) does not exceed 4 kHz.

With MMX34...014..., the side clearance to a "passive" neighbor must always be 20 mm in all operating points and always 50 mm to the "active" neighbor.

Up to an ambient air temperature of +40 °C, an installation height of up to 1000 m and a pulse frequency of up to 4 kHz, the frequency inverters of the M-Max™ series do not require any additional side clearance.

Higher ambient air temperatures up to a maximum of +50 °C, pulse frequencies f_{PWM} up to a maximum of 16 kHz and installation heights up to 2000 m require a minimum side clearance of 20 mm from a "passive" neighbor (housing wall) and always a clearance of 50 mm from an "active" neighbor (frequency inverter, switched-mode power supply unit).



The pulse frequency (f_{PWM}) can be adjusted with parameter P11.9.



Please note that the mounting makes it possible to open and close the control signal terminal covers without any problems.

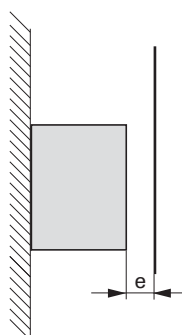


Figure 19: Minimum clearance at the front



The frequency inverters of the M-Max™ series are air-cooled with an internal fan.

3 Installation

3.2 Mounting

With frame sizes FS4 and FS5 a baffle must be fitted between the two devices. Otherwise, the upper device may overheat due to the device fan fitted at the top of the lower device.

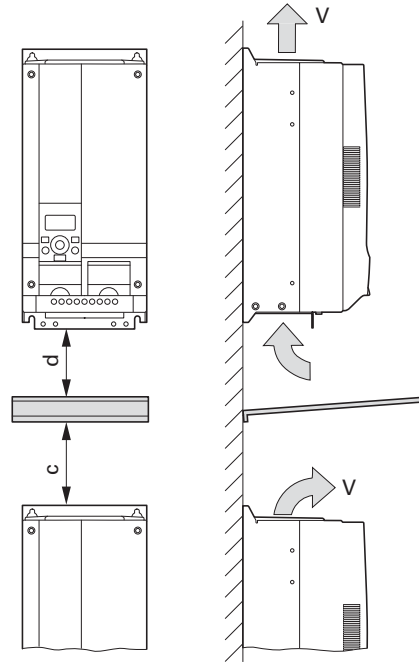


Figure 20: Air baffle due to increased circulation with device fan

If devices are arranged vertically above each other, the clearance between the two devices must at least be equal to dimension $c + d$ ("active neighbors").



Devices with strong magnetic fields (e.g. reactors or transformers) should not be installed in the immediate vicinity of the M-Max™ device.

3.2.3 Fixing

The frequency inverters in frame sizes FS1, FS2 and FS3 can also be screw fastened on a mounting rail.

➔ Install the frequency inverter only on a nonflammable mounting base (e.g., on a metal plate).

➔ Dimensions and weights of the frequency inverter are located in the appendix (➔ Page 201).

3.2.3.1 Fixing with screws

The number and arrangement of the required drill holes (drilling dimensions a_1 and b_1 in Figure 21) are also printed on the base plate of the M-Max device in frame sizes FS1, FS2 and FS3.

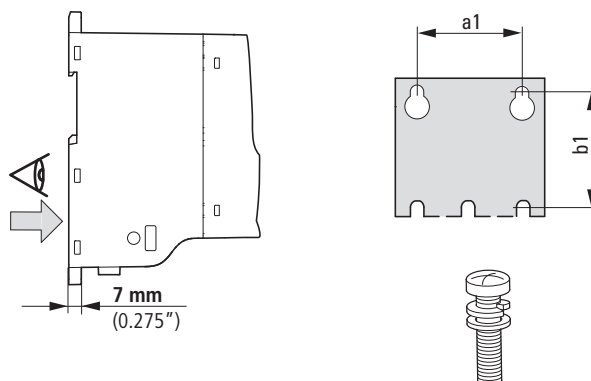


Figure 21: Mounting dimensions

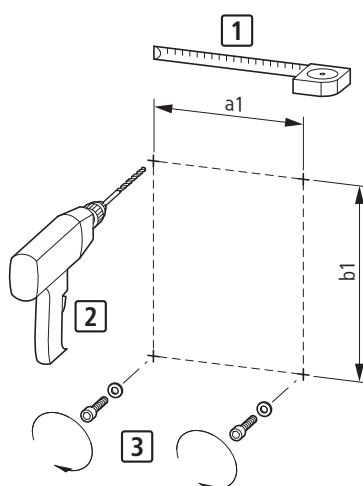


Figure 22: Mounting preparation

3 Installation

3.2 Mounting

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

➔ The maximum permissible tightening torque for the fixing screws is 1.3 Nm for frame sizes FS1, FS2 and FS3, and 4.6 Nm for frame sizes FS4 and FS5.

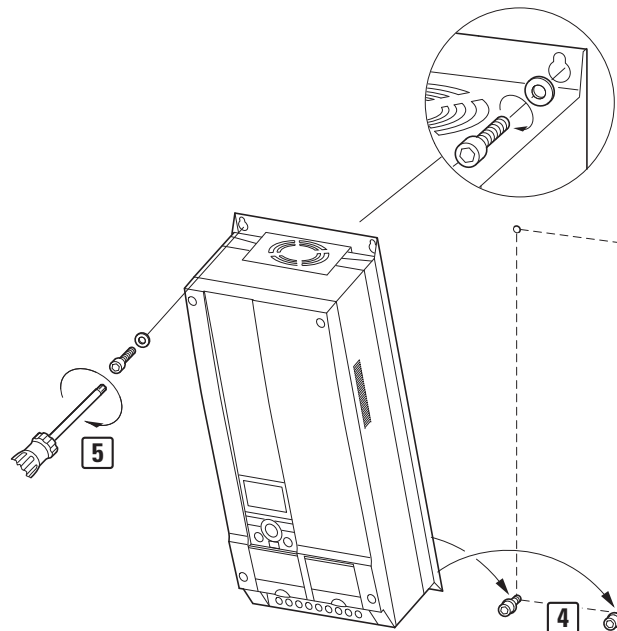


Figure 23: Mounting of frame sizes FS4 and FS5

3.2.3.2 Fixing on mounting rails

- ▶ Frame sizes FS1, FS2 and FS3 can be fitted on a mounting rail to IEC/EN 60715 as an alternative to screw fixing.

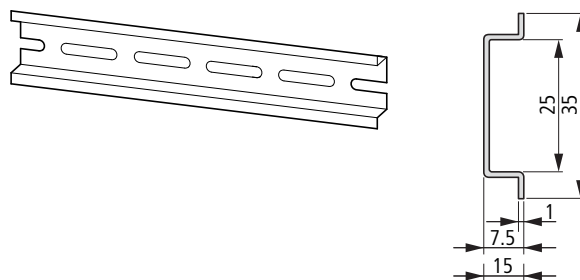


Figure 24: Mounting rail conforming with IEC/EN 60715

- ▶ Place the frequency inverter onto the mounting rail [1] from above and press it down until it snaps into place [2].

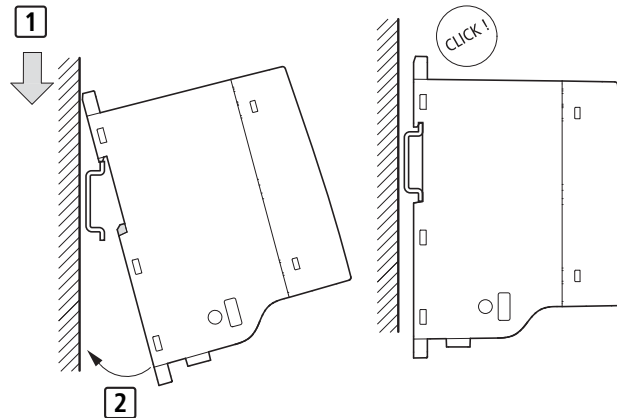


Figure 25: Fixing to the mounting rail

3.2.3.3 Dismantling from mounting rails

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

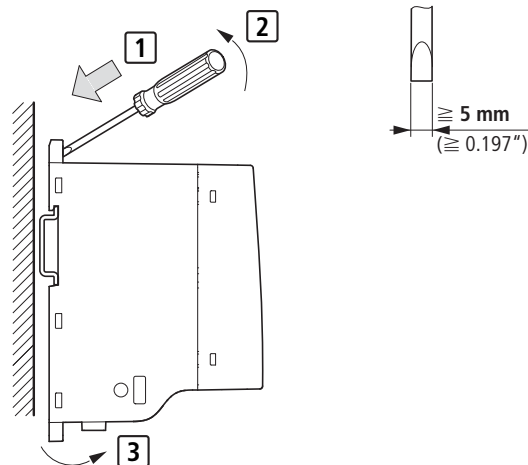


Figure 26: Dismantling from mounting rails

3 Installation

3.2 Mounting

3.2.3.4 Cable flange plate (Accessories)

The M-Max™ is supplied with a cable routing plate and brackets. These enable you to arrange the connection cables as required on the frequency inverter and fasten the shielded cables in accordance with EMC requirements.

- ▶ Always fit the cable routing plate for the connection cables in the power section [1] first of all, and then the cable bracket [2] for the control cables. The required mounting screws (M4) and cable clips [3] are supplied with the device.

➔ Mount the cable routing plate before the electrical installation.

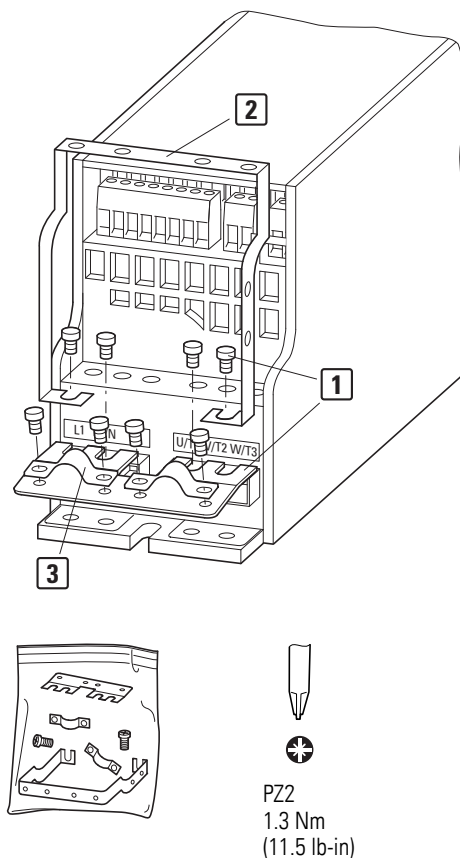


Figure 27: Mounting the cable routing plate, bracket and clips

3.3 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 person must also take measures to minimize or remove emission in the environment concerned (→ Figure 10, page 36). He must also utilize means to increase the interference immunity of the devices or systems.

In a magnet system (PDS) with frequency inverters, 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 frequency inverter cause the flow of high frequency leakage current during operation. All grounding measures must therefore be implemented with low impedance connections over a large surface area.

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

- The protective conductor must have a cross-section $\geq 10 \text{ mm}^2$,
- The protective conductor must be open-circuit monitored, or
- the second protective conductor must be fitted.

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

- Installation of the frequency inverter in a metallic, electrically conducting enclosure with a good connection to earth,
- screened motor cables (short cable lengths).



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

3.3.1 EMC measures in the control panel

For the EMC-compatible installation, connect all metallic parts of the device and the switching cabinet together over broad surfaces and so that high-frequencies will be conducted. Mounting plates and cabinet doors should make good contact and be connected with short HF-braided cables. Avoid using painted surfaces (Anodized, chromized). An overview of all EMC measures is provided in Figure 28 on Page 53.



Install the frequency inverter as directly as possible (without spacers) on a metal plate (mounting plate).



Route mains and motor cables in the switch cabinet as close to the ground potential as possible. This is because free moving cables act as antennas.

3 Installation

3.3 EMC installation

→ When laying HF-cables (e.g. screened motor cables) or suppressed cables (e.g. mains supply cables, control circuit and signal cables) in parallel, a minimum clearance of 300 mm should be ensured, in order to prevent the radiation of electromagnetic energy. Separate cable routing should also be ensured when large voltage potential differences are involved. Any necessary crossed cabling between the control signal and power cables should always be implemented at right angles (90 degrees).

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

3.3.2 Ground

The ground connection (PE) in the cabinet should be connected from the mains supply to a central grounding point (mounting plate). All protective conductors should be routed in star formation from this earth point and all conductive components of the PDS (frequency inverter, motor reactor, motor filter, main choke) are to be connected.

→ Avoid ground loops when installing multiple frequency inverters in one control panel. Make sure that all metallic devices that are to be grounded have a broad area connection with the mounting plate.

3.3.3 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 measurement values) must be screened and laid separately from each other.

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

→ Use only shields 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 Installation

3.3 EMC installation

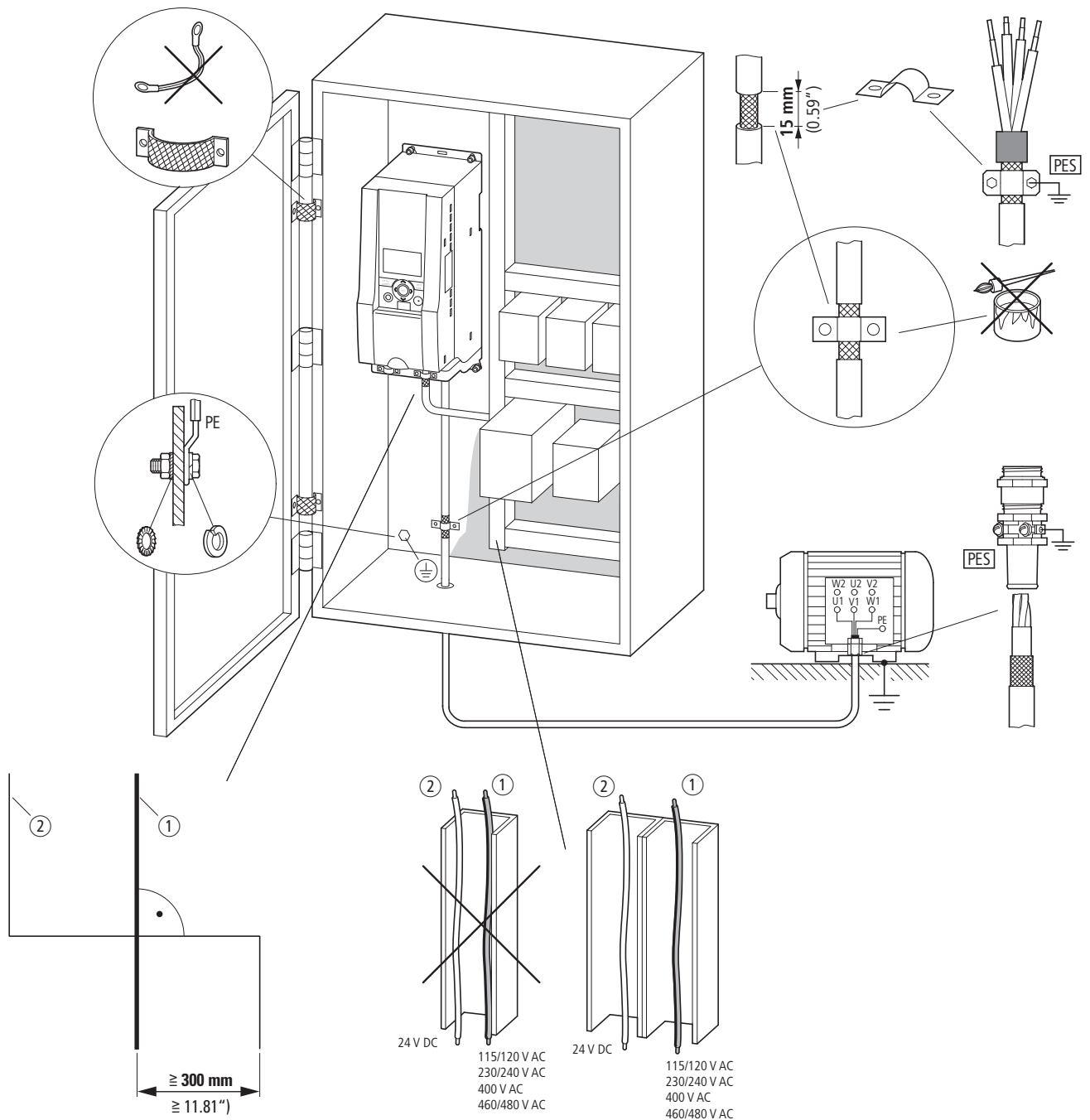


Figure 28: EMC-compliant setup (example: M-Max™)

- ① Power cable: L1, L2/N, L3 and U/T1, V/T2, W/T3, DC+/R+, R-
 - ② Control and signal lines: 1 to 26, A, B, fieldbus connection
- Large-area connection of all metallic control panel components.
 Mounting surfaces of frequency inverter and cable screen must be free from paint.
 Connect the cable screen in the output of the frequency inverter with a large surface area contact to the ground potential (PES).
 Large-area cable screen contacts with motor.
 Large-area earth connection of all metallic parts.

3 Installation

3.4 Electrical Installation

3.4 Electrical Installation



CAUTION

Carry out the wiring work only after the frequency inverter has been correctly mounted and secured.



DANGER

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

NOTICE

Fire hazard!
Only use cables, protective switches, and contactors that feature the indicated permissible nominal current value.

NOTICE

Ground contact currents in frequency inverters are greater than 3.5 mA (AC). According to product standard IEC/EN 61800-5-1, an additional equipment grounding conductor must be connected, or the cross-section of the equipment grounding conductor must be at least 10 mm².



DANGER

The components in the frequency inverter'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.

3.4.1 Power section connections

The following figure shows the general connection of the frequency inverter in the power section.

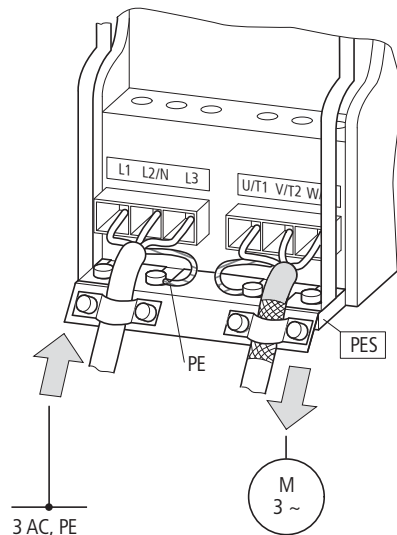


Figure 29: Example: three-phase mains connection

3.4.1.1 Terminal designation

- L1, L2/N, L3: Connection terminals for the supply voltage (input, mains voltage):
 - Single-phase AC voltage: connection to L2 and L3 on MMX11...
 - Single-phase AC voltage: Connection to L1 and L2 with MMX12...
 - Three-phase AC voltage: Connection to: L1, L2, L3 with MMX32... and MMX34...
- U/T1, V/T2, W/T3: Connection terminals for the three-phase input wiring to the three-phase motor (output, frequency inverter).
- ⊕, PE: connection for protective ground (reference potential). PES with mounted cable routing plate for shielded cables.
- R+, R-: Connection terminals for external brake resistance (only with MMX34..., output braking transistor),
- DC+, DC-: Direct connection on the internal DC link



Some terminals have double designations due to the design of the housing (FS):
L2/N = L2, N
DC+/R+ = DC+, R+

3 Installation

3.4 Electrical Installation

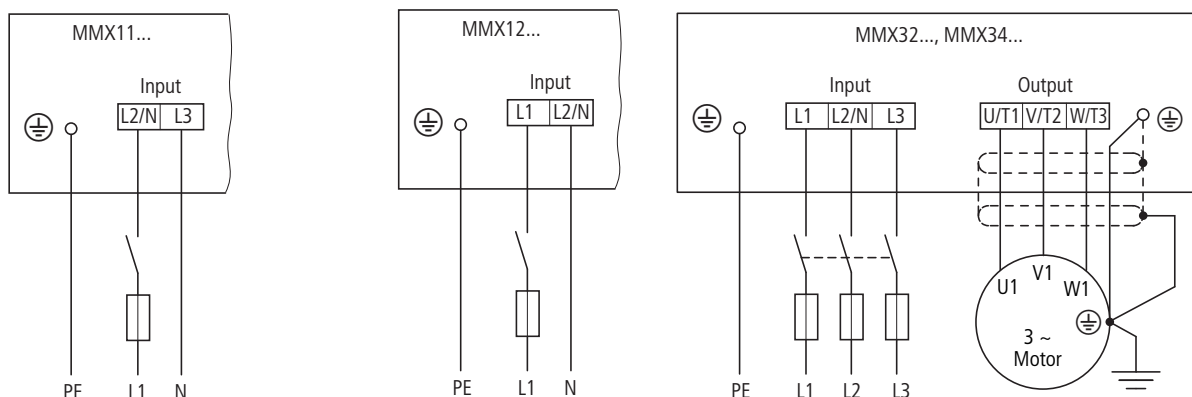


Figure 30: Connection to power section

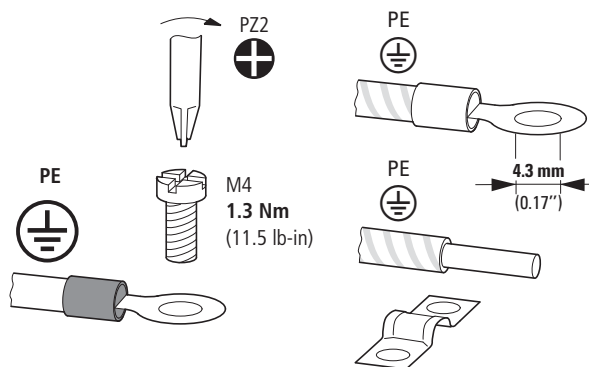


Figure 31: Ground connection

NOTICE

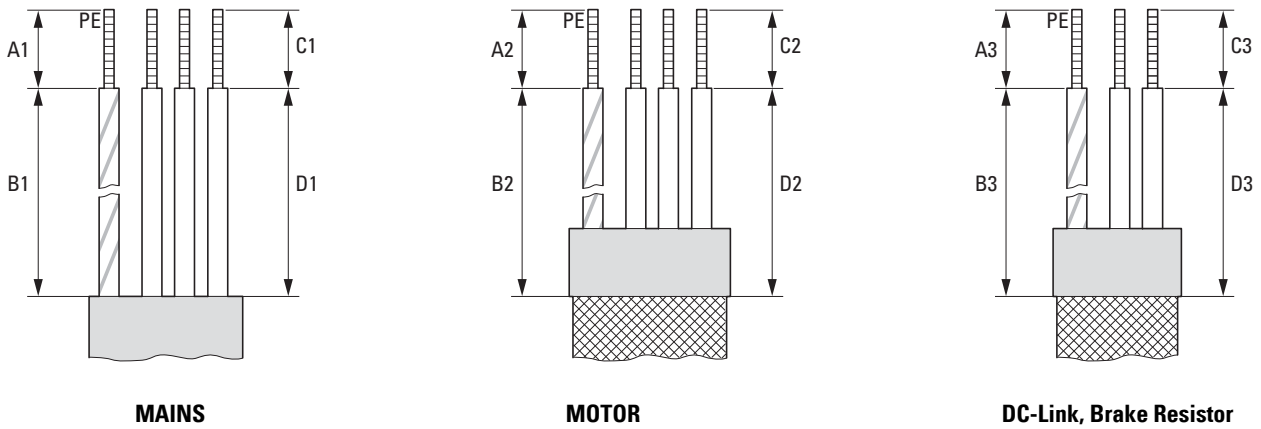
The frequency inverter must always be connected to the ground potential via a grounding cable (PE).

The ground connection must be directly connected with the cable routing plates.

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

- ▶ Connect the shielding at both ends and over a large surface area with the protective ground PES (protective earth shielding). You can connect the shielding of the motor cable directly to the cable routing plate (360° coverage) with the protective ground.

3.4.1.2 connection cables



mm (inch)	L1, L2, L3		PE		U/T1, V/T2, W/T3		PE	m2	DC+/R+, R-, DC-		PE	B3
	C1	D1	A1	b1	C2	D2	A2		C3	D3	A3	
FS1	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)
FS2	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)
FS3	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)	8 (0.3)	20 (0.8)	8 (0.3)	35 (1.4)
FS4	8 (0.3)	40 (1.6)	8 (0.3)	30 (1.2)	8 (0.3)	50 (2)	8 (0.3)	30 (1.2)	8 (0.3)	40 (1.6)	8 (0.3)	40 (1.6)
FS5	8 (0.3)	40 (1.6)	8 (0.3)	30 (1.2)	8 (0.3)	50 (2)	8 (0.3)	30 (1.2)	8 (0.3)	50 (2)	8 (0.3)	50 (2)

MAINS = Electrical supply system, MOTOR = Motor connection, DC-Link = internal DC link, Brake Resistor = Braking resistance

Figure 32: Stripping lengths in the power section

- ▶ Prevent the shielding from becoming unbraided, i.e. by pushing the separated plastic covering over the end of the shielding or with a rubber grommet on the end of the shielding. As an alternative, in addition to a broad area cable clip, you can also twist the shielding braid at the end and connect to protective ground with a cable clip. To prevent EMC disturbance, this twisted shielding connection should be made as short as possible (→ Figure 34).

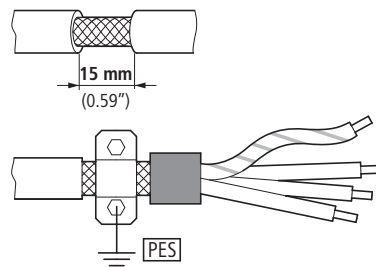


Figure 33: Screened connection cable

3 Installation

3.4 Electrical Installation

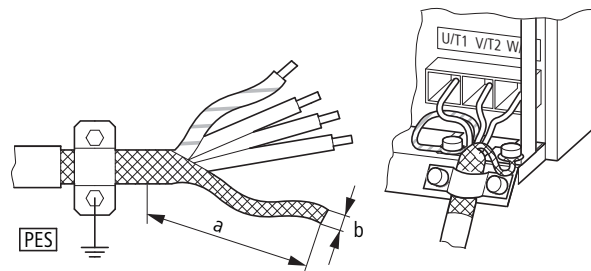


Figure 34: Connection with twisted cable screen
 Recommended value for twisted cable shielding:
 $b \geq 1/5 a$

Twisted shielding braid should be connected with a ring cable terminal (→ Figure 31, page 56) on PES.

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 frequency inverter and therefore minimizes the equalizing current loads on the shielding braid.

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

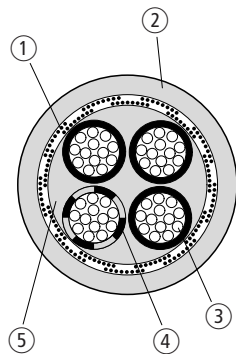


Figure 35: Four-core screened motor supply cable

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

If there are additional subassemblies in a motor feeder (such as motor contactors, overload relays, motor reactor, sinusoidal 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.

3.4.1.3 Arrangement and terminal cross section

The arrangement and size of the connection terminals depends on the construction of the power section (FS1 to FS5).

The cross-sections to be used in the connections and the tightening torques for screws are listed in the following.

		mm ²	AWG	mm	inch	Nm	ft-lbs	mm		
FS1	MMX12AA1D7... MMX12AA2D4... MMX12AA2D8...	0.2 - 2.5	24 - 12	8	0.31	0.5 - 0.6	0.37 - 0.44	0.6 x 3.5		
	MMX32AA1D7... MMX32AA2D4... MMX32AA2D8... MMX34AA1D3... MMX34AA1D9... MMX34AA2D4...	0.2 - 2.5	24 - 12	8	0.31	0.5 - 0.6	0.37 - 0.44	0.6 x 3.5		
	FS2	MMX11AA1D7... MMX11AA2D4... MMX11AA2D8... MMX11AA3D7...	0.2 - 2.5	24 - 12	8	0.31	0.5 - 0.6	0.37 - 0.44	0.6 x 3.5	
	MMX12AA3D7... MMX12AA4D8... MMX12AA7D0...	0.2 - 2.5	24 - 12	8	0.31	0.5 - 0.6	0.37 - 0.44	0.6 x 3.5		
	MMX32AA3D7... MMX32AA4D8... MMX32AA7D0... MMX34AA3D3... MMX34AA4D3... MMX34AA5D6...	0.2 - 2.5	24 - 12	8	0.31	0.5 - 0.6	0.37 - 0.44	0.6 x 3.5		

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3.4 Electrical Installation

		mm²	AWG	mm	inch	Nm	ft-lbs	mm			
FS3	MMX11AA4D8...	0.2 - 4	24 - 10	8	0.31	0.5 - 0.6	0.37 - 0.44	0.6 x 3.5			
	MMX12AA9D6...	0.2 - 4	24 - 10	8	0.31	0.5 - 0.6	0.37 - 0.44	0.6 x 3.5			
	MMX32AA011... MMX34AA7D6... MMX34AA9D0... MMX34AA012... MMX34AA014...	0.2 - 4	24 - 10	8	0.31	0.5 - 0.6	0.37 - 0.44	0.6 x 3.5			
FS4	MMX32AA012... MMX32AA017... MMX32AA025... MMX34AA016... MMX34AA023...	0.5 - 16	20 - 6	8	0.39	1.2 - 1.5	0.88 - 1.11	0.6 x 3.5			
	FS5	MMX32AA031... MMX32AA038... MMX34AA031... MMX34AA038...	0.5 - 16	20 - 6	8	0.39	1.2 - 1.5	0.88 - 1.11	0.6 x 3.5		

3.4.2 Connection on control section

The control signal terminals are arranged under the frontal cover flap.

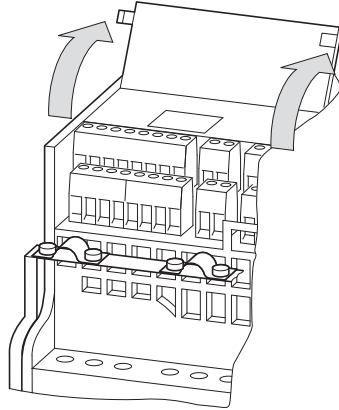


Figure 36: Position of control signal terminals

The supplied cable bracket can be fitted to the cable routing plate of the power section and fitted with the provided cable clips.

The control cables should be screened and twisted. The shielding is exposed on one side (PES), on the cable hold down clamps on the frequency inverter for instance.



Prevent the shielding from becoming unbraided, i.e. by pushing the separated plastic covering over the end of the shielding or with a rubber grommet on the end of the shielding.

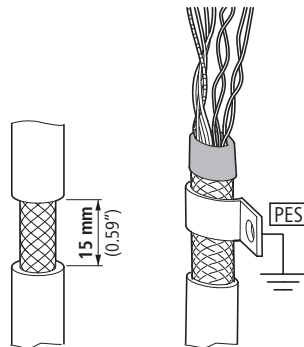


Figure 37: Prevent the shield from becoming unbraided

Alternatively, in addition to the broad area cable clip, you can also twist the shielding braid at the end and connect to the protective ground with a cable lug. To prevent EMC interference, this twisted shield connection should be made as short as possible (→ Figure 34, page 58).

3 Installation

3.4 Electrical Installation

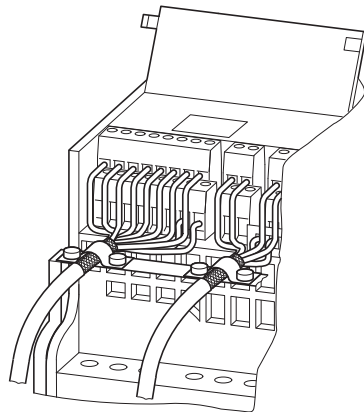


Figure 38: Example for a single-side connection (PES) to the frequency inverter

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

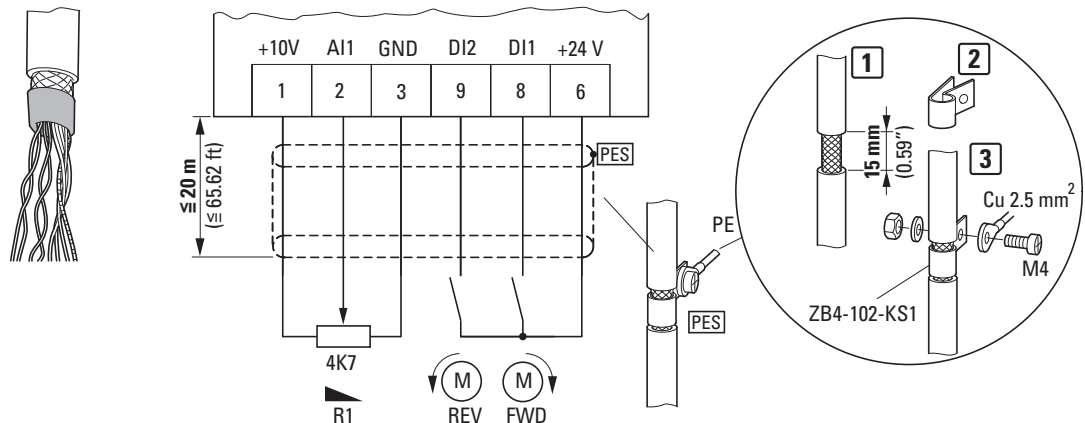


Figure 39: Example for an insulated end of the control cable

3.4.2.1 Arrangement and designation



ESD measures

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

The following figure shows the arrangement and designation of the control signal terminals of the M-Max™.

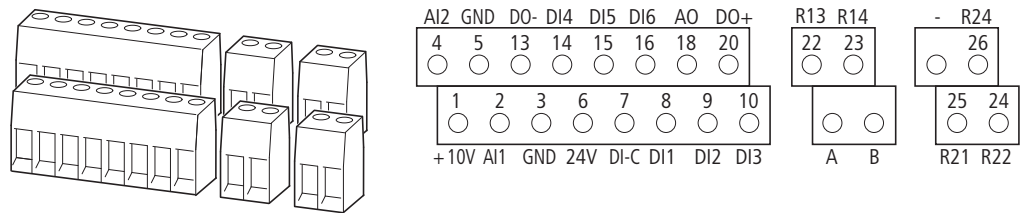








Figure 40: Assignments and designations for control signal terminals

Table 4: Possible sizes and specifications of the connection cables on the control signal terminals

					
mm ²	mm ²	AWG	mm	Nm	ft-lbs
0.14 - 1.5	0.25 - 0.5	26 - 16	5	0.22 - 0.25	0.16 - 0.18

3.4.2.2 Microswitches and control signal terminals

Four microswitches are arranged under the blanking plate. These are used to configure the control signal terminals directly.

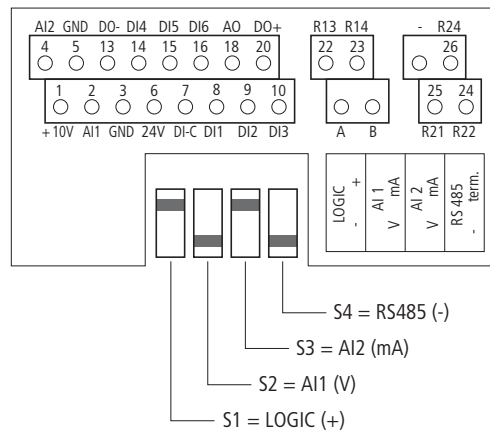


Figure 41: Microswitch default settings

S1	8, 9, 10, 14, 15, 16	LOGIC	Control logic: + = increase logic (FS), Source part no. - = decrease logic, Sink part no.	→ Page 67
S2	2	AI1	Analog input 1 (P2.1): V = 0 - +10 V (DS) mA = 4 - 20 mA	→ Page 65
S3	4	AI2	Analog input 2 (P2.5): mA = 4 - 20 mA (DS) V = 0 - +10 V	→ Page 65
S4	A, B	RS485	Bus terminating resistor (A/B control terminal): - = disconnected term. = switched on (term = terminator)	→ Page 71

3 Installation

3.4 Electrical Installation

3.4.2.3 Function of the control signal terminals

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

Table 5: Factory-set functions of the control terminals

Terminal	Signal	Default Setting	Description	
1	+10V	Set voltage, output	-	Maximum load 10 mA, reference potential GND
2	AI1	Analog signal input 1	Frequency reference value ¹⁾	0 - +10 V ($R_i > 200 \text{ k}\Omega$) 0/4 - 20 mA ($R_B = 200 \text{ }\Omega$) Selectable via microswitch S2 10-bit resolution
3	GND	Reference potential	-	0 V
4	AI2	Analog input 2	PID controller, actual value ¹⁾	0 - +10 V ($R_i > 200 \text{ k}\Omega$) 0/4 - 20 mA ($R_B = 200 \text{ }\Omega$) Selectable via microswitch S3 10-bit resolution
5	GND	Reference potential	-	0 V
6	24 V	Control voltage for DI1 - DI6, output (+24 V)	-	Maximum load 50 mA, reference potential GND
7	DI-C	Reference potential of the digital inputs DI1 - DI6	LOGIC- (GND)	Selectable through microswitch LOGIC -/+
8	DI1	Digital input 1	Start enable FWD ¹⁾	0 - +30 V ($R_i > 12 \text{ k}\Omega$)
9	DI2	Digital input 2	Start enable REV ¹⁾	0 - +30 V ($R_i > 12 \text{ k}\Omega$)
10	DI3	Digital input 3	Fixed frequency B0 ¹⁾	0 - +30 V ($R_i > 12 \text{ k}\Omega$)
13	DO-	Digital output	Active = READY ¹⁾	Transistor, max. 50 mA, supply voltage control signal terminal 20
14	DI4	Digital input 4	Fixed frequency B1 ¹⁾	0 - +30 V ($R_i = 12 \text{ k}\Omega$)
15	DI5	Digital input 5	Error acknowledgment ¹⁾	0 - +30 V ($R_i = 12 \text{ k}\Omega$)
16	DI6	Digital input 6	PI controller deactivated ¹⁾	0 - +30 V ($R_i = 12 \text{ k}\Omega$)
18	AO	Analog output	Output frequency ¹⁾	0 - +10 V, maximum 10 mA 10-bit resolution
20	DO+	Digital output	Supply voltage, see control signal terminal 13	Supply voltage for digital output DO max. 48 V DC, max. 50 mA
22	R13	Relay 1, normally open contact	Active = RUN ¹⁾	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
23	R14	Relay 1, normally open contact	Active = RUN ¹⁾	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
24	R22	Relay 2, changeover contact (N/C)	Active = FAULT ¹⁾	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
25	R21	Relay 2, changeover contact	Active = FAULT ¹⁾	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
26	R24	Relay 2, changeover contact (N/O)	Active = FAULT ¹⁾	Maximum switching load: 250 V AC/2 A or 250 V DC/0.4 A
A	A	RS485 signal A	BUS-Communication	Modbus RTU
B	B	RS485 signal B	BUS-Communication	Modbus RTU

1) programmable function (→ Section "8.14 List of parameters", page 261)

3.4.2.4 Analog inputs

Connection area of the analog and digital inputs and outputs.

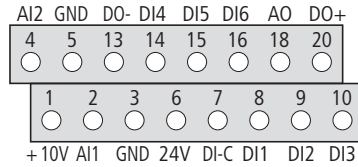


Figure 42: Control signal terminals (digital and analog inputs/outputs)

The frequency inverter M-Max™ has two analog inputs for specifying the frequency setpoint value and the actual value return to the PI controller:

- Control signal terminal 2 (AI1), voltage signal 0 (2) - +10 V, input resistance 200 kΩ.
- Control signal terminal 4 (AI2), current signal 0 (4) - 20 mA, Load resistance 200 Ω.

Adjusting and the parameter definition of analog inputs are described in Section "Analog input (P2)", Page 106.

The analog input AI1 (control signal terminal 2) is default set for the frequency reference value (P6.2). The setpoint can be entered using an external potentiometer (recommended fixed resistance: 1 kΩ to 10 kΩ). The fixed resistance of the setpoint potentiometer is fed from the frequency inverter via the control signal terminal 1 with +10 V (maximum load rating: 10 mA).

Control signal terminals 3 and 5 are reference points (GND) for the analog setpoint signals.

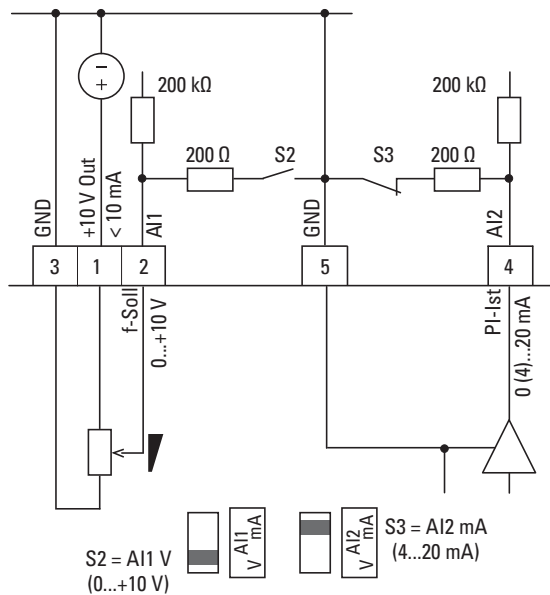


Figure 43: Analog setpoint inputs AI1 and AI2
Connection example: Potentiometer (4.7 kΩ)
M22-R4K7; Article no. 229490

3 Installation

3.4 Electrical Installation

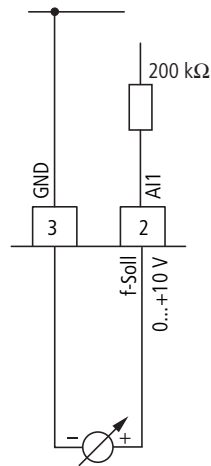


Figure 44: Analog setpoint value signal, e. g. from a superordinate controller (PLC)

3.4.2.5 Analog Output

The frequency inverter provides an analog voltage signal (0 - +10 V) at control terminal 18. This signal is default set proportional to the output frequency f_{Out} : 0 - f_{max} (P6.4). The calibration and parameterization of the analog output are described in Section "Analog output (P4)", Page 121.

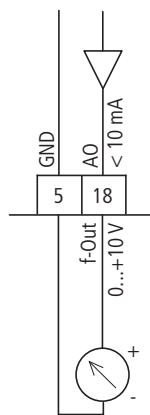


Figure 45: Analog output AO (connection example)

3.4.2.6 Digital inputs

The frequency inverter has six digital inputs (DI1 to DI6) that have an identical function and operation.

Their control section is default set for +24 V (positive logic, source type). The internal control voltage from control terminal 6 (+24 V, maximum 50 mA) or an external voltage source (+24 V) can be used for this. The permissible residual ripple must be less than $\pm 5\% \Delta U_a / U_a$. The parameterizable functions are described in Section "Digital input (P3)", Page 110.

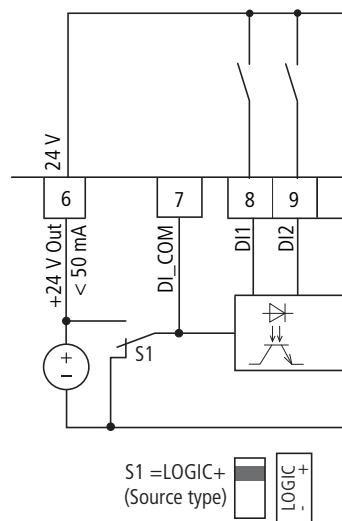


Figure 46: Digital inputs with internal supply voltage

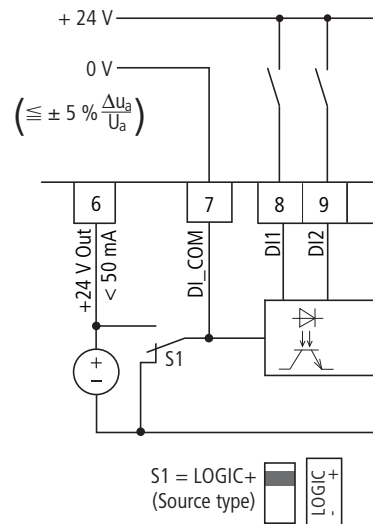


Figure 47: Digital inputs with external supply voltage

An overview of the factory set functions and the electrical connection data are shown in Section "Function of the control signal terminals", Page 64.

3 Installation

3.4 Electrical Installation

Microswitch S1 (LOGIC) is used to change the control logic to so-called negative logic (Sink part no.). The digital inputs are fed internally or externally via control signal terminal 7 (DI_COM) with +24 V and connected to the relevant 0V potential (GND) via the input terminals DI1 to DI6.

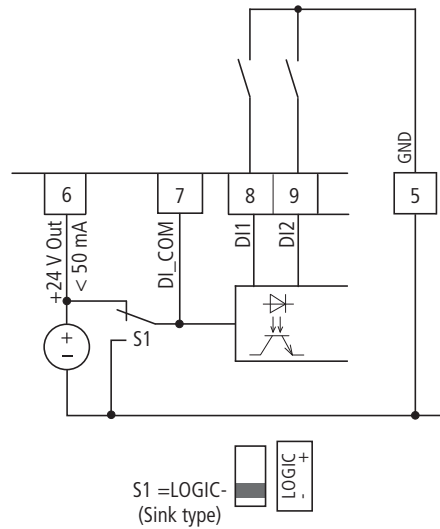


Figure 48: Digital inputs (decrease logic, Sink part no.) with internal supply voltage

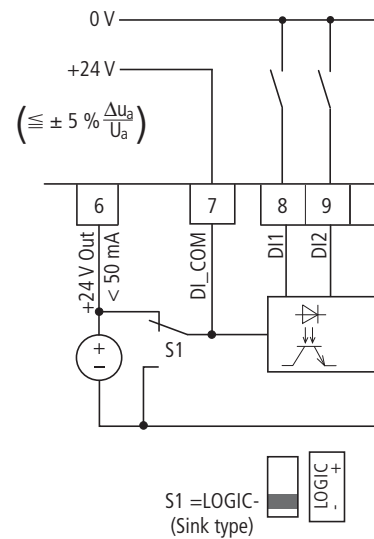


Figure 49: Digital inputs (decrease logic, Sink part no.) with external supply voltage

3.4.2.7 Digital output (Transistor)

The transistor output (control signal terminal 13, DO-) can be fed via control signal terminal 20 (DO+) with the internal control voltage (+24 V) or with an external DC voltage of up to +48 V. The permissible residual ripple must be less than $\pm 5\% \Delta U_a / U_a$. The maximum permissible load current is 50 mA.

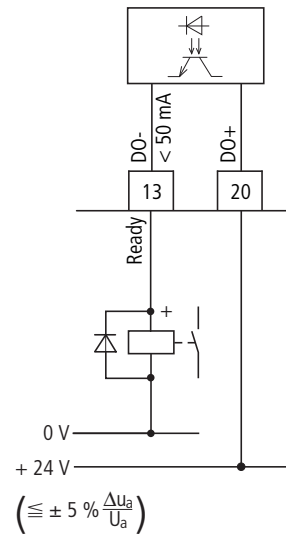


Figure 50: Digital output DO and connection examples (coupling relay with freewheeling diode: ETS4-VS3; Item No. 083094)

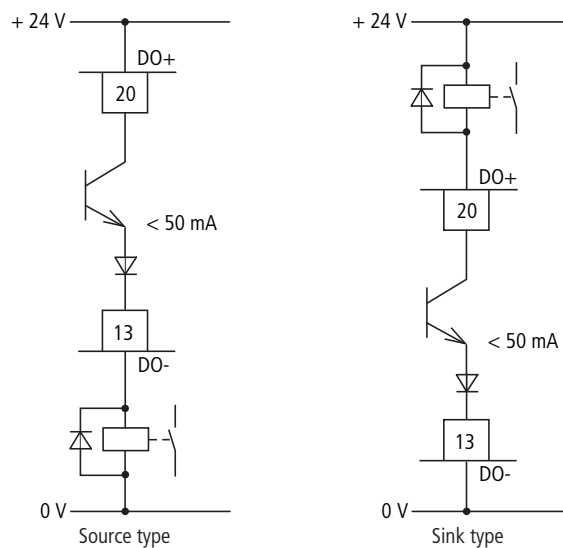


Figure 51: Connection example and operation of DO in Source and Sink type

The parameter assignment is described in Section "Digital output (P5)", Page 122.

3 Installation

3.4 Electrical Installation

3.4.2.8 Digital outputs (relays)

The following figure shows the arrangement of the connection terminals for both relay contacts.

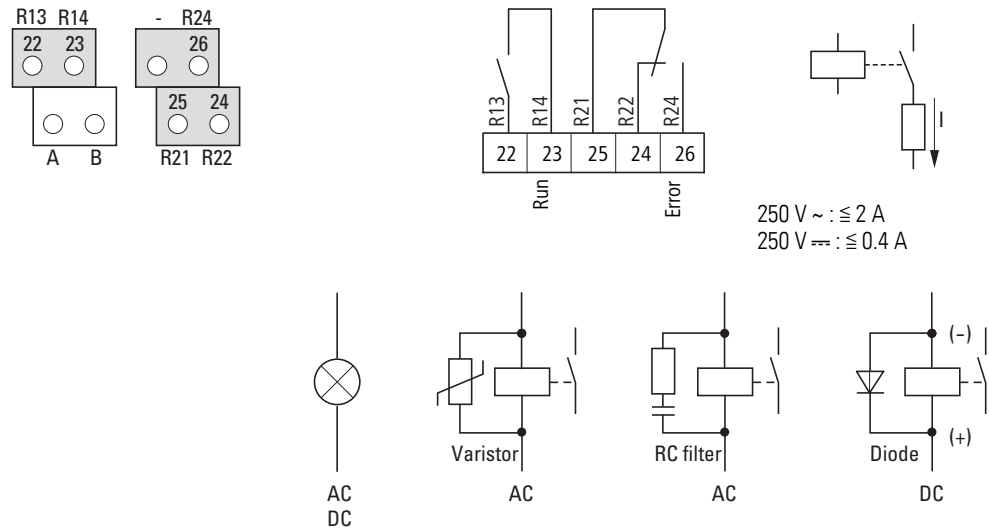


Figure 52: Relay outputs with connection examples, Control relay with suppressor circuit

The two relay outputs (control signal terminals 22 to 26) enable the frequency inverter to generate galvanically isolated feedback signals in control circuits with other potentials:

- maximum switching duty: 250 V DC, 0.4 A (DC voltage),
- maximum switching duty: 250 V AC, 2 A (AC voltage).



With voltages greater than 48 V, you should fasten the connection cables of the relay in the opening on the right (housing).

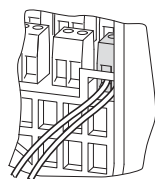


Figure 53: Fixed connection cables at $U > 48$ V (relay)

The parameterizable functions are described in Section “Digital output (P5)”, Page 122.

The default setting causes N/O contact R13/R14 (control signal terminal 22/23) of relay RO1 to indicate operation (RUN).

N/O contact R21/R24 (control signal terminal 25/26) of relay RO2 indicates a detected fault (ERROR = FAULT).



If the supply voltage of the frequency inverter is switched off upon the occurrence of an error message, the N/O R21/R24 opens again (relay drops out).

3.4.2.9 Serial interface A-B

The following figure shows the connections of the serial interface and the position of the micro-switch for the bus termination resistor.

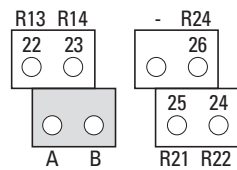


Figure 54: Connection terminals of the serial interface

The two control signal terminals A and B enable the connection of a screened RS485 twisted-pair cable.

The bus terminating resistor required at the end of a data cable is integrated in the frequency inverter and can be connected via microswitch S4.



The network cable must have a bus termination resistor ($120\ \Omega$) connected at each physical end to prevent reflections and the resulting transmission faults.

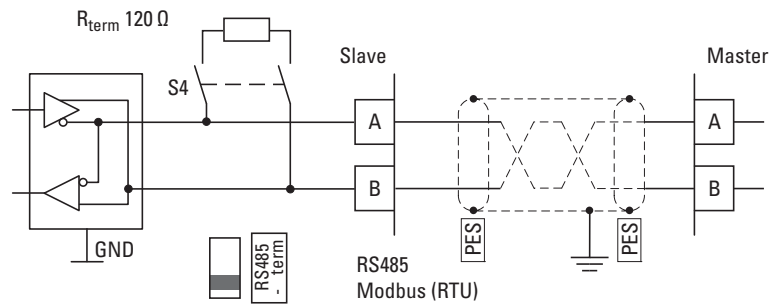


Figure 55: Two-wire RS485 connection
(Slave = M-Max™ frequency inverter)

The parameter definition of the serial interface is described in Chapter “Serial interface (Modbus RTU)”.

3 Installation

3.4 Electrical Installation

3.4.3 Block diagram

3.4.3.1 MMX11

The following diagrams show all the terminals on an M-Max™ frequency inverter and their functions at the default settings.

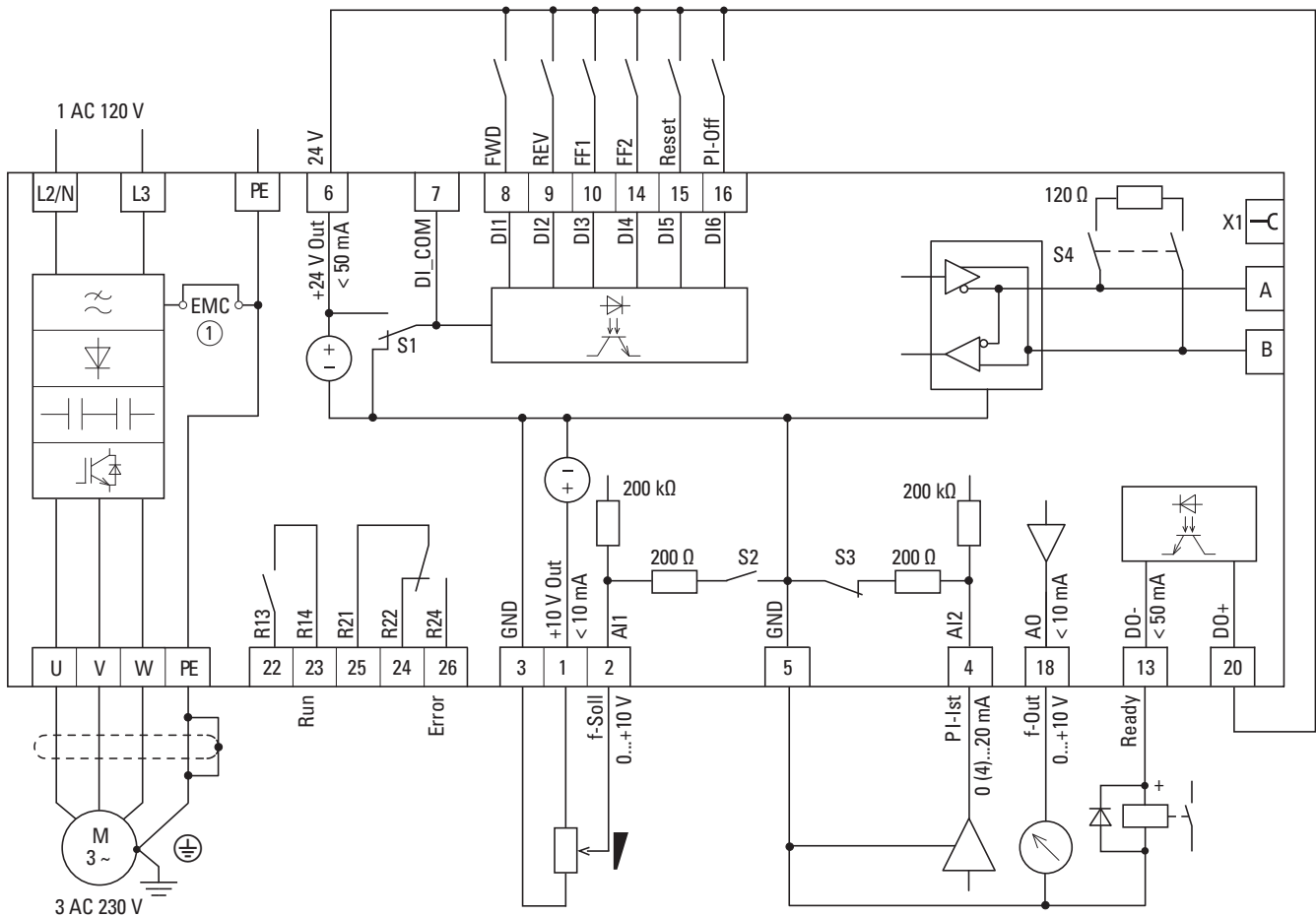


Figure 56: MMX11 block diagram...
MMX11 has a voltage doubler circuit inside the internal DC link. A power supply of 1 AC 120 V (115 V) will output a motor voltage of 3 AC 230 V.

