TMM456E-9906

ÖKIMO
Antriebstechnik

Product Manual

MotorMaster
Frequency Inverter

MM407...422-EMC
MM515...540-EMC
MM655...6110

Software Version: 5.X

CE

This Product Manual includes the following important information in connection with the CE marking:
- Validity
- Planning the installation, mounting and wiring, commissioning, servicing

1117-102-100/02

NOTE: The setting-up and commisioning of MM45 and MM6 Frequency Inverters is almost identical to that with the MM3SV range. Reference is therefore made to both MM6 and MM3SV.

Software version

This Product Manual is compatible with MM456 Frequency Inverters with version 5.X software. Contact your supplier should MM456 Frequency Inverter indicates a different software version on power-up.

Installation details

Serial number:
(see product label or name plate) _____

Where installed:
(for your own information)

_____

MM456 Frequency Inverter as in EMC DIRECTIVE used as: ☐ Component ☐ Relevant Apparatus

Mounting: ☐ Wall-mounted ☐ Enclosure

For your personal notes

KIMO Antriebstechnik
KIMO Industrie-Elektronik GmbH
Am Weichselgarten 19, D-91058 Erlangen
Issue 5.x/00

Available product documentation

MM456 Frequency Inverters use a revolutionary software concept which provides for:

- Easy use and programming for normal applications
- High level of flexibility and sophistication for complex volume applications

To cater for the needs of these two user groups the product documentation is structured as follows:

Documentation	**Contents**	**Chapters**	**Status**
Product Manual TMM456E-9906	• Technical data, installation, CE, EMC, LVD and UL issues, options • Setting-up and commissioning for all normal applications	0...11	Supplied with every MM456 Frequency Inverter
Parameter List TMM456/3SV-PMLE-9906 (supplied separately as part of product manual)	• Complete parameter list		
Software and Application Manual TMM456/3SV-SAM 9908	• Setting-up and commissioning for all normal applications • Detailled description of all function blocks • Application information for various applications (available soon)	21...27* 28.1...28.8	Must be ordered separately
Application Software ASM-K02	• Variable-speed control of fans in ventilation applications (HVAC)		Must be ordered separately

* Chapters 24...26 are identical to chapters 4...6 in the Product Manual

WARNINGS, RISKS

The following warnings and risks are included to enable the user to obtain the maximum effectiveness and to alert the user to safety issues.

WARNING

Installation, operation, programming and maintenance of the equipment should be carried out by qualified personnel. A qualified person is someone who is technically competent and familiar with all safety information and established safety practices; with the installation process, operation and maintenance of this equipment; and with all the hazards involved. Non-compliance with this warning may result in lethal personal injury and/or equipment damage.

Never work on any control equipment without first isolating all power supplies from the equipment.

The capacitors in the d.c. link carry high voltages also after switching off. Wait at least 3 min before removing the protective cover, otherwise there is a high risk of electric shock. Measure the DC+ and DC- terminal voltage to confirm that the voltage is less than 50 V.

The drive motor must be connected to an appropriate safety earth. Failure to do so presents an electrical shock hazard.

The heat sink can reach a temperature of up to 90 °C.

CAUTION

These MM456 inverters were tested before they left our factory. However, before installation and start-up, inspect all equipment for transit damage, loose parts, packing materials etc.

Never perform high voltage resistance checks on the wiring without first disconnecting the MM456 Frequency Inverter from the circuit being tested.

ELECTROSTATIC SENSITIVE COMPONENTS

This equipment contains electrostatic discharge (ESD) sensitive components.
Observe static control precautions when handling, installing and servicing this product.

REPLACING EQUIPMENT

When replacing a MM456 Frequency Inverter it is essential that all user defined parameters that determine drive operation are correctly installed before putting back into service.

Failure to do so may create a hazard or risk of lethal injury.

INSTALLATION

This product conforms to IP20 protection. Due consideration should be given to the appropriate regulations of safety and protection in accordance with the environmental conditions of installation. To maintain compliance with the European LOW-VOLTAGE DIRECTIVE as in EN50178, the MM456 Frequency Inverter should preferably be mounted in a suitable enclosure requiring a tool for opening.

Ensure that
- mechanically secure fixings are used as recommended.

- cooling and air flow around the product are as recommended.
- cables and wire terminations are as recommended and clamped to required torque.
- the installation and commissioning of this product are carried out by a qualified competent person.
- the product rating is not exceeded.

This equipment must be permanently earthed due to the relatively high leakage current.

Refer to **SPECIAL INSTRUCTIONS**, page 0-12 should the MM456 Frequency Inverter be wall mounted.

APPLICATION RISK

The integration of this product into other system is not the responsibility of the supplier or manufacturer as to its applicability, effectiveness or safety of operation or of other apparatus or systems.

Where appropriate the user should consider the relevant aspects of the following risk assessment

RISK ASSESSMENT

Under fault conditions or conditions not intended:

- The motor speed may be incorrect.
- The motor speed may be excessive.
- The direction of rotation may be incorrect.
- The motor may be energized (unless suitable precautions are taken in the installation).

In all situations the user should provide sufficient guarding to prevent risk of injury and/or install suitable monitoring and safety systems in accordance with safety regulations.

SPECIAL INSTRUCTIONS

APPLICATION AREA: Speed control of three-phase induction or synchronous motors in industrial applications (non consumer)

APPLICATIONS ADVICE: Applications advice and training is available from your supplier.

POWER LOSS: During power loss the MM456 inverter will not operate as specified. The power should not be reapplied for a period of 30 s to allow the inverter limit circuit to operate correctly.

MAINTENANCE: Maintenance should only be performed by trained competent persons in accordance with the manufacturer's instructions using only the recommended spares (or return to supplier for repair). Use of unapproved spare parts may create a hazard and risk of injury. Refer to **MAINTENANCE**, page 7-2 for more details.

REPAIRS The supplier should be contacted if a MM456 Frequency Inverter is defect. A repair can be arranged at the manufacturer of authorized agent.
Repair reports can only be given if a sufficient and accurate defect report is returned with the defect inverter.

PACKAGING: The packaging is combustible and if disposed of in this manner incorrectly may lead to the generation of toxic fumes which are lethal.

WEIGHT:	Consideration should be given to the weight of the product when handling.
PROTECTIVE INSULATION:	All exposed metal parts are protected by basic insulation and bonding to earth i.e. Class I**. Earth bonding is the responsibility of the installer**. All signal terminals are protected by double insulation, i.e. Class II insulation. The purpose of this protection is to allow safe connection to other low voltage equipment.
WALL MOUNTING:	The matching NEMA 1 cover (see page 9-6) must be used to conform to the European LOW-VOLTAGE DIRECTIVE as in EN50178.
RISK OF ELECTRIC SHOCK OR INJURY:	MM456 Frequency Inverter used without the required precautions can represent an electrical hazard and risk of severe personal injury. Rotating or moving parts or structures powered by the inverter also represent a mechanical hazard with risk of severe personal injury or damage to machinery or property.

SCOPE OF THIS PRODUCT MANUAL

This Product Manual describes the operation of MM456 Frequency Inverters.

It is **not** intended that this Product Manual describes the function of the apparatus or system into which the MM456 Frequency Inverter is installed.

This Product Manual is to be made available to all persons who are required to design an installation using the MM456 Frequency Inverter or to install, set up, commissioning, service operate or are in any way involved with the MM456 Frequency Inverter itself.

These persons who must be suitably qualified must read this Product Manual thoroughly and completely before beginning with the installation and commissioning.

TECHNICAL CHANGES

The manufacturer reserves the right to change the content and product specification without notice.

WARRANTY

This piece of equipment is warranted against defects in design materials and workmanship for a period of 12 month from the date of delivery as detailed in the general terms of supply and payment of the ZVEI (Federation of the German Electrical Industry).

Chapter 1 - PRODUCT OVERVIEW

GENERAL DESCRIPTION

MM456 Frequency Inverters:

- Suitable for the speed control of standard 3-phase induction motors (squirrel-cage motors with fixed or variable speed)
- Universally suitable for general industry applications with a constant torque requirement as well as for fans and pumps with a quadratic load characteristic
- Can be supplied for the following supply voltages:

			for motors up to	
• 1/N AC:	- 230 V	±15 %	2.2	kW
• 3AC:	- 380...460 V	±10 %	11	kW (15 kW with HVAC)
	- 230 V	±15 %	7.5	kW (11 kW with HVAC)

- Universally suitable for nearly all drive applications
- Optimum cost/performance

Powerful microprocessor control and software:

- Simple programming and diagnostics with an operating panel consisting of 2x16 character plain multilanguage LCD display, 5 function keys for programming and 5 additional keys to allow basic operation control in LOCAL MODE.
- Sine-wave PWM modulation in the full speed range
- Special low-noise quiet-pattern PWM
- Advanced protection functions with auto-restart control
- Many powerful application-orientated software functions, see page 1-4
- RS232 serial link
- Input for 2 track incremental encoder for speed detection

EMC:

- All MM456 Frequency Inverters are supplied with a built-in EMC filter to class B interference protectionor can be supplied with external EMC filters. Please refer to supplier for difficult applications (e.g. long cable runs).

Options MM45:

- Removable operating panel
- Mounting kit for separate mounting programming pad, e.g. in a door of an enclosure
- NEMA 1 top cover
- RS 485/422 serial link (technology box)
- PROFIBUS-DP Bussystem (technology box)
- CANBUS Devicenet and CANopen (technology box)
- ECHELON bus interface
- Braking resistors
- KIMOVIS software for operating and programming (WINDOWS and DOS)

Options MM6:

- Options as with MM45
- Digital speed feedback (technology box)

Standard supply:

- MM456 Frequency Inverter
- Product Manual TMM456 including parameter list

Further documentation:

- Software and application manual TMM456/3SV-SAM
- EMC Compendium AF-MM-02
- Product information CE marking of electronic drive equipment PI-LKTM-005

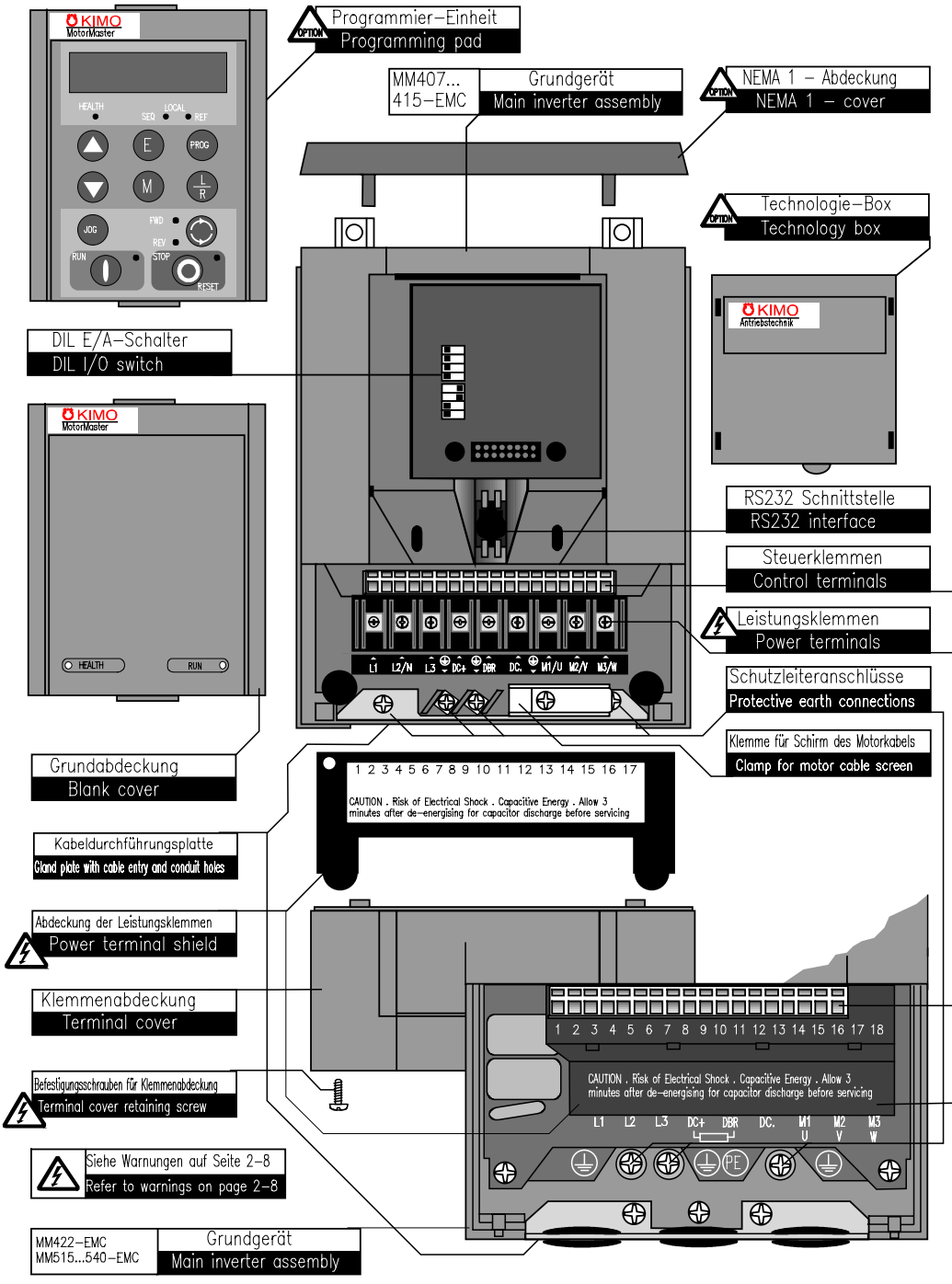


Fig. 1.1a: Main parts of MM45 Frequency Inverter
(Main inverter assembly MM422, MM515...540 lower right)

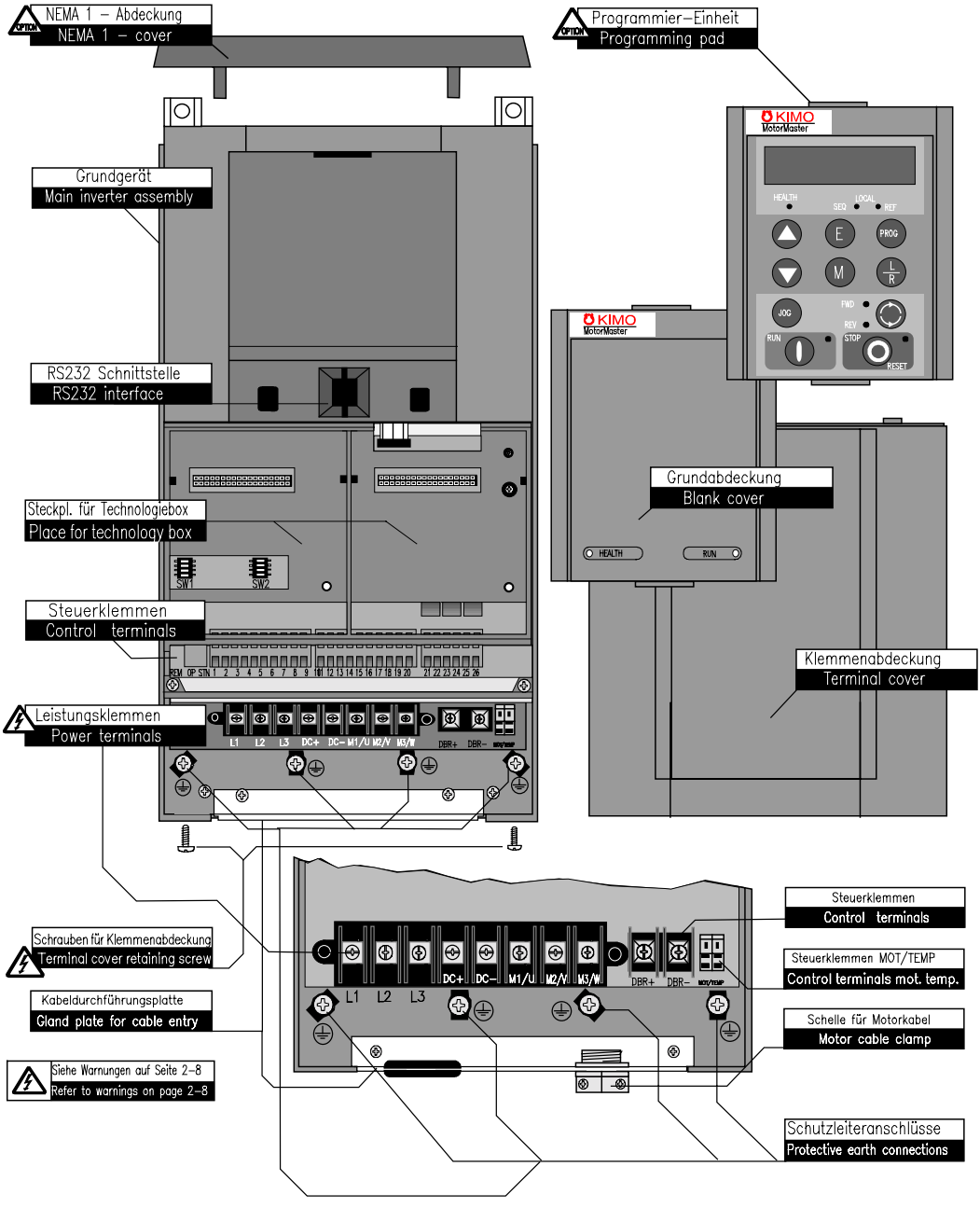


Fig. 1.1b: Main parts of MM6 Frequency Inverter

TECHNICAL DATA

General

Control;	Full local control via the operating panel or with external analog and digital control inputs
Output frequency:	0...120 Hz, 0...240 Hz or 0...480 Hz (selectable)
Switching frequency:	3, 6 or 9 kHz (selectable, available frequencies depends on rated size)
Stopping modes:	Ramp, Ramp with d.c.holding pulse, d.c. injection braking , coast, FRAMP (fast ramp)
Ramps:	Ramp up, ramp down, fast stop and S-Ramps
Flux control:	- v/f-control with linear and quadratic torque including fixed and auto boost, - dynamic sensorless Vektor control with autotune for dynamic operation with high torque at small speed, Slip compensation
Skip frequencies:	4 with adjustable band widths (e.g. to avoid mechanical resonances)
Parameter sets:	4 x 16 parameters, 8 x 8, software connectable to any relevant parameter
Application software:	Universal function blocks can be software wired to suit almost any application
PID-Controller:	Universally programmable PID controller
Link:	Serial link RS232 integrated
Hoisting and travel drives:	Integrated ramp functions and brake control
Password:	Integrated password protection for customer setted parameters
Speed control:	Processing of 2 track incremental encoder or analog tachogenerator (Technology box for digital speed feedback required with MM6)
Digital MOP:	Digital motor potentiometer
Jog:	Adjustable jog speed
Logic functions:	10 configurable Logik function blocks each with 3 Inputs, programmable as NOT, AND, NAND, OR, NOR, XOR
Processing function:	10 programmable processing functions each with 3 inputs for 21 functions such as ABSOLUTE VALUE, SWITCHING, ADDING, SUBTRACTING .....
Other:	Autostart control, fly catching
Programming pad: (Option)	Removeable, 2x16 character LCD display (illuminated), (Option) 5 function keys for programming, 5 additional function keys for loakl operation, 7 LED's

Protection; Trip conditions:	Short circuit line - line, or line - earth, Peak current >250 % rated current, I x t overload 50...105 % (adjustable), Heat sink overtemperature, overvoltage, undervoltage , input for external trips (e.g. for connection of an external thermistor relay)
Current limit:	0...150 % rated current adjustable

V/f characteristic:	Linear:	for constant torque
	Quadratic:	pumps and fans
	Adjustments:	base frequency and voltage

Diagnostics:	with LCD display and status LED's

Inputs/outputs;		MM45:	MM6:
	Analog inputs:	2	4
	Analog output:	1	2
	Digital inputs:	7	8
	Digital outputs:	2x 24 V Industry logic	3 x Relays
	Thermistor input:	Refer to suplier	1

Environmental requirements

Permissible temperature:	0 ...+45 °C 0 ...+40 °C	Operation: - at constant torque (CT) - with quadratic torque at higher power (HVAC)
	0 ...+40 °C 0 ...+35 °C	with NEMA1 top cover (CT) with NEMA1 top cover (HVAC)
	-25 ...+55 °C	Storage
	-25 ...+70 °C	Transport (short term)
Climatic condition:	Class 3K3 (EN60721-3-3)	5...85 % relative humidity
	Other requirements:	Dust free (see pollution) non corrosive and non flammable
Pollution:	Degree 2 pollution (IEC 664-1):	Dry non-conducting dust or particles, infrequent light condensation when switched off permissible
Altitude:	≥1000 m above sea level	1 % / 100 m power derating

Safety

Relevant standards:	Europe:	EN50178 (1998) valid for - Enclosure mounting - Wall mounting provided the NEMA1 top cover is securely fitted
	North America, Canada:	UL508C valid for: - Enclosure mounting as"Open-type Drive" - Wallmounted provided the NEMA 1 top cover is securely fitted as "Type 1 Enclosed"
Overvoltage category (IEC664-1 (1992)):	III	Only for use with TT/TN voltage supplies with an earthed neutral
Rated insulation voltage to PE:	AC 460 V	
Protective class: (IEC 536 (1976))	I	Basic insulation with PE connection (protective earth). The user is responsible for the PE connection
IP- Protection: (EN 60529 (1991))	Enclosure mounted: Wall mounted with top cover fitted:	All surfaces IP20 Top cover IP40, Other surfaces IP20
UL (c-UL): Enclosure rating	Enclosure mounted: Wall mounted with top cover fitted:	Open type Type 1
Prospective short circuit current:	MM45: ≤5 kA MM6: ≤10 kA	
Earthing:	Permanent earthing is mandatory. One of the two following methods can be used: - Use a copper conductor of at least 10 mm^2 cross-sectional area - Use a two independent earth conductors each connected to a parallel to a separate earth terminal of the MM456 Frequency Inverter. **NOTE**: Each conductor itself must meet the local requirements for a protective earth conductors.	

EC-Directives

EMC-DIRECTIVE:	The requirements of the European EMC-DIRECTIVE are met as follows: - MM407...422-EMC integrated EMC filters - MM515...540-EMC integrated EMC filters - MM655...6110 with approved external EMC filters The EMC Installation Instructions (page 3-9...18) and information on applying the EMC DIRECTIVE (page 8-3...11) must be observed.
LOW VOLTAGE DIRECTIVE:	The requirements of the European LOW VOLTAGE DIRECTIVE for CE marking are adhered to

Power circuit

	Product code	MM407-EMC		MM415-EMC		MM422-EMC	
	Supply voltage:	1/N AC 230 V ±15 %, 50...60 Hz ±5 Hz					
Normal operation with 150 % overload (CT)							
♦ Typical applications:	Motor power	0.75	kW	1.5	kW	2.2	kW
- Machinery	Motor current I_n	4.0	A	7.0	A	10.5	A
- Transport technology	Motor cable Europe [5]	1	mm^2	1	mm^2	1/1.5	mm^2
- Long-travel and hoisting	Motor cable North America [6]	14	AWG	14	AWG	14	AWG
	Switching frequency	3/6/9	kHz	3/6/9	kHz	3/6/9	kHz
♦ Overload capability:	Approx. losses 6 kHz	52	W	97	W	143	W
150 % I_n / 60 s	Supply current	8	A	15	A	23	A
	Supply fuse / Circuit breaker [1]	10	A	20	A	25	A
	Supply cable Europe [5]	1/1.5	mm^2	2.5/4	mm^2	4/6	mm^2
	Supply cable North America [6]	14	AWG	12	AWG	10	AWG
	Earth leakage current	>10	mA	>10	mA	>10	mA
	Fuse for UL compliance [2]	10	A [1]	20	A [1]	25	A [1]
Operation at higher power with 110 % overload(HVAC)							
♦ Main applications:	Motor power	1.1	kW [4]	2.2	kW [4]	3	kW [4]
- Pumps	P_{shaft} typical 2-pole	1.0	kW	1.9	kW	3.0	kW
- Fan	P_{shaft} typical 4-pole	0.9	kW	1.4	kW	2.8	kW
♦ Overload capability:	Max. current I_n	4.0	A	7.0	A	10.5	A
110 % I_n / 10 s	Motor cable Europe [5]	1	mm^2	1	mm^2	1/1.5	mm^2
	Motor cable North America [6]	14	AWG	14	AWG	14	AWG
	Approx. losses 3 kHz	52	W	97	W	143	W
	Switching frequency	3	kHz	3	kHz	3	kHz
	Supply current	8	A	15	A	23	A
	Supply fuse / Circuit breaker [1]	10	A	20	A	25	A
	Supply cable Europe [5]	1/1.5	mm^2	2.5/4	mm^2	4/6.0	mm^2
Special setting for higher-rating neccessary, see page 10-9	Supply cable North America [6]	14	AWG	12	AWG	10	AWG
	Earth leakage current	>10	mA	>10	mA	>10	mA
	Fuse for UL compliance [2]	10	A [1]	20	A [1]	25	A [1]
Integrated braking chopper:							
Max. current	- ED ≤30 %, 30 s max.	4	A	4	A	10	A
Ext. braking resistor	- Minimum value	100	Ω	100	Ω	56	Ω
Available braking resistors for	- Light braking	200BR0004 200 Ω/0.04 kW		100BR001 100 Ω/0.08 kW		100BR001 100 Ω/0.08 kW	
	- High braking torque short term	100BR001 100 Ω/0.08 kW		100BR001 100 Ω/0.08 kW		100BR006 100 Ω/0.08 kW	
	- High braking torque with heavy braking operation	100BR006 100 Ω/0.6 kW		100BR006 100 Ω/0.6 kW		100BR012 100 Ω/1.2 kW	
Installation, Mounting:							
Cooling		Convection		Convection		Fan	
Weight approx.:	- MotorMaster Frequency Inverter	2.8	kg	2.9	kg	4.1	kg
	- Programming Pad (Option)	0.1	kg	0.1	kg	0.1	kg
Dimensions:	- Height	198	mm	198	mm	233	mm
	- Height with top cover	198	mm	198	mm	233	mm
	- Width	155	mm	155	mm	171	mm
	- Depth	155	mm	155	mm	181	mm
Air flow clearance:	- Above, below	80	mm	80	mm	80	mm
	- Left, right	15	mm	15	mm	15	mm
	- Front with wall mounting [7]	15	mm	15	mm	15	mm
Power terminals:	- Max. conductor size	4 mm^2/10 AWG		4 mm^2/10 AWG		4 mm^2/10 AWG	
	- Max. torque	1,0	Nm	1,0	Nm	1,0	Nm
Terminals for braking chopper:	- Max. conductor size	4 mm^2/10 AWG		4 mm^2/10 AWG		4 mm^2/10 AWG	
	- Max. torque	1.0	Nm	1.0	Nm	1.0	Nm
Outline drawing:		3.1a		3.1a		3.1b	

1) Fuse or circuit breaker with delayed release

2) UL Listed JDDZ, class K5 or H; Ul Listed JDRX, class H

3) For operation to UL

4) Reduced shaft power

MM515-EMC	MM522-EMC	MM540-EMC	MM655	MM675	MM6110
3AC 380...460 V ±10 %, 50...60 Hz ±5 Hz					
Operation with constant torque (CT)					
1.5 kW	2.2 kW	4.0 kW	5.5 kW	7.5 kW	11 kW
4.5 A	5.5 A	9.5 A	12 A	16 A	23 A
1.0 mm^2	1.0 mm^2	1.5 mm^2	1.5/2.5 mm^2	2.5/4 mm^2	4/6 mm^2
14 AWG	14 AWG	14 AWG	12 AWG	12 AWG	10 AWG
3/6/9 kHz	3/6/9 kHz	3/6/9 kHz	3/6 kHz	3/6 kHz	3/6 kHz
77 W	106 W	175 W	220 W	260 W	330 W
6 A	8 A	11 A	15 A	22 A	28 A
3x10 A	3x10 A	3x16 A	3x20 A	3x25 A	3x32 A
1/1.5 mm^2	1/1.5 mm^2	1.5/2.5 mm^2	2.5/4 mm^2	4/6 mm^2	6/10 mm^2
14 AWG	14 AWG	14 AWG	12 AWG	10 AWG	8 AWG
>10 mA	>10 mA	>10 mA	>10 mA	>10 mA	>10 mA
3x10 A[1)]	3x10 A[1)]	3x15 A[1)]	3x20 A[1)]	3x20 A[1)]	3x20 A[1)]
Operation with quadratic torque at higher power (HVAC)					
2.2 kW[4)]	3.0 kW[4)]	5.5 kW[4)]	7.5 kW	11 kW	15 kW
2.0 kW	2.8 kW	4.3 kW	7.5 kW	11 kW	15 kW
1.9 kW	2.5 kW	4.2 kW	7.5 kW	11 kW	15 kW
4.5 A	5.5 A	9.5 A	16 A	23 A	31(27[3)])A
1 mm^2	1 mm^2	1/1.5 mm^2	2.5/4 mm^2	4/6 mm^2	6/10 mm^2
14 AWG	14 AWG	14 AWG	12 AWG	10 AWG	8 AWG
77 W	106 W	175 W	270 W	350 W	450 W
3 kHz	3 kHz	3 kHz	3 kHz	3 kHz	3 kHz
6 A	8 A	11 A	20 A	28 A	35(32[3)])A
3x10 A	3x10 A	3x16 A	3x25 A	3x32 A	3x40 A
1/1.5 mm^2	1/1.5 mm^2	1.5/2.5 mm^2	4/6 mm^2	6/10 mm^2	10 mm^2
14 AWG	14 AWG	14 AWG	10 AWG	8 AWG	8 AWG
>10 mA	>10 mA	>10 mA	>10 mA	>10 mA	>10 mA
3x10 A[1)]	3x10 A[1)]	3x15 A[1)]	3x32 A[1)]	3x32 A[1)]	3x40 A[1)]
Integrated braking chopper					
10 A	10 A	10 A	7.5 A	15 A	15 A
56 Ω	56 Ω	56 Ω	100 Ω	50 Ω	50 Ω
200BR0004	200BR0004	100BR001	100BR001	100BR001	100BR006
200Ω/0.04 kW	200Ω/0.04 kW	100Ω/0.08 kW	100Ω/0.08 kW	100Ω/0.08 kW	100Ω/0.6 kW
100BR001	100BR006	100BR006	100BR006	39BR006	39BR012
100Ω/0.08 kW	100Ω/0.6 kW	100Ω/0.6 kW	100Ω/0.6 kW	39Ω/0.6 kW[8)]	39Ω/1.2 kW[8)]
100BR006	100BR012	100BR012	100BR012	39BR012	39BR050
100Ω/0.6 kW	100Ω/1.2 kW	100Ω/1.2 kW	100Ω/1.2 kW	39Ω/1.2 kW[8)]	39Ω/5.0 kW[8)]
Installation, Mounting					
Convection	Convection	Fan	Fan	Fan	Fan
4.0 kg	4.2 kg	4.2 kg	8.8 kg	8.9 kg	9.0 kg
0.1 kg	0.1 kg	0.1 kg	0.1 kg	0.1 kg	0.1 kg
233 mm	233 mm	233 mm	348 mm	348 mm	348 mm
233 mm	233 mm	233 mm	365 mm	365 mm	365 mm
181 mm	181 mm	181 mm	201 mm	201 mm	201 mm
200 mm	200 mm	200 mm	208 mm	208 mm	208 mm
80 mm	80 mm	80 mm	70 mm	70 mm	70 mm
15 mm	15 mm	15 mm	20 mm	20 mm	20 mm
15 mm	15 mm	15 mm	0 mm	0 mm	0 mm
4 mm^2/10 AWG	4 mm^2/10 AWG	4 mm^2/10 AWG	2,5 mm^2/12 AWG	6 mm^2/8 AWG	6 mm^2/8 AWG
1,0 Nm	1,0 Nm	1,0 Nm	1,5 Nm	1,5 Nm	1,5 Nm
4 mm^2/10 AWG	4 mm^2/10 AWG	4 mm^2/10AWG	2,5 mm^2/12 AWG	2,5 mm^2/12 AWG	2,5 mm^2/12 AWG
1.0 Nm	1.0 Nm	1.0 Nm	1.0 Nm	1.0 Nm	1.0 Nm
3.1b	3.1b	3.1b	3.1c	3.1c	3.1c

Size of cables in accordance with: 5) EN60204-1 (see page 3-7) 6) NEC/NEPA-70 7) With NEMA1 top cover 8) Only with 3AC 400 V, otherwise refer to supplier

Voltage supply

Frequency Inverter MM...-EMC with integrated EMC filter are only for TT/TN supplies with an earthed neutral, use with IT-supplies is not permissible.

Other voltages (refer to supplier before use):

MM407...422-EMC:	2AC 220...240 V DC 220...340 V	±10 %, 50...60 Hz ±5 Hz ±10 %
MM515...540-EMC, MM655...6110:	3AC 380...460 V DC 380...650 V	±10 %, 50...60 Hz ±5 Hz ±10 %

Control circuit

Reference and auxiliary supplies

Reference supplies for analogue inputs	+10 V ± 5 %, 10 mA max. load
Auxiliary supply for digital inputs	+24 V ±15 %, 150 mA max. load

Analogue I/O

	Inputs		Outputs	
Range	0...+10 V	0/4...20 mA	0...+10 V	0...20 mA
Impedance	94 kΩ	220 Ω	100 Ω	100 Ω
Limit value	+24 V	7,9 V	5 mA	20 mA
Resolution	10 bit (1 in 1024)		8 bit (1 in 256)	
Sample rate	20 ms		20 ms	

Digital I/O

		Inputs	Outputs MM445:	Outputs MM6:
Logic system		DC 24 V Industry logic	DC 24 V Industry logic	Isolated relay contacts
Switching levels	'0'	<+6 V	open (+24 V auxiliary supply)	open
	'1'	>+18 V	activated (auxiliary supply +24 V - 1 V)	closed
Absolute max. voltage range		-30...+30 V	0...+ 30 V	AC 230 V
Impedance		47 kΩ	10 Ω	-
Max. output current			50 mA	3 A - res. load 250 VA - ind. load
Sample rate		20 ms	20 ms	20 ms

Thermistor motor protection

An input for connecting to an external motor thermistor device is available with the MM6 Frequency Inverter. Conductors of up to 2.5 mm^2 (12 AWG) may be connected. The use of 1...2.5 mm^2 as in EN 60204-1 is recommended.

Control terminals

"Cage-clamp" terminals without screws for 0.08...2.5 mm^2 conductors (ferrules not required). The use of 0.2...0.75 mm^2 as in EN 60204-1 is recommended

Special considerations for installation in compliance with UL

Solid state motor overload protection:	♦ These MM456 Frequency Inverters provide Class 10 motor overload protection. The maximum internal overload protection level (current limit) is 150 % for 60 s. Refer to **Chapter 4 - SETTING UP AND COMMISSIONING**, I*T TRIP for user current limit adjustment information. An external motor overload protective device must be provided by the installer where the motor has a full load ampere rating of less than 50 % of the Inverter output rating.
Short circuit rating of supply:	♦ All MM45 Frequency Inverters are suitable for use on a circuit capable of delivering not more than 5,000 RMS Symmetrical Amperes, 240 V / 460 V maximum (as appropriate). ♦ All MM6 Frequency Inverters are suitable for use on a circuit capable of delivering not more than 10,000 RMS Symmetrical Amperes, 480 V maximum (as appropriate).
Solid state short-circuit protection:	♦ These MM456 Frequency Inverters are provided with Solid-State Short-Circuit (output) Protection. Branch circuit fusing requirements must be in accordance with the latest edition of the National Electric Code NEC/NFPA 70.
Recommended branch circuit protection:	♦ It is recommended that UL Listed (JDDZ) non-renewable cartridge fuses, Class K5 or H; or UL Listed (JDRX) renewable cartridge, Class H, are installed upstream of the Inverter. Refer to page 1-8/9 for recommended fuse ratings.
Motor base frequency:	♦ The maximum settable base frequency is 480 Hz.
Field wiring temperature rating:	♦ MM409...422-EMC: Use 60 °C or 60/75 °C copper conductors only, MM655...611: Use 75 °C copper conductors only.
Field wiring terminal markings:	♦ For correct field wiring connections that are to be made to each terminal refer to **Power terminals**, page 2-8/9, and **Control terminals**, page 2-9...12.
Power wiring terminals:	♦ Refer to the table on page 1-8/9 for maximum conductor sizes.
Terminal tightening torque:	♦ Refer to the table on page 1-8/9 for maximum tightening torques.
Field grounding terminals:	♦ The field grounding terminals are identified with the International Grounding Symbol ⏚ (IEC Publication 417, Symbol 5019). Refer to page 2-4/8 and 3-5/6 for further information.
Operating ambient temperature:	♦ The maximum operating ambient temperature rating is 45 °C (40 °C for inverters with a Type 1 enclosure), refer to page 1-6.
Direct wall-mountable inverters:	♦ All MM456 Frequency Inverters fitted with a NEMA 1 cover are suitable for direct wall mounting applications as they have a "Type 1 Enclosure" rating. In order to preserve this enclosure rating, it is important to maintain the environmental integrity of the enclosure. Therefore, the installer must provide correct Type 1 closures for all unused clearance holes provided within the inverter's glandplate. Type 1 enclosed inverters are suitable for use in no worse than a Pollution Degree 2 environment.

ORDERING INFORMATION

Function	Order code	Technical data	Order no.
Frequency Inverters with built-in EMC filter for class B interference protection and for operation with 1/2AC 220...240 V or 3AC 380...460 V	MotorMaster MM407-EMC	0.75 kW, 1AC 220-240 V, 4.0 A	8671.207-100
	MotorMaster MM415-EMC	1.5 kW, 1AC 220-240 V, 7.0 A	8671.212-100
	MotorMaster MM422-EMC	2.2 kW, 1AC 220-240 V, 10.5 A	8671.213-100
	MotorMaster MM515-EMC	1.5 kW, 3AC 380-460 V, 4.5 A	8672.312-100
	MotorMaster MM522-EMC	2.2 kW, 3AC 380-460 V, 5.5 A	8672.313-100
	MotorMaster MM540-EMC	4.0 kW, 3AC 380-460 V, 9.5 A	8672.315-100
Frequency Inverters for operation with 3AC 380...460 V	MotorMaster MM655	5.5 kW, 3AC 380-460 V, 12 A (HVAC: 7.5 kW, 16 A)	8672.316
	MotorMaster MM675	7.5 kW, 3AC 380-460 V, 16 A (HVAC: 11 kW, 23 A)	8672.317
	MotorMaster MM6110	11 kW, 3AC 380-460 V, 23 A (HVAC: 15 kW, 31 A)	8672.320
Removable Programming Pad	OPTION MM-PROG	Programming pad/Prog.-Einheit	8629.001

Chapter 2 - PRE-INSTALLATION PLANNING

FUNCTIONAL OVERVIEW

MM456 Frequency Inverters are microprocessor based d.c.-link 3-phase inverters used to control the speed of standard 3-phase induction motors (standard squirrel-cage). A removable programming pad based on an illuminated 2x16 character LED display with operating keys allows easy access to operating function and adjustable parameters. The hierarchal menue allows parameters to be directly changed and provides access to many configurable optional functions for special application.

Fig. 2.1 is a general wiring diagram. The functional block diagram of Fig. 2.2 explains the control circuit in more detail in the basic configuration as supplied (default setting).

Many function blocks which can be freely wired with software links such as a PID controller, auto-start logic are available with MM456 Frequency Inverter. Fig. 2.3 shows an application functional block diagram with software links as in MACRO 1. A separate detailled description with many application examples is available as **TMM456/3SV-SAM Software and Application Manual**.

The basic functions of the MM456 frequency inverters are described in the following:

Power input circuit and d.c. link: The two-phase or three-phase supply voltage on terminals L1, L2 and L3 or L1, N is rectified to provide a d.c. output voltage. The connection between the rectifier and inverter is called the d.c. link and comprises a charging circuit and a d.c. link capacitor. The d.c. capacitors smooth the d.c. voltage fed to input to the inverter power stage.

Inverter output circuit: The inverter circuits convert the d.c. input from the d.c. link to the 3-phase output required to supply the motor with variable frequency. The gate drive signals generated by the control circuits control the IGBT output transistors to produce the required 3-phase output. The frequency and amplitude are determined by the control inputs and by the parameters set up via the programming pad.

Dynamic braking with external braking resistors: During motor deceleration or at other times when the motor acts as a generator, energy flows from the motor into the d.c. link capacitors and causes the d.c. link voltage to rise. Small amounts of regenerative energy can be absorbed by the d.c. link. The MM456 Frequency Inverter trips with "Overvoltage" if the d.c. link voltage exceeds the over-voltage trip level (approx. 400 V) in order to protect the inverter.

Most standard industrial motors when operated below the rated speed can provide a significant torque on braking due to the higher terminal voltage (i.e. overfluxing).

Higher braking powers can be catered for using an external braking resistor. The external braking resistor is switched to be in parallel with the link capacitors when the d.c. link voltage exceeds the brake threshold level.

Control circuits and software:

The function of the control circuits and software as supplied (function default condition) is shown in the functional block diagram Figure 2.2.

Inputs to the control circuit are provided by connections to the control board terminals (identified on the left hand side of the block diagram) and by parameters set via the operating panel.

Parameters:

Parameters are values or options that are programmed via the operating panel. These are usually set up during installation and commissioning and are not changed during normal operation.

Refer to **Chapter 4** for further information on the programming pad and parameter descriptions.

Diagnostics:

Diagnostic parameters are values that can be displayed in the diagnostic menu within the operating panel. These values are read-only and are provided for the user to determine operating or fault conditions. Refer to **Chapter 5** for further information and descriptions of the diagnostics.

Analogue inputs/outputs:

The analog inputs and outputs are freely configurable. For this purpose both the DIL switch (see page 2-13) and the associated software parameter (see page 5-8) must be correctly set to suit the particuler application.

Digital inputs and outputs:

Digital inputs to the control circuit are usually provided by externally switched contacts. An +24 V auxiliary supply is available between terminals 6 and 12 for this purpose. The maximum loading is 150 mA.

The digital outputs with MM45 Frequency Inverters are "Active High" outputs in 24 V industry logic. The maximum output load is 50 mA.

With MM6 Frequency Inverters isolated contacts of three output relays are available.

Refer to page 2-9 for further information on digital inputs and outputs which are freely configurable.