- ① MMX11...N...: without RFI filter (EMC)
- MMX11...F...: with RFI filter (EMC)

3.4.3.2 MMX12

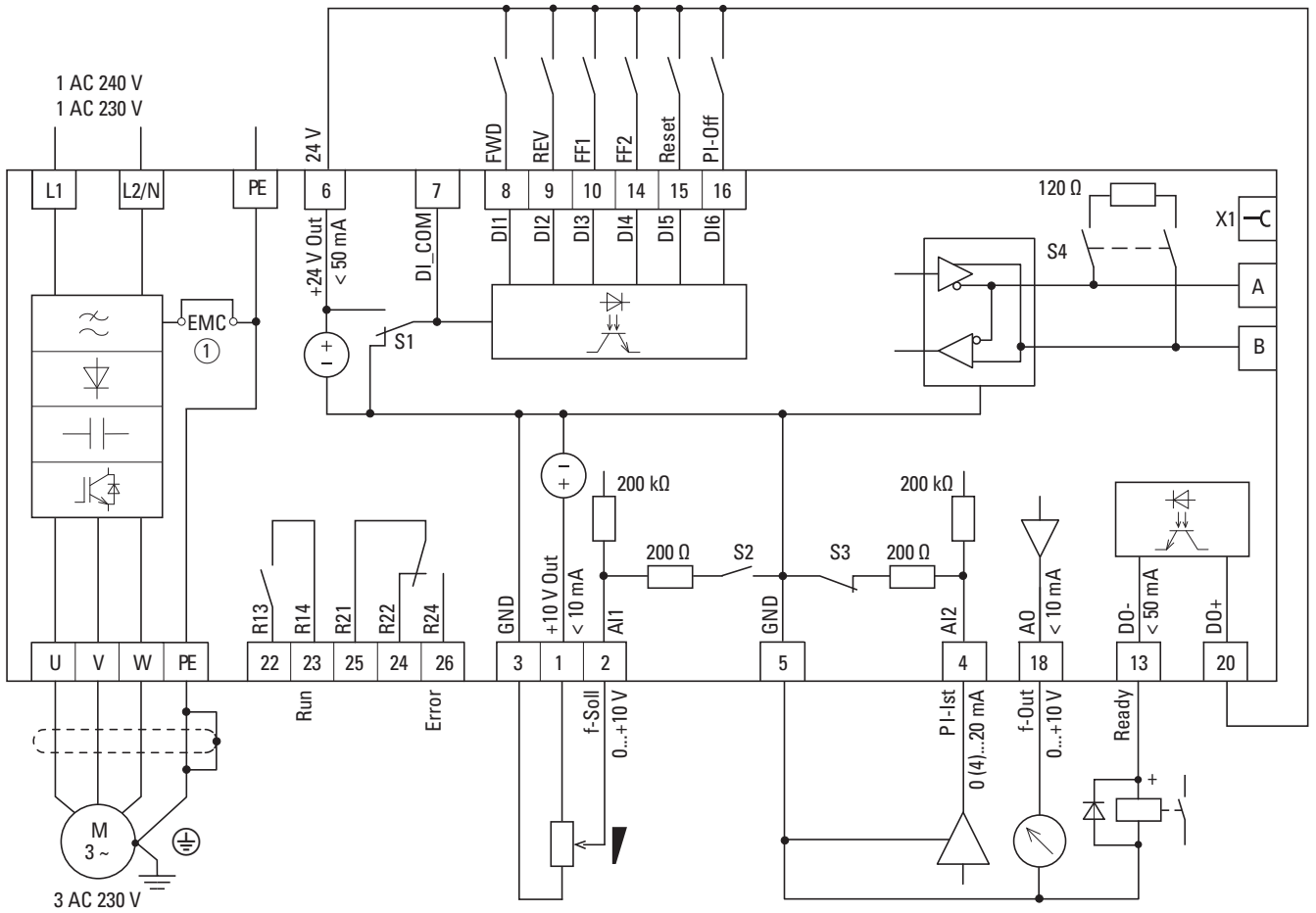


Figure 57: MMX12...F... block diagram

- ① MMX12...N...: without RFI filter (EMC)
- MMX12...F...: with RFI filter (EMC)

3 Installation

3.4 Electrical Installation

3.4.4 Insulation test

The frequency inverter of the M-Max™ series are tested, delivered and require no additional testing.



CAUTION

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



Wait at least 5 minutes after switching the supply voltage off before you disconnect one of the connection terminals (L1, L2/N, L3, U/T1, V/T2, W/T3, CD-, DC+, R+, R-) of the frequency inverter.

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

3.4.4.1 Testing the motor cable insulation

- ▶ Disconnect the motor cable from the connection terminals U/T1, V/T2 and W/T3 of the frequency inverter and from the motor (U, V, W). Measure the insulation resistance of the motor cable between the individual phase conductors and between the phase conductor and the grounding conductor.

The insulation resistance must be greater than 1 MΩ.

3.4.4.2 Testing the mains cable insulation

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

3.4.4.3 Testing the motor insulation

- ▶ Disconnect the motor cable from the motor (U, V, W) and open the bridge circuits (star or delta) in the motor terminal box. Measure the 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.

4 Operation

4.1 Checklist for commissioning

Before placing the frequency inverter into operation, make sure to check the following (checklist):

No.	Activity	Remark
1	Mounting and wiring have been carried out in accordance with the corresponding instructional leaflet (→ IL04020006Z und IL04020007Z).	
2	All wiring and line section leftovers, as well as all the tools used, have been removed from the frequency inverter's proximity.	
3	All terminals in the power section and in the control section were tightened with the specified torque.	
4	The lines connected to the output terminals of the frequency inverter (U/T1, V/T2, W/T3, DC+/R+, R-, DC-) are not short-circuited and are not connected to ground (PE).	
5	The frequency inverter has been earthed properly (PE).	
6	All electrical terminals in the power section (L1, L2/N, L3, U/T1, V/T2, W/T3, DC+/R+, R-, DC-, PE) were implemented properly and were designed in line with the corresponding requirements.	
7	Each single phase of the supply voltage (L1, L2, L3) is protected with a fuse.	
8	The frequency inverter and the motor are adapted to the mains voltage. (→ Section "1.3.1 Rating plate", page 11, 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 frequency inverter 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. (→ Section "8.14 List of parameters", page 261).	
12	The effective direction of a coupled machine will allow the motor to start.	
13	All emergency switching off functions and safety functions are in an appropriate condition.	

4 Operation

4.2 Hazard warnings for operation

4.2 Hazard warnings for operation

Please observe the following notes.



DANGER

Commissioning is only to be completed by qualified technicians.



DANGER

Hazardous voltage!

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



DANGER

The components in the frequency converter's power section are energized if the supply voltage (line voltage) is connected. For instance: power terminals L1, L2/N, L3, DC+/R+, R-, DC-, U/T1, V/T2, W/T3.

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

There can be a dangerous voltage on the relay terminals (22 to 26) even if the frequency inverter is not being supplied with line voltage (e.g., integration of relay contacts in control systems with 230 V AC).



DANGER

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

Pay attention to hazard warnings!



DANGER

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

(→ parameter P6.13)

4.3 Commissioning with control signal terminals (default settings)

NOTICE

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

Contactors and switching devices (repair and maintenance switches) on the motor side must never be opened while the motor is in operation when the frequency inverter is set to speed control operating mode (P11.8 = 1).

Inching operation of the motor with contactors and switching devices in the output of the frequency inverter is not permitted.

NOTICE

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



The START button is only functional if the KEYPAD operating mode is activated.

The STOP button is active in all operating modes. It can be deactivated with parameter (P6.16 = 0).



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)

M-Max™ frequency inverters are set in the factory and can be started directly via the control signal terminals by connecting the motor outputs allocated for the mains voltage (see connection example below).



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

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

4 Operation

4.3 Commissioning with control signal terminals (default settings)

Connection example	Terminal	Designation	
	L1	Single-phase mains connection (MMX12) - Single-phase mains connection (MMX11)	
	L2/N		
	L3		
	PE	Ground connection	
	6	Control voltage +24 V (output, maximum 50 mA)	
	8	FWD, Start release clockwise rotating field	
	9	REV, Start release left rotating field	
	U	Connection for three-phase ac motor (three-phase motor)	
	V		
	W		
	PE		
	3	Reference potential GND (0 V)	
	1	Setpoint value voltage +10 V (Output, maximum 10 mA)	
	2	Frequency reference value f-Set (Input 0 – +10 V)	

Connect the frequency inverter according to the connection example for the simple commissioning with the specified default settings (see connecting example above).



If the connections for the setpoint value potentiometer cannot be clearly allocated with terminals 1, 2 and 3, you should set the potentiometer to about 50% before giving the start release (FWD/REV) for the first time.

When the specified power supply is applied to connection terminal L2/N and L3 (MMX11) or L1 and L2/N (MMX12) or L1, L2/N and L3 (MMX32, MMX34), the LCD display lights up and all segments are displayed briefly.

The frequency inverter runs a self-test automatically when the power is applied.

The arrows ▲ in the top status line of the LCD display show the operating status:

- READY = ready for operation (proper operating state)
- STOP = stop (no start command)

The arrows ▼ in the bottom status line show the controller commands. Actuation is done via the control signal terminals (I/O = Control Input/Output) in the factory setting.

The FWD mark (Forward) designates the basic rotational direction (phase sequence for a clockwise rotating field) on connection terminals U/T1, V/T2 and W/T3.

4.3 Commissioning with control signal terminals (default settings)

The operating data of the output frequency is shown in the LCD display in alternating sequence with M1.1 and 0.00 Hz. The arrow ◀ in the left-hand status line indicates menu level MON (Monitor = Operating data display).

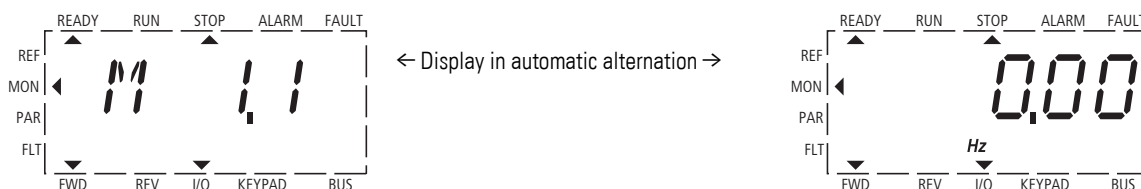
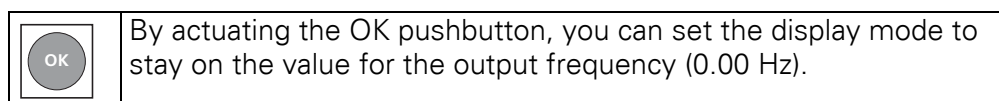


Figure 60: Operational data indicator (operational)



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

- Terminal 8: FWD = Clockwise rotating field (Forward Run)
- Terminal 9: REV = Counterclockwise rotating field (Reverse Run)

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

The start release (FWD, REV) is shown in the top status line (LCD display) by the arrow ▲ switching from STOP to RUN.

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



Figure 61: Operation (RUN) via control signal terminal (I/O) with left rotating field (REV) (e.g. - 12.34 Hz)

You can now set the output frequency (0 – 50 Hz) and therefore the speed of the connected ac motor (0 – n_{motor}) with the setpoint value potentiometer via terminal 2 (proportional voltage signal 0 – +10 V). The change in output frequency here is delayed based on the specified acceleration and deceleration ramps. In the factory settings, these times are set to 3 seconds.

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

Figure 62 on Page 82 shows a good example of the process, if the release signal (FWD/REV) is switched on and the maximum setpoint voltage (+10 V) is applied. The speed of the motor follows the output frequency depending on the load and moment of inertia (slip), from zero to n_{max} .

4 Operation

4.3 Commissioning with control signal terminals (default settings)

If the release signal (FWD, REV) is switched off during operation, the inverter is blocked immediately (STOP). The motor comes to an uncontrolled stop (see ① in Figure 62, Page 82).



The stop command can also be given via the STOP button on the operating unit. The STOP pushbutton is active in all operating modes. It can be disabled with parameter (P6.16 = 0).

A controlled run-down can be set using parameter P6.8 (STOP function) (P6.8 = 1).

The relevant deceleration time is set in parameter P6.6. The acceleration time is set in parameter P6.5.

Information on settings and the description of the parameters used here is provided in Section "Drives control (P6)", Page 126.

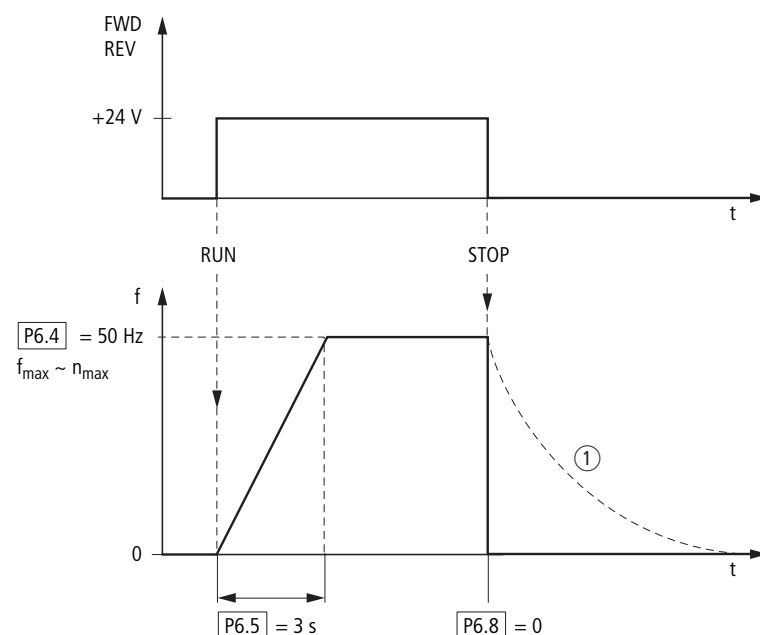


Figure 62: Start-Stop command with maximum setpoint value voltage, acceleration ramp 3 s

As an alternative (OR) to operation via control signal terminals, you can also operate the frequency inverter without connecting the control signal terminals by simply switching the control level and the setpoint value input.



LOC/REM pushbutton
LOC = local, keypad (KEYPAD)
REM = remote (I/O, BUS)

The following brief instructions indicate the required steps.

4.4 Brief Instructions

The brief instructions (→ Figure 63, page 85) provide a graphical description of the few steps necessary up to the motor start:

- The frequency inverter carries out a self-test when the supply voltage is applied. The backlight of the LCD display is switched on and all segments are actuated briefly.



When the MMX is switched on for the first time, it activates the Quickstart Wizard to guide you step-by-step through the drive parameters (alternating display of P1.1 = 1)
→ For this first read chapter6 (Parameters).
P1.1 = 0 enables you to access the parameters. The key sequence [BACK/RESET], [^], [OK] guides you to the MON operating data display. This is always displayed after switching off the power supply.

- The frequency inverter is ready to start when there is an alternating display M1.1 ↔ 0.00 Hz.



Pressing the OK pushbutton allows you to change the alternating mode of the displayed value M1.1.

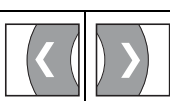
- The frequency inverter is now ready for operation, and is factory set for activation and frequency setting via the control signal terminals (I/O). The STOP pushbutton is active in this mode.



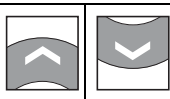
The KEYPAD control level can be activated via the LOC/REM pushbutton. The menu level (◀) moves to REF and the displayed value switches to 0.00 Hz (default settings).



Pressing the OK pushbutton activates the setpoint entry. The right-hand digit of the displayed 0.00 Hz flashes.



Use these two arrow buttons to select the entry digit (Cursor).



Use these two arrow buttons to change the frequency values (Frequency set value).



Changes are only possible when there is flashing at the entry digit (press OK pushbutton).



Press the START pushbutton to start (RUN) the drive in the selected direction (default settings FWD).

- The direction can be changed via the two arrow buttons (< or >, Cursor).

4 Operation

4.4 Brief Instructions

- The drive is factory set to stop at 0 Hz and can then be run in the opposite direction by pressing the START pushbutton. Parameter P6.14 = 0 must be set in order to change direction without a stop.



In the default settings, the STOP pushbutton is active in all operating modes.

The STOP function can be set via P6.8:

- free coasting
- Deceleration ramp.

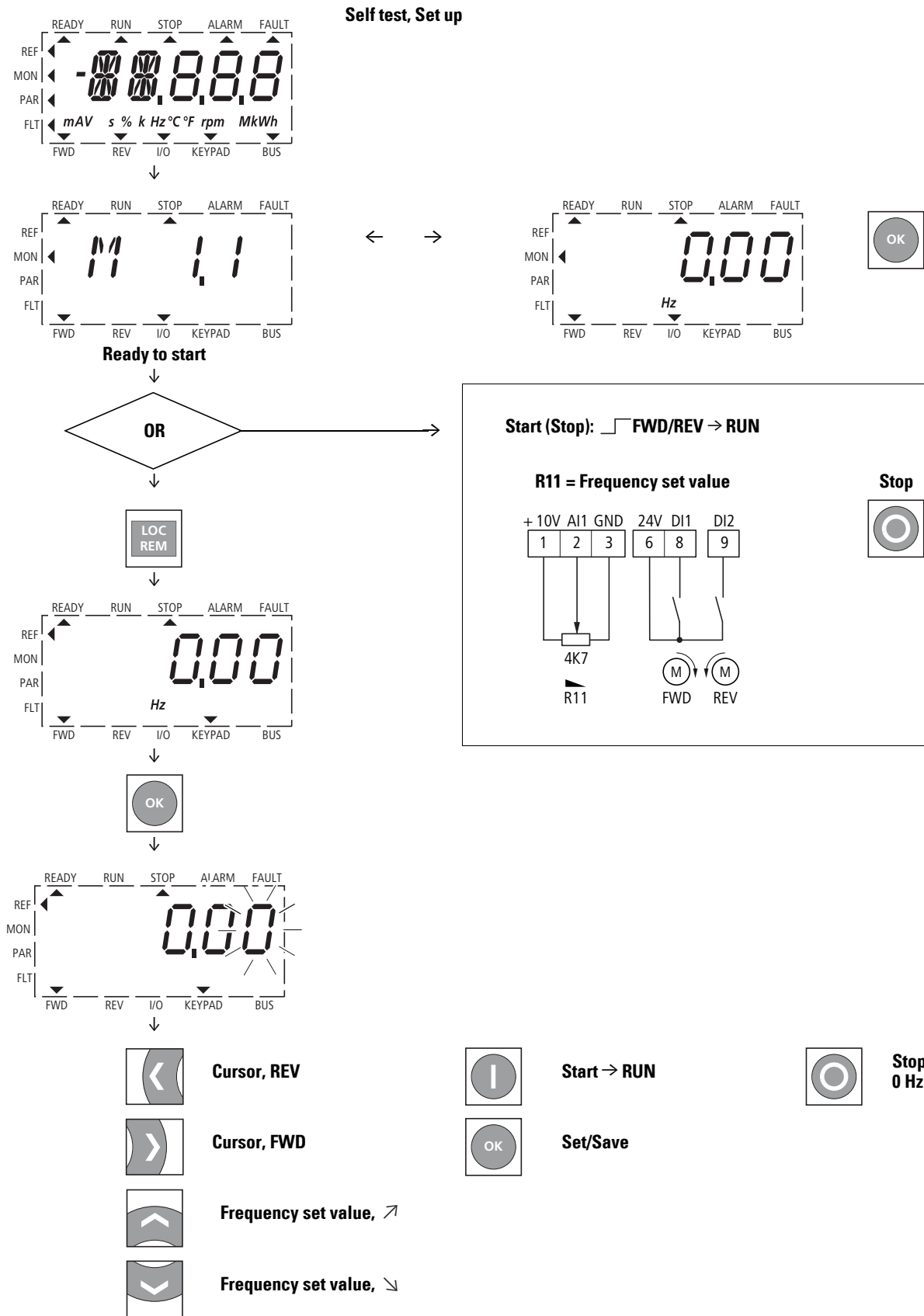


Figure 63: Brief instructions: Steps to the motor start

4 Operation

4.4 Brief Instructions

5 Error and Warning Messages

5.1 Introduction

M-Max™ frequency inverters have several internal monitoring functions. When deviations from the correct operating state are detected, faults (FAULT) and warning messages (ALARM) are differentiated between.

5.1.1 Error messages

Faults can cause faulty functionality and technical defects. The inverter (frequency inverter output) is automatically disabled if a fault is detected. The connected motor then runs down freely to a stop.

Error messages are shown on the display with an arrowhead ▲ under FAULT and with the error code F... (F1 = last fault, F2 = last but one fault, etc.).



Figure 64: Example of an error message (undervoltage)

5.1.2 Acknowledge error message (Reset)

The current error message flashes (e.g. F1 09). It can be acknowledged by pressing the BACK/RESET button or by actuating DI5 (default settings control signal terminal 15). The displayed error then automatically stops flashing, the four horizontal bars (Reset) are shown and the error message is then displayed continuously. The arrow point ▲ underneath FAULT disappears.



DANGER

If a start signal is present, the drive is restarted automatically, if P3.1 = 0 is set (REAF = Restart after FAULT) and the error message has been acknowledged (Reset).

The current fault message indication (F1...) is cleared when the supply voltage is interrupted or when you press the BACK/RESET key and then the OK key (indication d...) and then the BACK/RESET key again. The indication goes out and the arrow tip ◀ flashes at menu level MON.



In the error register (display F...) it is only possible to return to the menu level (arrow point ◀ FLT flashes) from display d... .

5 Error and Warning Messages

5.1 Introduction

Fault log (FLT)

The last nine faults can be called up and shown in succession in the fault log (FLT).

For this select the FLT menu level (◀). Use the arrow buttons ^ and v to call the faults F1 - F9 individually. Every error message is stored with the time of the error occurrence under d (day), H (hour) and m (minute). The call is made with the OK pushbutton, and the selection with ^ and v arrow buttons.

The content of the error memory is cleared when the factory setting is activated, when you press the BACK/RESET button, the display of the menu level (◀) flashes and the STOP pushbutton is held down for around 5 seconds.



Activating the default settings will reset all parameters!

5.1.3 Warnings

A warning message gives warning of possible damage and indicates impending errors that can still be prevented, such as an excessively high temperature rise.

Warning messages appear on the display with an arrow ▲ under ALARM and AL with the respective code number. The code numbers for faults and warning messages are identical.



Figure 65: Example of an alarm message



If a warning message occurs, the frequency inverter remains active (READY, RUN).

In the given example (AL 50 = current setpoint signal 4–20 mA interrupted), the drive stops following the absence of a reference value. If no more measures are introduced because of the warning message (e. g. a shutdown), the drive can start again automatically in the example AL 50 when the current signal returns (e.g. a contact fault in the signal line).

The alarm message (AL) is displayed alternating with the active operational display value.

Table 6 shows the error codes, their possible causes and indicates correction measures.

5.1.4 Error List

Table 6: List of fault messages (F) and warning messages (AL)

Indicator	Designation	Possible Cause	Note
01	Overcurrent	<ul style="list-style-type: none"> The frequency inverter has detected an excessive current ($> 4 \times I_N$) in the motor cable. Sudden load increase. Short-circuit in motor cable. inadequate motor. 	<ul style="list-style-type: none"> Check the load Check the motor size Check cables (→ parameter P6.6)
02	Overvoltage	<ul style="list-style-type: none"> The DC intermediate circuit voltage has exceeded the internal safety limit. the delay time is too short. high overvoltage peaks in line power 	<ul style="list-style-type: none"> Threshold of the overvoltage messages MMX11: 437 V MMX12: 437 V MMX32: 437 V MMX34: 911 V increase braking time
03	Ground (earth) fault	<ul style="list-style-type: none"> An additional leakage current was detected when starting by means of a current measurement. Insulation fault in the cables or in the motor 	Check the motor cable and the motor
08	System fault	<ul style="list-style-type: none"> Central processing unit error message Internal communication fault. 	Reset error: Switch mains voltage off and on (Restart). If the fault occurs again, please contact your closest Eaton representative ¹⁾ .
09	Undervoltage	The DC intermediate circuit voltage has exceeded the internal safety limit. Probable cause: <ul style="list-style-type: none"> the supply voltage is too low, internal device fault, Power failure. 	<ul style="list-style-type: none"> If a brief power failure takes place, reset the fault and restart the frequency inverter. Check the supply voltage. If it is OK, there is an internal fault. If this is the case, please contact your closest Eaton representative¹⁾.
13	Under-temperature	The IGBT switch temperature is below -10 °C.	Check the ambient air temperature
14	Overtemperature	The IGBT switch temperature is above 120 °C. An excessive temperature warning is issued if the IGBT switch temperature goes above 110 °C.	<ul style="list-style-type: none"> Make sure that there is an unobstructed flow of cooling air Check the ambient air temperature Make sure that the switching frequency is not too high in relation to the ambient temperature and to the motor load
15	Motor stalled	The motor blocking protection mechanism has been triggered.	Check the motor
16	Motor over-temperature	The frequency inverter's motor temperature model has detected motor overheating. Motor is overloaded	Decrease the motor load. If the motor is not overloaded, check the temperature model parameter.
17	Motor underload	Motor idle, connection to load machine interrupted (e.g. torn drive belt).	This function must be activated at P8.5. The setting for the underload message is made via P8.12 and P8.13.
22	EEPROM checksum error	<ul style="list-style-type: none"> Error when storing parameters. Malfunction, Component fault, Error in microprocessor monitoring. 	Please contact your closest Eaton representative ¹⁾ .
25	Watchdog	<ul style="list-style-type: none"> Error in microprocessor monitoring. Malfunction, Component fault. 	Reset the fault and restart. If the fault occurs again, please contact your closest Eaton representative ¹⁾ .
27	Back EMF	Electromotive force The voltage induced in the motor with the rotation is greater than the output voltage of the frequency inverter.	<ul style="list-style-type: none"> The rotation energy is greater than the braking energy. Lengthen deceleration times. Switch on brake chopper and braking resistance. Use higher rated frequency inverters.

5 Error and Warning Messages

5.1 Introduction

Indicator	Designation	Possible Cause	Note
35	Application error	The application is not working.	Please contact your closest Eaton representative ¹⁾ .
50	Live zero error (Analog input)	Monitored zero point (4 mA, 2 V → Parameter P2.1) <ul style="list-style-type: none"> • Current less than 4 mA, voltage less than 2 V. • Signal cable interrupted, • The signal source is faulty. 	Check the analog setpoint circuit and current and voltage source (→ Parameters P8.10).
51	External fault	Error message at a digital input (DI1 - DI6), programmed as input for an external error message.	<ul style="list-style-type: none"> • Check the programming (P3.5, P3.6) and check the device indicated by the error message. • Check the cabling for the respective device as well.
53	Field bus error	The communication link between the master device and the drive's field bus has been interrupted.	Check the installation. Further notes are provided in the manual of the optional field bus connection (CANopen, PROFIBUS DP etc.) If the installation is OK, please contact your closest Eaton representative ¹⁾ .
54	Field bus interface error	<ul style="list-style-type: none"> • MMX-NET-XA mounting frame for field bus interface cards is not connected to the frequency inverter. • Optional field bus connection is not fitted. 	Error message with activated field bus connection of the interface between the frequency inverter and the mounting frame (MMX-NET-XA). Error message as per P8.15. Further notes are provided in the manual of the optional field bus connection (CANopen, PROFIBUS DP etc.)
55	Reserve		

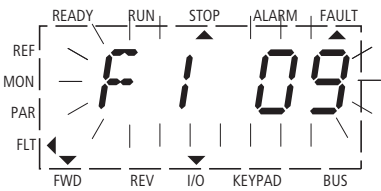

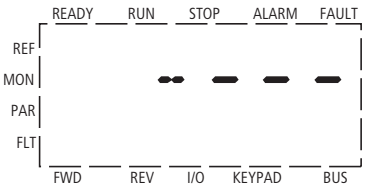
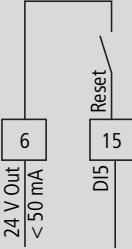


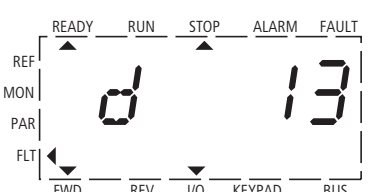


1) Malfunction service on the inside cover (imprint)

5.1.5 Acknowledge fault (Reset)

By switching the supply voltage off, the error message (F, FAULT) is acknowledged and reset. The error code with the respective operating times (d = days, H = hours, M = minutes) remains stored (FLT).

In the default settings, you can also acknowledge the error with a 24-V-DC signal on terminal 15 (DI5 = Reset). The failure code is not deleted in this case.

The following table shows the required operations for acknowledging an error message via the operating unit.

Operating unit element	Explanation
	<p>F1 = Current error message (flashing display) 09 = undervoltage (example)</p>
 	<p>Actuate the BACK/RESET pushbutton or terminal DI5 (Reset) to acknowledge the error message.</p> 
	<p>The acknowledged error message is displayed with READY and the failure code.</p>
 	<p>By actuating the OK pushbutton, the number of operating days (e.g.. d = 13 days) until this error message is displayed. You can also show the respective hours (H) and minutes (M) of operation with the arrow button ∇.</p>
	<p>You exit the fault log (FLT) with the BACK/RESET pushbutton. The \blacktriangleleft arrow moves to MON in the menu level.</p>
	<p>Use the OK pushbutton to activate the operating data display now or select another menu level with the arrow keys \wedge or ∇.</p>

5 Error and Warning Messages

5.1 Introduction

6 Parameters

6.1 Operating unit

The following figure shows and indicates the elements of the M-Max™'s integrated operating unit.

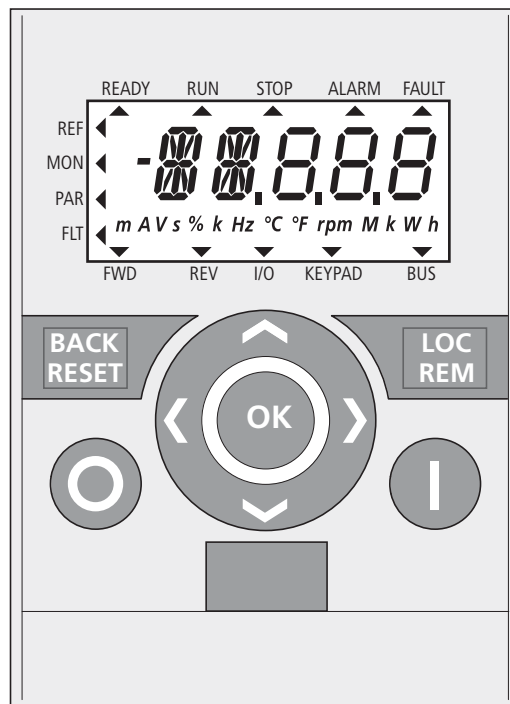
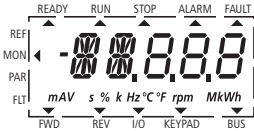












Figure 66: View of the keypad with LCD display, function keys and interface
LCD = Liquid Crystal Display

6 Parameters

6.1 Operating unit

Table 7: Operating unit elements

Operating unit element	Explanation
	<ul style="list-style-type: none"> • Backlit liquid crystal display (LCD). • Plain text with alphanumeric characters.
	<ul style="list-style-type: none"> • Acknowledge error message (Reset) • Activates the selection for the menu levels (◀ flashes).
	Move between different control levels (I/O - KEYPAD - BUS) according to parameter settings P6.1 and P6.17.
	<ul style="list-style-type: none"> • Select function and parameter. • Increase numerical value.
	<ul style="list-style-type: none"> • Confirm and activate selection (store). • Lock display.
	<ul style="list-style-type: none"> • Select function and parameter. • Reduce numerical value.
	<ul style="list-style-type: none"> • Move to the individual parameter groups (... S4.1 - P1.1 - P2.1 - P3.1 ...). • In displays with several digits move between the individual digits (Cursor). • Direction reversal (FWD ↔ REV) in KEYPAD mode.
	
	<ul style="list-style-type: none"> • Stops the running motor (P6.16). • Reset: Holding down the pushbutton for 5 seconds causes the default settings to be loaded. All parameters are reset and the fault memory (FLT) is cleared.
	Motor start with selected operating direction (only active in KEYPAD control level).
	Interface for communication (Option: MMX-COM-PC).



Actuating the arrow buttons increases or decreases the active (flashing) value, the parameter or function by one unit. Holding down an arrow button makes the change automatically.



6.1.1 Display unit

The following shows the display unit (LCD display with all display elements).

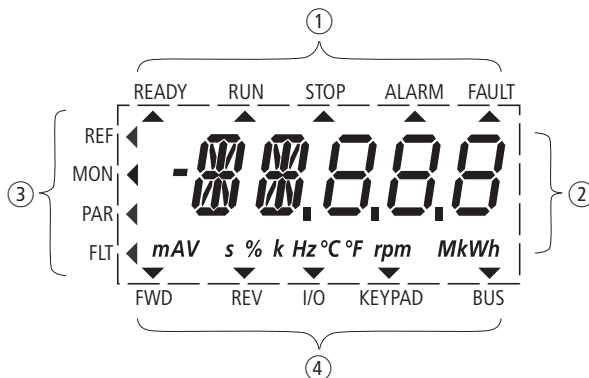


Figure 67: LCD display (areas)

The display unit consists of a backlit liquid crystal display (LCD). It is divided into four areas.

Table 8: Areas of the LCD display

Range	Description
① Status display	The arrowheads ▲ on the top border show information regarding the drive. <ul style="list-style-type: none"> • READY = Ready to start • RUN = operating signal • STOP = Stop, stop command activated • ALARM = alarm message activated • FAULT = The drive has been stopped due to an error message.
② Plain text display	Two 14- and three 7-segment blocks for displaying: <ul style="list-style-type: none"> • AL = Alarm message • F = Error messages • M = Measurement value (operating data) • P = Parameter numbers • S = System parameter • - = Anticlockwise field of rotation (REV). The respective units of measurement are displayed in the bottom line.
③ Menu level	The arrow ◀ shows the selected main menu: <ul style="list-style-type: none"> • REF = Setpoint input (Reference) • MON = Operational data indicator (Monitor) • PAR = Parameter levels • FLT = Fault log (Fault).
④ Control commands	The arrowhead ▼ points to the selected rotating field direction and the active control level: <ul style="list-style-type: none"> • FWD = Clockwise rotating field (Forward Run) • REV = Counterclockwise rotating field (Reverse Run) • I/O = Via control terminals (Input/Output) • KEYPAD = Via operating unit • BUS = via field bus (interface).

6 Parameters

6.1 Operating unit

6.1.2 Menu Navigation

By applying the specified supply voltage to the connection terminal L2/N and L3 (MMX11), L1 and L2/N (MMX12) or L1, L2/N and L3 (MMX32, MMX34), the frequency inverter automatically runs the following functions:

- The lighting of the LCD display is switched on and all segments are actuated briefly.
- After the self-test, the top status line of the LCD display indicates that the device is ready to start and proper operation by an arrow ▲ under READY.
The arrow under STOP indicates that there is no start command (FWD or REV).
- The arrow ▼ in the bottom status line shows the actuation via control signal terminals with the default setting on I/O Control (Control Input/Output). The arrow over FWD (Forward) indicates the basic rotational direction (phase sequence for a clockwise rotating field) on the output terminals U/T1, V/T2 and W/T3).
- Display for the operating data M1.1 and 0.00 Hz (output frequency) in automatic alternating sequence. The arrow ◀ in the left-hand status line indicates menu level MON (Monitor = Operating data display).

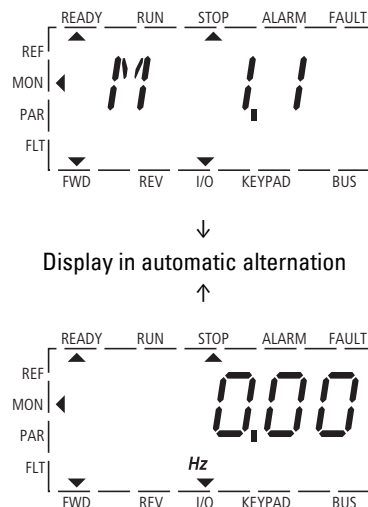



Figure 68: Operational data indicator (operational)

 By actuating the OK pushbutton, you can set the alternating display mode to stay on the output frequency (0.00 Hz).

The frequency inverter is ready for operation and can be started via the control signal terminal with the specified values from the default settings when connecting the allocated motor output (→ Section "4.3 Commissioning with control signal terminals (default settings)", page 79).

6.1.3 Setting parameters

The following table shows a good example of the general execution for selecting and setting parameters.




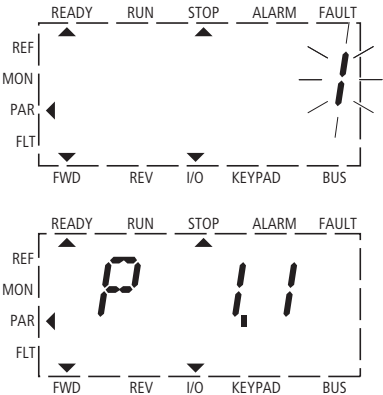



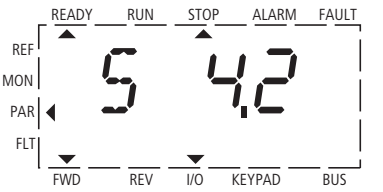



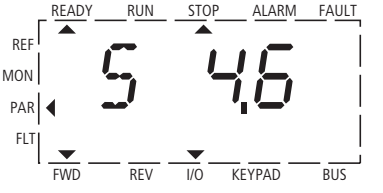

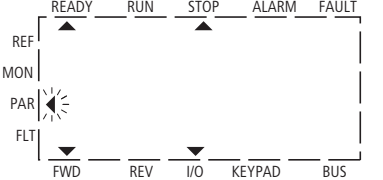


When the MMX is switched on for the first time, it activates the Quickstart Wizard to guide you through specific parameters (→ as per "Step" 2).

Sequence	Commands	Indicator	Description
0			<p>Measured value 1.1 The display changes automatically with the value of the output frequency 0.00 Hz (at STOP).</p>
1	 		<p>By actuating the BACK/RESET pushbutton, you activate the menu level (arrow flashes).</p> <p>The two arrow buttons enable you to select the individual main menus:</p> <ul style="list-style-type: none"> • REF = Setpoint input (Reference) • MON = Operational data indicator (Monitor) • PAR =Parameter levels • FLT = Fault log (Fault). <p>Use the OK pushbutton to open the selected main menu.</p>
2		 <p style="text-align: center;">↓ Display in automatic alternation ↑</p>	<p>The numerical first value is always shown from the selected main menu. Example: Main menu PAR, Parameter P1.1 The display automatically switches between the parameter number and the defined value. P1.1 = 1 is displayed at the first switch on and after the default settings have been activated.</p> <p>Use the OK pushbutton to activate the selected parameter. The value (1) flashes.</p>

6 Parameters

6.1 Operating unit

Sequence	Commands	Indicator	Description
3	  		<p>If the parameter value is flashing, you can use the two arrow keys to change the value within the permitted range.</p> <ul style="list-style-type: none"> • P1.1 = Basis parameters • P1.0 = Expert parameters <p>The selected value is confirmed with the OK pushbutton. The display now changes automatically between the new value and the respective parameter number.</p>
4a			<p>To select the parameter with the next higher number (P1.1 → P1.2 → P1.3...), use arrow key (^).</p>
4b			<p>To select the first parameter of the last parameter group (P1.1 → S4.2 → S5.3...), use arrow key (<).</p>
4c			<p>To select the first parameter of the group with the next higher number (P1.1 → P6.2 → P7.1...), use arrow key (^).</p>
4 d			<p>To select the last parameter value (P1.1 → S4.6 → S4.5...), use arrow key (v).</p>
5			<p>By actuating the BACK/RESET pushbutton, you exit main menu PAR (arrow flashes). To change to a different menu level, use arrow key ^ or v .</p>



Activate and save your changes with the OK pushbutton.

6.2 Parameter menu (PAR)

➔ The Parameter menu (PAR) enables you to access all parameters (➔ Section “8.14 List of parameters”, page 261).

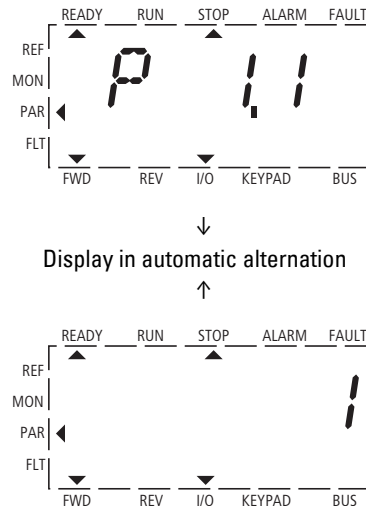


Figure 69: Parameter menu (P1.1 = 1, quick-configuration)

➔ The parameter menu always starts with the parameter P1.1. P1.1 = 1 means that you are guided through the parameters by the Quickstart Wizard. Here you must confirm a specified number of parameters individually. P1.1 = 0 gives you free access to all parameters.

6 Parameters

6.2 Parameter menu (PAR)

6.2.1 Quickstart Wizard



The quick-start assistant guides you in the quick configuration through all important settings that have to be made or that you should check for your application. The parameters that are called during the process are listed in Table 9, Page 105 in column "Basic (Standardoperation)".



The process is run from parameter to parameter. Returning is not possible here.



In the quick-configuration, the OK pushbutton is used to activate the individual parameter values and then move on automatically to the next parameter. The currently set value of each parameter is shown automatically in succession. By actuating the OK pushbutton again, you activate the value entry (value flashes).



The arrow buttons have a restricted functionality for change of parameter values and cursor control in the quick-start configuration.



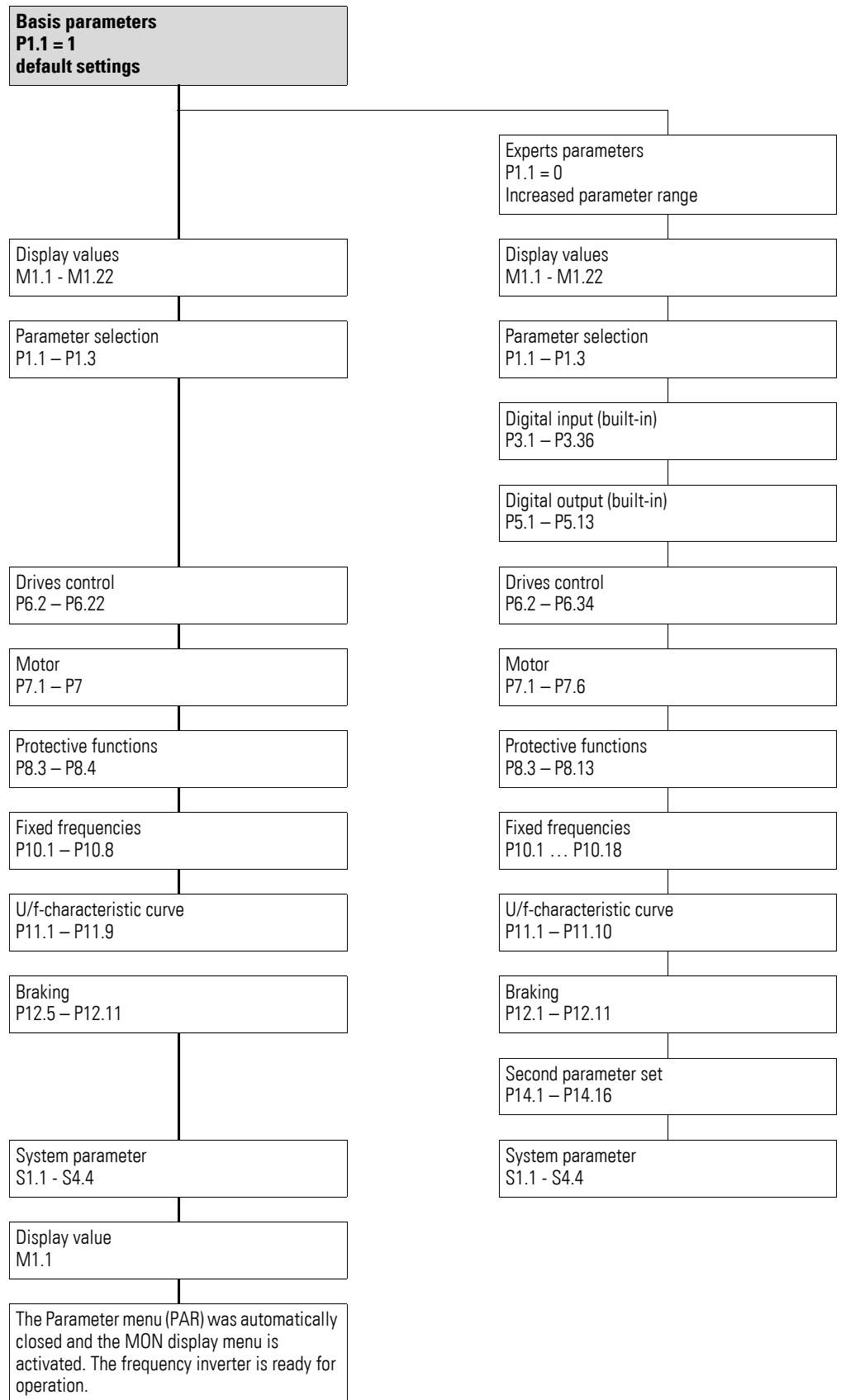
When the quick configuration is completed, the frequency display M1.1 is activated automatically.

Selecting the PAR main menu again enables the quick configuration parameters to be called as required and then modified by the QuickStart Wizard without any guidance.

Besides the parameters of the quick-configuration, system parameters S1.1 to S4.3 are also shown after the first setting.



P1.1 = 0 activates access to all parameters and the full functionality of all buttons of the keypad (free parameter definition)



6 Parameters

6.2 Parameter menu (PAR)

The abbreviations used in the parameter lists have the following meaning:

PNU	Parameter number
ID	Identification number of the parameter
RUN	Access rights to the parameters during operation (RUN): ✓ = Modification permissible, - = Modification only possible in STOP
ro/rw	Parameter read and write permissions via a fieldbus connection (BUS): ro = read only rw = read and write
Value	Setting of the parameters
DS	Default settings: • DS (P1.1 = 1) Basis parameters

The illustration below shows the list of parameters in this manual and in the MaxConnect program (→ Page 216).

PNU	ID	Access right		Value	Description	DS			
		RUN	ro/rw						
Index	ID	Value	Variable Text			Min	Max	Unit	Default



Access rights are not shown in the MaxConnect PC software. The number and order of displayed columns and sections can be changed as required in MaxConnect (similar columns in Excel or under Tools – Options – Parameter/value).

6.2.2 Parameter selection (P1)

In the parameter selection (P1), you can choose between the factory set quick configuration (P1.1 = 1) with a reduced parameter set and all parameters (P1.1 = 0).

The setting of the parameters with the quick configuration (P1.1 = 1) is guided by a Quickstart Wizard (→ Section "6.2 Parameter menu (PAR)", page 99). Each executed parameter must be processed in succession up to frequency display M1.1. A return to a previous parameter is not possible here. The preset application parameters are selected under P1.2. Only when the quick-start assistant (M1.1) is completed can the parameters be called again and then also individually.



With P1.1 = 0 (all parameters) and P1.2 = 0, 1, 2 or 3, you can link the predefined application values with all parameters.



Every single parameter value is reset to default settings every time that the application menu is activated.

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P1.1	115	✓	rw		Parameter ranges	1
				0	All Parameters. All parameters are shown and can be changed.	
				1	Only quick configuration parameters. Only the selected parameters of the quick configuration are shown and can be changed.	
P1.2	540	-	rw		Applications → Listing of the preset application parameters, Table 9, Page 105.	0
				0	Basis	
				1	Pump drive	
				2	Fan drive	
				3	Hoisting device (high load)	
P1.3	1472	-	rw		Default setting (FS), country specific.	0
				0	EU (Europe, 50 Hz networks)	
				1	USA (North America, 60 Hz networks)	
					The country specific default settings takes into account the frequency based parameters in relation to 50 and 60 Hz networks:	


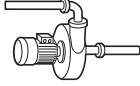

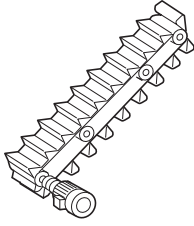
PNU	Designation	P1.3 = 0	P1.3 = 1
P6.4	Maximum frequency	50 Hz	60 Hz
P7.3	Motor, rated speed	1440 rpm	1720 rpm
P7.6	Motor, rated frequency	50 Hz	60 Hz
P11.2	Cut-off frequency	50 Hz	60 Hz
P11.4	U/f characteristic curve, mean frequency value	25 Hz	30 Hz
P14.3	Motor rated speed (2PS)	1440 rpm	1720 rpm
P14.6	Motor rated frequency (2PS)	50 Hz	60 Hz
P14.8	Maximum frequency (2PS)	50 Hz	60 Hz

2 PS = second parameter set

The following table shows the preset application parameters of parameter P1.2. in the default setting.

With P1.1 = 1 you are guided through the drive parameters in steps (Quickstart Wizard) after the power supply is switched on and after the default settings are activated.

Table 9: Predefined application parameters from parameter P1.2

Parameter (PNU)	 Basic (Standard drive)	 Pump drive	 Fan drive	 Feed unit (high load)	Designation
P1.1	1 = Only quick configuration parameters	1 = Only quick configuration parameters	1 = Only quick configuration parameters	1 = Only quick configuration parameters	Parameter range
P1.2	0 = Basic	1 = Pump drive	2 = Fan drive	3 = Hoisting device (high load)	Application
P1.3	0 = EU	0 = EU	0 = EU	0 = EU	Default settings, country specific.
P6.1	1 = Control signal terminals (I/O) (I/O)	1 = Control signal terminals (I/O) (I/O)	1 = Control signal terminals (I/O) (I/O)	1 = Control signal terminals (I/O) (I/O)	Control level
P6.2	3 = AI1 (analog setpoint value 1)	3 = AI1 (analog setpoint value 1)	3 = AI1 (analog setpoint value 1)	3 = AI1 (analog setpoint value 1)	Setpoint definition (0 – 10 V) of control signal terminal 2
P6.3	0.00 Hz	20.00 Hz	20.00 Hz	0.00 Hz	Minimum frequency
P6.4	50.00 Hz	50.00 Hz	50.00 Hz	50.00 Hz	Maximum frequency
P6.5	3.0 s	5.0 s	20.0 s	1.0 s	Acceleration time (acc1)
P6.6	3.0 s	5.0 s	20.0 s	1.0 s	Deceleration time (dec1)
P6.7	0 = Ramp (acceleration)	0 = Ramp (acceleration)	0 = Ramp (acceleration)	0 = Ramp (acceleration)	Start Function
P6.8	0 = Free coasting	1 = Deceleration time (ramp)	0 = Free coasting	0 = Free coasting	Stop Function
P7.1	I_e	I_e	I_e	I_e	Motor, Rated current ²⁾
P7.3	1440 rpm	1440 rpm	1440 rpm	1440 rpm	Motor, rated speed(min ⁻¹)
P7.4	0.85	0.85	0.85	0.85	Motor, power factor (cos φ) ²⁾
P7.5	230/400 V ¹⁾	230/400 V ¹⁾	230/400 V ¹⁾	230/400 V ¹⁾	Motor, rated operating voltage
P7.6	50.00 Hz	50.00 Hz	50.00 Hz	50.00 Hz	Motor, rated frequency
P11.7	0 = Deactivated	0 = Deactivated	0 = Deactivated	1 = active	Torque increase
M1.1	0.00 Hz	0.00 Hz	0.00 Hz	0.00 Hz	Output Frequency

1) 230 V = MMX11..., MMX12..., MMX32...
400 V = MMX34...

2) Depends on performance variables.

6 Parameters

6.2 Parameter menu (PAR)

6.2.3 Analog input (P2)

In parameter group P2, you can adapt the analog inputs:

The signal range depends on the switch position of the microswitches (→ Figure 70):

- S2 = V: AI1 (control signal terminal 2), voltage signal 0/2 - +10 V.
- S3 = mA: AI2 (control signal terminal 4), current signal 0/4 - 20 mA.

Reference potential for the analog inputs (AI1, AI2) is GND (control signal terminals 3 and 5).



The allocation of the analog inputs (AI1, AI2) can be set under parameter P6.2 and P6.18 (setpoint input) as well as P9.5 and P9.6 (PI controller, actual value).

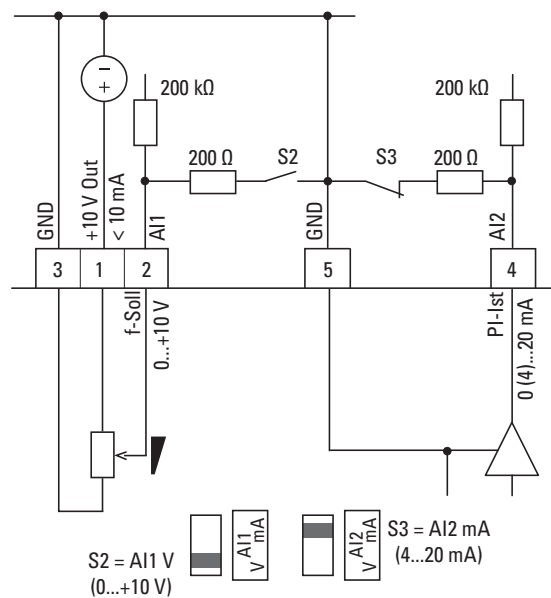


Figure 70: Analog inputs AI1 and AI2

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P2.1	379	✓	rw		AI1 signal range (Analog input). Depending on the switch position of microswitch S2 (FS =frequency reference value).	0
				0	S2 = V: 0 - +10 V, voltage signal (FS, → P6.2). S2 = mA: 0 - 20 mA, current signal.	
				1	With live-zero, S2 = V: 2 - +10 V, voltage signal, S2 = mA: 4 - 20 mA, current signal. → At P8.1 it is possible to set the response of the MMX to a setpoint error (live zero).	
P2.2	380	✓	rw		AI1, minimum value Scaling (-100.00 % - 100.00 %) of the analog input signal (V/mA) in the zero range (minimum pick-up time). → Section "6.2.3.1 Scaled value range (AI1, AI2)", page 108.	0.00
P2.3	381	✓	rw		AI1, maximum value Scaling (-100.00 % - 100.00 %) of the analog input signal (V/mA) in the limit value range (highest limit value). → Section "6.2.3.1 Scaled value range (AI1, AI2)", page 108.	100.00
P2.4	378	✓	rw		AI1, filter time constant 0.0 no filter function. 0.1 - 10.0 s = Filter time constant for the analog input signal (V/mA). → Section "6.2.3.2 Filter time constant", page 109.	0.1
P2.5	390	✓	rw		AI2 Signal range (analog input). Depending on the switch position of microswitch S3 (FS = PID controller, actual value).	1
				0	S3 = V: 0 - +10 V, voltage signal S3 = mA: 0 - 20 mA, current signal	
				1	With live-zero, S3 = V: 2 - +10 V, voltage signal, S3 = mA: 4 - 20 mA, current signal (FS, → P9.6). → At P8.1 it is possible to set the response of the MMX to a setpoint error (live zero).	
P2.6	391	✓	rw		AI2, minimum value Like P2.2	0.00
P2.7	392	✓	rw		AI2, maximum value Like P2.3	100.00
P2.8	389	✓	rw		AI2, filter time constant Like P2.4	0.1

6 Parameters

6.2 Parameter menu (PAR)

6.2.3.1 Scaled value range (AI1, AI2)

The following graphs show examples of the curve characteristics of the scaled and non-scaled input signals.

Example A: P2.2 (P2.6) = 30 %, P2.3 (P2.7) = 80 %

The incoming, analog input signal 0 – +10 V (4 – 20 mA) is used here in the selected range from 30 to 80 %. This limited signal range is predefined as 0 to 100 % input signal ($AI_{scal.}$):

- as frequency reference value from 0 – f_{max} (P6.4),
- as a process variable from 0 - 100 % actual value for the PID controller.

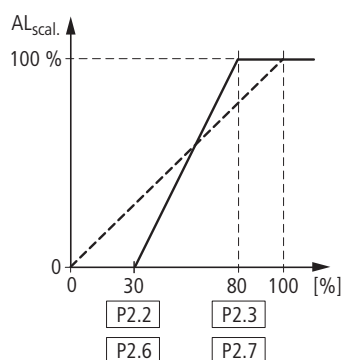


Figure 71: Example of scaled analog input signals

Example B: P2.2 (P2.6) = -30 %, P2.3 (P2.7) = 100 %

The incoming analog input signal 0 – +10 V (4 – 20 mA) is not evaluated in the selected range from 0 to 30 %. In relation to the 30 %-signal, a constant offset signal of (here) 23 % is predefined in this case. The scaled input signal ($AI_{scal.}$) is therefore 23 to 100 %:

- as frequency reference value: 23 % $f_{max} - f_{max}$ (P6.4),
- as a process variable: 23 - 100 % actual value for the PID controller.

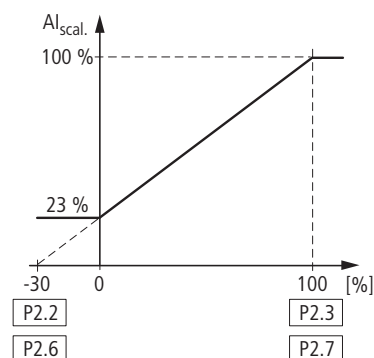


Figure 72: Example of scaled analog input signals with offset

6.2.3.2 Filter time constant

The filter time constant can be used to filter out disturbance with analog signals.

In the default setting the filter time constant is active with 0.1 seconds. The time value set here applies to 63 % of the maximum analog signal (+10 V, 20 mA).

➔ Long filter times lead to a delay in the analog signal processing.

You can deactivate the filter time constant by setting the parameter to 0.0:

P2.4 (AI1) = Filter time constant, analog input AI1

P2.8 (AI2) = Filter time constant, analog input AI2

P4.4 (AO) = Filter time constant, Analog output AO

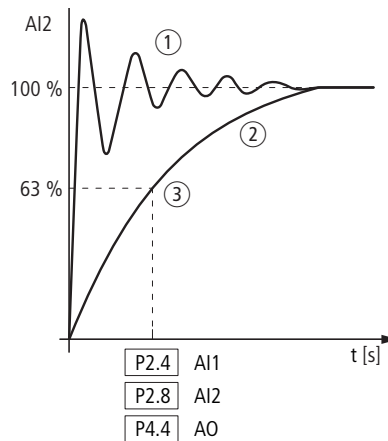


Figure 73: Filter time constant

- ① Analog signal with faults (unfiltered)
- ② Filtered analog signal
- ③ Filter time constant at 63 % of the setpoint value

6 Parameters

6.2 Parameter menu (PAR)

6.2.4 Digital input (P3)

The parameter group P3 is used to set the operation and function of the digital inputs DI1 to DI6.

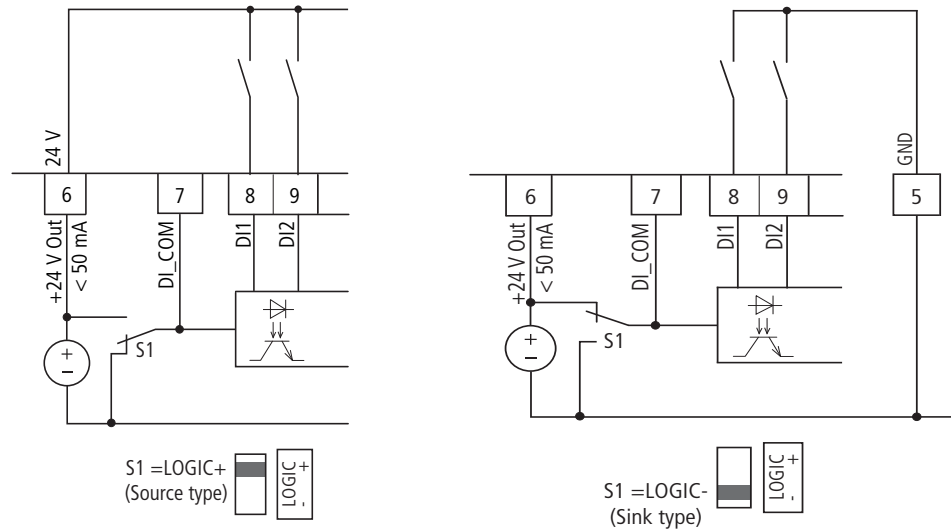


Figure 74: Digital inputs for Source and Sink type



Source type (LOGIC+) = switch at the voltage source. All digital inputs are connected to the voltage sink via microswitch S1 (0 V = reference potential GND).

Sink type (LOGIC-) = switch at the voltage sink (0 V = reference potential GND). All digital inputs are connected to the voltage source via microswitch S1.

Both switch types ensure failsafe actuation.

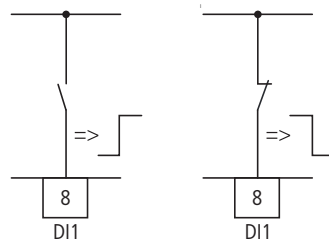


Figure 75: Control logic reaction to a rising or falling edge (Source type, Sink type)

In the default setting, the operation of the M-Max™ is active via control signal terminals (I/O) with LOGIC+ (Source type):

- DI1 (control signal terminal 8): FWD (Forward = Start enable clockwise rotating field).
- DI2 (control signal terminal 9): REV (Reverse = Start enable anti-clockwise rotating field).
- DI3 (control signal terminal 10): FF1 (fixed frequency 1 = 10 Hz).
- DI4 (control signal terminal 14): FF2 (fixed frequency 2 = 15 Hz).
- DI5 (control signal terminal 15): Reset (acknowledge error message ALARM).

- DI6 (control signal terminal 16): PID-Off (lock of the PID controller).



The joint actuation of control signal terminal 10 (FF1) and control signal terminal 14 (FF2) activates in the default setting the fixed frequency FF3 (20 Hz).



The individual digital inputs (DI...) can be assigned several functions. The assigned functions are activated if with LOGIC+ the control signal terminal is actuated with +24 V (rising edge, failsafe).

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P3.1	300	✓	rw	0	Start-Stop-Logic (rising edge). DI1 (FWD), DI2 (REV), REAF. REAF (Restart after Fault) = Restart after an error message Function same as P3.1 = 3. The automatic restart after an error message (FAULT) requires setting P6.13 = 1. The rising edge of the control voltage at control signal terminal 8 (DI1) or control signal terminal 9 (DI2) is then not controlled.	3
				1	DI1 (FWD) + DI2 = REV (see example A, Page 117).	
				2	DI1 (Start pulse), DI2 (Stop pulse). Start and stop command via the control signal terminals 8 (DI1 = Start) and 9 (DI2 = Stop) by a momentary pulse (+24 V). (see example B, Page 118)	
				3	DI1 (FWD), DI2 (REV) DI1 (control signal terminal 8) starts the drive with a clockwise rotating field (FWD) and DI2 (control signal terminal 9) with an anticlockwise rotating field (REV). Both control commands are interlocked (exclusive OR).	
P3.2	403	✓	rw		Start signal 1 (FWD)	1
				0	Deactivated	
				1	activated via control signal terminal 8 (DI1).	
				2	activated via control signal terminal 9 (DI2).	
				3	activated via control signal terminal 10 (DI3).	
				4	activated via control signal terminal 14 (DI4).	
				5	activated via control signal terminal 15 (DI5).	
6	activated via control signal terminal 16 (DI6).					
P3.3	404	✓	rw		Start signal 2 (REV).	2
					Allocation of the function to control signal terminals same as P3.2.	

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)																																								
		RUN	ro/rw																																											
P3.4	412	✓	rw		Reversing (changes the direction of the field of rotation from FWD to REV.) Allocation of the function to control signal terminals same as P3.2.	0																																								
P3.5	405	✓	rw		External fault (N/O) Allocation of the function to control signal terminals same as P3.2 Error message when applying +24 V to the assigned control signal terminal (DI1 to DI6).	0																																								
P3.6	406	✓	rw		External fault (N/C) Allocation of the function to control signal terminals same as P3.2 Error message when switching off or interrupting (wire-breakage-safe) the applied control voltage (+24 V) from the assigned control signal terminal (DI1 to DI6).	0																																								
P3.7	414	✓	rw		Error acknowledgment (Reset) Allocation of the function to control signal terminals same as P3.2 Acknowledges a displayed error message (Reset) when switching on +24 V on the assigned control signal terminal (DI1 to DI6).	5																																								
P3.8	407	✓	rw		Start enable Allocation of the function to control signal terminals same as P3.2 Rotational direction-independent start release when switching on +24 V on the assigned control signal terminal (DI1 to DI6).	0																																								
P3.9	419	✓	rw		Fixed frequency, binary value B0 Allocation of the function to control signal terminals same as P3.2. The binary connection of three digital inputs enable calling seven fixed frequencies (eight fixed frequencies if parameter P6.2 = 0 is set). The limitation of the fixed frequencies is done based on parameters P6.3 (minimum frequency) and P6.4 (maximum frequency). The switch between the individual fixed frequencies is done with the acceleration time and deceleration times in P6.5 and P6.6.	3																																								
<table border="1"> <thead> <tr> <th colspan="3">Input (binary)</th> <th>Fixed frequency</th> </tr> </thead> <tbody> <tr> <td>B0</td> <td>b1</td> <td>m2</td> <td>(Default setting)</td> </tr> <tr> <td></td> <td></td> <td></td> <td>FF0, P10.1 = 5 Hz, only if P6.2 = 0</td> </tr> <tr> <td>X</td> <td></td> <td></td> <td>FF1, P10.2 = 10 Hz</td> </tr> <tr> <td></td> <td>X</td> <td></td> <td>FF2, P10.3 = 15 Hz</td> </tr> <tr> <td>X</td> <td>X</td> <td></td> <td>FF3, P10.4 = 20 Hz</td> </tr> <tr> <td></td> <td></td> <td>X</td> <td>FF4, P10.5 = 25 Hz</td> </tr> <tr> <td>X</td> <td></td> <td>X</td> <td>FF5, P10.6 = 30 Hz</td> </tr> <tr> <td></td> <td>X</td> <td>X</td> <td>FF6, P10.7 = 40 Hz</td> </tr> <tr> <td>X</td> <td>X</td> <td>X</td> <td>FF7, P10.8 = 50 Hz</td> </tr> </tbody> </table>						Input (binary)			Fixed frequency	B0	b1	m2	(Default setting)				FF0, P10.1 = 5 Hz, only if P6.2 = 0	X			FF1, P10.2 = 10 Hz		X		FF2, P10.3 = 15 Hz	X	X		FF3, P10.4 = 20 Hz			X	FF4, P10.5 = 25 Hz	X		X	FF5, P10.6 = 30 Hz		X	X	FF6, P10.7 = 40 Hz	X	X	X	FF7, P10.8 = 50 Hz	
Input (binary)			Fixed frequency																																											
B0	b1	m2	(Default setting)																																											
			FF0, P10.1 = 5 Hz, only if P6.2 = 0																																											
X			FF1, P10.2 = 10 Hz																																											
	X		FF2, P10.3 = 15 Hz																																											
X	X		FF3, P10.4 = 20 Hz																																											
		X	FF4, P10.5 = 25 Hz																																											
X		X	FF5, P10.6 = 30 Hz																																											
	X	X	FF6, P10.7 = 40 Hz																																											
X	X	X	FF7, P10.8 = 50 Hz																																											
P3.10	420	✓	rw		Fixed frequency, binary value B1. Allocation of the function to control signal terminals same as P3.2.	4																																								
P3.11	421	✓	rw		Fixed frequency, binary value B2. Allocation of the function to control signal terminals same as P3.2.	0																																								

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P3.12	1020	✓	rw		Deactivate PID controller.	6
					Allocation of the function to control signal terminals same as P3.2. When the assigned control signal terminal is actuated (DI1 – DI6), the PID controller is disabled and the setpoint source set at P6.2 is used.	
P3.13	1400	✓	rw		Thermistor input (currently deactivated).	0
					Assignment of control signal terminal as per P3.2.	
P3.14	1401	✓	rw		External brake, feedback signal (N/O).	0
					Assignment of control signal terminal as per P3.2.	
P3.15	1402	✓	rw		Change acceleration/deceleration time.	0
					Assignment of control signal terminal as per P3.2. <ul style="list-style-type: none"> • Switch acceleration time from acc1 (P6.5) to acc2 (P6.19). • Switch deceleration time from dec1 (P6.6) to dec2 (P6.20). 	
P3.16	1403	✓	rw		Stop acceleration/deceleration time.	0
					Assignment of control signal terminal as per P3.2. Stops all acceleration (P6.5, P6.19, P14.9) and deceleration times (P6.6, P6.20, P14.10).	
P3.17	1404	✓	rw		Block parameters	0
					Assignment of control signal terminal as per P3.2. Blocks access to all parameters. Note: The resetting of all parameters to the default settings via the STOP pushbutton (held down 5 s) remains active.	

6 Parameters

6.2 Parameter menu (PAR)

6.2.4.1 Motor potentiometer

The function of an electronic motor potentiometer for entering setpoints can be set with parameters P3.18 to P3.20. The following example shows the operating direction set via the control signal terminals 8 and 9 (factory setting). The control signal terminals 10, 14 and 16 are used here to control the motor potentiometer.

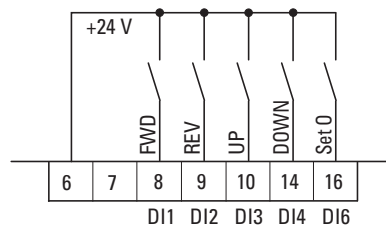


Figure 76: Motor potentiometer for both operating directions

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P3.18	1405	✓	rw		Motor potentiometer, increase value. Acceleration time → Section " P6.5" (acc1). Assignment of control signal terminal as per P3.2.	0
P3.19	1406	✓	rw		Motor potentiometer, reduce value. Deceleration time → Section " P6.6" (dec1). Assignment of control signal terminal as per P3.2.	0
P3.20	1407	✓	rw		Motor potentiometer, set value to zero. Assignment of control signal terminal as per P3.2.	0

Example

- ▶ To activate the motor potentiometer as per Figure 76 set the following parameters:

- P3.2 = 1 Start FWD, control signal terminal 8, DI1 (DS)
- P3.3 = 2 Start REV, control signal terminal 9, DI2 (DS)
- P3.9 = 0 Deactivate the function "FF1 = Fixed frequency binary value B0" (factory setting), control signal terminal 10, DI3
- P3.10 = 0 Deactivate the function "FF2 = Fixed frequency binary value B1" (factory setting), control signal terminal 14, DI4
- P3.12 = 0 Deactivate the function "PI-OFF" (factory setting), control signal terminal 16, DI6
- P3.18 = 3 Motor potentiometer, increase value (UP) via control signal terminal 10, DI3

- P3.19 = 4 Motor potentiometer, reduce value (DOWN) via control signal terminal 14, DI4
- P3.20 = 6 Motor potentiometer, set value to zero (Set 0) via control signal terminal 16, DI6
- P6.2 = 5 Frequency setpoint entry via motor potentiometer

The start enable for direct field direction (FWD, REV) is implemented with a two-wire control on control signal terminal 8 (FWD) or control signal terminal 9 (REV).

The frequency setpoint can then be increased (UP) with a control command (pulse) at terminal 10. The acceleration is executed with the time (acc1) set at P6.5 up to the maximum output frequency set at P6.4.

➔ The frequency setpoint set here is also retained after the start enable is deactivated or when the field direction changes (FWD, REV). It is not cleared until the power supply is switched off (POWER OFF).

The set frequency setpoint of the motor potentiometer can be reduced (DOWN) via the control signal terminal 14 (DI4). The deceleration is performed with the time (dec1) set at P6.6 down to 0 Hz if there is no minimum frequency set at P6.3.

➔ The UP control command has a higher priority than DOWN. If the UP command is activated when the DOWN command is activated, the setpoint is increased again.

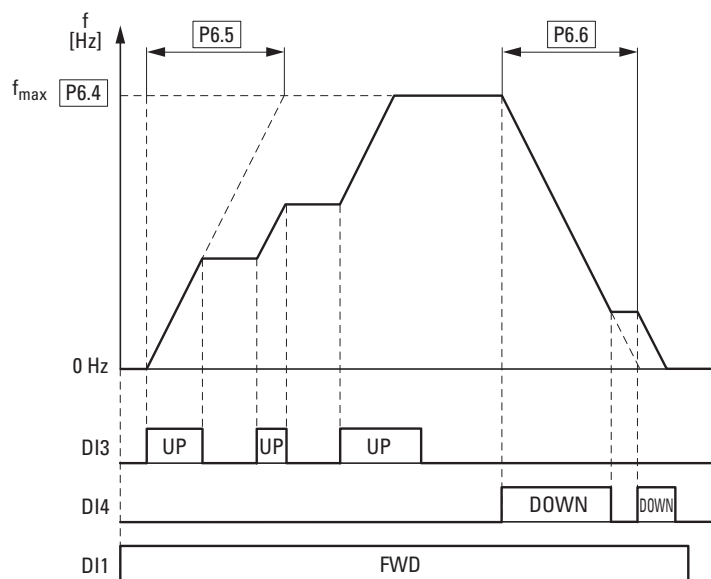


Figure 77: Motor potentiometer example

6 Parameters

6.2 Parameter menu (PAR)

If the minimum frequency (P6.3) is set, the motor potentiometer always starts at $f = 0$ Hz. Once the set minimum frequency is exceeded, the motor potentiometer operates in the range up to the maximum frequency (P6.4). The f_{\min} value is only below the lower limit after the start enable is deactivated (FWD, REV).



Below the f_{\min} value (P6.3) DI3 and DI4 can only be used to increase the frequency setpoint.

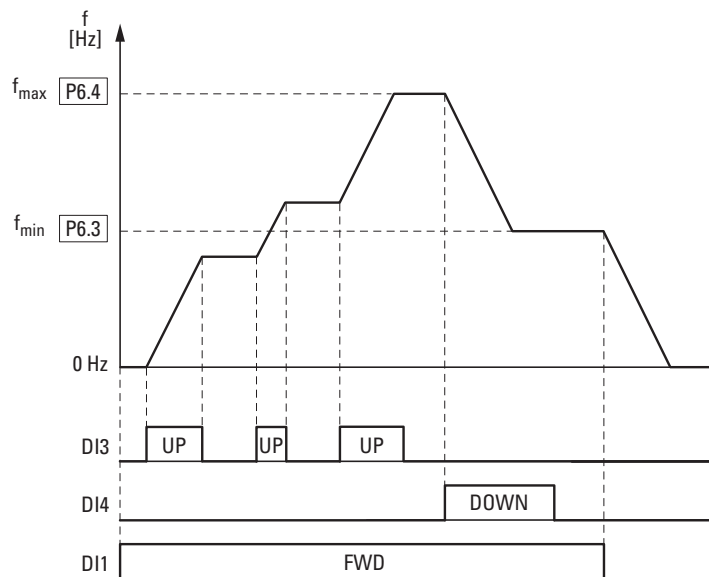


Figure 78: Motor potentiometer with f_{\min} limit

When the control signal terminal 16 (DI6) is activated, the motor potentiometer is set to 0 Hz.

6.2.4.2 Two-wire control

The parameters must be set as follows for the so-called two-wire control:

- P3.1 = 1
- P6.8 = 0

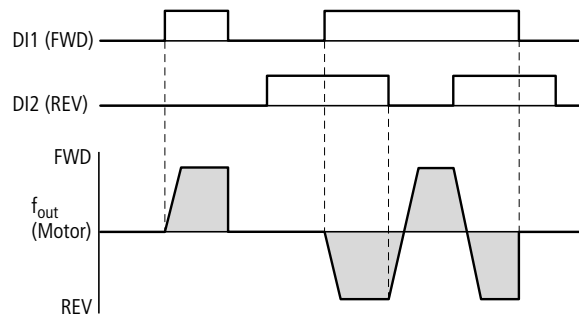


Figure 79: DI1 (FWD), Two-wire control DI1 + DI2 = REV

The start enable via control signal terminal 8 (DI1) is always required for operation:

- Actuation control signal terminal 8 (DI1) = Start enable, clockwise rotating field (FWD).
- Actuation control signal terminal 8 (DI1) plus control signal terminal 9 (DI2) = Start enable anticlockwise rotating field (REV).

The separate actuation of control signal terminal 9 (DI2) does not allow any start enable.

6 Parameters

6.2 Parameter menu (PAR)

6.2.4.3 Three-wire control

With the so-called three-wire control, the start and stop commands are set via spring-return switches (pulse), similar to a contactor control.

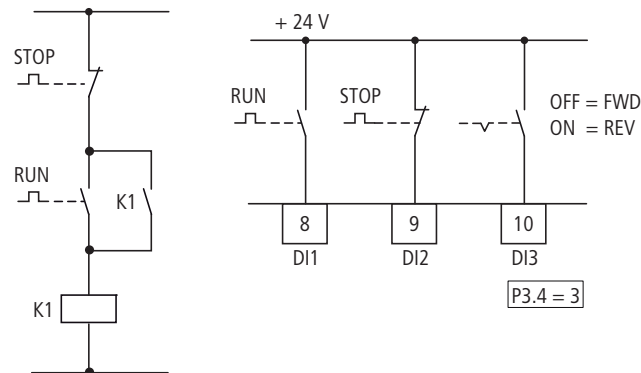


Figure 80: Example of contactor control and three-wire control

Standard actuation for a drive with pushbutton switch (Normally open, Normally closed) and self-actuating.

Parameter P3.1 = 2 enables this actuation via the control signal terminals 8 (DI1) and 9 (DI2) to be simulated.

Parameter P3.4 = 3 enables the rotation reversal (FWD ↔ REV) to be activated (reversing starter) via control signal terminal 10 (DI3).

→ Set P3.9 = 0.

6.2.4.4 Sequence control



The parameterization of the sequencing control is described in Page 151.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P3.21	1408	✓	rw		Sequence control, program start. Assignment of control signal terminal as per P3.2.	0
P3.22	1409	✓	rw		Sequence control, program pause. Assignment of control signal terminal as per P3.2.	0
P3.23	1410	✓	rw		Counter, input signal. Assignment of control signal terminal as per P3.2. Counts the activation of the selected digital input (DI1 - DI6).	0
P3.24	1411	✓	rw		Counter, reset Assignment of control signal terminal as per P3.2. Resets the outputs P5.1 = 20, P5.1 = 21 and display value M1.21 to zero.	0

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P3.25	1412	✓	rw		Change control level.	0
					Assignment of control signal terminal as per P3.2. Move between the control levels set at P6.1 and P6.17 (LOC-REM function).	
P3.26	1413	✓	rw		Change setpoint source (I/O).	0
					Assignment of control signal terminal as per P3.2. Move between the setpoint sources AI1 and AI2 set via P6.2 and P6.18.	
P3.27	1414	✓	rw		Activate second parameter set (2PS).	0
					Assignment of control signal terminal as per P3.2. The values set at the parameter group P14 are activated.	
P3.28	1415	✓	rw		Field bus, remote input	0
					Assignment of control signal terminal as per P3.2. The assigned digital input is written directly to the general status word (ID 2102, bit 11).	
P3.29	1416	✓	rw		Meter, output signal 1	0
					Trigger value for P5.1 = 20	
P3.30	1417	✓	rw		Meter, output signal 2	0
					Trigger value for P5.1 = 21	
P3.31	1418	✓	rw		DI1 logic (control signal terminal 8).	0
					The logic activates the response of the control signal terminal (→ Figure 75).	
					N/O contact (failsafe) N/C contact.	
					0	
				1	N/C contact.	
P3.32	1419	✓	rw		DI2 logic (control signal terminal 9).	0
					Function same as P3.31.	
P3.33	1420	✓	rw		DI3 logic (control signal terminal 10).	0
					Function same as P3.31.	
P3.34	1421	✓	rw		DI4 logic (control signal terminal 14).	0
					Function same as P3.31.	
P3.35	1422	✓	rw		DI5 logic (control signal terminal 15).	0
					Function same as P3.31.	
P3.36	1423	✓	rw		DI6 logic (control signal terminal 16).	0
					Function same as P3.31.	
P3.37	1480	✓	rw		Manual mode	0
					0 = Deactivated 1 = activated The control level and setpoint source required in manual mode can be set at parameters P6.31 to P6.33.	

6 Parameters

6.2 Parameter menu (PAR)

6.2.4.5 Locked keypad

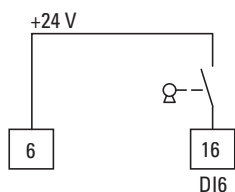


Figure 81: Enable via key switch

In this example, all pushbuttons of the keypad are deactivated (also the STOP button). Only the display can be activated (MON menu level). To remove the key lock, the control signal terminal 16 (DI6), for example, must be activated via a keyswitch and, after activating PW (shown in the display), a password must be entered with the arrow keys and confirmed with the OK key.



The password protection can be removed for each parameter individually or for all parameters via S4.3.

Example

- | | |
|-------------|---|
| P3.12 = 0 | Deactivate the function "PI-OFF" (factory setting), control signal terminal 16, DI6 |
| P3.36 = 1 | Logic of control signal terminal 16 (DI6) switched to the N/C function |
| P3.37 = 6 | Activate "Manual Mode" function on control signal terminal 16 (DI6) |
| P6.31 = 1 | Manual mode via control level (factory setting) |
| P6.32 = 3 | Setpoint source in manual mode (factory setting) |
| P6.33 = 1 | Keypad locked in manual mode (factory setting) |
| S4.3 = 1234 | Password, here for example 1234 |

6.2.5 Analog output (P4)

A 0 - +10 V analog voltage signal is output at control signal terminal 18 (AO). The maximum permissible load is 10 mA. Reference potential is GND on control signal terminals 3 and 5.

In the default setting, the voltage signal (0 - 10 V) is proportional to the output frequency $f_{\text{Out}} = 0 - f_{\text{max}}$ (P6.4).

➔ The output signal at control signal terminal 18 (f-Out) is not monitored by the frequency inverter.

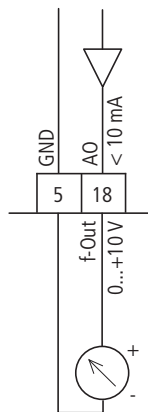


Figure 82: Analog output AO

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P4.1	307	✓	rw		AO signal (Analog Output).	1
				0	Deactivated	
				1	Output frequency $f_{\text{Out}} = 0 - f_{\text{max}}$ (P6.4)	
				2	Output current $I_2 = 0 - I_{N \text{ Motor}}$ (P7.1)	
				3	Torque $M_N = 0 - 100 \%$ (calculated value)	
P4.2	310	✓	rw		AO, minimum value	1
				0	0 V	
				1	2 V (live-zero)	
P4.3	1456	✓	rw		AO, gain Gain Factor: 0.00 - 200.00 %. The maximum value set here always corresponds to the maximum output voltage 10 V.	100.00
P4.4	1477	✓	rw		AO, filter time constant	0.10
					0.01 - 10.00 s = Filter time constant for the analog output voltage. ➔ Section "6.2.3.2 Filter time constant", page 109	

6 Parameters

6.2 Parameter menu (PAR)

6.2.6 Digital output (P5)

The frequency inverters of the M-Max™ series have three digital outputs in different specifications:

- Relay RO1: N/O contact R13-R14, control signal terminals 22 and 23,
- Relay RO2: changeover contact R21-R22 (N/C contact, control signal terminals 25 and 24) / R21-R24 (N/O contact, control signal terminals 25 and 26),
- Transistor output DO: control signal terminal 13 (DO-). Control signal terminal 20 (DO+) = Input of the supply voltage for the transistor output.

Notes on electrical connections are found on Page 70 and 71.

The messages listed under parameter P5.1 can be assigned multiple times. These are independent of the selected control level and operating mode.

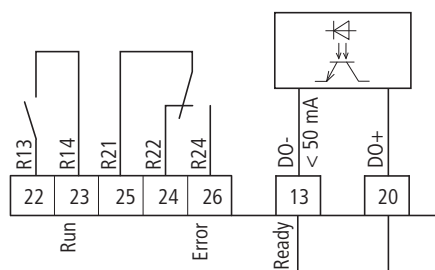


Figure 83: Digital outputs

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P5.1	313	✓	rw		R01 Signal (Relay 1 Output).	2
				0	Deactivated	
				1	READY, the frequency inverter is ready for operation.	
				2	RUN, the inverter of the frequency inverter is enabled (FWD, REV).	
				3	FAULT, error message. Error detected (= STOP).	
				4	Error message inverted (no error message).	
				5	ALARM, warning message (→ Section "6.2.9 Protective functions (P8)").	
				6	REV (Reverse run), anticlockwise rotating field active.	
				7	Output frequency = frequency reference value.	
				8	Motor controller active.	
				9	Zero frequency Output frequency = 0 Hz.	
				10	Frequency monitoring 1 For the frequency ranges set at P5.4 and P5.5.	
				11	Frequency monitoring 2 For the frequency ranges set at P5.6 and P5.7.	
12	PID monitoring For the deviation set at P9.17.					

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
			rw	13	Overtemperature message.	
				14	Overcurrent control active.	
				15	Overvoltage control active.	
				16	Sequence control active.	
				17	Sequence control, single step completed.	
				18	Sequence control, program cycle completed.	
				19	Sequence control, pause.	
				20	Counter, value 1 reached. The counter value is \geq the trigger value set at P3.21 and can be reset by activating P3.24.	
				21	Counter, value 2 reached. The counter value is \geq the trigger value set at P3.22 and can be reset by activating P3.24.	
				22	RUN message active.	
				23	AL 50 - message (life-zero). Indicated if the value of AI1 and/or AI2 goes below the 4 mA or 2 V setpoint signal (life zero) (P2.1 = 1, P2.5 = 1).	
				24	LOG function fulfilled. Message if the logical operation of P13.3 is fulfilled (LOG = 1).	
				25	PID controller, actual value monitoring. Message if the actual value is within the hysteresis set at P9.15 and P9.16.	
				26	External brake actuated. Switch threshold: set value of P12.8.	
				27	Current monitoring Switch threshold: set value of P5.8.	
				28	Fieldbus, remote output. The assigned digital output is written directly to the general control word (ID 2001, bit 13).	
P5.2	314	✓	rw		R02 signal (relay output 2) Assignment of the function same as P5.1.	3
P5.3	312	✓	rw		DO Signal (Digital Output) Assignment of the function same as P5.1.	1
P5.4	315	✓	rw		Frequency monitoring 1 Monitoring of the selected frequency range. A monitoring message can be implemented via the digital outputs (value 10 = P5.1, P5.2, P5.3).	0
				0	Deactivated	
				1	0.00 - P5.5 Hz	
				2	P5.5 - P6.4 Hz	
P5.5	316	✓	rw		Frequency monitoring 1, range 0.00 - P6.4 Hz	0.00

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P5.6	346	✓	rw		Frequency monitoring 2	0
					Monitoring of the selected frequency range. A monitoring message can be implemented via the digital outputs (value 11 = P5.1, P5.2, P5.3).	
				0	Deactivated	
				1	0.00 - P5.7 Hz	
				2	P5.7 - P6.4 Hz	
P5.7	347	✓	rw		Frequency monitoring 2, range	0.00
					0.00 - P6.4 Hz	

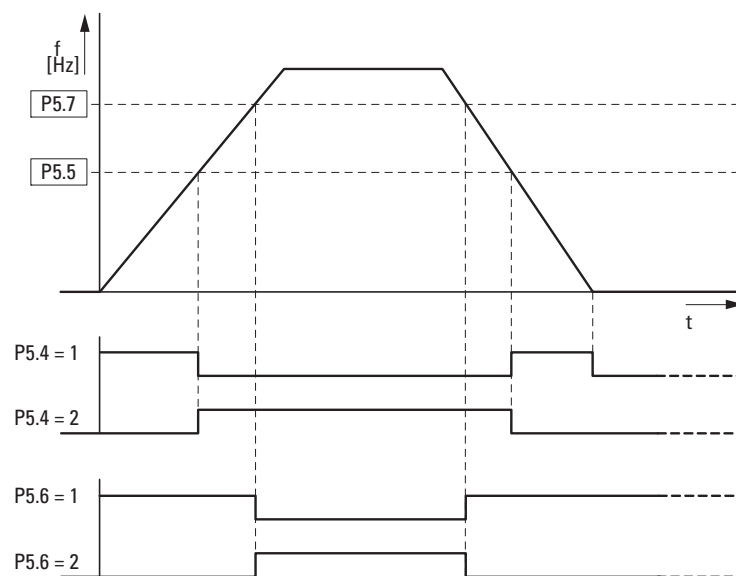


Figure 84: Frequency monitoring (P5.5 - P5.7)

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P5.8	1457	✓	rw		Current monitoring	0.00
					0.00 - 2 x I _e [A] Monitoring within the set current range (P7.2). A monitoring message can be implemented via the digital outputs (value 27 = P5.1, P5.2, P5.3).	
P5.9	1458	✓	rw		DO logic (control signal terminal 13)	0
					Operation of transistor output DO-.	
				0	N/O contact.	
			1	N/C contact.		
P5.10	1331	✓	rw		R01 logic (control signal terminals 22, 23).	0
					Operation of relay contact R13/R14.	
				0	N/O contact.	
			1	N/C contact.		
P5.11	1332	✓	rw		R02 logic (control signal terminal 24, 25, 26).	0
					Operation of relay changeover contact.	
				0	N/O contact (R21-R24) or N/C contact (R21-R22).	
			1	N/C contact (R21-R24) or N/O contact (R21-R22).		
P5.12	1459	✓	rw		DO, switch-on delay	0.00
					0.00 - 320.00 s	
P5.13	1460	✓	rw		DO, off-delay	0.00
					0.00 - 320.00 s	
P5.14	1461	✓	rw		R01, switch-on delay	0.00
					0.00 - 320.00 s	
P5.15	1424	✓	rw		R01, off-delay	0.00
					0.00 - 320.00 s	
P5.16	1425	✓	rw		R02, switch-on delay	0.00
					0.00 - 320.00 s	
P5.17	1426	✓	rw		R02, off-delay	0.00
					0.00 - 320.00 s	

6 Parameters

6.2 Parameter menu (PAR)

6.2.7 Drives control (P6)

In this parameter group (P6), you can define the operating conditions for the frequency inverter M-Max™.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P6.1	125	✓	rw		Control level	1
				1	Control signal terminals (I/O) You can switch directly between I/O and KEYPAD with the LOC/REM pushbutton.	
				2	Operating unit (KEYPAD) The LOC/REM pushbutton has no function here.	
				3	Field bus (BUS) You can switch directly between BUS and KEYPAD with the LOC/REM pushbutton.	



Selecting the control levels can be done directly with the LOC/REM pushbutton between the control levels selected in P6.1 and the operating unit.



During operation (RUN) the drive is always stopped (STOP) when changing control levels (LOC/REM pushbutton).

The control level selected with parameter P6.1 or with the LOC/REM pushbutton is shown on the bottom page in the LCD display (→ Figure 85).

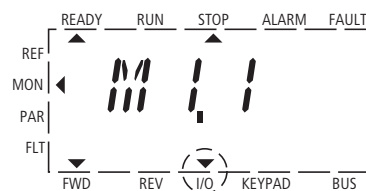


Figure 85: Example: Control level I/O activated

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P6.2	117	✓	rw		Setpoint Source	3
				0	Fixed frequency (FF0) The value can be set in parameter P10.1.	
				1	Operating unit (KEYPAD) This setting causes the setpoint value defined at REF to be read. It can be set via the keypad with the arrow buttons or at parameter P6.15.	
				2	Field bus (BUS) Setpoint entry via Modbus RTU (control signal terminals A and B) or optional fieldbus connection (e.g. CANopen, PROFIBUS DP).	
				3	AI1 (analog setpoint 1) Voltage set value: 0 (2) – +10 V at control signal terminal 2. Scaling and filtering: P2.1 to P2.4 .	
				4	AI2 (analog setpoint value 2) Current setpoint value: 0 (4) -20 mA to control signal terminal 4 Scaling and filtering: P2.5 to P2.8.	
				5	Motor potentiometer The actuation is implemented via the digital inputs assigned at P3.18 and P3.19 (DI1 - DI6). The required acceleration and deceleration times can be set at P6.5 (acc1) and P6.6 (dec1). Assigning a digital input (DI1 - DI6) at P3.20 enables the set value of the motor potentiometer to be set directly to zero.	
P6.3	101	-	rw		Minimum frequency 0.00 - P6.4 Hz	0.00
P6.4	102	-	rw		Maximum frequency P6.3 - 320 Hz	50.00
P6.5	103	-	rw		Acceleration time (acc1) 0.1 - 3000 s (→ Figure 86 below)	3.0
P6.6	104	-	rw		Deceleration time (dec1) 0.1 - 3000 s (→ Figure 86 below)	3.0

6 Parameters

6.2 Parameter menu (PAR)

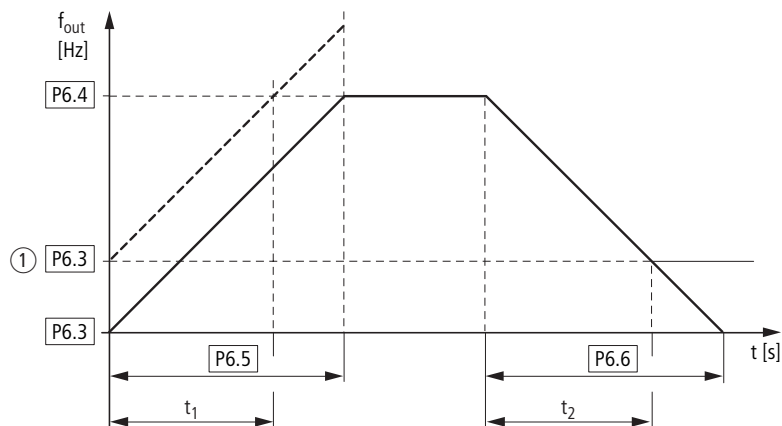


Figure 86: Acceleration and deceleration time
Reference points for the acceleration and deceleration times set in parameters P6.5 and P6.6 are always 0 Hz (P6.3) and the maximum output frequency f_{max} (P6.4).
① When a minimum output frequency is set (P6.3 greater than 0 Hz), the acceleration and deceleration times of the drive are reduced to t_1 and t_2 .

The values for the acceleration time t_1 and the deceleration time t_2 are calculated as follows:

$$t_1 = \frac{(P6.4 - P6.3) \times P6.5}{P6.4}$$

$$t_2 = \frac{(P6.4 - P6.3) \times P6.6}{P6.4}$$



The defined acceleration (P6.5) and deceleration times (P6.6) apply for all changes to the frequency setpoint value.

If the start-release (FWD, REV) is switched off, the output frequency (f_{out}) is immediately set to zero. The motor runs down uncontrolled.

If a controlled run-down is requested (with value from P6.6), parameter P6.8 must be 1.

Starting friction and load inertia can lead to longer acceleration times for the drive than are set in P6.5. Large centrifugal masses or if driven by the load, the deceleration time of the drive can be greater than is set in P6.6.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P6.7	505	-	rw		Start Function	0
				0	Ramp (acceleration) The acceleration time with the value set at parameter P6.5.	
				1	Flying restart circuit Starting on a running motor. By switching on a small current value, a small torque is created. With a frequency search (beginning with the maximum frequency P6.4), the correct rotational field frequency is determined. The output frequency is then adapted to the specified setpoint frequency based on the defined acceleration (P6.5) and deceleration (P6.6) times. You should use this function if the motor is already turning at the start command, with flow-machines (pumps, fans) and with short interruptions in input voltage for instance.	
P6.8	506	-	rw		Stop Function	0
				0	Free coasting The motor carries out an uncontrolled stop (coasting) after the start enable (FWD/REV) is switched off or when the STOP pushbutton (P6.16) is actuated.	
				1	Ramp (deceleration) = dynamic braking. Deceleration time with the value set under P6.6. If the energy that is fed back by the motor during the dynamic braking is too high, the deceleration time has to be extended. On devices with internal braking transistors, the excess energy can be dispelled through an external braking resistance (optional) (see → Section "6.2.13 Braking (P12)", page 164).	
P6.9	500	-	rw		Wave form, time-based S-form	0.0
				0.0	Linear acceleration and deceleration time based on P6.5 and P6.6.	
				0.1 - 10.0 s	Time-graded transition to start and end of the acceleration ramp (P6.5) and deceleration ramp (P6.6). The time set here applies for both ramps (→ Figure 87).	

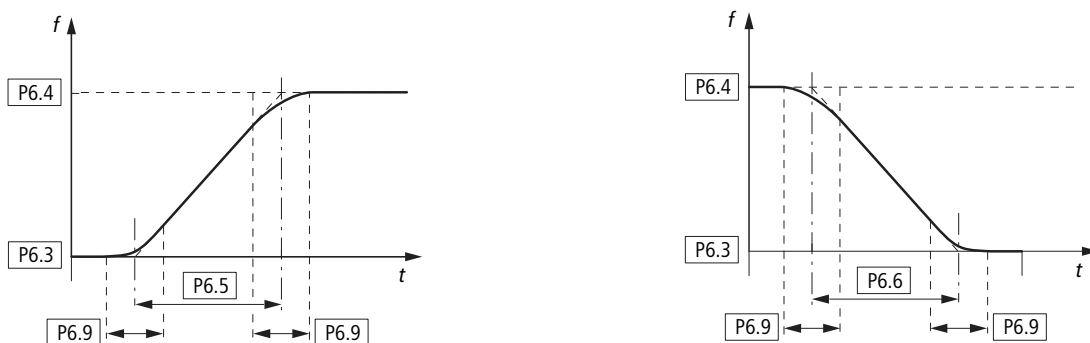


Figure 87: S-formed curve for acceleration and deceleration ramps

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P6.15	184	✓	rw		Frequency reference value REF -P6.4 - 0.00 - P6.4 Hz The setpoint value (REF) defined here can be activated at parameter P6.2 and via the keypad (LOC/REM). In KEYPAD operating mode, the value can be changed with the arrow buttons. The changes are written back automatically to this parameter (P6.15).	0.00
P6.16	1474	✓	rw		Stop pushbutton In the default settings, the STOP pushbutton of the keypad is active in all operating modes. The Stop function can be set at parameter P6.8.	1
				0	Deactivated Stop executed only via control signal terminals (I/O) or field bus (BUS). Switching the LOC/REM pushbutton to KEYPAD removes the block on the STOP pushbutton function set here. Note: This does not deactivate the Reset function (FS loading with 5 s actuation of the STOP pushbutton).	
				1	activated	
P6.17	1427	-	rw		Control level 2	3
					Assignment of the control levels as per P6.1. Control level 2 is activated via parameter P3.25.	
P6.18	1428	-	rw		Setpoint Source 2	2
					Assignment of setpoint sources as per P6.2. Setpoint source 2 is activated via parameter P3.26.	

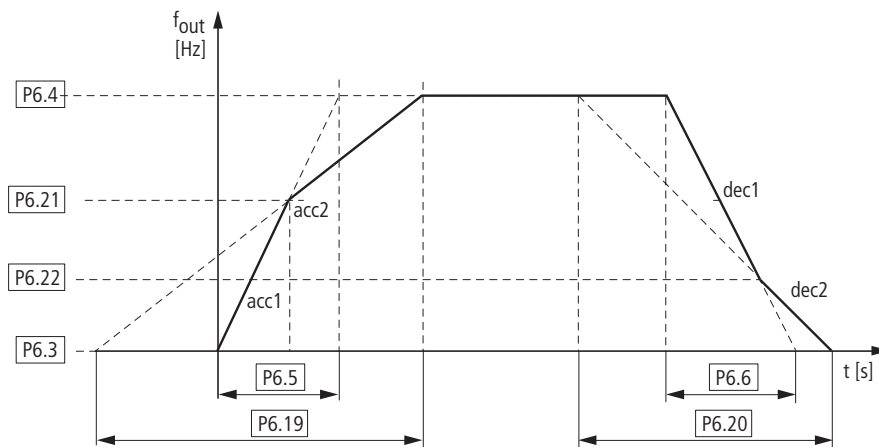


Figure 89: Ramp time changeover

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P6.19	502	✓	rw		Second acceleration time (acc2) 0.1 - 3000 s (see P6.5). The activation is executed via parameter P3.15.	10.0
P6.20	503	✓	rw		Second deceleration time (dec2) 0.1 - 3000 s (see P6.6). The activation is executed via parameter P3.15.	10.0
P6.21	526	-	rw		Transition frequency (acc1 - acc2) 0.00 - P6.4 Hz 0.00 Hz = deactivated If the output frequency set here is exceeded, the acceleration time is switched automatically from acc1 (P6.5) to acc2 (P6.19).	0.00
P6.22	1334	-	rw		Transition frequency (dec1 - dec2) 0.00 - P6.4 Hz 0.00 Hz = deactivated If the output frequency set here is exceeded, the deceleration time is switched automatically from dec1 (P6.6) to dec2 (P6.20).	0.00
P6.23	1429	-	rw		REV blocked	0
					The rotating field reversal of the output frequency is blocked.	
				0	Deactivated	
				1	activated	

In systems with mechanical resonances, you can cut out these frequency ranges for stationary operation. Up to three different frequency ranges can be set.

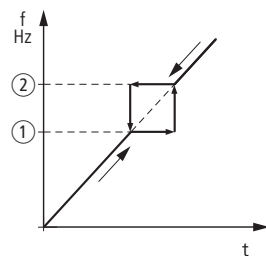


Figure 90: Setting range for frequency masking

- ① P6.24, P6.26, P6.28
- ② P6.25, P6.27, P6.29

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)	
		RUN	ro/rw				
P6.24	509	-	rw		Frequency jump 1, lower value (①).	0.00	
					0.00 - P6.4 Hz		
P6.25	510	-			Frequency jump 1, upper value (②).	0.00	
P6.26	511	-	rw		Frequency jump 2, lower value (①).	0.00	
					0.00 - P6.4 Hz		
P6.27	512	-	rw		Frequency jump 2, upper value (②).	0.00	
					0.00 - P6.4 Hz		
P6.28	513	-	rw		Frequency jump 3, lower value (①).	0.00	
					0.00 - P6.4 Hz		
P6.29	514	-	rw		Frequency jump 3, upper value (②).	0.00	
					0.00 - P6.4 Hz		
P6.30	759	-	rw		REAF, number of automatic restarts.	3	
					1 - 10 You can define here the permissible number of automatic restarts (REAF = Restart After Failure).		
P6.31	1481	-	rw		Manual mode, control level	1	
					Assignment of the control levels as per P6.1. Manual mode is activated via parameter P3.37.		
P6.32	1482		rw		Manual mode, setpoint source	3	
					Assignment of setpoint sources as per P6.2. Manual mode is activated via parameter P3.37.		
P6.33	1483		rw		Manual mode, KEYPAD blocked.	1	
					The Start/Stop functions are blocked in manual mode via the keypad.		
					0		Deactivated
					1		activated

6 Parameters

6.2 Parameter menu (PAR)

6.2.8 Motor (P7)

For optimal operation, you should enter the ratings plate information for the motor here. This information makes up the base values for the motor controller (electrical reproduction, → Section “6.2.12 U/f-characteristic curve (P11)”, page 158).

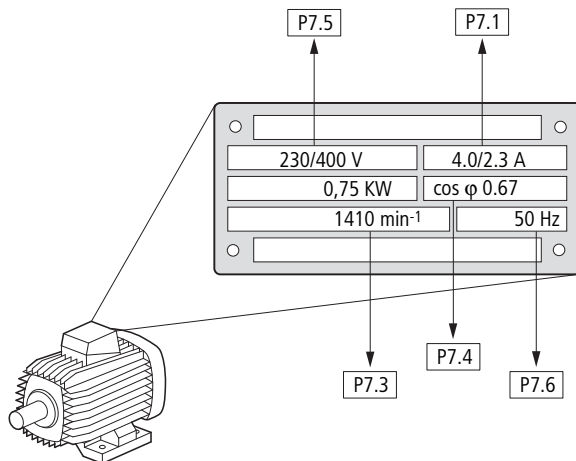


Figure 91: Motor parameters from rating plate



The motor data is factory set (see in example on Page 135) to the rated operational data of the frequency inverter and depends on the rating.

6.2.8.1 Switching type for stator windings of the motor

When selecting the rating data, take the dependency of the type of switching on the strength of the feeding mains voltage into account:

- 230 V (P7.5) → delta circuit → P7.1 = 4 A,
- 400 V (P7.5) → star-connected circuit → P7.1 = 2.3 A.

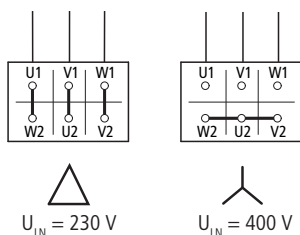


Figure 92: Circuits (delta, star)

Example

Single-phase connection for frequency inverter MMX12AA4D8... on a mains voltage of 230 V. The stator winding of the motor is a delta circuit (motor rated operation current 4 A in accordance with the rating plate in Figure 91). See ¹⁾ in the default settings.

Required changes for the electrical reproduction for the motor: P7.1 = 4.0, P7.3 = 1410, P7.4 = 0.67.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P7.1	113	-	rw		Motor, rated operational current	4.8 ¹⁾
					Setting range: $0.2 \times I_e - 2 \times I_e$ [A] I_e = Frequency inverter's rated operational current (→ motor rating plate).	
P7.2	107	-	rw		Current limitation	7.2 ¹⁾
					Setting range: $0.2 \times I_e - 2 \times I_e$ [A] Default setting: $1.5 \times I_e$	
P7.3	112	-	rw		Motor, rated speed	1440 1720
					Setting range: 300 – 20000 rpm (min ⁻¹) (→ Motor ratings plate).	
P7.4	120	-	rw		Motor, power factor (cos φ)	0.85 ¹⁾
					Setting range: 0.30 – 1.00 (→ Motor ratings plate)	
P7.5	110	-	rw		Motor, rated operating voltage	230 ¹⁾
					Setting range: 180 – 500 V (→ Motor ratings plate). Pay attention to the supply voltage and the type of circuit in the stator winding!	
<p>Note! This parameter value has a direct influence on the V/f characteristic curve (e.g. operation with 87 Hz characteristic curve). This must be taken into account, particularly with values (P7.5) that are different to the rating data of the frequency inverter ($U_{LN} = 100\%$ in P11.3). This may cause the over-excitation of the motor and thus lead to an increased thermal load.</p>						
P7.6	111	-	rw		Motor, rated frequency	50.00 60.00
					Setting range: 30 – 320 Hz (→ Motor ratings plate).	
<p>Note! This parameter value is also automatically entered in parameter P11.2 (cutoff frequency of the V/f characteristic). Any change to P11.2 does not have an effect on parameter P7.6.</p>						

1) Example:

Default settings of the MMX12AA4D8... assigned to the motor with the rating plate of Figure 91.

Single-phase connection of the (MMX12...) frequency inverter to a 230 V mains voltage.

The stator winding of the motor is a delta circuit (rated motor current 4 A).

Required changes to the parameters for the electrical specifications of the motor: P7.1 = 4.0, P7.3 = 1410, P7.4 = 0.67

6 Parameters

6.2 Parameter menu (PAR)

6.2.9 Protective functions (P8)

In parameter range P8, you can set the reaction of the frequency inverter to external influences and increase the protection to the drive system (PDS):

- 0 = deactivated, no reaction
- 1 = Caution (e.g. Warning message AL 50)
- 2 = Error (stop mode after error message based on parameters P6.8, e.g. F...50)

The error - (FAULT) and warning messages (ALARM) are described in chapter 5.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P8.1	700	-	rw		Set points error (live-zero)	1
					Monitors the live zero of the analog inputs AI1 and AI2 if the parameters P2.1 and P2.5 are set to 1 (4 mA, 2 V): <ul style="list-style-type: none"> • AI1, control signal terminal 2, P2.1 • AI2, control signal terminal 4, P2.5. A warning or an error message (F... 50) is output if the signal drops below 3.0 mA or 1.5 V for 5 seconds or under 0.5 mA or 0.25 V for 0.5 seconds. This response time can be changed at P8.10.	
				0	Deactivated	
				1	Danger (AL 50) Note: If the setpoint is restored (≥ 4 mA, ≥ 2 V) the drive starts up automatically if there is no disconnection by the warning message.	
	2	Error (F... 50), stop function according to P6.8.				
P8.3	703	-	rw		Earth-fault protection	2
					The earth-fault monitoring checks the currents in the motor phases and is continually active. It protects the frequency inverter from ground faults with high currents.	
				0	Deactivated If the monitoring is deactivated, the response time is shortened to a start signal. Notice: When the monitoring is deactivated, a ground fault can cause damage to the inverter.	
				1	Danger (AL 03)	
	2	Error (F... 03), stop function according to P6.8				

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P8.4	709	-	rw		Stall protection	1
					The blocking protection is functions as an overload protection. It protects the motor from brief overloads (e. g. blocked motor shaft) and is set via parameter P7.2. Note: With long motor cable lengths and low motor power (poor efficiency $\cos \varphi$), a higher (capacitive) motor current can flow causing early tripping. Solution: Motor reactor or sinus filter.	
				0	Deactivated	
				1	Danger (AL 15)	
				2	Error (F... 15), stop function according to P6.8.	
P8.5	713	-	rw		Underload protection	0
					The underload protection monitors the load of the connected motor in the range of 5 Hz up to the maximum output frequency. This requires that the output current of the frequency inverter be monitored. A message will be generated if the values set in P8.12 and P8.13 are undershot within 20 seconds.	
				0	Deactivated	
				1	Danger (AL 17)	
				2	Error (F... 17), stop function according to P6.8	

6 Parameters

6.2 Parameter menu (PAR)

6.2.9.1 Heat protection of the motor (P8.6 – P8.9)



The motor temperature protection is based on a calculated temperature model and uses the motor current set in parameter P7.1 to determine the motor load. It does not use a temperature measurement in the motor.

NOTICE

The calculated temperature model cannot protect the motor if the cooling flow to the motor is influenced, by a blocked air entry-way for instance.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P8.6	704	-	rw		Motor, temperature protection	0
					The motor temperature protection is designed to protect the motor from overheating. It is based on a temperature algorithm and uses the motor current (P7.1) to determine the motor load (→ Figure 94, page 140).	
				0	Deactivated	
				1	Danger (AL 16)	
				2	Error (F... 16), stop function according to P6.8.	
P8.7	705	-	rw		Motor, ambient temperature	40
					Setting range: -20 – +100 °C	
P8.8	706	-	rw		Motor, cooling factor at zero frequency	40.0
					Setting range: 0.0 – 150 % The cooling factor of the motor with a zero frequency defines the relationship to the cooling of the motor at the rated frequency with the rated operational current without an external fan (→ Figure 93, page 139).	
P8.9	707	-	rw		Motor, thermal time constant	45
					Setting range: 1 – 200 min The temperature time constant determines the time-span in which the heat calculation model achieves 63% of its end value. It depends on the design of the motor and is different from manufacturer to manufacturer. The larger the motor design, the greater the time constant.	

The temperature model is based on the assumption that the motor achieves a winding temperature of 140°C at rated speed and an ambient air temperature of 40 °C, with 105 % rated load.

The cooling efficiency, without external cooling, is a function of the speed (corresponding with the output frequency of the frequency inverter). When the motor is stationary (zero frequency), heat is also dissipated through the housing surface.

When the motor is under a great load, the current required by the motor can be higher than the rated operational current. The current provided by the frequency inverter can be higher than the rated operational current of the motor. If the load requires this much current, there is a danger of a thermal

overload. This is especially the case at lower frequencies (< 25 Hz). Here, the cooling effect (speed of the motor fan) and the load rating of the motor (see data sheet of the motor) are reduced similarly with lower frequencies. On motors that are equipped with an external fan, there is less of a load reduction at lower speeds.

With parameters P8.6 to P8.9, a motor temperature protection can be set for the frequency inverter M-Max™ which protects the motor from overheating. The temperature protection is calculated. A direct temperature measuring in the windings of the motor (see thermistor protection) offers great protection.

The reaction of the M-Max™ frequency inverter to a detected thermal overload can be set via parameter P8.6. At parameter P8.8 you can set the cooling output (P_{Cool}) on the motor at zero frequency (standstill). Note here the specifications of the motor manufacturer.

Possible setting values are 0 to 150 % of the cooling output at the rated frequency f_N (see rating plate of the motor = P7.6).

➔ If the protection function is deactivated (P8.6 = 0), the temperature model of the motor is reset to zero.

The thermal current I_{th} corresponds with the load current at maximum thermal load rating on the motor. In continuous operation, at rated frequency ($f_N = P7.6$) and rated loading, the value of I_{th} corresponds with the rated operational current of the motor (see rating plate of the motor = P7.1).