BASIC WIRING AND BLOCK DIAGRAMS

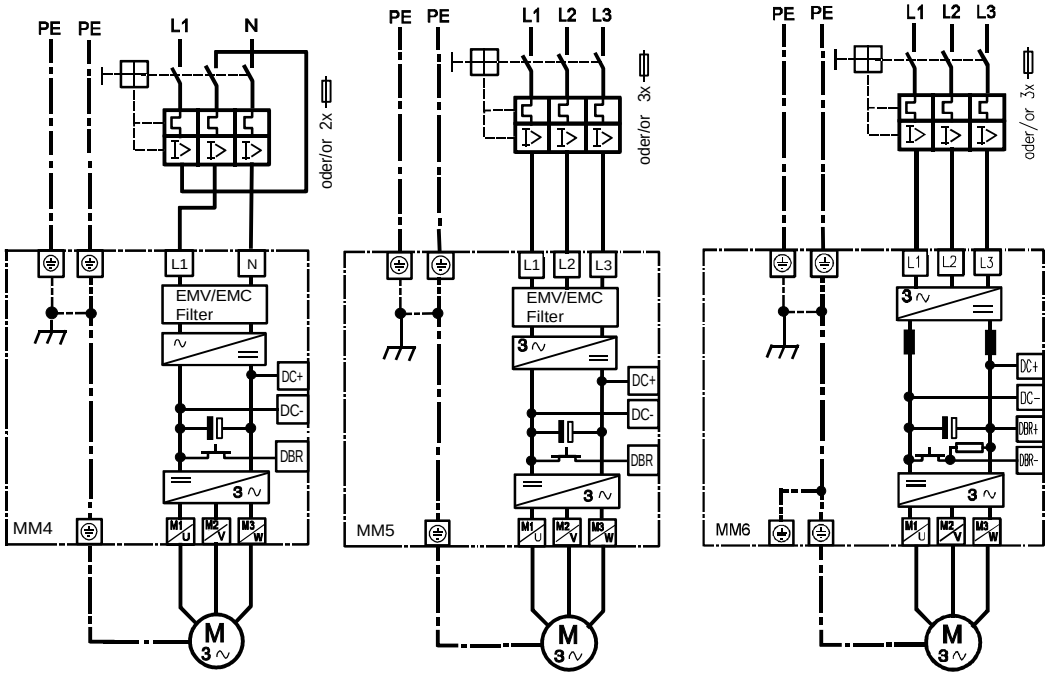
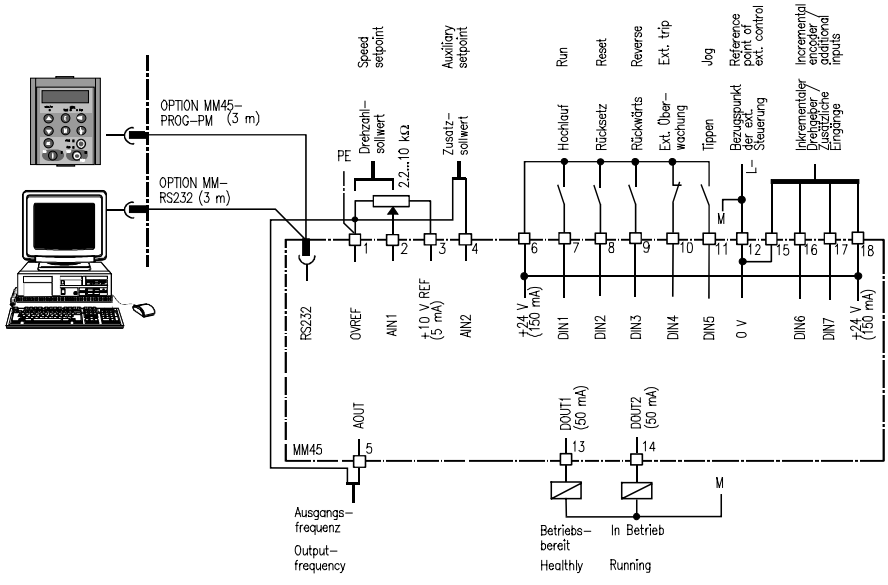


Fig. 2.1: General wiring diagram of power sections of MM4, MM5 und MM6 Frequency Inverters



WICHTIG: . Brücke 6-10 wenn externe Überwachung nicht angeschlossen/
IMPORTANT: Link 6-10 if external Trip not used
. OPTION MM-PROG-PM (3m) nur für Fernmontage der Programmier-Einheit/
OPTION MM-PROG-PM (3m) only for distant mounting of the Programming Pad
. Klemme 6, +24 V auf keinen Fall mit externer 24 V Spannungsversorgung verbinden/
Terminal 6, +24V must not be connected to an external 24 V supply voltage

Fig. 2.2a: General wiring diagram of control circuit of MM45 Frequency Inverters

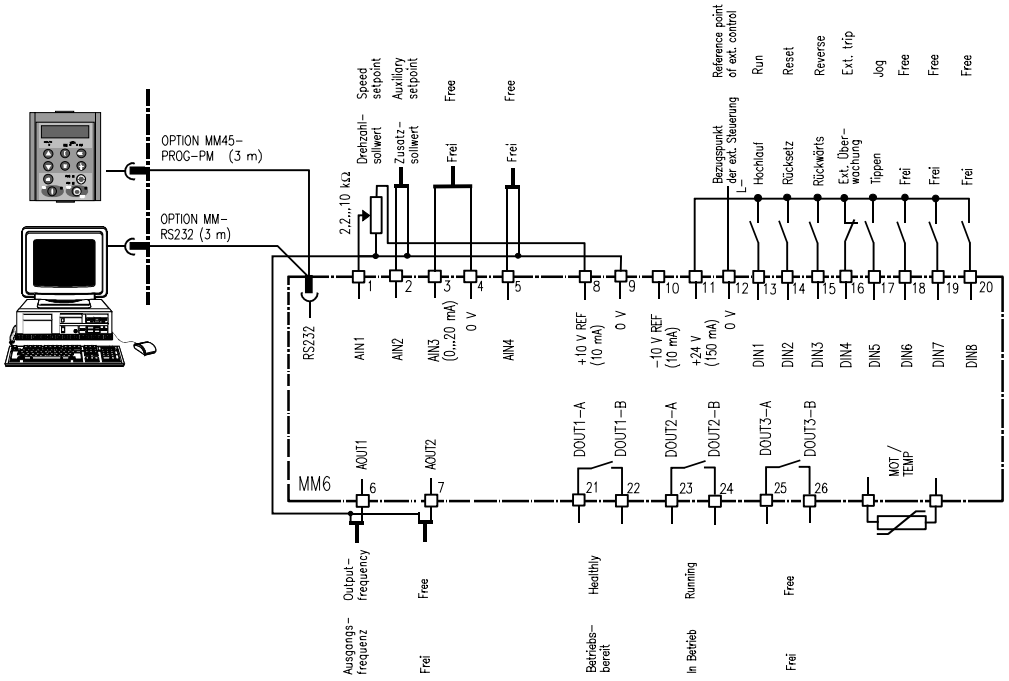


Fig. 2.2b: General wiring diagram of control circuit of MM6 Frequency Inverter

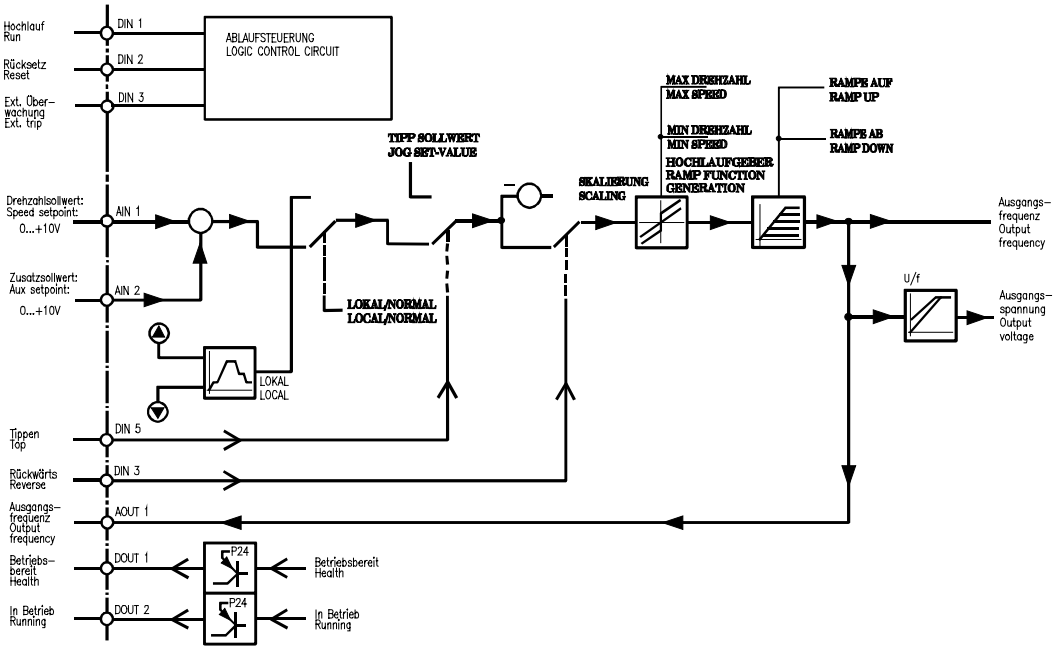


Fig. 2.3: Functional block diagram of supplied configuration of control circuit (Digital outputs with MM45, MM6 has relay outputs)

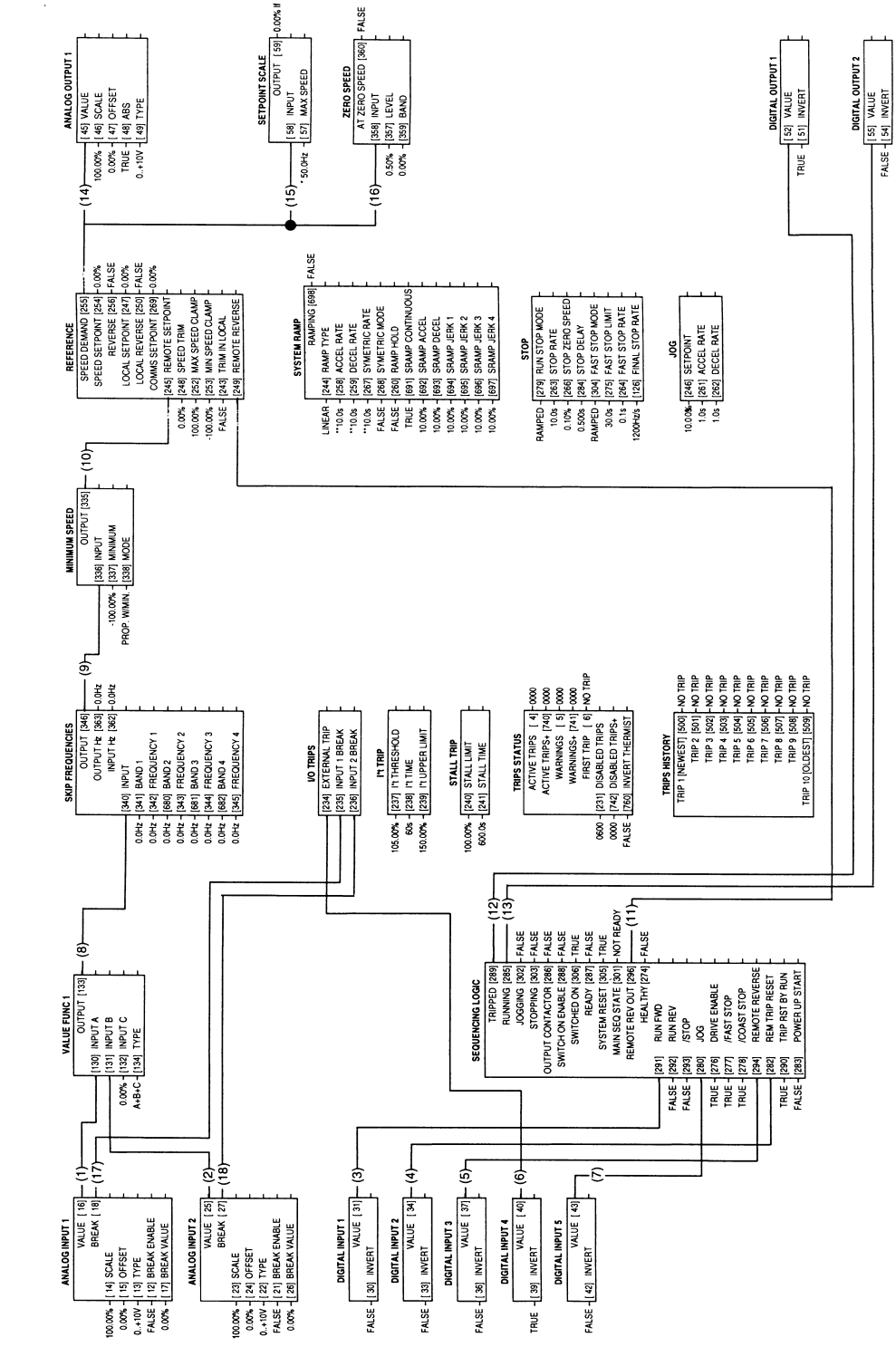
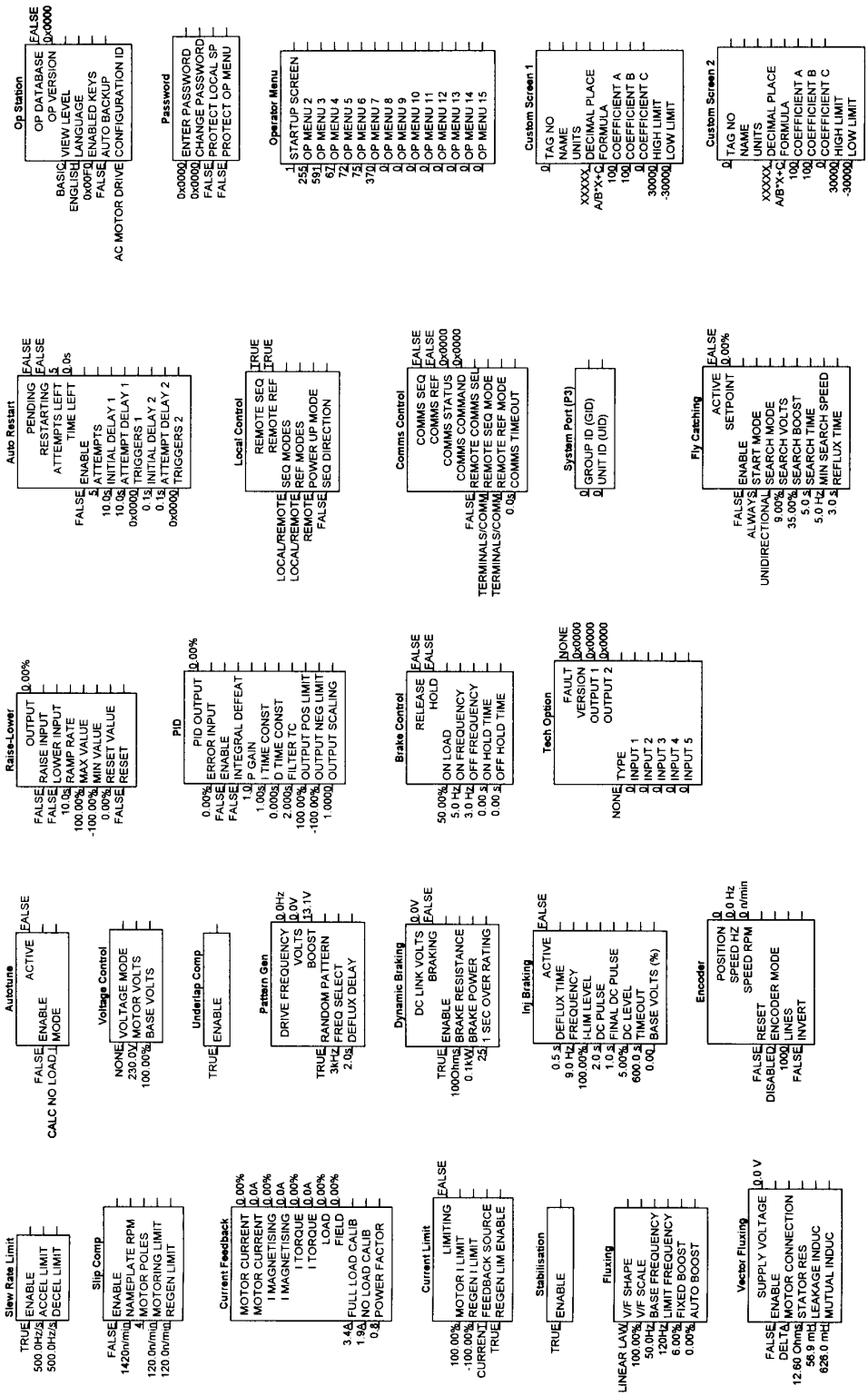


Fig. 2.4: Application functional block diagram with software links as in MACRO 1



(default supply condition)

TERMINAL DESCRIPTIONS

WARNINGS !

- Frequency Inverters with integrated or external EMC filters may only be used with TT/TN voltage supplies with an earthed neutral.
  The use with IT supplies is not permissible.
- The power terminals carry high voltages which can be lethal.
- Never work on any control equipment or motors without first removing all power supplies from the equipment and waiting for the drive to be stationary.
- Always wait until the link capacitors are discharged (at least 3 min).

Power terminals with MM45

Terminal	Designation	Function	Explanation
	⏚ ⏚	Two connections for protective earth of voltage supply, see Fig. 3.2, page 3-4 (must be used)	Observe all safety and EMV requirements as described in **Chapter 3**.
1 2	L1 L2/N	Connection for single-phase voltage supply with MM407...422-EMC	L/N AC 230 V ±15 %/ 2AC 230 V ±15 %
1 2 3	L1 L2 L3	Connection for three-phase voltage supply with MM515...540-EMC	3AC 380...460 V ±10 %
4	DC-	Negative connection to d.c. link ←	Applications (terminals 4 and 6): - D.C. supply - Parallel connection of d.c. links of two or more inverters (only after refering to supplier)
5	DBR	Connection for external braking resistor	
6	DC+	Positive connection to d.c. link also for connection to external braking resistor ←	
7 8 9	M1/U M2/V M3/W	Motor connection (three-phase)	3-phase supply voltage: - 3AC 0...supply voltage - 0...f_{max}
	⏚	Connection for protective earth of motor	Observe all safety and EMV requirements as described in **Chapter 3**.
	Clamp	Connection for screen of control cable	
	⏚	Clamp for screen of motor cable	

Refer to the General wiring diagram of power sections, Fig. 2.1 (page 2-4) for further information on connections to the power terminals.

Power terminals with MM6

Terminal	Designation	Signal, function	Explanation
	⏚ ⏚	Two connections for protective earth of voltage supply, see Fig. 3.2, page 3-5/6 (must be used)	Observe all safety and EMV requirements as described in **Chapter 3**.
	L1 L2 L3	Connection for three-phase voltage supply with MM6	3AC 380...460 V ±10 %
	DC+	Positive connection to d.c. link	Applications: - D.C. supply - Parallel connection of d.c. links of two or more inverters (only after referring to supplier) - Connection of additional external braking chopper
	DC-	Negative connection to d.c. link	
	M1/U M2/V M3/W	Motor connection (three-phase)	3-phase supply voltage: - 3AC 0...supply voltage - 0...f_{max}
	⏚	Connection for protective earth of motor and screen	Observe all safety and EMV requirements as described in **Chapter 3**.
	DBR+	Connection for external braking resistor when using internal braking chopper	Observe minimum value of braking resistance, see page 1-9
	DBR-		

Refer to the General Wiring Dagram, Fig. 2.1 (page 2-4) and Block Diagram, Fig. 2.3 (page 2-5) for further information on connections to the power terminals.

Control terminals of MM45

All MM45 Frequency Inverters have the identical control terminals The functions of the control terminals as supplied (factory default condition) are described in the following table Refer to "Control Terminals" for details on cable sizes on page 1-10.

NOTE: In the following table, parameters are indicated by a special bold type, e.g. `MAX SPEED`. These parameters can be changed using the programming pad (refer to **chapter 4**).

Terminal	Designation	Signal, function	Explanation
1	0 V REF	Zero volt reference for analog signals or 20 mA current-loop connection	- Do not use for other purposes !!
2	AIN1	Configurable analog input in the range `0...+10 V, +2...+10 V, 0...+5 V, +1...+5 V, -10..+10 V, 0...20 mA, 4...20 mA, 20...4 mA, 20...0 mA` usually used as speed setpoint: 0 V = `MIN SPEED` +10 V = `MAX SPEED` forwards	- As set by the DIL switch and `QUICK SETUP|AIN 1 TYPE` (see page 5-8) - `MAX` and `MIN SPEED` see page 5-4 - Input impedance = 94 kΩ.
3	+10 V REF	Internal +10 V reference voltage for analog inputs	- 5 mA max. load - Tolerance approx. ±3 %
4	AIN2	Configurable analog auxiliary-input usually used as a trim set-value, otherwise as AIN1	- As `AIN 1`

Terminal	Designation	Signal, function	Explanation
5	AOUT	Analog output in the range 0...+10 V, or 0...20 mA, usually used as output frequency: 0 V = 0 Hz +10 V = MAX SPEED	- 5 or 20 mA max. load - Accuracy ± 3 %
6	+24 V	+24 V auxiliary supply for digital inputs	- 150 mA max. load together with terminal 24 - Tolerance approx.. ±10 % Not to be connected to an external 24 V supply voltage
7	DIN1	Configurable digital input, usually used as command "Run", for starting and stopping the drive: 0 V = Stop +24 V = Run	- Stopping as set in RUN STOP MODE (see page 5-7)
8	DIN2	Configurable digital input, usually used to reset trips: 0 V = Normal +24 V = Reset	- Edge triggered
9	DIN3	Configurable digital input, usually used to control the direction of motion: 0 V = Forwards +24 V = Reverse	
10	DIN4	Configurable digital input, usually used for an external monitoring circuit: 0 V = Fault +24 V = No fault	- Connect to +24 V (terminal 6) if not used
11	DIN5	Configurable digital input, usually used to select the jog speed: +24 V = Jog speed 0 V = Normal	
12	0 V	0 V Reference point for digital inputs	
13	DOUT1	Configurable digital output usually used for "Health": Open = No supply, fault or alarm Activated = Health	- "Active high" outputs, e.g. to excite external DC 24 V relays, max. load 50 mA
14	DOUT2	Configurable digital output usually used for "Running": Open = No supply, fault or alarm Activated = Running	
15	0 V	0 V intended for incremental encoder or return of output relays	
16	DIN6	Configurable digital input, intended for connection to A track of incremental encoder	- Can be used as further inputs - Used as preset inputs with MACRO 5
17	DIN7	Configurable digital input, intended for connection to B track of incremental encoder	
18	+24V	24 V supply intended for incremental encoder	- 150 mA max. load together with terminal 6 - Tolerance approx.. ±10 % Not to be connected to an external 24 V supply voltage

Control terminals with MM6

All MM6 Frequency Inverters have the idenctical control terminals The functions of the control terminals as supplied (factory default condition) are described in the following table Refer to "Control Terminals" for details on cable sizes on page 1-10.

NOTE: In the following table, parameters are indicated by a special bold type, e.g. `MAX SPEED`. These parameters can be changed using the programming pad (refer to **Chapter 4**).

Terminal	Designation	Signal, function	Explanation
1	AIN1	Configurable analog input in the range `0..+10 V, +2..+10 V, 0..+5 V, +1..+5 V, -10..+10 V, 0..20 mA, 4..20 mA, 20..4 mA, 20..0 mA` usually used as speed setpoint: 0 V = `MIN SPEED` +10 V = `MAX SPEED` forwards	- As set by the DIL switch and `QUICK SETUP|AIN 1 TYPE` (see page 5-8) - `MAX` and `MIN SPEED` see page 5-4 - Input impedance = 94 kΩ.
2	AIN2	Configurable analog auxiliary-input in the range `0..+10 V, +2..+10 V, 0..+5 V, +1..+5 V, -10.+10 V, 0..20 mA, 4..20 mA, 20..4 mA, 20..0 mA` usually used as a trim set-value: 0 V = `MIN SPEED` +10 V = `MAX SPEED` forwards	- As set by the DIL switch and `QUICK SETUP|AIN 2 TYPE` (see page 5-8) - `MAX` and `MIN SPEED` see page 5-4 - Input impedance = 94 kΩ.
3	AIN3	Configurable analog input in the range `0..20 mA, 4..20 mA, 20..4 mA, 20..0 mA`	- As set by the DIL switch `QUICK SETUP |AIN 3 TYPE`(see page 5-8)
4	0V	0 V for digital inputs	
5	AIN4	Configurable analog input in the range `0..+10 V, +2..+10 V, 0..+5 V, +1..+5 V,`	- As set by the DIL switch `QUICK SETUP |AIN 4 TYPE`(see page 5-8)
6	AOUT1	Analog output in the range `0..+10 V, 0..20 mA, 4..20 mA`, usually used as output frequency: 0 V = 0 Hz +10 V = `MAX SPEED`	- As set by the DIL switch SW2 and `....|AOUT 2 TYPE` (see page 28.1-8) - 5 or 20 mA max. load - Accuracy ± 3 %
7	AOUT2	Analog output in the range `-10..±10 V, 0..+10 V`, not used in factory default setting (MACRO 1)	- 5 mA max. load - Accuracy ± 3 %
8	+10 V REF	Internal +10 V reference voltage for analog inputs	- 5 mA max. load - Tolerance approx. ±3 %
9	0 V	Zero voltage reference for analog signals	
10	-10 V REF	Internal +10 V reference voltage for analog inputs	- 5 mA max. load - Tolerance approx. ±3 %
11	+24 VC	+24 V auxiliary supply for digital inputs	- 150 mA max. load together with terminal 24 - Tolerance approx.. ±10 % Not to be connected to an external 24 V supply voltage
12	0V	Reference point for digital inputs	

Terminal	Designation	Signal, function	Explanation
13	DIN1	Configurable digital input, usually used as command "Run", for starting and stopping the drive: 0 V = Stop +24 V = Run	- Stopping as set in RUN STOP MODE (see page 5-7)
14	DIN2	Configurable digital input, usually used to reset trips: 0 V = Normal +24 V = Reset	- Edge triggered
15	DIN3	Configurable digital input, usually used to control the direction of motion: 0 V = Forwards +24 V = Reverse	
16	DIN4	Configurable digital input, usually used for an external monitoring circuit: 0 V = Fault +24 V = No fault	- Connect to +24 V (terminal 6) if not used
17	DIN5	Configurable digital input, usually used to select the jog speed: +24 V = Jog speed 0 V = Normal	
18	DIN6	Configurable digital input, not used in factory default setting (MACRO 1)	- Can be used as further inputs - Used as preset inputs with MACRO 5
19	DIN7	Configurable digital input, not used in factory default setting (MACRO 1)	
20	DIN8	Configurable digital input, not used in factory default setting (MACRO 1)	
21 22	DOUT1-A DOUT1-B	Configurable digital output usually used for "Health": Open = No supply, fault or alarm Activated = Health	Isolated relay contact
23 24	DOUT2-A DOUT2-B	Configurable digital output usually used for "Running": Open = No supply, fault or alarm Activated = Running	Isolated relay contact
25	DOUT3-A	Configurable digital output, not used in factory default setting (MACRO 1)	Isolated relay contact
26	DOUT3-B		
	MOT/ TEMP	Connection for thermistor motor protection	Input in double isolated

Configurable inputs and outputs

MM456 Frequency Inverters use a completely new concept of freely connectable function blocks. The analog and digital outputs can now be connected without restaint to the available internal analog and digital function blocks by means of software. As an example, Fig. 2.4 shows the application functional block diagram with software links corresponding to the default factory set conditions (MACRO 1).

With the inputs and outputs, the range must also set using the DIL switch. Fig. 2.5 shows the switch settings for available ranges of these inputs and outputs. In addition the software must be set accordingly, see page 5-8.

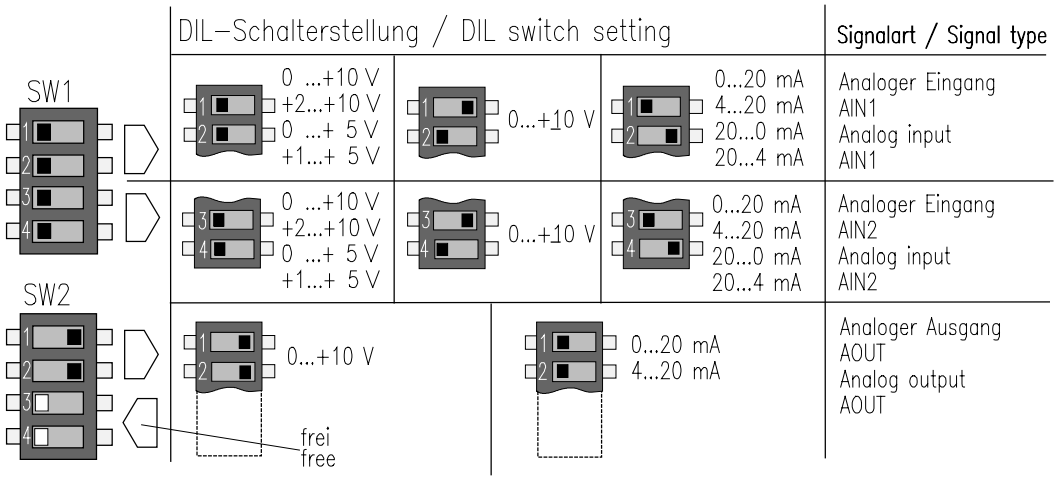


Fig. 2.5: DIL switch setting for analog inputs (AIN1, AIN2) and analog output (AOUT1)

With MM6 Frequency Inverters switch SW2 is to the right of switch SW1.

Chapter 3 - MOUNTING AND INSTALLATION

PRECAUTIONS

CAUTION!
This product conforms to IP20 protection. Due consideration should be given to environmental conditions of installation for safe and reliable operation.

- The installation and commissioning of the MM456 Frequency Inverter is carried out only by competent personnel in accordance with safe working practices
- The enclosure into which the MM456 Frequency Inverter is mounted must be suitable for the working environment
- Use of mechanically secure fixings as recommended in the following
- The cooling and airflow are as recommended in the following outline and mounting drawings
- The cables and wire terminations are as recommended and securely clamped. The power connections should be tightened to the recommended torque.

EQUIPMENT INSPECTION

Check the following before mounting or storing the MM456 Frequency Inverter:

- Signs of transit damage
- The type code and ratings on the name plate onform to the requirement (refer to **Chapter 2 - PRODUCT OVERVIEW** for more information).

If the unit is not being installed immediately, store the unit in a well-ventilated place away form high temperatures, humidity, dust, or metal particles.

Refer to **Chapter 7 - SERVICING** for informationen on returning damaged equipment.

MOUNTING

MM456 Frequency Inverters should be mounted vertically on a flat vertical surface with 4 suitable screws. With MM407 and MM415 the two lower fixing holes are accessible after removing the terminal cover plate. The overall dimensions of the MM456 Frequency Inverter and the positions of the fixing points are given in Figure 3.1 (page 3-3).

MM456 Frequency Inverters must be mounted to allow the free flow of air vertically through the inverter. Care should also be taken to ensure that the mounting surface is cool and that any heat generated by adjacent equipment is not transmitted to the MM456 Frequency Inverter.

For adequate natural ventilation of the MM456 Frequency Inverter, minimum clearance for cooling as defined in Fig. 3.1, must be maintained. Side-by-side mounting of two or more MM456 Frequency Inverters or other power electronic equipment is permissible provided the vertical clearance for cooling with each Frequency Inverter is adhered to and the ambient operating temperature is not exceeded (page 1-6).

OUTLINE AND MOUNTING DRAWINGS

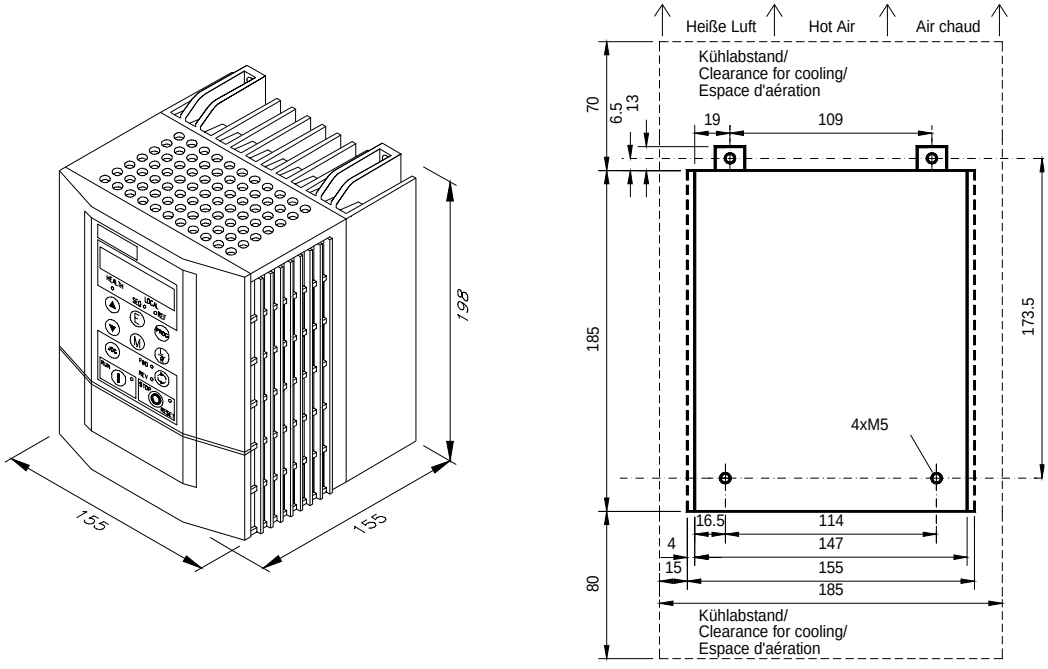


Fig 3.1a: Outline drawing and mounting MM407/415-EMC

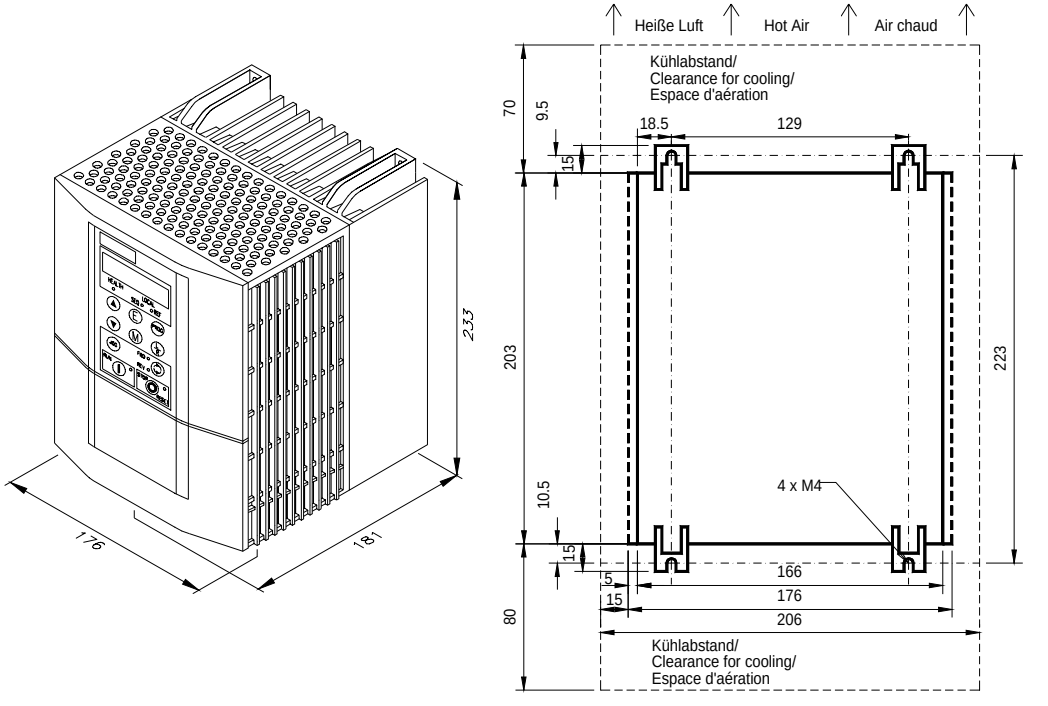


Fig. 3.1b: Outline drawing and mounting MM422-EMC und MM515...540-EMC

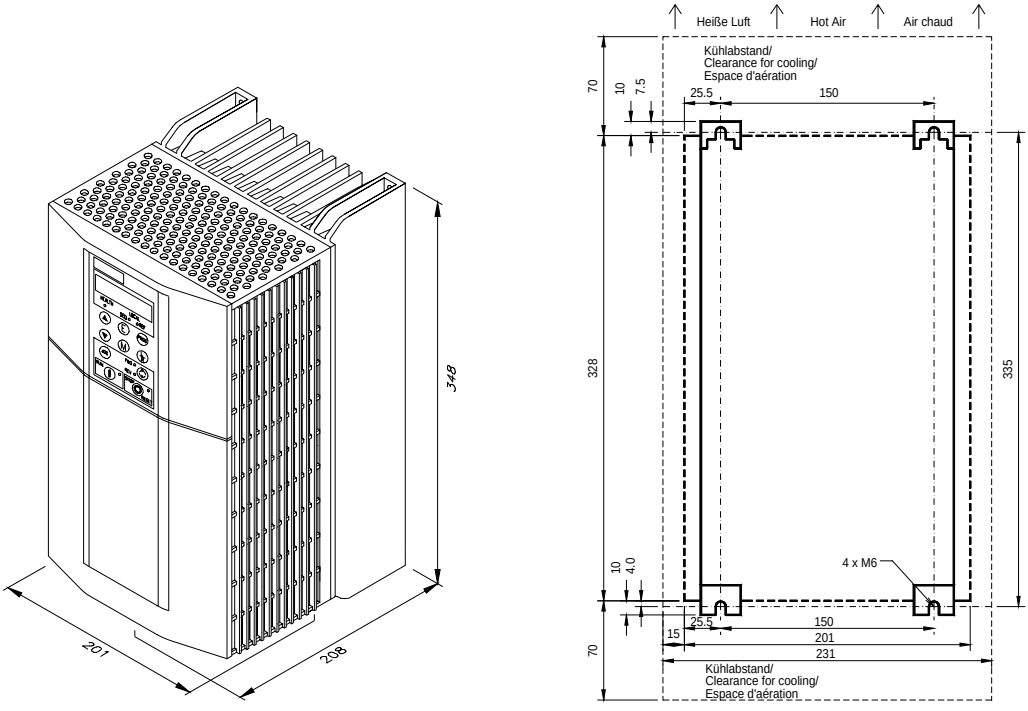


Fig. 3.1c: Outline drawing and mounting MM655...6110

INSTALLATION

Using screwless cage-clamp terminals

- Prepare wire ends: - strip to 5...6 mm
  - ferrules are not required but can be used
- Insert a flat-bladed (size 3.5 mm max.) inside the smaller hole of the cage-clamp terminal
- Lever screwdriver keeping it firmly pressed into the hole. The cage will open
- Insert wire into cage keeping the screwdriver in position
- Remove screwdriver. The terminal will now provide the correct clamping force for a secure connection.

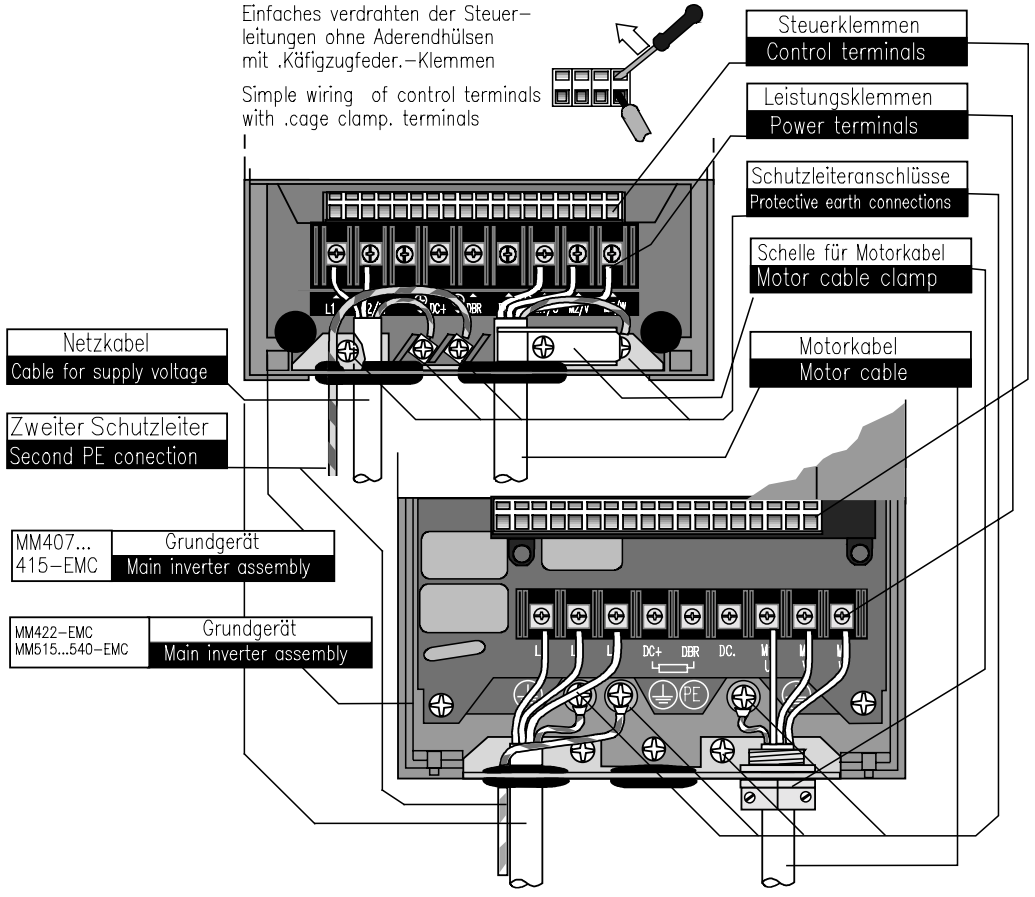


Fig. 3.2a: MotorMaster MM45
Wiring with instruction for using screwless cage-clamp terminals and for connection of protective earth and screening of motor cables

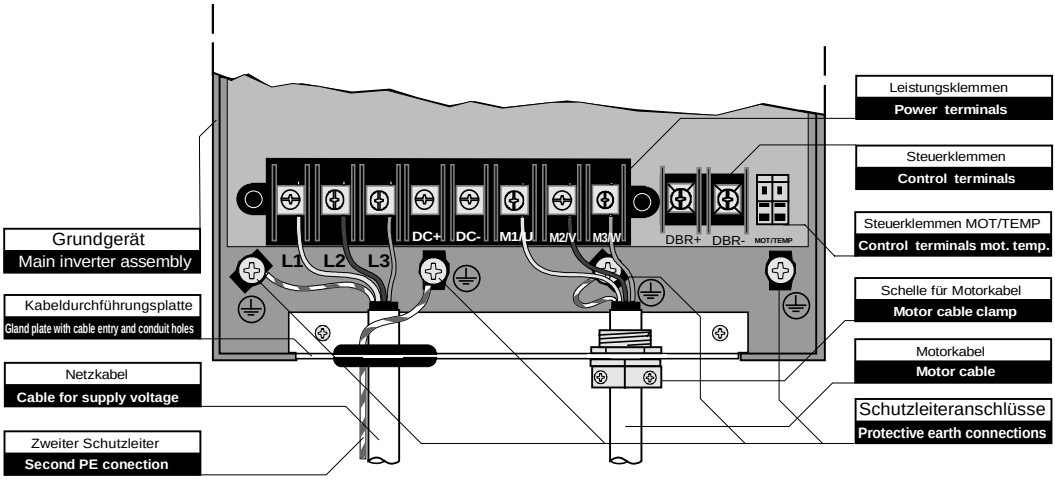


Fig. 3.2b: MotorMaster MM6
Wiring with instruction for using screwless cage-clamp terminals and for connection of protective earth and screening of motor cables

Gland for screened motor cable

A special cable gland with good EMC properties for screened motor cables is available as OPTION MM-MOT-GLAND, see page 9-2.