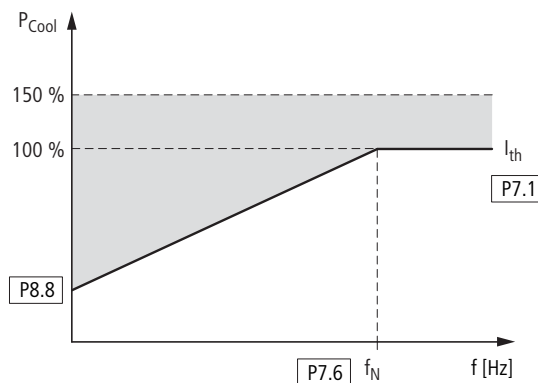


Figure 93: Motor cooling power

The time constant for the motor temperature (P8.9) defines how long it takes until the temperature has achieved 63% of its end value in the motor. In practice, this temperature time is constant depending on the type and design of the motor. It varies between the different design sizes at the same shaft power and between the different motor manufacturers.

6 Parameters

6.2 Parameter menu (PAR)

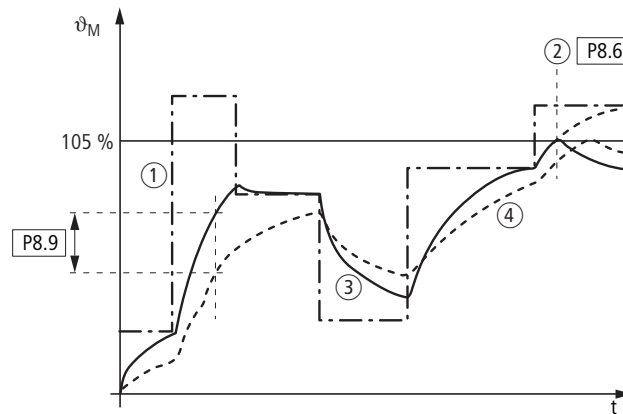


Figure 94: Motor Temperature Calculation

- ① Motor current I/I_T
- ② Trip value shut-off (error message) or warning according to P8.6
- ③ Calculated value for the motor temperature $Q = (I/I_T)^2 \times (1 - e^{-t/T})$
- ④ Motor temperature θ_M (example) P8.9 = Motor temperature time constant (T)

The larger a motor is, the greater the time constant.

The factory set value (P8.9 = 45 min) can be set in the range between 1 and 200 minutes. The guide value is twice time t_6 of a motor. The t_6 time defines the time in seconds in which a motor can be operated safely at six times the rated operational current (for this see data sheet of the motor, manufacturer specifications).

If the drive is stopped, the time constant is increased internally to three times the set parameter value (P8.9).

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P8.10	1430	-	rw		Setpoint error (live-zero), response time 0.0 - 10.0 s (see parameter P8.1)	0.5
P8.11	1473	✓	rw		(Reserve)	0
				0	DS	
				1	- (Not permissible)	
P8.12	714	✓	rw		Underload protection at cut-off frequency 10.0 - 150.0 % of the motor torque. The underload protection enables faults such as a torn drive belt or the dry running of a pump to be detected without any additional sensors. The reaction to a detected underload can be set at P8.5. The value set here determines the lowest permissible torque limit. This function is also effective with output frequencies above the cutoff frequency (P11.2, field weakpoint).	50.0 60.0
					<p>Figure 95: Underload limit</p> <p>Note: The value set here is reset automatically to the default setting (50.0 %) if the parameter for the rated motor current (P7.1) is changed.</p>	
P8.13	715	✓	rw		Underload protection at zero frequency. 5.0 - 150 % of the motor torque. The value set here determines the lowest permissible torque limit at zero frequency (range 0 - 5 Hz). Note: The value set here is reset automatically to the default setting (50.0 %) if the parameter for the rated motor current (P7.1) is changed.	10.0
P8.14	733	✓	rw		Field bus error Reaction to a field bus error if the fieldbus is set as active control level (BUS) (P6.1 = 2, P6.17 = 2).	2
				0	Deactivated	
				1	Danger (AL 53)	
				2	Error (F...53), stop function according to P6.8.	
P8.15	734	✓	rw		Field bus interface error Reaction to a field bus interface error (slot) at the frequency inverter or when the fieldbus interface card is missing when the fieldbus is set as active control level (BUS) (P6.1 = 2, P6.17 = 2).	2
				0	Deactivated	
				1	Danger (AL 54)	
				2	Error (F...54), stop function according to P6.8.	

6 Parameters

6.2 Parameter menu (PAR)

6.2.10 PID controller (P9)

The PID controller enables the control of higher-level process variables (e.g. flow volume, air pressure) via the frequency inverter. The PID controller can be activated at P9.1.

If the PID controller is disabled via a digital input (in the factory setting DI6, P3.12=6), the setpoint source set at P6.2 is used for operating the frequency inverter.



PID control is superimposed on the frequency inverter function. You should therefore set all of the frequency inverter's drive-related parameters, such as maximum output frequency (motor speed), acceleration and deceleration ramps (mechanical load, belts). Frequency inverter and motor are process-integrated actuators. The output frequency to the motor (which determines the speed) is specified as manipulated variable from the PID controller.



When the PID controller is activated, the setpoints and actual values become process variables and are normalized automatically into percentages (%). For example, the specified setpoint (0 - 100 %) here is the same as a volume flow (0 - 50 m³/h). The process variable is the actual value (m³/h) from a sensor and is again evaluated as a percentage (0 - 100 %). If this process data is to be displayed in the physical variable (m³/h), you can set the conversion with parameter P9.19 (→ Display factor (P9.19)).

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P9.1	163	✓	rw		PID controller	0
				0	Deactivated	
				1	activated for drive control	
				2	activated for external application	
P9.2	118	✓	rw		PID controllers, P amplification Setting range: 0.0 - 1000 % Proportional Gain (KP) <ul style="list-style-type: none"> Low values attenuate the control action. High values can cause oscillation. 	100
P9.3	119	✓	rw		PID controller, I reset time Setting range: 0.00 - 320.0 s Integral time constant	10.0
P9.4	167	✓	rw		PID controller, setpoint input via operating unit Setting range: 0.0 - 100.0 % Note: The setting range depends on the parameter value P9.18. For example, with P9.18 = 0.1, the scaled setting range is 0.0 to 10.0 %. The scaling can only be modified with setpoint 0.0.	0.0
P9.5	332	✓	rw		PID controller, setpoint source	0
				0	The setting range is limited by P6.3 (raised starting frequency) and P6.4 (end frequency). <ul style="list-style-type: none"> Potentiometer (keypad) Frequency [Hz] Process variable [%] with P9.1 = 1 	
				1	Field bus	
				2	AI1	
				3	AI2	
P9.6	334	✓	rw		PID controller, actual value (PV)	2
				0	Field bus	
				1	AI1 and S2, (→ Figure 41, page 63) P2.1 = 0 (0 mA/0 V) P2.1 = 1 (4 mA/2 V)	
				2	AI2 and S3, (→ Figure 41, page 63) P2.5 = 0 (0 mA/0 V) P2.5 = 1 (4 mA/2 V)	
P9.7	336	✓	rw		PID controller, actual value limiting, minimum Setting range: 0.0 - 100.0 %	0.0
P9.8	337	✓	rw		PID controller, actual value limiting, maximum	100.0
				0	Setting range: 0.0 - 100.0 %	
P9.9	340	✓	rw		PID controller, control deviation	0
				0	Not inverted	
				1	Inverted Inverted PID control (P9.9 = 1) is used in applications in which the feedback value generator supplies an inverted signal. Example: With increasing pressure, a pressure sensor' output signal (+10 V...0 V = 0...max. bar) drops.	

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P9.10	132	✓	rw		PID controller, D derivate action time	0.00
					Setting range: 0.00 - 10.00 s	
					Differential time constant	
P9.11	1431	✓	rw		PID controller, output filter, deceleration time	0.0
					Setting range: 0.00 - 10.00 s	
P9.12	1016	✓	rw		Sleep mode, frequency	0.00
					Setting range: 0.00 - 6.4 Hz The frequency inverter stops automatically if the frequency of the drive drops below the sleep level defined by this parameter for a longer period than the time defined by parameter P9.14.	
P9.13	1018	✓	rw		Sleep mode, wake up frequency	25.0
					Setting range: 0.00 - 100 % The wake up frequency defines the value below which the actual value must drop before the RUN mode of the frequency inverter is restored.	
P9.14	1017	✓	rw		Sleep mode, deceleration time	30
					Setting range: 0 - 3600 s This parameter determines the minimum period in which the frequency inverter must stay below the frequency set at P9.12 before the frequency inverter is stopped.	
P9.15	1433	✓	rw		Hysteresis, upper limit	0.0
					Setting range: 0.00 -100 % The FBV (Feedback Value Check) signal P5.1 (2.3) = 25 is issued when the actual value drops below the lower limit value (P9.16) in RUN mode. It remains active until: <ul style="list-style-type: none"> The actual value exceeds the upper limit value P=9.15. The frequency inverter switches from RUN mode to STOP mode . 	
P9.16	1434	✓	rw		Hysteresis, lower limit	0.0
					Setting range: 0.00 - 100 % See P9.15	

6.2.10.1 Feedback value check signal (FBV)

The FBV (Feedback Value Check) signal is issued when the actual (process) value (PV) drops below the lower limit value (P9.16) in RUN mode. It remains active until:

- The actual value exceeds the upper limit value (P9.15).
- the frequency inverter changes from RUN mode to STOP mode (deceleration with the set ramp time).

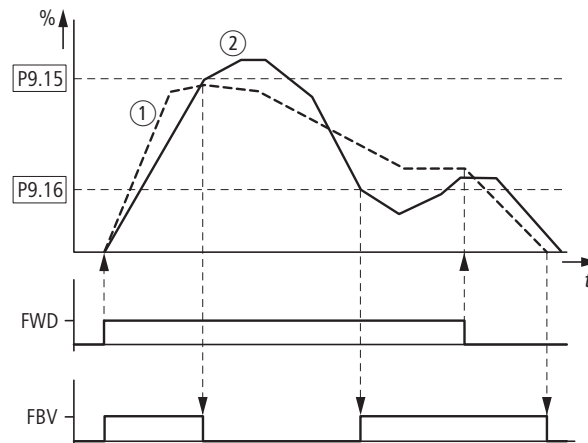


Figure 96: PID controller, actual value message FBV

- ① Output frequency (Hz).
 ② Actual value (process variable PV).
 FWD: Start signal, clockwise rotating field
 FBV: Actual value indication, limit values exceeded (P9.15, P9.16).



The upper and lower actual value limits (P9.15, P9.16) are “process messages”. They cannot be used for monitoring the actual value signal. FBV is not a fault message.

When P5.1 (2.3) = 25, you can set the digital output or a signalling relay for the FBV.

The FBV actual value message enables the PID controller of the M-Max™ to implement a direct “two-stage control”, as is commonly used for HVAC applications.

Example: ventilation system with two fans (frequency inverter). Under normal operating conditions, the maximum output power of fan 1 (M1) is sufficient to maintain the actual value (PV) at the reference value. When fan 1 is fully utilized and additional airflow is required, a second fan (M2) with constant power is a simple solution.

6 Parameters

6.2 Parameter menu (PAR)

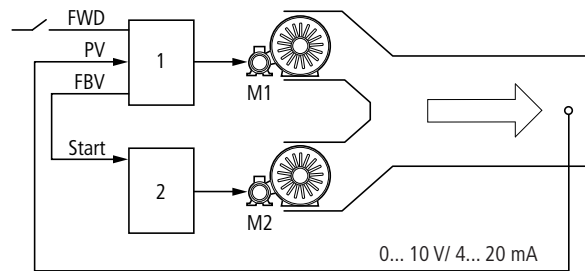


Figure 97: Block diagram, ventilation with “two-stage control”

- 1: Frequency inverter with PID controller for fan motor M1.
 - 2: Motor starter (frequency inverter, soft starter, contactor) for fan motor M2.
- FWD: Start signal drive 1.
FBV: Actual value message of drive 1 for activating drive 2.
PV: Process variable (air volume m³/h) as normalized actual value.
Start: Start signal, drive 2.

The control system shown in the example given here is executed according to the time diagram in Figure 96. The process variables in the limit values are shown in percent (%). The output frequency (Hz) is overlaid in the same diagram.

- Start of fan motor M1 with FWD signal. The actual value (PV) is below the limit value of P9.16. The FBV output (P5.1 (23 = 25)) then switches and fan motor M2 (Start) starts automatically.
- The actual value rises and reaches the upper limit (P9.15). The FBV output is automatically switched off (= fan M2 Off). Fan M1 remains in operation and works in linear control mode. In a correctly set up system, this is the normal operating range.
- If the actual value drops below the limit value (P9.16), the FBV output is switched. The fan M2 is activated again to support fan M1.
- When the FWD signal is removed from frequency inverter 1, the inverter goes from RUN to STOP mode and decelerates the drive over the set ramp time.
- When frequency inverter 1 is stopped, the FBV output is automatically de-energized so that fan M2 also stops.

6.2.10.2 PID-system deviation (OD)

The PID-system deviation (e) is the difference between reference and actual value (process variable PV).

The digital output configured as OD is activated when PID control is active (P 9.1 = 1) and a user-definable percentage system deviation (PN 9.17) is exceeded. The OD output stays activated for as long as this deviation is exceeded.

- ▶ If you wish to configure a parameterizable digital output or signalling relay as OD, you must set the limit value at P9.17 for activating the OD signal.
- ▶ Then parameterize one of the digital inputs as OD output by setting the value 12 at P5.1 (P5.2, P5.3).

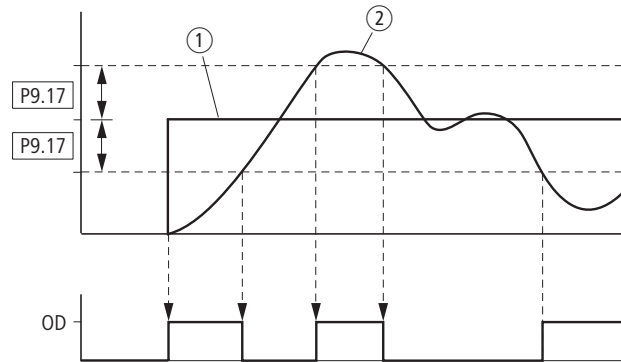


Figure 98: Function chart for OD (PID system deviation)

- ① Setpoint value
- ② Actual value

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P9.17	1435	✓	rw		PID controller, max. controller deviation OD Setting range: 0.00 - 100 % If the PID controller is activated (P9.1 = 1), and the deviation between the setpoint and the actual value exceeds the value entered here, the PID monitoring is activated. Setting at P5.1 (2.3) = 12.	3.0
P9.18	1475	✓	rw		PID controller, scale setpoint value display. Setting range: 0.1 - 32.7 Setpoint display, multiplication of a factor to display process-adjusted variables. The value is displayed in M1.17. Note: This parameter value automatically scales the setting value of parameter P9.4 and the display value of M1.17.	1
P9.19	1476	✓	rw		PID controller, scale actual value display. Setting range: 0.1 - 32.7 Actual value indication, multiplication factor for displaying process variables. The value is displayed at M1.18.	1
P9.20	1478	✓	rw		PID controller – output signal limit. Setting range: 0.00 - 100.0 %	100.0

6 Parameters

6.2 Parameter menu (PAR)

6.2.11 Fixed frequency setpoint value (P10)

Fixed frequencies have a higher priority than frequency reference values. They can be called individually, binary coded, or via the digital inputs DI1 to DI6 or via the sequencing control program.



The maximum permitted set value for a fixed frequency is limited by parameter P6.4 (maximum frequency). A fixed frequency value can go below a minimum limit frequency set at parameter P6.3.



The fixed frequency values can be changed during operation (RUN).

6.2.11.1 Fixed frequency

In this parameter group P10, you can set eight different fixed frequency setpoint values (FF0 to FF7).

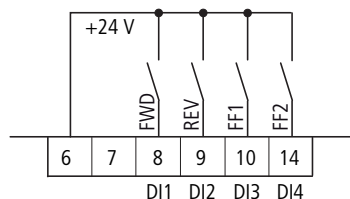


Figure 99: Fixed frequencies FF1, FF2 and FF3 (= FF1 + FF2)

The fixed frequencies FF1 = 10 Hz, FF2 = 15 Hz and FF3 = 20 Hz can be called via digital inputs DI3 (control signal terminal 10) and DI4 (control signal terminal 14) in the default setting.

Input (binary)			Fixed frequency
B0	b1	m2	(Default setting)
			FF0, P10.1 = 5 Hz, only if P6.2 = 0
X			FF1, P10.2 = 10 Hz
	X		FF2, P10.3 = 15 Hz
X	X		FF3, P10.4 = 20 Hz
		X	FF4, P10.5 = 25 Hz
X		X	FF5, P10.6 = 30 Hz
	X	X	FF6, P10.7 = 40 Hz
X	X	X	FF7, P10.8 = 50 Hz

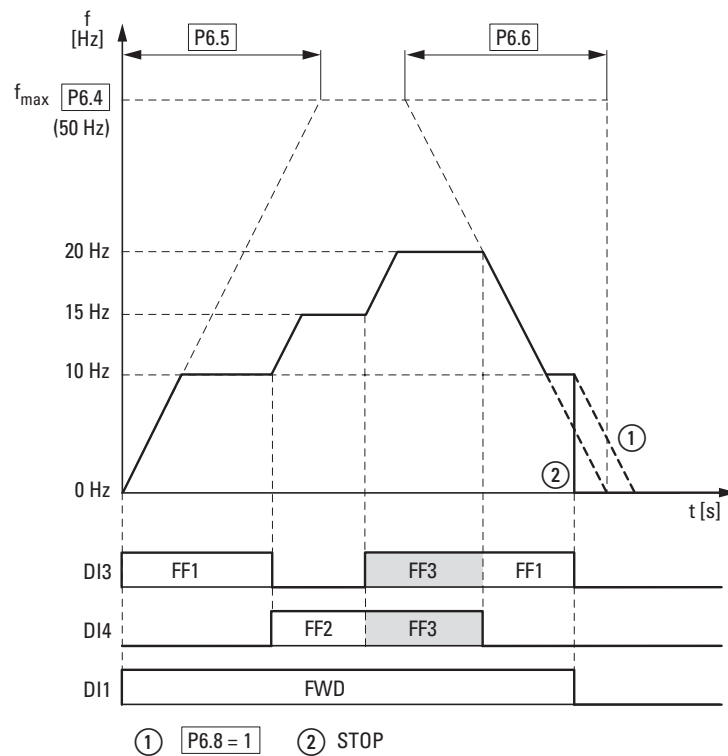


Figure 100: Example: Activation of the fixed frequencies in the default setting with acceleration and deceleration ramps

The change between the individual fixed frequencies is done with the acceleration times and deceleration times set at P6.5 and P6.6. (→ Figure 100). When the FWD or REV enables are revoked, the output frequency is inhibited directly ② (coasting to halt). When P6.8 = 1, the drive performs a controlled deceleration ①.

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P10.1	124	✓	rw		Fixed frequency FF0	5.00 6.00
					0.00 Hz up to the maximum frequency value (P6.4). This value is only active if for the setpoint input has been set the parameter P6.2 = 0.	
P10.2	105	✓	rw		Fixed frequency FF1	10.00 12.00
					0.00 Hz up to the maximum frequency value (P6.4). In the default setting, this value can be called directly via DI3 (control signal terminal 10).	
P10.3	106	✓	rw		Fixed frequency FF2	15.00 18.00
					0.00 Hz up to the maximum frequency value (P6.4). In the default setting, this value can be called directly via DI4 (control signal terminal 14).	
P10.4	126	✓	rw		Fixed frequency FF3	20.00 24.00
					0.00 Hz up to the maximum frequency value (P6.4). In the default setting, this value can be called directly by joint actuation of control signal terminals 10 and 14 (DI3 and DI4).	
P10.5	127	✓	rw		Fixed frequency FF4	25.00 30.00
					0.00 Hz up to the maximum frequency value (P6.4). For activation, parameter P3.11 must be assigned a third digital input. For example, P3.11 = 5: DI5 (control signal terminal 15). This value can then be called up directly via DI3. Note: In the default setting, DI5 (control signal terminal 15) is assigned with the error acknowledgement (Reset). Setting P3.11 = 0 is recommended.	
P10.6	128	✓	rw		Fixed frequency FF5	30.00 36.00
					0.00 Hz up to the maximum frequency value (P6.4). For activation, parameter P3.11 must be assigned a third digital input. For example, P3.11 = 5: DI5 (control signal terminal 15), see Note on P10.5). This value can be called directly by joint actuation of control signal terminals 10 (DI3) and 15 (DI5).	
P10.7	129	✓	rw		Fixed frequency FF6	40.00 48.00
					0.00 Hz up to the maximum frequency value (P6.4). For activation, parameter P3.11 must be assigned a third digital input. For example, P3.11 = 5: DI5 (control signal terminal 15), see Note on P10.5). This value can be called directly by joint actuation of control signal terminals 14 (DI4) and 15 (DI5).	
P10.8	130	✓	rw		Fixed frequency FF7	50.00 60.00
					0.00 Hz up to the maximum frequency value (P6.4). For activation, parameter P3.11 must be assigned a third digital input. For example, P3.11 = 5: DI5 (control signal terminal 15), see Note on P10.5). This value can be called directly by joint actuation of control signal terminals 10 (DI3), 14 (DI4) and 15 (DI5).	

6.2.11.2 Sequence control

The sequence control enables a cyclical program sequence with the fixed frequency setpoints FF0 to FF7. To run the program you can also select from four different operating modes and assign operating direction (FWD/REV) and run time to the individual fixed frequencies. The program sequence is programmed in binary code and is represented by a decimal number for simple entry.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P10.9	1436	✓	rw		Sequence control, operating mode. Selection of operating modes for cyclical program execution. The start of the program execution via a digital input (DI1 - DI6) is executed according to parameter P3.21. The pause of the program execution via a digital input (DI1 - DI6) is executed according to parameter P3.22.	0
				0	Deactivated	
				1	Execute program cycle once.	
				2	Execute program cycle continuously.	
				3	Execute program cycle in steps.	
				4	Execute program cycle continuously in steps.	
P10.10	1437	✓	rw		Sequence control, program (FWD/REV) 0 - 255 Summated decimal value from the binary coded program sequence (→ Table 10, page 152).	0

Table 10 shows the parameters of the fixed frequencies (P10.1 - P10.8) with the associated run times (P10.11 - P10.18) and the corresponding values in binary and decimal format.

Depending on the selected rotating field direction (FWD/REV), the decimal value is multiplied by 0 (= FWD) or 1 (= REV). The sum of all decimal values forms the program number for parameter P10.10.

6 Parameters

6.2 Parameter menu (PAR)

Table 10: Determining the program number (P10.10)

	Fixed frequency		Values				Example A		Example B	
	Hz	s	binary	decimal	FWD	REV	(→ Figure 101)		(→ Figure 102)	
FF0	P10.1	P10.11	2 ⁰	1	0	1	FWD	0	FWD	0
FF1	P10.2	P10.12	2 ¹	2	0	1	FWD	0	FWD	0
FF2	P10.3	P10.13	2 ²	4	0	1	FWD	0	FWD	0
FF3	P10.4	P10.14	2 ³	8	0	1	FWD	0	FWD	0
FF4	P10.5	P10.15	2 ⁴	16	0	1	FWD	0	FWD	0
FF5	P10.6	P10.16	2 ⁵	32	0	1	FWD	0	FWD	0
FF6	P10.7	P10.17	2 ⁶	64	0	1	FWD	0	REV	64
FF7	P10.8	P10.18	2 ⁷	128	0	1	FWD	0	REV	128
Sequence control, program (FWD/REV): P10.10 =								0		192



The fixed frequencies (FF0 - FF7) are only active if the run times (P10.11 - P10.18) of the associated parameters are set (> 0 s).

The run times in the individual program steps must be greater than the transition times for the subsequent frequency value → Figure 101, page 154. (Example A):

Acceleration time P6.5 = 3.0 s

Maximum frequency P6.4 = 60 Hz

FF1: P10.2 = 20 Hz

FF2: P10.3 = 40 Hz

$$t_{ff} \cong \frac{\Delta FF \times P6.5}{P6.4}$$

$$P10.13 \cong \frac{(P10.3 - P10.4) \times P6.5}{P6.4} \cong \frac{(40 \text{ Hz} - 20 \text{ Hz}) \times 3 \text{ s}}{60 \text{ Hz}} \cong 1 \text{ s}$$

The transition time from FF1 to FF2 is one second. Parameter P10.13 should therefore be set to a value greater than one second.

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P10.11	1438	✓	rw		Set time for FF0	0
					0 - 1000 s 0 s = Fixed frequency FF0 deactivated (sequence control P10.9)	
P10.12	1439	✓	rw		Set time for FF1	0
					0 - 1000 s 0 s = Fixed frequency FF1 deactivated (sequence control P10.9)	
P10.13	1440	✓	rw		Set time for FF2	0
					0 - 1000 s 0 s = Fixed frequency FF2 deactivated (sequence control P10.9)	
P10.14	1441	✓	rw		Set time for FF3	0
					0 - 1000 s 0 s = Fixed frequency FF3 deactivated (sequence control P10.9)	
P10.15	1442	✓	rw		Set time for FF4	0
					0 - 1000 s 0 s = Fixed frequency FF4 deactivated (sequence control P10.9)	
P10.16	1443	✓	rw		Set time for FF5	0
					0 - 1000 s 0 s = Fixed frequency FF5 deactivated (sequence control P10.9)	
P10.17	1444	✓	rw		Set time for FF6	0
					0 - 1000 s 0 s = Fixed frequency FF6 deactivated (sequence control P10.9)	
P10.18	1445	✓	rw		Set time for FF7	0
					0 - 1000 s 0 s = Fixed frequency FF7 deactivated (sequence control P10.9)	

6 Parameters

6.2 Parameter menu (PAR)

Example A

P10.9 = 1: Execute program cycle once.

P10.10 = 0 (→ Table 10, page 152): The fixed frequencies FF0 to FF7 (P10.1 - P10.8) are set in numerical order with the associated run times (P10.11 - P10.18) and clockwise rotating field (FWD) as setpoint value.

The start command (RUN) for the sequence control is set via the digital input (DI1 - DI6) defined at parameter P3.21. It has a higher priority than other start commands. This also applies to the fixed frequency setpoints of the sequence control compared to setpoint sources.



CAUTION

If a start command is present at a digital input (DI1 - DI6) assigned at P3.21, the sequence control is also automatic (without a switching edge) when the mains voltage is switched on (e.g. after an interruption of the mains voltage supply)!

If the start command (RUN) is switched off during the program cycle, the drive stops according to the settings at P6.8. The program sequence is then ended immediately. A renewed start command begins once more with the first fixed frequency.



Parameter P3.22 is used to assign a digital input (DI1 - DI6) with the "Sequence control pause" function. This stops the program sequence and can resume it from this stop point (fixed frequency).

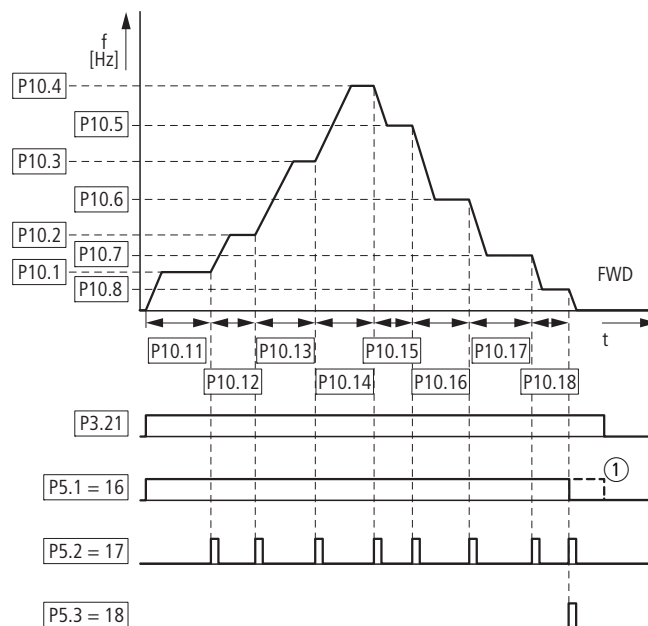


Figure 101: Example A, program cycle executed once (P10.9 = 1, P10.10 = 0)

The operating states of the sequence control can be displayed via the digital outputs RO1, RO2 and DO.

The following assignments are shown in example A:

- Relay RO1 (P5.1 = 16) indicates operation (RUN) of the sequence control. It switches on with the start command and switches off once a program cycle has been completed (P10.9 = 1, P10.9 = 3) at the end of the program cycle (with P5.3 = 18).
- ① With a continuous program sequence (P10.9 = 2, P10.9 = 4) the start signal is switched off first (P3.21).
- Relay RO2 (P5.2 = 17) indicates the end of the individual run times (P10.11 - P10.18).
- Transistor DO (P5.3 = 18) indicates the end of a program cycle.



Value 19 (e.g. P5.3 = 19) enables a pause command (P3.22) of the sequencing control to be indicated via a digital output.

6 Parameters

6.2 Parameter menu (PAR)

Example B

Comparable example A.

P10.9 = 1: Execute program cycle once.

P10.10 = 192 (→ Table 10, page 152): This decimal program code (192 = 64 + 128) assigns the clockwise rotating field (REV) to fixed frequencies FF6 (P10.7) and FF8 (P10.8).

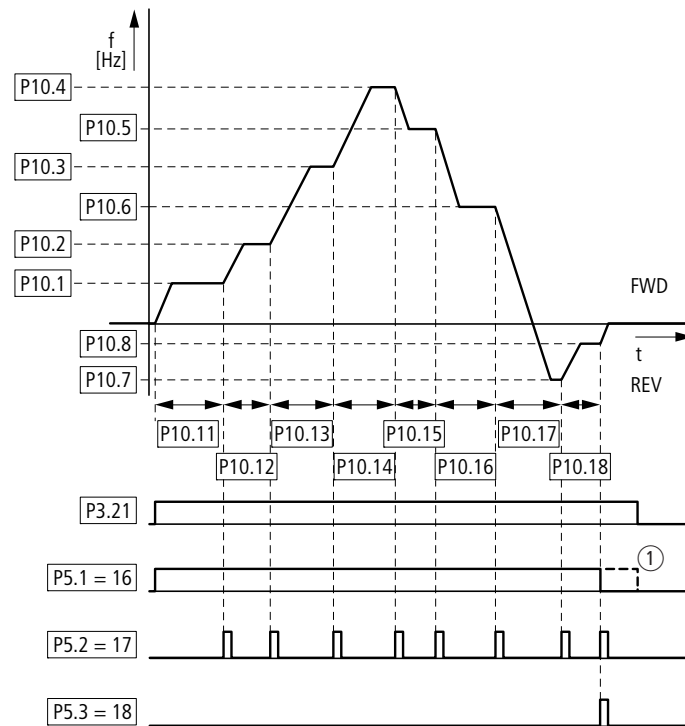


Figure 102: Example B, program cycle executed once (P10.9 = 1, P10.10 = 192)

Example C

Comparable example A.

P10.10 = 0

P10.9 = 2: Execute program cycle once in steps.

Each fixed frequency (P10.1 - P10.10) is called individually in the program sequence. After the assigned run times (P10.11 - P10.18) have elapsed, the output frequency is set to zero according to the Stop function (P6.8) before the numerically next fixed frequency value is executed.

A clockwise rotating field (REV) can also be assigned here to the individual fixed frequencies as a decimal program number at parameter P10.10 (→ Table 10, page 152).

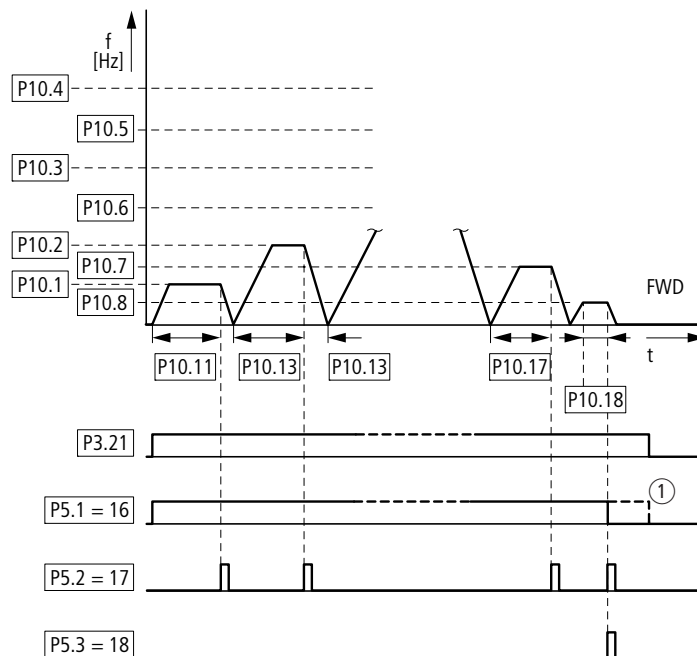


Figure 103: Example C, program cycle executed once in steps (P10.9 = 2, P10.10 = 0)

6 Parameters

6.2 Parameter menu (PAR)

6.2.12 U/f-characteristic curve (P11)

The frequency inverters of the M-Max™ series operate with a sinusoidal pulse width modulation (PWM) in the inverter. The IGBTs are actuated here by two V/f-based control procedures, that you can select in parameter P11.8.

P11.8 = 0:

- Frequency control (Hz),
- Parallel connection of several motors,
- Large power difference ($P_{FU} \gg P_{Motor}$),
- Switching in the output.

P11.8 = 1:

- Speed control (rpm, min^{-1}) with slip compensation,
- Single operation (only one motor), maximum one power rating smaller,
- High torque (requirement: exact motor data for the motor calculation model).

The U/f-characteristic curve (voltage/frequency characteristic curve) designates a control process for the frequency inverter, with which the motor voltage is controlled in a certain ratio to the frequency. If the voltage/frequency ratio is constant (linear characteristic), the magnetizing flux and the torque behavior of the connected motor is virtually constant.

In the standard application, the benchmark values for the U/f-characteristic curve correspond with the rated operational data of the connected motor (see rating plate for the motor):

- Cut-off frequency P11.2 = Rated motor frequency P7.6 = Maximum frequency P6.4.
- Output voltage P11.3 = Nominal motor voltage P7.5.



The rating data of the U/f-characteristic curve is assigned automatically and corresponds with the values of parameter P7.5 (nominal motor voltage) and P7.6 (rated motor frequency). If you require other values for the U/f-characteristic curve, you must first set parameters P7.5 and P7.6, before you change the parameters of the U/f-characteristic curve shown here.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P11.1	108	-	rw		U/f characteristic curve, characteristic	0
				0	<p>Linear</p> <p>The output voltage changes linearly with the output frequency; from zero to voltage P11.3 with the cut-off frequency P11.2.</p> <p>By defining a minimum frequency (P6.3), a voltage corresponding with one of the linear characteristic curves is output.</p> <p>The U/f ratio running linearly between zero and the cut-off frequency remains constant.</p> <p>With parameter P11.6, the voltage value can be raised by percentages in a linear U/f-ratio over the entire manipulating range.</p>	
				1	<p>Quadratic</p> <p>The output voltage changes quadratically with the output frequency; from zero to voltage P11.3 with the cut-off frequency P11.2.</p> <p>By defining a minimum frequency P6.3, a voltage corresponding with one of the quadratic characteristic curves is output. The U/f ratio running quadratically between zero and the cut-off frequency remains constant.</p> <p>With parameter P11.6, the voltage value can be raised as a percentage by a quadratic U/f ratio over the entire manipulating range.</p>	
				2	<p>Parameterizable</p> <p>In connection with parameters P11.4, P11.5 and P11.6, the U/f ratio and therefore the parameters for characteristic curve progress can be defined as required.</p>	

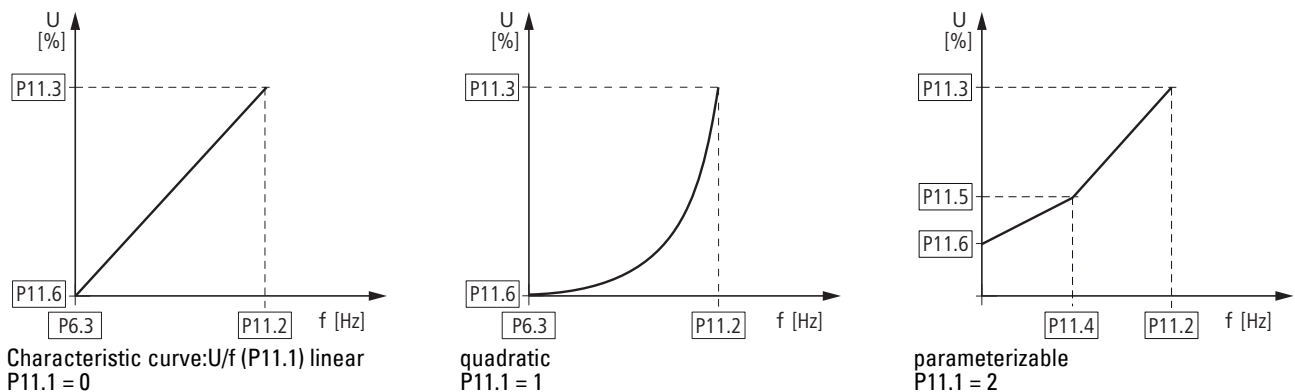
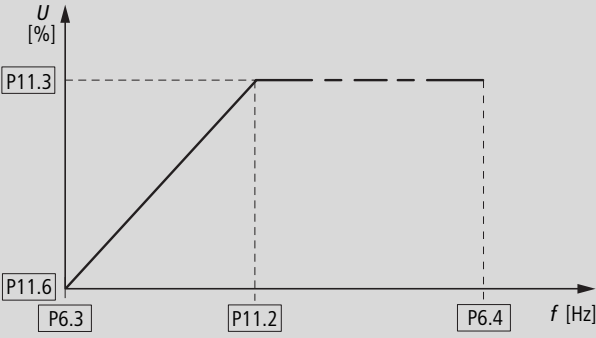


Figure 104: U/f-characteristic curve (P11.1)

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P11.2	602	-	rw		<p>Cut-off frequency</p> <p>30.00 – 320.00 Hz</p> <p>The output voltage reaches its maximum rated value P11.3 with the cut-off frequency. For example: 400 V at 50 Hz.</p> <p>If the maximum output voltage (P6.4) is set to higher values, the output voltage remains constant as of the cut-off frequency defined here.</p> <p>As of this cut-off frequency, the voltage/frequency ratio is no longer constant. The magnetization of the connected motor is reduced with increasing frequency (field weakening range).</p>  <p>Example: linear U/f characteristic curve with cut-off frequency and field weakening range.</p>	50.00 60.00
P11.3	603	-	rw		<p>Output voltage</p> <p>10.00 – 200.00 % of mains voltage</p> <p>In the standard application, the value set here is equal to 100 % of the mains voltage supply and corresponding with the nominal motor voltage set under P7.5 (→ rating plate motor).</p>	100.00
P11.4	604	-	rw		<p>U/f characteristic curve, mean frequency value</p> <p>0.00 – P11.2 Hz</p> <p>Definition of a frequency value for the voltage value set under P11.5</p> <p>Defined ratio (break-point) for the defined U/f-characteristic curve (P11.1 = 2, see characteristic P11.1 = 2)</p>	50.00 60.00
P11.5	605	-	rw		<p>V/f characteristic curve, mean voltage value</p> <p>0.00 - P11.3 %</p> <p>Definition of a voltage value for the frequency value set under P11.4</p> <p>Defined ratio (break-point) for the defined U/f-characteristic curve (P11.1 = 2, see characteristic P11.1 = 2)</p>	100.00

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P11.6	606	-	rw		Output voltage at 0 Hz	0.00
					0.00 - 40.00 % Definition of a start voltage at 0 Hz (zero frequency voltage) Note: A high start voltage enables a high torque at the start. ▽ Notice: A high torque at low speed causes a high thermal load on the motor. If temperatures are too high, the motor should be equipped with an external fan.	
P11.7	109	-	rw		Torque increase	0
				0	Deactivated	
				1	activated Automatic increase of the output voltage (Boost) with an increased load and low speed (e.g. heavy starting duty). ▽ Notice: A high torque at low speed causes a high thermal load on the motor. Note: If temperatures are too high, the motor should be fitted with an external fan.	
P11.8	600	-	rw		Control mode	0
				0	Frequency control (U/f-characteristic curve) The setpoint entry controls the output frequency of the frequency inverter (resolution of the output frequency = 0.01 Hz). Note: In this mode, multiple motors, with varying outputs, can be connected in parallel in the output of the frequency inverter.	
				1	Speed control with slip compensation, The setpoint entry controls the motor speed depending on the load torque (calculation by motor model). Note: In this mode, only one motor with the assigned power (current) may be connected in the output of the frequency inverter. Note: The speed control requires a precise electrical reproduction of the connected motor. The ratings plate information for the motor must be set in the parameter group P7 in this case.	

On the constant three-phase AC supply, the three-phase asynchronous motor has a constant rotor speed (n_1 , P7.3, rating plate specifications) according to the number of pole pairs and mains frequency. The slip here represents the difference between the rotating field of the stator and that of the rotor. In static operation, the slip is constant.

Load changes (①) at the motor shaft cause a larger slip (Δn) and thus a reduced rotor speed (②). In controlled operation (V/F characteristic curve), the frequency inverter cannot compensate this load-related speed difference. The speed behavior of the motor is even, as in a constant AC supply.

6 Parameters

6.2 Parameter menu (PAR)

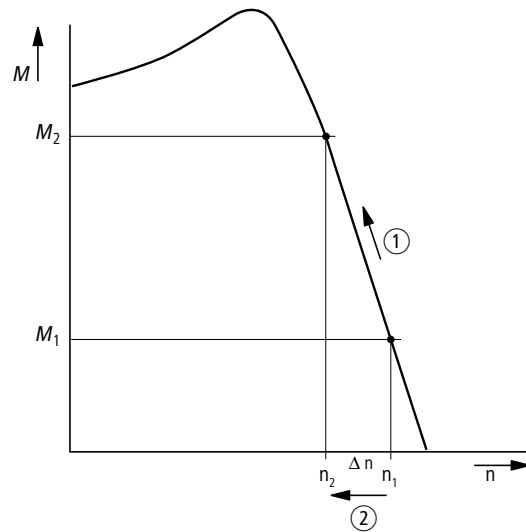


Figure 105: Speed behavior without slip compensation

In "Speed control" mode ($P11.8 = 1$), the frequency inverter can compensate these load-related deviations. From the measured voltage and current values of the stator winding (u_1, i_1) the internal motor model calculates the required manipulated variables for the flux variable i_m and the torque variable i_w . In the equivalent circuit diagram of the three-phase motor, the load-related slip is shown as the resistance R'_2/s . In idle operation without a load, this resistance approaches infinity, and approaches zero as the load increases.

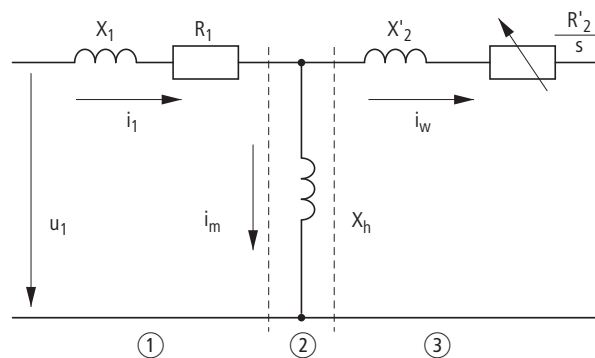


Figure 106: Equivalent circuit diagram for an asynchronous motor

- ① Stator winding
- ② Air gap
- ③ Transformed rotor winding

An exact calculation requires the precise rating specifications of the motor (parameter group 7). The speed control ($P11.8 = 1$) can then compensate the load-related slip deviations. The simple illustration shows that, as the load torque increases (①), the resulting speed reduction is compensated by an increase in the output frequency (②) (→ Figure 107).

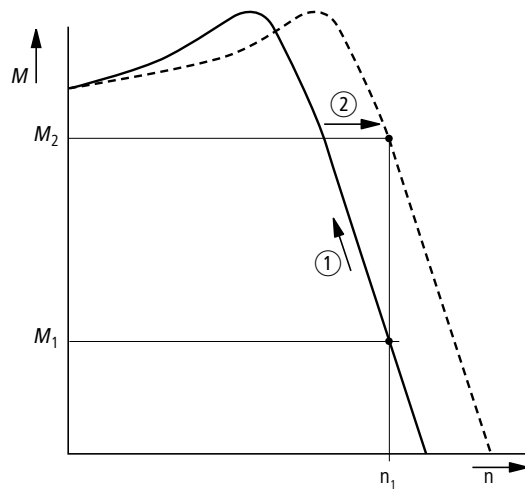


Figure 107: Speed behavior with slip compensation

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P11.9	601	-	rw		Pulse frequency 1.5 - 16.0 kHz Using a high switching frequency can reduce the magnetization noise in the motor. The heat dissipation in the inverter (IGBT) increases with higher switching frequencies. With motor frequencies < 5 Hz a higher speed stability can be achieved at low switching frequencies. Note: As a protection against thermal overload, MMX reduces the switching frequency automatically if, for example, too high values are set and with high ambient temperatures and high load currents. Parameter P11.10 = 1 must be set for operation at a constant pulse frequency.	6.0
P11.10	522	-	rw		Pulse frequency, stabilizer (sinusoidal filter)	0
				0	Deactivated	
				1	Activated Note: When using a sinusoidal filter, the pulse frequency must be constant.	

6 Parameters

6.2 Parameter menu (PAR)

6.2.13 Braking (P12)

In parameter group P12 you can set different brake functions:

- DC braking,
- Generative braking (brake chopper),
- Mechanical braking (actuation).

The brake functions allow you to reduce undesired coasting and long coasting times. Mechanical braking also ensures safe operating states.

6.2.13.1 DC-braking

With DC braking, the frequency inverter supplies the three-phase stator winding of the three-phase motor with DC current. This generates a stationary magnetic field which in turn induces a voltage in the rotor while the rotor is in motion. As the electrical resistance of the rotor is very low, even small induction can generate high rotor currents and thus a strong braking effect.

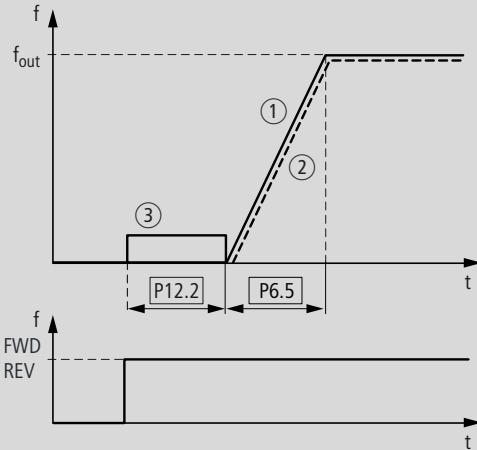
As the speed decreases, the frequency of the induced voltage reduces and therefore the inductive resistance also. The ohmic resistance becomes more effective and thus increases the braking effect. However, the generated braking torque drops off abruptly before the rotor is at a standstill and disappears completely as soon as the rotor movement has ended.



DC braking is therefore not suitable for holding loads or for intermediate braking. Nor for intermediate braking. Once DC braking has been activated, the motor comes to a standstill.

NOTICE

DC braking results in additional heating of the motor. Configure the brake torque, set via braking current (P12.1) and the braking duration (P12.2 and P12.4), as low as possible therefore.

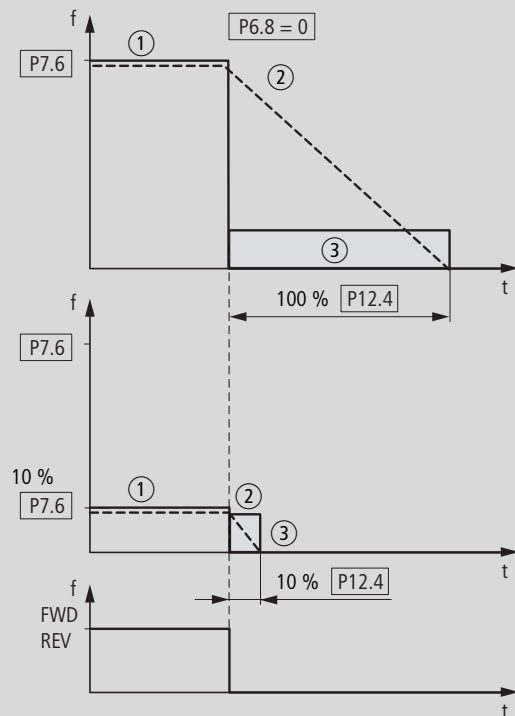
PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P12.1	507	-	rw		DC braking, current Set value for the DC current, which supplies the motor during the DC braking. The value depends on the rated operational current I_e of the frequency inverter: $0.2 \times I_e - 2 \times I_e$ A The parameter is only active, if a value > 0 has been entered for P12.2 or P12.4.	I_e
P12.2	516	-	rw		DC braking, braking time at start 0.00 - 600.00 s The braking time of the DC braking ③ is activated with the start command (FWD, REV).  <p>After the time set here has elapsed, the frequency inverter starts automatically with the acceleration time set at P6.5. The speed of the motor ② follows the characteristic of the output frequency ①.</p>	0.00

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P12.3	515	-	rw		<p>DC braking, start frequency during delay ramp</p> <p>0.00 - 10.00 Hz</p> <p>The output frequency (f_{out}) set here automatically activates the DC braking after a stop command (FWD/REV switched off).</p> <p>Requirement: P6.8 = 1 (Stop function ramp).</p> <p>After the Stop command, the output frequency ① is reduced according to the deceleration time set at P6.6. Depending on the inertia and load torque, the speed of the motor ② is reduced accordingly and is braked from the set frequency value with direct current.</p> <p>You can set the duration of the DC braking ③ under P12.4.</p>	1.50

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P12.4	508	-	rw		<p>DC braking, braking time in case of STOP</p> <p>0.00 - 600.00 s</p> <p>Duration of DC braking after the stop command.</p> <p>With P6.8 = 1 (Stop function ramp), the activation of the DC braking occurs with the output frequency set under P12.3 with the braking time set here.</p> <p>With P6.8 = 0 (free run-out), the activation of the DC braking ③ occurs directly with the stop command. If the output frequency ① is greater than or equal to the rated motor frequency (P7.6), the value set here is considered for the duration of the braking time.</p> <p>If the output frequency is less than or equal to 10 % of the rated motor frequency (P7.6), the duration for DC braking is reduced respectively to 10 % of the value set here.</p>	0.00



6 Parameters

6.2 Parameter menu (PAR)

6.2.13.2 Regenerative braking

If the rotor of an asynchronous motor is driven oversynchronously in the direction of the rotating field, it generates electric power via its stator windings. The motor becomes a generator. In the frequency inverter, this generative energy causes an increase in the DC link voltage.

Oversynchronous speeds occur, for example, when the output frequency in frequency inverter operation is reduced with short deceleration times, the connected machine has a large flywheel mass or when the flowing medium in pumps and fans works against the speed reduction.

The rise in the DC link voltage is monitored by the M-Max™ frequency inverter and always enables a braking torque of around 30 % of the motor rated torque. A higher braking torque can be achieved by selecting a higher rated frequency inverter. A brake chopper is integrated with the 3-phase frequency inverters (MMX32... and MMX34...) from frame size FS2. When used in conjunction with an external high-capacity resistor, the brake chopper makes it possible to achieve braking torques of up to 100 % of the rated motor torque.

The external braking resistor is connected via terminals R+ and R-.

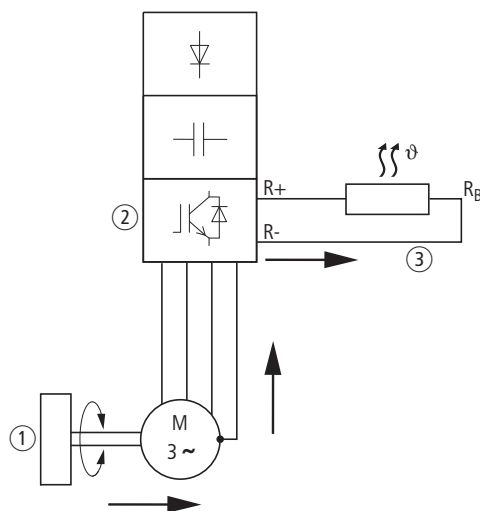


Figure 108: Regenerative braking with external braking resistance

- ① Machine flywheel mass
- ② Inverter with brake chopper (brake transistor)
- ③ Braking resistance (R_B), → Energy flow (braking torque)

The brake chopper can be activated at parameter P12.5. This function is only active with the three-phase frequency inverters MMX32... and MMX34... in frame sizes FS2 and FS5.



This parameter is not visible with frequency inverters without a braking transistor.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P12.5	504	-	rw		Brake chopper	0
				0	Brake-chopper deactivated	
				1	Automatic activation in operation (RUN)	
				2	Automatic activation in operation (RUN) and upon stop (STOP)	
P12.6	1447	-	rw		Brake chopper, switching threshold	765
					<p>This function is only active with the three-phase frequency inverters MMX32... and MMX34... in frame sizes FS2 and FS5.</p> <p>Setting range: 0 - 870 V</p> <p>The switching threshold for the brake transistor should always be above the maximum DC link voltage.</p> <p>For example, allowing for the maximum permissible mains voltage peak of + 10 %:</p> $U_{LN} = 400 \text{ V AC} \rightarrow U_{LN} + 10 \% = 440 \text{ V AC} = U_{LN10}$ $U_{DC} = 1.41 \times U_{LN10} = 1.41 \times 440 \text{ V} \sim 623 \text{ V DC (maximum permissible DC link voltage in motor operation)}$ <p>On threshold for brake transistor:</p> <ul style="list-style-type: none"> • MMX32... at $U_{LN} = 230 \text{ V} \rightarrow 405 \text{ V}$ • MMX34... at $U_{LN} = 400/480 \text{ V} \rightarrow 765 \text{ V}$ <p>Note: Lower values for the switching threshold ON will switch on the braking resistance earlier so that it is subject to a greater load.</p> <p>With values over 437 V and 911 V error message F02 is output, → Page 89.</p> <p>The DC link voltage is shown at M1.8. In practice the value of the DC link voltage during motor operation is around 565 V at $U_{LN} = 400 \text{ V}$.</p>	

6.2.13.3 Mechanical brake (actuation)

The actuation of an external mechanical brake can be implemented via one of the digital outputs (P5, → Page 122), if the value 26 (= External brake actuated) is assigned:

- Transistor output DO: control signal terminal 20 (DO-), supply voltage control signal terminal 13 (DO+), maximum 48 V DC/50 mA, Parameter 5.3.
- Relay RO1: N/O contact control signal terminal 22 (R13) and 23 (R14), maximum 250 V AC/2 A or 250 V DC/0.4 A, Parameter P5.1.
- Relay RO2: changeover contact, control signal terminal 25 (R21), 24 (R22) and 26 (R24), maximum 250 V AC/2 A or 250 V DC/0.4 A, Parameter P5.2.

6 Parameters

6.2 Parameter menu (PAR)

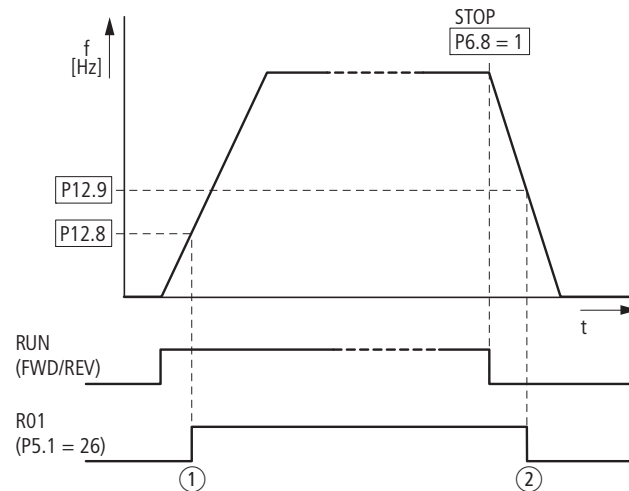


Figure 109: External brake actuated via R01

- ① Brake, released
- ② Brake activates and brakes the drive mechanically.

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P12.7	1448	-	rw		Open external brake, deceleration time Setting range: 0.00 - 320.00 s Condition: RUN (Start enable) After the time set here has elapsed, the value 26 is switched to the assigned digital output (P5...) (brake actuated).	0.2
P12.8	1449	-	rw		Open external brake, frequency limit value Setting range: 0.00 - P6.4 Hz Condition: RUN (Start enable) If the frequency set here is exceeded, the value 26 switches the assigned digital output (P5...) and the brake is actuated (ventilated).	1.50
P12.9	1450	-	rw		Close external brake, frequency limit value Setting range: 0.00 - P6.4 Hz If the frequency goes below the value set here, the value 26 deactivates the assigned digital output (P5...). The brake closes again.	1.00
P12.10	1451	-	rw		Close external brake, frequency limit value on reversing (REV) Setting range: 0.00 - P6.4 Hz	1.50
P12.11	1452	-	rw		Open external brake, current limit value Setting range: 0.00 - P7.2 A Condition: RUN (Start enable) On reaching the current value set here, the value 26 is switched to the assigned digital output (P5...) (brake actuated).	0.00

6.2.14 Logic function (P13)

The logic function enables you to link both parameters P13.1 (A) and P13.2 (B) logically with each other. The result (LOG) can then be assigned to the digital outputs DO (P5.3), RO1 (P5.1) and RO2 (P5.2). The type of operation (And, Or, Exclusive-Or) is defined in parameter P13.3.

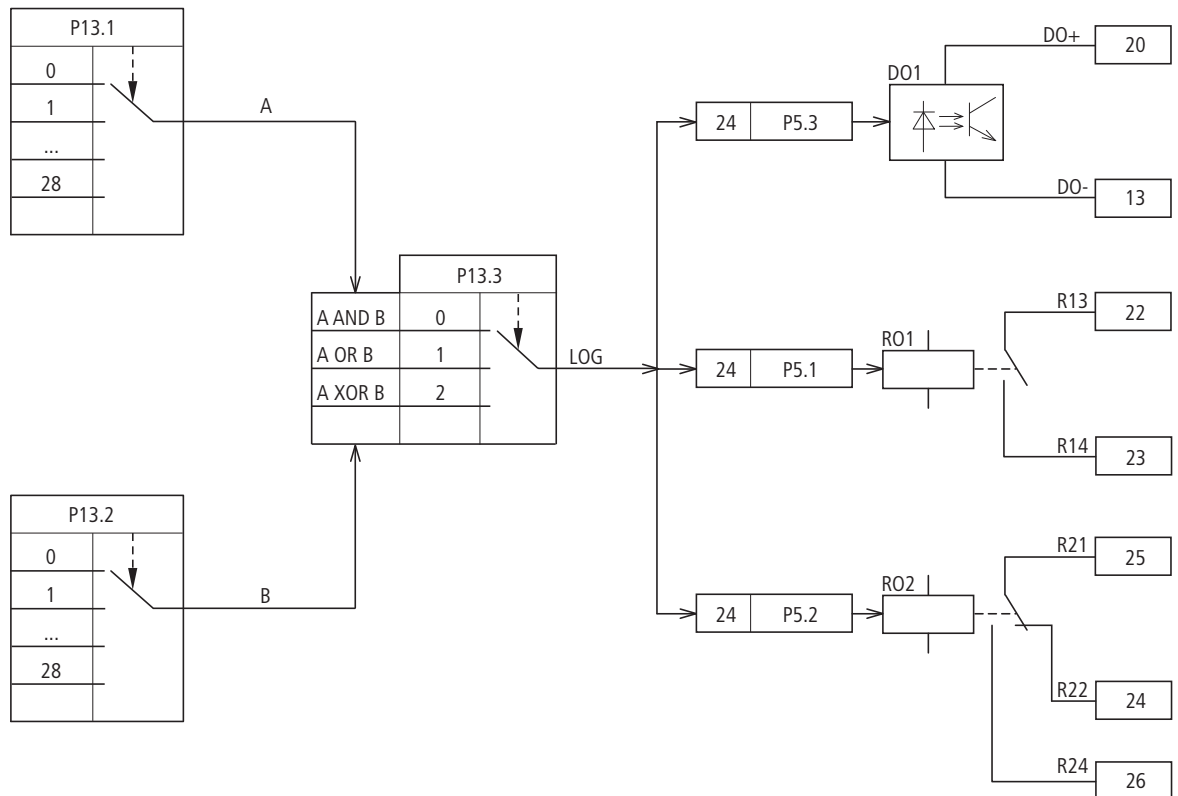


Figure 110: Logic linking of A and B

Example:

Digital output RO1 (N/O contact R13/R14) is required to indicate during operation that the set current limit has been reached:

- P5.1 = 24, LOG function fulfilled.
- P13.1 = 2, Operation (RUN), signal A
- P13.2 = 27, Current monitoring, signal B
- P13.3 = 0, A AND B.

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P13.1	1453	-	rw		LOG function, Selection input A	0
					Value range for signal A.	
				0	Deactivated	
				1	READY, the frequency inverter is ready for operation.	
				2	RUN, the inverter of the frequency inverter is enabled (FWD, REV).	
				3	FAULT, error message Error detected (= STOP).	
				4	Error message inverted (no error message).	
				5	ALARM, warning message (→ Section "6.2.9 Protective functions (P8)")	
				6	REV (Reverse run), anticlockwise rotating field active	
				7	Output frequency = frequency reference value	
				8	Motor controller active	
				9	Zero frequency Output frequency = 0 (Hz)	
				10	Frequency monitoring 1 For the frequency ranges set at P5.4 and P5.5.	
				11	Frequency monitoring 2 For the frequency ranges set at P5.6 and P5.7.	
				12	PID monitoring For the deviation set at P9.17	
				13	Overtemperature message	
				14	Overcurrent control active.	
				15	Overvoltage control active.	
				16	Sequence control active.	
				17	Sequence control, single step completed.	
				18	Sequence control, program cycle completed.	
				19	Sequence control, pause.	
				20	Counter, value 1 reached. The counter value is \geq the trigger value set at P3.21 and can be reset by activating P3.24.	
				21	Counter, value 2 reached. The counter value is \geq the trigger value set at P3.22 and can be reset by activating P3.24.	
				22	RUN message active	
				23	Setpoint error (live-zero). Indication, AL 50 if the value at AI1 and/or AI2 is below the 4 mA or 2 V setpoint signal (live zero) (P2.1 = 1, P2.5 = 1).	
24	LOG function fulfilled. Message if the logical operation of P13.3 is fulfilled (LOG = 1).					
25	PID controller, actual value monitoring. Message if the actual value is within the hysteresis set at P9.15 and P9.16.					

PNU	ID	Access right		Value	Description	DS (P1.3)																														
		RUN	ro/rw																																	
				26	External brake actuated. Switch threshold: set value of P12.8.																															
				27	Current monitoring Switch threshold: set value of P5.8.																															
				28	Fieldbus, Remote output The number of the assigned digital output is written directly to the control word (ID2001, bit 13).																															
P13.2	1454	-	rw		LOG function, Selection input B see P13.1	0																														
P13.3	1455	-	rw		LOG function, select operation. Logical operation (LOG) of the selected functions of parameter P13.1 (A) and P13.2 (B).	0																														
<table border="1"> <thead> <tr> <th colspan="2">Signal</th> <th colspan="3">Logic link (LOG)</th> </tr> <tr> <th>A</th> <th>B</th> <th>AND</th> <th>OR</th> <th>XOR (exclusive or)</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>1</td> <td>0</td> </tr> </tbody> </table>							Signal		Logic link (LOG)			A	B	AND	OR	XOR (exclusive or)	0	0	0	0	0	0	1	0	1	1	1	0	0	1	1	1	1	1	1	0
Signal		Logic link (LOG)																																		
A	B	AND	OR	XOR (exclusive or)																																
0	0	0	0	0																																
0	1	0	1	1																																
1	0	0	1	1																																
1	1	1	1	0																																
<p>The result of the logic operation (LOG) can be assigned to one of the three digital outputs (DO = P5.3), RO1 = P5.1 and RO2 = P5.2 with the value 24, or called via the serial interface (RS485, Modbus RTU) or an optional fieldbus connection (CANopen, PROFIBUS DP).</p>																																				
				0	A AND B, A and B																															
				1	A OR B, A or B																															
				2	A XOR B, exclusive A or B																															

6 Parameters

6.2 Parameter menu (PAR)

6.2.15 Second parameter set (P14)

Selected parameters for a second motor are combined in parameter group P14. This enables the alternative operation of two motors at the output of the frequency inverter, also with different rating data.

In the default setting, the parameters of this second parameter set (P14) are identical to the default settings of the basic parameters (first parameter set) and described in the relevant sections:

- P14.1 - P14.6 = P7.1 - P7.6 (Motor)
- P14.7 - P14.10 = P6.3 - P6.6 (Drives control)
- P14.11 = P11.1, P14.12 = P11.7 (V/f control)
- P14.13 - P14.16 = P8.6 - P8.9 (protection function).

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P14.1	1347	-	rw		Motor (2PS), rated operational current Setting range: $0.2 \times I_e - 2 \times I_e$ I_e = Rated operational current of the frequency inverter (→ Motor rating plate).	4.8 ¹⁾
P14.2	1352	-	rw		Current limit (2PS) Setting range: $0.2 \times I_e - 2 \times I_e$ $1.5 \times I_e$	7.2 ¹⁾
P14.3	1350	-	rw		Motor (2PS) nominal speed Setting range: 300 – 20000 rpm (min ⁻¹) (→ Motor rating plate).	1440 1720
P14.4	1351	-	rw		Motor (2PS), motor power factor (cos φ). Setting range: 0.30 - 1.00 (→ Motor rating plate).	0.85 ¹⁾
P14.5	1348	-	rw		Motor (2PS), rated operating voltage Setting range: 180 - 500 V (→ Motor rating plate). Pay attention to the supply voltage and the type of circuit in the stator winding!	230 ¹⁾
P14.6	1349	-	rw		Motor (2PS), rated frequency Setting range: 30 - 320 Hz (→ Motor rating plate).	50.00 60.00
P14.7	1343	-	rw		Minimum frequency (2PS) 0.00 - P14.8 Hz	0.00
P14.8	1344	-	rw		Maximum frequency (2PS) P14.7 - 320 Hz	50.00 60.00
P14.9	1345	✓	rw		Acceleration time (2PS, acc3) 0.1 - 3000 s	3.0
P14.10	1346	✓	rw		Deceleration time (2PS, dec3) 0.1 - 3000 s	3.0
P14.11	1355	-	rw		U/f characteristic curve (2PS), characteristic (→ Section " P11.1", page 159)	0
				0	Linear	
				1	Quadratic	
				2	Parameterizable	

PNU	ID	Access right		Value	Description	DS (P1.3)
		RUN	ro/rw			
P14.12	1354	-	rw		Torque increase (2PS)	0
				0	Deactivated	
				1	activated Automatic increase of the output voltage (Boost) with an increased load and low speed (e.g. heavy starting duty). ▽ Notice: A high torque at low speed causes a high thermal load on the motor. Note: If temperatures are too high, the motor should be fitted with a fan.	
P14.13	1353	-	rw		Motor (2PS), temperature protection	2
					The motor temperature protection is designed to protect the motor from overheating. It is based on a temperature algorithm and uses the motor current (P14.1) to determine the motor load (→ Section "The temperature model is based on the assumption that the motor achieves a winding temperature of 140°C at rated speed and an ambient air temperature of 40 °C, with 105 % rated load.", page 138).	
				0	Deactivated	
				1	Danger (AL16)	
				2	Error (F... 16), stop function according to P6.8.	
P14.14	1469	-	rw		Motor (2PS), ambient temperature	40
					Setting range: -20 – +100 °C	
P14.15	1470	-	rw		Motor (2PS), cooling factor at zero frequency.	40.0
					Setting range: 0.0 – 150 % The cooling factor of the motor at zero frequency defines the ratio for cooling the motor at the rated frequency with the rated operational current without an external fan (→ Figure 94, page 140).	
P14.16	1471	-	rw		Motor (2PS), thermal time constant.	45
					Setting range: 1 – 200 min The temperature time constant determines the time-span in which the heat calculation model achieves 63% of its end value. It depends on the design of the motor and is different from manufacturer to manufacturer. The larger the motor design, the greater the time constant.	

1) Example → Section "6.2.8 Motor (P7)", page 134.

The following examples show two practical applications for the second parameter set.

6 Parameters

6.2 Parameter menu (PAR)

Example 1 :

Roller conveyor with rotary table

- Motor M1 (0.75 kW/1.9 A/400 V) drives the rollers on the rotary table and transports the goods further.
- Motor M2 (1.5 kW/3.6 A/400 V) rotates the table for the alternating acceptance of goods from two feed lines.

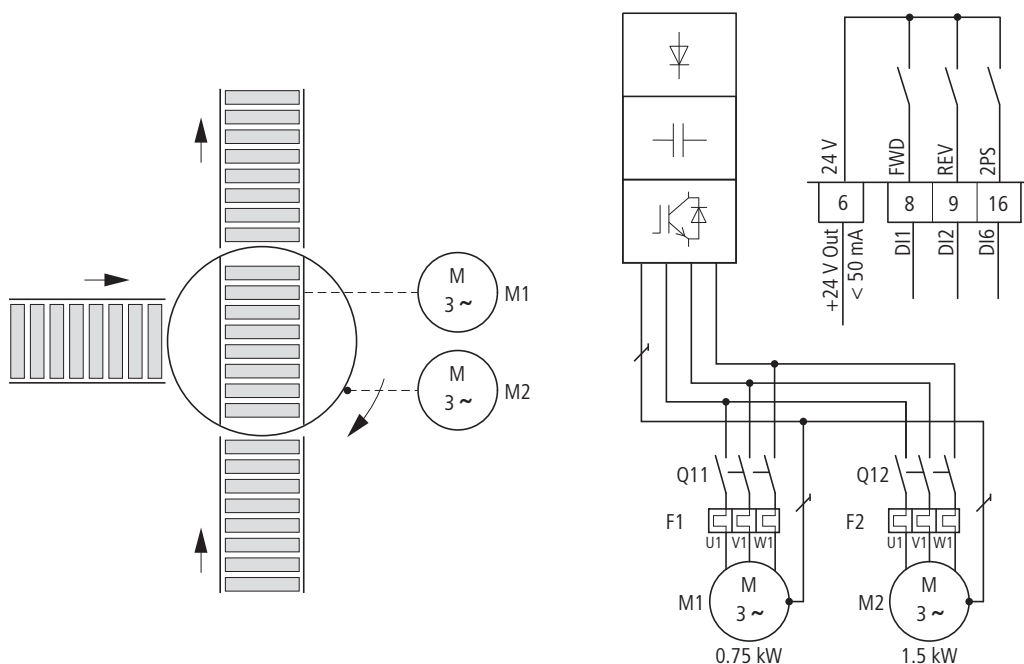


Figure 111: Roller conveyor with rotary table

For alternating operation (rotary movement “exclusive or” of the transport rollers) on the rotary table, a frequency inverter for the largest connected load (3.6 A → MMX34AA4D3...) was selected.

The different rating data of the motors were set in the parameter groups P7 (for motor M1) and P14 (for motor M2). The second parameter set (P14) is activated here as an example via digital input DI6 (P3.27 = 6).

The change between the two motors is implemented in this example via contactors Q11 (M1) and Q12 (M2) at standstill. The enabling and selection of the relevant parameter group is activated via the digital inputs:

- Motor M1 = DI1 (FWD, control signal terminal 8) operation with parameter group P7.
- Motor M2 = DI1 (FWD, control signal terminal 8) and DI6 (2PS, control signal terminal 16) operation with parameter group P14 (second parameter set).

During maintenance and setting work the following applies for reversing duty:

- Motor M1 = DI2 (REV, control signal terminal 9) operation with parameter group P7.
- Motor M2 = DI2 (REV, control signal terminal 9) and DI6 (2PS, control signal terminal 16) operation with parameter group P14 (second parameter set).



Digital input DI6 is assigned in the factory setting (P3.12 = 6) with the function PI-OFF (PID controller, deactivated). With P3.12 = 0 you should switch off this function of DI6. With P3.27 = 6 you assign the digital input DI6 with the function: second parameter set (2PS).

**Example 2:
Stop function with two different deceleration times**

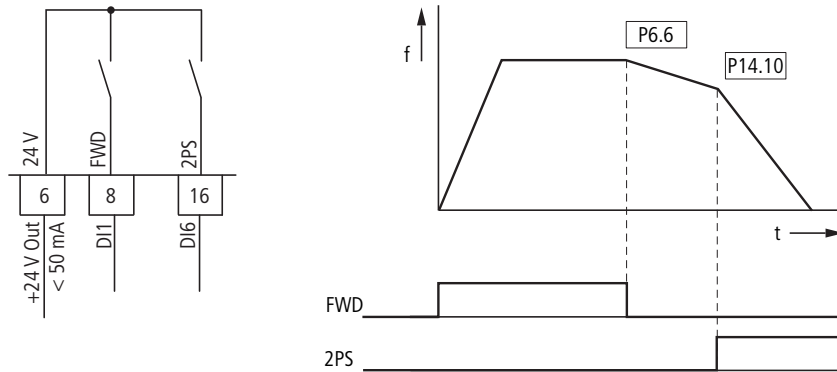


Figure 112: Stop function with two different deceleration times

The Stop function with deceleration time can be activated with parameter P6.8 = 1. When the enable signal at digital input DI1 (FWD, control signal terminal 8) is deactivated, the output frequency of the frequency inverter is reduced according to the deceleration time (dec1) set at P6.6.

The second parameter set (2PS) enables you to set at P14.10 another value that is different to dec1 or dec2. The second parameter set (P14) here, for example, is activated via digital input DI6 (P3.27 = 6). When DI6 is activated, the output frequency is reduced according to the set deceleration time (dec3) set at P14.10.

NOTICE

The motor parameters must be identical in both parameter groups (P7 and P14).



Digital input 6 is assigned in the default setting (P3.12 = 6) with the function PI-OFF (PID controller, deactivated). With P3.12 = 0 you can remove this function (PI-OFF) from digital input 6.

6 Parameters

6.2 Parameter menu (PAR)

6.2.16 System parameter

The system parameters (S parameters) inform the user of device-specific settings.



The S parameters are not visible (i. e. hidden), as long as you have activated the quick-start assistant (P1.1 =1, → Section “6.2 Parameter menu (PAR)”, page 99).

PNU	ID	Access right		Value	Description	DS
		RUN	ro/rw			
Hard- and Software Information						
S1.1	833	-	ro	xx	API SW ID: control section, software identification.	-
S1.2	834	-	ro	x	API SW ID Version: Control section, software version.	-
S1.3	835	-	ro	x	Power SW ID: Power section, software identification.	-
S1.4	836	-	ro	xx	Power SW Version: Power section, software version.	-
S1.5	837	-	ro	90xx	Application ID.	-
S1.6	838	-	ro	x.xx	Application revision.	-
S1.7	839	-	ro	xx	System load Load as percentage [%].	-
Communication						
Information on interface RS485 (control signal terminals A, B)						
S2.1 ¹⁾	808 ¹⁾	-	ro	xx.yyy	Communication status xx = Number of error messages (0 to 64). yyy = Number of correct messages (0 to 999).	0.000 ¹⁾
S2.2 ¹⁾	809 ¹⁾	✓	rw	0 1	Field bus protocol Field bus deactivated Modbus RTU	0 ¹⁾
S2.3 ¹⁾	810 ¹⁾	✓	rw		Address (slave) Station address 1 to 255.	1 ¹⁾
S2.4 ¹⁾	811 ¹⁾	✓	rw	0 1 2 3 4 5 6 7 8	Baud rate Transfer rate (1 Baud = 1 symbol per second) The baud rate must be equal on the send and receive sides. = 300 Baud = 600 Baud = 1200 Baud (1.2 k Baud) = 2400 Baud (2.4 k Baud) = 4800 Baud (4.8 k Baud) = 9600 Baud (9.6 k Baud) = 19200 Baud (19.2 k Baud) = 38400 Baud (38.4 k Baud) = 57600 Baud (57.6 k Baud)	5 ¹⁾

1) With a field bus connection (option, e.g. CANopen, PROFIBUS DP etc.) modified ID numbers and different default settings are stored here. Detailed information is provided in the specific manuals of the relevant fieldbus interface card.

6 Parameters

6.2 Parameter menu (PAR)

PNU	ID	Access right		Value	Description	DS
		RUN	ro/rw			
S2.6	813	✓	rw		Parity type	0
				0	= No function (inaccessible)	
S2.7	814	✓	rw		Communication status "timeout"	0
				0	= Not used	
				1	= 1 s	
				2	= 2 s	
				... 255	= up to 255 s	
S2.8	815	✓	rw		Reset communication status	
				0	= Not used	
				1	= Resets parameter S2.1	
Unit counter						
S3.1	827	-	ro	-	MWh counter	0.00
S3.2	828	-	ro	-	Operating days [d]	0
S3.3	829	-	ro		Operating hours [h]	0
S3.4	840	-	ro	0 - 0000	RUN counter, days	-
S3.5	841	-	ro	0 - 24	RUN counter, hours	-
S3.6	842	-	ro	0 - 0000	FLT counter: Error counter	-
User Settings						
S4.1	830	✓	rw	0 - 15	Display contrast	15
S4.2	831	-	rw		Default settings (DS)	0
				0	= Default setting or changed value (user setting for parameter).	
				1	= Restores default settings for all parameters.	
S4.3	832	✓	ro		Password entry	0000
					The password protection applies to all parameters. Password forgotten (→ Section "1.11 Service and warranty", page 25)	
				0000	Deactivated	
				0001 - 9999	Activated, set individual password	

6 Parameters

6.3 Operational data indicator (MON)

6.3 Operational data indicator (MON)

By applying the specified supply voltage (L1, L2/N, L3), the LCD display is illuminated (= Power ON) and all segments are shown briefly. The parameter number (M1.1) and the respective display value (0.00) are then displayed automatically in alternating sequence.

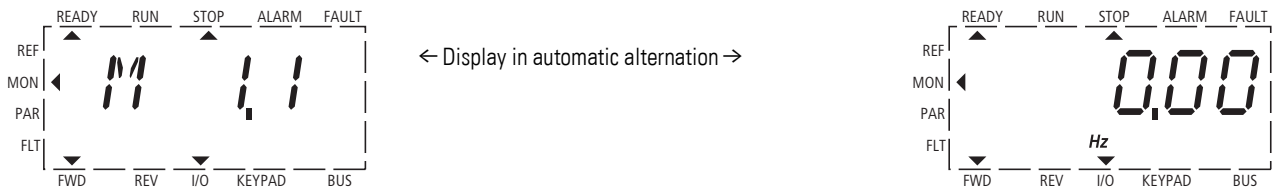


Figure 113: Operational data indicator

You can use the MON (Monitor) menu level to select the desired operational data indicator (parameter number M...) with the arrow buttons \wedge and \vee . The parameter number and the display value are shown in alternation automatically, and the display can be fixed on the selected display value with the OK pushbutton. If you wish to access a different operational data indicator, press the OK pushbutton once again. You can then make the selection with the arrow buttons \wedge and \vee and confirm with the OK pushbutton. The appropriate unit is shown under the respective operational data indicator.



The values of the operating data display cannot be changed by hand (i. e. by value entry).



You can select operational data indicators during operation (RUN).

PNU	ID	Designation	Display value	Material Type	Description
M1.1	1	Frequency output value	0.00	Hz	Frequency to motor
M1.2	25	Frequency setpoint value	0.00	Hz	Frequency reference value
M1.3	2	Motor Speed	0	rpm	Calculated shaft speed of the motor (min ⁻¹) ¹⁾
M1.4	3	Motor current	0.00	A	Measured motor current
M1.5	4	Motor Torque	0.0	%	Calculated ratio of torque to rated torque of the motor ¹⁾ .
M1.6	5	Motor rating	0.0	%	Calculated ratio of actual output power to rated motor output ¹⁾ .
M1.7	6	Motor Voltage	0.0	V	Measured output voltage to motor.
M1.8	7	DC Bus voltage	000	V	Measured intermediate circuit voltage (depending on the supply voltage).
M1.9	8	Unit Temperature	00	°C	Measured heat sink temperature.
M1.10	9	Motor temperature	0	%	% (calculated value) ²⁾
M1.11	13	Analog input 1	0.0	%	Value at control signal terminal 2 (AI1)
M1.12	14	Analog input 2	0.0	%	Value at control signal terminal 5 (AI2)
M1.13	26	Analog output 1	0.0	%	Value at control signal terminal 18 (AO1)
M1.14	15	Digital input	0	-	DI1, DI2, DI3 status (→ Section " Example of status displays", page 182).
M1.15	16	Digital input	0	-	DI4, DI5, DI6 status(→ Section " Example of status displays", page 182)
M1.16	17	Digital output	1	-	RO1, RO2, DO status (→ Section " Example of status displays", page 182).
M1.17	20	PID setpoint value	0.0	%	Percentage of maximum setpoint value.
M1.18	21	PID feedback	0.0	%	Percentage of maximum actual value.
M1.19	22	PID Error value	0.0	%	Percentage of maximum fault value.
M1.20	23	PID Output	0.0	%	Percentage of maximum output value.
M1.21	1480	Counter, digital input	0	-	Number of control sections of a digital input (DI1 to DI6) assigned to P3.23. The counter reset command is set with P3.24.

1) The calculated motor data (M1.3, M1.5 and M1.6) is based on the values entered in parameter group P7 (→ Section "6.2.8 Motor (P7)", page 134).

2) The calculated motor temperature (M1.10) considers the temperature model of the protection function in parameter group P8 (→ Section "6.2.9 Protective functions (P8)", page 136)



Under the system parameters S3.1 to S4.1 (→ Section "6.2.16 System parameter", page 178) you can also display the operational data of the M-Max™ frequency inverter and adjust the contrast of the display unit.

6 Parameters

6.3 Operational data indicator (MON)

Example of status displays

The status displays of the digital inputs and outputs are equivalent. These make it possible to check for whether an output control signal (e.g. from an external controller) of the inputs (DI1 to DI6) activates the frequency inverter. This provides you with a simple means for checking the wiring (wire breakage).

The following table shows a few examples.

Display value:

- 1 = activated = High
- 0 = not activated = Low

PNU	ID	Display value	Description
M1.14	15	0	No digital input (DI1, DI2, DI3) is actuated.
		1	Control signal terminal 10 is actuated (DI3).
		10	Control signal terminal 9 is actuated (DI2).
		100	Control signal terminal 8 is actuated (DI1).
		101	The control signal terminals 10 and 8 are actuated (DI3 + DI1).
		111	The control signal terminals 10 and 9 and 8 are actuated (DI3 + DI2 + DI1).
M1.15	16	1	Control signal terminal 14 is actuated (DI6).
		10	Control signal terminal 15 is actuated (DI5).
		100	Control signal terminal 16 is actuated (DI4).
M1.16	17	1	Transistor DO is actuated. The transistor switches the voltage connected at control signal terminal 20 (DO+) to control signal terminal 13 (DO-).
		10	Relay RO2 is actuated. The control signal terminals 25 (R21) and 26 (R24) are connected (closed changeover contact).
		100	Relay RO1 is actuated. N/O contact, control signal terminal 22 (R13) and 23 (R14) is closed.

6.4 Setpoint input (REF)











REF: Setpoint value definition (Reference) via the operating unit

The settings of the frequency setpoint via the keypad have the same effect as the function of an electronic motor potentiometer. The set value is written in parameter P6.15 and can also be changed there. It is retained also with a disconnection of the supply voltage.



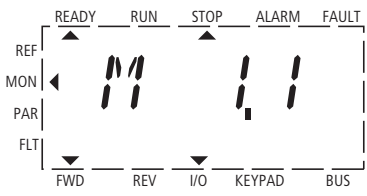
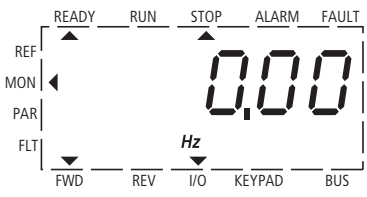

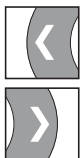
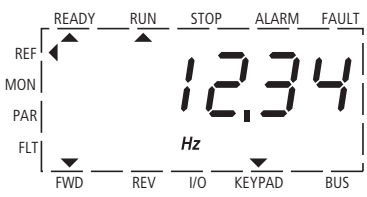
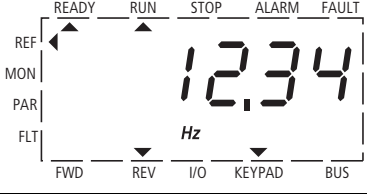
A frequency reference value value that is set under REF is only effective with the KEYPAD control level activated.

The following table shows a good example of specifying the frequency setpoint value via the operating unit.

Sequence	Commands	Indicator	Description
1	  		<p>Activate control level KEYPAD with the LOC/REM pushbutton. The arrow (◀) points to menu item REF.</p> <p>Actuating the START pushbutton enables the RUN mode (rotating field direction FWD).</p> <p>The STOP pushbutton (P6.16 = 1) activates the STOP mode. The Stop function is set at parameter P6.8.</p>
2	    		<p>Pressing the OK pushbutton activates the setpoint entry (right-hand segment flashing).</p> <p>The two arrow buttons (< or >) are used to select the entry digit (Cursor).</p> <p>The arrow buttons ^ or v are used to select the value of the entry digit (0, 1, 2, ...9, 0).</p> <p>Note: Changes in the frequency setpoint are only possible if the number display is flashing (Hz), even in RUN mode. The value is stored when the display is constant. When the supply voltage is switched off, the last setpoint entered (→ P6.15) and the KEYPAD mode are stored.</p>

6 Parameters

6.4 Setpoint input (REF)

Sequence	Commands	Indicator	Description
3		 <p>↓ Display in automatic alternation ↑</p> 	<p>If the supply voltage is switched on with the KEYPAD control level set, the MON menu item is activated first. The set display value is shown in automatic alternation (default setting : M.1.1 ↔ 0.00 Hz).</p>
			<p>Actuate the BACK/RESET, ^ and OK buttons in succession. The entry level is then reactivated (see sequence 2).</p>
4		<p>FWD</p>  <p>REV</p> 	<p>The two arrow buttons (< or >) are used to change the operating direction (FWD, REV).</p> <p>The rotating direction change is carried out in the default setting (P6.14 = 0) with an automatic stop at 0 Hz. For a direct changeover (FWD/REV) you must set parameter P6.14 = 1. Note: The frequency of the REV rotating field direction is not displayed with a negative sign. Note: When the setpoint entry is active (flashing number display), the arrow buttons are used to change the entry locations (Cursor).</p>

7 Serial interface (Modbus RTU)

7.1 General

Modbus is a centrally polled bus system in which a so-called master (PLC) controls the entire data transfer on the bus. Cross-traffic between the individual slaves is not possible.

Each data exchange is initiated only on request of the master. Only one request can be issued on the cable. A slave cannot initiate a transfer but only react to a request with a response.

Two types of dialog are possible between master and slave:

- The master sends a request to a slave and waits for a response.
- The master sends a request to all slaves and does not wait for a response (broadcast).



More information on Modbus can be found under www.modbus.org.

7.1.1 Communications

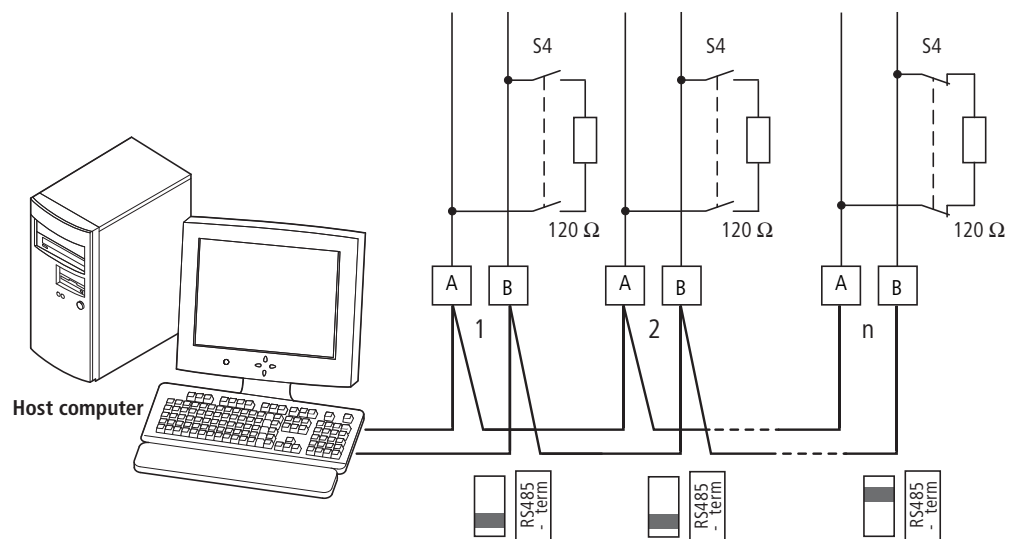


Figure 114: Modbus network with M-Max™

The figure shows a typical arrangement with a host computer (master) and any number (maximum 31 slaves) of frequency inverter M-Max™ (slaves). Each frequency inverter has a unique address in the network. This addressing is executed individually for each M-Max™ via system parameter S2.3 and is independent of the physical connection (position) in the network.

7 Serial interface (Modbus RTU)

7.2 Modbus parameters

7.1.2 Serial interface A-B

The electrical connection between master and the slaves connected in parallel is implemented via the serial interface A-B (A = negative, B = positive) with a shielded RS485 twisted pair cable.

The position of the connection terminals in the M-Max™ for the serial interface A-B (→ Figure 54, page 71).

The M-Max™'s built-in RS -485 port supports the Modbus RTU protocol and therefore allows a direct network connection without an additional interface module.

The network cable must be provided at each physical end (last station) with a bus termination resistor (120 Ω) in order to prevent signal reflections and the resulting transfer errors. This necessary resistor is already integrated in the M-Max™ frequency inverter and is switched on via microswitch S4 (→ Figure 55, page 71 or → Figure 114, page 185).

7.2 Modbus parameters

The following table shows the Modbus parameters in the M-Max™.

RUN Indicates the access right during operation (FWD or REV)

- = No parameter change possible,

✓ = Parameter change possible.

ro/rw Indicates the access right via the field bus

ro = Read only possible,

rw = Read and write possible.

PNU	ID	Access right		Designation	Value range	DS (P1.3)
		RUN	ro/rw			
S2.1	808 ¹⁾	-	ro	Communication status	Format xx.yyy xx = Number of received faulty messages (0 - 64). yyy = Number of received correct messages (0 - 999).	0.000 ¹⁾
S2.2	809 ¹⁾	✓	rw	Field bus protocol	0 = field bus deactivated 1 = Modbus	0 ¹⁾
S2.3	810 ¹⁾	✓	rw	Station address	1 - 255	1 ¹⁾
S2.4	811 ¹⁾	✓	rw	Baud rate	0 = 300 1 = 600 2 = 1200 (1.2 k Baud) 3 = 2400 (2.4 k Baud) 4 = 4800 (4.8 k Baud) 5 = 9600 (9.6 k Baud) 6 = 19200 (19.2 k Baud) 7 = 38400 (38.4 k Baud) 8 = 57600 (57.6 k Baud)	5 ¹⁾
S2.6	813	✓	rw	Parity type	0 = None → 2 Stop bits 1 = Even → 1 Stop bit 2 = Odd → 1 Stop bit	0

1) With a field bus connection (option, e.g. CANopen, PROFIBUS DP etc.) modified ID numbers and different factory settings are stored here. Detailed information is provided in the specific manuals of the relevant fieldbus interface card.

7 Serial interface (Modbus RTU)

7.2 Modbus parameters

PNU	ID	Access right		Designation	Value range	DS (P1.3)
		RUN	ro/rw			
S2.7	814	✓	rw	Timeout up to field bus error (error 53) if no master messages are received although Modbus is still active.	0 = Not used 1 = 1 s 2 = 2 s = up to 255 s	0
S2.8	815	✓	rw	Reset communication status xx and yyy are reset to 0	0 = Not used 1 = resets parameter S2.1	0
Drives control						
P6.1	125	✓	rw	Control level	1 = Control signal terminals (I/O) 2 = Control unit (KEYPAD) 3 = Interface (BUS)	1
P6.2	117	✓	rw	Setpoint Source	0 = Fixed frequency (FF0) 1 = Control unit (KEYPAD) 2 = Interface (BUS) 3 = AI1 (analog setpoint value 1) 4 = AI2 (analog setpoint value 2)	3

For Modbus to function at least the following parameters must be set:

PNU	Value	Note
S2.2	1	To activate Modbus.
S2.3	1 - 255	Set differently at each slave (MMX); 0 is used by the master for broadcasts.
S2.4	0 - 8	Same setting at the master and slave.
S2.6	0/1	Same setting at the master and slave.
P6.1	3	Field bus selected as a control level.
P6.2	2	Set setpoint value via the field bus; other setpoint sources also possible, fixed frequencies overlay all setpoint values, also a field bus setpoint value.

Another requirement is that the arrow ▼ in the lower status line of the LCD display is pointing to BUS (adjustable via the LOC/REM pushbutton). The PLC (master) must also be provided with an RS485 serial interface and the necessary Modbus RTU driver software.

7.3 Operating mode Modbus RTU

Operating mode Modbus RTU (Remote Terminal Unit) transfers the data in binary format (faster data rate) and determines the transfer format for the data request and the data response. Each message byte that is sent contains two hexadecimal characters (0 ... 9, A ... F).

The data transfer between a master (PLC) and the frequency inverter (M-
 Max™) is carried out according to the following sequence:

- Master request: the master sends a Modbus frame to the frequency inverter.
- Slave response: the frequency inverter sends a Modbus frame as a response to the master.

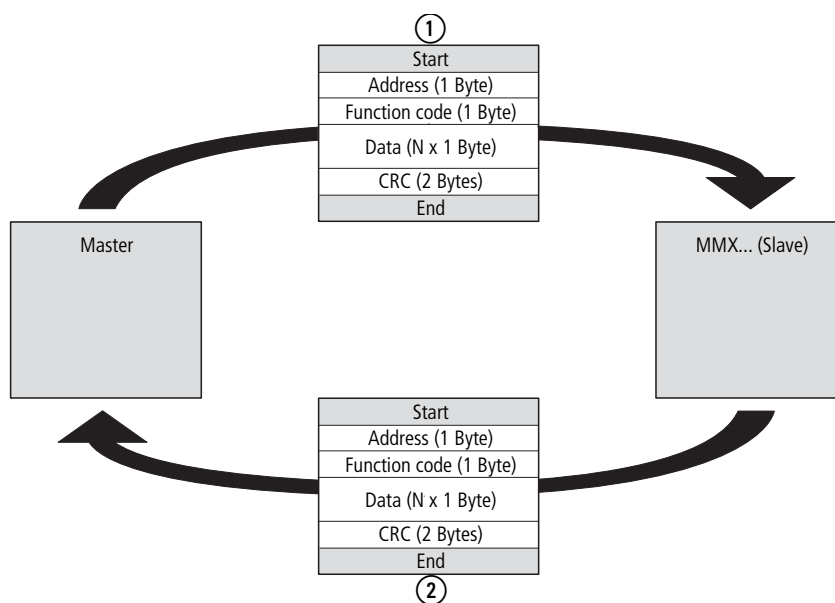


Figure 115: Data exchange between master and slave

- ① Master request
- ② Slave response, not with broadcast



The frequency inverter (slave) only sends a response if it has received a request from the master beforehand.

7.3.1 Structure of the master request

7.3.1.1 Address

- The slave address (1 to 255) of the recipient frequency inverter is entered in the parameter S2.3. Only the frequency inverter with this address can respond to the request.
- Address 0 is used as a so-called Broadcast (message to all slaves) from the master. In this mode, individual slaves cannot be addressed and data cannot be output from the slaves.

7.3.1.2 Function code

The function code defines the type of message. The following operations can be executed on the M-Max™:

Function code [hex]	Designation	Description
03	Read Holding Registers	Reading of the holding registers in the slave (process data, parameters, configuration). A master request enables up to 11 registers to be read.
04	Read Input Registers	Reading of the input registers in the slave (process data, parameters, configuration). A master request enables up to 11 registers to be read.
06	Write Single Register	Writing of a holding register in the slave. With a general telegram (Broadcast) the appropriate holding registers are written in all slaves. The register is read back for comparison.
10	Write Multiple Registers	Writing of several holding registers in the slave. With a general telegram (Broadcast) the appropriate holding registers are written in all slaves. A master request enables up to 11 registers to be read.

7.3.1.3 Data

The length of the data block (Data: N x 1 Byte) depends on the function code. This consists of two hexadecimal character sets between 00 and FF. The data block contains additional information for the slave in order to carry out the operation defined by the master in the function code. Example: number of parameters to be processed.

7.3.1.4 CRC

The telegrams in the Modbus RTU have a CRC (Cyclical Redundancy Check). This CRC field consists of two bytes that contain a binary 16 bit value. The CRC check is always run independently of the parity check for the individual characters of the telegram. The CRC result is attached to the end of the telegram by the master. The slave recalculates while receiving the telegram and compares the calculated value with the actual value in the CRC field. If both values are not identical, an error is set.

7 Serial interface (Modbus RTU)

7.3 Operating mode Modbus RTU

7.3.2 Structure of the slave response

7.3.2.1 Required transfer time

- The time between receiving a request from the master and the response of the frequency inverter is at least 3.5 characters (rest time).
- Once the master has received a response from the frequency inverter, it must wait for at least the rest time before it can send a new request.

7.3.2.2 Normal slave response

- If the master request contains a write register function (function code 06 or 16), the frequency inverter immediately returns the request as a response.
- If the master request contains a read register function (function code 03 or 04), the frequency inverter returns the read data with the slave address and the function code as a response.

7.3.2.3 Slave response in the fault scenario

If a request contains an error (e.g. incorrect data address or incorrect data value) other than a transfer error, the frequency inverter returns an exception message without executing anything. You can evaluate the exception message.

7.3.2.4 Structure of exception message

- Address (of the master request)
- Function code (of the master request): MSB is set to 1 (e.g. with function code 06 = 1000 0110)
- Data field contains the error code (is described in the following table)
- CRC

7.3.2.5 Error code description

Exception code	Importance	Description
01	Illegal function	This function is not supported.
02	Illegal data address	The address was not found.
03	Illegal data value	The data format is not permissible or is incorrect.
04	Slave device error	Occurrence of a non-regenerative error while the slave attempted to execute a slave response.
06	Slave device busy	The slave has received the master request error-free. However, it is engaged in processing a lengthy command.

Example

Master request that contains a non-existent data address.

Master request: 01 06 0802 0001 EBAA [hex]

hex	Series Name
01	Station address
06	Function code (here: Write a holding register)
0802	2050 [dec]. The ID number of the written register is 2051 [dec] as the master PLC has an offset of +1
0001	Content (2 bytes) for register 42051: 0000 0000 0000 0001 [bin]
EBAA	CRC

Slave response: 01 86 02 C3A1 [hex]

hex	Series Name
01	Station address
86	Function code (here: Write a holding register) MSB was set to 1
02	Error code: Stated address not found.
C3A1	CRC

7.3.2.6 No slave response

In the following cases, the frequency inverter ignores the request and does not send a reply:

- on receiving a broadcast request.
- if the request contains a transmission error.
- If the slave address in the request does not match that of the frequency inverter.
- With an invalid data length, (e.g. reading of 12 registers) error message F08 is triggered in the MMX.
- With a CRC or parity error.
With a CRC error the value of system parameter S2.1 is increased by 1 (xx = number of faulty messages).
- If the time interval between the messages is less than 3.5. characters.



The master must be programmed to repeat the request if it does not receive a response within a specified time.

7 Serial interface (Modbus RTU)

7.3 Operating mode Modbus RTU

7.3.3 Data storage with Modbus

The information is stored in one input and one holding register.

Register numbers	Type	Series Name
30001 - 39999	Read only (ro = read only)	Input-register
40001 - 49999	Read/write (rw = Read/write)	Holding register

The registers are the memory location of the data. The memory size of each register is 1 word.

7.3.4 Modbus-Register-Mapping

The register mapping enables the processing in MMX of the content listed in the following table via Modbus RTU.

Group	Register numbers	ID range	Assignment of the ID numbers
Display values	40001...40098 (30001...30098)	1...98	List of parameters: (→ Section "8.14 List of parameters")
Failure code	40099 (30099)	99	Error list: (→ Chapter 5 "Error and Warning Messages")
parameters	40101...40999 (30101...30999)	101...1999	List of parameters: (→ Section "8.14 List of parameters")
Input process data	42001...42099 (32001...32099)	2001...2099	(→ Page 193)
Output process data	42101...42199 (32101...32199)	2101...2199	(→ Page 194)

Each content in this table is assigned an ID number (abbreviation of the register numbers). This ID number is used in M-Max™ for the communication with Modbus RTU.

Example: Control word (ID 2001)

Value	ID	Register numbers
	2001	32001/42001
Utilization	Communication of Modbus RTU	Memory location of the data



With some PLC manufacturers, the interface driver for Modbus RTU communication may contain an offset of + 1 (the ID to be used would then be 2000 instead of 2001).



When processing values, the comma is not included, e.g. the motor current (ID 2106) in the display of the MMX is shown as 0.35 A but is transferred via Modbus as 0023 [hex] (0035 [dec]).

Modbus Process Data

Process data is processed in the M-Max™ frequency inverter faster than the display values, error codes and parameters.

7.3.4.1 Input process data

The input process data is used to control the M-Max™ frequency inverter.

ID	MODBUS register	Designation	Value range	Type
2001	32001, 42001	Field bus control word (BUS)	-	Binary code
2002	32002, 42002	Field bus general control word (BUS)	-	Binary code
2003	32003, 42003	Field bus speed reference value (BUS)	0.01	%
2004	32004, 42004	PID controller, setpoint value	0.01	%
2005	32005, 42005	PID Actual value	0.01	%
2006	32006, 42006	-	-	-
2007	32007, 42007	-	-	-
2008	32008, 42008	-	-	-
2009	32009, 42009	-	-	-
2010	32010, 42010	-	-	-
2011	32011, 42011	-	-	-

7.3.4.2 Control word (ID 2001)

These bits are used to control the M-Max™ frequency inverter. The content can be adapted to your own application and then sent as a control word to the frequency inverter.

Bit	Description	
	Value = 0	value = 1
0	Stop	Operation
1	Clockwise rotating field (FWD)	Anticlockwise rotating field (REV)
2	No Action	Reset error
3	As per setting P6.8	Free coasting (overwrite value from P6.8)
4	As per setting P6.8	Ramp (overwrite value from P6.8)
5	No Action	Overwrite acceleration/deceleration ramps to 0.1 s
6	No Action	Block setpoint value (speed not variable)
7	No Action	Overwrite setpoint value with 0
8	No Action	Control level = Field bus (overwrite value from P6.8)
9	No Action	Setpoint input = Field bus (overwrite value from P6.8)
10	Not Used	
11	Not Used	
12	No Action	The inverter is blocked and the drive stops as quickly as possible (an edge is required for restart)

7 Serial interface (Modbus RTU)

7.3 Operating mode Modbus RTU

Bit	Description	
	Value = 0	value = 1
13	No Action	Control of a digital output: <ul style="list-style-type: none"> • P5.1 = 28 (Relay R01) • P5.2 = 28 (Relay R02) • P5.3 = 28 (Transistor D0)
14	Not Used	
15	Not Used	

7.3.4.3 General control word (ID 2002)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB	NB

7.3.4.4 Speed reference value (ID 2003; frequency reference value)

The permitted value range lies between 0 and 10.000. In the application, this value is scaled to a percentage in the frequency range between the defined minimum and maximum frequencies.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB															LSB

7.3.4.5 Output process data

The output process data is used to monitor the frequency inverter.

ID	MODBUS register	Designation	Value range	Type
2101	32101, 42101	Field bus status word	-	Binary code
2102	32102, 42102	Field bus general status word	-	Binary code
2103	32103, 42103	Field bus actual speed	0.01	%
2104	32104, 42104	Motor frequency	0.01	+/- Hz
2105	32105, 42105	Motor speed	1	+/- rpm (min ⁻¹)
2106	32106, 42106	Motor current	0.01	A
2107	32107, 42107	Motor torque	0.1	+/- % (of the nominal value)
2108	32108, 42108	Motor power	0.1	+/- % (of the nominal value)
2109	32109, 42109	Motor voltage	0.1	V
2110	32110, 42110	DC-link voltage (DC)	1	V
2111	32111, 42111	Current error	-	Error code (E...)

7.3.4.6 Status word (ID 2101)

Information on the device status and messages are defined in the status word:

Bit	Description	
	Value = 0	value = 1
0	Drive not ready	Ready for operation (READY)
1	Stop	Running operation message (RUN)
2	Clockwise rotating field (FWD)	Anticlockwise rotating field (REV)
3	No fault	Fault detected (FAULT)
4	No caution	Caution active (ALARM)
5	Acceleration ramp	Frequency actual value equals setpoint value definition
6	-	Zero speed
7	Speed control deactivated	Speed control activated
8 - 15	Not Used	

7.3.4.7 General status word (ID 2102)

Bit	Description	
	Value = 0	value = 1
0	-	Control level = Field bus (BUS)
1	-	Setpoint input = Field bus (BUS)
2 - 10	Not Used	
11	Remote input not active	Remote input active The status of a selected digital input (P3.28) is read out.
12	Actuation (P3.37) not active	Actuation (P3.37) active
13	-	Control level = Control signal terminals (I/O)
14	-	Control level = KEYPAD
15	-	Control level = Field bus (BUS)

7.3.4.8 Actual speed (frequency actual value)

The actual speed of the frequency inverter is within a value range of 0 and 10,000. In the application, this value is scaled to a percentage in the frequency range between the defined minimum and maximum frequencies.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
MSB															LSB

7.3.5 Explanation of function code

7.3.5.1 Function code 03 [hex]: Reading of holding registers

This function reads the content of a number of consecutive holding registers (of specified register addresses).

Example:

Reading of motor speed (ID 2105) and motor current (ID 2106) of the M-
 MaxTM frequency inverter with the slave address 5.

Master request: 05 03 0838 0002 4622 [hex]

hex	Series Name
05	Station address
03	Function code (reading of holding registers)
0838	2104 [dec]: The ID number of the first requested register is 2105 [dec] as the master PLC has an offset of +1.
0002	Total number of requested registers (42105 - 42106)
4622	CRC

Slave response: 05 03 04 05D7 0018 0F0D [hex]

hex	Series Name
05	Station address
03	Function code (reading of holding registers)
04	Number of consecutive data bytes (2 registers x 2 bytes = 4 bytes)
05D7	Content (2 bytes) of register 42105: 1495 [dec] (motor speed = 1495 rpm)
0018	Content (2 bytes) of register 42106: 0024 [dec] (motor current = 0.24 A)
0F0D	CRC

7.3.5.2 Function code 04 [hex]: Reading of input registers

This function reads the content of a number of consecutive input registers (of specified register addresses).

Example:

Reading of motor speed (ID 2105) and motor current (ID 2106) of the M-Max™ frequency inverter with the slave address 5.

Master request: 05 04 0838 0002 F3E2 [hex]

hex	Series Name
05	Station address
04	Function code (here: Reading of input registers)
0838	2104 [dec]: The ID number of the first requested register is 2105 [dec] as the master PLC has an offset of +1.
0002	Total number of requested registers (32105 - 32106)
F3E2	CRC

Slave response: 05 04 04 05D7 0018 0EBA [hex]

hex	Series Name
05	Station address
04	Function code (here: Reading of input registers)
04	Number of consecutive data bytes (2 registers x 2 bytes = 4 bytes)
05D7	Content (2 bytes) of register 32105: 1495 [dec] (motor speed = 1495 rpm)
0018	Content (2 bytes) of registers 32106: 0024 [dec] (motor current = 0.24 A)
0EBA	CRC

7.3.5.3 Function code 06 [hex]: Writing a holding register

This function writes the data to a holding register (of specified register addresses).

Example:

Writing of the control word (BUS) (ID 2001) of an MMX frequency inverter with the slave address 5.

Master request: 05 06 07D0 0003 C2C8 [hex]

hex	Series Name
05	Station address
06	Function code (here: Writing of a holding register)
07D0	2000 [dec]: The ID number of the written register is 2001 [dec] as the master PLC has an offset of +1.
0003	Content (2 bytes) for register 42101: 0000 0000 0000 0011 [bin] → anticlockwise, RUN
C2C8	CRC

Slave response: 05 06 07D0 0003 C8C2 [hex]

The slave response is a copy of the master request if it is a normal response.

hex	Series Name
05	Station address
06	Function code (here: Writing of a holding register)
07D0	2000 [dec]: The ID number of the first requested register is 2001 [dec] as the master PLC has an offset of +1.
0003	Content (2 bytes) for register 42101: 0000 0000 0000 0011 [bin] → anticlockwise, RUN
C8C2	CRC



Function code 06 [hex] can be used for broadcasting.

7.3.5.4 Function code 10 [hex]: Writing of the holding registers

This function writes data to a number of consecutive holding registers (of specified register addresses).



Caution:

Although the registers to be written are consecutive, the ID numbers of the parameter list are not. Only the ID numbers in the process data list are consecutive.

Example:

Writing of the control word (ID 2001) of the general control word (ID 2002) and the speed reference value (ID2003) of an MMX frequency inverter with the slave address 5.

Master request: 05 10 07D0 0003 06 0001 0000 2710 D125 [hex]

hex	Series Name
05	Station address
10	Function code (here: Writing of the holding registers)
07D0	2000 [dec]: The ID number of the first written register is 2001 [dec] as the master PLC has an offset of +1.
0003	Total number of requested registers (42001 - 42103)
06	Number of consecutive data bytes (3 registers x 2 bytes = 6 bytes)
0001	Content (2 bytes) for register 42101: 0000 0000 0000 0001 [bin] (Start command)
0000	Content (2 bytes) for register 42102: 0000 [dec] (no content, as not used)
2710	Content (2 bytes) for register 42103: 10.000 [dez] (frequency reference value = 100.00 %)
D125	CRC

Slave response: 05 10 07D0 0003 8101 [hex]

hex	Series Name
05	Station address
10	Function code (here: Writing of the holding registers)
07D0	2000 [dec]: The ID number of the first written register is 2001 [dec] as the master PLC has an offset of +1.
0003	Total number of requested registers (42001 - 42103)
8101	CRC



Function code 10 [hex] can be used for broadcasting.

7 Serial interface (Modbus RTU)

7.3 Operating mode Modbus RTU

8 Appendix

8.1 Special technical data

The following tables show the technical data of the frequency inverter M-Max™ in the individual power classes with the allocated motor output.



The motor output allocation is based on the rated operational current.



The motor output designates the respective active power output to the drive shaft of a normal, four pole, internally or externally ventilated alternating current asynchronous motor with 1.500 rpm at 50 Hz or 1.800 rpm at 60 Hz.