Power wiring

CAUTION!
Never perform high-voltage insulation measurements on the wiring without first disconnecting the MM456 Frequency Inverter from the circuit being tested.

All relevant national standards and local electricity board regulations must be observed at the installation. Power cables must have a minimum rating of 1.1 x full load current. Power cables (particularly 3-phase motor cables) must be routed well away from cables carrying setpoints or feedback signals, screened motor feedback cables, and cables from other electronic equipment in the same plant.

The single-phase or three-phase main power supply should be within the voltage tolerances specified in **Chapter 1, POWER CIRCUIT (**page 1-6). Connect the voltage supply to terminals (L1, L2/N or L1, L2 and L3). The protective earth must be connected to the protective earth connections of the inverter.

Refer to page 3-7 and following and also to **Chapter 7, EMC, THE 'CE'-MARK, UL, CSA** for information on EMC wiring requirements.

Overload and short-circuit protection

The incoming voltage supply and cable to the motor should be wired and protected to the appropriate regulations such as are shown in the following table in accordance with the European regulations:

MM456 Frequency Inverter	Operation	Power cable Supply fuse [1] / Circuit breaker[2]	Size of power cable	Type of installation	Motor cable Size of power cable	Type of installation
MM407-EMC	QT	10 A	1 mm²	B1, C, E	1 mm²	B1, B2, C, E
	HVAC		1.5 mm²	B2		
MM415-EMC	QT	20 A	2.5 mm²	C, E	1 mm²	B1, B2, C, E
	HVAC		4 mm²	B1, B2		
MM422-EMC	QT	25 A	4 mm²	B1, C, E	1 mm²	C, E
	HVAC		6 mm²	B2	1.5 mm²	B1, B2
MM515-EMC	QT	10 A	1 mm²	B1, C, E	1 mm²	B1, B2, C, E
	HVAC		1.5 mm²	B2		
MM522-EMC	QT	10 A	1 mm²	B1, C, E	1 mm²	B1, B2, C, E
	HVAC		1.5 mm²	B2		
MM540-EMC	QT	16 A	1.5 mm²	E	1 mm²	C, E
	HVAC		2.5 mm²	B1, B2, C	1.5 mm²	B1, B2
MM655	QT	20 A	2.5 mm²	C, E	1.5 mm²	B1, C, E
			4 mm²	B1, B2	2.5 mm²	B2
	HVAC	25 A	4 mm²	B1, C, E	2.5 mm²	B1, C, E
			6 mm²	B2	4 mm²	B2
MM675	QT	25 A	4 mm²	B1, C, E	2.5 mm²	B1, C, E
			6 mm²	B2	4 mm²	B2
	HVAC	32 A	6 mm²	B1, C, E	4 mm²	B1, C, E
			10 mm²	B2	6 mm²	B2
MM6110	QT	32 A	6 mm²	B1, C, E	4 mm²	B1, C, E
			10 mm²	B2	6 mm²	B2
	HVAC	40 A	10 mm²	B1, B2, C, E	6 mm²	C, E
					10 mm²	B1, B2

[1] Standard slow-blow fuses should be used

[2] Circuit breakers with a delayed release overload suitable for use as motor protection should be used

The listed cable sizes are taken from "Electrical equipment of machines", EN 60204-1 for continuous operation in air up to 40 °C ambient temperature and are valid in accordance with the indicated type of installation as defined in the following:

B1 Round conduit or rectangular cable channel trunking with three separate single-core current-carrying conductors

B2 Round conduit or rectangular cable channel trunking with three current-carrying conductors in a single or multi-core cable

C Wall mount of three current-carrying conductors (single or multi core)

E Free-air mount e.g. on cable bridges (single or multi core)

Other ambient temperatures, methods of installation, customer, national or supply-company regulations may require other cable sizes. It is the installers whole responsibility to verify in all cases.

NOTE: For compliance with UL standards other requirements may apply, refer to **Special considerations for compliance with UL** (see page 1-11).

Earthing

WARNING !
The motor must be connected to an appropriate protective earth. Failure to do so constitutes a potentially lethal electrical shock hazard.

All Frequency Inverters must be permanently earthed. In accordance with the European LOW-VOLTAGE DIRECTIVE as in EN50178 permanent earthing requires either:

1. The cross section of the protective conductor should be at least 10 mm^2 (copper). This minimum cross section was determined with regard to mechanical strength.
2. Laying of a second protective earth conductor through separate terminals and electrically parallel to the protective conductor, see Fig. 3.2 on page 3-5. Each protective earth conductor shall individually satisfy the requirements for a protective earth conductor (note this ensures the equipment is still protectively earthed if one conductor is damaged).

Control wiring

A general wiring diagram for the MM456 Inverter is provided as Fig. 2.1 on page 2-4.

For normal speed control operation, the speed demand signals are connected to the analog input AIN1 referenced to 0 V. The maximum speed, and other associated parameters, are set from the programming pad.

The command "Run" is provided by connecting a DC 24 V control voltage e.g. single holding contact between DIN1 (Run) and +24V - close contact to run, open to stop. The other inputs are to be connected as described in Chapter 2.

A control output "Health" is available at output DOUT1. This output is normally "high". Any trip which causes the healthy output to deactivate is internally latched by the MM456 Frequency Inverter and the cause of the trip displayed on the LCD display of the programming pad. Once latched, such an alarm can be cleared only by removing and re-applying the supply voltage to the drive by removing and reapplying the Run input DIN1, or removing and reapplying a Reset signal to DIN2.

A further output "Running" is available as DOUT2.

The function of all inputs and outputs may change if the configuration of the software is altered.

0.2...0.75 mm2 (18 AWG) wire should be used for control cables. It is recommended that screened cable be used, with the screen connected at the MM456 Frequency Inverter end. In some installation it may be necessary to connect the screen of digital control inputs at both ends. Control wiring should be kept separate from power cables.

EMC INSTALLATION INSTRUCTIONS

Introduction

This section provides installation guidelines for MM456 Frequency Inverters and drive systems to maximise their '**E**lectro **M**agnetic **C**ompatibility' (EMC) in their intended operating environment.

All installers must read this section and apply the advice which is relevant to their application. **Pass on this information to others as is appropriate.**

All inverter-fed drive systems have the potential to produce electrical emissions, both radiated and conducted back into the AC supply. This is due to the inherent operation of all drives by switching large voltages and currents rapidly in order to control the motor. Because the drives internal controlling electronics operates continuously in very close proximity to electrically-noisy power-switching components, MM456 Frequency Inverters are inherently immune to most external sources of electrical noise.

Great care has been taken in the selection of suitable EMC filters for the voltage supply to provide the correct level of interface suppression, ease of installation and to ensure that electrical safety is not compromised.

MM6 Frequency Inverters require an external EMC filter. Use the specified EMC filters only to ensure that the required EMC performance is achieved.

The EMC performance can only be guaranteed to be within the limits specified when the MM456 Frequency Inverters are installed together with the EMC filters in accordance with the following installation instructions.

The subject of EMC is explored in more detail in a separate Application Note entitled "EMC Does and Don’ts" , available from your supplier. Also a Product Information PI-LKTM-005 describing the requirements of the EMC DIRECTIVE of the EU is available.

EMC filters to reduce line-conducted noise

MM45 Frequency Inverters have integrated EMC filters to reduce mains-bourne interference The installation requirements to meet interference supression level B and the Thermal Limitations are described in the following table.

The external EMC filter required by MM6 Frequency Inverters should be mounted as close to the inverter as possible. The connection between the MM6 Frequency Inverter and the EMC filter must always be as short as possible taking care not to obstruct any ventilation openings and **be segregated from all other cables**. If this cable exceeds 0.3 m in length then a screened/armoured cable, with the screen/armour earthed at both the filter and inverter ends with large-area contact surfaces (preferably with metal cable glands) must be used. The connection between MM456 Frequency Inverter and the motor must be installed away from other cables or wires and be

preferably also be screened. Ideally the filter will be mounted onto the same metallic panel as the drive. The RF connection between the inverter and filter and panel should be enhanced as follows:

- Galvanized mounting panels should be preferably used otherwise remove any paint/insulation between the mounting points of the EMC filter, MM456 Frequency Inverter and panel
- Liberally apply petroleum jelly over the mounting points and securing threads to prevent corrosion. Alternatively conducting paint could be used on mounting panels.
- If the proceeding is not possible then the RF earth bond between the EMC filter and MM456 Frequency Inverter is usefully improved by making an additional RF earth connection using wire braid of at least 10 mm^2 cross sectional area (due to skin effect).

Care should be taken to ensure that the protective earth conductor exiting from the filter is connected to the protective earth conditions of the MM456 Frequency Inverter. Any additional RF earth such as a cable screen **is not a protective earth**.

EMC filter must be **permanently connected to a protective earth** to prevent the risk of electric shock under abnormal operating instances (such as the loss of one phase of the AC supply).. Permanent earthing can be achieved installing a second conductor in parallel connection with the first protective conductor to separate protective earth terminals. Each conductor shall on its own meet the requirements for a protective earth conductor.

NOTE: Metal surfaces such as eloxized or yellow chromed e.g. with cable mounting or 35 mm DIN rails, screws and bolts have a high RF impedance which can be very detrimental for EMC performance.

On some specific customer sites the supply may not be balanced with respect to earth (non-earth referenced supplies). The earth leakage currents would increase and interfere with the operation of any earth-fault monitoring equipment on such installations. In addition the EMC performance of the filter would be degraded. For these reasons **the MM456 Frequency Inverter must not be used on none earth-referenced supplies**.

With all frequency inverters conducted and radiated interference increases with the inverter switching frequency. The emissions can therefore be reduced by selecting the lowest acceptable switching frequency which also reduces the losses in the EMC filter.

As with all power electronic drives the conducted emissions increase with motor cable length. The following relationship between switching frequency, cable length to motor, and thermal limitation of EMC filter losses should be considered.

Product Code	EMC-Filter Type	int./ext.	Switching frequency	Permissible maximum length of screened cable	
				Interference suppression to limit B	Thermal limitation of EMC filter
MM407-EMC		integrated	3 kHz	25 m	25 m
			6 kHz	25 m	25 m
			9 kHz	5 m	25 m
MM415-EMC		integrated	3 kHz	25 m	25 m
			6 kHz	25 m	25 m
			9 kHz	5 m	25 m
MM422-EMC		integrated	3 kHz	50 m	50 m
			6 kHz	50 m	50 m
			9 kHz	5 m	50 m

Product Code	EMC-Filter Type	int./ext.	Switching frequency	Permissible maximum length of screened cable	
				Interference suppression to limit B	Thermal limitation of EMC filter
MM515-EMC		integrated	3 kHz	50 m	50 m
			6 kHz	50 m	50 m
			9 kHz	1 m	50 m
MM522-EMC		integrated	3 kHz	50 m	50 m
			6 kHz	50 m	50 m
			9 kHz	1 m	50 m
MM540-EMC		integrated	3 kHz	50 m	50 m
			6 kHz	50 m	50 m
			9 kHz	1 m	50 m
MM655			3 kHz		
			6 kHz		
			9 kHz		
MM675			3 kHz		
			6 kHz		
			9 kHz		
MM6110			3 kHz		
			6 kHz		
			9 kHz		

If one EMC filter is to be used in a metal enclosure for several MM456 or other frequency inverters, then this filters should be mounted as close to the incoming AC supply to the enclosure as possible.

IMPORTANT WARNINGS !

- MM456 Frequency Inverters with integrated or external EMC filters are only suitable for use with TT/TN voltage supplies with an to earthed neutral. The use with isolated supply systems (IT systems) is not permissible.
- The EMC filters contain capacitors phase-to-phase and phase-to-earth. Discharge resistors are fitted, but the filters, terminals and wiring must not be touched for a period of 3 min after the removal of the AC supply.
  Not adhering to this warning can result in potentially lethal electric shock.
- The MM456 Frequency Inverter must only be used with **a permanent protective earth** connection making use of a second conductor in parallel with the protective conductor to a separate protective earth terminal on the MM456 Frequency Inverter. The conductor on its own shall meet the requirements for a protective earth conductor.
- Thermal performance of the EMC filter is influenced by switching frequency and cable length. Take note of limits summarized in the table above.
- Give important consideration to the following section regarding safety considerations when using earth-fault detection systems.

Interaction and safety considerations with earth-fault monitoring systems

Due to the internal phase-to-earth capacitors in the EMC filter, on initial connection of the supply voltage a pulse of current will flow in the earth. This has been minimised in the recommended EMC filters, but may still trip out any RCD (Resident Current Detector) in the earth system. In addition high frequency and DC components of earth leakage currents will flow under normal operating conditions.. Under certain fault conditions, larger DC protective earth currents may flow. The protective function of some RCDs cannot be guaranteed under such operating conditions. For these reasons the manufacturer does not recommend the use of RCDs, but where their use is mandatory, they should be capable of correct operation with DC and AC protective earth currents (e.g. type B RCDs as in amendment 2 of IEC755) and preferably have adjustable trip amplitude and time characteristics, to prevent tripping on initial power connection.

RCDs used with MM456 Frequency Inverters and other similar equipment are **not suitable for personnel protection**. Another means of providing personal safety must be provided for, see EN50178.

Minimising radiated emission

All MM456 Frequency Inverters will comply with the most stringent radiated emission limits of EN55011 Class B by mounting inside an enclosure with 10 dB attenuation between 30 and 100 MHz (which would typically be the attenuation provided by a metal enclosure with no aperture greater than 0.15 m) and screening any control and signal cabling outside of the enclosure in addition to the motor cables. The control and signal cables, if screened should be terminated at the entrance to the metal enclosure.

Inside the enclosure the radiated magnetic and electric fields will be high, due to proximity, and any components fitted inside the cubicle must be sufficiently immune. Remember that the EN55011 radiated emission measurements are made between 30 MHz and 1 GHz in the far field, at a distance of between 10 m and 30 m. No limits are specified lower than 30 MHz, or in close proximity. Emissions from individual components tend to be additive.

The cable between the enclosure and the motor must be screened or armoured and also contain the motor protective earth connection. When using screened cable only use high quality cable with a copper screen with a covering factor of at least 85 %. The screen/armour must be earthed at both ends by connecting it to both the entrance to the enclosure (or gland box for wallmount), and to the motor frame ideally in 360° termination's via cable glands (to meet the most stringent emission requirements). Screen-to-earth connections via 360° bonding is 75 % more effective than earthing via pigtails from the screen.

Some motor terminal boxes and conduit glands are made of plastic, if this is the case then copper braid must be connected between the screen and the motor frame. This also applies to metal terminal boxes which are insulated from the frame with a gasket or paint.

At the enclosure end often the screens are terminated on a special power-screen rail at the entrance to the enclosure. The integrity of the screen must be maintained over the entire length of the cable between the enclosure and motor. If the cable is interrupted to insert terminals, contactors, chokes, fuses etc., then the screen must be connected over the shortest possible distance with a suitable connection with a good H.F. characteristic.

Note that some hazardous area installations may preclude direct earthing at both ends of the screen, in this case earth the none direct end via a 1 µF, 50 VAC capacitor.

If a shielded cable is not available, lay unshielded motor cables in a metal conduit which will act as a shield. The conduit must be continuous with a direct electrical contact to the drive module and motor housing. If links are necessary, use braid with a minimum cross sectional area of 10 mm^2.

Safety earthing considerations always takes precedence over EMC earthing

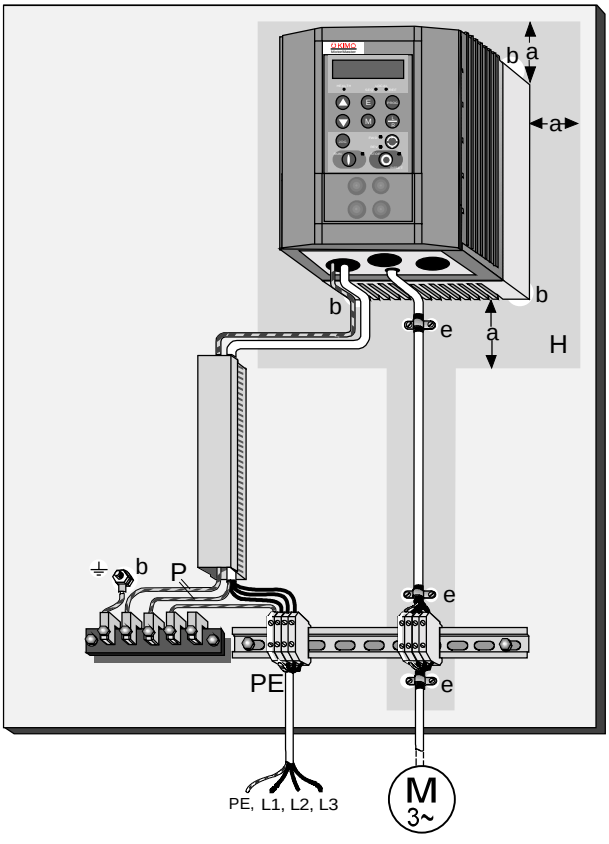
The use of screened cable to the motor without an EMC filter in the voltage supply is not recommended, as line-conducted interference will increase substantially and the capacitive coupling of the output cable to earth will result in high earth-leakage currents.

To ensure the correct operation of the MM456 Frequency Inverter, some control and signal cables such as for a tacho, encoders or serial interface have to be screened back to the inverter terminals. The screen integrity must be continous right back to the MM456 Frequency Inverter. Always minimise the length of screen stripped back to make this connection. The screen should only be connected at the MM456 Frequency Inverter. If high frequency noise is still a problem, earth at the non drive end via a 0,1 µF capacitor.

Screening and earthing when mounted in an enclosure

Make sure the requirements of EN60204-1 are adhered to with electrical equipment for machines. Satisfactory EMC performance is only achievable when the MM456 Frequency Inverter with associated equipment is mounted on a conducting metal mounting panel. Beware of constructions using insulating mounting panels or for EMC undefined mounting structures.

A single-point earthing strategy should be followed for a single MM456 Frequency Inverter mounted in an enclosure. Fig. 3-2a shows a typical arrangement of single-point earthing of screens and earth connections. The protective earth connection (PE) to the motor must run inside the screened cable between the motor and the inverter where it is to be connected to the protective-earth terminal of the inverter. In accordance with EN60204-1, only one protective earth conductor is permitted at each earth terminal. Local wiring regulations may require the protective-earth connection of the motor to be connected locally but this will not cause earth-loop problems due to the relatively high RF impedance of the local earth connection.



a 0.25 m spacing from "EMC hot area" to adjoining equipment, especially important with field-sensitive equipment (see page 3-12)

b Contact areas between metallic mounting panel and PE earthing bar, screens etc. to be free of paint and prepared as described on page 3-9/10

e Cable screen clamped to contact area on mounting panel

P Protective-earth cables:
2 separate parallel earth cables each to wiring regulations

H EMC hot area:
Avoid installing sensitive equipment in this area

Fig. 3.3: Screening and earthing when a MM456 Frequency Inverter is mounted in an enclosure

When more than one piece of electrical equipment is fitted inside an enclosure, care must be taken to ensure that noise flowing in the earth connections does not couple into other equipment. A star-point earthing policy separating noisy from quiet earths is highly recommended. Five separate earth branches should be provided for:

1. Clean earth bus bar (CEBB) — The Clean earth bus bar used as a reference point for all signal and control cabling. This may the further subdivided into an analogue and a digital reference busbar, each separately connected to the star earthing point. The digital reference is also used for any 24 V controls.

2. Dirty earth bus bar (DEBB) — The dirty earth busbar is provided for the earth connection to MM456 Frequency Inverters and other power electronic equipment (i.e. protective earth connections).

3. Enclosure metalwork bus bar (EMBB) — The enclosure metalwork bus bar is used for connecting all parts of the enclosure including panels, doors and the back plate. It is also used as a reference for any 110 or 220 V control used and for the control transformer screen.

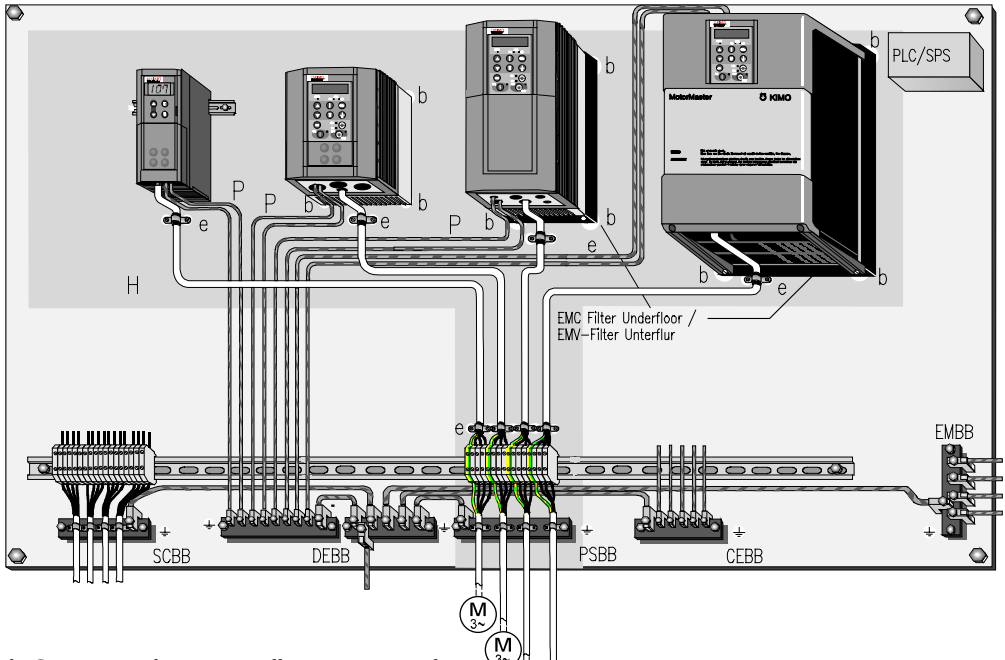
4. Power screen bus bar(PSBB) — The power screen bus bar is only for the connection of screens of power cables which **do not** have to go directly to the MM456 Frequency Inverter (such as motor cables, braking choppers and their resistors) or to other drive modules (refer to appropriate Product Manual to identify these). Noise coupled onto the incoming screens must flow to earth directly so as not to contaminate the rest of the enclosure. Hence the power screen busbar should be placed as close to the point of cable entry as possible.

5. Signal/control screen bus bar (SCBB) — The signal/control screen bus bar is to be used for external signal/ control screened cables which do not have to go directly to the MM456 Frequency Inverter. This bus bar should also be placed as close as to the point of cable entry as possible.

For optimum EMC, copper rails with a substantial cross-section should be used for the bus bars. Screened cables are best 'u' clamped (remove any plastic spacers) to ensure an optimum HF connection.

The five separate earth bus bars should be isolated from the mounting panel and connected to a central earth busbar (star point) near the PE or PEN terminal of the main supply. Flexible large cross-section cable with short lengths to ensure a low HF impedance should be used. The arrangement of the bus bars should be such that the connection to the single earth point are as short as possible.

Fig. 3.4 shows an implementation of a star-point earthing policy described above.



b Contact areas between metallic mounting panel and between the MM456 and MM3SV Frequency Inverter, EMC filter, PE earthing bar, screens etc. to be free of paint and prepared as described on page 3-9/10

H EMC hot area:
Avoid installing sensitive equipment in this area

e Cable screen clamped to contact area on mounting panel

P Protective-earth cables:
2 separate parallel earth cables each to wiring regulations

Fig. 3.4: Implementation of star-point earthing policy for multi-drive installation

Screening and earthing when wall mounted

To provide for good EMC performance the recommended matching EMC filter must be fitted and the cables between the wall-mount MM456 Frequency Inverter and the motor screened or armoured. With the underfloor EMC filters a specially-designed pressed-steel conduit for the cables between the EMC filter and the MM456 Frequency Inverter is supplied with the gland box. Also screening of control and signal cables may be required. Refer to **Minimising radiated emission** (page 3-9). In addition any connections to the DC link must also be screened, with the screen connected at both ends (e.g. also to the protective earth protection of an external braking chopper).

All MM456 Frequency Inverters comply with the radiated emission limits of EN55011 (1991) Class A when wall mounted to these instructions, using the recommended matching underfloor EMC filters and screened motor, control and signal cabling. Compliance with the more stringent limits of Class B can be achieved by mounting inside an enclosure with 10 dB attenuation between 30 and 100 MHz (which would typically be the attenuation provided by a standard metal cabinet with no aperture greater than 0.15 m). Minimise the length of unshielded cable inside the cubicle to prevent increased radiated emission.

A single-point earthing policy such as that using the provided earthing terminals to the MM456 Frequency Inverter and underfloor EMC filter as shown in Fig. 3.5 should be used.

The protective earth connection to the motor must run inside the screened cable between the motor and MM456 Frequency Inverter where it is to be connected to the protective earth terminal in the gland box or on the inverter. Note that in accordance with EN60204-1 only one protective earth conductor is permitted at each earth terminal. Local wiring regulations may require the protective-earth connection of the motor to be connected locally but this will not cause shielding problems due to relatively high RF impedance of the local earth connection.

The EMC filter must be permanently protective earthed in accordance with recommendations and warnings in **EMC filters to reduce line-conducted noise**, page 3-9/10. Usually two separate earth connections are required with underfloor EMC filters.

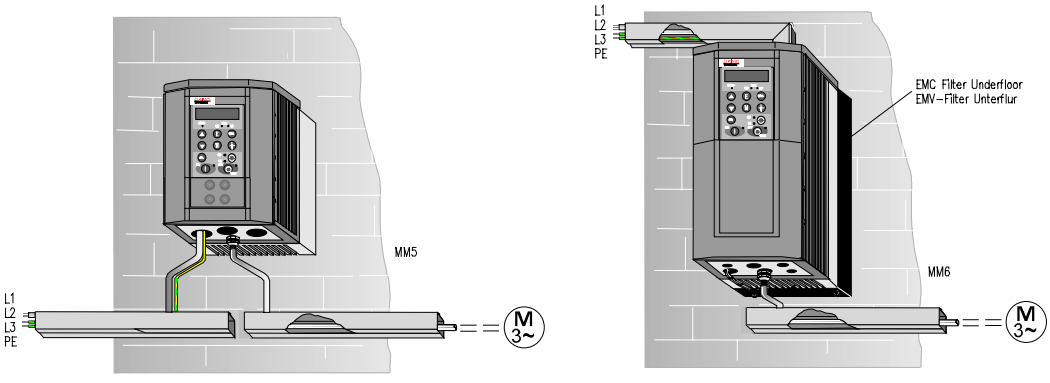


Fig. 3.5: Screening and earthing when a MM456 Frequency Inverter is wall mounted

Motor cable-length limitations

Screened/armoured cable has significant capacitance between the conductors and the screen which increases linearly with cable length. Typically this is 200 pF per metre but this will vary with cable type and current rating. Long cable lengths may have the following undesirable effects:

- Tripping on "over current" as the cable capacitance is charged and discharged at the switching frequency.
- Producing increased conducted emissions which degrade the performance of the EMC filter due to saturation. EMC compliance is only guaranteed up to the cable lengths shown in the table on page 3-10/11.
- Causes RCDs (Residential Current Detection) to trip out due to increased high frequency earth current.
- Cause excessive thermal losses in the EMC filter. The table on page 3-10/11 summarises cable length limitations due to thermal considerations.

These effects can be overcome by adding motor chokes at the output of the MM456 Frequency Inverter. In applications where multiple motors are connected to a single MM456 Frequency Inverter, minimise the length of screened/armoured cable connected to the MM456 Frequency Inverter by using a single length of cable to a star junction point, from where all the other motor cables are attached. Maintain the integrity of the shield. If the cable is interrupted (e.g. to insert terminals, contactors or other components), the screen must be connected over the shortest possible route with a suitable connection with a good H.F. characteristic. The section **POWER RELATED COMPONENTS**, page 9-2, gives information on the recommended motor chokes for use with long cables, cables onnected in parallel, or when EMC output filters are used with cables longer than those specified for EMC compliance.

Output filters can also be used to achieve EMC and filter thermal conformance with longer cable lengths than specified. These output (motor) filters also ensure a long motor life by reducing the high dV/dt and over voltage stresses applied to the motor windings by inverters. These filters should be mounted as close to the MM456 Frequency Inverter as possible. Refer to your supplier for advice in the selection of suitable filters.

Other layout considerations

The proximity between the source and victim circuit has a large effect on radiated coupling. The electromagnetic fields produced by inverters fall off rapidly with distance from the cabling/enclosure. It should be remembered that the radiated fields from EMC compliant drive systems are measured at least 10m from the equipment over the frequency band 30 to 1000 MHz (as required by EN55011, referenced by the generics and the drive product specific standard). Any equipment placed closer to the drive system than this will see larger magnitude fields, particularly very close to the drive. No magnetic/electric field sensitive equipment should be placed within 0.25 m of the following parts of a drive system using power electronics:

- EMC supply filters
- Output (motor) filters
- Input or output chokes/transformers
- Cable between MM456 Frequency Inverter and Motor (even when screened/armoured)
- Connections to external braking chopper and resistor (even when screened/armoured)
- C/DC brushed motors (and to their cooling fans)
- DC link connections (even when screened/armoured)
- Relays and contactors (even if they are suppressed)

Often the coupling between electrically 'noisy' and 'sensitive' cables is a problem. This can be minimised by separating parallel runs by at least 0.25m, and minimising the length of parallel runs. For long parallel runs (>10 m) the separation should be increased proportionally. For example if the parallel runs were 50 m then the separation would be $(50/10) \times 0.25$ m = 1.25 m.

In addition the coupling between two cables which must cross is minimised if they cross over at 90°. Hence sensitive cables should cross the cables to the motor at 90°, and should never be run close to them or in parallel for any great length.

Never run supply, DC link or motor cables in the same bundle as the signal/control and feedback cables, even if they are screened.

From experience the following equipment is defined as particularly sensitive and care must be taken in the installation:

- Any transducers which produce low level analogue outputs (<1 volt) e.g. load cells, strain gauges, torque measuring devices, thermocouples, thermistor temperature transducers, piezoelectric transducers, anometers, LVDT's
- A.M. radios (long and medium wave only)
- Video cameras and closed circuit TV
- Personal computers
- Capacitive devices such as proximity sensors and level transducers
- Mains borne communication systems
- Equipment not suitable for operation in the intended EMC environment i.e. with insufficient immunity to new EMC standards

Chapter 4 - SETTING-UP AND COMMISSIONING

NOTE: The setting-up and commisioning of MM6 Frequency Inverters is almost identical to that with MM3SV range. Reference is therefore made to both MM6 and MM3SV Frequency Inverters in this chapter.

PROGRAMMING PAD

Introduction

Every MM456/MM3SV inverter is fitted with a cover plate as standard, see Fig. 1.1, page 1-3. This enables the inverter to be used for applications without any special requirements, e.g. operation with an external set-value for speed.

With many requirements it is advantageous to replace the cover plate with the optional removeable programming pad (Fig. 1.1). The programming pad consists of an illuminated 2x16 character plain-language Liquid Cristal Display (LCD), 10 function keys and 7 status LEDs. This enables simple programming and diagnostics as well as local control of the inverter.

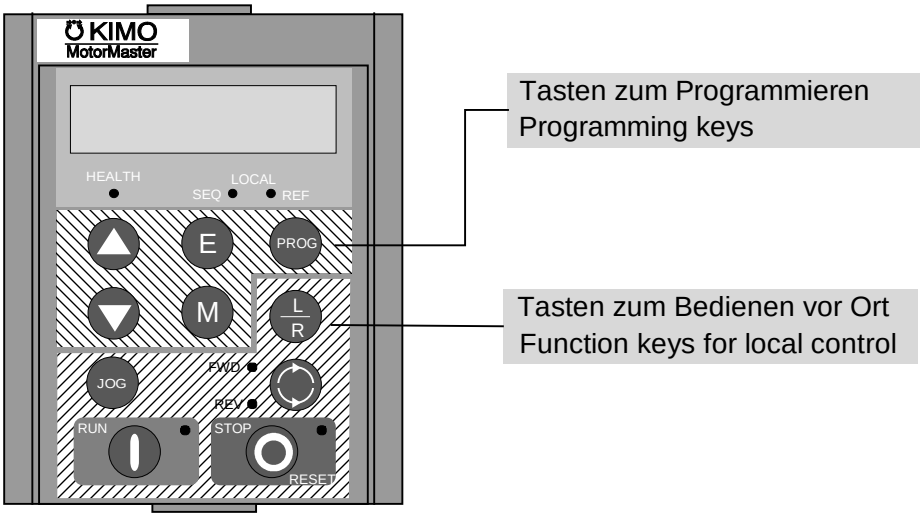


Fig. 4.1: Programming pad OPTION MM-PROG (Option)

The programming pad may be mounted external to the MM456/MM3SV inverter. A panel mount kit with a 3 m cable is available as an OPTION-PROG-PM, see page 9-9.

Since the setting up and commissioning procedures rely on the use of the programming pad, its operation is described in the following. Users familiar with the programming pad may proceed directly to **SETTING-UP ENERGIZING THE DRIVE,** page 4-10).

LCD plain-language display

The LCD plain-language display shows information on the various menues and parameters. The following types of display are provided for:

a:
```
 AC MOTOR DRIVE
4.0  kW 400V 5.X
```
Power-up screen with rated data (software version lower right)

b:
```
QUICK SETUP
menue at level 2
```
G Typical menue of the menue level 2

c:
```
MAX SPEED
     50.0 Hz
```
Adjustable parameters. Factory default settings which depend on the rated inverter power are indicated in this manual as XX...

d:
```
MAX SPEED
→    50.0 Hz
```
"Modify parameters" mode

e:
```
RUN FWD
←          FALSE
```
Adjustable parameters which are software linked and therefore in this condition not adjustable

f:
```
SPEED DEMAND
=    0.0 %
```
Parameters corresponding to measured values. These are indicated in this manual by YY...

g:
```
*** TRIPPED  ***
EXTERNAL FAULT
```
Fault message

The type faces **OPERATOR**, DIAGNOSTICS or **FUNCTION BLOCKS** indicate displays on the programming pad. The type face used indicates the View Level as follows:

	OPERATOR MENU **menu at level 1**	DIAGNOSTICS menu at level 1	**FUNCTION BLOCKS** **menu at level 2**
View Level: (see page 5-12)	**OPERATOR**	BASIC	**ADVANCED**

Function keys for programming the MM456/MM3SV

The following five function keys allow the user to move around the menu structure on the display and alter parameters:

MENU
This Menu key selects the next lower menu or function. If an adjustable menue has already been selected (example c, page 4-3), then pressing Ⓜ again will select the alternative mode (example d, page 4-3).

ESCAPE
The ESCAPE key allows the user to revert to the preceding menu level or leave the parameter modification mode.
Also any displayed trip message will disappear on presssing this key. However the latched trip itself will not be reset, see ◎ key.

UP
The UP key provides forward movement to explore the options available in the selected menu level. If a menu is already in the alternative mode (example d), then the present value can be decreased.

DOWN
The DOWN key provides backward movement to explore the options available in the selected menu level. If a menu is already in the alternative mode (example d), then the present value can be increased.

PROGRAMMING
This key has the functions as follows:
- toggles between the last position in the **`OPERATOR`** menu and the last position in the other menus.
- provides simple direct means of saving parameters by pressing for at least 2 s. There is no need to climb up and down the menu tree when testing or saving parameter settings, see page 4-9.
- when is `VIEW LEVEL` | **`BASIC`** enables `VIEW LEVEL` to be seleced and changed, see page 5-12.

Function keys for manual operation (LOCAL mode)

The following 5 function keys allow the user to manually control the drive in LOCAL mode.
These keys (apart from STOP/RESET) are only active when the drive is in LOCAL mode.

LOCAL
This key will toggle between the normal operating mode and the LOCAL control mode. This can only happen when the drive is stopped. The LEDs LOCAL (SEQ and/or REF) illuminated when LOCAL is selected. The menu **OPERATOR|SETPOINT (LOCAL)** is automatically selected as follows:

```
SETPOINT LOCAL
→     0.0 %
```

Control function is now with the programming pad using the four following keys and ▲ and ▼.

FORWARD/REVERSE
This key will change the direction of motor rotation. The LEDs FWD (forwards) and REV (reverse) indicate the direction of rotation.

JOG
This key selects the JOG mode following selection of LOCAL mode. The menu **OPERATOR|JOG DMD (LOCAL)** is automatically selected:

```
JOG DMD (LOCAL)
=     10.0 %
```

With the ◎ key the direction of rotation can be selected. This function is only active while the key is depressed. On releasing the drive will revent to a stopped condition.

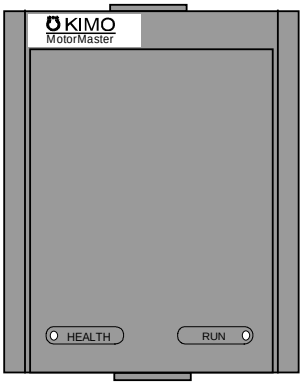
(green)

RUN
This key will start the MM456/MM3SV Frequency Inverter in a similar manner to placing 24 V on terminal DIN1. In addition any latched trip messages will be reset if no longer active.

(red)

STOP/RESET
This key will stop the MM456/MM3SV Frequency Inverter when in LOCAL mode in a similar manner to removing the 24 V from input DIN1.
In addition any latched trip messages and trips will be reset if no longer active.

Indicating LEDs



HEALTH	RUN	Zustand	Condition
		In Betrieb mit Sollwert = 0%	Running with zero reference
		In Betrieb	Running
		Anhalten	Stopping
	Wie oben, as above	Bremschopper aktiv	Braking chopper in operation
		Gestoppt	Stopped
		Automatisches Wiedereinschalten	Auto restarting
		Störung	Tripped
		Neu-Konfigurieren oder NVRAM fehlerhaft beim Einschalten	Re-configuration or corrupted non-volatile memory power-up

HEALTH	RUN	STOP	Zustand	Condition
			In Betrieb mit Sollwert = 0%	Running with zero reference
			In Betrieb	Running
			Anhalten	Stopping
			Gestoppt	Stopped
			Autotune	Autotuning
			Störung	Tripped
			Neu-Konfigurieren oder NVRAM fehlerhaft beim Einschalten	Re-configuration or corrupted non-volatile memory power-up

FWD	REV	Richtung	Direction
		Gewünschte und aktuelle Richtung sind vorwärts	Requested direction and actual direction are forward
		Gewünschte Richtung ist vorwärts aktuelle Richtung ist rückwärts	Requested direction is forward but actual direction is reverse
		Gewünschte und aktuelle Richtung sind rückwärts	Requested direction and actual direction are reverse
		Gewünschte Richtung ist rückwärts aktuelle Richtung ist vorwärts	Requested direction is reverse but actual direction is forward

LOCAL SEQ	LOCAL REF	LOKAL/Normal (Fernsollwert)	LOCAL/Normal (Remote)
		Steuerbefehle: Klemmen Sollwert: Klemmen	Commands: Terminals Set-value: Terminals
		Steuerbefehle: Klemmen Sollwert: ▲ bzw. ▼	Commands: Terminals Set-value: ▲ and ▼
		Steuerbefehle: ◐ ⊙ JOG ⟲ Sollwert: Klemmen	Commands: ◐ ⊙ JOG ⟲ Set-value: Terminals
		Steuerbefehle: ◐ ⊙ JOG ⟲ Sollwert: ▲ bzw. ▼	Commands: ◐ ⊙ JOG ⟲ Set-value: ▲ and ▼

Fig. 4.2: Explanation of the indicating LEDs with Blank cover and Programming Pad

Menu structure

Refer to last fold-out side of this Product Manual.

IMPORTANT OPERATIONS WITH THE PROGRAMMING PAD

Changing the language of the Programming Pad

A change in language can be set as follows:

1. Remove supply voltage to MM456/MM3SV Frequency Inverter (see page 4-3) and wait until LCD display is dark.

2. Reapply power with keys PROG depressed until the following screen is displayed::

```
LANGUAGE
         ENGLISH
```

3. Press M key to select "Modify parameters" mode.

4. Select desired language with the keys ▲ and ▼::

```
DEUTSCH
ENGLISH
ESPANOL
FRANCAIS
```

5. Press key E.

6. To ensure that the set language is retained on power down, use the save parameter function, see page 4-9/5-14.

If the factory default setting (MACRO 1) is selected, then the display will revent to the language of the factory default setting (see **PRODUCT/COUNTRY** in the following).

When MM456/MM3SV Frequency Inverters are exported to other countries it may be useful to modify the language and basic operating frequency of the factory default setting (MACRO 1). An example of this is with the American continent where English/60 Hz is usually required. This change can be accomplished as follows:

1. Remove supply voltage to MM456/MM3SV Frequency Inverter and wait until LCD display (see page 4-3) is dark.
2. Reapply power with keys ▲, E and PROG depressed until the following screen is displayed:

```
PRODUCT/COUNTRY
 GERMAN    50Hz
```

3. Press M key to select "Modify parameters" mode.
4. Select desired language with the keys ▲ and ▼:

```
GERMAN      50Hz
ENGLISH     60Hz
ENGLISH     50Hz
P LANGUAGE  60Hz
P LANGUAGE  50Hz
SPANISH     50Hz
FRENCH      50Hz
```

5. Press key E for 2 s to store change.

User reset to factory default settings

1. Remove supply voltage from MM456/MM3SV Frequency Inverter and wait until LCD display is dark.
2. With ▲ and ▼ keys depressed reapply power. Keep keys depressed until the following display appears:

```
AC MOTOR DRIVE
DEFAULTS LOADED
```

Factory default settings (MACRO1) is now loaded. If required, store this setting (see page 4-9). An alternative method is to load **MACRO 1** in the **SYSTEM | RESTORE DEFAULTS** menu, see page 5-15.See page 4-7 or page 5-15.