8 Appendix

8.1 Special technical data

8.1.1 Device series MMX11

MMX11		Symbols used in technical data and formulae	Material Type	1D7	2D4	2D8	3D7	4D8		
Rated operational current		I_e	A	1.7	2.4	2.8	3.7	4.8		
Overload current for 60 s every 600 s at 50 °C		I_L	A	2.6	3.6	4.2	5.6	7.2		
Starting current for 2 s every 20 s at 50 °C		I_L	A	3.4	4.8	5.6	7.4	9.6		
Apparent power at rated operation ¹⁾	230 V	S	kVA	0.68	0.96	1.12	1.47	1.91		
	240 V			0.71	0.99	1.16	1.54	1.99		
Assigned motor rating (230 V) ¹⁾		P	kW	0.25	0.37	0.55	0.75	1.1		
			HP	1/3 ²⁾	1/2	1/2	3/4	1		
Power side (primary side):										
Number of phases				single-phase or two-phase						
Rated operating voltage				110 - 15 % - 120 + 10 %, 50/60 Hz (94 - 132 V ±0 %, 45 - 66 Hz ±0 %)						
Input current				I_{LN}	A	9.2	11.6	12.4	15	16.5
Maximum leakage current to ground (PE) without motor										
MMX11...N...				I_{PE}	mA					
Braking torque										
Standard				M/M _N	%	≤ 30				
DC braking				I/I _e	%	≤ 100, adjustable				
Pulse frequency				f _{PWM}	kHz	6 (adjustable 1.5 – 16)				
Heat dissipation at rated operational current (I _e)				P _v	W	22.3	27.9	33.4	40.3	49.2
Efficiency				η		0.91	0.92	0.94	0.95	0.96
Fan (device-internal, temperature-controlled)						✓	✓	✓	✓	✓
Frame Size						FS2	FS2	FS2	FS2	FS3
Weight				m	kg	0.7	0.7	0.7	0.7	0.99

1) Internal voltage doubler connection

$$U_{LN} = 115 \text{ V} \rightarrow U_2 = 230 \text{ V}$$

$$U_{LN} = 120 \text{ V} \rightarrow U_2 = 240 \text{ V}$$

2) recommended value (calculated), no standard rating

8.1.2 Device series MMX12

MMX12		Symbols used in technical data and formulae	Material Type	1D7	2D4	2D8	3D7	4D8	7D0	9D6		
Rated operational current		I_e	A	1.7	2.4	2.8	3.7	4.8	7	9.6		
Overload current for 60 s every 600 s at 50 °C		I_L	A	2.6	3.6	4.2	5.6	7.2	10.4	14.4		
Starting current for 2 s every 20 s at 50 °C		I_L	A	3.4	4.8	5.6	7.4	9.6	14	19.2		
Apparent power at rated operation	230 V	S	kVA	0.68	0.96	1.12	1.47	1.91	2.79	3.82		
	240 V			0.71	0.99	1.16	1.54	1.99	2.91	3.99		
Assigned motor rating	230 V	P	kW	0.25	0.37	0.55	0.75	1.1	1.5	2.2		
			HP	1/3 ¹⁾	1/2	1/2	3/4	1	2	3		
Power side (primary side):												
Number of phases				single-phase or two-phase								
Rated operating voltage				208 V - 15 % - 240 V + 10 %, 50/60 Hz (177 - 264 V ±0 %, 45 - 66 Hz ±0 %)								
Input current				I_{LN}	A	4.2	5.7	6.6	8.3	11.2	14.1	15.8
Maximum leakage current to ground (PE) without motor												
MMX12...N...				I_{PE}	mA							
MMX12...F...				I_{PE}	mA	15.4		11.8			24.4	
Braking torque												
Standard				M/M _N	%	≤ 30						
DC braking				I/I _e	%	≤ 100, adjustable						
Pulse frequency				f _{PWM}	kHz	6 (adjustable 1.5 – 16)						
Heat dissipation at rated operational current (I _e)				P _V	W	17.9	24.6	29.2	40.2	49.6	66.8	78.1
Efficiency				η		0.93	0.93	0.95	0.95	0.95	0.96	0.96
Fan (device-internal, temperature-controlled)						✓	✓	✓	✓	✓	✓	✓
Frame Size						FS1	FS1	FS1	FS2	FS2	FS2	FS3
Weight				m	kg	0.55	0.55	0.55	0.7	0.7	0.7	0.99

1) recommended value (calculated), no standard rating

8 Appendix

8.1 Special technical data

8.1.3 Device series MMX32

MMX32	Symbols used in technical data and formulae	Material Type	1D7	2D4	2D8	3D7	4D8	7D0		
Rated operational current	I_e	A	1.7	2.4	2.8	3.7	4.8	7		
Overload current for 60 s every 600 s at 50 °C	I_L	A	2.6	3.6	4.2	5.6	7.2	10.4		
Starting current for 2 s every 20 s at 50 °C	I_L	A	3.4	4.8	5.6	7.4	9.6	14		
Apparent power at rated operation	230 V	S	kVA	0.68	0.96	1.12	1.47	1.91	2.79	
				240 V	0.71	0.99	1.16	1.54	1.99	2.91
Assigned motor rating	230 V	P	kW	0.25	0.37	0.55	0.75	1.1	1.5	
				HP	1/3 ¹⁾	1/2	1/2	3/4	1	2
Power side (primary side):										
Number of phases			three-phase							
Rated operating voltage			208 V - 15 % - 240 V +10 %, 50/60 Hz (177 - 264 V ±0 %, 45 - 66 Hz ±0 %)							
Input current			I_{LN}	A	2.7	3.5	3.8	4.3	6.8	8.4
Maximum leakage current to ground (PE) without motor										
MMX32...N...			I_{PE}	mA	8.6		16.1			
Braking torque										
Standard			M/M_N	%	≤ 30					
Brake-Chopper with external braking resistance			-				Max. 100% rated operational current I_e with external braking resistance			
Minimum braking resistance			R_B	Ω	-		50	50	50	
Switch-on threshold for the braking transistor			U_{DC}	V DC	-		440	440	440	
DC current braking			I/I_e	%	≤ 100, adjustable					
Pulse frequency			f_{PWM}	kHz	6 (adjustable 1.5 -16)					
Heat dissipation at rated operational current (I_e)			P_v	W	17.4	23.7	28.3	37.9	48.4	63.8
Efficiency			η		0.93	0.94	0.95	0.95	0.96	0.96
Fan (device-internal, temperature-controlled)			✓							
Frame Size					FS1	FS1	FS1	FS2	FS2	FS2
Weight			m	kg	0.55	0.55	0.55	0.7	0.7	0.7

1) recommended value (calculated), no standard rating

8 Appendix

8.1 Special technical data

MMX32	Symbols used in technical data and formulae	Material Type	011	012	017	025	031	038			
Rated operational current	I_e	A	11	12.5	17.5	25	31	38			
Overload current for 60 s every 600 s at 50 °C	I_L	A	14.4	18.8	26.3	37.5	46.5	57			
Starting current for 2 s every 20 s at 50 °C	I_L	A	19.2								
Apparent power at rated operation	230 V	S	kVA	3.82	5	7	10	12.4	15.1		
				240 V	3.99	5.2	7.3	10.4	12.9	15.8	
Assigned motor rating	230 V	P	kW	2.2	3	4	5.5	7.5	11		
				HP	3	–	5	7.5	10	–	
Power side (primary side):											
Number of phases			three-phase								
Rated operating voltage			208 V - 15 % - 240 V +10 %, 50/60 Hz (177 - 264 V ±0 %, 45 - 66 Hz ±0 %)								
Input current											
MMX32...N...			I_{LN}	A	13.4	14.2	20.6	30.3	36.6	44.8	
MMX32...F...			I_{LN}	A	13.4	10.9	15.2	21.4	27	32.8	
Maximum leakage current to ground (PE) without motor											
MMX32...N...			I_{PE}	mA	31	14	14	14	9	9	
Braking torque											
Standard			M/ M_N	%	≤ 30						
Brake-Chopper with external braking resistance			Max. 100% rated operational current I_e with external braking resistance								
Minimum braking resistance			R_B	Ω	31	14	14	14	9	9	
Switch-on threshold for the braking transistor			U_{DC}	V DC	440	440	440	440	440	440	
DC current braking			I/I_e	%	≤ 100, adjustable						
Pulse frequency			f_{PWM}	kHz	6 (adjustable 1.5 - 16)						
Heat dissipation at rated operational current (I_e)			P_v	W							
Efficiency			η								
Fan (device-internal, temperature-controlled)						✓	✓	✓	✓	✓	
Frame Size						FS3	FS4	FS4	FS4	FS5	FS5
Weight			m	kg	0.99	8	8	8	10	10	

1) recommended value (calculated), no standard rating

8 Appendix

8.1 Special technical data

8.1.4 Device series MMX34

MMX34		Symbols used in technical data and formulae	Material Type	1D3	1D9	2D4	3D3	4D3	5D6	7D6	9D0		
Rated operational current (I_e)		I_e	A	1.3	1.9	2.4	3.3	4.3	5.6	7.6	9		
Overload current for 60 s every 600 s at 50 °C		I_L	A	2	2.9	3.6	5	6.5	8.4	11.4	13.5		
Starting current for 2 s every 20 s at 50 °C		I_L	A	2.6	3.8	4.8	6.6	8.6	11.2	15.2	18		
Apparent power in rated operation	400 V	S	kVA	0.9	1.32	1.66	2.29	2.98	3.88	5.27	6.24		
	480 V	S	kVA	1.08	1.56	2	2.74	3.57	4.66	6.32	7.48		
Assigned motor rating	400 V	P	kW	0.37	0.55	0.75	1.1	1.5	2.2	3	4		
	460 V		HP	1/2	3/4	1	1-1/2	2	3	4 ³⁾	5		
Power side (Primary side)													
Number of phases				three-phase									
Rated voltage				U_{LN} V 380 V - 15 % - 480 V + 10 %, 50/60 Hz (323 - 528 V \pm 0 %, 45 - 66 Hz \pm 0 %)									
Input current				I_{LN}	A	2.2	2.8	3.2	4	5.6	7.3	9.6	11.5
Maximum leakage current to ground (PE) without motor													
MMX34...N...				I_{PE}	mA								
MMX34...F...				I_{PE}	mA	45.1		25.1		24.9			
Braking torque													
Standard				M/M _N	%	≤ 30							
Brake-Chopper with external braking resistance				-				Max. 100% rated operational current I_e with external braking resistance					
Minimum braking resistance				R_B	Ω	-		75	75	75	54	54	
Switch-on threshold for the braking transistor				U_{DC}	V DC	-		765	765	765	765	765	
DC current braking				I/I_e	%	≤ 100 , adjustable							
Pulse frequency				f_{PWM}	kHz	6 (adjustable 1.5 – 16)							
Heat dissipation at rated operational current (I_e)				P_v	W	21.7	29.7	31.7	51.5	66.4	88.3	116.9	136.2
Efficiency				η		0.94	0.95	0.95	0.95	0.96	0.96	0.96	0.97
Fan (device-internal, temperature-controlled)						✓	✓	✓	✓	✓	✓	✓	
Frame Size						FS1	FS1	FS1	FS2	FS2	FS2	FS3	FS3
Weight				m	kg	0.55	0.55	0.55	0.7	0.7	0.7	0.99	0.99

1) The rated operational data of the MMX34AA014... is limited to 4 kHz at a maximum ambient air temperature of +40 °C. Recommended value (calculated), no standard value.

8 Appendix

8.1 Special technical data

MMX34		Symbols used in technical data and formulae	Material Type	012	014	016	023	031	038
Rated operational current (I_e)		I_e	A	12	14	16	23	31	38
Overload current for 60 s every 600 s at 50 °C		I_L	A	18	21	24	34.5	46.5	57
Starting current for 2 s every 20 s at 50 °C		I_L	A	24	28				
Apparent power in rated operation	400 V	S	kVA	8.32	9.7	11	16	21.5	26.3
	480 V	S	kVA	9.98	11.64	13.3	19.1	25.7	31.6
Assigned motor rating	400 V	P	kW	5.5	5.5	7.5	11	15	18.5
	460 V		HP	7-1/2	10	10	15	20	25
Power side (Primary side)									
Number of phases				three-phase					
Rated voltage		U_{LN}	V	380 V - 15 % - 480 V + 10 %, 50/60 Hz (323 - 528 V \pm 0 %, 45 - 66 Hz \pm 0 %)					
Input current		I_{LN}	A						
Input current									
MMX34...N...		I_{LN}	A	14.9	18.7	17.1	25.5	33	41.7
MMX34...F...		I_{LN}	A	14.9	18.7	13.8	18.7	26.8	32.2
Maximum leakage current to ground (PE) without motor									
MMX34...N...		I_{PE}	mA						
MMX34...F...		I_{PE}	mA	24.9					
Braking torque									
Standard		M/ M_N	%	≤ 30					
Brake-Chopper with external braking resistance				Max. 100% rated operational current I_e with external braking resistance					
Minimum braking resistance		R_B	Ω	54	54	28	28	17	17
Switch-on threshold for the braking transistor		U_{DC}	V DC	765	765	765	765	765	765
DC current braking		I/I_e	%	≤ 100 , adjustable					
Pulse frequency		f_{PWM}	kHz	6 (adjustable 1.5 – 16)					
Heat dissipation at rated operational current (I_e)		P_v	W	185.1	223.7				
Efficiency		η		0.97	0.97				
Fan (device-internal, temperature-controlled)				✓	✓	✓	✓	✓	✓
Frame Size				FS3	FS3	FS4	FS4	FS5	FS5
Weight		m	kg	0.99	0.99	8	8	10	10

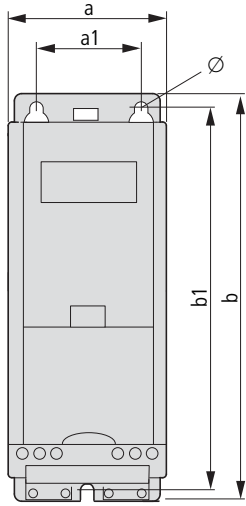
1) The rated operational data of the MMX34AA014... is limited to 4 kHz at a maximum ambient air temperature of +40 °C. Recommended value (calculated), no standard value.

8 Appendix

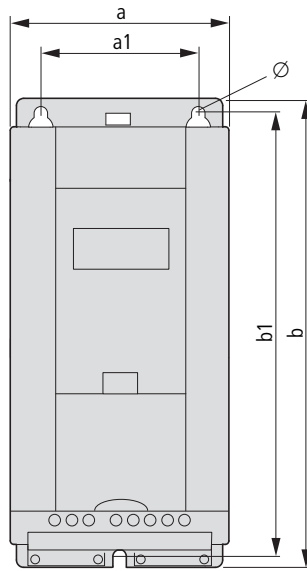
8.2 Dimensions and frame size

8.2 Dimensions and frame size

FS1



FS2



FS3

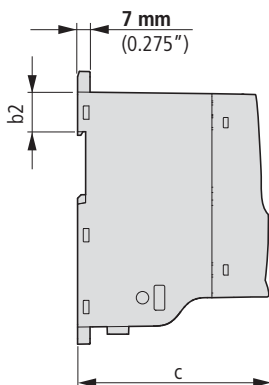
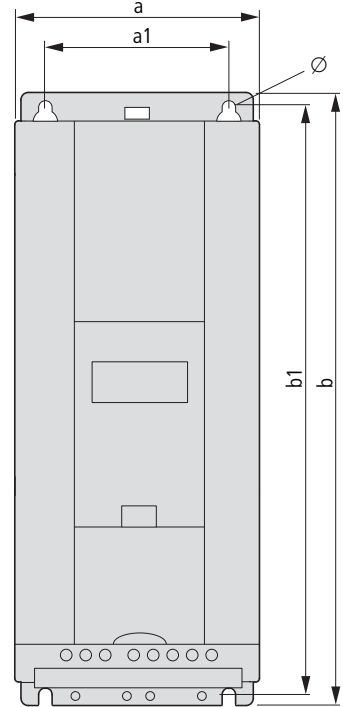


Figure 116: Dimensions and frame sizes FS1, FS2 and FS3 (FS = Frame Size)

8 Appendix
8.2 Dimensions and frame size

FS4, FS5

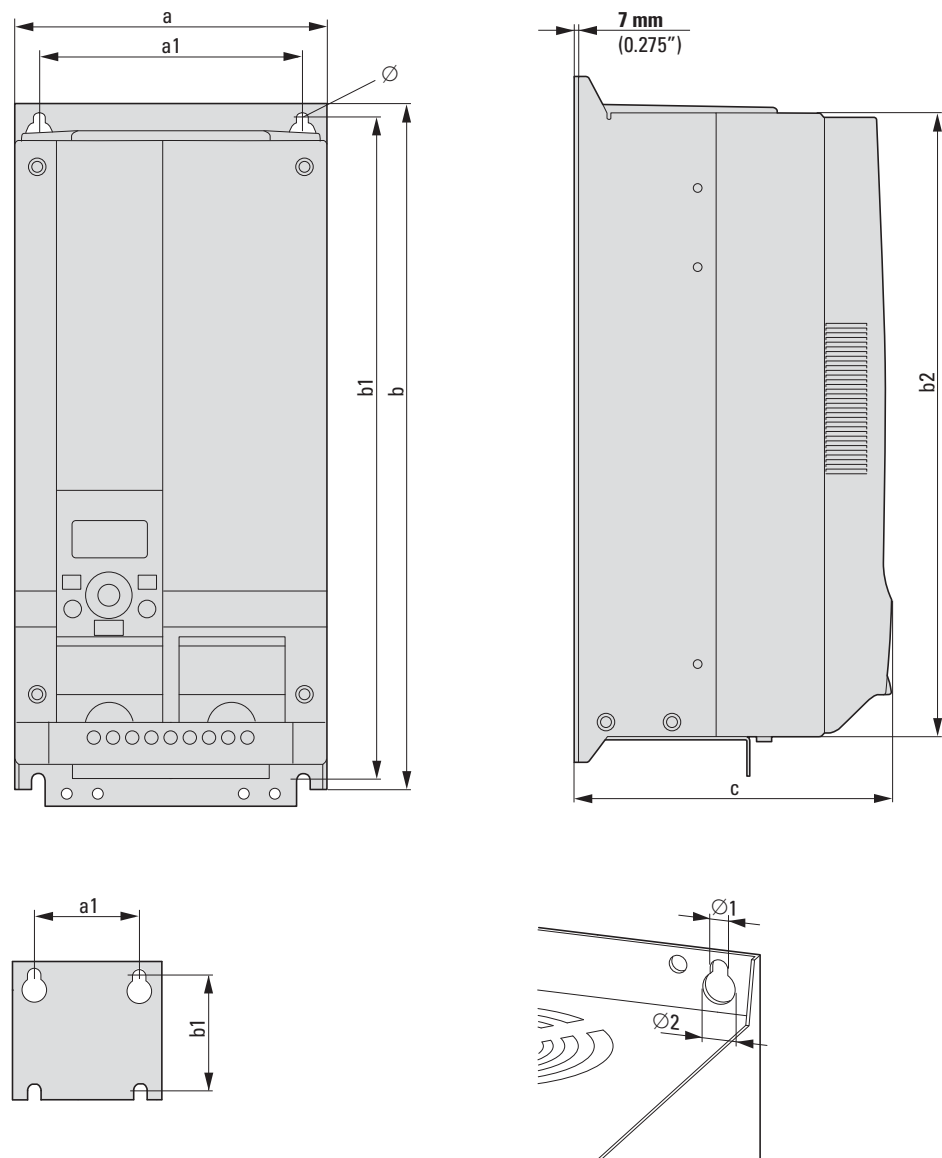


Figure 117: Dimensions and frame sizes FS4 and FS5 (FS = Frame Size)

8 Appendix

8.2 Dimensions and frame size

Table 11: Dimensions and frame size

Size	part no.	a	a1	b	b1	b2	c	Ø, Ø1	Ø2
		[mm] (inch)	[mm] (inch)	[mm] (inch)	[mm] (inch)	[mm] (inch)	[mm] (inch)	[mm] (inch)	[mm] (inch)
FS1	MMX12AA1D7...	66 (2.6)	38 (1.5)	160 (6.30)	147 (5.79)	32 (3.9)	102 (4.02)	4.5 (0.18)	–
	MMX12AA2D4...								
	MMX12AA2D8...								
	MMX32AA1D7...								
	MMX32AA2D4...								
	MMX32AA2D8...								
	MMX34AA1D3...								
	MMX34AA1D9...								
	MMX34AA2D4...								
FS2	MMX11AA1D7...	90 (3.54)	62.5 (2.46)	195 (7.68)	182 (7.17)	32 (1.26)	105 (4.14)	5.5 (2.17)	–
	MMX11AA2D4...								
	MMX11AA2D8...								
	MMX11AA3D7...								
	MMX12AA3D7...								
	MMX12AA4D8...								
	MMX12AA7D0...								
	MMX32AA3D7...								
	MMX32AA4D8...								
	MMX32AA7D0...								
	MMX34AA3D3...								
	MMX34AA4D3...								
MMX34AA5D6...									
FS3	MMX11AA4D8...	100 (3.94)	75 (2.95)	253 (9.96)	242 (9.53)	34 (1.34)	112 (4.41)	5.5 (2.17)	–
	MMX12AA9D6...								
	MMX32AA011...								
	MMX34AA7D6...								
	MMX34AA9D0...								
	MMX34AA012...								
MMX34AA014...									
FS4	MMX32AA012...	165 (6.5)	140 (5.51)	370 (14.57)	351 (13.82)	337 (13.27)	168 (6.61)	7 (0.28)	14 (0.55)
	MMX32AA017...								
	MMX32AA025...								
	MMX34AA016...								
	MMX34AA023...								
FS5	MMX32AA031...	165 (6.5)	140 (5.51)	414 (14.57)	398 (13.82)	383 (15.08)	205 (8.07)	7 (0.28)	14 (0.55)
	MMX32AA038...								
	MMX34AA031...								
	MMX34AA038...								

1 inch (1") = 25.4 mm, 1 mm = 0.0394 inch

8.3 PC interface card

8.3.1 MMX-COM-PC

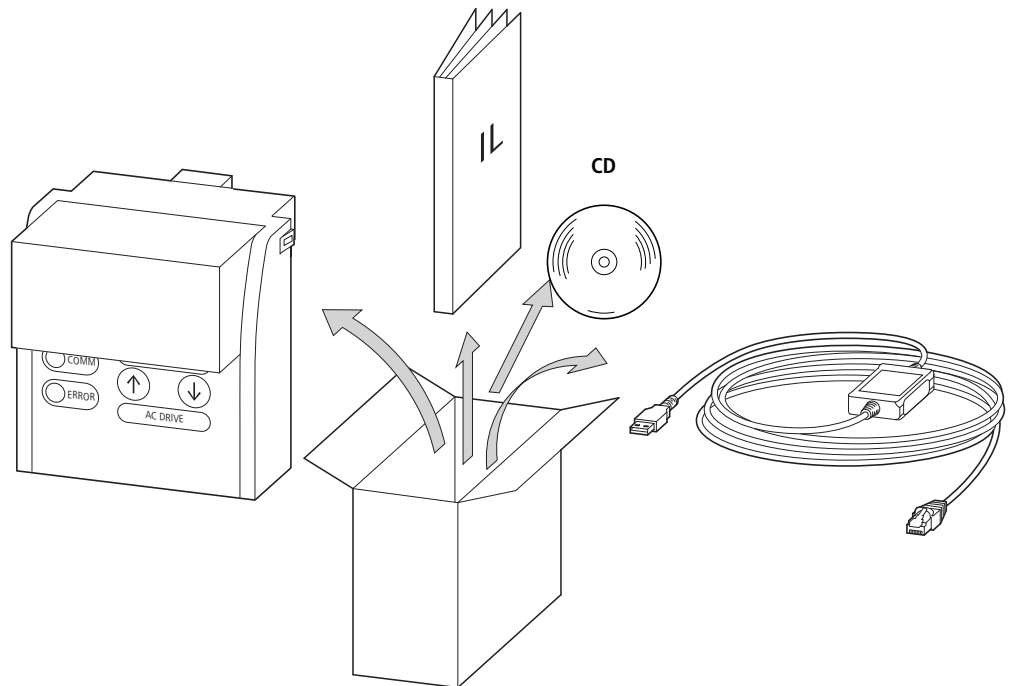


Figure 118: Equipment supplied MMX-COM-PC

- MMX-COM-PC connection module
- Instructional leaflet IL04012004Z
- CD with MaxConnect parameter software and driver software for XMx-CBL-3M4-USB
- Connection cable with interface converter XMx-CBL-3M4-USB



The MMX-COM-PC connection card is not supplied with the M-Max™ frequency inverter.

The MMX-COM-PC PC connection module enables the communication between the M-Max frequency inverter and a PC with the Windows operating system (point-to-point connection). Together with the MaxConnect parameter software, this enables you to:

- Upload and download all parameters.
- Store the parameters, compare them and print them in parameter lists.
- Graphically show time sequences in the Monitor display. The oscillograms can be stored in the PC and printed out.

The MMX-COM-PC interface module can be fitted and connected without any tools required. The MMX-COM-PC module is fitted on the front of the MMX frequency inverter.

8 Appendix

8.3 PC interface card

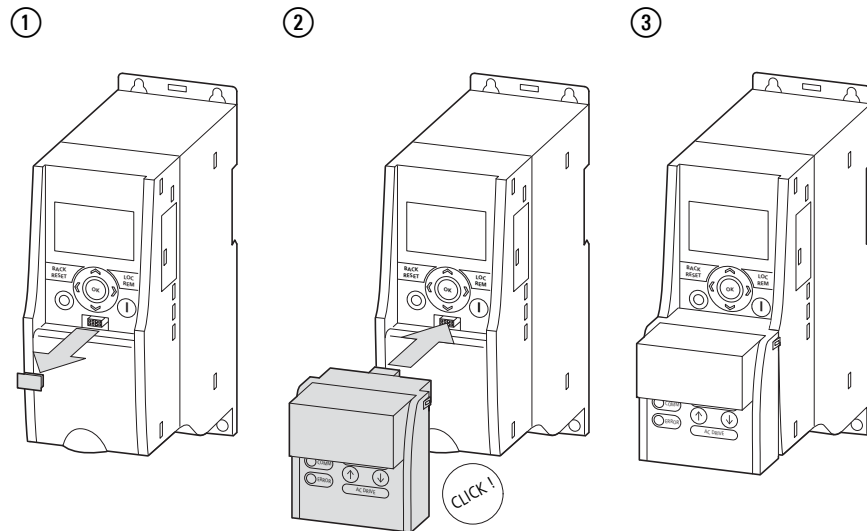


Figure 119: Fitting the MMX-COM-PC connection module

- ① Remove the interface cover on the frequency inverter (do not discard)
- ② Fitting the MMX-COM-PC
- ③ ready for operation

To remove, push in the two retaining clips on the side. The connection module can then be pulled off from the front, → Figure 120, Step [1].

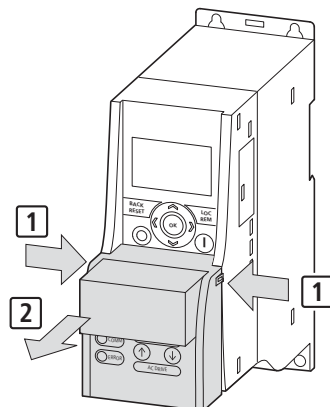


Figure 120: Removing the MMX-COM-PC connection module

When the power supply of the MMX frequency inverter is switched on with the MMX-COM-PC fitted, the parameters can be copied via the two function keys:

- Upload: the parameters from the frequency inverter (AC-DRIVE) are loaded in MMX-COM-PC (ADAPTER).
- Download: the parameters are loaded from the MMX-COM-PC (ADAPTER) to the frequency inverter (AC-DRIVES).

The active data transfer is indicated by the green flashing COMM LED. The ERROR LED will be lit red in the event of a faulty or interrupted data transfer.

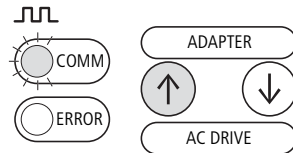


Figure 121: Upload

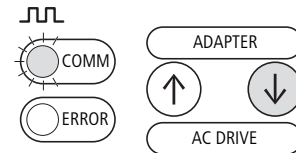


Figure 122: Download



In order to upload or download the parameters, for example for the commissioning of series machines, the frequency inverters must be connected to the mains voltage.

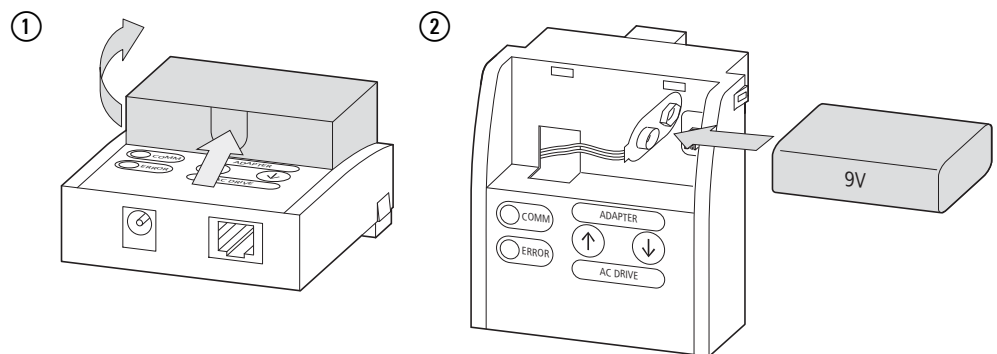
The MMC-COM-PC can also be supplied with a 9V battery or via an external 24 V voltage (DC) instead of the mains voltage of the frequency inverters.

Technical data for power supply:

- 9 V block battery, current consumption around 60 mA.
- 24 V plug power supply unit (e.g. Eaton article no. 207874) with 5.5 mm DC plug.



The power section is not active when the 9V and 24V power supply is used. The parameters for this are not transferred. The inputs and outputs of the control section are also non-functional.



8 Appendix
8.3 PC interface card

③

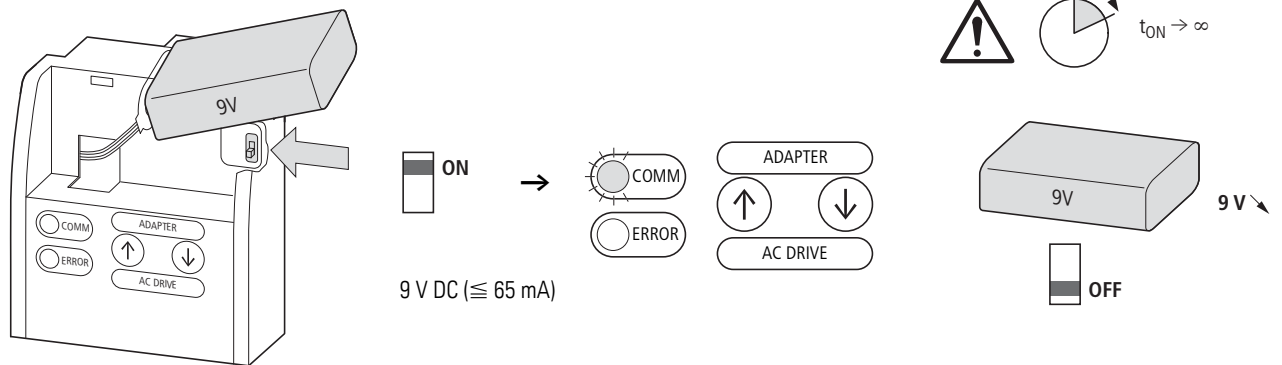


Figure 123: Inserting the 9 V block battery

- ① Open the cover
- ② 9V block battery plug connection
- ③ Switch the microswitch to ON. COMM LED is lit



Current consumption around 65 mA. Switch off 9 V block battery after use (microswitch OFF) or remove battery (discharged within around 24 h).

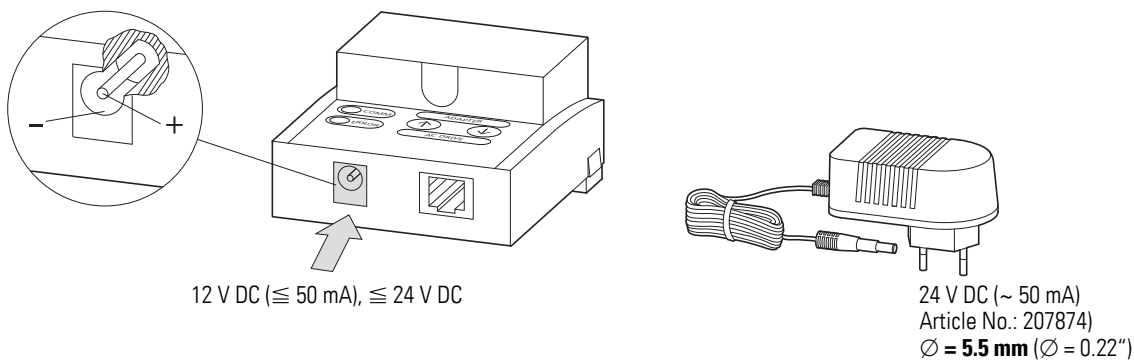


Figure 124: Power supply

The MMX-COM-PC can also be fed with a 12 to 24 V DC external power supply. The connection is implemented using a 5.5 mm power supply plug.



Further information on using the MMX-COM-PC connection module is provided in IL04012004Z.

8 Appendix

8.3 PC interface card

8.3.2 MaxConnect

The MaxConnect parameter software allows fast parameter assignment, operation, diagnostics and documentation (printout and storage of parameter lists) via a PC and the data transfer with an M-Max™ frequency inverter. MaxConnect is stored on the enclosed CD and is available free of charge for download.

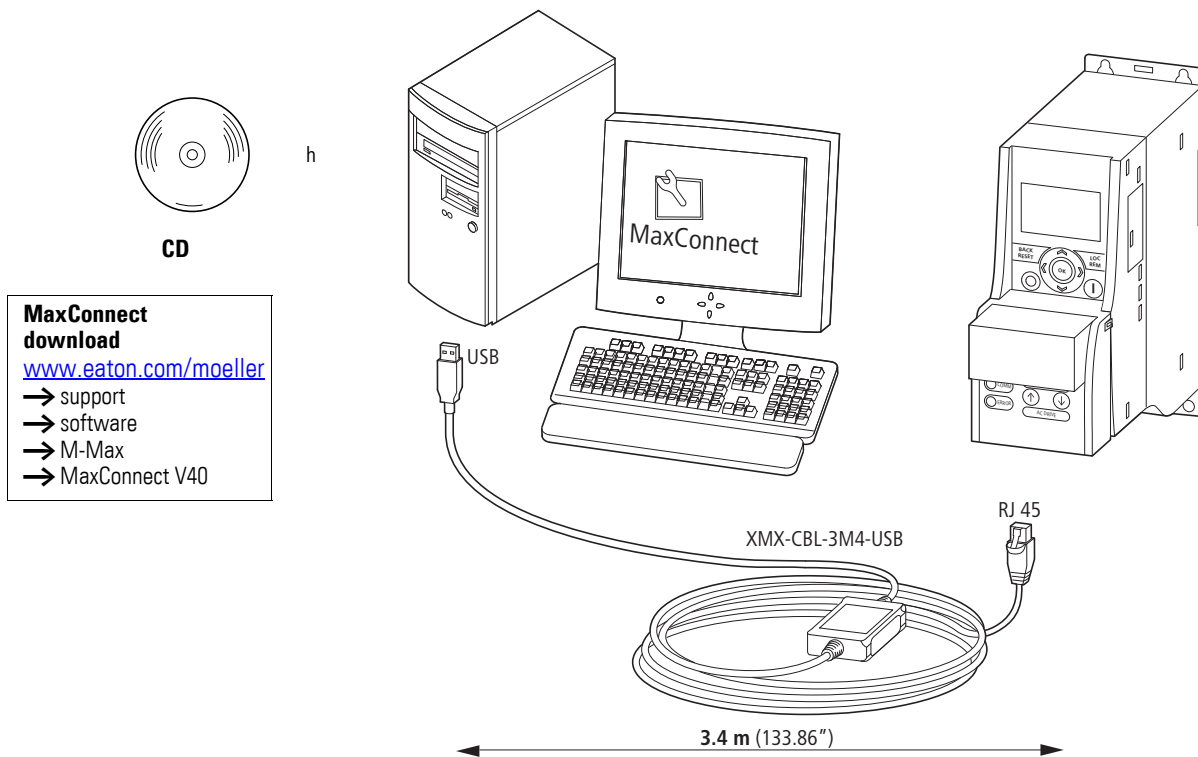


Figure 125: Parameter software MaxConnect

The XMx-CBL-3M4-USB connection cable supplied with the MMx-COM-PC is required for connecting to the PC. This connection cable includes a galvanically isolated interface converter which enables the connection of the RJ45 interface to a USB interface on a PC.

The following example shows some installation steps with the download from the Internet:

- ▶ First establish the connection to the Internet: www.moeller.net
- ▶ Choose here the Support area.
- ▶ In the Quick Search box enter "M-Max", activate the Software box and start the search.
- ▶ Download the software from this page:



Figure 126: Software download

- ▶ Confirm the download with Open and start the installation by double-clicking the file Eaton_MaxConnect_xxx_install.exe.

➔ The installation wizard starts up in English. The language can be selected in the Parameter menu, ➔ Page 220.

- ▶ Click Next in the following window.

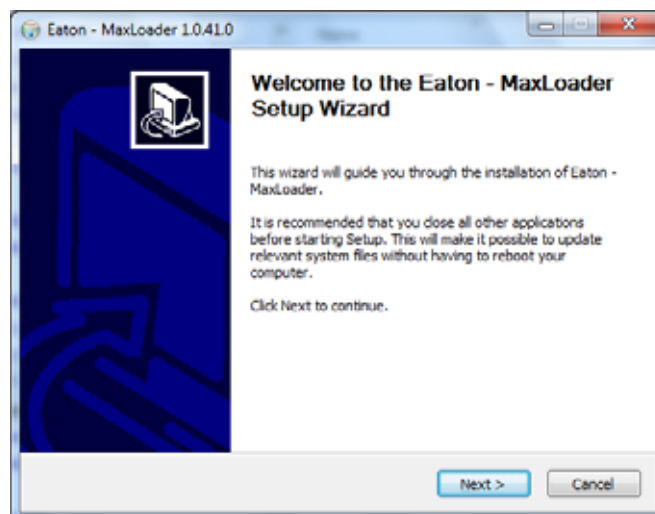


Figure 127: Setup Wizard

- ▶ Confirm the selection of the files to be installed by clicking the Next button.

➔ Required interface drivers not installed on the PC are selected automatically here (highlighted green). For example CP210x (Silicon Laboratories) for the interface converter of the XMX-CBL-3M4-USB.

8 Appendix

8.3 PC interface card

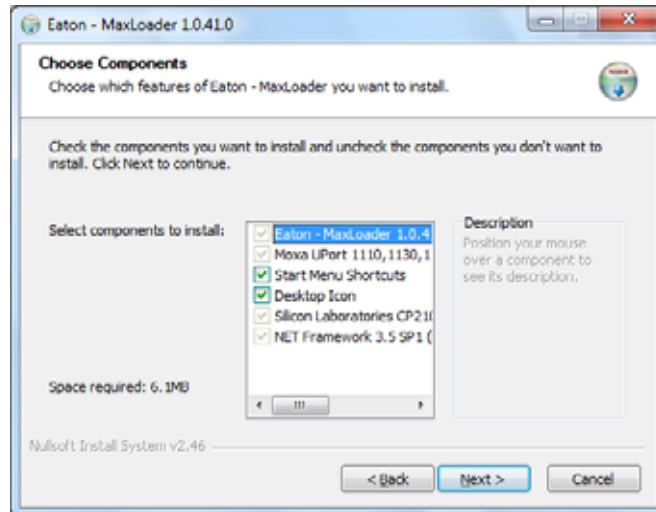


Figure 128: Files selected for installation



The installation wizard will automatically guide you through the remaining installation steps. Individual setting options are not described further here.

Finally, a message is output to indicate that the installation has been successfully completed.

- ▶ Click on Finish to finish the installation and start MaxConnect automatically.



- The Startup mode function requires a connection between the MMX frequency inverter and the PC (use XMX-CBL-3M4-USB connection cable).
- The MMX frequency inverter must be supplied with the mains voltage (LCD display lit). Click the Online button to activate the Startup mode.
- The Offline function can be used only when data records for MMX have already been saved on the PC.

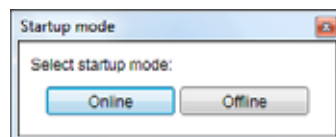


Figure 129: Commissioning mode

The automatic search for the connected drive is indicated by the message "Searching for connected device...".

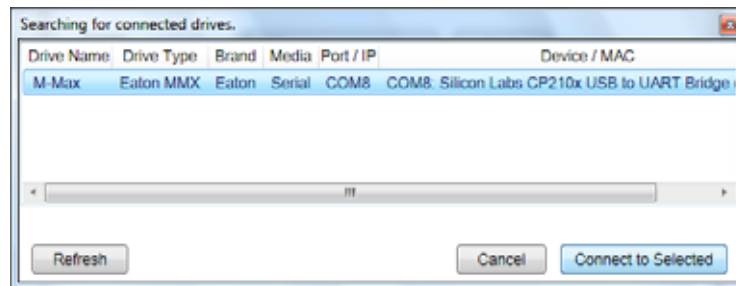


Figure 130: Connection establishment

The Select devices display can be used to confirm the connected M-Max frequency inverter (blue marking). This activates the Connect to Selected button.

- ▶ Clicking the Connect to Selected button activates the connection to the selected M-Max.



Do not switch off the MMX or disconnect it from the PC during the data transfer. Unsaved parameters and settings may otherwise be lost.

The parameters from the MMX are read out automatically.

Loading is indicated by an orange bar (lower left, "Uploading tree").

The progress and the loaded parameter areas are indicated by folder icons highlighted blue in the middle field.

The right field lists the associated parameters.

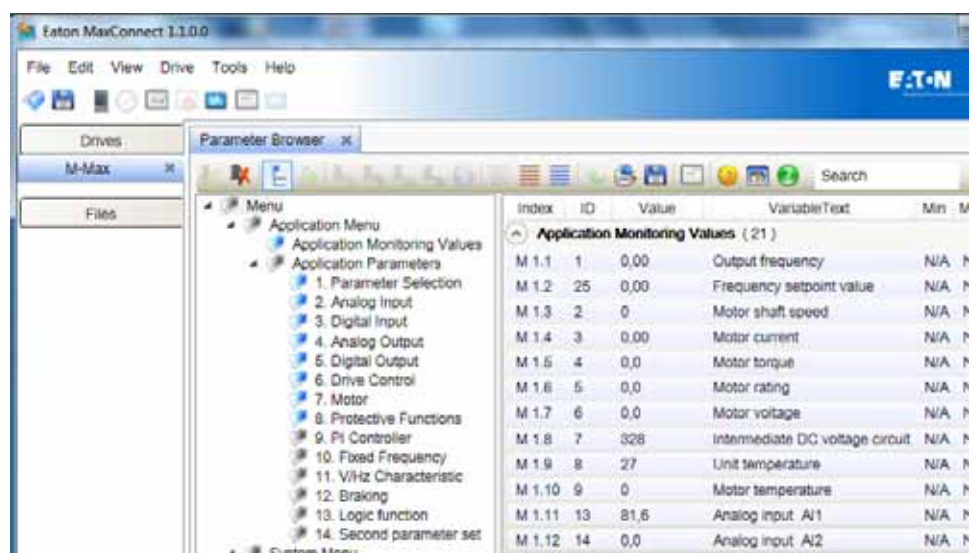


Figure 131: Loading the parameter structure

Adjusting settings

After loading, you can activate the general PC functions in the toolbar (top left). With the File button, for example, you can save the parameter set uploaded from the MMX on the PC or print the parameter list. Under Tools you can select the desired language, for example with option Language; German - Germany (or with F4 on the keyboard). Then click OK to activate the selected language.



Languages for which a language file has not yet been created are shown in English.

Change parameter values

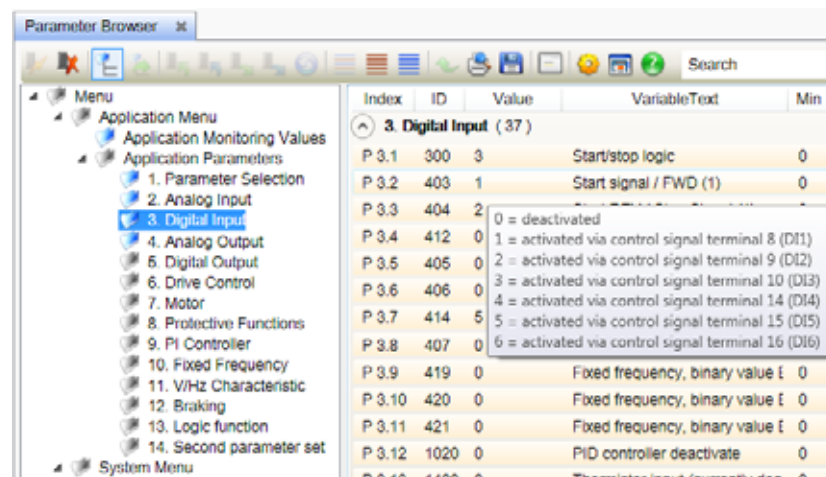


Figure 132: Selecting the parameter function

The function or value of a parameter can be changed in column "Value". You can activate the input field with the mouse. A field showing the possible settings and functions appears. This field disappears again after a while and can be called up again by moving the mouse.

To save a changed parameter value in the MMX, press Enter on the keypad or select another parameter with the mouse.

The setting values and functions of the parameters are described in section "6 Parameters" (→ Page 93).



The M-Max™ frequency inverter can not be controlled via the MaxConnect PC software. The Start - Stop functions are only possible via the control signal terminals (I/O), the keypad (KEYPAD) or in the automation system (BUS) in manual and automatic mode.

With MaxConnect you can configure parameters, back up your data and print out parameter data simply and easily. With View (Ctrl+2), the MMX's operational data can also be viewed graphically in the form of an oscilloscope plot.

The installation places a shortcut for MaxConnect on the PC desktop, with which you can start MaxConnect. The program then always starts in Startup mode (→ Page 218).



Figure 133: MaxConnect icon

8 Appendix

8.4 Mounting frame for fieldbus connection

8.4 Mounting frame for fieldbus connection

8.4.1 MMX-NET-XA

The MMX-NET-XA mounting frame enables the mounting and connection of field bus interface cards to the frequency inverters in frame sizes FS1, FS2 and FS3.

MMX-NET-XA consists of the two housing sections:

- The mounting plate with the 24-pole slot, pluggable connection cable and the ground terminal (shielding, GND, PE).
- The cover for holding and protecting the field bus interface card.

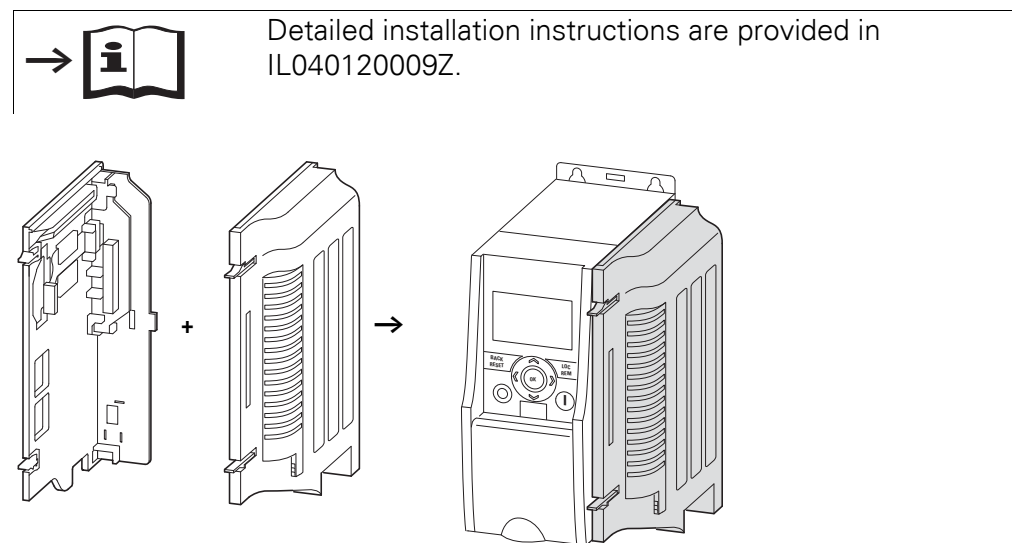


Figure 134: MMX-NET-XA mounting frame



The MMX-NET-XA mounting frame is not supplied with the M-Max™ frequency inverter.

The MMX-NET-XA mounting plate is fitted on the right-hand side (view from front of the keypad) of the MMX frequency inverter:

- ▶ First remove the cover of the interface in the MMX.

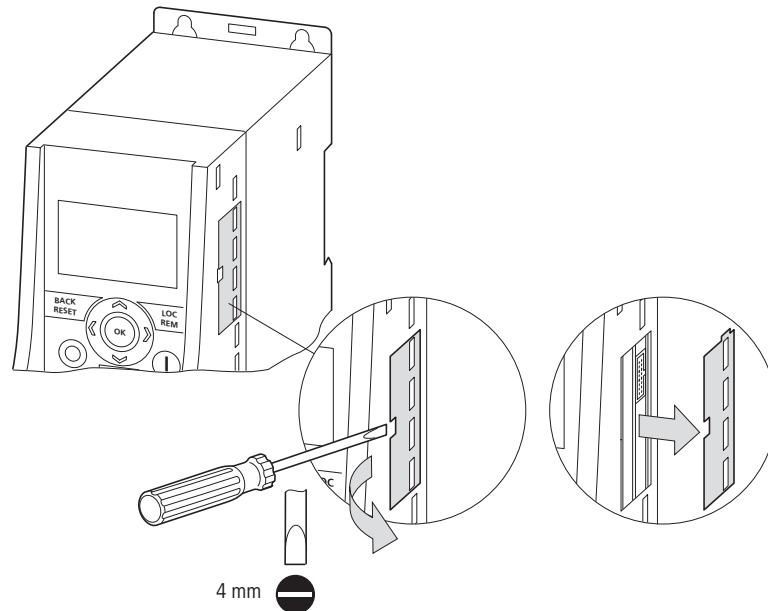


Figure 135: Removing the interface cover on the M-Max

The remaining installation steps are then carried out without any tools using the cutouts provided in the housing of the MMX (snap fixing).

- ▶ Fit the plug and connection cable onto the interface of the MMX.

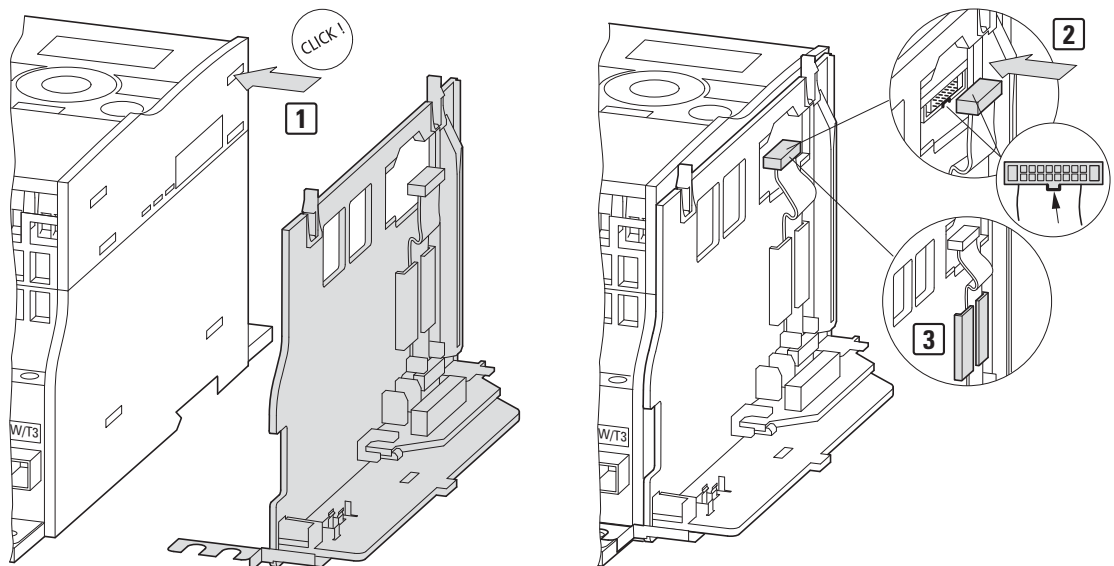


Figure 136: Fitting and connecting the mounting plate of the MMX-NET-XA

8 Appendix

8.4 Mounting frame for fieldbus connection

You can then fit a field bus interface card (eg. PROFIBUS DP etc.) in the cover of the mounting frame.

- ➔ Before installing the field bus interface card check whether the plug connection provided, such as GND or bus terminal resistor have to be changed.

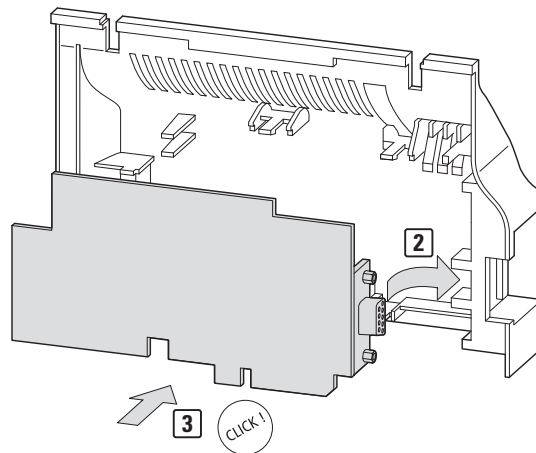


Figure 137: Cover of the MMX-NET-XA for holding the field bus interface card

- ▶ Then fit the cover with the inserted fieldbus interface card onto the already fitted and installed mounting plate of the MMX-NET-XA.

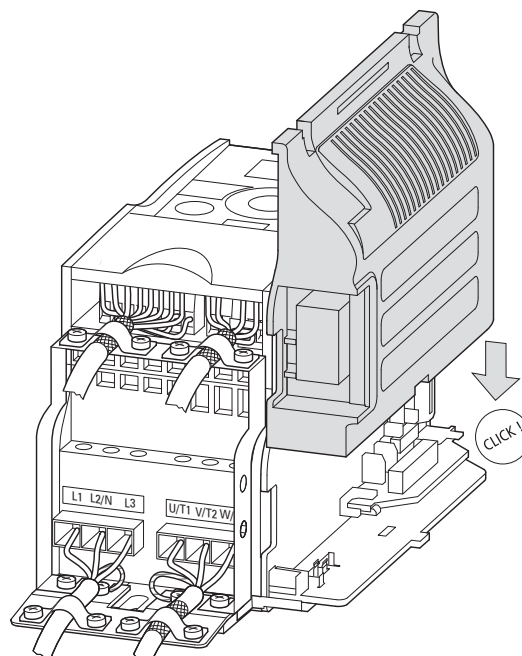


Figure 138: Connecting the interface card with the frequency inverter

- ▶ Make the connections to the selected fieldbus system through the opening in the mounting frame directly on the card.

8.4.2 MMX-NET-XB

The MMX-NET-XB interface module enables the flush mounting and connection of field bus interface cards to the frequency inverters in frame sizes FS4 and FS5.

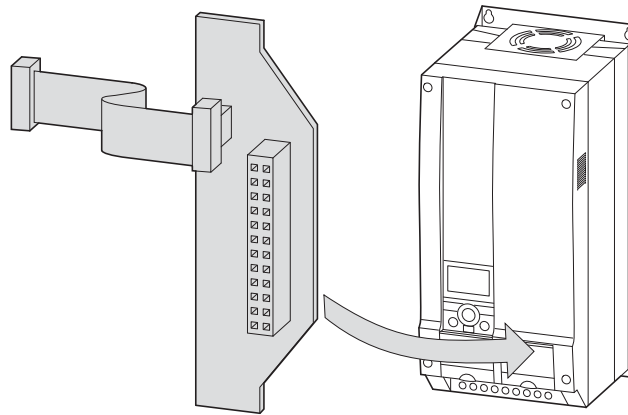


Figure 139: MMX-NET-XB interface module



The MMX-NET-XB interface module is not supplied with the M-
Max™ frequency inverter.



Detailed installation instructions are provided in
IL04012010Z.

The MMX-NET-XC interface module is fitted under the cover on the right-hand side (view from front of the keypad) of the MMX frequency inverter:

- ▶ First remove the cover of the frequency inverter (4 screws).

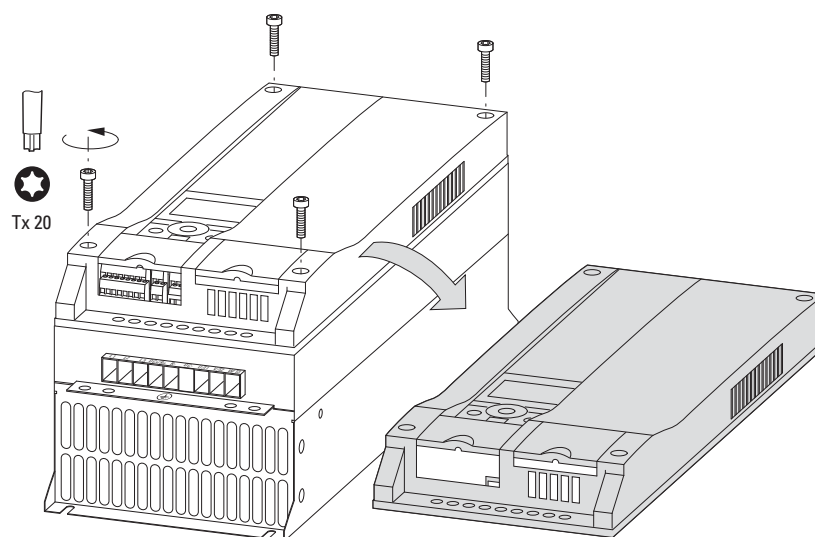


Figure 140: Remove cover (FS4, FS5)

8 Appendix

8.4 Mounting frame for fieldbus connection

Accessories are provided with the MMX-NET-XB for fitting the fieldbus interface card and interface module.