Displaying and changing parameters

Examples:

- Display of active setpoint **SPEED DEMAND** starting from the power-up screen: Ⓜ, Ⓜ, ▼.

  Increasing the ramp-up time **RAMP ACCEL RATE** starting from the power-up screen: Ⓜ, 2 x ▼, 2 x Ⓜ, 4 x ▼, Ⓜ, ▲ as required followed by Ⓔ.

Saving parameters in the MM456/MM3SV Frequency Inverter

1. Press PROG key for at least 2 s until the following screen is displayed:

```
SAVE TO MEMORY
```

2. Press Ⓜ key to select the command display **UP FOR ACTION** in the second row.
3. Press ▲ key to complete parameter store.
4. Press PROG key again to revent to original position in programming menu.

See page 5-14 for an alternative method of saving parameters.

Storing parameters in the programming pad

See page 5-14.

Loading parameters from the programming pad

1. Remove supply voltage to MM456/MM3SV Frequency Inverter and wait until LCD display is dark.
2. With ▼ key depressed reapply power. Keep key depressed until the following display appears:

```
ALL PARAMETERS
```

3. Press ▲ key to complete loading.

Loading preset configuration

Integrated MACROS for frequently used configurations are available for frequently used applications, see page 5-15.

SETTING-UP AND ENERGIZING THE DRIVE

WARNUNG!

Working on any part of the drive system or removing terminal covers is only allowed when the following is adhered to:

- complete and full **isolation** of the power and control voltage supplies
- **waiting** until the d.c. link is discharged (at least **3 min**)
- verification that all conducting parts are **free of voltage** before touching these parts
- taking measures to ensure that voltage supplies cannot be reapplied

Potentially lethal injury can occur if the above is not observed !

First-time check of electrical system

Before power is applied to the system the following items should be checked:

1. Single-phase voltage supply is correct and within the specification.
2. Motor is of correct voltage rating and is connected to the MM456/MM3SV Frequency Inverter in either star or delta as is appropriate.
3. All external wiring circuits; such as power connections, control connections, motor connections and in particular protective earth connections have been wired correctly.

NOTE: Completely disconnect the MM456/MM3SV Frequency Inverter before point-to-point checking with a buzzer or when checking insulation with a Meggar.

4. Check for visual damage to MM456/MM3SV Frequency Inverter or associated equipment.
5. Check for loose ends, clippings, drilling swarf, etc., lodged in the MM456/MM3SV Frequency Inverter or ancillary equipment.
6. If possible check that the motor can be turned freely and that the cooling fan is intact and free of obstructions.

Safety considerations

Ensure the safety of the complete system when the drive is energised. In particular ensure:

1. That rotation of the motor in either direction will not cause damage.
2. That nobody else is working on another part of the equipment which will be affected by powering up or drive movements.
3. That other equipment will not be adversely affected before energizing by powering up or drive movements.

Setting up the drive before energizing

1. Prevent application of the supply voltage to the MM456/MM3SV Frequency Inverter by removal of the input fuses or isolate via a suitable circuit breaker.
2. Disconnect the load from the motor shaft, if possible.

3. If any of the drive control terminals are not being used then refer to Fig. 2.1, on page 2-4 to check whether these unused terminals need to be connected. In particular make sure the following terminal connections are made:
   - MM45: Terminal 6-10 (Ext. trip)
   - MM6: Terminal 11-16 (Ext. trip), Terminal MOT/TEMP (Thermistor)
   - MM3SV: Terminal 18-23 (Ext. trip), Terminal 6-10 (Thermistor)
4. Check that the external contact to input DIN 1, Run is open:
   - MM45: Terminal 6-7
   - MM6: Terminal 11-13
   - MM3SV: Terminal 18-20
5. Check that the external speed setpoints are all zero.
6. Following careful adherence to 1... 5 above, connect main power supply to MM456 Frequency Inverter.
7. Make sure that important parameters in the menu `SETUP PARAMETERS|QUICK SETUP` such as min/max speed, ramp times etc. all have factory default values (see Tabele 4.1 below). These values should be adequate for many applications, however it may be necessary to change some of the parameters to suit individual applications.
8. Disconnect power to MM456/MM3SV Frequency Inverter.

NOTE: Terminals indicated are valid for factory default setting as in MACRO 1.

PARAMETER	Factory setting	Explanation	MM6/ MM3SV only	Further Info page
BASE FREQUENCY	50.0 Hz	Frequency at max. output voltage		5-4
MAX SPEED	50.0 Hz	Max. speed (frequency)		5-4
MIN SPEED	-100.0 %	Min speed (frequency))		5-4
RAMP ACCEL RATE	10.0 s	Acceleration time from 0 Hz to MAX SPEED		5-5
RAMP DECEL RATE	10.0 s	Deceleration time from MAX SPEED to 0 Hz		5-5
V/F-SHAPE	LINEAR LAW	Linear V/f characteristic		5-5
QUADRATIC TORQUE	FALSE	Constant torque operation (CT)	•	5-6
FULL LOAD CALIB	XXXX.X A	Rated motor current		5-6
NO LOAD CALIB	XXXX.X A	No-load motor current		5-5
POWER FACTOR	X.XX	cos φ at rated speed		5-5
MOTOR CURRENT	YYY.Y A	(measured current)		5-3/6
MOTOR I LIMIT	100.0 %	Current limit in %		5-6
FIXED BOOST	6.00 %	Additional voltage boost at slow speed		5-6
RUN STOP MODE	RAMPED	Ramp down on removing the RUN command (terminal 20)		5-7
JOG SETPOINT	10.00 %	Jog set value		5-7
AE1 TYPE	0..+10 V	Analog input 1: range		5-8
AE2 TYPE	0..+10 V	Analog input 2: range		5-8
AE3 TYPE	0..20 mA	Analog input 3: range	•	5-8
AE4 TYPE	0..+10 V	Analog input 4: range	•	5-8
DISABLED TRIPS	0600 >>	Trips which are to be ignored		5-8
DISABLED TRIPS+	0000 >>	Further trips which are to be ignored	•	5-8

See page 4-3 for an explanation of XXX.X and YYY.Y:

Table 4.1: Basic parameters in the menu `SETUP PARAMETERS|QUICK SETUP`

Energizing the drive

The following alternative methods of energizing the MM456/MM3SV Frequency Inverter are available:

- Energizing in the LOCALmode with local control from the optional programming pad (useful for first drive tests or fault finding).

- Energizing in the REMOTE Mode i.e. with control via terminals

After completing and understanding of all proceding steps in this chapter the drive may be powerd up as follows (preferably with the load disconnected):

1. Reconnect power. The following should be displayed:

With programming pad:	With standard cover plat ::
`AC MOTOR DRIVE` `4.0 kW 400V 5.X`	
LEDs: HEALTH, FWD, ! TOP	LED: HEALTH

   Should the above not displayed then locate the cause of the fault (see page 6-16)

2. If any of the basic drive parameters need to be changed then this should be done now. Refer to **PROGRAMMING PAD** page 4-2 for a full explanation of how to use the Programming Pad, and Chapter 5 - **PROGRAMMING THE APPLICATION** for an explanation of specific parameters which can be changed (see page 5-4).

3. Energizing in LOCAL Mode

   - Press key, LEDs LOCAL | SEQ and REF should light
   - Press key
   - Adjust local setvalue as required with and keys

   Energizing in REMOTE mode with terminal control

   - Apply a small set value to AIN1:
     - MM45: Between terminals 2 - 1
     - MM6/ MM3SV: Between terminals 1 - 4
   - Activate digital input by linking the following terminals:
     - MM45: Terminals 6 - 7
     - MM6: Terminals 11 - 13
     - MM3SV: Terminals 18 - 20

4. The shaft at the motor should rotate slowly.

5. If the motor rotates in the wrong direction exchange two of the output phases M1/U, M2/V, M3/W.

6. In applications where a high starting torque is required an increase in the parameter `FIXED BOOST` (see page 5-6) may be necessary. Excessive `FIXED BOOST` may cause the drive to trip on **`OVERLOAD`** or **`I*T TRIP`**.

7. If the motor current rating is smaller than the drive current rating then the `FULL LOAD CALIB` parameter (see page 5-5) should be reduced to match the motor rating.

Chapter 5 - PROGRAMMING THE APPLICATION

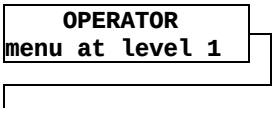
NOTE: The setting-up and commisioning of MM6 Frequency Inverters is almost identical to that with MM3SV range. Reference is therefore made to both MM6 and MM3SV Frequency Inverters in this chapter.

MAIN MENU - OPERATOR

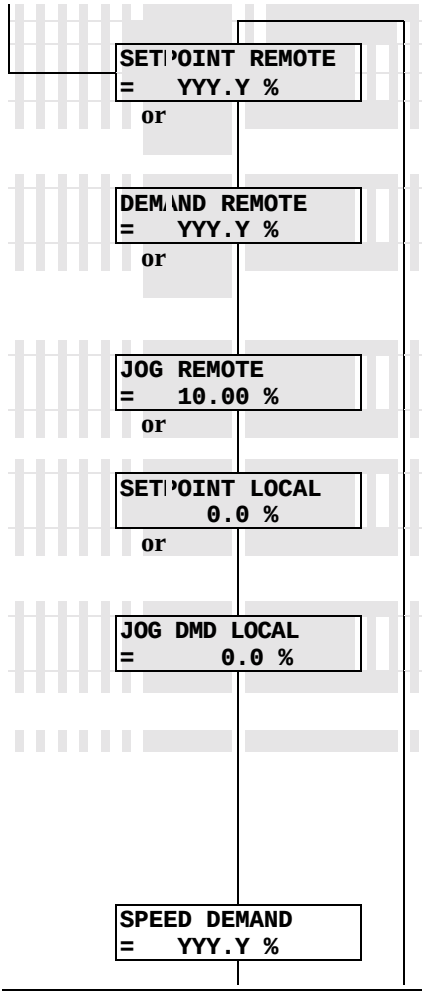
Operating conditions of the MM456/MM3SV Frequency Inverter which are important for the operator are brought together in the menu **OPERATOR**. Also the parameter **SETPOINT LOCAL** may be changed in this menu.

Special programming (see menues FUNKTION BLOCKS | MENUE | OPERATOR | SETUP PARAMETERS in the **Software and Application Manual TMM456-SAM**) enables up to any 14 parameters to be brought together in the **OPERATOR** menu. In addition two screens can be customized to display any process parameters, see menu SETUP PARAMETERS | FUNKTION BLOCKS | MENUE | CUSTOM SCREEN 1 in the **Software and Application Manual TMM456/ MM3SV-SAM**.

NOTE: Never forget to **save parameters** after modifying any parameter setting, see page 4-9/5-14.



Set-value



Range from:	to:	Default:
-300.00%	300.00%	YYY.Y%

Displays the remote setpoint of the input of the ramp function generator in % MAX SPEED provided LOCAL mode is not activated and the MM456/MM3SV Frequency Inverter is not in operation

Range from:	to:	Default:
-100.0 %	100.0 %	YYY.Y %

Displays the active remote setpoint of the output of the ramp function generator in % MAX SPEED provided LOCAL mode is not activated and the MM456/MM3SV Frequency Inverter is in operation.

Range from:	to:	Default:
0.0 %	100.0 %	10.0 %

Displays the JOG value in % MAX SPEED provided the terminal JOG is activated and not in LOCAL mode.

Range from:	to:	Default:
0.00%	100.00%	0.00%

Displays the local setpoint at the input of the ramp function generator in % MAX SPEED provided LOCAL mode is activated.

Range from:	to:	Default:
0.0 %	100.0 %	10.0 %

Displays the active local jog setpoint in % MAX SPEED when the JOG key in local mode is pressed.

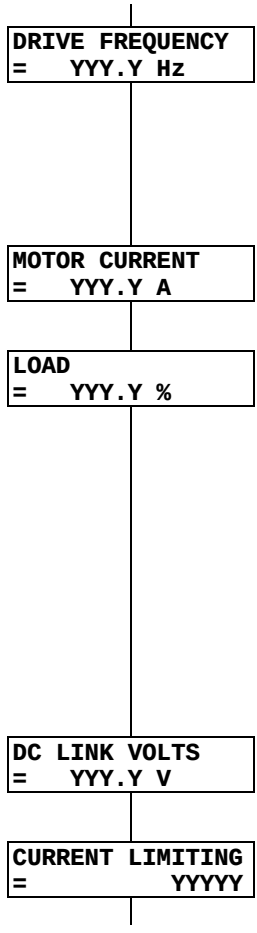
NOTE: The set values **SETPOINT REMOTE**, **DEMAND REMOTE, JOG REMOTE, SETPOINT LOCAL** and **JOG DMD LOCAL** displayed depends on the actual mode.

Keys L/R and JOG select the active mode of operation, see page 4-5.

Range from:	to:	Default:
-100.00%	100.00%	YYY.Y%

Displays the active setpoint in % MAX SPEED.

Operating point



Range from:	to:	Measured value:
0.00Hz	480.00Hz	YYY.Y¥Hz

Displays the output frequency of the MM456/MM3SV Frequency Inverter. The addition of the individual setpoints, the slip-frequency correction function and the output of the PID controller can cause the output frequency to differ from the main setpoint.

-

Range from:	to:	Measured value:
0.0 A	1000.0 A	YYY.Y A

Displays the motor current in A.

Range from:	to:	Measured value:
0.00%	200.00%	YYY.Y¥%

Estimated MOTOR LOAD (torque) referred to the load at rated frequency with rated output current. It is assumed that 100 % load corresponds to 100 % output current. The displayed load can be scaled to read as a percentage of the rating of the motor using the parameter FULL LOAD CALIB (see page 5-5).

NOTE: The diagnostic parameters MOTOR CURRENT and LOAD do not generally agree with each other, especially under low load conditions. This is because the magneting current of a motor is typically 30 %, even with a motor at no load.

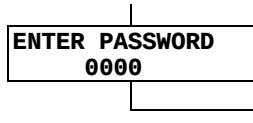
Range from:	to:	Measured value:
0.0 V	800.0 V	YYY.Y V

Measured d.c. link voltage.

Range from:	to::	Measured value:
FALSE	TRUE	FALSE

TRUE indicates current limiting.

Password



Range from:	to:	Default:
0000	9999	XXXX

Used to enter the password as a 4-digit hexadecimal number to regain access to the setup parameters. The password value entered must match the value previously set up in the parameter PASSWORD|ENTER PASSWORD., see page 5-11.

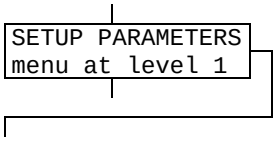
MAIN MENU - DIAGNOSTICS

The main menu **DIAGNOSTICS** customs many useful parameters for diagnostics. Refer to **Chapter 6** for more details.

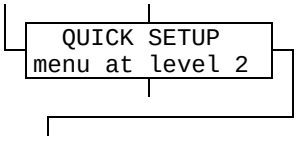
MAIN MENU - SETUP PARAMETERS | QUICK SETUP

Setup parameters used for the majority of applications are brought togetzer in the menu QUICK SETUP. This menu is described in the following.

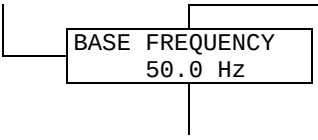
NOTE: Never forget to **save parameters** after modifying any parameter setting, see page 4-9/5-14.



QUICK SETUP



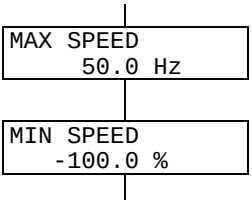
Base frequency



Range from:	to:	Default:
7.5 Hz	480.0 Hz	*50.0 Hz

Frequency at which the inverter produces maximum output voltage. This would be set at 50 Hz for a standard motor.

Maximum and minimum speeds



Range from:	to:	Default:
0.0 Hz	480.0 Hz	50.0 Hz*

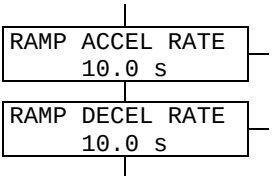
Speed/frequency at maximum setpoint input (100.0 %).

Range from:	to:	Default:
-100.0 %	100.0 % von MAX SPEED	-100.0 %

Speed/frequency at minimum setpoint input.

* Can be 60.0 Hz with certain language settings, see page 4-6.

Ramps



Range from:	to:	Default:
0.1 s	600.0 s	10.0 s

Time taken to ramp the frequency from 0 Hz to **MAX SPEED**

0.1 s	600.0 s	10.0 s

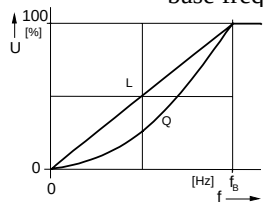
Time taken to ramp from **MAX SPEED** to 0 Hz

Voltage / frequency shape

V/F SHAPE
LINEAR

Range: see below **Default:** LINEAR

- PUMP/FAN — Quadratic torque characteristic up to base frequency.
- LINEAR — Constant torque characteristic up to base frequency



U: Output voltage

f_B: BASE FREQUENCY

L: LINEAR

Q: PUMP/fan

NOTE: With fans and pumps with a high starting torque or inertia it is often advantageous to use the LINEAR setting.

Operation at higher power with 110 % overload (HVAC)

QUADRATIC TORQUE
FALSE

With MM6/ MM3SV only

Range from: see below **to:** **Default::** FALSE

- FALSE — Normal operation with 150 % overload current
- TRUE — Operation at higher power with 110 % overload current mainly for quadratic torque loads (HVAC)

Before a change of parameter is implemented confirmation 'UP' FOR CONFIRM is required. After confirmation QUADR. TORQUE will be displayed.

Motor data

FULL LOAD CALIB
XXX.X A

Range from: 0.0 A **to:** 1000.0 A **Default:** XXX.X A

Scaling of the output current of the MM456 Frequency Inverter to match the rated motor current. The effective value of FULL LOAD CALIB is internally clamped to the rated output current of the inverter.

NO LOAD CALIB
XXX.X A

Range from: 0.0 A **to:** 1000.0 A **Default:** XXX.X A

Value of no-load motor current which is used for vector control. The effective value of NO LOAD CALIB is internally clamped to ≥10 % or ≤90 % of the rated inverter current.
This parameter is important for the correct determining of the parameter LOAD, **see Software and Application Manual TMM456-SAM**, page 28.4-6. The factory setting can be used for normal applications.

POWER FACTOR
X.XX

Range from: 0.50 **to:** 0.95 **Default:** X.XX

Set to name-plate cos φ rating.

MOTOR CURRENT
= YYY.Y A

Range from:	to:	Default:
0.0 A		

Displays the measured phase current of the motor in A

MOTOR I LIMIT
150.00 %

Range from:	to:	Default:
0.00 %	150.00 %	150.00 %

Maximum motoring current. If the drive output current exceeds MOTOR I LIMIT value then the drive will attempt to reduce the motoring load by reducing the motor frequency. The effective current limit is clamped at 150 % of the rated output current of the MM456/MM3SV Frequency Inverter.

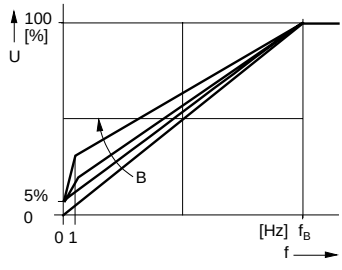
Voltage boost

FIXED BOOST is used to correctly flux the motor at low speeds and allows the drive to produce greater starting torque for high friction loads. Voltage boost increases the motor volts above the selected V/F characteristic at the lower end of the speed range.

FIXED BOOST
X.XX %

Range from:	to:	Default:
0.00 %	25.00 %	0.00 %

Level of extra volts applied to the motor at low speeds:



U: Output frequency

f_B: BASE FREQUENCY

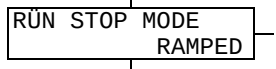
B: FIXED BOOST

Increase FIXED BOOST only as much as is necessary to provide the required starting torque. Excessive boost can cause the MM456 Frequency Inverter.
The required setting of FIXED BOOST depends on the application and on the type of size of motor. The following table gives some indication of typical maximum values.

Motor power	0.75 kW	2.2 kW	4 kW	11 kW	37 kW	75 kW	160 kW
FIXED BOOST	8...12 %	6...8 %	5...7 %	4...6 %	3...5 %	2...3 %	1...2 %

NOTE: For applications requiring very high motor starting torque, refer to page 10-7 for guidance on optimal settings for the FIXED BOOST Parameter.

Run stop mode



Range: see below — **Default:** RAMPED

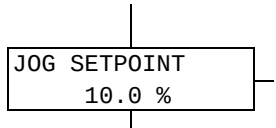
RAMPED — The motor speed is controlled down to zero at a rate set by the RAMP DOWN TIME 1/2 or **FRAMP** parameter. On reaching 0 Hz, d.c. current is injected for a length of time given by SETUP PARAMETER|**FUNCTION BLOCKS**|**SEQ & REF**|**STOP**|**STOP DELAY**, see page 28.2-17, (factory default setting 0.5 s).

DC-INJECTION — On a stop command the motor volts are rapidly reduced at constant frequency to deflux the motor. If injection braking begins from a speed greater than 20 % of BASE FREQUENCY a low frequency braking current is applied until the motor speed is almost zero. This is followed by a timed d.c. pulse to hold the motor shaft If injection braking begins from a speed below 20 % of base frequency, a d.c. pulse is applied to the motor.

NOTE: The lower menu **INJ BRAKING**, page 28.4-16, contains various parameters which allow the fine tuning of d.c. braking. However it is not usually necessary to modify these parameters.

COAST — The motor is allowed to freewheel to standstill at zero current from the MM456/MM3SV Frequency Inverter.

Jog



Range from: 0.00% **to:** 100.00% von MAX SPEED **Default:** 10.00%

Determines the speed that the drive will run at when the JOG terminal 11 is raised to +24 V (terminal 6) or the JOG key in the LOKAL mode is depressed.

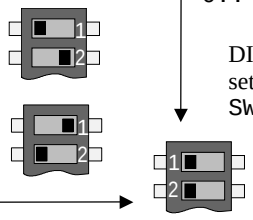
Analog inputs

AIN 1 TYPE
0..+10 V

Range:
see below
0..+10 V
20..0 mA
20..4 mA
4..20 mA
0..20 mA
-10..+10 V
+1..+5 V
0..+5 V
+2..+10 V

Default:
0..+10 V

DIL switch setting SW1

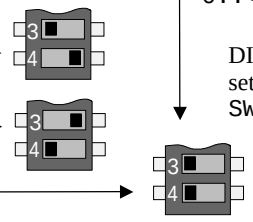


AIN 2 TYPE
0..+10 V

Range:
see below
0..+10 V
20..0 mA
20..4 mA
4..20 mA
0..20 mA
-10..+10 V
+1..+5 V
0..+5 V
+2..+10 V

Default:
0..+10 V

DIL switch setting SW1



NOTE: AIN 1 TYPE and AIN 2 TYPE must correspond to the setting of the upper DIL switch, see page 2-10

AIN 3 TYPE
0...20 mA

Range:
see below
0..20 mA
20..0 mA
20..4 mA
4..20 mA

Default:
0...20 mA

AIN 4 TYPE
0..+10 V

With MM6/ MM3SV only

Range:
see below
0..+10 V
+1..+5 V
0..+5 V
+2..+10 V

Default:
0..+10 V

Disabled trips

DISABLED TRIPS
0600

Range from:	to:	Default:
0000	1FF0	0600

The action of several trips may be disabled i.e. these trips do not lead to a triping of the MM456 Frequency Inverter or to a display of a trip condition.
The value 0600 indicates that trips associated with monitoring the external braking resistor are disabled. Trips which may be disabled are which with an "S" on page 6-7.

DISABLED TRIPS+
0000

With MM6/ MM3SV only

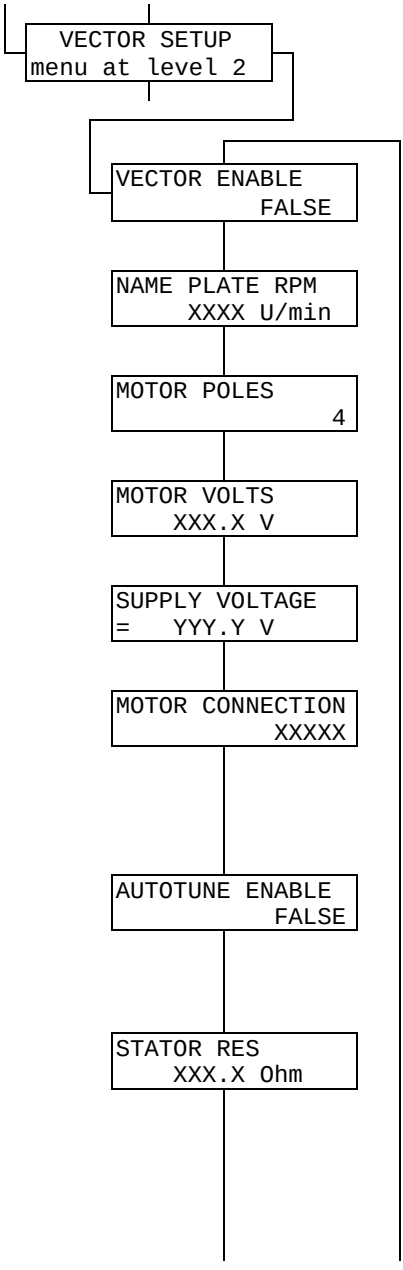
Range from:	to:	Default:
0000	1FF0	0000

Further disabled trips

VECTOR SETUP

The Menu VECTOR SETUP contains all adjustment parameters and several diagnostic parameters which allow the der MM456/MM3SV Frequency Inverter to be matched to the characterstics of settings of the motor. The advantage of vector operation is only available if the appropriate parameters are carefully set. The vector operation is only suitable for single-motor drives.

NOTE: Never forget to **save parameters** after modifying any parameter setting, see page 4-9/5-14.



Range: **Default:**
see below FALSE
FALSE Standard V/f operation
TRUE Vektor operation

Range from: **to:** **Default:**
0 U/min 15000 U/min XXXX U/min
Rated motor speed

Range from: **to:** **Default:**
2 12 4
No. of motor poles

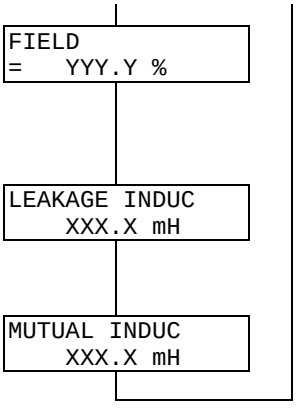
Range from: **to:** **Default:**
198.0 V 506.0 V XXX.X V
Rated motor voltage (230.0 or 400.0 V default value)

Range from: **to:** **Measured value:**
000.0 V 506.0 V YYY.Y V
Measured supply voltage

Range: **Default:**
see below XXXXX
DELTA Motor winding connected in delta
STAR Motor winding connected in star
Important to enable the parameter STATOR RES, LEAKAGE INDUC and MUTUAL INDUC to be interpreted as phase values.

Range: **Default:**
see below FALSE
FALSE VEKTOR-AUTOTUNE disabled
TRUE VEKTOR-AUTOTUNE enabled
NOTE: Refer to information at the end of this section.

Range from: **to:** **Default:**
0.00 Ohm 100.0 Ohm XXX.XX Ohm
Phase value of motor resistance.



Range from:	to:	Default:
0.00 %	200.00 %	YYY.Y%

Calculated magnetizing component of motor current in % of calibrated motor current.

Range from:	to:	Default:
0.0	1000.0 mH	XXX.X mH

Phase value of motor leakage inductance

Range from:	to:	Default:
0.0	1000.0 mH	XXX.X mH

Phase value of motor mutual inductance

NOTE: If the parameter VECTOR ENABLE is enabled, the motor parameters relevant to vector operation will be automatically determined based on electrical measurements at the next power-up (lasts approx. 5 s). On completion of this process the parameter VECTOR ENABLE is automatically reset to FALSE.

Refer to **SETTING UP THE SENSORLESS VECTOR FLUXING MODE**, page10-9 for more information on vector setup.

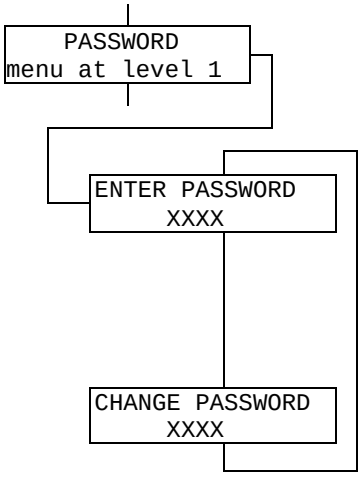
FUNCTION BLOCKS

A large numer of further parameters are available for special application in SETUP PARAMETERS | **FUNCTION BLOCKS**. To provide easier reading of the description of these parameters is not included in this Product Manual. Refer to **Software and Application Manual TMM456/ MM3SV-SAM** for detailled information on all function blocks.

MAIN MENU - PASSWORD

A password system which can be used to prevent unauthorised access to the adjustable parameters. Once the user has programmed in a password then the setup parameters become read-only. In order to change the parameter values the correct password must first be entered.

All drives shipped from the factory have a default password value of 0000.



Range from: **to:** **Default:**
0000 FFFF 0000
Used to enter the password as a hexadecimal number to regain access to the setup parameters. The password value entered must match the value previously setup in the CHANGE PASSWORD parameter. When set to 0000 the programming pad is always unlocked.

Range from: **to:** **Default:**
0000 FFFF 0000
Used to change the password or to initially programme a user password. When a password has been set up, the **save parameter** command (see page 4-7/5-14) should be used to save the password in the non-volatile memory.

Example: Initial programming of password:

1. Access the CHANGE PASSWORD menu and press the Ⓜ key. The display will show:

```
CHANGE PASSWORD
     0000
```

2. Using the ▲ and ▼ keys, set the password value required as a 4 digit hexadecimal number. The display will show, for example:

```
CHANGE PASSWORD
     89AB
```

NOTE: **When you are happy with the password make a note of the value and keep it in a safe place!**

3. Press the Ⓔ key to leave the CHANGE PASSWORD menu. The display will show:

```
CHANGE PASSWORD
     XXXX
```

4. Remember to use **save parameter** to store the password value in non-volatile memory, see page 4-7/5-14.

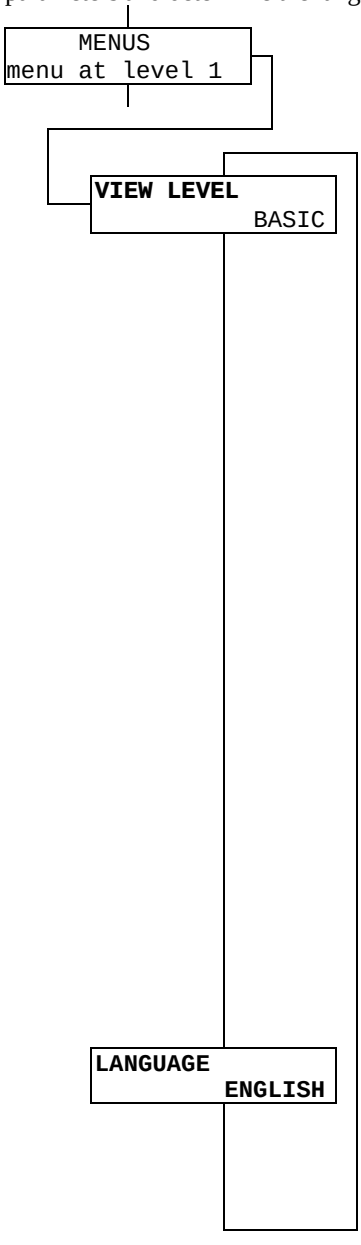
The level of password protection can be set using special programming (see menu SETUP PARAMETERS|**FUNCTION BLOCKS**|**MENUES**|**PASSWORD**, page 28.6-4).

MAIN MENU - TRIPS STATUS

The main menu TRIPS STATUS contains important parameters of the MM456/MM3SV Frequency Inverter relevant to trip monitoring. Refer to **Chapter 6 - TRIPS, DIAGNOSTICS AND FAULT FINDING**.

MAIN MENU - MENUS

The main menu MENUS contains parameters which govern the level of access (view level) to the parameters and determine the language of the LCD plain-language display on the programming pad:



Range: see below

Default: BASIC

▼ BASIC
All important menus for normal use are available, i.e.:

- **OPERATOR**	
- DIAGNOSTICS	
- SETUP PARAMETERS	QUICK SETUP
-	VECTOR-SETUP
- PASSWORD	ENTER PASSWORD
-	CHANGE PASSWORD
- TRIPS STATUS	DISABLED TRIPS
-	ACTIVE TRIPS
-	TRIP WARNINGS
-	FIRST TRIP
- MENUS	**VIEW LEVEL**
- PARAMETER SAVE	**SAVE TO MEMORY**
-	SAVE TO OP

OPERATOR
Intended for the operator, i.e. limited to:

- **OPERATOR**	
- MENUS	**VIEW LEVEL**
- PARAMETER SAVE	**SAVE TO MEMORY**

▲ **ADVANCED**
For experienced programmers all menues can be accessed.

NOTE: The type face of the menus and parameters in this Product Manual and associated parameter list are used to indicate the level of access i.e. VIEW LEVEL, see page 4-3).

Range: see below

Default: **ENGLISH**

▼ **ENGLISH**
ESPANOL
FRANCAIS
▲ **DEUTSCH**

MAIN MENU - PARAMETER SAVE and SYSTEM

The main menus **PARAMETER SAVE** and **SYSTEM** contain important command parameters to control the following storing and loading operations:

- Save parameters to Frequency Inverter:	PARAMETER SAVE | **SAVE TO MEMORY***
- Save parameters to programming pad:	PARAMETER SAVE | SAVE TO OP
- Load default settings (MACRO 1) and other preprogrammed settings (MACRO 2...6):	**SYSTEM | RESTORE DEFAULTS | LOAD MACRO 1*** : 6 99□
- Load from non-volatile memory (NVRAM):	**SYSTEM | LOAD FROM MEMORY**
- Load from programming pad:	**SYSTEM | LOAD FROM OP | ALL PARAMETERS+** **APPLICATION ONLY**

* These command parameters are very frequently used. An alternative simplified short-cut command is available, see page 4-7.

\+ Without motor parameters

□ With MM6/MM3SV only

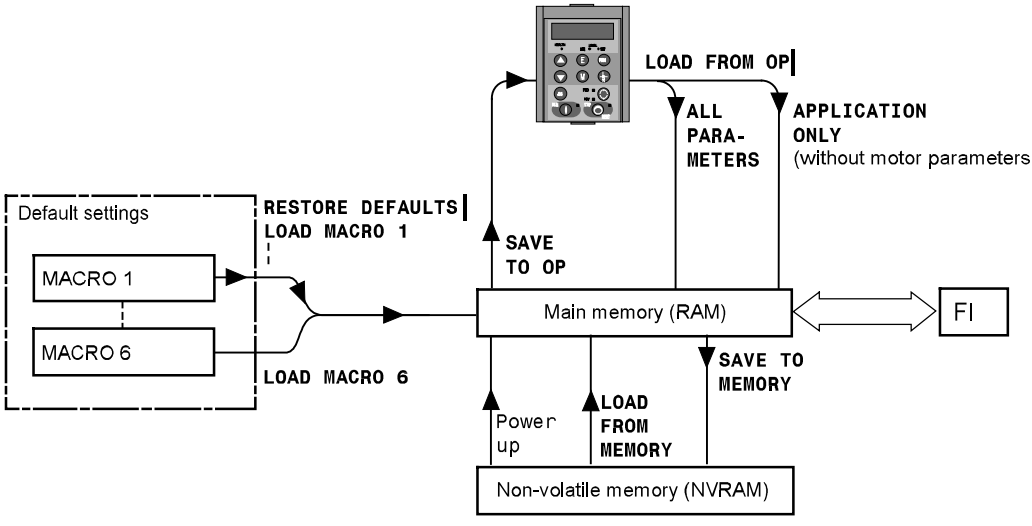
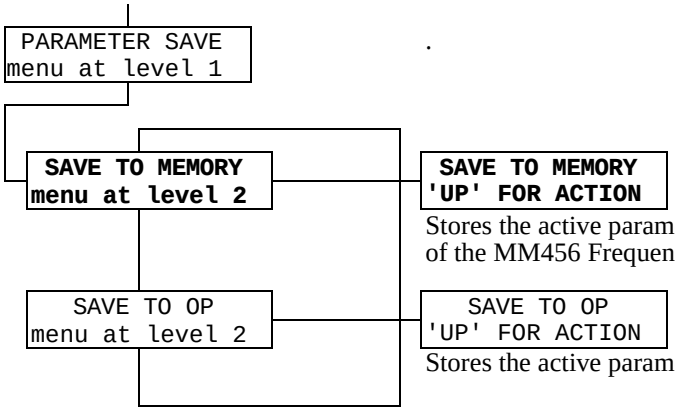


Fig. 5.1: Explanation of storing and loading operations

On power-up the stored parameters are loaded into the working memory (RAM). The MM456/ MM3SV Frequency Inverter uses these parameters when running. If any parameter values are changed, then the value in the main memory (RAM) **only** is modified.

On **SAVING** all parameters of the working memory RAM are copied to the non-volatile memory (NVRAM) overwriting the previous values. **Only then** are the changed parameters saved.

Saving parameters



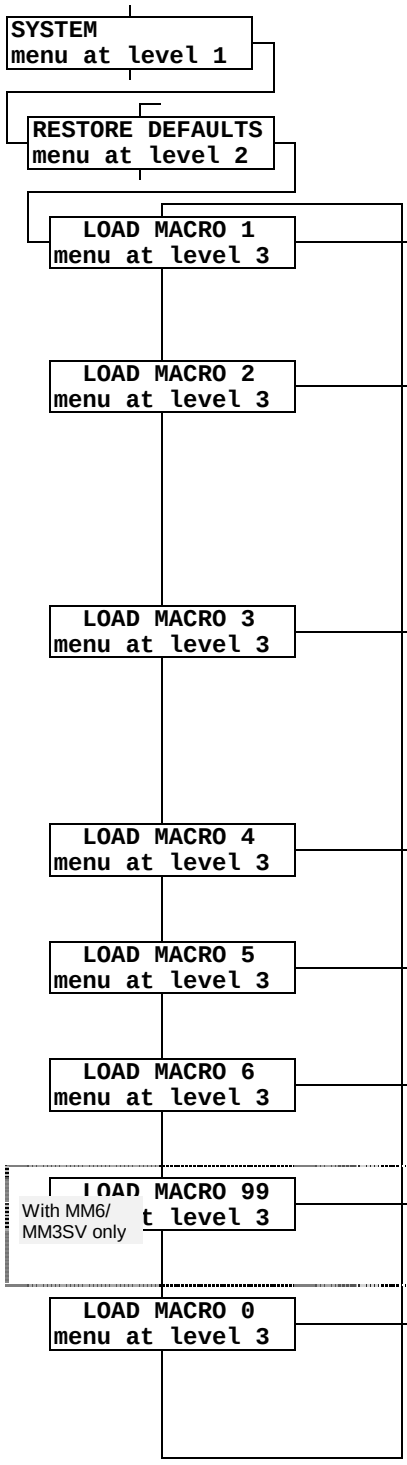
Stores the active parameters in the non-volatile memory of the MM456 Frequency Inverter.

Stores the active parameters in the programming pad.

Refer to **Saving parameters in the MM456/MM3SV Frequency Inverter**, page 4-9 for an alternative method of storing parameters using the PROG key.

NOTE: Never forget to **save parameters** after modifying any parameter setting.

Restoring default values and loading application MACROS



LOAD MACRO 1
'UP' FOR ACTION

Loads the default values and software links corresponding to MACRO 1
(factory default setting as supplied)

LOAD MACRO 2
'UP' FOR ACTION

MACRO 2 loads the default values and software links similar to MACRO 1 but with the following control inputs:

	MM45 Terminal	MM6 Terminal	MM3SV Terminal
- Run forwards	7	13	20
- Run reverse	8	14	21
- Reset	9	15	22

LOAD MACRO 3
'UP' FOR ACTION

With MACRO 3 the software links are configured for motor potentiometer trimming of set value inputs:

	MM45 Terminal	MM6 Terminal	MM3SV Terminal
- Faster	8	14	21
- Slower	9	15	22

LOAD MACRO 4
'UP' FOR ACTION

With MACRO 4 the software links are configured for a process PID controller.

LOAD MACRO 5
'UP' FOR ACTION

With MACRO 5 the software links are configured for 8 selectable preset speeds.

LOAD MACRO 6
'UP' FOR ACTION

With MACRO 6 the software links are configured for closed-loop speed control using an incremental encoder.

LOAD MACRO 99
'UP' FOR ACTION

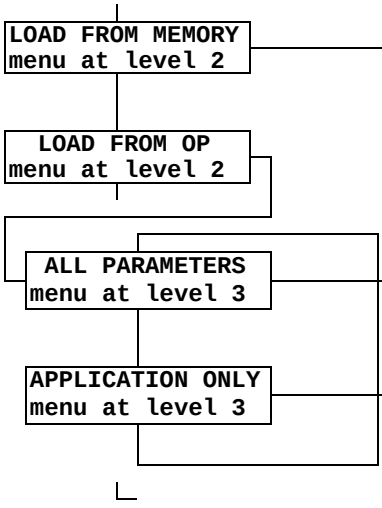
MACRO 99 loads the default values and software links corresponding to the function of MotorMaster MM3

LOAD MACRO 0
'UP' FOR ACTION

MACRO 0 removes all links and sets all parameters to their default values. This macro is for programming purposes only. A motor cannot be controlled until appropriate links are programmed.

These application MACROS are described in more detail in **Chapter 11**.

Loading parameters from memory or from Programming Pad



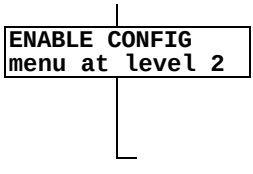
The motor parameters which are not loaded are:

In menu QUICK SETUP	In menu VECTOR SETUP	In the menus **FUNCTION BLOCKS**	
BASE FREQUENCY	NAMEPLATE RPM	**ENCODER LINES**	**INJ DC PULSE**
FULL LOAD CALIB	MOTOR POLES	**SLIP MOTOR LIMIT**	**INJ FINAL DC**
NO LOAD CALIB	MOTOR VOLTS	**SLIP REGEN LIMIT**	**INJ DC LEVEL**
POWER FACTOR	MOTOR CONNECTION	**AUTO BOOST**	**INJ BASE VOLTS**
FIXED BOOST	STATOR RES	**DEFLUX DELAY**	**FLY SEARCH VOLTS**
	LEAKAGE INDUC	**INJ DEFLUX TIME**	**FLY SEARCH BOOST**
	MUTUAL INDUC	**INJ FREQUENCY**	**FLY SEARCH TIME**

Links

A detailled description of the **LINKS** menu is in **Chapter 27 - PROGRAMMING WITH FUNCTION BLOCKS**.

Configuration mode



This parameter is to enable the configuration mode which allows software-links to be modified. Only activate this parameters in conjunction with the special instructions in **Chapter 27 - PROGRAMMING WITH FUNCTION BLOCKS**.

Other functions and parameters

To provide for easier reading, a detailled description of all other functions and parameters is in **Chapter 27 - PROGRAMMING WITH FUNCTION BLOCKS**.

Chapter 6 - TRIPS, DIAGNOSTICS AND FAULT FINDING

NOTE: The setting-up and commisioning of MM6 Frequency Inverters is almost identical to that with MM3SV range. Reference is therefore made to both MM6 and MM3SV Frequency Inverters in this chapter.

INTRODUCTION

The MM456/MM3SV Frequency Inverters provide comprehensive diagnostic, alarm and trip facilities. These facilities minimise the possibility of damage to the frequency inverter, motor and associated components under unusual or fault conditions. The diagnostics information, available at the operating panel, enables ready identification of these conditions.

In the event that a fault is traced to the Frequency Inverter, then the inverter should be **returned to the supplier** - no corrective maintenance should be attempted (see **Chapter 7, SERVICING**).

The following diagnostic information is available with MM456/MM3SV Frequency Inverters:

♦ Main Menu **OPERATOR**:	- Various measured values (see parameter list). These values are described in detail in the following main menu DIAGNOSTICS		
♦ Main Menu DIAGNOSTICS: Various measured values for an in-depth analysis arranged according to their function, e.g.:	- Set values:		SPEED DEMAND : JOG SETPOINT
	- Measured values:		DRIVE FREQUENCY : DC LINK VOLTS
The following trip information is displayed:	- Trips present:		ACTIVE TRIPS* ACTIVE TRIPS+*
	- First trips:		FIRST TRIP
The value or level of all inputs and outputs is displayed:	- Analog inputs:	MM45 MM6/MM3SV	AIN1/2 VALUE AIN1...4 VALUE
	- Digital inputs:	MM45 MM6/MM3SV	DIN1...7 VALUE DIN1...8 VALUE
	- Analog outputs:	MM45 MM6/MM3SV	AOUT1 VALUE AOUT1/2 VALUE
	- Digital outputs:	MM45 MM6/MM3SV	DOUT1/2 VALUE DOUT1...3 VALUE
♦ Main Menu TRIPS STATUS: Ausführliche Information über den aktuellen Störzustand:	- Disabled trips:		DISABLED TRIPS* DISABLED TRIPS+*
	- Active trips:		ACTIVE TRIPS* ACTIVE TRIPS+*
	- Warnings:		TRIP WARNINGS* TRIP WARNINGS+*
	- First trip:		FIRST TRIP
	- Stack of last 10 trips:		TRIP 1 (NEWEST) TRIP 10 (OLDEST)
♦ Trips which have inhibited the power stage to protect the MM456 Frequency Inverter are indicated as follows:	***** TRIPPED *****:		
♦ Other alerts e.g. to indicate that inhibited key action has been attempted	* KEY INAKTIV *		

***** These trips are displayed as 4-digit hexadecimal numbers, see page 6-5.

\+ These trips are only used in the MM6 and MM3SV Frequency Inverters.

TRIPS

When a trip occurs, the power stage of the MM456/MM3SV Frequency Inverter is immediately disabled causing the motor and load to coast to a stop. The trip is latched until action is taken to reset it. This ensures that trips due to transient conditions are captured and the inverter is made safe, even when the original cause of the trip is no longer present.

When using the Blank Cover (standard inverter)

If a trip condition is detected the following action will be taken:

- HEALTH LED flashes.
- The output **TRIPPED** of the function block SETUP PARAMETERS | **FUNCTION BLOCK** | **SEQ & REF** | **SEQUENCING LOGIC** | is set to **TRUE**. The **DIGITAL OUTPUT 1** (HEALTH) digital output changes between **TRUE** and **FALSE** depending on the output logic.

When the Programming Pad (OptionMM-PROG) is fitted

If a trip condition is detected the following action will be taken:

- HEALTH LED flashes.
- Display of trip message in LCD display.

The displayedtrip message(s) may be acknowledged by pressing the E key, see page 4-4.
However the latched trip itself will not be reset, refer to ◎ key for this purpose, see page 4-5.

Resetting a tripped condition

All trips must be reset before the Inverter can be enabled again. A trip can only be reset once the trip condition is no longer active, i.e. a trip due to a heatsink over-temperature will not reset until the temperature is below the trip level.

NOTE: More than one trip can be active at any time. For example, it is possible for both the HEATSINK TEMP and the LINK OVERVOLTS trips to be active. Alternatively it is possible for the Inverter to trip due to an OVERCURRENT error and then for the HEATSINK TEMP trip to become active after the Inverter has stopped (this may occur due to the thermal trime constant of the heatsink).

The following procedure must be adapted to reset trips and restart the drive:

- Remove cause of trip
- Reset trips by one of the following alternative means:
  - Remove supply voltage to MM456/MM3SV Frequency Inverter and wait until LCD display (or LEDs with basic cover) is dark. Reapply power.
  - Press STOP/RESET key

- Activate remote trip reset input (Terminal DIN2 in factory default condition corresponding to MACRO 1)
- When in REMOTE MODE by reapplying RUN (terminal DIN1 in factory default condition corresponding to MACRO 1)
- When in LOCAL MODE by pressing . key to reset trips, clear messages and restart drive.
- Enable **AUTO RESTART** function block, see following

Success is indicated by the HEALTH LED (on the Blank Cover or Programming Pad) ceasing to flash and returning to an illuminated healthy state. The output **TRIPPED** of the function block SETUP PARAMETERS|**FUNCTION BLOCK**|**SEQ & REF**|**SEQUENCING LOGIC** output is reset to **FALSE**.

Automatic Trip Reset (AUTO RESTART)

Using the Programming Pad the MM456 Frequency Inverter can be programmed automatically attempt to restart the drive after a preset time once the trip conditions has occured. The parameter **AC ENABLE** in function block SETUP PARAMETERS|**FUNCTION BLOCK**|**SEQ & REF**|**SEQUENCING LOGIC** is used to activate **AUTO RESTART**. Refer to page 28.2-8 for further information.

Setting Trip conditions

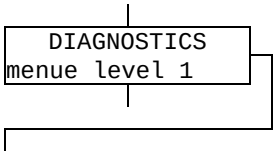
Certain trip conditions can be adapted for special applications. Parameter in the following function blocks which can be adapted are:

SETUP PARAMETERS|**FUNCTION BLOCK**|**TRIPS**|**TRIPS STATUS** |**I/O TRIPS,**
|**I*T TRIPS,**
|**STALL TRIP.**

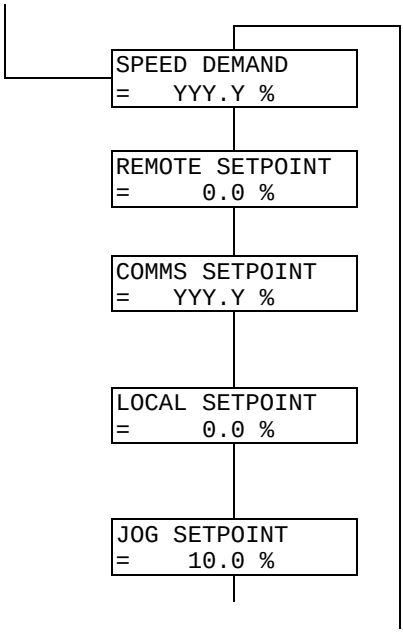
Refer to **Chapter 28.5 - FUNCTION BLOCK DESCRIPTION** for further information.

MAIN MENU - DIAGNOSTICS

The main menu DIAGNOSTICS contains many diagnostics parameters which enable the MM456/MM3SV Frequency Inverter to be optimized for operation with the motor used and the machine to be driven.



Set-value



Range from:	to:	Measured value:
0.00%	100.00%	YYY.Y¥%

Displays the active speed in % MAX SPEED

Range from:	to:	Measured value:
-300.00%	300.00%	0.00%

Displays the remote setpoint in % MAX SPEED

Range from:	to:	Measured value:
-300.00%	300.00%	YYY.Y¥%

Displays the serial link setpoint in % MAX SPEED

Range from:	to:	Measured value:
0.00%	100.00%	0.00%

Displays the local setpoint at the input of the ramp function generator for **LOCAL** mode in % MAX SPEED

Range from:	to:	Measured value:
0.00%	100. 00%	10.00%

Displays the jog setpoint in % MAX SPEED

Operating data

DRIVE FREQUENCY
= YYY.YY Hz

Range from:	to:	Measured value:
0.00 Hz	480.00 Hz	YYY.YY Hz

Displays the output frequency of the MM456 Frequency Inverter. The addition of the individual setpoints, the slip-frequency correction function and the output of the PID controller can cause the output frequency to differ from the main setpoint.

ENCODER SPEED
= YYY.Y Hz

Range from:	to:	Default:
0.0 Hz		YYY.Y Hz

Motor frequency corresponding to the motor speed determined from the incremental encoder.

ENCODER SPEED
= YYY.Y n/min

Range from:	to:	Default:
0.0 U/min		YYY.Y n/min

Motor speed determined from the incremental encoder.

ENCODER SPEED
= YYY.Y %

Range from:	to:	Default:
0.0 %		YYY.Y %

Motor speed determined from the incremental encoder as a percentage of MAX SPEED.

MOTOR CURRENT
= YYY.Y A

Range from:	to:	Measured value:
0.00 A	1000.0 A	YYYY.Y A

Displays the motor current in A (Line current)

LOAD
= YYY.Y %

Range from:	to:	Measured value:
0.00%	200.00%	YYY.Y¥%

Estimated MOTOR LOAD (torque) referred to the load at rated frequency with rated output current. It is assumed that 100 % load corresponds to 100 % output current. The displayed load can be scaled to read as a percentage of the rating of the motor using the parameter FULL LOAD CALIB (see page 5-10).

NOTE: The diagnostic parameters MOTOR CURRENT and LOAD do not generally agree with each other, especially under low load conditions. This is because the magneting current of a motor is typically 30 %, even with a motor at no load.

FIELD
= YYY.Y %

Range from:	to:	Measured value:
0.00%	200.00%	YYY.Y¥%

Estimated magneting flux of the motor. The three motor data parameters (see page 5-5) are used for this calculation

CURRENT LIMITING
= YYYYY

Range:	Measured value:
see below	FALSE

FALSE Normal operation
TRUE In current limit

Displays if the MM456 Frequency Inverter has reached the set current limit.

BRAKING
= YYYYY

Range from:	to:	Measured value:
see below		YYYYY

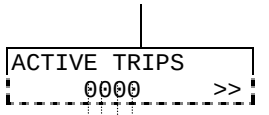
FALSE Normal operation
TRUE Braking chopper active

DC LINK VOLTS
= YYY.Y V

Range from:	to:	Measured value:
0.0 V	800.0 V	YYY.Y V

Measured d.c. link voltage

Trips



Range:
The hexadecimal numbers represent the trip status of the drive (no trips).

```
0 No trip or warning present      =         NO TRIP
1 d.c. link voltage overvoltage   = LINK OVERVOLTS
2 d.c. link voltage undervoltage  =LINK UNDERVOLTS
4 Over current in motor           =    OVERCURRENT
8 Heat sink                       =  HEATSINK TEMP
9
:
F Additive sum of above
```

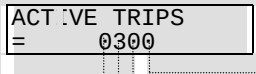
```
0 No trip or warning in this range
1 External trip AIN1              =  EXTERNAL TRIP S
2 Analog input AIN1               =  INPUT 1 BREAK S
4 Analog input AIN2               =  INPUT 2 BREAK S
8 Motor "stalled"                 =  MOTOR STALLED S
9
:
F Additive sum of above
```

```
0 No trip or warning in this range
1 I*T trip                        =        I*T TRIP
2 Brake resistor overloaded       = BRAKE RESISTOR S
4 Braking chopper overloaded      =   BRAKE SWITCH S
8 Programming pad defect          =     OP STATION S
:
F Additive sum of above
```

```
0 No trip or warning in this range
1 Serial link faulty              =     LOST COMMS S
2 Not used
4 Not used
8 Not used
9
:
F Additive sum of above
```

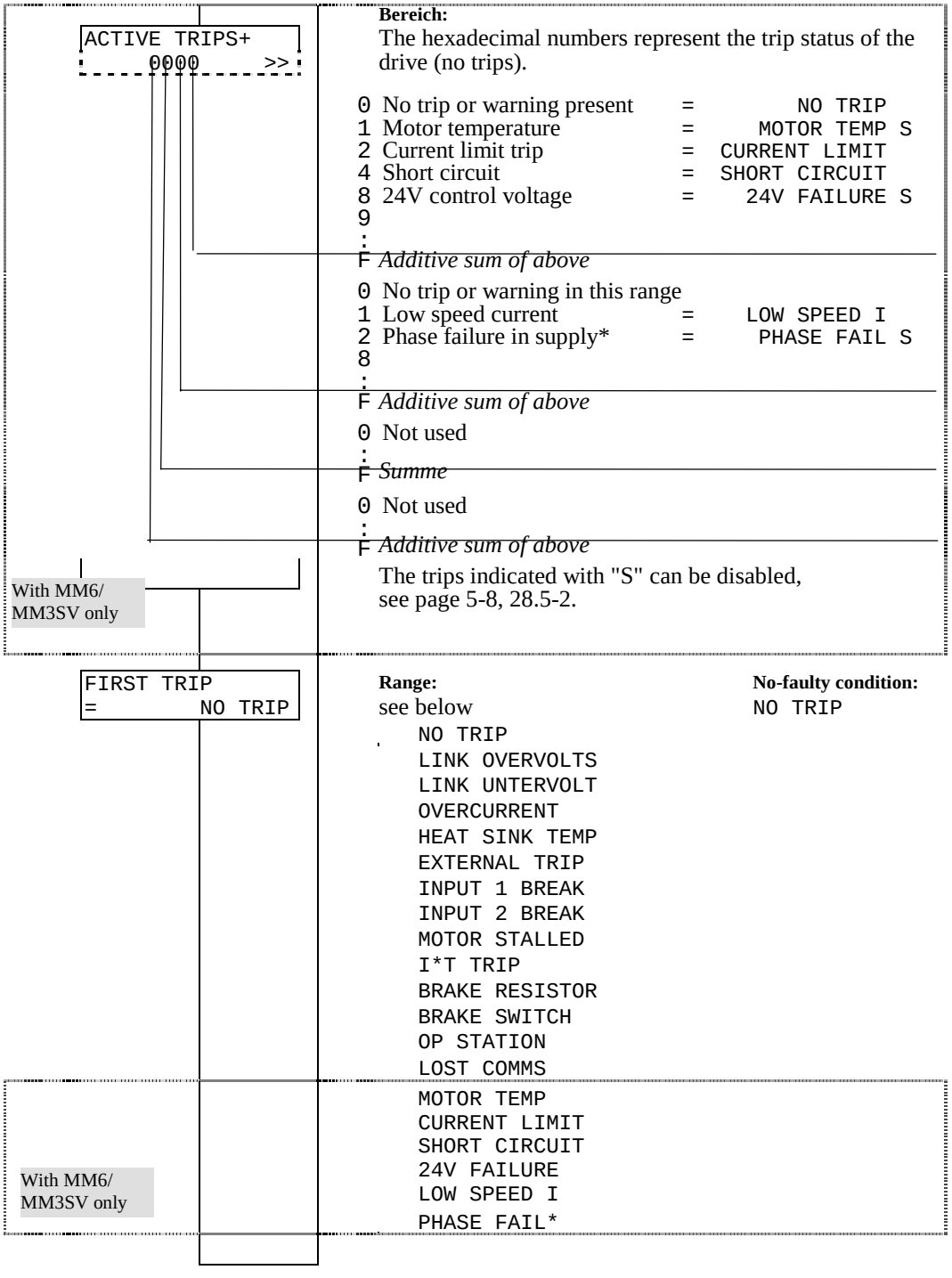
The trips indicated with "S" can be disabled, see page 5-8, 28.5-2.

Example:



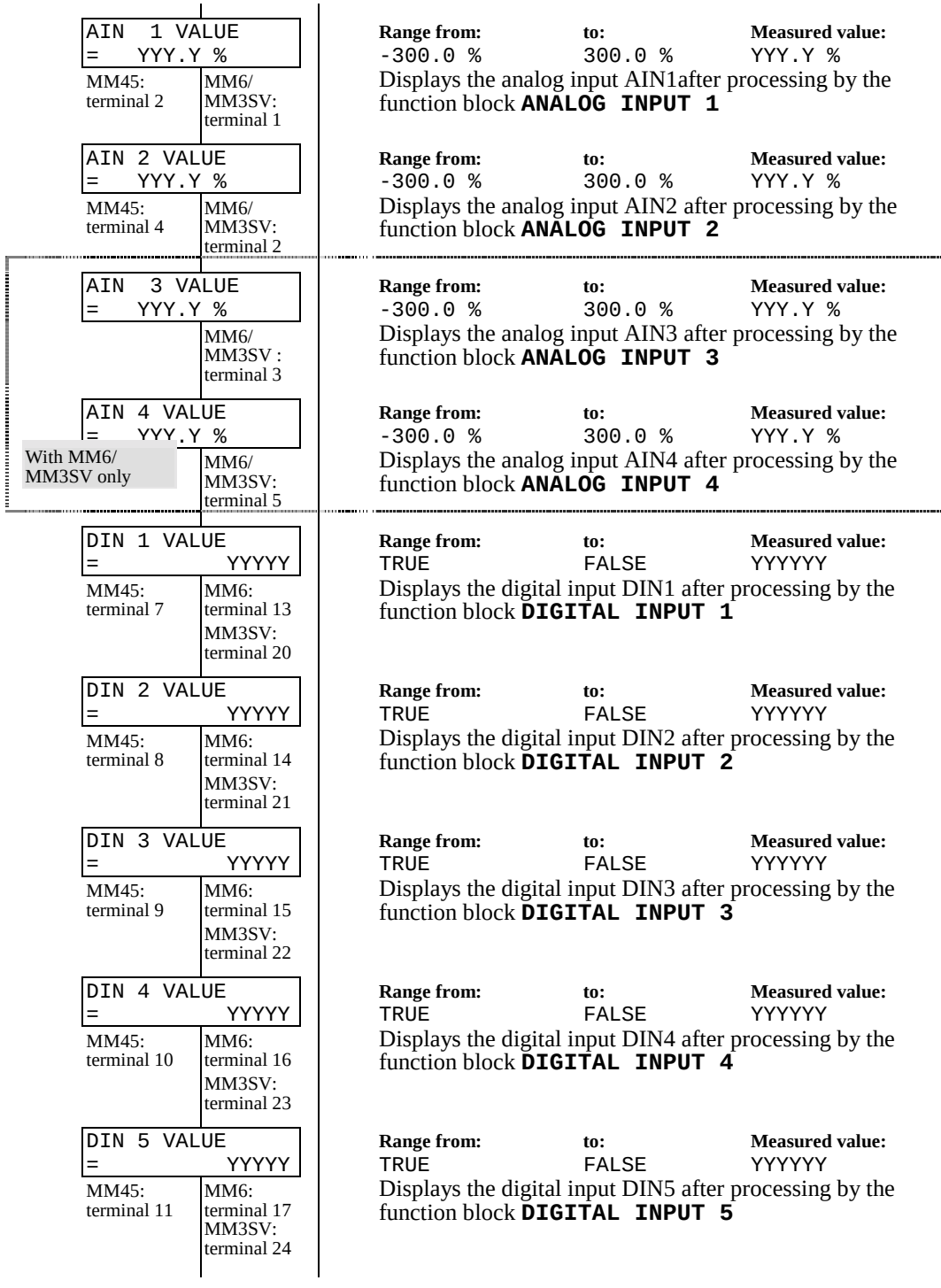
0 No trip or warning in this range
0 No trip or warning in this range
3=
1 I*T trip
+
2 Braking resistor overloaded
0 No trip or warning in this range

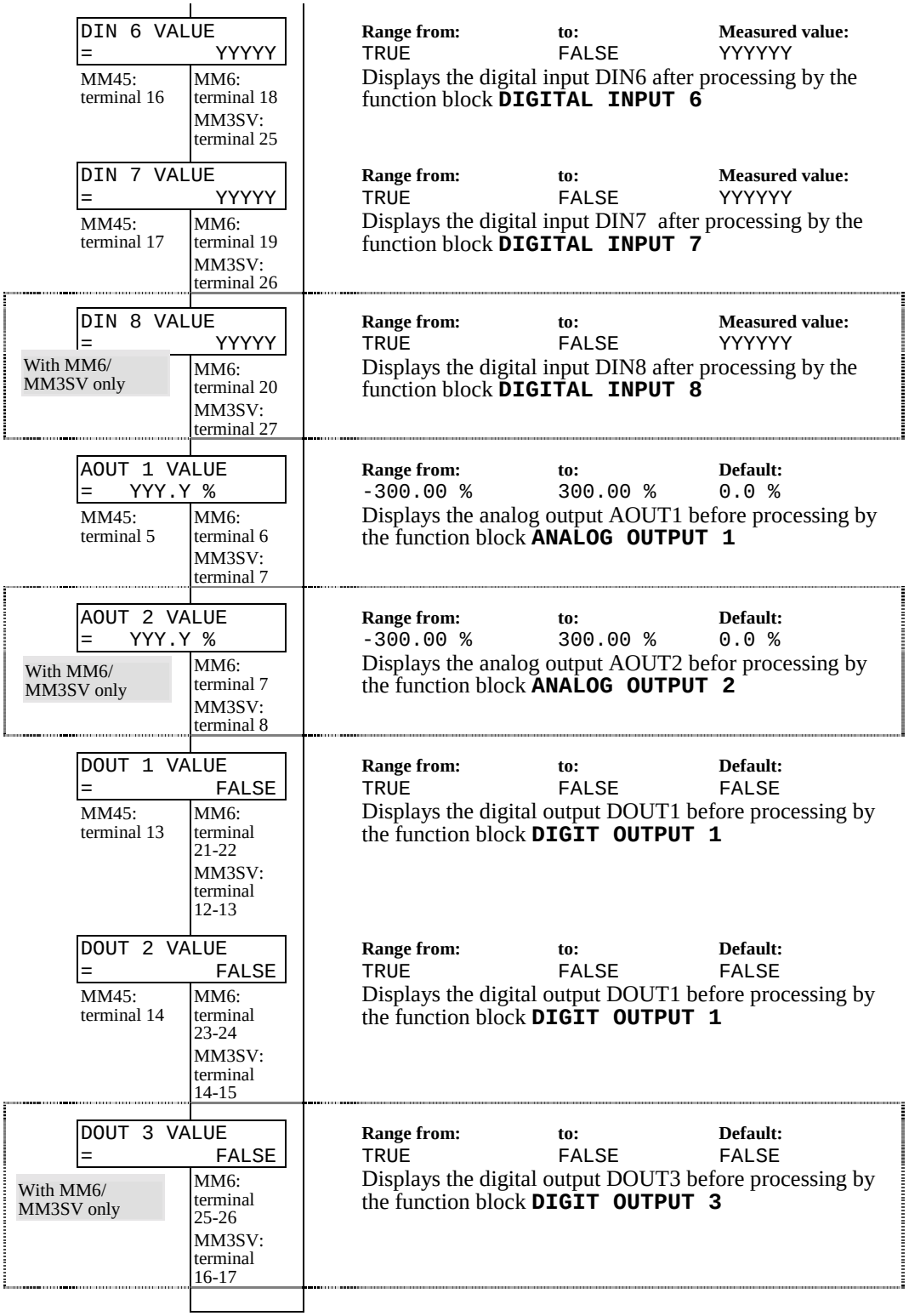
NOTE:
It is not necessary to learn the hexadecimal system. On pressing the key the individuel trips are successively displayed. For further information on messages refer to **TRIPS AND WARNINGS** on page 6-13.



* Phase failure detection with MM6 Frequency Inverters only.

Inputs/Outputs




DIN 6 VALUE
= YYYYY
MM45: terminal 16
MM6: terminal 18
MM3SV: terminal 25
Range from: to: Measured value:
TRUE FALSE YYYYYY
Displays the digital input DIN6 after processing by the function block DIGITAL INPUT 6
DIN 7 VALUE
= YYYYY
MM45: terminal 17
MM6: terminal 19
MM3SV: terminal 26
Range from: to: Measured value:
TRUE FALSE YYYYYY
Displays the digital input DIN7 after processing by the function block DIGITAL INPUT 7
DIN 8 VALUE
= YYYYY
With MM6/ MM3SV only
MM6: terminal 20
MM3SV: terminal 27
Range from: to: Measured value:
TRUE FALSE YYYYYY
Displays the digital input DIN8 after processing by the function block DIGITAL INPUT 8
AOUT 1 VALUE
= YYY.Y %
MM45: terminal 5
MM6: terminal 6
MM3SV: terminal 7
Range from: to: Default:
-300.00 % 300.00 % 0.0 %
Displays the analog output AOUT1 before processing by the function block ANALOG OUTPUT 1
AOUT 2 VALUE
= YYY.Y %
With MM6/ MM3SV only
MM6: terminal 7
MM3SV: terminal 8
Range from: to: Default:
-300.00 % 300.00 % 0.0 %
Displays the analog output AOUT2 befor processing by the function block ANALOG OUTPUT 2
DOUT 1 VALUE
= FALSE
MM45: terminal 13
MM6: terminal 21-22
MM3SV: terminal 12-13
Range from: to: Default:
TRUE FALSE FALSE
Displays the digital output DOUT1 before processing by the function block DIGIT OUTPUT 1
DOUT 2 VALUE
= FALSE
MM45: terminal 14
MM6: terminal 23-24
MM3SV: terminal 14-15
Range from: to: Default:
TRUE FALSE FALSE
Displays the digital output DOUT1 before processing by the function block DIGIT OUTPUT 1
DOUT 3 VALUE
= FALSE
With MM6/ MM3SV only
MM6: terminal 25-26
MM3SV: terminal 16-17
Range from: to: Default:
TRUE FALSE FALSE
Displays the digital output DOUT3 before processing by the function block DIGIT OUTPUT 3

MAIN MENU - TRIPS STATUS

TRIPS STATUS
menu at level 1

DISABLED TRIPS
0600 >>

Range from:	to:	Default:	
0000	FFFF	0600	>>

Disabled trips. Only those indicated by S on page 6-7 may be disabled.

DISABLED TRIPS+
0000 >>

With MM6/ MM3SV only

Range from:	to:	Default:	
0000	FFFF	0000	>>

Disabled trips. Only those indicated by S on page 6-8 may be disabled.

ACTIVE TRIPS
= 0600 >>

Range from:	to:	Status:	
0000	FFFF	0600	>>

All active trips

ACTIVE TRIPS+
= 0000 >>

With MM6/ MM3SV only

Range from:	to:	Status:	
0000	FFFF	0000	>>

All active trips

TRIP WARNINGS
= 0600 >>

Range from:	to:	Status:	
0000	FFFF	0000	>>

Warnings which can lead to an trip if not acted on.

TRIP WARNINGS+
= 0000 >>

With MM6/ MM3SV only

Range from:	to:	Status:	
0000	FFFF	0000	>>

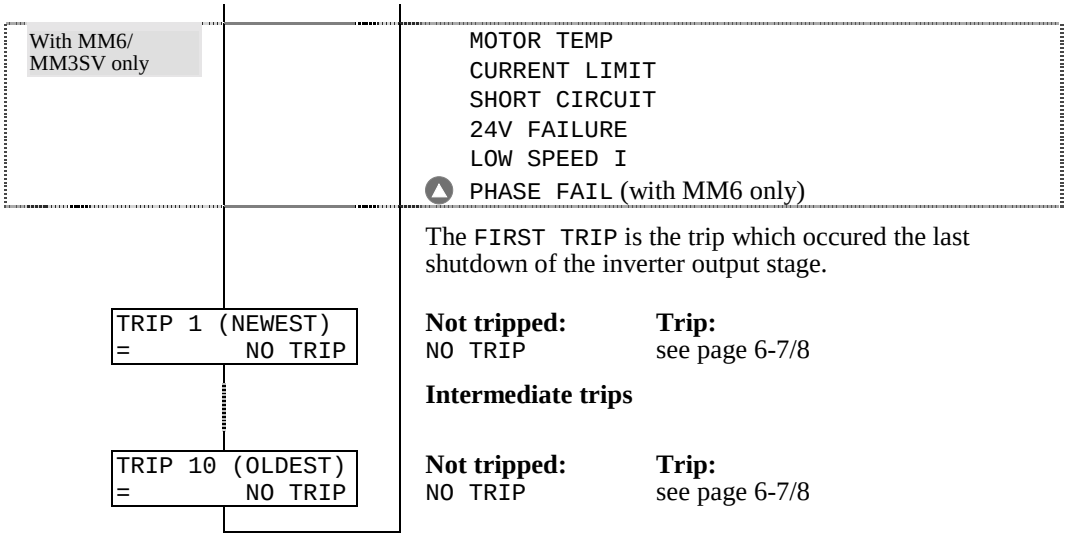
Warnings which can lead to an trip if not acted on.

NOTE: Refer to page 6-7 for an explanation of the hexadecimal representation of trips.

FIRST TRIP
= NO TRIP

Range from:	to:	Default:
see below		NO TRIP

- NO TRIP
- LINK OVERVOLTS
- LINK UNTERVOLT
- OVERCURRENT
- HEAT SINK TEMP
- EXTERNAL TRIP
- INPUT 1 BREAK
- INPUT 2 BREAK
- MOTOR STALLED
- I*T TRIP
- BRAKE RESISTOR
- BRAKE SWITCH
- OP STATION
- LOST COMMS



The FIRST TRIP is the trip which occured the last shutdown of the inverter output stage.

Not tripped:	**Trip:**
NO TRIP	see page 6-7/8

Intermediate trips

Not tripped:	**Trip:**
NO TRIP	see page 6-7/8

The last ten trips are stored as a stock. For further information on trips messages refer to **Trips** on page 6-7/8 and **TRIPS AND WARNINGS** on page 6-13/14.

TRIPS AND WARNINGS

Trip messages and fault finding

The following trip messages indicate faults which have caused the MM456/MM3SV Frequency Inverter to trip:

	Possible cause	Cure	see page
***** TRIPPED *** LINK OVERVOLTS**	Link overvoltage: - Supply voltage is too high - Decelleration too high with high inertia load	- Check supply voltage - Increase RAMP DECEL RATE - Fit a braking resistor - Check value and function	5-5
***** TRIPPED *** LINK UNDERVOLTS**	Link undervoltage: - Supply voltage is too low - Supply phase missing (one or more phases)	- Check supply voltage	
***** TRIPPED *** OVER CURRENT**	Overcurrent: - Acceleration or Decelleration too fast for large load inertia - Shock overload - Short circuit or earth fault at motor connection - Motor cables too long - too many parallel motors - FIXED BOOST or **AUTO BOOST** set to high	- Check parameter RAMP ACCEL RATE and RAMPE DECEL RATE - Check load - Check connection to motor - Refer to supplier - Check parameter settings	5-5, 28.4-9 5-6, 28.4-9
***** TRIPPED *** HEATSINK TEMP**	Heatsink Temperature: - Ambient temperature too high - Specified cooling spacing not provided	- Check mounting	
***** TRIPPED *** EXTERNAL TRIP**	+24V on terminal 10 not present	- Check external trip circuit	
***** TRIPPED *** INPUT 1 BREAK**	Analog input AIN1 faulty at 4...20 mA setting: - Not correctly connected	- Check AIN1 TYPE - Check wiring	5-8, 28.1-2
***** TRIPPED *** INPUT 2 BREAK**	Analog input AIN2 faulty at 4...20 mA setting: - Not correctly connected	- Check AIN2 TYPE - Check wiring	5-8, 28.1-3
***** TRIPPED *** MOTOR STALLED**	Motor has been operated too long in current limit: - Motor load too high - MOTOR I LIMIT parameter set too low - FIXED BOOST parameter set too high - **STALL TIME** set too short	- Check load - Check parameter settings	5-6, 28.4-7 5-6, 28.4-9
***** TRIPPED *** I*T TRIP**	I*T monitoring function indicates overload: - Motor load too high - **I*T THRESHOLD**, **I*T TIME** and/or. **I*T-UPPER LIMIT** set too low	- Check load - Check parameter settings	28.5-5
***** TRIPPED *** BRAKE RESISTOR**	Monitoring function braking indicates overload: - Acceleration high with large inertia - Too frequent deceleration	- Check rating of resistor - Check brake resistor parameters	
***** TRIPPED *** BRAKE SWITCH**	Monitoring function braking chopper indicates overload: - Acceleration high with large inertia - Too frequent deceleration	- Refer to supplier	

	Possible cause	Cure	see page
***** TRIPPED *** OP STATION**	Programming pad disconnected when in LOCAL MODE	- Check connection	
***** TRIPPED *** LOST COMMS**	Monitoring function for serial comuncation indicates lost communications: - Master not in operation - Setting incorrect	- Increase parameter **COMMS TIMEOUT** - Verify other COMM settings.	28.7-2
***** TRIPPED *** MOTOR TEMP**	Thermistor input faulty: - No connection between terminals 6-10 Motor temperature too high: - Excessive load - Motor voltage incorrect - FIXED BOOST or **AUTO BOOST** set too high	- Check wiring - Check load - Check motor connection - Check parameter settings	6-3 5-6, 28.4-9
***** TRIPPED *** CURRENT LIMIT**	Motor current ≥ 180 % rated current: - Shock load	- Remove cause for shock load	
***** TRIPPED *** SHORT CIRCUIT**	IGBT-desaturation: - Motor output is short circuitted - Earth fault	- Check motor circuit	
***** TRIPPED *** 24V FAILURE**	24V control voltage ≤17 V: - External short circuit - Excessive load	- Check connection to 24 V control voltage	
***** TRIPPED *** LOW SPEED I**	Motor current at zero frequency >100 % : - FIXED BOOST or **AUTO BOOST** set too high	- Check parameter settings	5-6, 28.4-9
***** TRIPPED *** PHASE FAIL** (With MM6/ MM3SV only)	Phase failure in supply (MM6 only): - Phase missing	- Check supply	

Refer to **Resetting a tripped condition**, page 6-3 for on how to reset a tripped condition.

"KEY INACTIVE" messages

The following messages indicate that an inhibited key action has been attempted:

*** KEY INACTIVE *** **DRIVE RUNNING**	Attempt modifying a parametr which can only be changed whendrive is stopped.
*** KEY INACTIVE *** **REMOTE SEQ**	Attempt at giving a command which is correct be changed when in the REMOTE MODE.
*** KEY INACTIVE *** **PARAMETER LINKED**	Attempt at modifying a parameter which is already software-linked to a function module.
*** KEY INACTIVE *** **LIMIT REACHED**	Attempt at setting a parameter outside the permissible range.

"CHECKSUM FAIL"

Every time the MM456/MM3SV Frequency Inverter is powered up and initiated, the internal checksum is verified. Should a wrong checksum be produced, than is indicated as follows.

With Blank Cover:	With Programming Pad:	***CHECKSUM FAIL*** DEFAULTS LOADED
LEDs: HEALTH and RUN flash	All LEDs flash	

Possible causes of this fault are:

- An internal assembly has been exchanged
- Power failure durring **PARAMETER SAVE**
- MM456/MM3SV Frequency Inverter is faulty

A checksum fail fault can be best cured using the Programming Pad:

- Press key E which will automatically reset the MM456/MM3SV Frequency Inverter to the factory default value to MACRO 1.

It may be necessary to reset the language of the LCD display (see page 4-6):

- On all account reprogramm the parameters for the particular applications with care before attempting to restart the drive.

Should the previous instructions for any reason not be succesful then the MM456/MM3SV Frequency Inverter is probably damaged. Sie **Chapter 7 - SERVICING** for appropriate instructions.

OTHER FAULT FINDING

Problem	Possible Cause	Cure	see page
Inverter will not power up	♦ Fuse blown	- Check supply details, replace with correct fuse	
	♦ Faulty cabling	- Check all connections are correct and secure	
		- Check cable continuity	
Inverter fuse keeps blowing	♦ Faulty cabling or connections wrong	- Check for problem and rectify before replacing with correct fuse	
	♦ Faulty inverter	- Contact your supplier	
Cannot obtain HEALTH state	♦ Incorrect or no supply available	- Check supply details	
Motor will not run at switch-on	♦ Motor jammed	- Stop the inverter and clear the jam	
Motor runs and stops	♦ Motor becomes jammed	- Stop the inverter and clear the jam	
Motor runs at full speed only	♦ Reversed tachogenerator or open circuit tachogenerator	- Check tachogenerator connections	
	♦ Open circuit speed reference potentiometer	- Check connections	
Motor runs in wrong direction	♦ Motor connection incorrect	- Reverse two phases	

Chapter 7 - SERVICING

MAINTENANCE

MM456 Frequency Inverters are practically free of maintenance. However the following should be periodically inspected:

Cooling system:
- MM422-EMC, MM522/540-EMC: Is the fan in operation?
  MM6: Are all fans in operation?
- Make sure cooling inlets of the enclosure are free from obstructions and dust build-up
- As previous for cooling outlets
- Verify that cooling air can circulate freely and that adequate enclosure cooling is available

Mounting,
- Make sure the MM456 Frequency Inverter is securely mounted

Terminals:
- Make sure all wires are securely clamped

REPAIR

The MM456 Frequency Inverters must not be repaired by the user. If repair is necessary return the unit to your supplier.

WARNINGS !
Before disconnecting the MM456 Frequency Inverter, ensure isolation of the main supply to terminals L1, L2, L3 and L1, N.

Wait for at least 3 minutes for the d.c. link terminals (DC+ & DC-) to discharge to safe voltage levels (<50 V), failure to do so constitutes a potentialy lethal electrical shock hazard.

SAVING APPLICATION DATA BEFORE RETURNING EQUIPMENT

Although the MM456 Frequency Inverter retains parameter settings during power down, it is recommended that the Programming Pad is also used to record the valid settings and is not returned with the inverter. This is however possible if the inverter's microprocessor control is still functional. Use the PARAMETER SAVE | SAVE TO OP function (see page 5-14) to perform the parameter save to Programming Pad.

RETURNED EQUIPMENT

The following procedures are recommended in the unlikely event of a fault which necessitates return of a MM456 Frequency Inverter to your supplier:

- Contact your supplier to arrange return of the controller, if necessary. Your supplier will request the following information:
  - Type of MM456 Frequency Inverter
  - Serial number
- The return, repair or replacement procedure must be agreed with your supplier before returning equipment.
- Package and despatch the controller taking care that the packaging is environmentally suitable, recyclebar and provide ample transport protection.
- Make sure to include a detailed fault report. This will help shorten the repair time and reduce the repair cost.
- If polystyrene chips, or equivalent, are being used as a packing material then the MM456 Frequency Inverter must first be sealed in a polythene bag or similar, to prevent ingress of the packing material.

DISPOSAL

During transport, our products are protected by suitable packaging as far as necessary. The packaging consists entirely of environmentally compatible material that should be taken for central disposal as valuable secondary raw materials.

Contact the relevant Local Authority Department to obtain information on disposal facilities including disposal of old equipment.

Chapter 8 - EEC DIRECTIVES AND 'CE' MARKING, UL FOR USA AND CANADA

Page

BASICS OF 'CE' MARKING

The European Economic Community (EEC) has been created by the merger of the EC and EFTA countries. EEC represents one third of the world's electronic market. Unrestricted exchange of goods and products is ensured by having product specifications unified throughout Europe in the form of the EC Directives.

In addition to the MACHINERY DIRECTIVE, which has been in force since 1.1.1995, the EMC DIRECTIVE which has been obligatory since 1.1.1996, the LOW-VOLTAGE DIRECTIVE from 1.1.1997 is especially interesting when using AC drive converters.

Several basic comments are now explained which are the prerequisites for applying the 'CE' Mark.

- The 'CE' Mark is used as passport for products in the European Economic Community, and is only intended to secure unrestricted movement of products and goods. It is sufficient for the supervisory authorities as proof that the product was manufactured, with a high probability that all of the directives for a certificate of conformance, were fulfilled. This is certified using an EEC Declaration of Conformance, which refers to all of the applicable directives. The 'CE' Mark is only an administrative symbol which exclusively addresses the relevant supervisory authorities and demonstrates that all of the applicable legislation has been observed. Advertising with the CE Mark is considered as advertising with resource which is self-evident and is therefore not permissible (unfair competition).
- This means that the 'CE' Mark does not represent a symbol of quality to support product advertising.
- There is only one 'CE' Mark independent of the number of different Directives which are maintained (for instance, the extreme case involving toys which also have the 'CE' Mark due to the product standard which is valid for toys).
- Manufacturers or plant manufacturers may not subsequently withdraw a 'CE' Mark (e.g. if additional Directives are not fulfilled) (this step is for the exclusive use of the relevant authorities within the scope of sanctions)
- Manufacturers, distributors and users are responsible in observing the legislation directives regarding the selection of the associated regulation and standards with respect to the legislation.
- The product- and system/plant manufacturers are responsible in maintaining the EMC and additional specifications. These legal responsibilities cannot be transferred to suppliers, in this case business agreements apply.
- To support the system/plant manufacturer, appropriate declarations of conformance have been made available for the MM456.
- The product liability is exactly the same both with and without 'CE' Mark
- MM456 AC drive converters have been designed and manufactured so that the EMC Directive and other regulations are fulfilled. This is guaranteed using type tests and measurements which represent those typical for plants and systems.

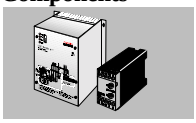
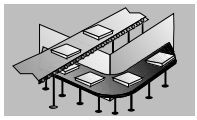
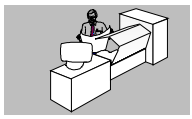
EMC DIRECTIVE

Responsibility for EMC and 'CE' marking

The manufacturer is adhering to the CEMEP recommendations on **'CE'** marking to the EMC DIRECTIVE with variable-speed power drive systems.

CEMEP is the "European Committee of Manufacturers of Electrical Machines and Power Electronics" and is the representative of the manufacturers of variable speed drives to the European Commission. A copy of these recommendations for the application of **'CE'** marking to Power Drive Systems (PDS) including MM456 Frequency Inverters in available on request.

These CEMEP recommendations interpret the EEC DIRECTIVE 89/336/EWG for EMC (EMC-DIRECTIVE) in the application to Power Drive Systems are shown in Fig. 8.1.