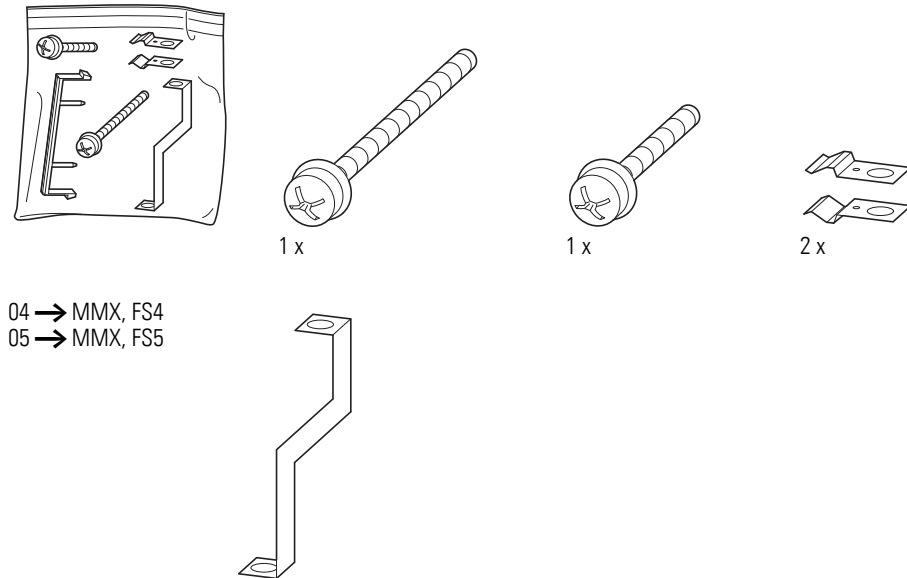


Figure 141: Mounting accessories for FS4, FS5

- ▶ To install, remove the screw in the bottom right corner of the frequency inverter (chassis connection, board).
- ▶ Then fit the metal bracket marked 04 (= FS4) or 05 (= FS5) with this screw.
- ▶ At the top end of the metal bracket fasten the two metal clips.

The field bus interface cards with pluggable screw terminals must be plugged in to support the terminals of the plastic strip.

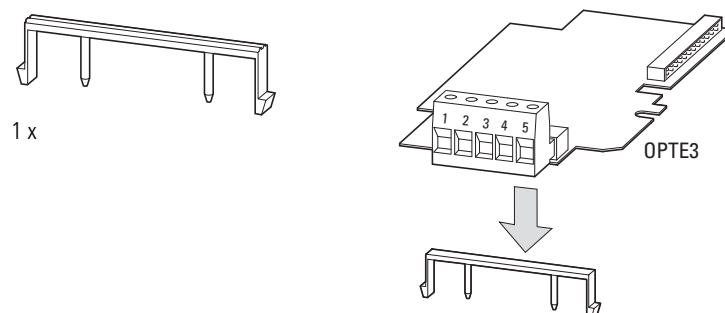


Figure 142: Plastic bridge for holding the control terminals
(example: OPTE3 0 XMX-NET-PS-A)

- ▶ Then connect the required field bus interface card to the MMX-NET-XB interface module.

The mounting is carried out without tools at the corresponding cutouts in the housing of the MMX (snap fitting). Plug and connection cable are then fitted to the interface of the MMX (below the LCD display unit).

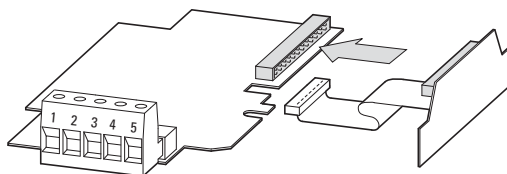
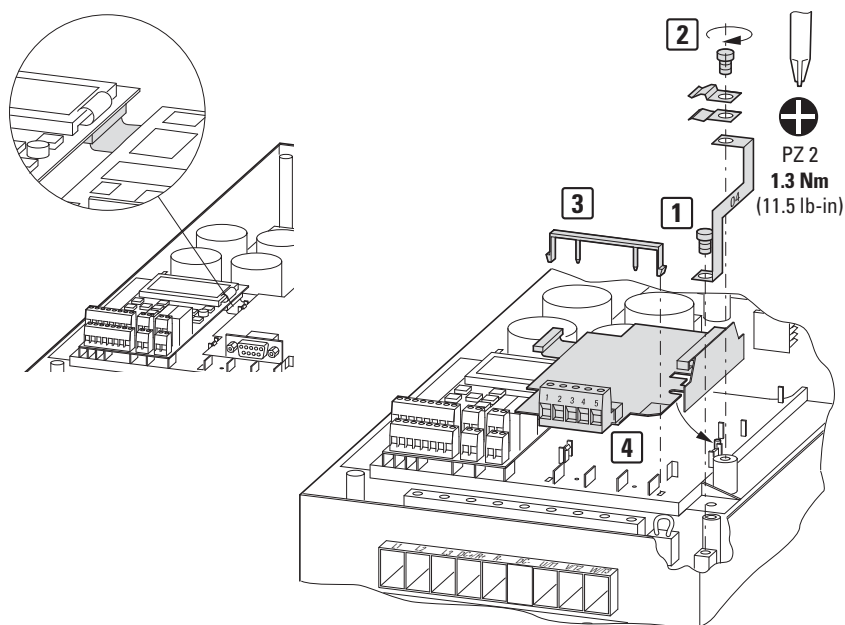


Figure 143: Connecting the MMX-NET-XB interface module with the fieldbus interface cards



Before installing the field bus interface card check whether the plug connection provided, such as GND or bus terminal resistor have to be changed.

- ▶ Fit the combination of MMX-NET-XB interface module and fieldbus interface card and connect them.

8.5 PROFIBUS DP field bus interface card

➔ The PROFIBUS DP field bus interface card XMX-NET-PD-A or XMX-NET-PS-A are not supplied with the M-Max™ frequency inverter.

XMX-NET-PD-A and XMX-NET-PS-A enable the connection (slave) of frequency inverters of the M-Max™ series to the standard PROFIBUS DP field bus.

➔ The optional MMX-NET-XA mounting frame is required for mounting and connecting the MMX frequency inverter.

Technical data:

- Communication protocol: PROFIdrive (PROFIBUS profile for variable speed drives).
- Data transfer: RS485, half-duplex.



Further information on hardware and engineering the XMX-NET-PS-A interface card is provided in the manual MN04012002Z.

8.5.1 XMX-NET-PD-A

The fieldbus connection is implemented with a 9-pole Sub-D plug connector.

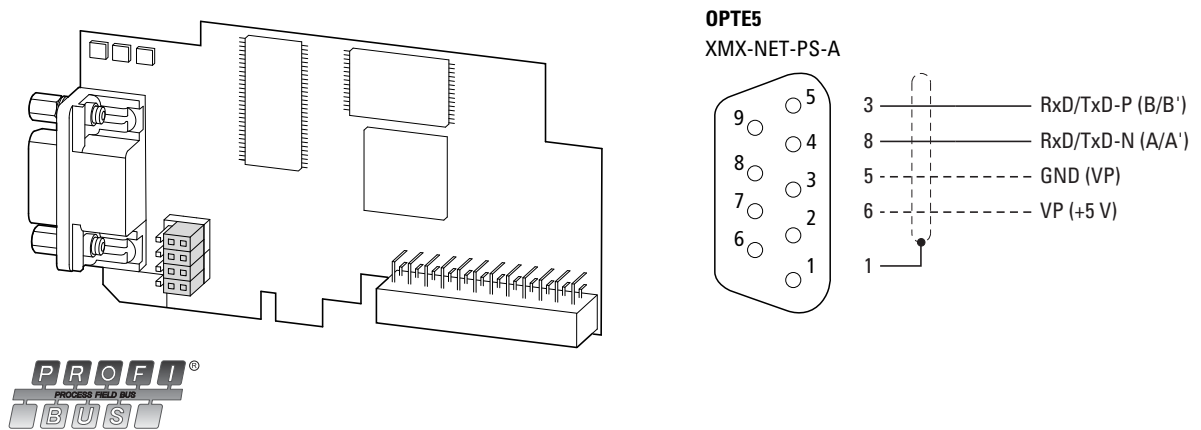


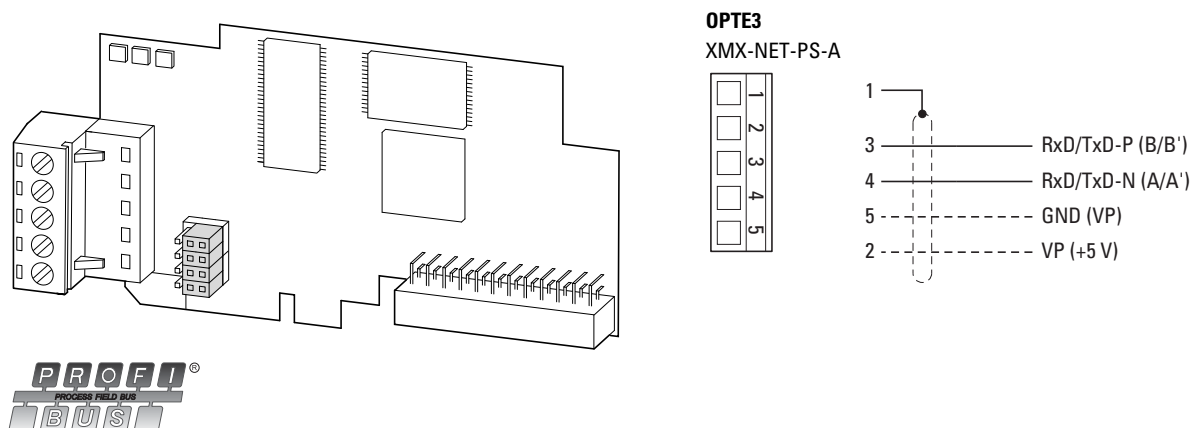
Figure 144: XMX-NET-PD-A PROFIBUS DP field bus interface card with 9-pole Sub-D plug connection



Detailed installation instructions are provided in IL04012008Z.

8.5.2 XMX-NET-PS-A

The fieldbus connection is implemented with a pluggable 5-pole screw terminal.



Detailed installation instructions are provided in IL04012008Z.

8.6 Cables and fuses

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

For an installation in accordance with UL Standards, the fuses and copper cable that are UL-approved and have a heat-resistance of +60/75 °C are to be used.

Use power cables with insulation according to the specified mains voltages for the permanent installation. A shielded cable is not required on the mains side. On the motor side however, a complete (360°), low-impedance, shielded cable is necessary.

The length of the motor cable depends on the radio interference class and is a maximum of 30 m at M-Max™.


NOTICE

Fuses and cables selected must always comply with the applicable regulations at the installation site.

8 Appendix

8.6 Cables and fuses





Table 12: Fuses and Maximum Cross-Sections

	F1, Q1 = 		L1, L2/N, L3		U, V, W		PE		R+, R-	
	1~	3~	mm ²	AWG ¹⁾	mm ²	AWG ¹⁾	mm ²	AWG ¹⁾	mm ²	AWG ¹⁾
MMX11AA1D7N0-0 MMX11AA2D4N0-0 MMX11AA2D8N0-0 MMX11AA3D7N0-0	20A	-	2 x 2.5	2 x 14	3 x 2.5	3 x 14	2.5	14	-	-
MMX12AA1D7... MMX12AA2D4... MMX12AA2D8... MMX12AA3D7...	10 A	-	2 x 1.5	2 x 16	3 x 1.5	3 x 16	1.5	16	-	-
MMX32AA1D7N0-0 MMX32AA2D4N0-0 MMX32AA2D8N0-0 MMX32AA3D7N0-0 MMX34AA1D3N0-0 MMX34AA1D9N0-0 MMX34AA2D4N0-0	-	6A	3 x 1.5	3 x 16	3 x 1.5	3 x 16	1.5	16	-	-
MMX34AA3D3...	-	6A	3 x 1.5	3 x 16	3 x 1.5	3 x 16	1.5	16	2 x 1.5	2 x 16
MMX11AA4D8...	32 A 30 A ²⁾	-	2 x 6	2 x 10	3 x 6	3 x 10	-	-	-	-
MMX12AA4D8... MMX12AA7D0...	20A	-	2 x 2.5	2 x 14	3 x 2.5	3 x 14	2.5	14	-	-
MMX32AA4D8... MMX32AA7D0...	-	10 A	3 x 1.5	3 x 16	3 x 1.5	3 x 16	1.5	16	-	-
MMX34AA4D3... MMX34AA5D6...	-	-	3 x 1.5	3 x 16	3 x 1.5	3 x 16	1.5	16	2 x 1.5	2 x 16
MMX12AA9D6...	32 A ¹⁾	-	2 x 6	2 x 10	3 x 6	3 x 10	6	10	-	-
MMX32AA011... MMX34AA7D6... MMX34AA9D0... MMX34AA012...	-	20A	3 x 2.5	3 x 14	3 x 2.5	3 x 14	2.5	14	2 x 2.5	2 x 14
MMX34AA014...	-	25 A	3 x 4	3 x 12	3 x 12	3 x 12	4	12	3 x 4	2 x 12
MMX32AA012...	-	20A	3 x 6	10	3 x 6	10	6	10	2 x 6	10
MMX32AA017...	-	25 A								
MMX32AA025...	-	32 A 40 A ²⁾								
MMX32AA031...	-	40A	3 x 10	8	3 x 8	8	10	8	2 x 10	8
MMX32AA038...	-	50A		6		6		6		6
MMX34AA016...		25 A	3 x 6	10	3 x 6	10	6	10	2 x 6	10
MMX34AA023...	-	32 A 40 A ²⁾								
MMX34AA031...	-	40A	3 x 10	8	3 x 8	8	10	8	2 x 10	8
MMX34AA038...	-	50 A ²⁾		6		6		6		6

1) AWG = American Wire Gauge





2) UL fuse with AWG

Table 13: Specified fuses

Part no. M-Max™	Maximum permitted mains supply voltage			 2)	 3)
		U_{LN} [V]	VDE [A]	UL¹⁾ [A]	part no. Eaton (VDE)
MMX11AA1D7...	1 AC 120 V +10 %	20	20	FAZ-B20/1N	-
MMX11AA2D4...	1 AC 120 V +10 %	20	20	FAZ-B20/1N	-
MMX11AA2D8...	1 AC 120 V +10 %	20	20	FAZ-B20/1N	-
MMX11AA3D7...	1 AC 120 V +10 %	20	20	FAZ-B20/1N	-
MMX11AA4D8...	1 AC 120 V +10 %	32	30	FAZ-B32/1N	-
MMX12AA1D7...	1 AC 240 V +10 %	10	10	FAZ-B10/1N	-
MMX12AA2D4...	1 AC 240 V +10 %	10	10	FAZ-B10/1N	-
MMX12AA2D8...	1 AC 240 V +10 %	10	10	FAZ-B10/1N	-
MMX12AA3D7...	1 AC 240 V +10 %	10	10	FAZ-B10/1N	-
MMX12AA4D8...	1 AC 240 V +10 %	20	20	FAZ-B20/1N	-
MMX12AA7D0...	1 AC 240 V +10 %	20	20	FAZ-B20/1N	-
MMX12AA9D6...	1 AC 240 V +10 %	32	30	FAZ-B32/1N	-
MMX32AA1D7...	3 AC 240 V +10 %	6	6	FAZ-B6/3	PKM0-6.3
MMX32AA2D4...	3 AC 240 V +10 %	6	6	FAZ-B6/3	PKM0-6.3
MMX32AA2D8...	3 AC 240 V +10 %	6	6	FAZ-B6/3	PKM0-6.3
MMX32AA3D7...	3 AC 240 V +10 %	6	6	FAZ-B6/3	PKM0-6.3
MMX32AA4D8...	3 AC 240 V +10 %	10	10	FAZ-B10/3	PKM0-10
MMX32AA7D0...	3 AC 240 V +10 %	10	10	FAZ-B10/3	PKM0-10
MMX32AA011...	3 AC 240 V +10 %	20	20	FAZ-B20/3	PKM0-20
MMX32AA012...	3 AC 240 V +10 %	20	20	FAZ-B20/3	PKM0-20
MMX32AA017...	3 AC 240 V +10 %	25	25	FAZ-B25/3	PKM0-25
MMX32AA025...	3 AC 240 V +10 %	32	40	FAZ-B32/3	PKM0-32
MMX32AA031...	3 AC 240 V +10 %	40	40	FAZ-B40/3	PKM4-40
MMX32AA038...	3 AC 240 V +10 %	50	50	FAZ-B50/3	PKM4-50

8 Appendix

8.6 Cables and fuses

Part no. M-Max™	Maximum permitted mains supply voltage U_{LN} [V]			 2)	 3)
		VDE [A]	UL¹⁾ [A]	part no. Eaton (VDE)	
MMX34AA1D3...	3 AC 480 V +10 %	6	6	FAZ-B6/3	PKM0-6.3
MMX34AA1D9...	3 AC 480 V +10 %	6	6	FAZ-B6/3	PKM0-6.3
MMX34AA2D4...	3 AC 480 V +10 %	6	6	FAZ-B6/3	PKM0-6.3
MMX34AA3D3...	3 AC 480 V +10 %	6	6	FAZ-B6/3	PKM0-6.3
MMX34AA4D3...	3 AC 480 V +10 %	10	10	FAZ-B10/3	PKM0-10
MMX34AA5D6...	3 AC 480 V +10 %	10	10	FAZ-B10/3	PKM0-10
MMX34AA7D6...	3 AC 480 V +10 %	20	20	FAZ-B20/3	PKM0-20
MMX34AA9D0...	3 AC 480 V +10 %	20	20	FAZ-B20/3	PKM0-20
MMX34AA012...	3 AC 480 V +10 %	20	20	FAZ-B20/3	PKM0-20
MMX34AA014...	3 AC 480 V +10 %	25	25	FAZ-B25/3	PKM0-25
MMX34AA016...	3 AC 480 V +10 %	25	25	FAZ-B25/3	PKM0-25
MMX34AA023...	3 AC 480 V +10 %	32	40	FAZ-B32/3	PKM0-32
MMX34AA031...	3 AC 480 V +10 %	40	40	FAZ-B40/3	PKM4-40
MMX34AA038...	3 AC 480 V +10 %	50	50	FAZ-B50/3	PKM4-50

1) Fuse UL-rated, class J, 600 V

2) I_{cn} 10 kA

3) I_{cn} 50 kA

8.7 Mains contactors



The mains contactors shown here allow for the input-side rated operating current I_{LN} of the frequency inverter without a main choke. The selection is based on the thermal current $\rightarrow I_{th} = I_e$ (AC-1) at the stated ambient temperature.

NOTICE

The inching operation is not permissible via the mains contactor (Pause time ≥ 60 s between switching off and on).



Technical data on the mains contactors can be found in the main catalog HPL, Contactors DILEM and DILM7.

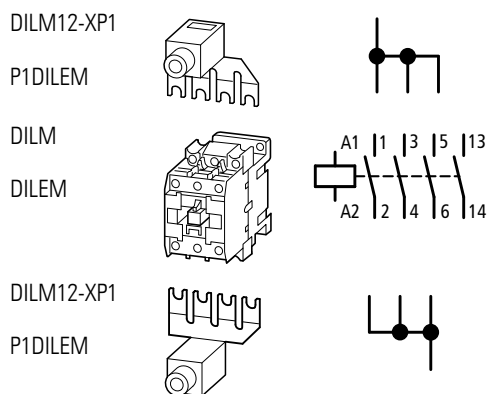


Figure 145: Mains contactor at single-phase connection

8 Appendix

8.7 Mains contactors

Part no. M-Max™	Rated operating voltage		Rated input current (without mains choke)		related mains contactor		
	(50 Hz)	(60 Hz)	(...A...)	(...F...)	Part no.	thermal current AC-1	
	U_{LN}	U_{LN}	I_{LN} [A]	I_{LN} [A]		+50 °C I_N [A]	+40 °C I_N [A]
MMX11AA1D7N0-0	1 AC 120 V	1 AC 120 V	9.2	9.2	DILM7 + DILM12-XP1	20	22
MMX11AA2D4N0-0	1 AC 120 V	1 AC 120 V	11.6	11.6	DILM7 + DILM12-XP1	20	22
MMX11AA2D8N0-0	1 AC 120 V	1 AC 120 V	12.4	12.4	DILM7 + DILM12-XP1	20	22
MMX11AA3D7N0-0	1 AC 120 V	1 AC 120 V	15	15	DILM7 + DILM12-XP1	20	22
MMX11AA4D8N0-0	1 AC 120 V	1 AC 120 V	16.5	16.5	DILM7 + DILM12-XP1	20	22
MMX12AA1D7...	1 AC 230 V	1 AC 240 V	4.2	4.2	DILEM-10 + DILM12-XP1 DILM7	20 21	22
MMX12AA2D4...	1 AC 230 V	1 AC 240 V	5.7	5.7	DILEM-10 + DILM12-XP1 DILM7	20 21	22
MMX12AA2D8...	1 AC 230 V	1 AC 240 V	6.6	6.6	DILEM-10 + DILM12-XP1 DILM7	20 21	22
MMX12AA3D7...	1 AC 230 V	1 AC 240 V	8.3	8.3	DILEM-10 + DILM12-XP1 DILM7	20 21	22
MMX12AA4D8...	1 AC 230 V	1 AC 240 V	11.2	11.2	DILM7	21	22
MMX12AA7D0...	1 AC 230 V	1 AC 240 V	14.1	14.1	DILM7	21	22
MMX12AA9D6... ²⁾	1 AC 230 V	1 AC 240 V	15.8	15.8	DILM7	–	22
MMX32AA1D7...	3 AC 230 V	3 AC 240 V	2.7	2.7	DILEM-10	20	22
MMX32AA2D4...	3 AC 230 V	3 AC 240 V	3.5	3.5	DILEM-10	20	22
MMX32AA2D8...	3 AC 230 V	3 AC 240 V	3.8	3.8	DILEM-10	20	22
MMX32AA3D7...	3 AC 230 V	3 AC 240 V	4.3	4.3	DILEM-10	20	22
MMX32AA4D8...	3 AC 230 V	3 AC 240 V	6.8	6.8	DILEM-10	20	22
MMX32AA7D0...	3 AC 230 V	3 AC 240 V	8.4	8.4	DILEM-10	20	22
MMX32AA011... ²⁾	3 AC 230 V	3 AC 240 V	13.4	13.4	DILM7	–	22
MMX32AA012...	3 AC 230 V	3 AC 240 V	14.2	10.9	DILM7	21	22
MMX32AA017...	3 AC 230 V	3 AC 240 V	20.6	15.2	DILM7 DILM17 ¹⁾	21 38	22 40
MMX32AA025...	3 AC 230 V	3 AC 240 V	30.3	21.4	DILM17	38	40
MMX32AA031N...	3 AC 230 V	3 AC 240 V	36.6		DILM17 DILM40 ¹⁾	38 57	40 60
MMX32AA031F...	3 AC 230 V	3 AC 240 V		27	DILM17	38	40
MMX32AA038N...	3 AC 230 V	3 AC 240 V	44.8		DILM40	57	60
MMX32AA038F...	3 AC 230 V	3 AC 240 V		32.8	DILM25	43	45

1) For UL® installation observe note → Page 235

2) maximum operating temperature +40 °C

Part no. M-Max™	Rated operating voltage		Rated input current (without mains choke)		related mains contactor		
	(50 Hz)	(60 Hz)	(...N...)	(...F...)	Part no.	thermal current AC-1	
	U_{LN}	U_{LN}	I_{LN} [A]	I_{LN} [A]		+50 °C I_N [A]	+40 °C I_N [A]
MMX34AA1D3...	3 AC 400 V	3 AC 480 V	2.2	2.2	DILEM-10	20	22
MMX34AA1D9...	3 AC 400 V	3 AC 480 V	2.8	2.8	DILEM-10	20	22
MMX34AA2D4...	3 AC 400 V	3 AC 480 V	3.2	3.2	DILEM-10	20	22
MMX34AA3D3...	3 AC 400 V	3 AC 480 V	4	4	DILEM-10	20	22
MMX34AA4D3...	3 AC 400 V	3 AC 480 V	5.6	5.6	DILEM-10	20	22
MMX34AA5D6...	3 AC 400 V	3 AC 480 V	7.3	7.3	DILEM-10	20	22
MMX34AA7D6...	3 AC 400 V	3 AC 480 V	9.6	9.6	DILEM-10	20	22
MMX34AA9D0...	3 AC 400 V	3 AC 480 V	11.5	11.5	DILM7	21	22
MMX34AA012...	3 AC 400 V	3 AC 480 V	14.9	14.9	DILM7	21	22
MMX34AA014... ²⁾	3 AC 400 V	3 AC 480 V	18.7	18.7	DILM7 DILM17 ¹⁾	– 38	22 40
MMX34AA016...	3 AC 400 V	3 AC 480 V	17.1	13.8	DILM7 DILM17 ¹⁾	21 38	22 40
MMX34AA023...	3 AC 400 V	3 AC 480 V	25.5	18.7	DILM17	38	40
MMX34AA031N...	3 AC 400 V	3 AC 480 V	33		DILM17 DILM25 ¹⁾	38 43	40 45
MMX34AA031F...	3 AC 400 V	3 AC 480 V		26.8	DILM17	38	40
MMX34AA038N...	3 AC 400 V	3 AC 480 V	41.7		DILM25 DILM40 ¹⁾	43 57	45 60
MMX34AA038F...	3 AC 400 V	3 AC 480 V		32.2	DILM17 DILM25 ¹⁾	38 43	40 45

1) for UL® installation observe the following note

2) maximum operating temperature +40 °C



For UL® compliant installation and operation, the mains side switching devices must allow for a 1.25 times higher input current. The switching devices meet this requirement.

8.8 interference filter

The external interference filter for frame size FS1, FS2 and FS3 enable the further limitation of the conducted emission in the relevant environment. The limit values are divided into categories (C1, C2, C3). Category C1 (public utility supply system in 1st environment, e.g. private residential area) allows the lowest emitted interference, while category C3 describes the interference level in severely polluted industrial networks (2nd environment).

The observance of the permissible limit values depends on the length of the motor cable and the switching frequency (f_{PWM}) of the inverter.

(→ Table 14).



The interference suppression filters listed here must only be used in conjunction with the devices of the MMX...N... series.



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

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

With leakage currents ≥ 3.5 mA the following must be fulfilled in accordance with EN 61800-5-1 and EN 50178:

- the protective conductor cross-section must be ≥ 10 mm² or
- a second protective conductor must be connected, or
- the continuity of the protective conductor must be monitored.



For mobile applications, a plug connector is permissible only when a second, permanently installed, earthing conductor is installed.

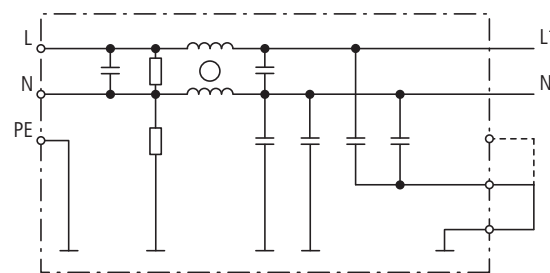


Figure 146: MMX-LZ1 schematic diagram

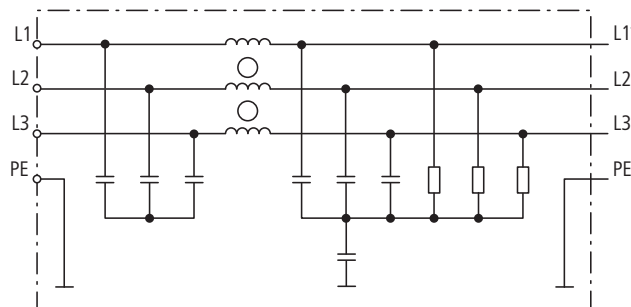


Figure 147: MMX-LZ3 schematic diagram

Engineering note (example):

MMX12AA2D8N0-0 frequency inverter and MMX-LZ1-009 interference suppression filter.

In the "Rated operation" setting, the maximum leakage current (I_{LK}) can reach 25.6 mA (→ Table 15). At a required maximum pulse frequency (f_{PWM}) of 16 kHz (adjustable at P11.9), the following motor cable lengths are permissible (→ Table 15):

- In category C1 : 10 m.
- In category C2 : 30 m.
- In category C3 : 50 m.

At a fixed pulse frequency of 1.5 kHz (P11.9 = 1.5, P11.10 = 11) a maximum motor cable length in category C1 of 50 m is permissible.

If "low leakage current" operation is required, the plug must be refitted on the interference suppression filter to < 3.5 mA. The maximum leakage current (I_{LK}) can reach values of up to 1.7 mA (→ Table 14). In this operating mode, the following maximum motor cable lengths are permissible (→ Table 14):

- In category C1 : 10 m at a maximum pulse frequency of 4.5 kHz or 5 m at maximum 6 kHz.
- In category C2 : 10 m at a maximum pulse frequency of 6 kHz or 5 m at maximum 9 kHz.

In category C3 the "low leakage current" operation is not possible.

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8.8 interference filter

Table 14: Motor cable lengths and pulse frequencies with external interference suppression filter

Part no. M-Max™	Assigned interference filter	EMC category					
		C1		C2		C3	
		I [m]	P11.9 (f _{PWM}) [kHz]	I [m]	P11.9 (f _{PWM}) [kHz]	I [m]	P11.9 (f _{PWM}) [kHz]
MMX12AA1D7N0-0 MMX12AA2D4N0-0	MMX-LZ1-009 (rated operation) ¹⁾	≤ 10 ≤ 50	≤ 16 1.5	≤ 30 ≤ 50 ≤ 100	≤ 16 ≤ 3 ≤ 1.5	≤ 50 ≤ 100	≤ 16 ≤ 1.5
MMX12AA2D8N0-0	MMX-LZ1-009 (low leakage current) ²⁾	≤ 10 ≤ 5	≤ 4.5 ≤ 6	≤ 10 ≤ 5	≤ 6 ≤ 9	≤ 10 ≤ 5	≤ 6 ≤ 9
MMX11AA1D7N0-0 MMX11AA2D4N0-0	MMX-LZ1-015 (rated operation) ¹⁾	≤ 10 ≤ 50	≤ 16 ≤ 1.5	≤ 30 ≤ 70	≤ 16 ≤ 1.5	≤ 50 ≤ 70 ≤ 100	≤ 16 ≤ 3 ≤ 1.5
MMX11AA2D8N0-0 MMX11AA3D7N0-0 MMX12AA3D7N0-0 MMX12AA4D8N0-0 MMX12AA7D0N0-0	MMX-LZ1-015 (low leakage current) ²⁾	≤ 10 ≤ 5	≤ 4.5 ≤ 6	≤ 10	≤ 6	≤ 5	≤ 16
MMX11AA4D8N0-0 MMX12AA9D6N0-0	MMX-LZ1-017 (rated operation) ¹⁾	≤ 10 ≤ 50	≤ 16 ≤ 1.5	≤ 30 ≤ 70	≤ 16 ≤ 1.5	≤ 50 ≤ 70 ≤ 100	≤ 16 ≤ 3 ≤ 1.5
	MMX-LZ1-017 (low leakage current) ²⁾	≤ 10 ≤ 5	≤ 4.5 ≤ 6	≤ 10	≤ 6	≤ 10	≤ 6
MMX32AA1D7N0-0 MMX32AA2D4N0-0 MMX32AA2D8N0-0 MMX34AA1D3N0-0 MMX34AA1D9N0-0 MMX34AA2D4N0-0	MMX-LZ3-006	≤ 10 ≤ 30	≤ 16 1.5	≤ 30 ≤ 50	≤ 16 ≤ 1.5	≤ 50	≤ 12
MMX32AA3D7N0-0 MMX32AA4D8N0-0 MMX32AA7D0N0-0 MMX34AA3D3N0-0 MMX34AA4D3N0-0 MMX34AA5D6N0-0	MMX-LZ3-009	≤ 10 ≤ 30	≤ 16 ≤ 3	≤ 30 ≤ 50	≤ 16 ≤ 1.5	≤ 50 ≤ 70	≤ 12 ≤ 3
MMX32AA011N0-0 MMX34AA7D6N0-0 MMX34AA9D0N0-0 MMX34AA012N0-0 MMX34AA014N0-0	MMX-LZ3-022	≤ 10 ≤ 30	≤ 16 ≤ 1.5	≤ 30 ≤ 50	≤ 16 ≤ 6	≤ 70 ≤ 100	≤ 12 ≤ 1.5

1) Maximum permissible cable length (m)

2) At maximum permissible pulse frequency (f_{PWM})

Note (example):

- f_{PWM} ≤ 16 kHz → P11.9 = 16, P11.10 = 0

- f_{PWM} = 1.5 kHz (constant) → P11.9 = 1.5, P11.10 = 1

Table 15: Special technical data for MMX-LZ...

Part no.	Maximum mains supply voltage U_{LN} [V]	Rated operational current I_N [A]	Maximum leakage current $I_{lk}^{1)}$ [mA]	Maximum contact current when the PE is broken		Max. power loss P_V [W]	Weight m [kg]	Size
				$I_{touch}^{2)}$ [mA]	$n ET$ F			
MMX-LZ1-009	1 ~ 240 V + 10 % (50/60 Hz)	9	① 17.6 ② 1.7	14 2.2	31.2 4.3	3	0.8	FS1
MMX-LZ1-015		15	① 25.6 ② 1.7	43.5 2.9	89 6.4	6	1.2	FS2
MMX-LZ1-017		17	① 25.6 ② 1.7	43.5 2.9	89 6.4	10	2	FS3
MMX-LZ3-006	3 ~ 480 V + 10 % (50/60 Hz)	6	7.3	6.3	170	3	0.8	FS1
MMX-LZ3-009		9	10.9	5.5	195	6	1.2	FS2
MMX-LZ3-022		22	10.9	5.5	195	10	2	FS3

1) RMS value of the leakage current to EN 60939

Only with MMX-LZ1: ① = rated operation, ② = leakage current (< 3.5 mA).

2) Peak value of the working current to EN 60939

N = peak value of the touch current present in normal operation with a protective conductor break

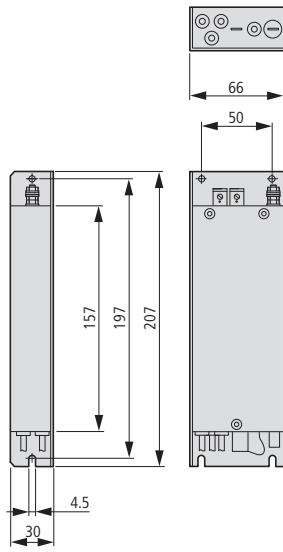
F = peak value of the worst case touch current with a protective conductor break or with a break of two or three phases with MMX-LZ3...
o with a break of the N conductor on MMX-LZ1... .

Table 16: General rated operational data for MMX-LZ...

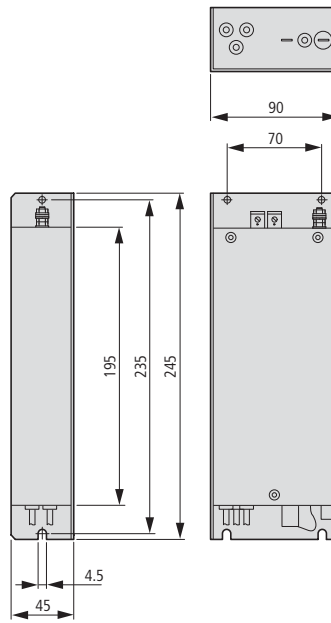
Technical Data	Symbols used in technical data and formulae	Material Type	Value
General			
Mains frequency (f_{LN})	f_{LN}	Hz	50/60
Environmental Conditions			
Climate category			IEC 25-100-21
Ambient air temperature	θ	°C	+40
Degree of protection			IP00
Connections			
Screwed terminal (mains side) (L1, L2, L3, N)		mm ² AWG	0.2 - 4 24 - 11
Tightening torque	W	Nm ft-lbs	0.6 - 0.8 0.44 - 0.59
PE (mains side)			M4 (screw)
Output lead to frequency inverter	l	mm	100
PE with ring cable lug (M4)	l	mm	65

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8.8 interference filter

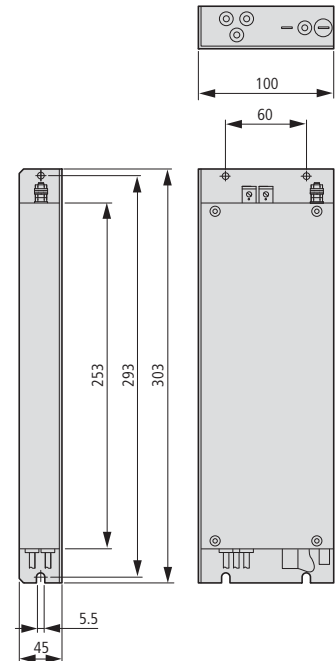
MMX-LZ1-009



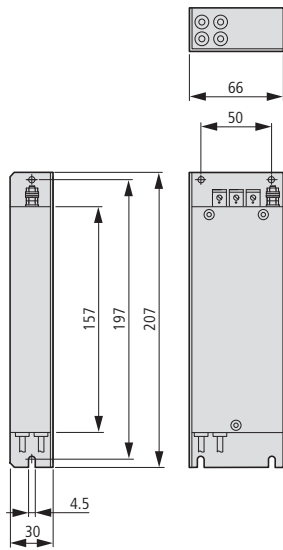
MMX-LZ1-015



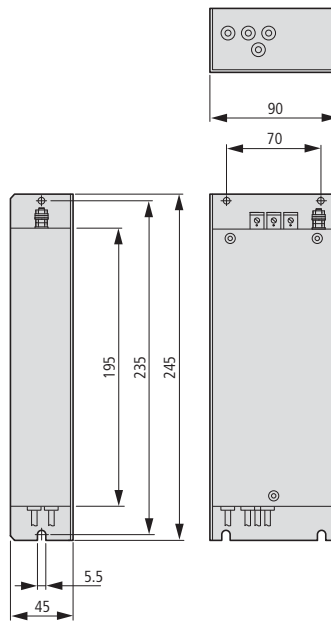
MMX-LZ1-017



MMX-LZ3-006



MMX-LZ3-009



MMX-LZ3-022

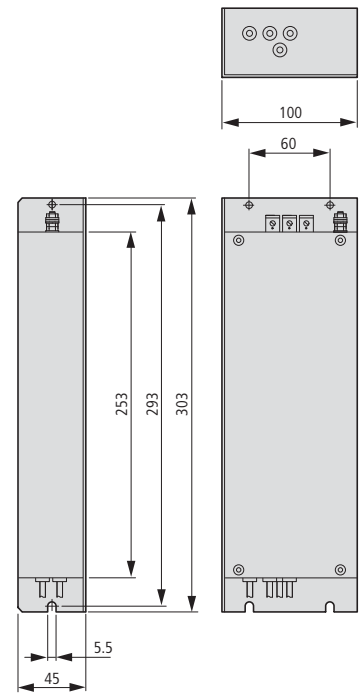


Figure 148: MMX-LZ... external interference suppression filters

8.9 Braking resistances

The MMX34AA3D3... to MMX34AA014...versions of M-Max™ series frequency inverters are fitted with an internal brake chopper. This can be activated at parameter P12.5 (→ Page 169).

A brake resistor connected to the power terminals R+ and R- of the MMX is switched on if the DC link voltage exceeds the value set at P12.6. The DC link voltage can be read at M1.8.

The brake resistors listed here convert the mechanical brake energy into heat which occurs during lengthy regenerative operation or when braking large moments of inertia. The stated values (P_{DB}) of the brake resistors apply to continuous operation.

In many applications, the brake resistors are not loaded in continuous operation but in short-time operation. The short-time rating can be calculated from the ratio of the duty factor to continuous rating. The type related overload factor depends on the time and design of the resistor:

$$P_{\max} \leq \frac{P_{DB} \times 100 \%}{ED [\%]}$$

P_{\max} = Maximum short-time rating

P_{DB} = Continuous rating 100 % with duty factor

ED = Duty factor

t_c = Cycle time, maximum 120 seconds

The duty factor is stated as a percentage (%) and is calculated with the formula:

$$ED [\%] = \frac{ED \times 100 \%}{t_c}$$

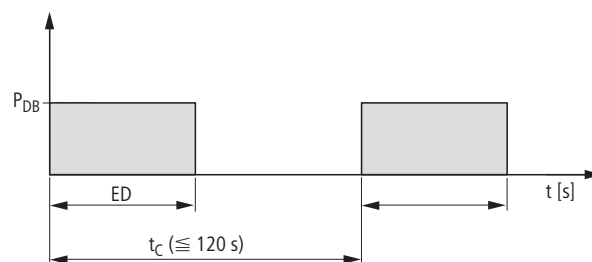


Figure 149: Duty factor

Example:

With a duty factor of 48 s and a cycle time of 120 s the ED value = 40 % and with a duty factor of 8 s and a cycle time of 40 s, 20 %.

Resistor BR10561K0-T-PF has a continuous rating of 1000 W. At 40 % ED the permissible overload factor is 2.6 (→ Figure 150, „Overload factors (e.g. BR1...)“). The short-time rating here is 2600 W. At 20 % ED the permissible overload factor is 6 and thus the short-time rating $P_{\max} = 6000$ W.

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8.9 Braking resistances

- ➔ With braking resistance BR3... the permissible overload factor is around 50 % of the value of BR1... (➔ Figure 150, „Overload factors (e.g. BR1...)“).
- ➔ In applications compliant with the UL® regulations, the rating data for continuous braking power and the short-time rating (P_{max}) must be reduced by 25 %.

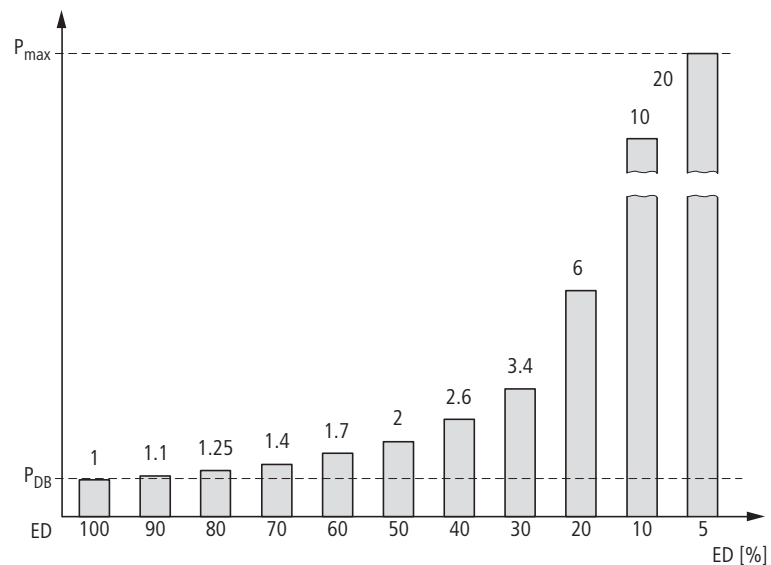


Figure 150: Overload factors (e.g. BR1...)

NOTICE

The surface temperature of the resistors can reach values of over 100°C!

Depending on the rating, the braking resistances are available in three different versions. If the type designation ends with a “-T”, the resistor or the resistor combination is provided with a thermostat for up to 230 V, 1 A, AC-1.

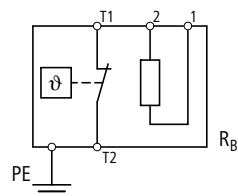


Figure 151: Braking resistance with thermostat (BR...-T...)

8.9.1 BR1...-T-PF and BR3...-T-PF

BR1...-T-PF and BR3...-T-PF series resistors are mounted in a perforated housing and are provided with a thermostatic circuit breaker. The housings are made from galvanized perforated sheet metal and are open at the bottom. When mounted they comply with degree of protection IP 65.

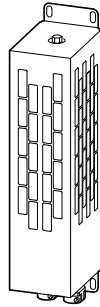


Figure 152: Braking resistance BR1...-T-PF

Table 17: Rating and short-time rating

BR...	R_B [Ω]	P_{DB} [W]	P_{max} [kW]	P_{DB} (UL®) [W]	P_{max} (UL®) [kW]
BR10361K0-T-PF	36	1000	20	800	16
BR1036500-T-PF	36	500	10	400	8
BR10561K0-T-PF	56	1000	20	800	16
BR1056300-T-PF	56	300	6	250	5
BR1056800-T-PF	56	800	16	600	12
BR30362K4-T-PF	36	2450	24.5	2100	21
BR30362K8-T-PF	36	2800	28	2750	27.5
BR30363K6-T-PF	36	3600	36	3400	34

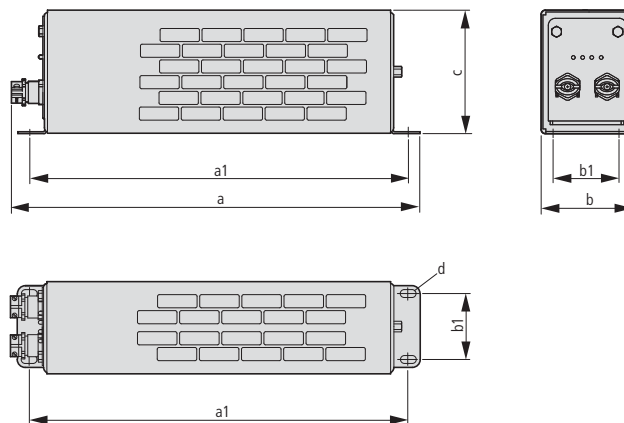


Figure 153: Dimensions BR...-T-PF

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8.9 Braking resistances

Table 18: Dimensions and weights of BR...-T-PF braking resistance (→ Figure 153)

BR1, BR3	a [mm]	a1 [mm]	b [mm]	b1 [mm]	c [mm]	d [mm]	m [kg]
BR10361K0-T-PF	445	428	140	120	120	6 x 12	3.4
BR1036500-T-PF	445	428	95	70	95	6 x 12	2.2
BR10561K0-T-PF	445	428	140	120	120	6 x 12	3.4
BR1056300-T-PF	345	328	95	70	95	6 x 12	1.6
BR1056800-T-PF	395	378	140	120	120	6 x 12	2.9
BR30362K4-T-PF	485	380	326	300	301	9	9.6
BR30362K8-T-PF	485	380	326	300	301	9	10.2
BR30363K6-T-PF	485	380	326	300	301	9	11.5

8.9.2 BR2... and BR2...-T-SAF

BR2... and BR2...-T-SAF series resistors are short-circuit proof and intrinsically safe, and are mounted in an anodized aluminum housing with IP 65 protection.

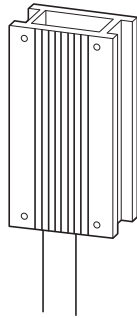


Figure 154: Braking resistance BR2...

The BR2...-T-SFA type is a combination of several BR2... resistors with a thermostatic circuit-breaker, assembled in a mounting frame for fitting in the base (footprint) of the MMX frequency inverters in frame sizes FS1, FS2 and FS3.

Table 19: Rating and short-time rating

BR...	R_B [Ω]	P_{DB} [W]	P_{max} [kW]	$P_{DB} (UL^{\circ})$ [W]	$P_{max} (UL^{\circ})$ [kW]
BR2047240	47	240	4	800	16
BR2060200	60	200	1.8	400	8
BR2036400-T-SAF	36	400	3.6	800	16
BR2047240-T-SAF	47	240	4	250	5
BR2060200-T-SAF	60	200	1.8	600	12
BR2065400-T-SAF	65	400	4	2100	21
BR2075480-T-SAF	75	480	8	2750	27.5

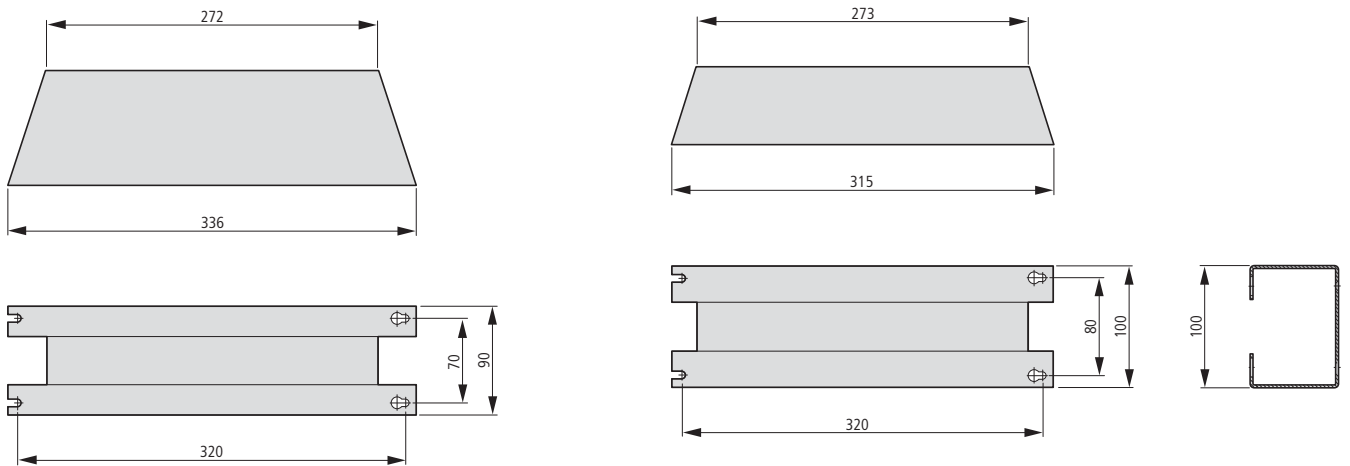


Figure 155: Braking resistance BR2... in base frame

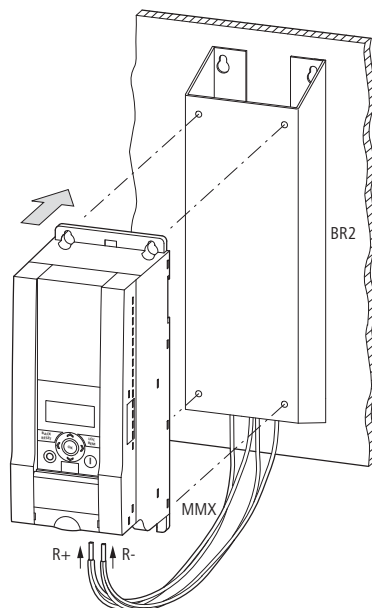


Figure 156: Braking resistance BR2... in base frame

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8.9 Braking resistances

8.9.3 Assignment to MMX

Table 20: Assignment of brake resistors to the M-Max™ frequency inverters with the permissible ED values (example):

→ Section "8.1.4 Device series MMX34", page 206

MMX34...	3D3	4D3	5D6	7D6	9D0	012	014
Permissible R_{min}	55 Ω	55 Ω	55 Ω	35 Ω	35 Ω	35 Ω	35 Ω
Duty factor	ED [%]	ED [%]	ED [%]	ED [%]	ED [%]	ED [%]	ED [%]
BR2047240	-	-	-	10	-	-	-
BR2060200	10	10	10	-	-	-	-
BR2036400-T-SAF	-	-	-	-	10	10	-
BR2047240-T-SAF	-	-	-	10	-	-	-
BR2060200-T-SAF	10	10	10	-	-	-	-
BR2065400-T-SAF	25	25	-	-	-	-	-
BR2075480-T-SAF	-	-	25	-	-	-	-
BR10361K0-T-PF	-	-	-	30	25	14	10
BR1036500-T-PF	-	-	-	13	10	7	5
BR10561K0-T-PF	55	55	40	7	5	-	-
BR1056300-T-PF	15	15	10	7	5	-	-
BR1056800-T-PF	35	35	25	18	13	10	7
BR30362K4-T-PF	-	-	-	50	40	30	20
BR30362K8-T-PF	-	-	-	60	45	33	25
BR30363K6-T-PF	-	-	-	100	75	55	40

8.10 Mains chokes

Allocating the mains chokes is done according to the rated input currents of the frequency inverter (without upstream mains reactor).

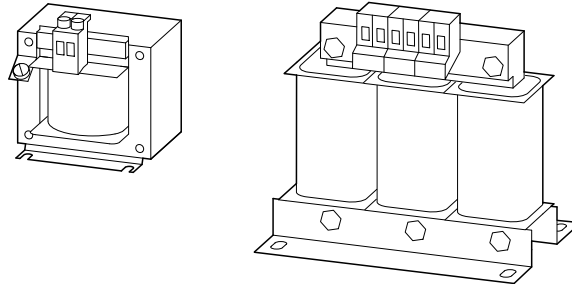



Figure 157: main chokes DEX-LN...

- ➔ When the frequency inverter is operating at its rated current limit, the mains choke with a u_K value of around 4% causes a reduction of the frequency inverter's maximum possible output voltage (U_2) to about 96 % of the mains voltage (U_{LN}).
- ➔ Mains chokes reduce the magnitude of the current harmonics up to about 30 % and increase the lifespan of frequency inverters and upstream-connected switching devices.
- ➔  Further information and technical data on the mains chokes of the DEX-LN series is provided in instructional leaflet IL04012007Z.

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8.10 Mains chokes

Part no. M-Max™	Rated operating voltage MMX U _{LN} (50/60 Hz)	Rated input current (without mains choke)		Assigned mains choke part no. at ambient air temperature		maximum rated operating voltage U _{LN} (50/60 Hz) [V]	Rated operational current at ambient air temperature	
		(...N...)	(...F...)	Up to +40 °C	to +50 °C		Up to +40 °C	to +50 °C
		I _{LN} [A]	I _{LN} [A]				I _N [A]	I _N [A]
MMX11AA1D7...	1 AC 120 V	9.2	9.2	DEX-LN1-013		240 V +10 %	13	
MMX11AA2D4...	1 AC 120 V	11.6	11.6	DEX-LN1-013		240 V +10 %	13	
MMX11AA2D8...	1 AC 120 V	12.4	12.4	DEX-LN1-013		240 V +10 %	13	
MMX11AA3D7...	1 AC 120 V	15	15	DEX-LN1-018		240 V +10 %	18	
MMX11AA4D8...	1 AC 120 V	16.5	16.5	DEX-LN1-018		240 V +10 %	18	
MMX12AA1D7...	1 AC 230 V	4.2	4.2	DEX-LN1-006		240 V +10 %	6	
MMX12AA2D4...	1 AC 230 V	5.7	5.7	DEX-LN1-006		240 V +10 %	6	
MMX12AA2D8...	1 AC 230 V	6.6	6.6	DEX-LN1-006	DEX-LN1-009	240 V +10 %	6	9
MMX12AA3D7...	1 AC 230 V	8.3	8.3	DEX-LN1-009		240 V +10 %	9	
MMX12AA4D8...	1 AC 230 V	11.2	11.2	DEX-LN1-013		240 V +10 %	13	
MMX12AA7D0...	1 AC 230 V	14.1	14.1	DEX-LN1-018		240 V +10 %	18	
MMX12AA9D6...	1 AC 230 V	15.8	15.8	DEX-LN1-018		240 V +10 %	18	
MMX32AA1D7...	3 AC 230 V	2.7	2.7	DEX-LN3-004		240 V +10 %	4	
MMX32AA2D4...	3 AC 230 V	3.5	3.5	DEX-LN3-004		240 V +10 %	4	
MMX32AA2D8...	3 AC 230 V	3.8	3.8	DEX-LN3-004		240 V +10 %	4	
MMX32AA3D7...	3 AC 230 V	4.3	4.3	DEX-LN3-006		240 V +10 %	6	
MMX32AA4D8...	3 AC 230 V	6.8	6.8	DEX-LN3-010		240 V +10 %	10	
MMX32AA7D0...	3 AC 230 V	8.4	8.4	DEX-LN3-010		240 V +10 %	10	
MMX32AA011...	3 AC 230 V	13.4	13.4	DEX-LN3-016		240 V +10 %	16	
MMX32AA012...	3 AC 230 V	14.2	10.9	DEX-LN3-016		240 V +10 %	16	
MMX32AA017N...	3 AC 230 V	20.6		DEX-LN3-025		240 V +10 %	25	
MMX32AA017F...	3 AC 230 V		15.2	DEX-LN3-016		240 V +10 %	16	
MMX32AA025N...	3 AC 230 V	30.3		DEX-LN3-040		240 V +10 %	40	
MMX32AA025F...	3 AC 230 V		21.4	DEX-LN3-025		240 V +10 %	25	
MMX32AA031...	3 AC 230 V	36.6	27	DEX-LN3-040		240 V +10 %	40	
MMX32AA038N...	3 AC 230 V	44.8		DEX-LN3-050		240 V +10 %	50	
MMX32AA038F...	3 AC 230 V		32.8	DEX-LN3-40		240 V +10 %	40	

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8.10 Mains chokes

Part no. M-Max™	Rated operating voltage MMX U _{LN} (50/60 Hz)	Rated input current (without mains choke)		Assigned mains choke part no. at ambient air temperature		maximum rated operating voltage U _{LN} (50/60 Hz) [V]	Rated operational current at ambient air temperature	
		(...N...)	(...F...)	Up to +40 °C	to +50 °C		Up to +40 °C	to +50 °C
		I _{LN} [A]	I _{LN} [A]				I _N [A]	I _N [A]
MMX34AA1D3...	3 AC 400 V	2.2	2.2	DEX-LN3-004		500 V +10 %	4	
MMX34AA1D9...	3 AC 400 V	2.8	2.8	DEX-LN3-004		500 V +10 %	4	
MMX34AA2D4...	3 AC 400 V	3.2	3.2	DEX-LN3-004		500 V +10 %	4	
MMX34AA3D3...	3 AC 400 V	4	4	DEX-LN3-004	DEX-LN3-010	500 V +10 %	4	10
MMX34AA4D3...	3 AC 400 V	5.6	5.6	DEX-LN3-006	DEX-LN3-010	500 V +10 %	6	10
MMX34AA5D6...	3 AC 400 V	7.3	7.3	DEX-LN3-010		500 V +10 %	10	
MMX34AA7D6...	3 AC 400 V	9.6	9.6	DEX-LN3-010	DEX-LN3-016	500 V +10 %	10	16
MMX34AA9D0...	3 AC 400 V	11.5	11.5	DEX-LN3-016		500 V +10 %	16	
MMX34AA012...	3 AC 400 V	14.9	14.9	DEX-LN3-016		500 V +10 %	16	
MMX34AA014...	3 AC 400 V	18.7	18.7	DEX-LN3-025		500 V +10 %	25	
MMX34AA016N...	3 AC 400 V	17.1		DEX-LN3-025		500 V +10 %	25	
MMX34AA016F...	3 AC 400 V		13.8	DEX-LN3-016		500 V +10 %	16	
MMX34AA023N...	3 AC 400 V	25.5		DEX-LN3-025	DEX-LN3-040	500 V +10 %	25	40
MMX34AA023F...	3 AC 400 V		18.7	DEX-LN3-025		500 V +10 %	25	
MMX34AA031...	3 AC 400 V	33	26.8	DEX-LN3-040		500 V +10 %	40	
MMX34AA038N...	3 AC 400 V	41.7		DEX-LN3-050		500 V +10 %	40	
MMX34AA038F...	3 AC 400 V		32.2	DEX-LN3-040		500 V +10 %	40	

8 Appendix

8.11 motor reactor

8.11 motor reactor

The motor reactor is in the output of the frequency inverter. Its rated operational current must always be greater than/equal to the rated operational current of frequency inverter.