Group definition with examples	**EC Conformity, CE Marking, responsibility**		
Components  Components or spare parts which cannot be operated alone Electronic drive equipment such as MM456 Frequency Inverters		**Unrestricted distribution:** e.g. Trade and retail outlets including DIY stores	**Supply exclusive to EMC competent professional assemblers**: e.g. manufacturers of machines, installers of industrial installations
		CEMEP-1	CEMEP-2
	Intrinsic function *	required	not required
	EC Declaration of Conformity	required	not required
	CE mark	required	not required
	Responsibility: - Manufacturer/supplier of MM456 Frequency Inverter	- EMC responsibility of MM456 Frequency Inverter - Must stock and supply required EMC filters - EMC installation instructions must be easily understood and suitable for implementation by a laymen	- Providing suitable EMC installation instructions
	- User	- Implementation of the EMC installation instructions (Chapter 3) - Final responsibility for EMC	- Final responsibility for EMC
Installation  Installations which are assembled on site such as Pump stations, Chemical plants, Steel mills using MM456 Frequency Inverters		CEMEP-3	
	EC Declaration of Conformity	not required	
	CE mark	not required	
	Responsibility: - Manufacturer/supplier of MM456 Frequency Inverter - Installation installer (and operating company)	- Not a mandatory requirement, but a suitable contribution to EMC is expected - The protection requirements of the EMC directive must be adhered to (EMC planning is recommended) - Final responsibility for EMC, in particular for preventing interference with neighbouring installations	
Apparatus, Machines  Apparatus and machines which are sold as a complete functional unit such as Vacuum cleaners, lathes, Palletising machines using MM456 Frequency Inverters		CEMEP-4	
	EC Declaration of Conformity	required	
	CE mark	required	
	Responsibility: - Manufacturer/supplier of MM456 Frequency Inverter - Manufacturer of apparatus or machine	- Not a mandatory requirement, but a suitable contribution to EMC is expected - Final responsibility for EMC including issuing a Declaration of Conformity and **'CE'** marking	

* The term "intrinsic function" is being interpreted by the European Commission to mean components (such as MM456 Frequency Inverters) which have a function "directly usable" to the final user.

Fig. 8.11: Applying the EMC Directive according to the recommendations of CEMEP

According to the terminology of CEMEP, MM456 Frequency Inverters are "components". A clear distinction between the following two classes of components is required:

MM456 frequency inverters for exclusive supply to EMC competent professional assemblers, e.g. manufacturers of machines and apparatus and installers of industrial installations (CEMEP-2).

The majority of MM456 Frequency Inverters will be incorporated into a higher system consisting of a motor, cable, drive load and other drive or automation equipment by EMC competent professional assemblers.

The EMC DIRECTIVE **does not require** MM456 Frequency Inverters to be issued with an EMC Declaration of Conformity or **'CE'** marked for supply to this type of user.

To assist EMC competent professional assembler using MM456 Frequency Inverters, the manufacturer confirms that a power drive system (PDS) using a MM45 Frequency Inverter with integrated EMC filter or MM6 with approved external EMC filter is EMC compliant to EN50081-1/2 and EN50082-1/2 (see tables on page 8-8 for more details) when installed in accordance with the **EMC INSTALLATION INSTRUCTIONS** on pages 3-9...18. A Manufacturer's EMC Declaration is included in the middle of this Product Manual. Professional assemblers may use this statement of compliance as the basis for their own justifical of overall compliance with the EMC DIRECTIVE.

MM456 Frequency Inverter available to the general public e.g. through retail outlets, DIY stores, wholesales etc. (CEMEP-1

For classification to CEMEP-1 for sale to end users, the MM456 Frequency Inverter must have an "intrinsic function". An example of such an intrinsic function where an existing fixed-speed motor application (such as a fan or a pump) is converted to variable speed drive by using a MM456 Frequency Inverter. In such an application the end user would not necessarily be expected to have EMC expertise. The MM45 Frequency Inverter with integrated EMC filter or MM6 with approved external EMC filter must be used. The **'CE'** marking is valid provided the installation instruction on pages 3-9...18 are adhered to. The validity chart (Fig. 8.2) confirms the validity of the **'CE'** mark for EMC (page 8-10).

'CE' mark on MM456 Frequency Inverter

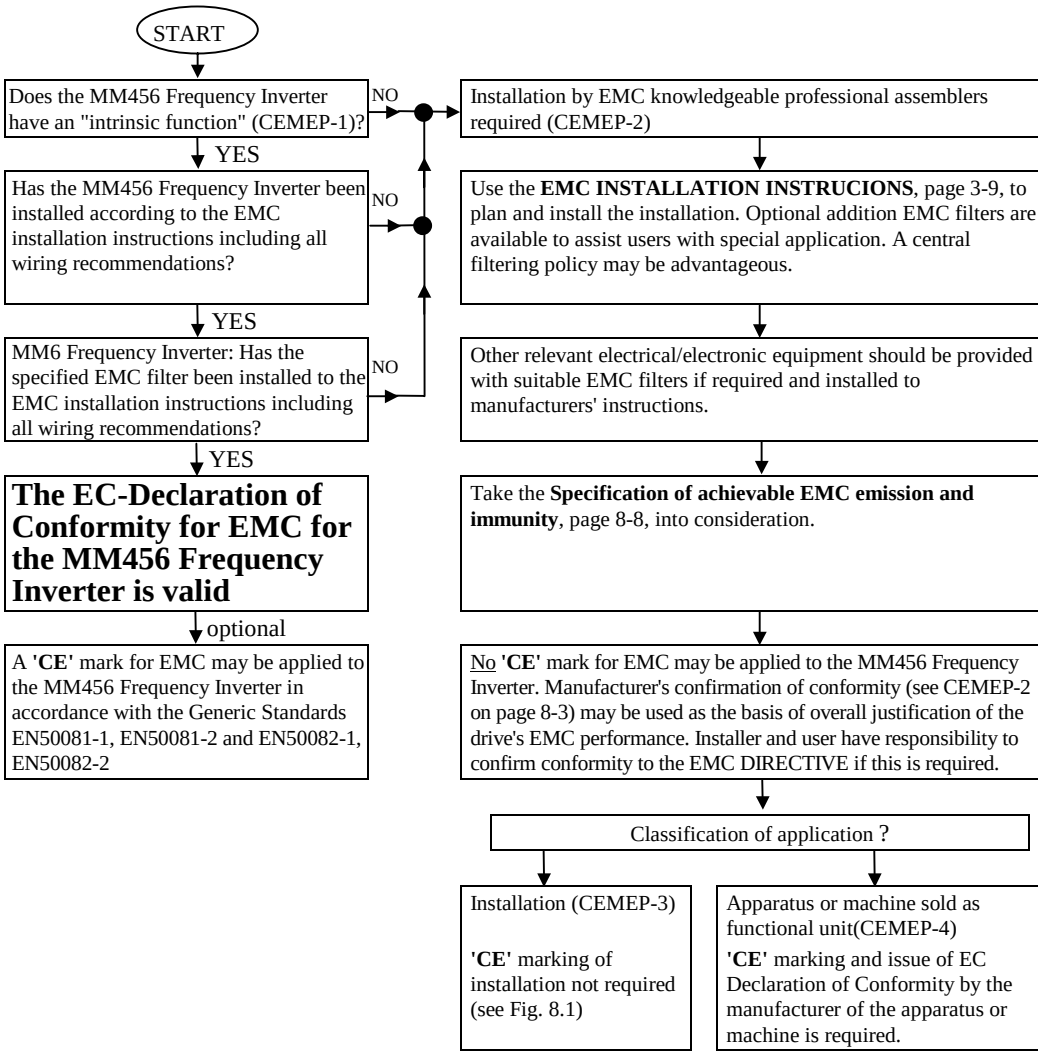
The **'CE'** mark for the LOW VOLTAGE DIRECTIVE is now mandatory, MM456 Frequency Inverters are corresponding **'CE'** marked on the product rating label. This **'CE'** mark only applies for EMC if the validity chart (Fig. 8.2) confirms validity (only possible with CEMEP-1 classification).

Validity of 'CE' mark for EMC

The validity chart in Fig. 8.2 provides the following EMC relevant information:

- Validity of EC Declaration of Conformity and **'CE'** mark to EMC DIRECTIVE (page 8-9).
- Applying a **'CE'** mark to the MM45 Frequency Inverter in accordance with the EMC DIRECTIVE in 1996.
- Requirements for obtaining **'CE'** approval for apparatus or machines using MM456 Frequency Inverters

It must be clearly understood by the customer before installation commences who is legally responsible for **'CE'** marking and conformance with the EMC DIRECTIVE. Misappropriation of the **'CE'** mark is a criminal offence.



Please enquire for validity of wall mounted MM456 Frequency Inverters.

Fig. 8.2: Validity chart of the 'CE' mark for EMC with MM456 Frequency Inverter

Consideration of EMC environment

When considering the relevant EMC interference and immunity standards it is important to distinguish between the following classes of EMC environments:

	Supplied directly from the public electricity supply				**Supplied from separate transformer station**	
	Residential (including public buildings, banks, hospitals etc.)		**Commercial and light industry where no residential are connected to same supply**		**Industrial installation**	
	RF interference	**Immunity**	**RF interference**	**Immunity**	**RF interference**	**Immunity**
Basic and Generic Standards	EN55011 or EN50081-1 (Class B)	EN50082-1 see below for referenced standards	EN55011 or EN50081-1 (Class B)	EN50082-1 see below for referenced standards	EN55011 or EN50081-2 (Class A)	EN50082-2
EMC Product Standard for Power Drive Systems EN61800-3	Unrestricted distribution (CEMEP-1): < 25 A Class B > 25 A Class A		EMC measures do not have to be implemented		EMC measures do not have to be implemented	
	Restricted distribution i.e. when installed by EMC competent professional assemblers (CEMEP-2): Class A permissible	see below for referenced standards	If interference in a neighbouring installation occurs, the operator is responsible for taking measures to prevent interference. In this case the required interference levels must be adhered to at the point of supply to the effected neighbouring installation.	see below for referenced standards	If interference in a neighbouring installation occurs, the operator is responsible for taking measures to prevent interference. In this case the required interference levels must be adhered to at the point of supply to the effected neighbouring installation.	see below for referenced standards
Standards for immunity:	IEC1000-4-2: Electrostatic discharge (e.g. from electrostatically charged persons)					
	IEC1000-4-3/6: Electromagnetic fields (e.g. from portable telephones)					
	IEC1000-4-4: Fast electrical transients (burst) (e.g. from opening contacts in inductive circuits)					
	IEC1000-4-5: Voltage surges (e.g. on local lightning strikes, tripping large motor loads)					

NOTE: The EMC product drive standard is under review. More stringert limits for RF interference are expected soon.

Fig. 8.3: EMC Interference and Immunity Standards applicable to MM456 Frequency Inverters and similar equipment

The "Residential" and "commercial and light industry" **emission limits** (Class B) are more stringent than the "Industrial installation with a separate transformer station" limits, so equipment which meets EN50081-1 automatically meets EN50081-2.

The "Industrial" **immunity** requirements are more stringent than the "Residential" and "commercial and light industry" requirements, and equipment which meets EN50082-2 automatically meets EN50082-1.

More and more Product Specific standards are being released with less onerous EMC requirements than the Basic or Generic Standards. In accordance with EMC Drive Product Standard for Power Drive System EN61800-3 EMC filters are only **mandatory** in ‘residential’ type EMC environments.

The EMC Drive Product Standard and the CEMEP recommendations are discussed in more detail in the booklet MotorMaster "EMC Does and Don'ts" AF-MM-02 and in the Product Information PI-LKTM-005 available on request.

It is important for the customer to identify what EMC standards are to be applied to the final machine/system and in what EMC environment it will operate, so that any additional compliance costs can be minimised. It should be remembered that when two or more EMC compliant components are combined to form the final machine/system, the resulting machine/system may not be compliant. Emissions from combined components tend to be additive, while the immunity remains constant.

'CE' marking of MM45 with built-in EMC filter

MM45 Frequency Inverters with built-in EMC filter can be **'CE'** marked (as in CEMEP-1) to comply with the mains terminal limits of EN55011 (or EN50081-1) Class B as indicated previously and when installed in accordance with the **EMC INSTALLATION INSTRUCTIONS** on pages 3-9...18. The Class B limit is the most stringent limit applied in Europe to date, and allows product to be used in either the"'residential" and "commercial and light industrial" or "industrial" EMC environments. Refer to **Consideration of EMC environments**, page 8-5 for more details.

'CE' marking of MM6 with external EMC filter

MM6 Frequency Inverters can be **'CE'** marked (as in CEMEP-1) when used with the specified matching EMC filters to comply with the mains terminal limits of EN55011 Class B (or EN50081-1) as indicated previously and when installed in accordance with the **EMC INSTALLATION INSTRUCTIONS** on pages 3-9...18. The Class B limit is the most stringent limit applied in Europe to date, and allows product to be used in either the"'residential" and "commercial and light industrial" or "industrial" EMC environments. Refer to **Consideration of EMC environments**, page 8-5 for more details. Recommended matching EMC filters for MM6 Frequency Inverters are summarised in the table on page 8-2 and described in more detail on page 8-3. The fitment of the recommended matching EMC filter is **mandatory** where **'CE'** marking is to be applied for EMC.

If the customer is treating the MM6 Frequency Inverter as a **Component for supply to EMC competent professional assemblers** (CEMEP-2) and is taking the EMC responsibility, then the EMC filters are optional and may assist the customer in achieving EMC compliance. Suitable filters are summarised in the table on page 8-2 and in more detail on page 8-3. In this situation the customer may also achieve compliance by less expensive more global measures depending on the limits to be achieved, such as the use of a combination of global or local filtering and screening methods, natural mitigation through distance or use of distributed parasitic elements of the existing installation.

The required EMC RF interference suppression and immunity for **'CE'** marking of MM6 Frequency Inverter is only obtained when the **EMC INSTALLATIONS INSTRUCTIONS** on pages 3-9...18 are all carefully adhered to.

Specification of achievable EMC emission and immunity

MM456 Frequency Inverters with the option to be **'CE'** marked meet the following EMC emission limits provided they are installed with the internal or recommended matching EMC filters for **'CE'** marking in accordance with **EMC INSTALLATION INSTRUCTIONS**, page 3-9...18. Take note of the permissible cable length and restrictions on switching frequency as described on page 3-8.

Port	Phenomenon	Basic standard	Mounting	Level	Generic standard
Enclosure Port	Radiated	EN55011 (1998)	Suitable Metal enclosure+	Class B	EN50081-1 (1993)
			Wall mounting	Class A	EN50081-2 (1994)
Power Port	Conducted	EN55011 (1998)	all	Class B	EN50081-1 (1993) EN50081-2 (1994)

+ Ask your supplier for further information

All MM456 Frequency Inverters meet the following EMC immunity performance criteria as defined in EN50082-2 (1992) when installed and used as recommended.

Port	Phenomenon	Test standard	Test withstand level	Acceptance Criterion	Generic standard
Enclosure Port	ESD	IEC 801-2	6 kV CD, 8 kV AD	Self recovery	EN50082-1 (1993)
	RF Field	IEC 801-3	10 V/m, 1 kHz AM	No change	
Power Ports (supply voltage)	Fast Transient Burst	IEC 801-4	2 kV	Self recovery	EN50082-2 (1995)
	Surge	IEC 801-5	1 kV (P-P), 2 kV (P-E)	Self recovery	
Signal & Control	Fast Transient Burst	IEC 801-4	2 kV	Self recovery	
Power Interfaces	Fast Transient Burst	IEC 801-4	2 kV	Self recovery	

Internal or recommended matching EMC filters for MM456 Frequency Inverters may be flash tested in circuit up to d.c. 2850 V for 1 min. Ensure all other equipment that may be damaged by such flash testing has been suitably isolated/removed/short circuited as applicable. Due to the internal capacitors between phase and earth, the d.c. voltage should be wound up slowly, to prevent excessive earth current. For similar reasons a.c. flash testing cannot be performed due to the excessive earth leakage current. The repeated flash testing is not recommended as it may degrade the insulation.

EMC responsibility for installers and users of MM456 Frequency Inverters in installations

This section summarises the previous considerations for installers and users of MM456 Frequency Inverters in installations which are assembled on site (CEMEP-3).

For end users of MM456 Frequency Inverters, a correctly installed power drive system (PDS) created from the supplied MM456 Frequency Inverter together with integrated EMC filter will be compliant to the generic emission and immunity as previously indicated when installed in accordance to **EMC INSTALLATION INSTRUCTIONS** (see page 3-6).

EMC responsibility of manufacturers of apparatus and machines sold as complete functional units

This section summarises the previous considerations for manufacturers of apparatus and machines sold as complete functional units (CEMEP-4).

The manufacturer's confirmation that a correctly installed power drive system (PDS) consisting of a MM456 Frequency Inverter and recommended EMC filter (MM6 only) will be compliant to the relevant EMC standards (see page 8-8) can be used as the basis for justification of the overall compliance with the EMC DIRECTIVE. For this purpose a Manufacturer's EMC Declaration is included on page 8-11.

If the relevant apparatus or machine contains other electrical components than the PDS, then the complete apparatus or machine must be assessed against an appropriate EMC standards, since when two compliant pieces of electrical/electronic equipment are brought together, the whole may not be compliant.

If it is the responsibility of the manufacturer of the apparatus or machine sold as a functional unit to establish EMC conformity and to **'CE'** mark. There are three methods of demonstrating EMC conformity:

- Self certification to a relevant standard
- Third party testing to a relevant standard
- Writing a technical construction file stating the technical rationale as to why the relevant apparatus is compliant. An EMC "competent body" must then assess this and issue a technical report or certificate to demonstrate compliance

Upon demonstrating EMC compliance an EC-Declaration of Conformity for the apparatus or machine may be issued and a **'CE'** mark applied.

Professional end users with EMC expertise who are using MM456 Frequency Inverters and other equipment defined as components who supply, place on the market or install the relevant apparatus must take responsibility for demonstrating EMC conformance, applying the 'CE' mark and issuing an EC Declaration of Conformity.

EC Declaration of Conformity for EMC

CE

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		015er01a	18. Juni 1999

EG-KONFORMITÄTSERKLÄRUNG

gemäss
EG-RICHTLINIE 89/336/EWG,
ARTIKEL 10 sowie ANHANG I
(EMV-RICHTLINIE)

Wir, KIMO INDUSTRIE-ELEKTRONIK GmbH, Adresse wie oben, erklären in alleiniger Verantwortu[illegible]nic equipment

EC DECLARATION OF CONFORMITY

in Accordance with the
EEC DIRECTIVE 89/336/EEC,
ARTICLE 10 and ANNEX I
(EMC DIRECTIVE)

We KIMO INDUSTRIE-ELEKTRONIK GmbH, address as above, declare under our sole

MotorMaster MM407-EMC, MM415-EMC
MotorMaster MM515-EMC, MM522-EMC, MM540-EMC

bei Installation unter Berücksichtigung aller Anweisungen in der Produktbeschreibung (mit jedem Gerät geliefert) mit den folgenden Normen übereinstimmt:

when installed in accordance with the instructions in the Product Manual (provided with each piece of equipment) is in Conformity with the following standards:

EN50081-1 (1992) (Leitungsgebundene Störungen)
EN50081-2 (1994) (Funkabstrahlung)
EN50082-1 (1992) & Entwurf prEN50082-2 (1992)

EN50081-1 (1992) (conducted emissions)
EN50081-2 (1994) (radiated emissions)
EN50082-1 (1992) & draft prEN50082-2 (1992)

gemäß den Bestimmungen der **EG-RICHTLINIE**

89/336/EWG mit Änderungen
92/31/EWG sowie 93/68/EWG.

following provisions of the **EEC-DIRECTIVE**

89/336/EEC with amendments
92/31/EEC and 93/68/EEC.

KIMO INDUSTRIE-ELEKTRONIK GmbH

ppa. Dr. John P. Gibson
Produktmanager - Product Manager

Dipl.-Ing (FH) Roland Lutz
Qualitätswesen - Quality Assurance

Manufacturer's EMC declaration

Not to be confused with a "Declaration of Conformity".

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		015eh01a	18. Juni 1999

EMV - HERSTELLERERKLÄRUNG **MANUFACTURER'S EMC DECLARATION**

Die nac

MotorMaster MM407-EMC, MM415-EMC
MotorMaster MM515-EMC, MM522-EMC, MM540-EMC

sind konform mit den folgenden Normen:

EN50081-1 (1992) (Leitungsgebundene Störungen)
EN50081-2 (1994) (Funkabstrahlung)
EN50082-1 (1992) & Entwurf prEN50082-2 (1992)

are declared in conformity with the following standards:

EN50081-1 (1992) (conducted emissions)
EN50081-2 (1994) (radiated emissions)
EN50082-1 (1992) & draft prEN50082-2 (1992)

Vorausgesetzt alle Anweisungen der zugehörigen Produktbeschreibungen (geliefert mit jedem Gerät) wurden beachtet.

Provided all installation instructions in the Product Manual (provided with each piece of equipment) are adhered to.

KIMO INDUSTRIE-ELEKTRONIK GmbH

ppa. J. Gibson
ppa. Dr. John P. Gibson
Produktmanager - Product Manager

Dipl.-Ing (FH) Roland Lutz
Qualitätswesen - Quality Assurance

Managing directors: Dipl.-Ing. Klaus Recker, Dr.-Ing. Rolf Mayer
Company reg.: HRB 3933 Fürth
Sparkasse Erlangen
Konto Nr. 29-002120
BLZ 763 500 00

DIN EN ISO 9001 TAW Cert Zert.Nr.: 19021198

LOW VOLTAGE DIRECTIVE

The LOW VOLTAGE DIRECTIVE requires **'CE'** marking of all electrical equipment that is brought into service in the European Community. All MM456 Frequency Inverters are **'CE'** marked on the name plate to indicate compliance with the LOW VOLTAGE DIRECTIVE.

CE

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EG-KONFORMITÄTSERKLÄRUNG

**gemäss
EG-RICHTLINIE 73/23/EWG,
und Änderung durch 93/86/EWG
ARTIKEL 13 sowie ANHANG III
(NIEDERSPANNUNGS-RICHTLINIE)**

Wir, KIMO INDUSTRIE-ELEKTRONIK GmbH, Adresse wie oben, erklären in alleiniger Verantwortung

EC DECLARATION OF CONFORMITY

**in accordance with the
EEC DIRECTIVE 73/23/EEC,
and amended by 93/86/EEC
ARTICLE 13 and ANNEX III
(LOW VOLTAGE DIRECTIVE)**

We KIMO INDUSTRIE-ELEKTRONIK GmbH, address as above, declare under our sole

onic equipment

**MotorMaster MM407-EMC, MM415-EMC
MotorMaster MM515-EMC, MM522-EMC, MM540-EMC
MotorMaster MM655, MM675, MM6110**

MotorMaster MM655, MM675, MM6110

bei Installation unter Berücksichtigung aller Anweisungen in der Produktbeschreibung (mit jedem Gerät geliefert) mit der folgenden Norm übereinstimmt:

when installed in accordance with the instructions in the Product Manual (provided with each piece of equipment) is in Conformity with the following standard:

VDE0160 (1994) / prEN50178 (1996)

gemäß den Bestimmungen der EG-RICHTLINIE 72/23 EWG mit Änderung 93/68/EWG.

VDE0160 (1994) / prEN50178 (1996)

following the provisions of the EEC-DIRECTIVE 72/23 EWG with amendment 93/68/EWG.

KIMO INDUSTRIE-ELEKTRONIK GmbH

ppa. Dr. John P. Gibson
Produktmanager - Product Manager

Dipl.-Ing (FH) Roland Lutz
Qualitätswesen - Quality Assurance

MACHINERY DIRECTIVE

The MACHINERY DIRECTIVE requires '**CE**' marking of the complete machine. MM456 Frequency Inverters are classified as components and therefore '**CE**' marking to the MACHINERY DIRECTIVE is not applicable.

However a "Manufacturer's Declaration" (not to be confused with a "Declaration of Conformity") defining safety consideration may be required by some machine builders.

KIMO

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		015mr01a	18. Juni 1999

HERSTELLERERKLÄRUNG

gemäss
EG-RICHTLINIE 89/392/EWG,
ART. 4, ABS. 2, sowie ANH. II B
(MASCHINENRICHTLINIE)

MANUFACTURERS DECLARATION

in accordance with the
EEC DIRECTIVE 89/392/EEC,
CHAP. 4, PAR. 2, and APPENDIX II B
(MACHINERY DIRECTIVE)

Die nachfolge

MotorMaster MM407-EMC, MM415-EMC
MotorMaster MM515-EMC, MM522-EMC, MM540-EMC
MotorMaster MM655, MM675, MM6110

sind nicht selbständig betreibbare Komponenten

are components to be incorporated into machinery

Die Maschine oder Anlage darf erst dann in Betrieb genommen werden, wenn die Schutz- und Sicherheitsanforderungen der **RICHTLINIE 89/392/EWG** vollständig erfüllt sind.

The complete machinery or installation using this equipment may only be put into service when the safety considerations of the **DIRECTIVE 89/329/EEC** are fully adhered to.

Desweiteren wird auf

EN 60204-1 (Sicherheit von Maschinen - Elektrische Ausrüstung von Maschinen)

verwiesen. Die in der jeweiligen Produktbeschreibung aufgeführten Anweisungen, Warnungen und Sicherheitshinweise sind zusätzlich zu beachten.

Particular reference should be paid to

EN 60204-1 (Safety of Machinery - electrical Equipment of Machines).

All instructions, warnings and safety relevant information of the Product Manual must also be adhered to.

KIMO INDUSTRIE-ELEKTRONIK GmbH

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Company reg.:	HRB 3933 Fürth	BLZ 763 500 00

DIN EN ISO 9001 TAW Cert Zert.Nr.: 19021198

UL FOR USA AND CANADA

UL listing for the USA and c-UL lisiting for Canada in accordance with UL508C have been applied for. Without the top cover fitted MotorMaster MM456 Frequency Inverters meet the requirement of an "Open-Type" piece of equipment. With the top cover fitted, the requirements of "Type 1 Enclosed" for direct wall mounting are fulfilled. These listings are only valid if the **Special considerations for installation in compliance with UL**, page 1-11 are adhered to.

UL:

UL:

Chapter 9 - OPTIONS

POWER RELATED OPTIONS

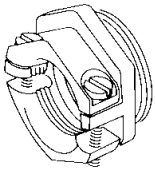
Summary of available options

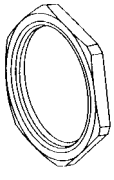
MM456 Frequency Inverter	Gland for screened motor cable	EMC Filter	Chokes Line	Motor	Top cover NEMA 1	Braking resistors		
						leichtes Bremsen	high braking torque	high braking torque and heavy braking operation
MM407-EMC	OPTION MM-MOT-GLAND-P16	integrated (Class B)	MM-L415/2	MM-L302	MM45-NA1	200BR0004	100BR001	100BR006
MM415-EMC						100BR001		
MM422-EMC			auf Anfrage	MM-L305	MM45-NA2		100BR006	100BR012
MM515-EMC			MM-L302	MM-L302		200BR0004	100BR001	100BR006
MM522-EMC						100BR001	100BR006	100BR012
MM540-EMC			auf Anfrage	MM-L302				
MM655	OPTION MM-MOT-GLAND-P21	FB311	MM-L305	MM-L305	MM6-NA3	100BR001	100BR006	100BR006
MM675			MM-L307	MM-L307		100BR006	39BR006	39BR012
MM6110			MM-L318	MM-L318		100BR012	39BR012	39BR050
Further Info	Page 9-2	Page 9-3	Page 9-5		Page 9-6	Page 9-7	Page 9-7	Page 9-7

Refer to **EMC INSTALLATION INSTRUCTIONS** (pages 3-9...18) and **EMC DIRECTIVE** (pages 9-2...9) for important information on adhering to the EMC DIRECTIVE

GLANDS FOR SCREENED MOTOR CABLES

Equipment code	Electrical data	Order no.
OPTION MM-MOT-GLAND-P16	Motor cable gland	8629.005-116
OPTION MM-MOT-GLAND-P21	Motor cable gland	8629.005-121





External EMC filters type FB (Recommended matching EMC filters for the EC Declaration Conformity for EMC)

Equipment code		Electrical data	Order no.
FN 3258-30/07	FB311	7.5-15 kW, 480 V, 34 A, EMC filter	8613.320-400

Refer to **EMC INSTALLATION INSTRUCTIONS** (pages 3-6...14) and to **EMC DIRECTIVE** (pages 8-3...11) for important information on adhering to the EMCDIRECTIVE

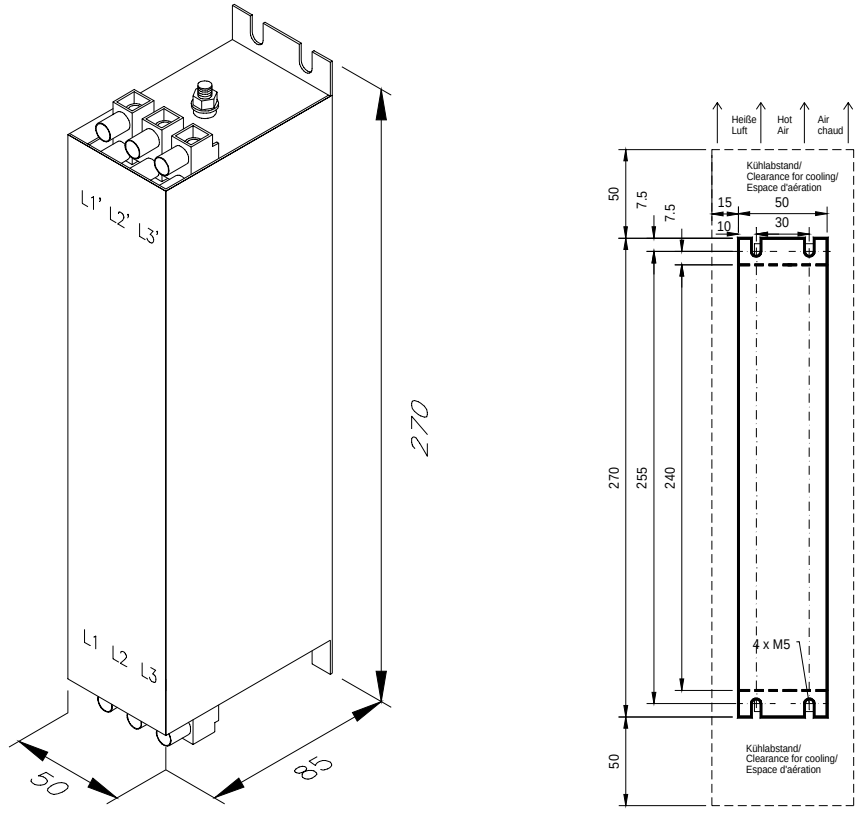


Fig. 9.1: Outline drawings and mounting - OPTION FB311 (new type)

Line and motor chokes

Equipment code	Electrical data	Order no.
OPTION MM-L415/2	1.5-2.2kW, Line choke	8614.211-100
OPTION MM-L302	2.2-4.0kW, Line or motor choke	8614.312-100
OPTION MM-L305	4.0-7.5kW, Line or motor choke	8614.316-100
OPTION MM-L307	7.5-11 kW, Line or motor choke	8614.317-100
OPTION MM-L318	11-22 kW , Line or motor choke	8614.322-100

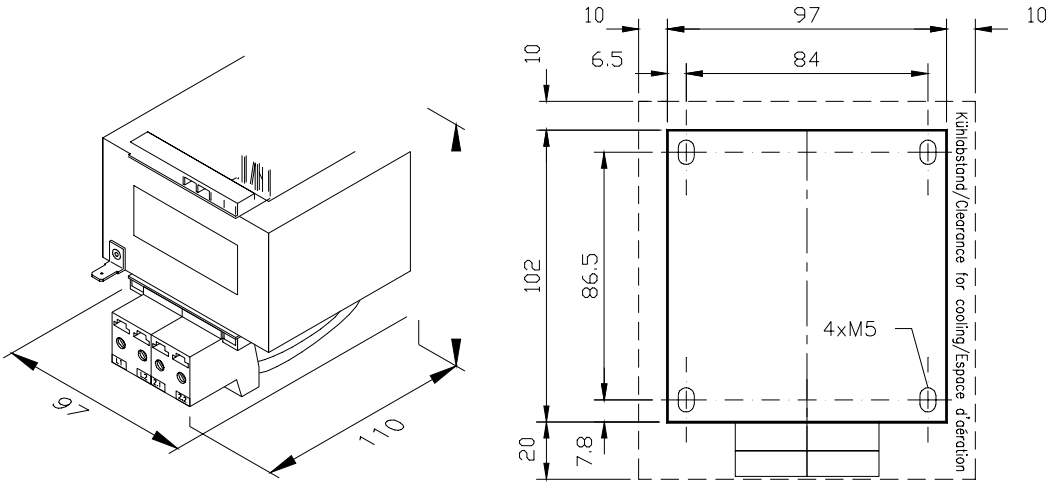


Fig. 9.2a: Outline drawings and mounting OPTION L415/2

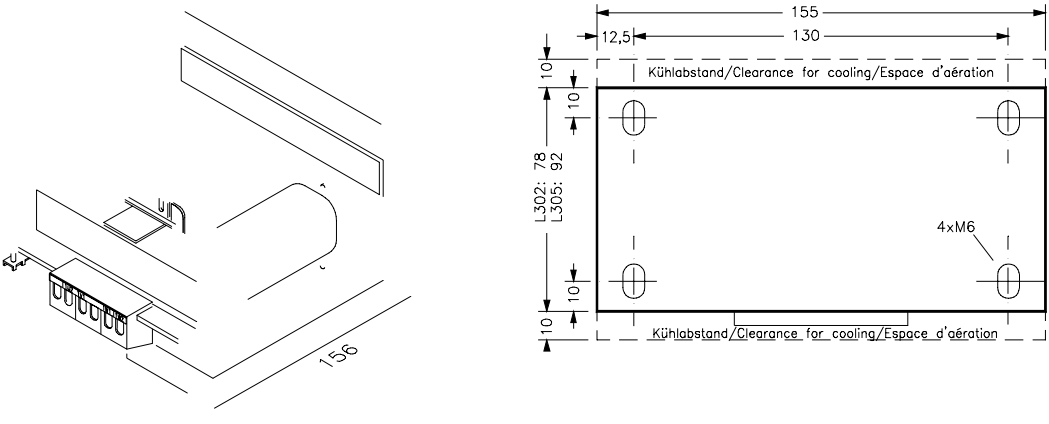


Fig. 9.2b: Outline drawings and mounting OPTION L302/L305

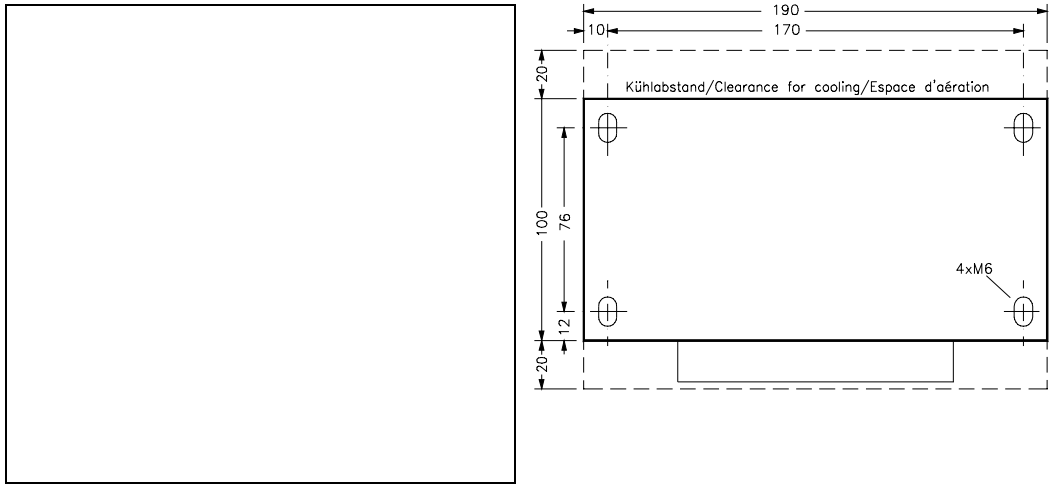


Fig. 9.2c: Outline drawings and mounting OPTION L307

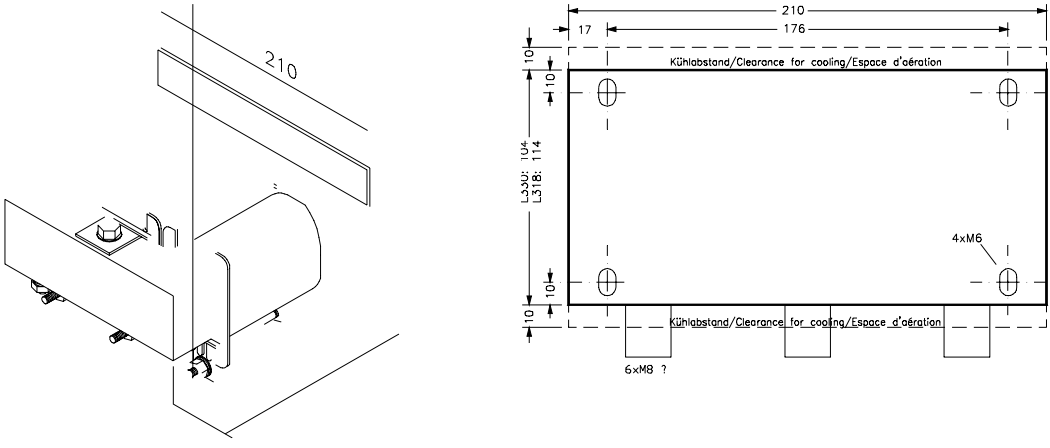


Fig. 9.2d: Outline drawings and mounting OPTION L318

NEMA 1 top cover

Equipment code	Electrical data	Order-no.
OPTION MM45-NA11	NEMA1 Cover 1	8629.011
OPTION MM45-NA12	NEMA1 Cover 2	8629.012
OPTION MM6-NA13	NEMA1 Cover 3	8629.013

The NEMA 1 top cover provides protection to IP4X on the upper surface (no falling part can enter the MM456 Frequency Inverter) and therefore satisfies the requirements of EN 50178 for wall mounting. This is particularly important in Europe as EN 50178 can serve as the basics for demonstrating conformance to the EC LOW-VOLTAGE DIRECTIVE responsible for the safety of electrical equipment.
Tighten top cover to 1.2 Nm torque.

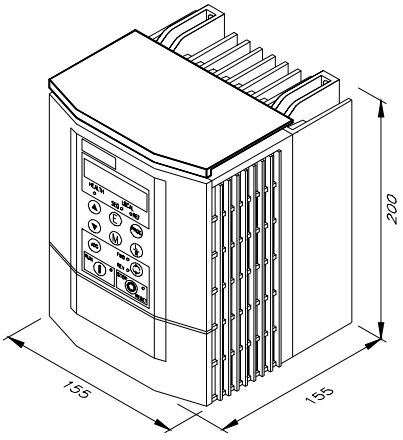


Fig. 9.3a: OPTION MM45-NA11 for MM407...MM415-EMC

Fig. 9.3b: OPTION MM45-NA12 for MM422...MM540-EMC

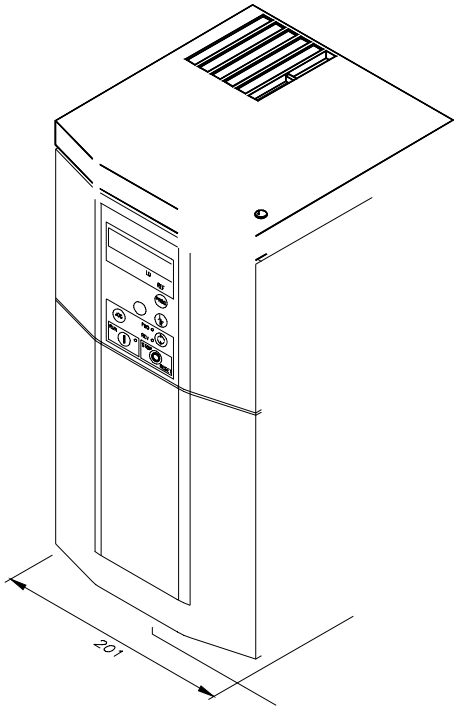


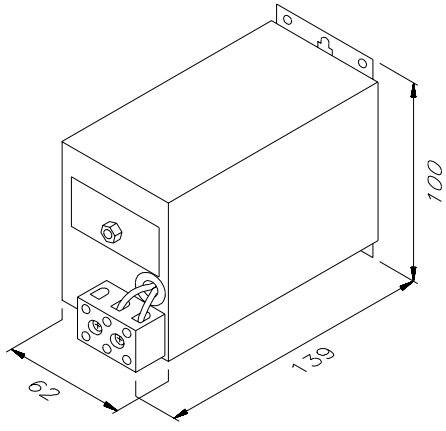
Fig. 9.3c: OPTION MM6-NA13 for MM655...MM6110

Outline drawing and mounting for NEMA 1

External braking resistors

Equipment code	Electrical data	Order no.
OPTION 200BR004	200 Ohm, 0.044 kW, braking resistor	8601.207-100
OPTION 100BR001	100 Ohm, 0.08 kW, braking resistor	8601.213-100
OPTION 100BR006	100 Ohm, 0.6 kW, braking resistor	8381.101-601
OPTION 100BR012	100 Ohm, 1.2 kW, braking resistor	8381.101-122
OPTION39BR006	39 Ohm, 0.6 kW, braking resistor	8381.340-006
OPTION39BR012	39 Ohm, 1.2 kW, braking resistor	8381.340-012
OPTION39BR050	39 Ohm, 5.0 kW, braking resistor	8381.340-050

Braking resistors OPTION 100BR006...39BR050 have an integrated overtemperature thermostat which should be connected in the external monitoring circuit of the MM456 Frequency Inverter.