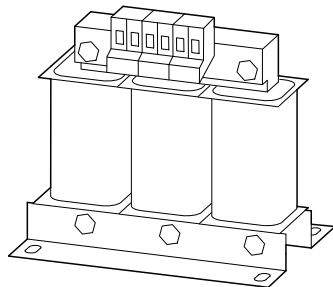


Figure 158: Motor reactors DEX-LM...



When multiple motors are connected in parallel in the motor reactor, the rated operational current of the motor reactor must be greater than the total current of all motors.



Further information and technical data on the motor reactors of the DEX-LN series is provided in instructional leaflet IL04012007Z.

Table 21: Allocation of the motor reactors with frequency inverters of the 200-V class
(maximum power supply: 750 V ±0%, maximum permitted frequency: 200 Hz)

Part no. M-Max™	Rated operational current I_e [A]	Assigned motor reactor		assigned motor power			
		part no. at ambient air temperature up to +50 °C	Rated operational current I_2 [A]	(230 V, 50 Hz)		(230 V, 60 Hz)	
				P [kW]	I_M [A] ¹⁾	P [HP]	I_M [A] ¹⁾
MMX11AA1D7...	1.7	DEX-LM3-005	5	0.25	1.4	1/3 ²⁾	1.6 ²⁾
MMX11AA2D4...	2.4	DEX-LM3-005	5	0.37	2	1/2	2.2
MMX11AA2D8...	2.8	DEX-LM3-005	5	0.55	2.7	1/2	2.2
MMX11AA3D7...	3.7	DEX-LM3-008	8	0.75	3.2	3/4	3.2
MMX11AA4D8...	4.8	DEX-LM3-011	11	1.1	4.6	1	4.2
MMX12AA1D7...	1.7	DEX-LM3-005	5	0.25	1.4	1/3 ²⁾	1.6 ²⁾
MMX12AA2D4...	2.4	DEX-LM3-005	5	0.37	2	1/2	2.2
MMX12AA2D8...	2.8	DEX-LM3-005	5	0.55	2.7	1/2	2.2
MMX12AA3D7...	3.7	DEX-LM3-005	5	0.75	3.2	3/4	3.2
MMX12AA4D8...	4.8	DEX-LM3-005	5	1.1	4.6	1	4.2
MMX12AA7D0...	7	DEX-LM3-008	8	1.5	6.3	2	6.8
MMX12AA9D6...	9.6	DEX-LM3-011	11	2.2	8.7	3	9.6
MMX32AA1D7...	1.7	DEX-LM3-005	5	0.25	1.4	1/3 ²⁾	1.6 ²⁾
MMX32AA2D4...	2.4	DEX-LM3-005	5	0.37	2	1/2	2.2
MMX32AA2D8...	2.8	DEX-LM3-005	5	0.55	2.7	1/2	2.2
MMX32AA3D7...	3.7	DEX-LM3-005	5	0.75	3.2	3/4	3.2
MMX32AA4D8...	4.8	DEX-LM3-005	5	1.1	4.6	1	4.2
MMX32AA7D0...	7	DEX-LM3-008	8	1.5	6.3	2	6.8
MMX32AA011...	11	DEX-LM3-011	11	2.2	8.7	3	9.6
MMX32AA012...	12	DEX-LM3-016 ³⁾	16	3	11.5	3	9.6
MMX32AA017...	17	DEX-LM3-035 ⁴⁾	35	4	14.8	5	15.2
MMX32AA025...	25	DEX-LM3-035 ⁴⁾	35	5	19.6	7-1/2	22
MMX32AA031...	31	DEX-LM3-035 ⁴⁾	35	7.5	26.4	10	28
MMX32AA038...	38	DEX-LM3-50	50	11	38	—	—

1) The rated operational currents of the allocated motor outputs apply for normal four-pole, internally and externally ventilated three-phase asynchronous motors with 1500 rpm (at 50 Hz) and 1800 rpm (at 60 Hz).

2) Recommended value (calculated), no standard rating.

3) DEX-LM3-011 can also be used up to a maximum rated motor current of 11 A.

4) DEX-LM3-016 can also be used up to a maximum rated motor current of 16 A.

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8.11 motor reactor

Table 22: Allocation of the motor reactors for frequency inverters of the 400-V class
(maximum power supply: 750 V \pm 0%, maximum permitted frequency: 200 Hz)

Part no. M-Max™	Rated operational current I_e [A]	Assigned motor reactor part no. at ambient air temperature		Rated operational current of the motor reactor		Assigned motor rating			
		Up to +40 °C	to +50 °C	40 °C	50 °C	(400 V, 50 Hz)		(460 V, 60 Hz)	
				I_2 [A]	I_2 [A]	P [kW]	I_M [A] ¹⁾	P [HP]	I_M [A] ¹⁾
MMX34AA1D3...	1.3	DEX-LM3-005		5		0.37	1.1	1/2	1.1
MMX34AA1D9...	1.9	DEX-LM3-005		5		0.55	1.5	3/4	1.6
MMX34AA2D4...	2.4	DEX-LM3-005		5		0.75	1.9	1	2.1
MMX34AA3D3...	3.3	DEX-LM3-005		5		1.1	2.6	1-1/2	3
MMX34AA4D3...	4.3	DEX-LM3-005		5		1.5	3.6	2	3.4
MMX34AA5D6...	5.6	DEX-LM3-005	DEX-LM3-008	5	8	2.2	5	3	4.8
MMX34AA7D6...	7.6	DEX-LM3-008		8		3	6.6	4 ³⁾	6.2 ³⁾
MMX34AA9D0...	9	DEX-LM3-011		11		4	8.5	5	7.6
MMX34AA012...	12	DEX-LM3-011 ²⁾	DEX-LM3-016	11	16	5.5	11.3	7-1/2	11
MMX34AA014...	14	DEX-LM3-016		16		5.5	11.3	10	14
MMX34AA016...	16	DEX-LM3-016		16		7.5	15.2	10	14
MMX34AA023...	23	DEX-LM3-035		35		11	21.7	15	21
MMX34AA031...	31	DEX-LM3-035		35		15	29.3	20	27
MMX34AA038...	38	DEX-LM3-050		50		18.5	36	25	34

1) The rated operational currents of the allocated motor outputs apply for normal four-pole, internally and externally ventilated three-phase asynchronous motors with 1500 rpm (at 50 Hz) and 1800 rpm (at 60 Hz).

2) For rated motor currents greater than 11 A, the DEX-LM3-016 (16 A) must be used here.

3) Recommended value (calculated), no standard rating.

8.1.2 Sinusoidal filter

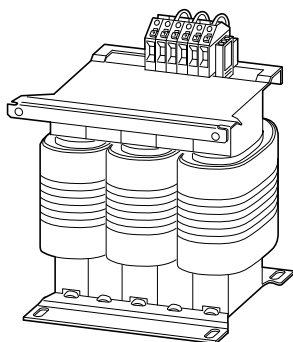


Figure 159: Sinusoidal filter SFB 400/...

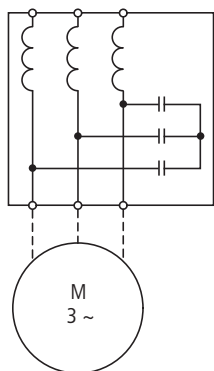


Figure 160: Circuit diagram sinusoidal filter

The sinusoidal filter SFB removes high-frequency components above the set resonance frequency from the frequency inverter output voltage (→ Figure 162). This reduces the conducted and radiated emission. The output voltage of the sinusoidal filter (→ Figure 161) achieves a sinusoidal shape with a slight superimposed ripple voltage. The THD factor of the sinusoidal voltage is normally 5 to 10 %. This reduces the development of noise and losses in the motor.

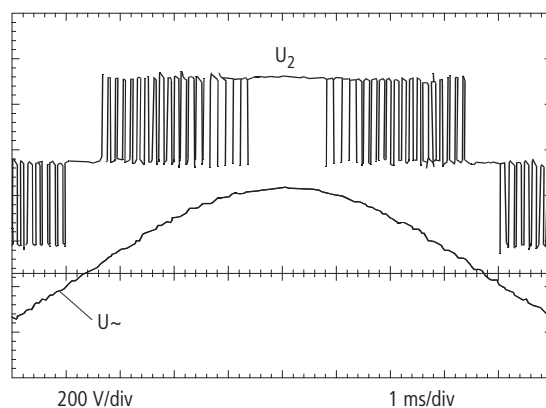


Figure 161: Output voltage to motor
 U_2 : Inverter output voltage
 U_{\sim} : Simulated sinusoidal voltage

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8.12 Sinusoidal filter

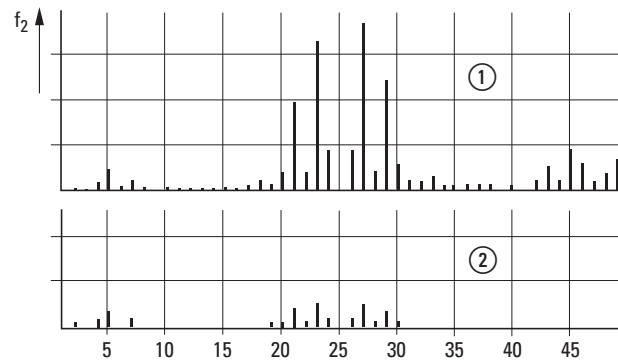


Figure 162: High frequency components of the output voltage

① Without sinusoidal filter

② With sinusoidal filter

f: Rotating field frequency

n: Harmonics ordinal

Advantages of the sinusoidal filter:

- Long motor cables.
 - max. 200 m with supply voltages up to 480 V +10 %.
 - max. 400 m with supply voltages up to 240 V +10 %.
- Extended lifespan like that of a mains-operated motor.

Disadvantages of the sinusoidal filter:

- Up to around 9 % voltage drop. At 400 V this is around 36 V.
- Heat dissipation
- Pulse frequency must be fixed.

Technical data for the sinusoidal filter:

Degree of protection	IP00, suitable for flush mounting in devices and systems
Frequency range	0 - 150 Hz
Permissible pulse frequency	4 - 8 kHz, fixed
Ambient air temperature	≤ 40 °C
Approvals	cURus

Table 23: Assignment of sinusoidal filters

Frequency inverters		Assigned sinusoidal filter U _{LN} maximum 3 AC 0 - 480 V +10 % (0 - 120 Hz)							
part no.	Rated operational current I _e [A]	part no.	Article no.	Maximum permissible rated operational current I _N [A]	Typical voltage drop [%]	Dimensions B x H x T			Weight [kg]
						[mm]	[mm]	[mm]	
MMX11AA1D7...	1.7	SFB400/4	271538	4	7	155	160	105	4
MMX11AA2D4...	2.4								
MMX11AA2D8...	2.8								
MMX11AA3D7...	3.7								
MMX12AA1D7...	1.7								
MMX12AA2D4...	2.4								
MMX12AA2D8...	2.8								
MMX12AA3D7...	3.7								
MMX32AA1D7...	1.7								
MMX32AA2D4...	2.4								
MMX32AA2D8...	2.8								
MMX32AA3D7...	3.7								
MMX34AA1D3...	1.3								
MMX34AA1D9...	1.9								
MMX34AA2D4...	2.4								
MMX34AA3D3...	3.3								
MMX11AA4D8...	4.8	SFB400/10	271590	10	7.5	155	160	120	5.5
MMX12AA4D8...	4.8								
MMX12AA7D0...	7								
MMX12AA9D6...	9.6								
MMX32AA4D8...	4.8								
MMX32AA7D0...	7								
MMX34AA4D3...	4.3								
MMX34AA5D6...	5.6								
MMX34AA7D6...	7.6								
MMX34AA9D0...	9								
MMX32AA011...	11	SFB400/16.5	271591	16.5	7	190	185	160	8.5
MMX32AA012...	12								
MMX34AA012...	12								
MMX34AA014...	14								
MMX34AA016...	16								
MMX32AA017... ¹⁾	17	SFB400/23.5	271593	23.5	8	240	280	190	14.5
MMX34AA023...	23								

8 Appendix

8.12 Sinusoidal filter

Frequency inverters		Assigned sinusoidal filter U _{LN} maximum 3 AC 0 - 480 V +10 % (0 - 120 Hz)							
part no.	Rated operational current I _e [A]	part no.	Article no.	Maximum permissible rated operational current I _N [A]	Typical voltage drop [%]	Dimensions B x H x T			Weight
						[mm]	[mm]	[mm]	[kg]
MMX32AA025...	25	SFB400/32	271594	32	8.7	240	280	200	19
MMX32AA031...	31								
MMX34AA031...	31								
MMX32AA038... ²⁾	38	SFB400/48	271597	48	7.8	240	280	220	25.5
MMX34AA038... ²⁾	38	(SFB400/37)	271595	37	8.6	240	280	210	21

1) SFB 400/16.5 can also be used up to a maximum rated motor current of 16.5 A.

2) SFB 400/37 can also be used up to a maximum rated motor current of 37 A.



For more technical data for the SFB400/... series sinusoidal filter, see the manufacturer's instructions.

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8.13 FAQ

Frequently Asked Questions

Is there a reset function on the M-Max frequency inverter?

Yes, the parameters of the M-Max can be reset to their factory settings:

- if the STOP button of the keypad is pressed for around 5 seconds or
- if parameter S4.2 is set to 1 or
- if the PC connection is (MMX-COM-PC) connected via the MaxConnect parameter software.



When the factory settings are reset or restored, all parameters and also the fault memory are reset.

Is there a fault list on the M-Max (history)?

Yes. However, the fault memory can only be read out via the keypad. To do this, the FLT menu level must be selected. Up to 9 faults can be logged and stored. Any further fault messages will then delete the oldest fault.



When the factory settings are reset or restored, all fault messages are deleted.

Does the M-Max frequency inverter have an "Automatic restart"?

Yes. For example, after the power supply has failed or another fault message has been output, the frequency inverter can automatically restart without a control command or fault acknowledgement. For this the following parameters must be set:

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
P3.1	300	✓	rw	Start stop logic	0 = DI1 (FWD), DI2 (REV), REAF 1 = DI1 (FWD) + DI2 = REV 2 = DI1 (Start pulse), DI2 (Stop pulse) 3 = DI1 (FWD), DI2 (REV)	111	3	0
P6.13	731	–	rw	REAF, automatic restart after an error message	0 = Deactivated 1 = activated	125	0	1

REAF = Restart After Failure



The general factory settings require the control signal terminal 8 (DI1 = FWD) to be supplied with 24 V (control signal terminal 6). Alternatively, P3.31 = 1 enables the logic of control signal terminal 8 to be set as an N/C contact so that the power supply (24 V at terminal 8) can be omitted.

Can several motors be connected in parallel to the output of the M-Max frequency inverter?

Yes, operation with several motors is possible as long as the following points are observed:

- The operating mode is set to Frequency control (U/f) (P11.8 = 0). Vector control or control with slip compensation is never permissible.
- The sum of all motor currents (P7.3) must be less than the frequency inverter's output current (rated operational current). The selection of the frequency inverter must be based on the shaft output power of the motors.
- The motor protection (P8) provided in the frequency inverter can not be used here. It is recommended that a separate motor protective device is used for each motor (bimetal relay or thermistor as well as a contactor for each motor). The evaluation of the overload signal can be indicated to the frequency inverter as an "External fault" signal via a digital input.
- The worst (smallest) power factor of the motor should be entered at P7.4. With several motors (e.g. >10, winding machine) it may be necessary to select a frequency inverter with a higher rating since low power motors have a poorer power factor ($\cos \varphi$) and therefore require a higher reactive current (larger DC link capacitors).
- Two identical motors (Kalander machines, conveyor belt etc.) can be connected directly to the frequency inverter. With more than two motors, a motor choke should be installed in front of the branch circuit.

Can a single-phase motor (AC motor) be connected to the output of the M-Max frequency inverter?

This is possible with the MMX11 and MMX12 series. This configuration was not system tested and its operability cannot be guaranteed.



No liability is accepted for this connection variant.

The following points must always be taken into account:

- The control mode must be set to Frequency control (U/f) (P11.8 = 0). Vector control or control with slip compensation is never permissible.
- Experience with fan motors has shown that the best results are achieved with low values for the pulse frequency (P11.9) and the output voltage at zero frequency (P11.6, starting voltage). The usable operating range is between around 20 to 50 Hz.
- AC motors with a short-circuited winding have very little power and require frequency inverters that can guarantee an output current up to 200 % of the motor current in continuous operation.
- The current consumption of AC motors with capacitors is around three times that of a three-phase motor of the same rating.



It is generally more economical to connect a three-phase AC motor at the output of a frequency inverter instead of a single-phase AC motor.

Can frequency inverters be operated with a Type A residual current device?

The frequency inverters of the MMX11 and MMX12 device series can be operated on a Type A residual current device if they are connected to a single-phase network with an grounded neutral conductor.



- The connection requirements of EN61800-5-1 must be fulfilled.
- Normally residual current devices trip with considerably lower fault currents; such as a 30mA RCD at around 15 to 20 mA. An early tripping at switch-on must be expected with frequency inverter with RFI filters.
- The leakage current to ground of the frequency inverter depends on different factors such as the layout and wiring of the control panel, the cable type, the cable routing and the length of the motor cable, the pulse frequency and the RFI filter.

Can M-Max frequency inverter be used for dynamic braking?

The frequency inverters of the MMX32 and MMX34 device series from frame size FS2 are provided with an internal voltage-controlled braking transistor (brake chopper). When used in conjunction with an external braking transistor, they can be used for dynamic braking if the regenerative energy of the motor is fed back to the internal DC link and the set switch threshold value (P12.6) is exceeded. This method enables braking in all operating modes, not only with the STOP command.

Can tapped winding motors be connected to the output of the M-Max frequency inverter?

Yes if both windings of the motor are permanently connected. To utilize the full speed range, the motor windings must be connected in a double star circuit. The frequency inverter must be selected according to the motor line current in the selected circuit type.

Why is the mains input current on MMX34 - when using a mains choke - less than the motor current in the output of the frequency inverter?

The mains current of a three-phase frequency inverter (MMX32, MMX34) with a main choke is virtually entirely active current (p.f. ($\cos \varphi$) around 1). The output current to the motor is thus the apparent current. It consists of the torque forming active current and the flux forming reactive current. The reactive current component is supplied by the internal DC link and depends on the power factor ($\cos \varphi$) of the motor.

Can a thermistor be connected directly to the M-Max frequency inverter?

No, these frequency inverters only allow the direct connection of thermostats (thermo-click). Thermistors must be connected via an external tripping device (e.g. EMT). In both cases, a digital input of the frequency inverter can be used for the connection. The trip can be indicated by assigning the External fault signal.

8.14 List of parameters

The abbreviations used in the lists of parameters have the following meaning:

PNU	Parameter number
ID	Identification number of the parameter
RUN	Access rights to the parameters during operation (RUN): ✓ = Modification permissible, - = Modification only possible in STOP
ro/rw	Parameter read and write permissions via a fieldbus connection (BUS) ro = read only rw = read and write
DS	Factory setting of the parameters
Own	User setting of the parameters

8.14.1 Quick configuration (basis)



When first switching on or after activating the default settings (S4.2 = 1), you are guided step by step through the provided parameters by the quick-start assistant. The defined values are confirmed with the OK button or they can be changed to suit your application and the motor data.

The quick-start assistant can be switched off in the first parameter (P1.1) by entering a zero (access to all parameters).

In parameter P1.2, you can switch to the specified application setting with the quick-start assistant (Table 9, page 105).

The quick-start assistant ends this first cycle by automatically switching to frequency display (M1.1 = 0.00 Hz).

By selecting the parameter level (PAR) again, besides the selected parameters for the quick-configuration, the system parameters (S) are also shown in other cycles.

8 Appendix

8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
P1.1	115	✓	rw	Parameter range	0 = all parameters 1 = Only quick configuration parameters	104	1	
P1.2	540	-	rw	Application	0 = Basic 1 = Pump drive 2 = Fan drive 3 = Hoisting device (high load)	104	0	
P1.3	1472	-	rw	Default setting (DS), Country-specific	0 = EU 1 = USA	104	0 1	
P6.1	125	✓	rw	Control level	1 = Control signal terminals (I/O) 2 = Control unit (KEYPAD) 3 = Field bus (BUS)	126	1	
P6.2	117	✓	rw	Setpoint input	0 = fixed frequency (FF0) 1 = Control unit (KEYPAD) 2 = field bus (BUS) 3 = AI1 (analog setpoint value 1) 4 = AI2 (analog setpoint value 2) 5 = Motor potentiometer	127	3	
P6.3	101	-	rw	Minimum frequency	0.00 - P6.4 Hz	127	0.00	
P6.4	102	-	rw	Maximum frequency	P6.3 - 320.00 Hz	127	50.00 60.00	
P6.5	103	-	rw	Acceleration time (acc1)	0.1 - 3000 s	127	3.0	
P6.6	104	-	rw	Deceleration time (dec1)	0.1 - 3000 s	127	3.0	
P6.7	505	-	rw	Start Function	0 = Acceleration time (ramp) 1 = Flying restart circuit	129	0	
P6.8	506	-	rw	Stop Function	0 = Free coasting 1 = Deceleration time (ramp)	129	0	
P7.1	113	-	rw	Motor, rated operational current	$0.2 \times I_e - 2 \times I_e$ (→ Motor rating plate)	135	I_e	
P7.3	112	-	rw	Motor, rated speed	300 - 20000 min ⁻¹ (→ Motor rating plate)	135	1440 1720	
P7.4	120	-	rw	Motor, power factor (cos φ)	0.30 - 1.00 (→ Motor rating plate)	135	cos φ	
P7.5	110	-	rw	Motor, rated operating voltage	180 - 500 V (→ Motor rating plate)	135	230 400	
P7.6	111	-	rw	Motor, rated frequency	30 - 320 Hz (→ Motor rating plate)	135	50.00 60.00	
P11.7	109	-	rw	Torque increase	0 = Deactivated 1 = activated	159	0	
M1.1	1	-	ro	Output Frequency	Hz	181	0.00	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
System parameters in the quick-configuration								
S1.1	833	-	ro	API SWD ID	-	178	-	
S1.2	834	-	ro	API SW Version	-	178	-	
S1.3	835	-	ro	Power SW ID	-	178	-	
S1.4	836	-	ro	Power SW Version	-	178	-	
S1.5	837	-	ro	Application ID	-	178	-	
S1.6	838	-	ro	Application, revision	-	178	-	
S1.7	838	-	ro	System load	-	178	-	
S2.1 ¹⁾	808	-	ro	Communication status	RS485 in xx.yyy format xx = Number of error messages (0 - 64) yyy = number of correct messages (0 - 999)	178		
S2.2 ¹⁾	809	✓	rw	Field bus protocol	0 = FB disabled 1 = Modbus	178	0	
S2.3 ¹⁾	810	✓	rw	Address (slave)	1 - 255	178	1	
S2.4 ¹⁾	811	✓	rw	Baud rate	0 = 300 1 = 600 2 = 1200 3 = 2400 4 = 4800 5 = 9600	178	5	
1) These parameters are overwritten with the bus-specific parameters when a fieldbus connection (e.g. CANopen) is used. The parameter values described in the manual of the fieldbus interface then apply.								
S2.6	813	✓	rw	Parity type	0 = None, no → 2 Stop bits 1 = Even, → 1 Stop bit 2 = Odd → 1 Stop bit	179	0	
S2.7	814	✓	rw	Communication status "timeout"	0 = not used 1 = 1 s 2 = 2 s = up to 255 s	179	0	
S2.8	815	✓	rw	Reset communication status	0 = not used 1 = resets parameter S2.1	179	0	
S3.1	827	-	ro	MWh counter	MWh	179	-	
S3.2	828	-	ro	Days Installed	0 - 0000 days	179	-	
S3.3	829	-	ro	Operating Hours	0 - 24 h	179	-	
S3.4	840	-	ro	RUN counter, days	0 - 0000 days	179	-	
S3.5	841	-	ro	RUN counter, hours	0 - 24 h	179	-	
S3.6	842	-	ro	FLT counter	Trip Counter: 0 - 0000	179	-	
S4.1	830	✓	rw	Display contrast	0 - 15	179	7	
S4.2	831	-	rw	Default settings (DS)	0 = Default settings or changed value 1 = restores default settings for all parameters	179	0	
S4.3	832	✓	rw	Password entry	0000 - 9999	179	0000	

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8.14 List of parameters

8.14.2 All Parameters



When first switching on or after activating the default settings (S4.2 = 1) parameter P1.1 must be set to 0 for access to all parameters.

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
Parameter selection								
P1.1	115	✓	rw	Parameter range	0 = all parameters 1 = Only quick configuration parameters	104	1	
P1.2	540	-	rw	Application	0 = Basic 1 = Pump drive 2 = Fan drive 3 = Hoisting device (high load)	104	0	
P1.3	1472	-	rw	Default setting (DS), Country-specific	0 = EU 1 = USA	104	0	
Analog input								
P2.1	379	✓	rw	AI1, Signal range	(microswitches S2) 0 = 0 - +10 V/0 - 20 mA 1 = 2 - +10 V/4 - 20 mA	107	0	
P2.2	380	✓	rw	AI1, minimum value	-100.00 - 100.00 %	107	0	
P2.3	381	✓	rw	AI1, maximum value	-100.00 - 100.00 %	107	100	
P2.4	378	✓	rw	AI1, filter time constant	0.0 - 10.0 s	107	0.1	
P2.5	390	✓	rw	AI2, Signal range	(microswitches S3) Like P2.1	107	1	
P2.6	391	✓	rw	AI2, minimum value	-100.00 - 100.00 %	107	0	
P2.7	392	✓	rw	AI2, maximum value	-100.00 - 100.00 %	107	100	
P2.8	389	✓	rw	AI2, filter time constant	0.0 - 10.0 s	107	0.1	
Digital input								
P3.1	300	✓	rw	Start/stop logic	0 = DI1 (FWD), DI2 (REV), REAF 1 = DI1 (FWD) + DI2 = REV 2 = DI1 (Start pulse), DI2 (Stop pulse) 3 = DI1 (FWD), DI2 (REV)	111	3	
P3.2	403	✓	rw	Start signal 1 (FWD)	0 = Deactivated 1 = activated via control signal terminal 8 (DI1) 2 = activated via control signal terminal 9 (DI2) 3 = activated via control signal terminal 10 (DI3) 4 = activated via control signal terminal 14 (DI4) 5 = activated via control signal terminal 15 (DI5) 6 = activated via control signal terminal 16 (DI6)	111	1	
P3.3	404	✓	rw	Start signal 2 (REV)	like P3.2	111	2	
P3.4	412	✓	rw	Reversing	like P3.2	112	0	
P3.5	405	✓	rw	External fault (N/O)	like P3.2	112	0	
P3.6	406	✓	rw	External fault (N/C)	like P3.2	112	0	
P3.7	414	✓	rw	Error acknowledgment (Reset)	like P3.2	112	5	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
P3.8	407	✓	rw	Start enable	like P3.2	112	0	
P3.9	419	✓	rw	Fixed frequency, binary value B0	like P3.2	112	3	
P3.10	420	✓	rw	Fixed frequency, binary value B1	like P3.2	112	4	
P3.11	421	✓	rw	Fixed frequency, binary value B2	like P3.2	112	0	
P3.12	1020	✓	rw	PID controller, deactivated (PI-OFF)	like P3.2	113	6	
P3.13	1400	✓	rw	Thermistor input, currently deactivated	like P3.2	113	0	
P3.14	1401	✓	rw	External brake, feedback signal (N/O)	like P3.2	113	0	
P3.15	1402	✓	rw	Change acceleration/ deceleration time	like P3.2	113	0	
P3.16	1403	✓	rw	Stop acceleration/ deceleration time	like P3.2	113	0	
P3.17	1404	✓	rw	Block parameters	like P3.2	113	0	
P3.18	1405	✓	rw	Motor potentiometer, increase value	like P3.2	114	0	
P3.19	1406	✓	rw	Motor potentiometer, reduce value	like P3.2	114	0	
P3.20	1407	✓	rw	Motor potentiometer, set value to zero	like P3.2	114	0	
P3.21	1408	✓	rw	Sequence control, program start	like P3.2	118	0	
P3.22	1409	✓	rw	Sequence control, program pause	like P3.2	118	0	
P3.23	1410	✓	rw	Counter, input signal	like P3.2	118	0	
P3.24	1411	✓	rw	Counter, reset	like P3.2	118	0	
P3.25	1412	✓	rw	Change control level	like P3.2	119	0	
P3.26	1413	✓	rw	Change setpoint source (I/O)	like P3.2	119	0	
P3.27	1414	✓	rw	Second parameter set (2 PS)	like P3.2	119	0	
P3.28	1415	✓	rw	Field bus, remote input	like P3.2	119	0	
P3.29	1416	✓	rw	Meter, output signal 1	0 - 65535	119	0	
P3.30	1417	✓	rw	Meter, output signal 2	0 - 65535	119	0	
P3.31	1418	✓	rw	DI1 logic (control signal terminal 8)	0 = N/O 1 = N/C	119	0	
P3.32	1419	✓	rw	DI2 logic (control signal terminal 9)	Like P3.31	119	0	
P3.33	1420	✓	rw	DI3 logic (control signal terminal 10)	Like P3.31	119	0	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
P3.34	1421	✓	rw	DI4 logic (control signal terminal 14)	Like P3.31	119	0	
P3.35	1422	✓	rw	DI5 logic (control signal terminal 15)	Like P3.31	119	0	
P3.36	1423	✓	rw	DI6 logic (control signal terminal 16)	Like P3.31	119	0	
P3.37	1480	✓	rw	Manual mode	like P3.2	119	0	
Analog output								
P4.1	307	✓	rw	AO signal (Analog Output)	0 = Deactivated 1 = Output frequency f-Out = 0 – f _{max} (P6.4) 2 = Output current I ₂ = 0 – I _{N Motor} (P7.1) 3 = Torque M _N = 0 – 100 % (calculated value) 4 = PID controller, output (0 - 100 %)	121	1	
P4.2	310	✓	rw	AO, minimum value	0 = 0 V 1 = 2 V (live-zero)	121	1	
P4.3	1456	✓	rw	AO, gain	0.00 - 200.00 %	121	100.00	
P4.4	1477	✓	rw	AO, filter time	0.00 - 10.00 s	121	0.0	
Digital output								
P5.1	313	✓	rw	R01 Signal (Relay 1 Output)	0 = Deactivated 1 = READY, ready for operation 2 = RUN, enable (FWD, REV) 3 = FAULT, error message 4 = Error message inverted 5 = ALARM, Danger 6 = REV, anticlockwise rotating field 7 = Output frequency = frequency reference value 8 = Motor controller active 9 = Zero frequency 10 = Frequency monitoring 1 11 = Frequency monitoring 2 12 = PID control 13 = Overtemperature message 14 = Overcurrent control active 15 = Overvoltage control active 16 = Sequence control active 17 = Sequence control, single step completed 18 = Sequence control, program cycle completed 19 = Sequence control, pause 20 = Counter, value 1 reached 21 = Counter, value 2 reached 22 = RUN message active 23 = Setpoint error (live-zero) 24 = LOG function fulfilled 25 = PID controller, actual value monitoring 26 = External brake actuated 27 = Current monitoring 28 = Field bus, remote output	122	2	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
P5.2	314	✓	rw	R02 Signal (Relay Output 2)	Like P5.1	123	3	
P5.3	312	✓	rw	D0 Signal (Digital Output 1)	Like P5.1	123	1	
P5.4	315	✓	rw	Frequency monitoring 1	0 = Deactivated 1 = 0.00 - P5.5 Hz 2 = P5.5 - P6.4 Hz	123	0	
P5.5	316	✓	rw	Frequency monitoring 1, range	0.00 - P6.4 Hz	123	0.00	
P5.6	346	✓	rw	Frequency monitoring 2	0 = Deactivated 1 = 0.00 - P5.7 Hz 2 = P5.7 - P6.4 Hz	124	0	
P5.7	347	✓	rw	Frequency monitoring 2, range	0.00 - P6.4 Hz	124	0.00	
P5.8	1457	✓	rw	Current monitoring	0.00 – P7.2 A	125	0.00	
P5.9	1458	✓	rw	D0 logic (control signal terminal 13)	0 = N/O 1 = N/C	125	0	
P5.10	1331	✓	rw	R01 logic (control signal terminal 22, 23).	Like P5.9	125	0	
P5.11	1332	✓	rw	R02 logic (control signal terminal 24, 25, 26).	Like P5.9	125	0	
P5.12	1459	✓	rw	D0, switch-on delay	0.00 - 320.00 s	125	0.00	
P5.13	1460	✓	rw	D0, off-delay	0.00 - 320.00 s	125	0.00	
P5.14	1461	✓	rw	R01, switch-on delay	0.00 - 320.00 s	125	0.00	
P5.15	1424	✓	rw	R01 Off-delay	0.00 - 320.00 s	125	0.00	
P5.16	1425	✓	rw	R02, switch-on delay	0.00 - 320.00 s	125	0.00	
P5.17	1426	✓	rw	R02 Off-delay	0.00 - 320.00 s	125	0.00	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
Drives control								
P6.1	125	✓	rw	Control level	1 = Control signal terminals (I/O) 2 = Control unit (KEYPAD) 3 = Field bus (BUS)	126	1	
P6.2	117	✓	rw	Setpoint Source	0 = fixed frequency (FF0) 1 = Operating unit (REF) 2 = field bus (BUS) 3 = AI1 (analog setpoint value 1) 4 = AI2 (analog setpoint value 2) 5 = Motor potentiometer	127	3	
P6.3	101	-	rw	Minimum frequency	0.00 - P6.4 Hz	127	0.00	
P6.4	102	-	rw	Maximum frequency	P6.3 - 320.00 Hz	127	50.00	
P6.5	103	-	rw	Acceleration time (acc1)	0.1 - 3000 s	127	3.0	
P6.6	104	-	rw	Deceleration time (dec1)	0.1 - 3000 s	127	3.0	
P6.7	505	-	rw	Start Function	0 = Ramp, acceleration 1 = Flying restart circuit	129	0	
P6.8	506	-	rw	Stop Function	0 = Free coasting 1 = Ramp, deceleration	129	0	
P6.9	500	-	rw	S ramp, time-based S-form	0.00 = linear 0.1 - 10.0 s (S-shaped)	129	0.0	
P6.10	717	-	rw	REAF, Wait time before an automatic restart	0.10 - 10.00 s	130	0.50	
P6.11	718	-	rw	REAF, Test time before an automatic restart	0.00 - 60.00 s	130	30.00	
P6.12	719	-	rw	REAF, Start function with automatic restart	0 = Ramp 1 = Flying restart circuit 2 = Set as in P6.7	130	0	
P6.13	731	-	rw	REAF, automatic restart after an error message	0 = deactivated 1 = activated	130	0	
P6.14	1600	-	rw	Stop on rotation direction change (KEYPAD)	0 = Deactivated 1 = activated	130	1	
P6.15	184	-	rw	Setpoint input (REF)	-P6.4 - 0.00 - +P6.3 Hz	131	0.00	
P6.16	1474	-	rw	STOP pushbutton	0 = Deactivated 1 = activated	131	1	
P6.17	1427	-	rw	Control level 2	1 = Control signal terminals (I/O) 2 = Control unit (KEYPAD) 3 = Field bus (BUS)	131	3	
P6.18	1428	-	rw	Setpoint Source 2	0 = fixed frequency (FF0) 1 = Operating unit (REF) 2 = field bus (BUS) 3 = AI1 (analog setpoint value 1) 4 = AI2 (analog setpoint value 2) 5 = Motor potentiometer	131	2	
P6.19	502	-	rw	Second acceleration time (acc2)	0.1 - 3000 s	132	10.0	
P6.20	503	-	rw	Second deceleration time (dec2)	0.1 - 3000 s	132	10.0	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
P6.21	526	-	rw	Transition frequency (acc1 - acc2)	0.00 - P6.4 Hz	132	0.00	
P6.22	1334	-	rw	Transition frequency (dec1 - dec2)	0.00 - P6.4 Hz	132	0.00	
P6.23	1429	-	rw	REV blocked	0 = Deactivated 1 = activated	132	0	
P6.24	509	-	rw	Frequency jump 1, lower value	0.00 - P6.4 Hz	133	0.00	
P6.25	510	-	rw	Frequency jump 1, upper value	0.00 - P6.4 Hz	133	0.00	
P6.26	511	-	rw	Frequency jump 2, lower value	0.00 - P6.4 Hz	133	0.00	
P6.27	731	-	rw	Frequency jump 2, upper value	0.00 - P6.4 Hz	133	0.00	
P6.28	513	-	rw	Frequency jump 3, lower value	0.00 - P6.4 Hz	133	0.00	
P6.29	514	-	rw	Frequency jump 3, upper value	0.00 - P6.4 Hz	133	0.00	
P6.30	759	-	rw	REAF, number of automatic restarts	1 - 10	133	3	
P6.31	1481	-	rw	Manual mode, control level	1 = Control signal terminals (I/O) 2 = Control unit (KEYPAD) 3 = Field bus (BUS)	133	1	
P6.32	1482	-	rw	Manual mode, setpoint source	0 = fixed frequency (FF0) 1 = Operating unit (REF) 2 = field bus (BUS) 3 = AI1 (analog setpoint value 1) 4 = AI2 (analog setpoint value 2) 5 = Motor potentiometer	133	3	
P6.33	1483	-	rw	Manual mode, KEYPAD blocked	0 = Deactivated 1 = activated	133	1	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
Motor								
P7.1	113	-	rw	Motor, rated operational current	$0.2 \times I_e - 2 \times I_e$ (→ Motor rating plate)	135	I_e	
P7.2	107	-	rw	Current limitation	$0.2 \times I_e - 2 \times I_e$	135	$1.5 \times I_e$	
P7.3	112	-	rw	Motor, rated speed	$300 - 20000 \text{ min}^{-1}$ (→ Motor rating plate)	135	1440 1720	
P7.4	120	-	rw	Motor, power factor (cos φ)	0.30 - 1.00 (→ Motor rating plate)	135	0.85	
P7.5	110	-	rw	Motor, rated operating voltage	180 - 500 V (→ Motor rating plate)	135	230 400	
P7.6	111	-	rw	Motor, rated frequency	30 - 320 Hz (→ Motor rating plate)	135	50.00 60.00	
Protective functions								
P8.1	700	-	rw	Setpoint error (live-zero)	0 = Deactivated 1 = Danger 2 = Error, stop according to P6.8	136	1	
P8.3	703	-	rw	Earth-fault protection	Like P8.1	136	2	
P8.4	709	-	rw	Stall protection	Like P8.1	137	1	
P8.5	713	-	rw	Underload protection	Like P8.1	137	0	
P8.6	704	-	rw	Motor, temperature protection	Like P8.1	137	2	
P8.7	705	-	rw	Motor, ambient air temperature	-20 - +100 °C	137	40	
P8.8	706	-	rw	Motor, cooling factor at zero frequency	0.0 - 150 %	137	40.0	
P8.9	707	-	rw	Motor, thermal time constant	1 - 200 min	137	45	
P8.10	1430	-	rw	Setpoint error (live-zero), response time	0.0 - 10.0 s	141	0.5	
P8.11	1473	-	rw	(Reserve)	Like P8.1	141	0	
P8.12	714	-	rw	Underload protection at cut-off frequency	10.0 - 150 %	141	50.0 60.0	
P8.13	715	-	rw	Underload protection at zero frequency	10.0 - 150 %	141	10.0	
P8.14	733	-	rw	Field bus error	0 = Deactivated 1 = Danger (AL 53) 2 = Error (F... 53) stop function according to P6.8	141	2	
P8.15	734	-	rw	Field bus, interface error	0 = Deactivated 1 = Danger (AL 54) 2 = Error (F... 54) stop function according to P6.8	137	2	

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PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
PID controller								
P9.1	163	✓	rw	PID controller	0 = Deactivated 1 = activated for drive control 2 = activated for external application	143	0	
P9.2	118	✓	rw	PID controllers, P amplification	0.0 - 1000.0 %	143	100.0	
P9.3	119	✓	rw	PID controller, I reset time	0.00 - 320.00 s	143	10.00	
P9.4	167	✓	rw	PID controller, setpoint input via operating unit	0.0 - 100.0 %	143	0.0	
P9.5	332	✓	rw	PID controller, setpoint source	0 = Operating unit (P9.4) 1 = Field bus (option) 2 = AI1 3 = AI2	143	0	
P9.6	334	✓	rw	PID controller, actual value (PV)	0 = Field bus (Option) 1 = AI1 2 = AI2	143	2	
P9.7	336	✓	rw	PID controller, actual value limiting, minimum	0.0 - 100.0 %	143	0.0	
P9.8	337	✓	rw	PID controller, actual value limiting, maximum	0.0 - 100.0 %	143	100.0	
P9.9	340	✓	rw	PID controller, controller deviation	0 = not inverted 1 = inverted	143	0	
P9.10	132	✓	rw	PID controller, D derivate action time	0.00 - 10.0 s	143	0.00	
P9.11	1431	✓	rw	PID controller, output filter, deceleration time	0.00 - 10.0 s	143	0.0	
P9.12	1016	✓	rw	Sleep mode, frequency	0.00 - P6.4 Hz	143	0.00	
P9.13	1018	✓	rw	Sleep mode, wake up frequency	0.0 - 100.0 %	144	25.0	
P9.14	1017	✓	rw	Sleep mode, deceleration time	0 - 3600 s	144	30	
P9.15	1433	✓	rw	Hysteresis, upper limit	0.0 - 100.0 %	144	0.0	
P9.16	1434	✓	rw	Hysteresis, lower limit	0.0 - 100.0 %	144	0.0	
P9.17	1435	✓	rw	PID controller, max. system derivation	0.0 - 100.0 %	147	3.0	
P9.18	1475	✓	rw	PID controller, scale setpoint value display	0.1 - 32.7	147	1.0	
P9.19	1476	✓	rw	PID controller, scale actual value display	0.1 - 32.7	147	1.0	
P9.20	1478	✓	rw	PID controller, output signal limitation	0.00 - 100.0 %	147	100.0	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
Fixed frequencies								
P10.1	124	✓	rw	Fixed frequency FF0	0.00 - P6.4 Hz	150	5.00 6.00	
P10.2	105	✓	rw	Fixed frequency FF1	0.00 - P6.4 Hz	150	10.00 12.00	
P10.3	106	✓	rw	Fixed frequency FF2	0.00 - P6.4 Hz	150	15.00 18.00	
P10.4	126	✓	rw	Fixed frequency FF3	0.00 - P6.4 Hz	150	20.00 24.00	
P10.5	127	✓	rw	Fixed frequency FF4	0.00 - P6.4 Hz	150	25.00 30.00	
P10.6	128	✓	rw	Fixed frequency FF5	0.00 - P6.4 Hz	150	30.00 36.00	
P10.7	129	✓	rw	Fixed frequency FF6	0.00 - P6.4 Hz	150	40.00 48.00	
P10.8	130	✓	rw	Fixed frequency FF7	0.00 - P6.4 Hz	150	50.00 60.00	
P10.9	1436	✓	rw	Sequence control	0 = Deactivated 1 = Program cycle, execute once 2 = Execute program cycle continuously 3 = Execute program cycle in steps 4 = Execute program cycle continuously in steps	151	0	
P10.10	1437	✓	rw	Sequence control, program (FWD/REV)	0 - 255	151	0	
P10.11	1438	✓	rw	Set time for FF0	0 - 10000 s	153	0	
P10.12	1439	✓	rw	Set time for FF1	0 - 10000 s	153	0	
P10.13	1440	✓	rw	Set time for FF2	0 - 10000 s	153	0	
P10.14	1441	✓	rw	Set time for FF3	0 - 10000 s	153	0	
P10.15	1442	✓	rw	Set time for FF4	0 - 10000 s	153	0	
P10.16	1443	✓	rw	Set time for FF5	0 - 10000 s	153	0	
P10.17	1444	✓	rw	Set time for FF6	0 - 10000 s	153	0	
P10.18	1445	✓	rw	Set time for FF7	0 - 10000 s	153	0	

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
U/f characteristic curve								
P11.1	108	-	rw	U/f characteristic curve	0 = Linear 1 = Quadratic 2 = parameterizable	159	0	
P11.2	602	-	rw	Cut-off frequency	30.00 - 320.00 Hz	160	50.00 60.00	
P11.3	603	-	rw	Output voltage	10.00 – 200.00 % of the motor rated voltage (P6.5)	160	100.00	
P11.4	604	-	rw	U/f characteristic curve, mean frequency value	0.00 - P11.2 Hz	160	50.00 60.00	
P11.5	605	-	rw	U/f characteristic curve, mean voltage value	0.00 - P11.3 %	160	100.00	
P11.6	606	-	rw	Output voltage at zero frequency	0.00 - 40.00 %	161	0.00	
P11.7	109	-	rw	Torque increase	0 = Deactivated 1 = activated	161	0	
P11.8	600	-	rw	Control mode	0 = Frequency control (U/f) 1 = Speed control with slip compensation	161	0	
P11.9	601	-	rw	Pulse frequency	1.5 - 16.0 kHz	163	6.0	
P11.10	522	-	rw	Stabilize pulse frequency, (sinusoidal filter)	0 = Deactivated 1 = activated	163	0	

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8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
Braking								
P12.1	507	-	rw	DC braking, current	$0.2 \times I_e - 2 \times I_e$	165	I_e	
P12.2	516	-	rw	DC braking, braking time at start	0.00 - 600.00 s	165	0.00	
P12.3	515	-	rw	DC braking, start frequency during delay ramp	0.00 - 10.00 Hz	166	1.50	
P12.4	508	-	rw	DC braking, braking time in case of STOP	0.00 - 600.00 s	167	0.00	
P12.5	504	-	rw	Brake chopper	(only active and visible with braking transistor installed) 0 = Deactivated 1 = Automatic activation in operation (RUN) 2 = Automatic activation in operation (RUN) and upon stop (STOP)	169	0	
P12.6	1447	-	rw	Brake chopper, switching threshold	(only active and visible with braking transistor installed) 0 - 870 V	169	405 767	
P12.7	1448	-	rw	Open external brake, deceleration time	0.00 - 320.00 s	170	0.20	
P12.8	1449	-	rw	Open external brake, frequency limit value	0.00 - P6.4 Hz	170	1.50	
P12.9	1450	-	rw	Close external brake, frequency limit value	0.00 - P6.4 Hz	170	1.00	
P12.10	1451	-	rw	Close external brake, frequency limit value on reversing (REV)	0.00 - P6.4 Hz	170	1.50	
P12.11	1452	-	rw	Open external brake, current limit value	0.00 - P7.2 A	170	0.00	

8 Appendix
8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
Logic function								
P13.1	1453	-	rw	LOG function, Selection input A	0 = Deactivated 1 = READY, ready for operation 2 = RUN, enable (FWD, REV) 3 = FAULT, error message 4 = Error message inverted 5 = ALARM, Danger 6 = REV, anticlockwise rotating field 7 = Output frequency = frequency reference value 8 = Motor controller active 9 = Zero frequency 10 = Frequency monitoring 1 11 = Frequency monitoring 2 12 = PID control 13 = Overtemperature message 14 = Overcurrent control active 15 = Overvoltage control active 16 = Sequence control active 17 = Sequence control, single step completed 18 = Sequence control, program cycle completed 19 = Sequence control, pause 20 = Counter, value 1 reached 21 = Counter, value 2 reached 22 = RUN message active 23 = Setpoint error (live-zero) 24 = LOG function fulfilled 25 = PID controller, actual value monitoring 26 = External brake actuated 27 = Current monitoring 28 = Field bus, remote output	172	0	
P13.2	1454	-	rw	LOG function, Selection input B	Like P13.1	173	0	
P13.3	1455	-	rw	LOG function, select operation	0 = A AND B 1 = A OR B 2 = A XOR B	173	0	

8 Appendix

8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
Second parameter set								
P14.1	1347	-	rw	Motor (2PS), rated current limit	$0.2 \times I_e - 2 \times I_e$ (→ Motor rating plate)	174	I_e	
P14.2	1352	-	rw	Current limit (2PS)	$0.2 \times I_e - 2 \times I_e$	174	$1.5 \times I_e$	
P14.3	1350	-	rw	Motor (2PS) nominal speed	$300 \dots 20000 \text{ min}^{-1}$ (→ Motor rating plate)	174	1440 1720	
P14.4	1351	-	rw	Motor (2PS), power factor (cos ϕ)	0.30 - 1.00 (→ Motor rating plate)	174	0.85	
P14.5	1348	-	rw	Motor (2PS), rated operating voltage	180 - 500 V (→ Motor rating plate)	174	230 400	
P14.6	1349	-	rw	Motor (2PS), rated frequency	30 - 320 Hz (→ Motor rating plate)	174	50.00 60.00	
P14.7	1343	-	rw	Minimum frequency (2PS)	0.00 - P14.8 Hz	174	0.00	
P14.8	1344	-	rw	Maximum frequency (2PS)	P14.7 - 320.00 Hz	174	50.00 60.00	
P14.9	1345	-	rw	Acceleration time (2PS, acc3)	0.1 - 3000 s	174	3.0	
P14.10	1346	-	rw	Deceleration time (2PS, dec3)	0.1 - 3000 s	174	3.0	
P14.11	1355	-	rw	U/f characteristic curve (2PS), characteristic	0 = Linear 1 = Quadratic 2 = parameterizable	174	0	
P14.12	1354	-	rw	Torque increase (2PS)	0 = Deactivated 1 = activated	175	0	
P14.13	1353	-	rw	Motor (2PS), temperature protection	0 = Deactivated 1 = Danger 2 = Error, stop according to P6.8	175	2	
P14.14	1469	-	rw	Motor (2PS), ambient air temperature	-20 - +100 °C	175	40	
P14.15	1470	-	rw	Motor (2PS), cooling factor at zero frequency	0.0 - 150 %	175	40.0	
P14.16	1471	-	rw	Motor (2PS), thermal time constant	1 - 200 min	175	45	

8 Appendix

8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
System parameter								
Hard- and Software Information								
S1.1	833	-	ro	API SW ID	-	178	0	
S1.2	834	-	ro	API SW Version	-	178	0	
S1.3	835	-	ro	Power SW ID	-	178	0	
S1.4	836	-	ro	Power SW Version	-	178	0	
S1.5	837	-	ro	Application, ID	-	178	0	
S1.6	838	-	ro	Application, revision	-	178	0	
S1.7	839	-	ro	System load	%	178	0	
Communications								
S2.1 ¹⁾	808	-	ro	Communication status	In xx.yyy format xx = Number of error messages (0 - 64) yyy = number of correct messages (0 - 999)	178		
S2.2 ¹⁾	809	✓	rw	Field bus protocol	0 = FB disabled 1 = Modbus RTU	178	0	
S2.3 ¹⁾	810	✓	rw	Address (slave)	1 - 255	178	1	
S2.4 ¹⁾	811	✓	rw	Baud rate	0 = 300 1 = 600 2 = 1200 3 = 2400 4 = 4800 5 = 9600 6 = 19200 7 = 38400 8 = 57600	178	5	
1) These parameters are overwritten with the bus-specific parameters when a fieldbus connection (e.g. CANopen) is used. The parameter values described in the manual of the fieldbus interface then apply.								
S2.6	813	✓	rw	Parity type	0 = None, no → 2 Stop bits 1 = Even, → 1 Stop bit 2 = Odd → 1 Stop bit	179	0	
S2.7	814	✓	rw	Communication status "timeout"	0 = not used 1 = 1 s 2 = 2 s = up to 255 s	179	0	
S2.8	815	✓	rw	Reset communication status	0 = not used 1 = resets parameter S2.1	179	0	

8 Appendix

8.14 List of parameters

PNU	ID	Access right		Designation	Value range	Seite	DS (P1.3)	Own
		RUN	ro/rw					
Unit counter								
S3.1	827	-	ro	MWh counter	MWh	179	-	
S3.2	828	-	ro	Days Installed	0 - 0000 days	179	-	
S3.3	829	-	ro	Operating Hours	0 - 24 h	179	-	
S3.4	840	-	ro	RUN counter, days	0 - 0000 days	179	-	
S3.5	841	-	ro	RUN counter, hours	0 - 24 h	179	-	
S3.6	842	-	ro	FLT counter	Trip Counter: 0 - 0000	179	-	
User Settings								
S4.1	830	✓	rw	Display contrast	0 - 15	179	7	
S4.2	831	-	rw	Default settings (DS)	0 = Default setting or changed value 1 = restores default settings for all parameters	179	0	
S4.3	832	✓	ro	Password entry	0000 - 9999	179	0000	



Parameters marked with "M" (Monitor) are values currently being measured, variables calculated from these measured values, or status values from control signals.

The M parameters cannot be edited (only display values)

8 Appendix

8.14 List of parameters

PNU	ID	Access right ro/rw	Designation	Value range	Seite	Display Format	Measured values
Display values							
M1.1	1	ro	Frequency output value	Hz	181	0.00	
M1.2	25	ro	Frequency setpoint value	Hz	181	0.00	
M1.3	2	ro	Motor Speed	rpm (calculated value, rpm)	181	0	
M1.4	3	ro	Motor current	A	181	0.00	
M1.5	4	ro	Motor Torque	% (calculated value)	181	0.0	
M1.6	5	ro	Motor rating	% (calculated value)	181	0.0	
M1.7	6	ro	Motor Voltage	V	181	0.0	
M1.8	7	ro	Intermediate DC voltage circuit	V	181	0.0	
M1.9	8	ro	Unit Temperature	?C	181	0	
M1.10	9	ro	Motor temperature	% (calculated value)	181	0	
M1.11	13	ro	Analog input 1	%	181	0.0	
M1.12	14	ro	Analog input 2	%	181	0.0	
M1.13	26	ro	Analog output 1	%	181	0.0	
M1.14	15	ro	Digital input 1 - 3	DI1, DI2, DI3 status	181	0	
M1.15	16	ro	Digital input 4 - 6	DI4, DI5, DI6 status	181	0	
M1.16	17	ro	Digital output	RO1, RO2, DO status	181	1	
M1.17	20	ro	PID setpoint value	%	181	0.0	
M1.18	21	ro	PID feedback	%	181	0.0	
M1.19	22	ro	PID Error value	%	181	0.0	
M1.20	23	ro	PID Output	%	181	0.0	
M1.21	1480	ro	Counter, digital input	-	181	0	

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