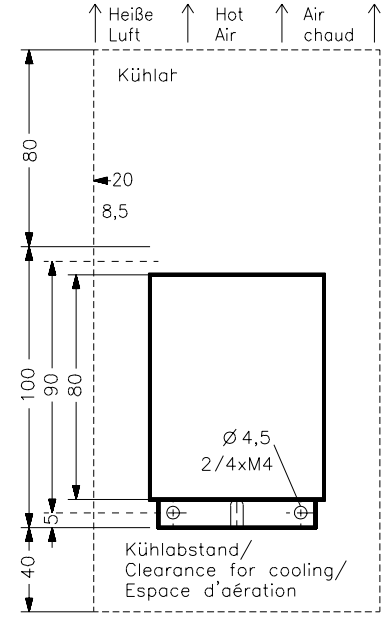


Fig. 9.4a: Outline drawing and mounting OPTION 200BR0004

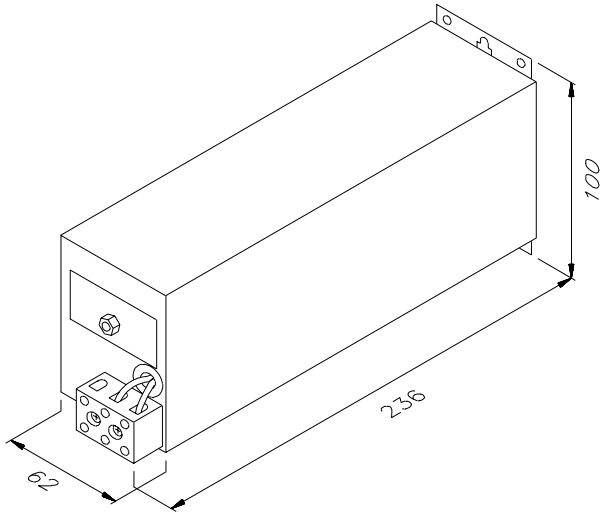


Fig. 9.4b: Outline drawing and mounting OPTION 100BR001

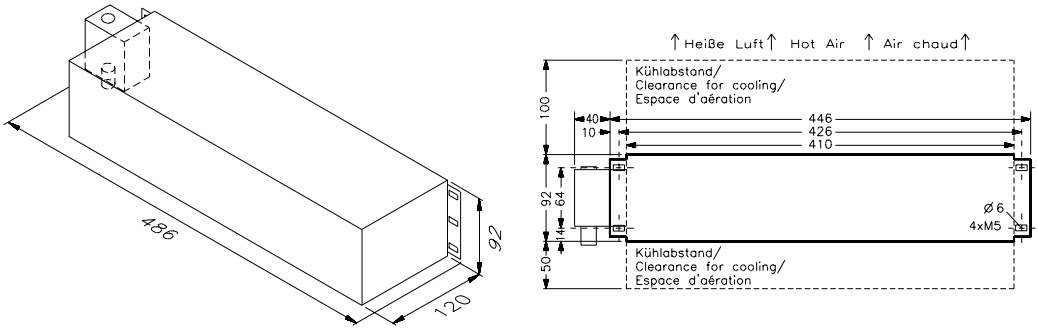


Fig. 9.4c: Outline drawing and mounting OPTION 100BR006

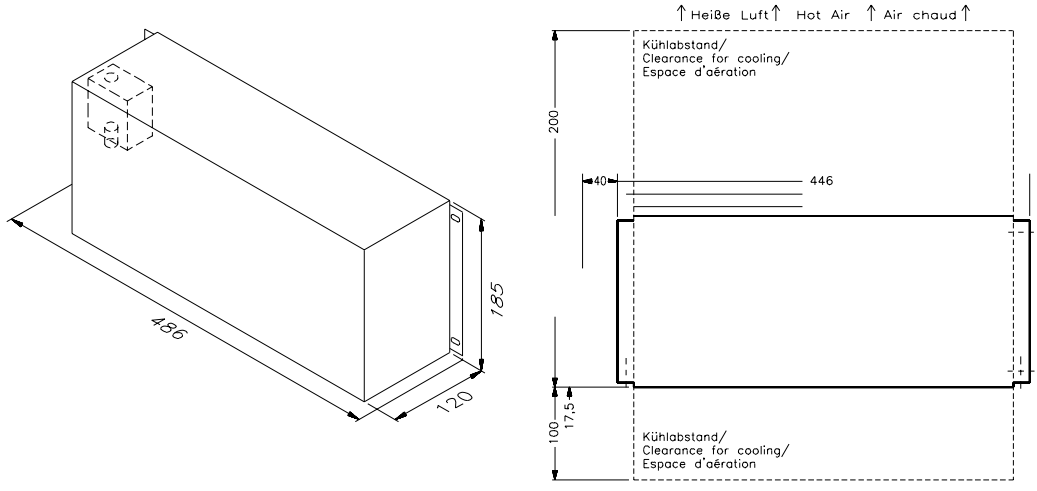
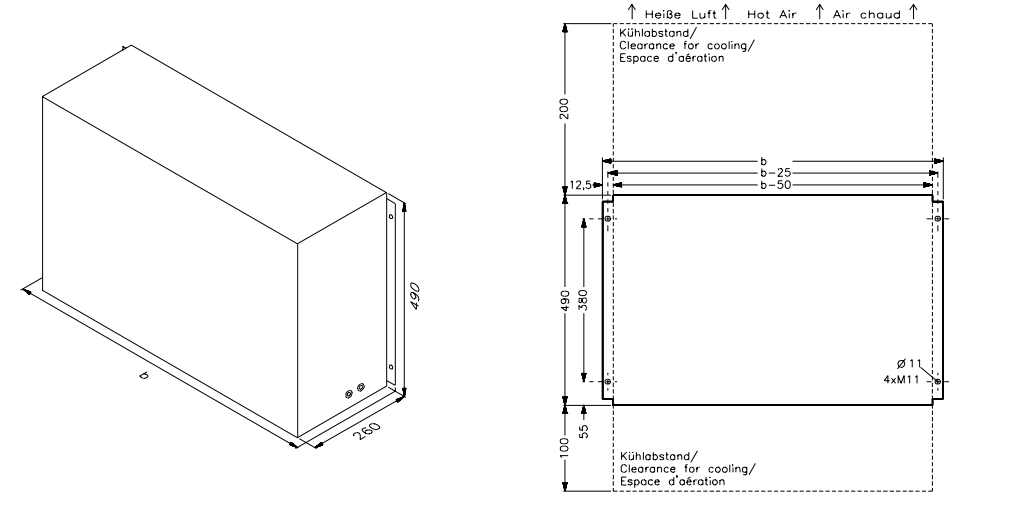


Fig. 9.4d: Outline drawing and mounting OPTION 100BR012



OPTION 39BR050: **b** 395 mm

Fig. 9.4e: Outline drawing and mounting OPTION 39BR050

OTHER OPTIONS

Programming pad (with Option for remote mounting)

Equipment code	Electrical data	Order no.
OPTION MM-PROG-PM	Programming pad	8629.001
OPTION MM-PROG	Programming pad	8629.002

Refer to Fig. 1.1, page 1-3 and PROGRAMMING PAD, page 4-2 for more details.

The mounting kit for remote mounting consists of a mounting frame which allows the programming pad to be mounted on the door of an electrical enclosure and a 3 m connecting cable to the MM456 Frequency Inverter. The protection class IP54 can be achiebed with the recommended mounting instructions.

Fig. 9.5: Mounting drawing for remote mounting of the Programming Pad with OPTION MM-PROG-PM

Operating panel

Equipment code	Electrical data	Order no.
OPTION MM-OP	Operating panel	8629.006

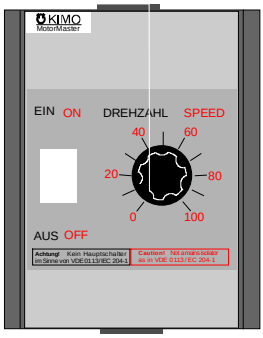


Fig. 9.6: Operating panel

The operating panel consists of the blank cover with prewired ON/OFF switch and setpoint potentiometer mounted. These components should be connected as shown in Fig. 10.1a., page 10-3. This provides a complete functional inverter unit for application requiring easy basic control with wall-mounting (see also NEMA 1 top cover, page 9-6).

Relais modules

Equipment code	Electrical data	Order no.
OPTION MM45-RELAY-DC24V	Relay module DC24V	8629.051
OPTION MM45-RELAY-DC12V	Relay module DC12V	8629.053
OPTION MM45-THERMISTOR	Motor protection	8629.052

The DC 24 V version is a miniature relay with LED for mounting on 35 mm DIN rails suitable as an interface relay for the two 24 V digital outputs.

The DC 12V version is similar to the previous relay but suitable for operation at 12 V. With appropriate programming the analog output of the MM456 Frequency Inverter can be used as a digital output with the help of this relay.

The thermistor protection relay is to provide motor protection based on a thermistor sensor in the motor winding for MM45 Frequency Inverters. This protection relay is also suitable for mounting on 35 mm DIN rails.

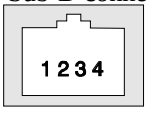
RS232 serial interface connecting cable

Equipment Code	Electrical data	Order no.
OPTION MM-RS232	RS232 Connecting cable	8616.001

To connect a Personal Computer to connector P3 of the MM456 Frequency Inverter this special cable is required. The connecting cable is 3 m long and terminates in a 9-pole Sub-D connector. A standard 25/9-pole adapter should be used to provide a 25-pole Sub-D connection if required.

P3 Port

Pin	1	2	3	4
Lead	Black	Red	Green	Yellow
Signal	0 V	5 V	T X	R X



9-pole Sub-D Connector

Pin	1	2	3	4
Lead	Black	Red	Green	Yellow
Female pin of 9-pole connector	5	not connected	3	2
Female pin of 25-pole connector*	7	not connected	2	3

*If 25/9-pole adapter used

Note: There is 5 V present on pin 2 of the P3 port. This may damage a PC to which the connection cable is connected. This lead should on no account be connected to the PC.

RS485/422 Serial Interface

Equipment Code	Electrical data	Order no.
OPTION MM45-RS485/422	RS485/422 Interface	8629.021
OPTION MM6-RS485/422	RS485/422 Interface	8629.026

This option provides an optoisolated RS422/485 serial data port to allow an intelligent device to monitor or update the parameters of a network of 32 MM456 Frequency Inverters.

As the ASCII mode is more commonly used this is used as the basis for the following information:

Transmission standard:	RS485 (RS422) (bi-directional)
Basic protocol:	ANSI-X3.28-2.5-B1
Data rates:	300, 600, 1200 ,2400, 4800, 9600 or 19200 baud
Character format (300 to 9600 baud):	ASCII + 1 start, 1 parity and 1 stop bit [10 bit]
Parity:	Defaults to Even

	START	D0	D1	D2	D3	D4	D5	D6	PARITY	STOP

For further information refer to the Product Manual TMMRS485E.

Fig. 9.7: RS485/422 Serial Link Option Board

PROFIBUS-DP option module

Equipment Code	Electrical data	Order no.
OPTION MM45-PROFIBUS-DP	PROFIBUS-DP bus interface	8629.022
OPTION MM6-PROFIBUS-DP	PROFIBUS-DP bus interface	8629.027

PROFIBUS-DP is the performance-optimized version of PROFIBUS, specifically dedicated to time-critical communication between automation systems such as PLCs and distributed peripherals such as MM456 Frequency Inverters. It is suitable as a replacement for the costly parallel wiring of 24 V control and 4 (0)...20 mA analogue signals.

PROFIBUS-DP is based on DIN 19245 T1 and uses application-orientated extensions as defined in DIN 19245 T3. As part of the European standardisation of field bus systems PROFIBUS-DP is integrated in the draft standard for field bus systems pr EN 50170. The basic specification of PROFIBUS-DP as implemented by the OPTION MM456 PROFIBUS-DP option module is as follows:

Transmission technology:	- EIA RS485 twisted cable pair - max. distance 200 m at 1.5 MBaud extendible with repeaters
Basic protocol:	- DIN 19245 part 3
Data rates:	- 1.5 MBaud (extension to 12 MBaud planned)
PROFIBUS-DP services:	- fast read/write - random access write - diagnostic read - broadcast/multicast (synchronise and freeze)
Device type:	- DP-Slave
Status indication:	- various LEDs

For further information refer to the Product Manual TMMPBDPEE.

CAN option module

Equimpent code	Electrical data	Order-no.
OPTION MM45-	.	

Please enquire for details

KIMOVIS PC software

Equipment Code	Electrical data	Order no.
OPTION MM-KIMOVIS-W	PC program KIMOVIS f. WINDOWS	8618.001
OPTION MM-KIMOVIS-D	PC program KIMOVIS f. DOS	8618.002

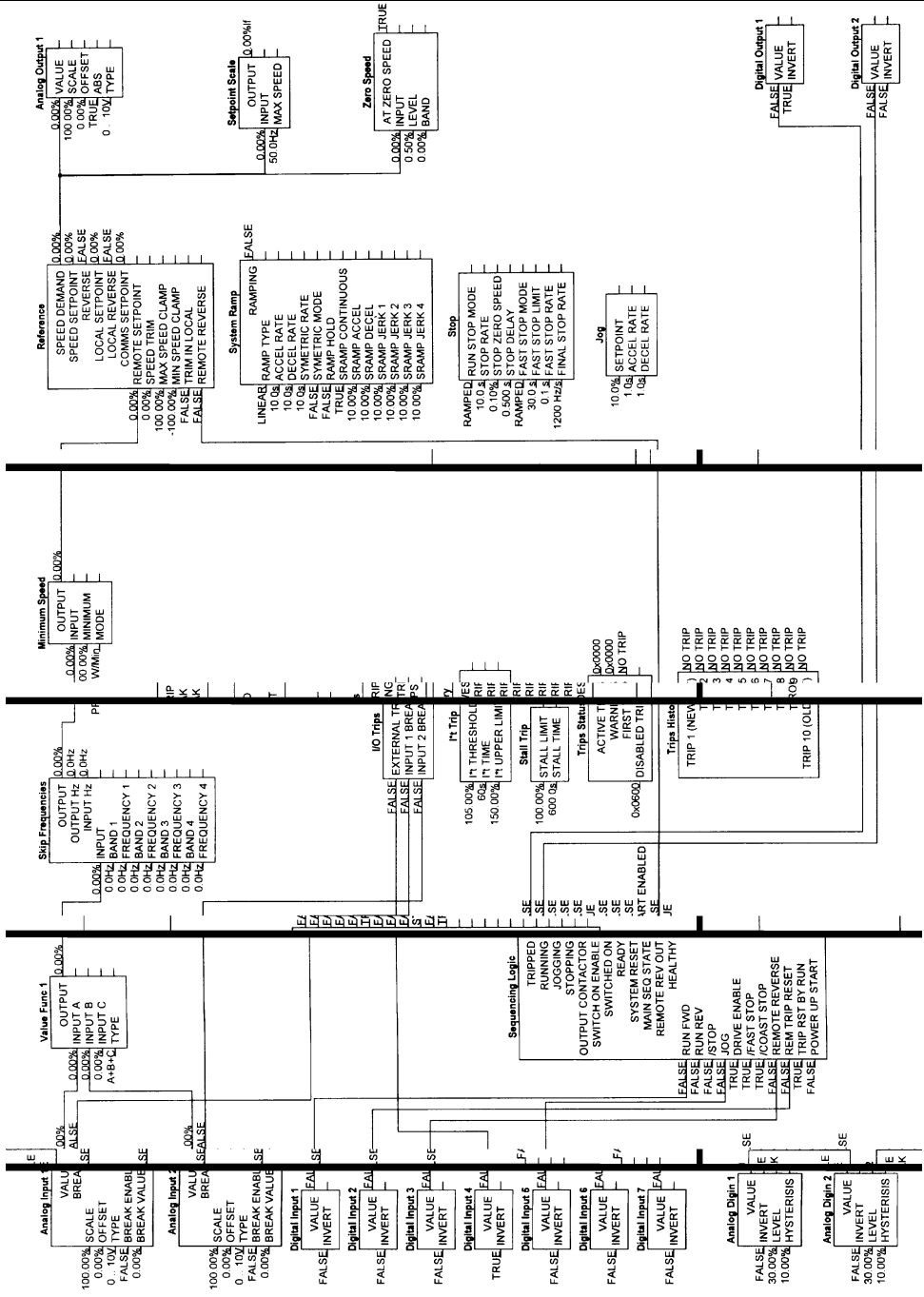
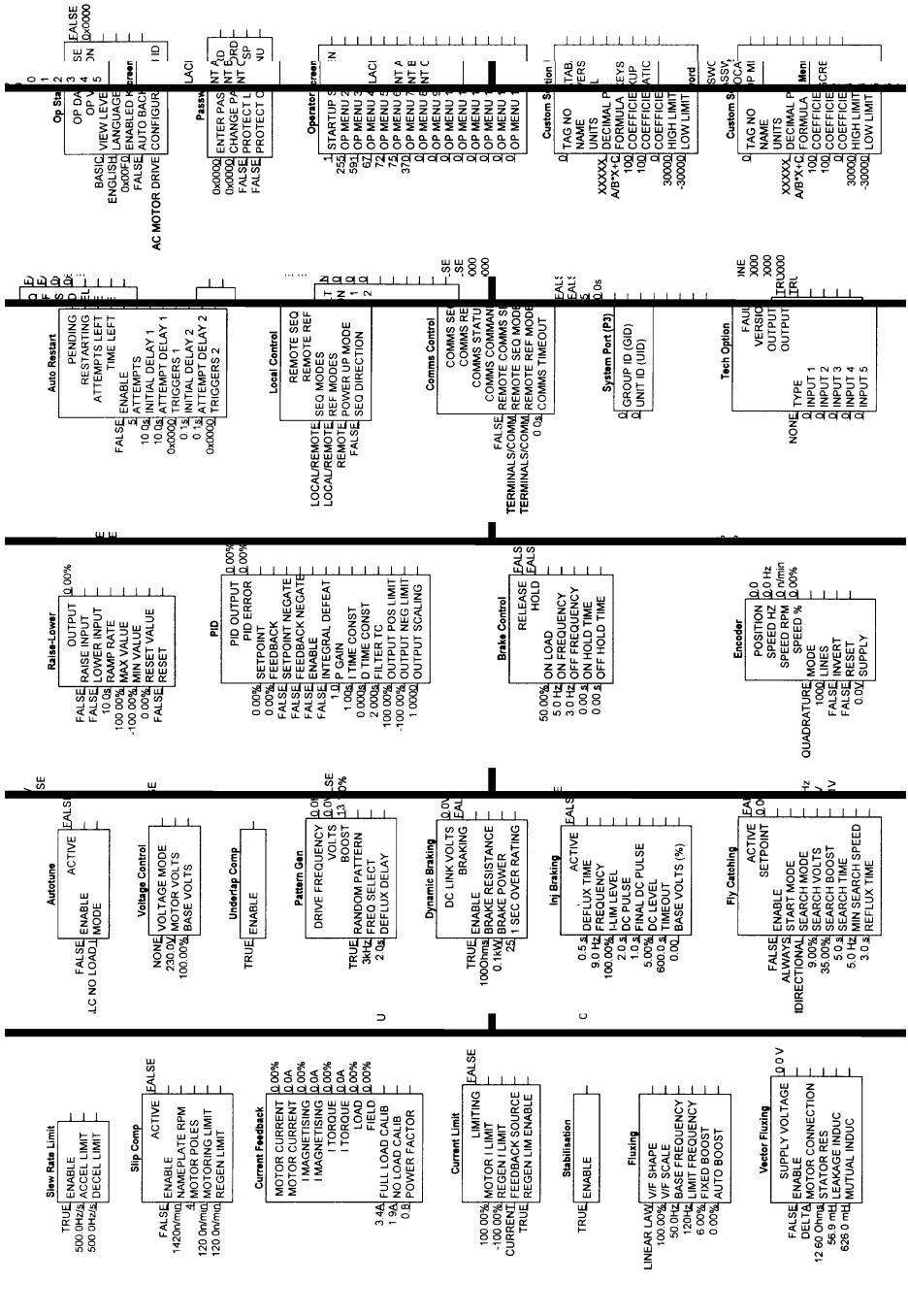


Fig. 9.8a: Example for programming with OPTION MM-KIMOVIS-W for MS-WINDOWS


Slew Rate Limit
TRUE ENABLE
500.0Hz/s ACCEL LIMIT
500.0Hz/s DECEL LIMIT
Slip Comp
FALSE ENABLE
-142.0rv/mi NAMEPLATE RPM
4 MOTOR POLES
120.0rv/mi MOTORING LIMIT
120.0rv/mi REGEN LIMIT
Current Feedback
0.00% MOTOR CURRENT
0.0A MOTOR CURRENT
0.00% I MAGNETISING
0.0A I MAGNETISING
0.00% I TORQUE
0.0A I TORQUE
0.00% LOAD
0.00% FIELD
3.44 FULL LOAD CALIB
1.94 NO LOAD CALIB
0.8 POWER FACTOR
Autotune
FALSE ACTIVE
FALSE ENABLE
LC NO LOAD MODE
Voltage Control
NONE VOLTAGE MODE
230.0V MOTOR VOLTS
100.00% BASE VOLTS
Undervlap Comp
TRUE ENABLE
Pattern Gen
0.0 DRIVE FREQUENCY
0.0 VOLTS
15.0% BOOST
TRUE RANDOM PATTERN
3kHz FREQ SELECT
2.0s DEFLUX DELAY
Dynamic Braking
0.0 DC LINK VOLTS
FALSE BRAKING
TRUE ENABLE
1000Ohms BRAKE RESISTANCE
0.1kW BRAKE POWER
25 I SEC OVER RATING
Current Limit
FALSE LIMITING
100.00% MOTOR I LIMIT
-100.00% REGEN I LIMIT
CURRENT FEEDBACK SOURCE
TRUE REGEN LIM ENABLE
Stabilisation
TRUE ENABLE
Fluxing
LINEAR LAW V/F SHAPE
100.00% V/F SCALE
50.0Hz BASE FREQUENCY
120Hz LIMIT FREQUENCY
6.00% FIXED BOOST
0.00% AUTO BOOST
Vector Fluxing
0.0 V SUPPLY VOLTAGE
FALSE ENABLE
DELTA MOTOR CONNECTION
12.60 Ohms STATOR RES
56.9 mH LEAKAGE INDUC
626.9 mH MUTUAL INDUC
Raise-Lower
0.00% OUTPUT
FALSE RAISE INPUT
FALSE LOWER INPUT
10.0s RAMP RATE
100.00% MAX VALUE
-100.00% MIN VALUE
0.00% RESET VALUE
FALSE RESET
PID
0.00% PID OUTPUT
0.00% PID ERROR
0.00% SETPOINT
0.00% FEEDBACK
FALSE SETPOINT NEGATE
FALSE FEEDBACK NEGATE
FALSE INTEGRAL DEFEAT
1.0 P GAIN
1.00s I TIME CONST
0.000s D TIME CONST
2.000s FILTER TC
100.00% OUTPUT POS I LIMIT
-100.00% OUTPUT NEG I LIMIT
1.0000 OUTPUT SCALING
Brake Control
FALSE RELEASE
FALSE HOLD
50.00% ON LOAD
5.0 Hz ON FREQUENCY
3.0 Hz OFF FREQUENCY
0.00s ON HOLD TIME
0.00s OFF HOLD TIME
Encoder
0.0 POSITION
0.0 Hz SPEED HZ
0 r/min SPEED RPM
0.00% SPEED %
QUADRATURE MODE
1000 LINES
FALSE INVERT
FALSE RESET
0.0V SUPPLY
Fly Catching
FALSE ACTIVE
0.0 SETPOINT
FALSE ENABLE
ALWAYS START MODE
BIDIRECTIONAL SEARCH MODE
9.00% SEARCH VOLTS
35.00% SEARCH BOOST
5.0 s SEARCH TIME
5.0 Hz MIN SEARCH SPEED
3.0 s REF LUX TIME
Inj Braking
FALSE ACTIVE
0.5 s DEFLUX TIME
9.0 Hz FREQUENCY
100.00% I LIM LEVEL
2.0 s DC PULSE
1.0 s DEFLUX PULSE
5.00% DC LEVEL
600.0 s TIMEOUT
0.00 BASE VOLTS (%)
Auto Restart
PENDING
RESTARTING
ATTEMPTS LEFT
TIME LEFT
FALSE ENABLE
5 ATTEMPTS
10.0s INITIAL DELAY 1
10.0s ATTEMPT DELAY 1
0x0000 TRIGGERS 1
0.1s INITIAL DELAY 2
0.1s ATTEMPT DELAY 2
0x0000 TRIGGERS 2
Local Control
REMOTE SEQ
REMOTE REF
LOCAL/REMOTE SEQ MODES
LOCAL/REMOTE REF MODES
REMOTE POWER UP MODE
FALSE SEQ DIRECTION
Comms Control
COMMS SE
COMMS RE
COMMS STATU
COMMS TIMEOUT
FALSE REMOTE COMMS S
TERMINALS/COMM REMOTE SEQ MODE
TERMINALS/COMM REMOTE REF MODE
0.0s COMMS TIMEOUT
System Port (P3)
0 GROUP ID (GID)
0 UNIT ID (UID)
Tech Option
FAU
VERSIO
OUTPUT
OUTPUT
NONE TYPE
0 INPUT 1
0 INPUT 2
0 INPUT 3
0 INPUT 4
0 INPUT 5
Op Station
FALSE
0x0000
SE
DA
V
BASIC VIEW LEVE
ENGLISH LANGUAGE
0x005F ENABLED K
FALSE AUTO BACK
AC MOTOR DRIVE CONFIGUR
I ID
Passw
0x0000 ENTER PAS
0x0000 CHANGE PA
FALSE PROTECT L
FALSE PROTECT C
LACI
Operator Screen
1 STARTUP S
256 OP MENU 2
561 OP MENU 3
72 OP MENU 4
75 OP MENU 5
370 OP MENU 6
0 OP MENU 7
0 OP MENU 8
0 OP MENU 9
0 OP MENU 1
0 OP MENU 1
0 OP MENU 1
0 OP MENU 1
Custom Station 1
0 TAG NO
NAME
UNITS
XXXXX DECIMAL PL
A/B*X+C FORMULA
100 COEFFICIE
100 COEFFICIE
0 COEFFICIE
30000 HIGH LIMIT
-30000 LOW LIMIT
Custom Station 2
0 TAG NO
NAME
UNITS
XXXXX DECIMAL PL
A/B*X+C FORMULA
100 COEFFICIE
100 COEFFICIE
0 COEFFICIE
30000 HIGH LIMIT
-30000 LOW LIMIT

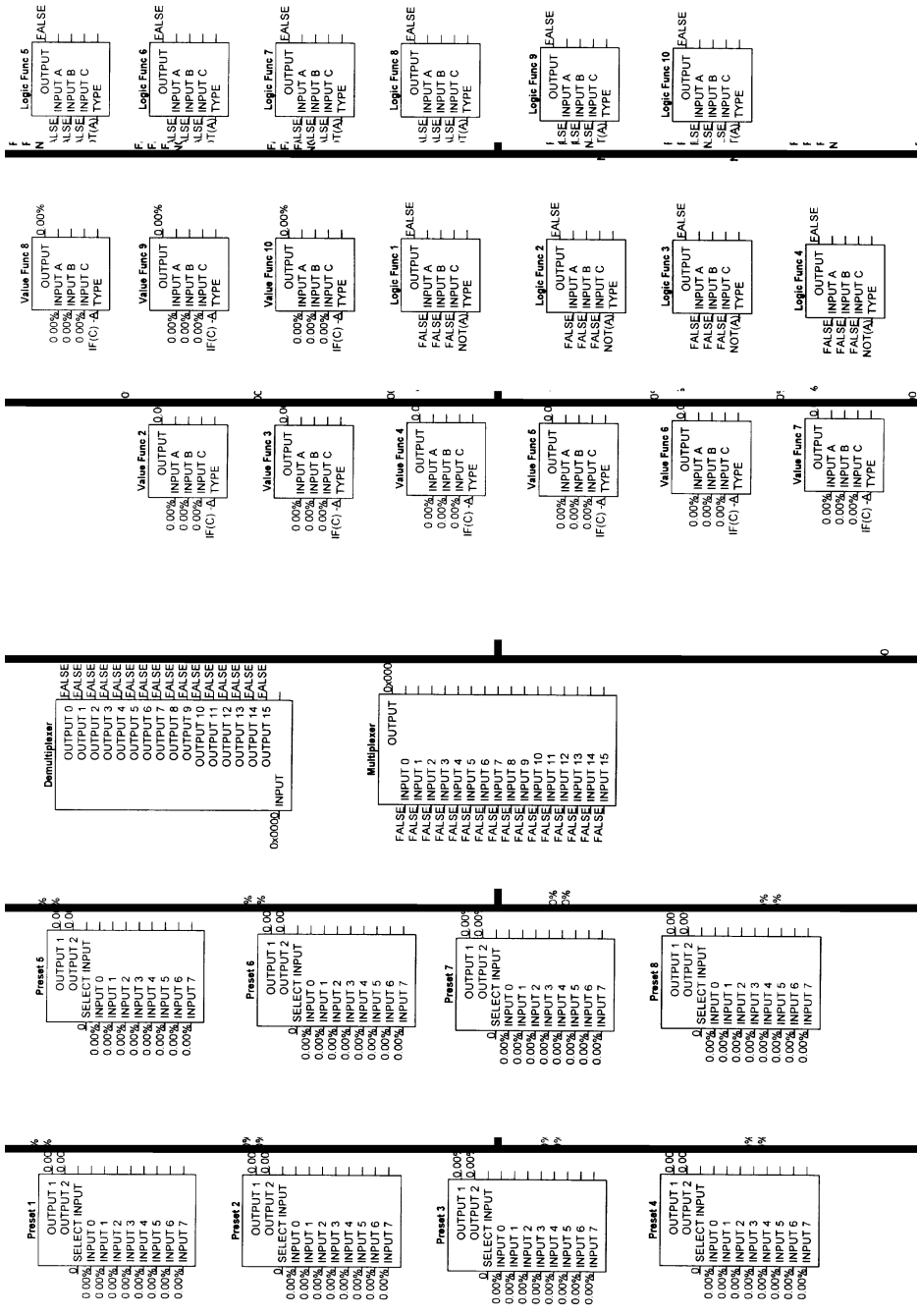

Logic Func 5
Logic Func 6
Logic Func 7
Logic Func 8
Logic Func 9
Logic Func 10
Value Func 8
Value Func 9
Value Func 10
Logic Func 1
Logic Func 2
Logic Func 3
Logic Func 4
Value Func 2
Value Func 3
Value Func 4
Value Func 5
Value Func 6
Value Func 7
Demultiplexer
Multiplexer
Preset 5
Preset 6
Preset 7
Preset 8
Preset 1
Preset 2
Preset 3
Preset 4
OUTPUT
INPUT A
INPUT B
INPUT C
TYPE
SELECT INPUT
OUTPUT 1
OUTPUT 2

Fig. 9.8b: Example for programming with OPTION MM-KIMOVIS-D for MS-DOS

Encoder option module for MM6

Equimpent code	Electrical data	Order-no.
OPTION MM6-ENCODER-RS422	Encoder input	8629.041
OPTION MM6-ENCODER-HTTL	Encoder input	8629.041-100

For further information refer to the Product Manual TMMENCE.

Chapter 10 -APPLICATION NOTES

Page

General

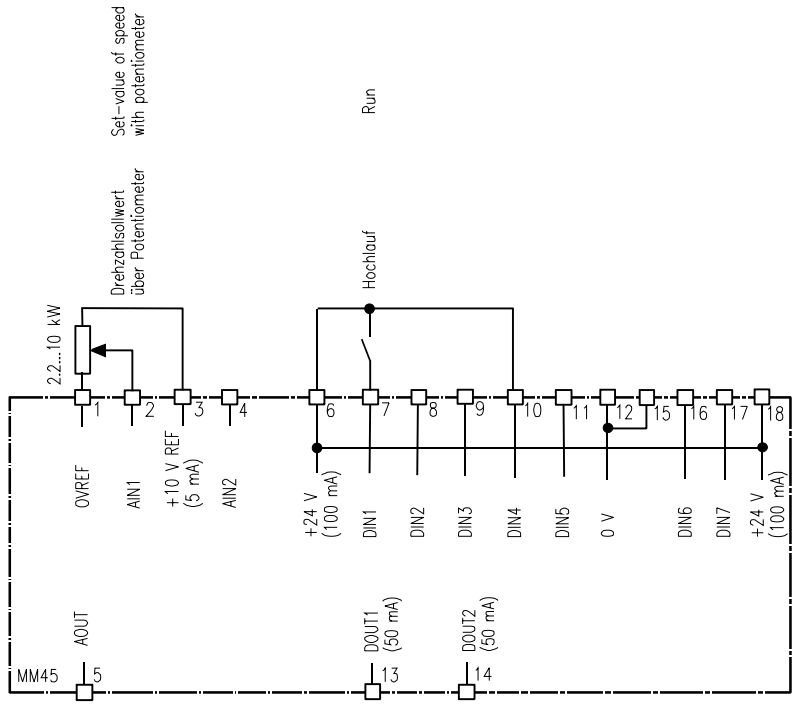
Relays:	Always use gold flash relays, or others designed for low current operation (5 mA), on all control wiring.
Analogue inputs and outputs:	Screened control cable should be used for analogue inputs and outputs. The screen should be connected to earth in the near vacinity of the inverter.
Digital inputs and outputs:	The control cable for digital inputs and outputs should be preferably screened. The screen should be connected to earth at the near vacinity of the inverter and also to earth at the far end.
Cable layout:	Make sure control cables are run separate from power cables.
Service isolator:	With some applications it is necessary or established practice to install an isolator between the inverter and the motor. This isolation should only be switched when the inverter is inhibited. **RECOMMENDATION**: Make use of an isolator with an advanced-timed auxiliary contact connected in the Ext. Trip Circuit. This will interrupt the current before the main isolator contacts open.
Power-factor correction equipment:	All power factor correction equipment must be removed from the motor before the MM456 Frequency Inverter can be used.
Suitable motors:	Motors with a low efficiency or cos ø (power factor) should be avoided since they require a larger kVA rated inverter to produce the correct shaft power. Motors with an installation class F or above are recommended.

EMC considerations

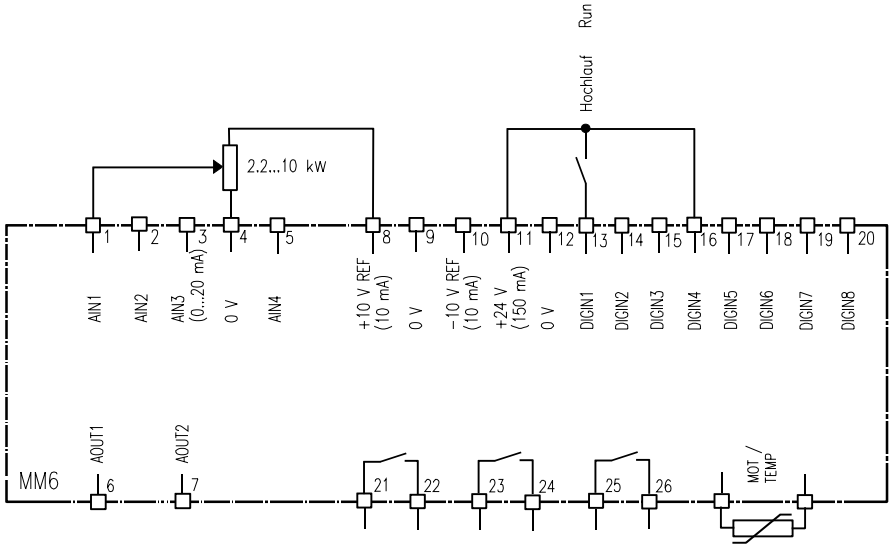
Pay careful attention to the recommendations in Chapter 3 and 7 concerning EMC. Further information is available in the booklet MotorMaster EMC "Does and Don’ts" AF-MM-02.

Minimum connection requirements

The diagram below shows the minimum connection requirements in order to operate the MM456 Frequency Inverter.

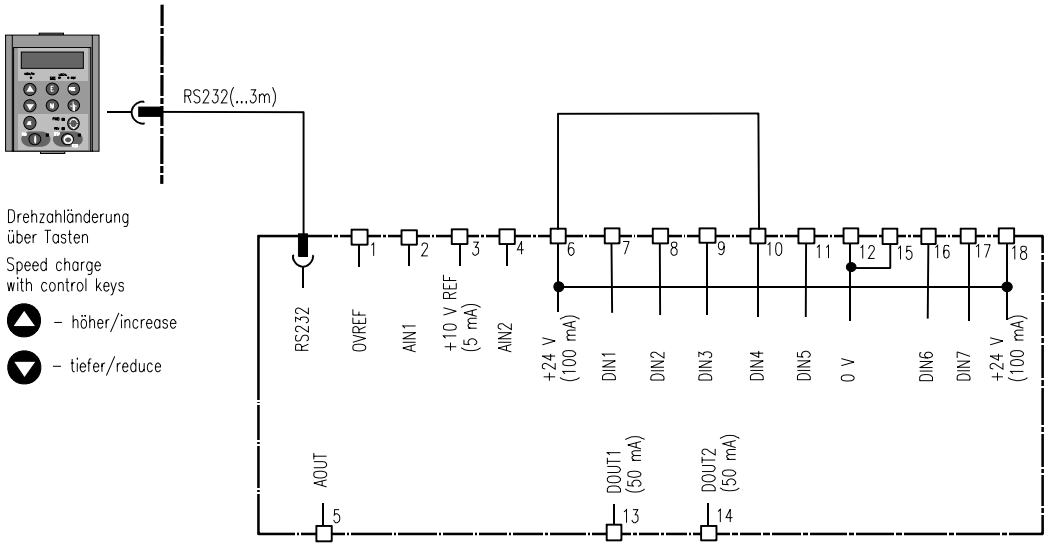


MM45

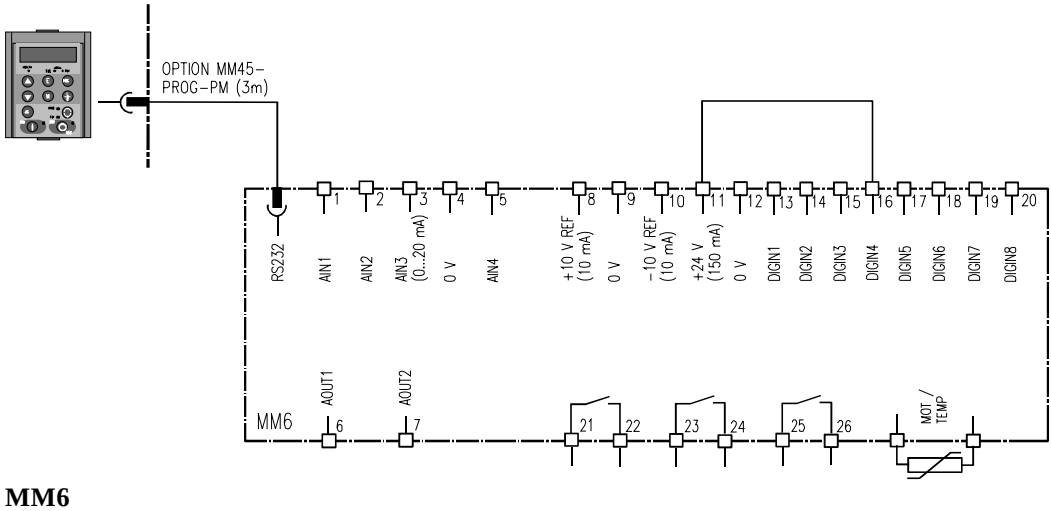


MM6

Fig. 10.1: Minimum connection requirements without Programming Pad with switch and potentiometer (Blank cover with prewired switch and potentiometer is available as OPTION MM-OP)



MM45



MM6

Fig. 10.2: Minimum connection requirements with Programming Pad if LOCAL mode is selected

Brake motors

Brake motors are used in many applications requiring a mechanical brake for safety or other operational reasons. The brake motor is usually one or the two following types:

- Standard induction motor fitted with an externally-fed electromechanical brake. MM456 Frequency Inverters have an integrated brake-control logic which must be set correctly (refer to **Software and Application Manual TMM456/3SV-SAM,** page 28.3-12, **BRAKE CONTROL**).
- Conical brake motors utilize a brake activated by the axial displacement of the squired-cage rotor. With this type of motor, the starting current is relatively high due to the large air gap. Make sure the maximum inverter current is sufficient to pull-in the conical rotor. If in doubt refer to your supplier. It is important to set the **SETUP PARAMETERS**|QUICK SETUP|FIXED BOOST parameter, see page 5-6, to ensure reliable brake release with conical-rotor brake motors.

Synchronous motors with reluctance or permanent magnet rotors

Although intended primarily for use with induction (asynchronous) motors, MM456 Frequency Inverters can also be used for speed control of synchronous motors. Synchronous motors can offer economic solutions in applications where tight control of speed is required together with the low maintenance characteristics of an AC motor.

MM456 frequency inverters are suitable for operation with synchronous motors. The correct setting of the V/f characteristic is essential for the correct operation.

Typical applications are in the glass, textile and man-made fibre industry or for simple positioning applications.

In contrast to induction motors, synchronous motors run at synchronous speed whether on no load or full load. Synchronous speed is set by the frequency of the supply applied to the stator. The stator flux can be kept constant by keeping the stator volts/frequency ratio constant as with an induction motor.

Torque is produced in the motor by a increase in load angle between the stator and rotor fluxes. Maximum torque occurs when the load angle approaches 90°. If the load angle exceeds this value then torque drops and the motor will stall. Systems involving synchronous motors need careful design to ensure that the motor can accelerate the load and handle transient load changes without stalling.

NOTE: Set SETUP PARAMETERS|QUICK SETUP|BASE FREQUENCY to data on motor ratings plate, see page 5-4.

Slip-ring induction motors

There is no particular problem using a MM456 Frequency Inverter with a slip-ring induction motor provided the starting resistors are bridged.

High-speed motors

High speed motors with speed often greater than 15,000 min^{-1} are often used in the wood making and other industries. Special high-frequency motors are required. These high-frequency motors usually have a very low inductance leakage and therefore require a motor choke installed between the inverter and the motor. Please refer to your supplier for advice with such applications.

Pole-change motors

Pole changing during operation is not permissible as high-energy voltage surges occur which can damage the MM3 Frequency Inverter. If pole-changing is required, control circuit to inhibit the inverter for at least 1 s during and following pole-changing must be provided for.

Using line chokes

MM456 frequency inverters are fitted with DC link chokes to limit the ripple current seen by the DC link capacitors and thus increase their working life. Line chokes are therefore not essential.

However line chokes may be used to further reduce the harmonic content of the supply current where this a particular requirement of the application or where greater protection from mains borne transients is required. This and other advantages are:

- High energy voltage transients such as can be caused by switching the steps of capacitor compensation equipment are reduced at the inverter input.
- With short-duration supply interruptions, the charging circuit for the link capacitors of the MM456 Frequency Inverter is not active. A very high charging current can flow with low supply impedance. An excessive charging current can overstress the input rectifier and link capacitors.
- The current harmonics in the d.c. link are reduced which can result in a longer working life of the link capacitors.

See page 8-4 for details on available line chokes.

Using motor chokes

Installations with motor cable runs in excess of 50 m may suffer from nuisance overcurrent trips. This is due to the capacitance of the cable causing current spikes to be drawn from the inverter output. A choke may be fitted in the inverter output which limits the capacitive current. Screened cable has a higher capacitance and may cause problems in shorter runs (typically in excess of 30 m).
See page 8-4 for details on available motor chokes.

Using multiple motors on a single MM456 Frequency Inverter

It is possible to use a single large inverter to supply several smaller motors provided the following is taken into consideration:

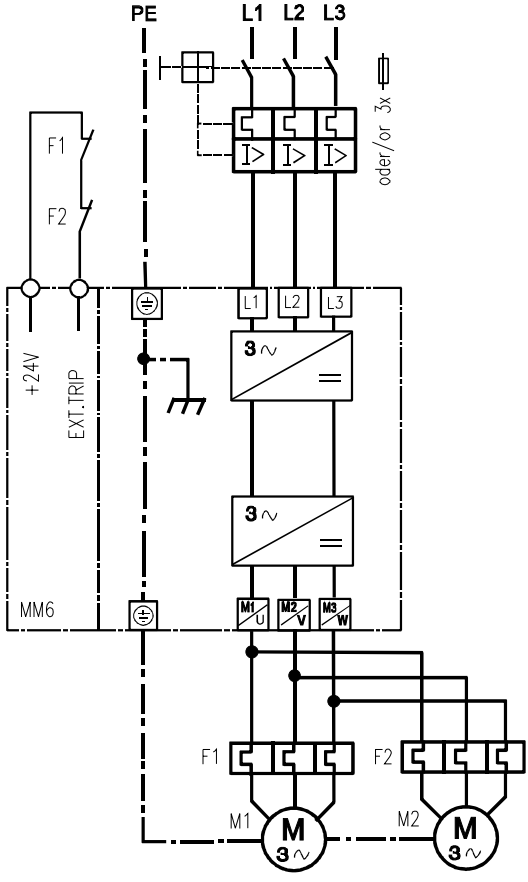


Fig. 10.6: Multiple motors on a single MM456 Frequency Inverter

- The drive must be rated to supply the **total current of all motors**. It is not sufficient to simply sum the power ratings of the motors, since the drive has also to supply the magnetising current for each motor.

  Sensorless vector control is not suitable for multi-motor drives. Make sure that VECTOR ENABLE, see page 5-9, is FALSE.

- Each motor must be overload protected e.g. with thermal overcurrent relays connected in series (EXT. TRIP, TERMINAL 23).

- With installation using motor powers of significally different powers (e.g. 1:3), the smallest motor may have difficulty starting or running at low speed. This due to the relatively high stator resistance which would require a high boost level. Too high boost could cause the larger motor to saturate with a resulting loss in starting torque. A solution to this problem is to increase the frame size of the smaller motors.

- A current-based overload device will not prevent the motor overheating due to inadequate cooling at low speed. Force vented motors may be required. Consult your motor supplier.

- Individual motors may be switched and/or reversed using contactors provided that the peak transient currents do not exceed the maximum inverter current.

CAUTION!

With multiple motor installations the total cable length should not exceed the values given in EMC INSTALLATION INSTRUCTIONS, page 3-9...11.

If in doubt refer to your supplier.

Switching at the inverter output

The use of contactors to disconnect a motor from an inverter operating under load is in principle possible. This method of disconnecting the load should however only be used for infrequent emergency purposes. The use of this method for normal operation would stress the power electronic components and reduce the working life.

The use of contactors in connection with an arrangement to inhibit the inverter at least 50 ms before closing or opening the contractor **is permissible**.

High starting torque

In development

Operation with higher-rating quadratic torque for fans and pumps (HVAC)

The HVAC higher rating for fans and pumps with a quadratic load characteristic has the disadvantage that a much lower overload capability is available. If problems occur the following recommendations should be of assistance:

Problem	Recommendation to overcome problem
Starting torque not sufficient, ***** TRIPPED ***** **I*T TRIP** with trip	Check setting of FULL LOAD CALIB see page 5-5. Setting V/F SHAPE to LINEAR (see page 5-5) will give a high starting torque at the expense of small reduction in efficiency at low speeds. This change is particularly recommended when 'V' belts are used. Increase FIXED BOOST (see page 5-6) as is required while avoiding excessive boost. Also activate SETUP PARAMETERS|**FUNCTION BLOCKS**|**MOTOR CONTROL**|**FLUXING**|**BOOST AUTO** to increase boost during starting. Increase RAMP ACCEL RATE (see page 5-5) to reduce starting-torque requirement to accelerate high inertia loads.
Inverter trips with Alarm ***** TRIPPED ***** **MOTOR STALLED** after several minutes	Motor load is too high, the inverter therefore operates in current limit with reduced frequency. To prevent this Trip increase parameter (see page 28.4-9) increase parameter SETUP PARAMETERS|**FUNCTION BLOCKS**|**TRIPS**|**STALL TRIP**|**STALL LIMIT** to 150.00 %
Heavy duty starting or high ambient temperatures	With applications involving heavy-duty starting (e.g. with high inertia fan) or with a high ambient temperature it is recommended that a MM456 Frequency Inverter rated for the motor power with constant torque is provided for.
Automatic start on connecting power ?	Set parameter SETUP PARAMETERS |**FUNCTION BLOCKS**|**SEQ & REF**|**SEQUENCING LOGIC**|**POWER UP START** to **TRUE**.

NOTE: When using MM456 Frequency Inverter with larger motor for HVAC applications the settings as above should be used. Never forget to **save parameters** after modifying any parameter setting, see page 4-9 and 5-14.

The previous settings for operation with high-rating quadratic load with pumps and fans (HVAC) can also be set with the sets of the Application Software **ASM-K02 - Variable Speed Control of Fans in Ventilation Applications (HVAC)**. Also useful functions such as:

- Operation with preset speeds
- Operation with PID controller are configured and set suitable for most applications are provided for.
- Auto-restart logic preset for operation with pumps and fans.

SETTING UP THE SENSORLESS VECTOR FLUXING MODE

Required motor parameters

Before using the sensorless vector fluxing mode the MM456 Frequency Inverter must be tuned to the motor in use by matching the motor parameters in the Inverter to those of the motor being controlled. The most important motor parameters are:

- Per phase stator resistance
- Per phase leakage inductance
- Per phase mutual (magnetising) inductance

Tuning can be performed by one of the following methods:

- Auto identification of motor parameters using AUTOTUNE
- Entering motor parameters from known equivalent circuit
- Entering motor parameters determined from simple measurements each of which are described in detail in the following.

Before proceeding with one of these methods, the following basic motor parameters must be entered:

- In menu SETUP PARAMETERS | QUICK SETUP:
  BASE FREQUENCY
  FULL LOAD CALIB
  POWER FACTOR
- In menu SETUP PARAMETERS | VECTOR SETUP:
  NAMEPLATE RPM
  MOTOR POLES
  MOTOR VOLTS
  SUPPLY VOLTAGE
  MOTOR CONNECTION

Auto identification of motor parameters using AUTOTUNE

The Autotune feature can be used to identify, modify and store the following parameters:

VECTOR SETUP	STATOR RES LEAKAGE INDUC MUTUAL INDUC
QUICK SETUP	NO LOAD CALIB

The remaining important parameters are preset to a value depending on the overall "power-build as detailed in menu SETUP PARAMETERS | VECTOR SETUP, page 5-9.

Operating the MM456/MM3V Frequency Inverter with the Autotune function block enabled starts the autotune sequence. This is done as follows:

- Select view level **ADVANCED** in MENUS | **VIEW LEVEL**, see page 5-12.
- Select parameter **AUTOTUNE ENABLE** in menu SETUP PARAMETERS | VECTOR SETUP and set to **TRUE**.

- On starting the Inverter, the Autotune sequence is initiated. When complete (after a maximum of 10 seconds), the Inverter is returned to the stopped condition and the parameter **AUTOTUNE ENABLE** is reset to **FALSE**.
- Verify satisfactory vector performance with parameters determined by **AUTOTUNE.**
- Save parameters, see page 4-9/5-14.

Refer to the following for further information on AUTOTUNE:
- Menu VEKTOR SETUP : Page 5-9/10
- Funktion block **AUTOTUNE** Page 28.4-11
  (in **Software and Applikation Manual TMM456/3SV-SAM**)

Entering motor parameters from known equivalent circuit

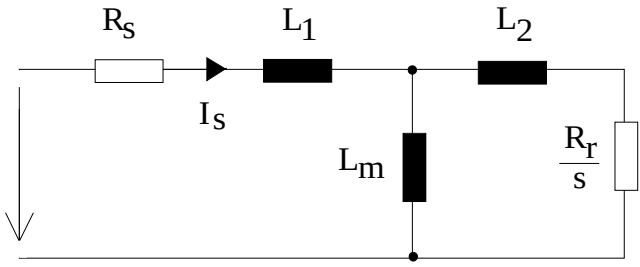


Fig. 10.4: The Motor Equivalent Circuit

Set the following parameters in the menu SETUP PARAMETERS | VECTOR SETUP to values calculated from the motor equivalent circuit as follows:

- STATOR RES = R_3 [Ohms]
- LEAKAGE INDUC = $(L_1 + L_m) - \frac{(L_m)^2}{(L_2 + L_m)}$ [mH]
- MUTUAL INDUC = $\frac{(L_m)^2}{(L_2 + L_m)}$ [mH]

Save parameters when all motor parameters have been entered, see page 4-9/5-14.

Entering motor parameters from simple measurement

Measure and enter motor parameters using the following procedure:

- Disable Vector operation by selecting parameter VECTOR ENABLE in menu SETUP PARAMETERS | VECTOR SETUP and setting to FALSE (if not already disabled).
- Run MM456 Frequency Inverter at base frequency (usually 50.0 Hz) with the motor connected without a load. Measure the motor current by observing the parameter MOTOR CURRENT in the OPERATOR MENU or DIAGNOSTICS menues. Set the parameter NO LOAD CALIB in the menu SETUP PARAMETERS | QUICK SETUP to this measured value.

- Re-enable vector operation by selecting parameter VECTOR ENABLE in menu SETUP PARAMETERS | VECTOR SETUP and setting to TRUE.
- Run MM456/MM3SV Frequency Inverter at approx. 50.0 Hz with the unloaded motor still connected. Trimm the parameter STATOR RES in the menu SETUP PARAMETERS | VECTOR SETUP until the diagnostic parameter FIELD in the same menu shows approx. 70.0...80.0 %.

The following alternative method may also be used to provide a more accurate value of parameter STATOR RES:

- Set parameter STATOR RES in menu SETUP PARAMETERS | VECTOR SETUP to 0.0 Ohm and power up motor at zero speed.
- Measure the effective motor voltage by observing the parameter **BOOST** in menu SETUP PARAMETERS | **FUNCTION BLOCKS** | **MOTOR CONTROL** | **PATTERN GEN**. Calculate a new value of the parameter STATOR RES as follows and enter this value:

  Star connection of Motor: STATOR RES: $\frac{\text{BOOST}}{\sqrt{3}\,\text{NO LOAD CALIB}}$

  Delta connection of Motor: STATOR RES: $\frac{\sqrt{3}\,\text{BOOST}}{\text{NO LOAD CALIB}}$

- Set parameter LEAKAGE INDUC in the menu SETUP PARAMETERS | VECTOR SETUP to 0.0 mH and run again at the base frequency (usually 50.0 Hz) with the unloaded motor still connected. Trimm the parameter MUTUAL INDUCT until the parameter FIELD in the same menu shows approx. 100.0 %. Use this set value of MUTUAL INDUCT to determine the find values of the inductance parameters:
  - Enter 20 % of set MUTUAL INDUCT to LEAKAGE INDUC
  - Enter 80 % of set MUTUAL INDUC to final value of MUTUAL INDUC

Save parameters, see page 4-9/5-14.

IMPORTANT: Remember to save the parameter settings.

Chapter 11 - APPLICATION MACROS

Page

GENERAL ABOUT APPLICATION MACROS

The MM456 Frequency Inverter is supplied for integrated application Macros which preset (load the default values and software links) the MM456 Frequency Inverter for a particular function when loaded:

- MACRO 1 corresponds to the factory default setting providing for basic speed control.
- MACRO 2 is almost identical to MACRO 1 except the default values and software links for separate "run forward" and "run reverse" commands are loaded.
- MACRO 3 loads the software links for a motor potentiometer function with "Raise", "Lower" and "Preset" function used as a ± 10 % trimm which is added to the sum of the analog inputs.
- MACRO 4 loads the software links for a PID controller operation.
- MACRO 5 loads the software links for selectable preset speeds (MM45: 4 preset speeds, MM6: 8 preset speeds).
- MACRO 6 loads the software links for closed-loop Speed control using an incremental encoder.
- MACRO 0 removes all links and sets all parameters to their default values. This macro is for programming purposes only. A motor cannot be controlled until appropriate links are programmed.

For instruction on loading the macros please refer to **Restoring default values and loading application MACROS**, page 5-15.

There is a special short cut for selectionof the factory default setting (MACRO 1), see **User reset to factory default setting**, page 4-7.

APPLICATIONS MACRO 1

Use of MACRO 1

MACRO 1 is the standard application Macro which sets the defaults and software links to the factory default setting. All descriptions in this Product Manual are based on this setting.

Block diagrams

The **General wiring diagram of control circuit** is Fig. 2.2 on page 2-4
The **Functional Block Diagram** is Fig. 2.3 on page 2-6.
The **Application functional block diagram** with software links as in MACRO 1 (default supply condition) is Fig. 2.4 on page 2-7.

Operator menu

See page 5-2/3

Terminal allocation

See page 2-9/11.

APPLICATIONS MACRO 2 - Run, reverse commands

Use of MACRO 2

The only differenz between MACRO 2 and the factory preset default values is the separate "run forward" and "run reverse" commands. This results in a slight different terminal arrangement.

Block diagrams MACRO 2

The **General wiring diagram of MACRO 2** is Fig. 11.2a on page 11-4
The **Functional block diagram of MACRO 2** is Fig. 11.2b on page 11-4.
The **Application functional block diagram of MACRO 2** with software links as in MACRO 2 (default supply condition) is Fig. 11.3c on page 11-5.

Operator menu MACRO 2

See page 5-2/3

Terminal allocation MACRO 2

Terminal MM45	Terminal MM6	Designation	Signal, function	Explanation
1 : 6	1 : 12	AIN1 : 0 V	MM45: see page 2-9/10 MM6: see page 2-11	MM45: page 2-9/10 MM6: page 2-11
7	13	DIN1	Configurable digital input used here for "Run forwards": +24V = Run foward 0V = Stop (or reverse, see DIN 2)	- Stopping as set in **RUN STOP MODE** (see page 5-7)
8	14	DIN2	Configurable digital input used here for "Run reverse": +24V = Run reverse 0V = Stop (or forward, see DIN 1)	
9	15	DIN3	Configurable digital input used here to reset trips: +24V = Reset 0V = Normal	- Edge triggered
10 : 18	16 : 26	DIN4 : DOUT2/ DOUT3-B	MM45: see page 2-10 MM6: see page 2-11	MM45: page 2-9/10 MM6: page 2-11

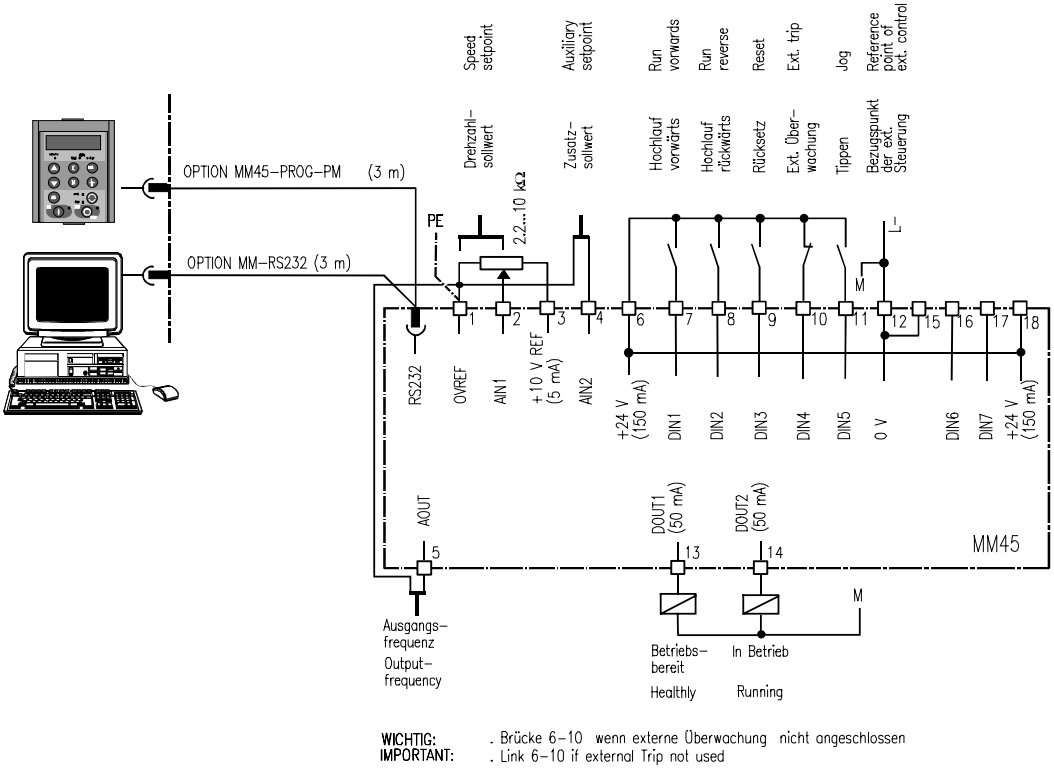


Fig. 11.2a: General wiring diagram of MACRO 2 (terminal numbers valid with MM45)

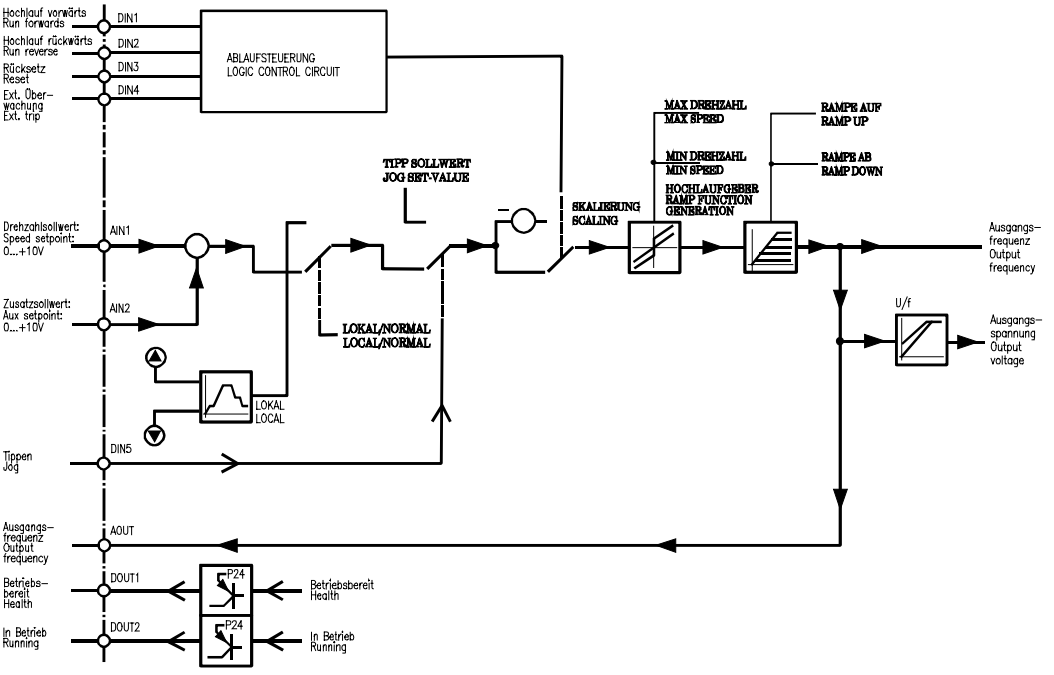


Fig. 11.2b: Functional block diagramm of MACRO 2
(Digital outputs with MM45, MM6 has relay outputs)

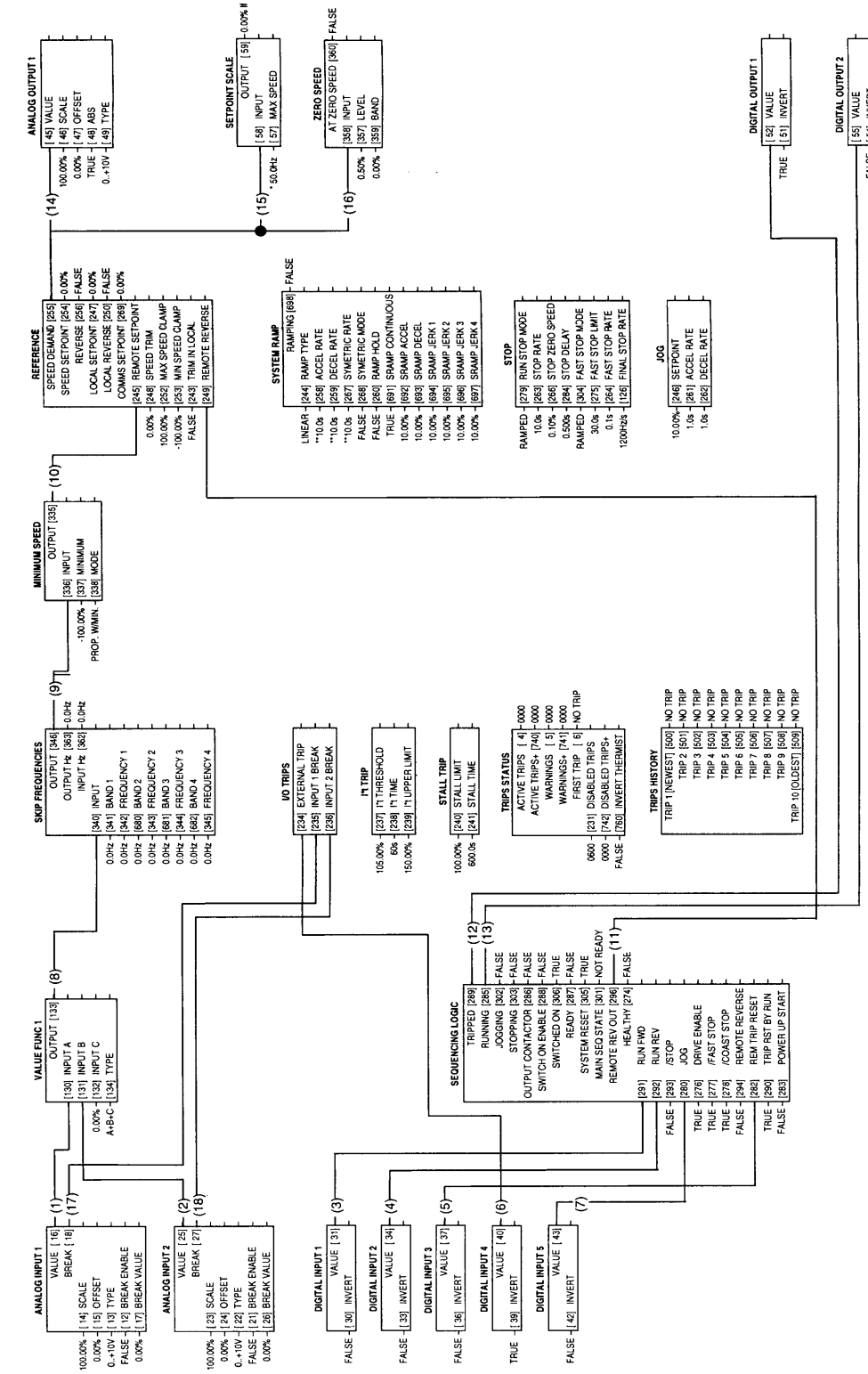


Fig. 11.2c: Application Functional block diagramm with software links as in MACRO 2

APPLICATION MACRO 3 - Motorpotentiometer

Use of MACRO 3

MACRO 3 provides motorpotentiometer-like a raise/lower (push button) interface as an additional Setpoint Trim. The Setpoint is derived from the sum of **ANALOG INPUT 1** (AIN1, terminal 2)**, ANALOG INPUT 2** (AIN2, terminal 4) and the output of the raise/lower ramp. This ramp is controlled by the 3 digital inputs **RAISE INPUT** (connected to DIN2, terminal 8), **LOWER INPUT** (connected to DIN3, terminal 9) and **RL RESET** (connected to DIN5, terminal 11) of the **RAISE/LOWER** function block.

The raise/lower trim is restricted to be ±10.00 %. This limit is set by the **RL MIN VALUE** and **RL MAX VALUE** parameters in the **RAISE/LOWER** function block.

Note that the raise/lower ramp output is automatically preserved in non-voltatile memory during a power-down.

Block diagrams MACRO 3

The **General wiring diagram of MACRO 3** is Fig. 11.3a on page 11-7
The **Functional block diagram of MACRO 3** is Fig. 11.3b on page 11-7.
The **Application functional block diagram of MACRO 3** with software links as in MACRO 3 (default supply condition) is Fig. 11.3c on page 11-8.

Operator menu MACRO 3

See page 5-2/3

Terminal allocation MACRO 3

Terminal MM45	Terminal MM6	Designation	Signal, function	Explanation
1 : 6	1 : 12	AIN1 : 0 V	MM45: see page 2-9/10 MM6: see page 2-11	MM45: page 2-9/10 MM6: page 2-11
7	13	DIN1	Configurable digital input, usually used as command "Run", for starting and stopping the drive: +24 V = Run 0 V = Stop	- Stopping as set in **RUN STOP MODE** (see page 5-7)
8	14	DIN2	Configurable digital input used here for "Raise": +24 V = Raise 0 V = No action	
9	15	DIN3	Configurable digital input used here for "Low": +24 V = Lower 0 V = No action	
10	16	DIN4	MM45: see page 2-9/10 MM6: see page 2-11	MM45: page 2-9/10 MM6: page 2-11
11	17	DIN5	Configurable digital input, usually used to reset motor potentiometer to **RL RESET VALUE**: +24 V = Reset to **RL RESET VALUE** 0 V = Normal	
12 : 18	16 : 26	DIN6 : DOUT2/ DOUT3-B	MM45: see page 2-10 MM6: see page 2-11	MM45: page 2-9/10 MM6: page 2-11

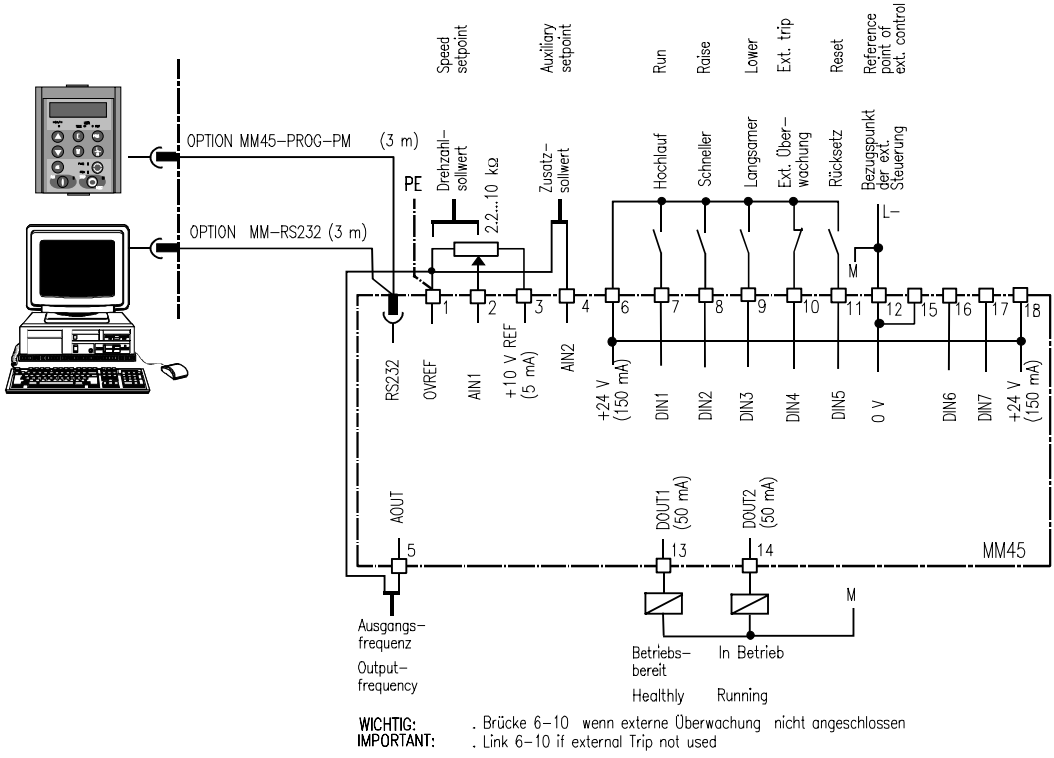


Fig. 11.3a: General wiring diagram of MAKRO 3 (Terminal numbers valid for MM45)

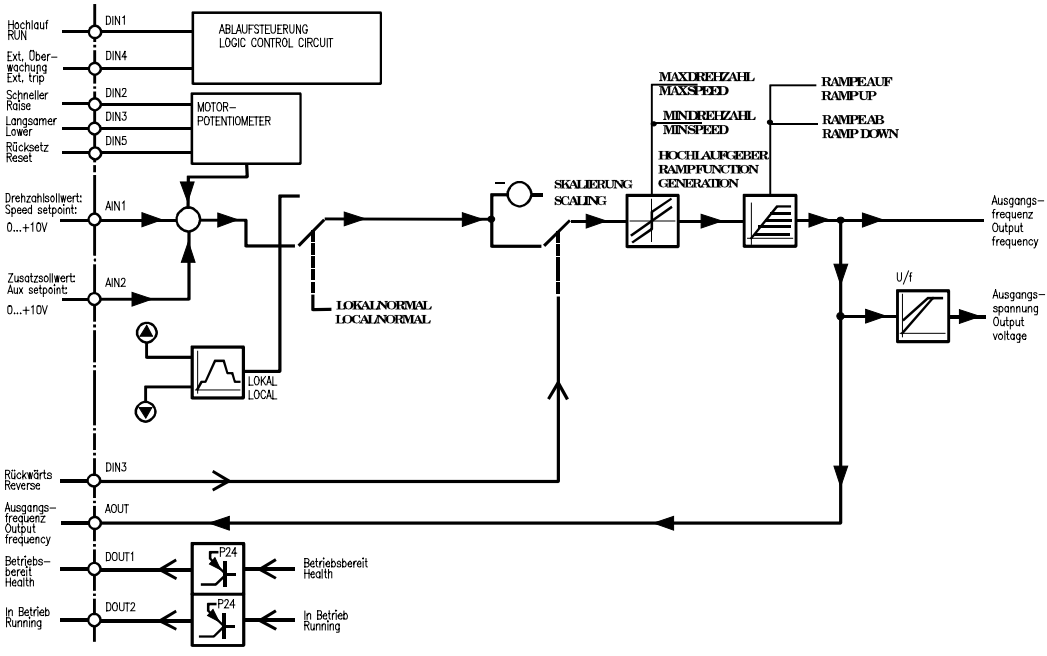


Fig. 11.3b: Functional block diagram of MAKRO 3
(Digital outputs with MM45, MM6 has relay outputs)

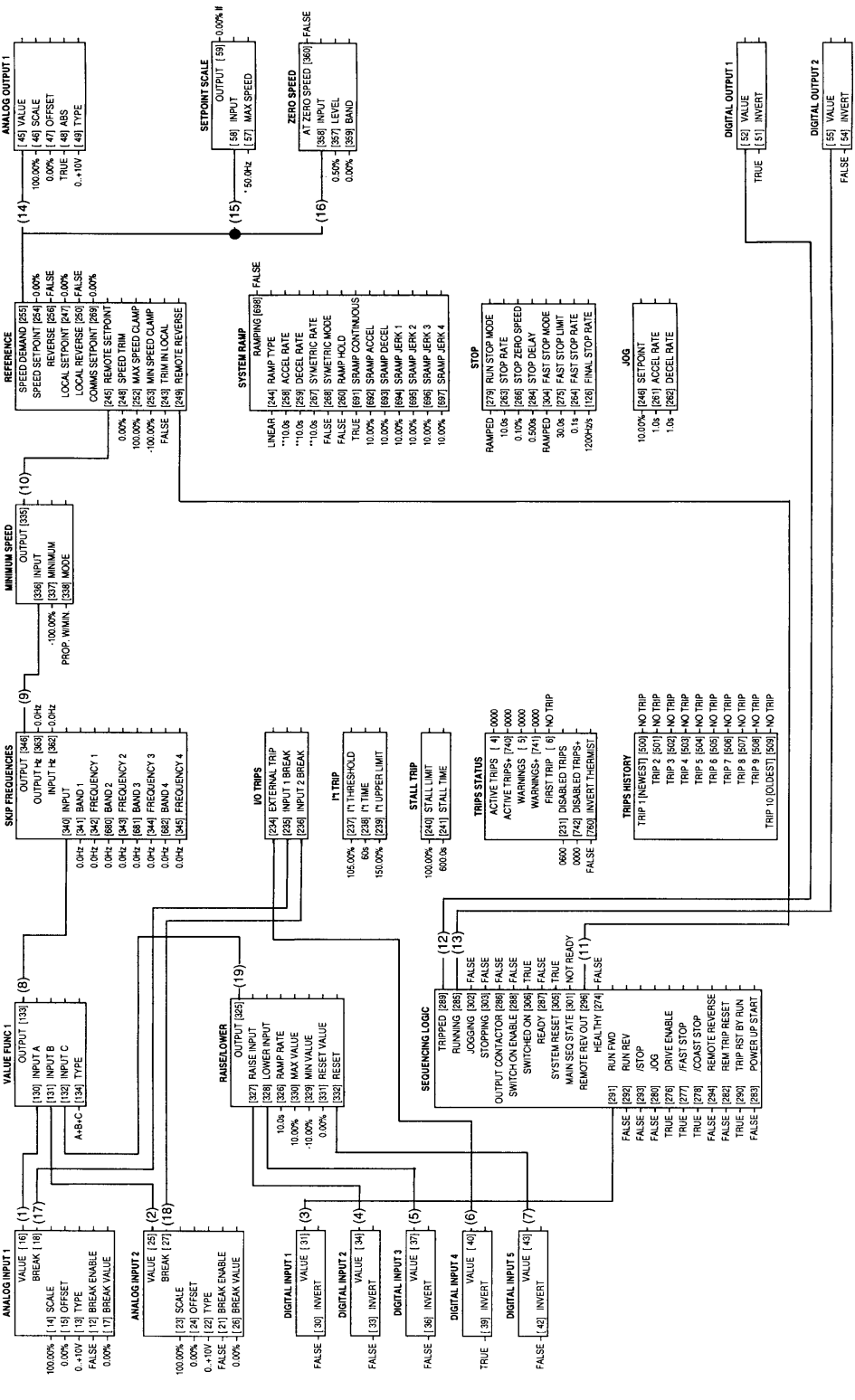


Fig. 11.3c: Application Functional block diagramm with software links as in MAKRO 3

APPLICATION MACRO 4 - PID process control

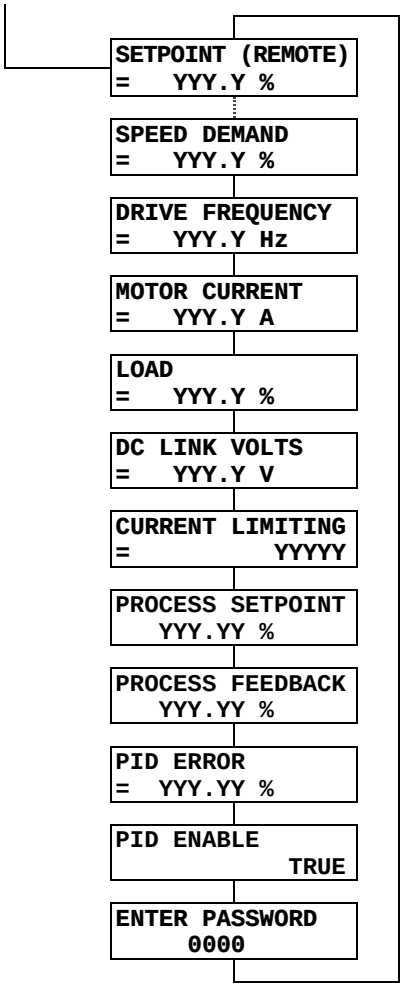
Use of MACRO 4

MACRO 4 loads the software links for a preset PID controller operation.

Block diagrams MACRO 4

The **General wiring diagram of MACRO 4** is Fig. 11.4a on page 11-11
The **Functional block diagram of MACRO 4** is Fig. 11.4b on page 11-11.
The **Application functional block diagram of MACRO 4** with software links as in MACRO 4 (default supply condition) is Fig. 11.4c on page 11-12.

Operator menu MACRO 4



See page 5-2

See page 5-3

See page 5-3

See page 5-3

See page 5-3

See page 5-3

See page 5-3

CUSTOMER SCREEN 1 used for this MACRO, see page 28.6-7

CUSTOMER SCREEN 2 used for this MACRO, see page 28.6-7

See page 28.3-10

See page 28.3-10

See page 5-3

Terminal allocation MACRO 4

Terminal MM45	Terminal MM6	Designation	Signal, function	Explanation
1	-	0 V REF	Zero volt reference for analog signals or current loop connection	- Do not use for other purposes!!
2	1	AIN1	Configurable analog input in the range `0...+10 V, +2...+10 V, 0...+5 V, +1...+5 V, -10..+10 V, 0...20 mA, 4...20 mA, 20...4 mA, 20...0 mA` used here as process setpoint.	- As set by the DIL switch **`ANIN 1`**|**`AIN 1 TYPE`** (see page 5-8) - **`MAX`** and **`MIN SPEED`** see page 5-4 - Input impedance = 94 kΩ.
3	-	+10 V REF	see page 2-9	
4	2	AIN2	Configurable analog input in the range `0...+10 V, +2...+10 V, 0...+5 V, +1...+5 V, -10..+10 V, 0...20 mA, 4...20 mA, 20...4 mA, 20...0 mA` used here as process feedback, otherwise as AIN1	- As `AIN 1`
5 : 10	3 : 16	AIN3 : DIN4	MM45: see page 2-10 MM6: see page 2-11/12	MM45: page 2-10 MM6: page 2-11/12
11	17	DIN5	Configurable digital input, used here to enable the PID controller: +24 V = Enable 0 V = Inhibit	
12 : 18	18 : 26	DIN6 : DOUT2/ DOUT3-B	MM45: see page 2-10 MM6: see page 2-12	MM45: page 2-10 MM6: page 2-12

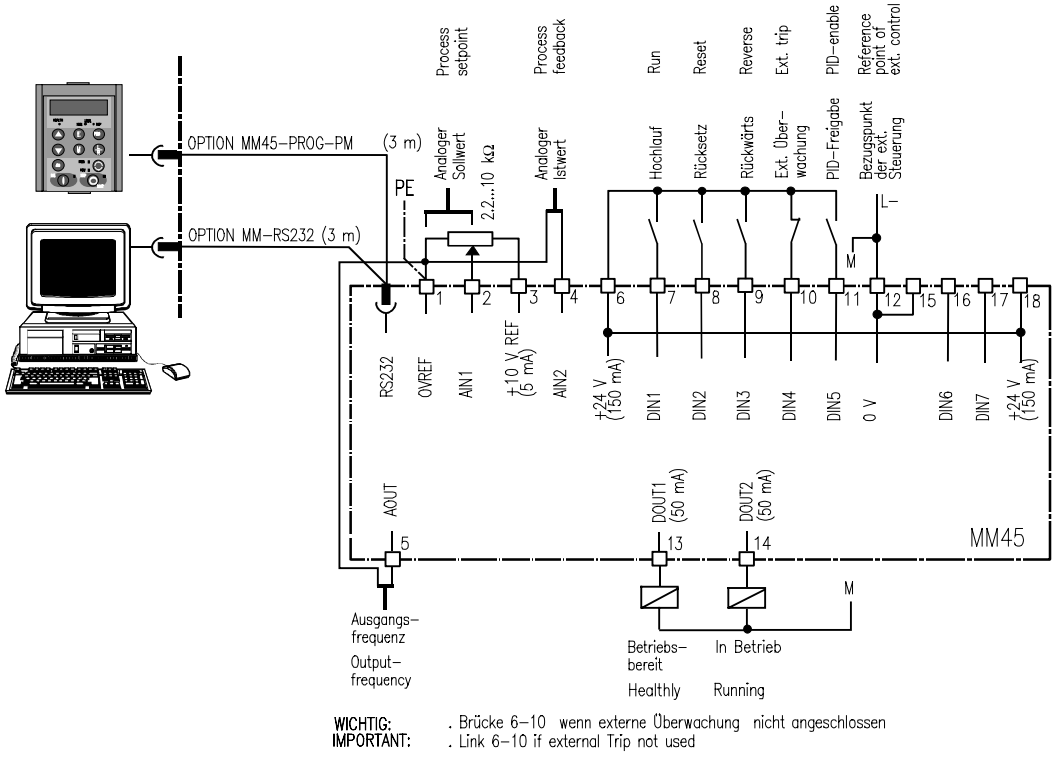


Fig. 11.4a: General wiring diagram of MAKRO 4 (Terminal numbers valid for MM45)

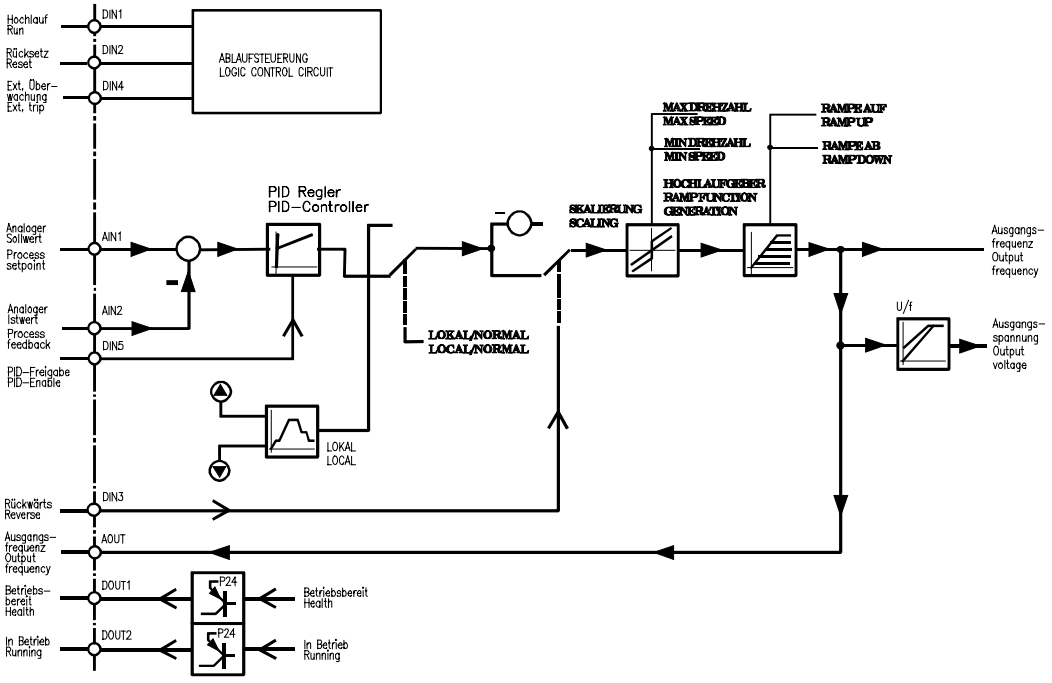


Fig. 11.4b: Functional block diagramm of MAKRO 4
(Digital outputs with MM45, MM6 has relay outputs)

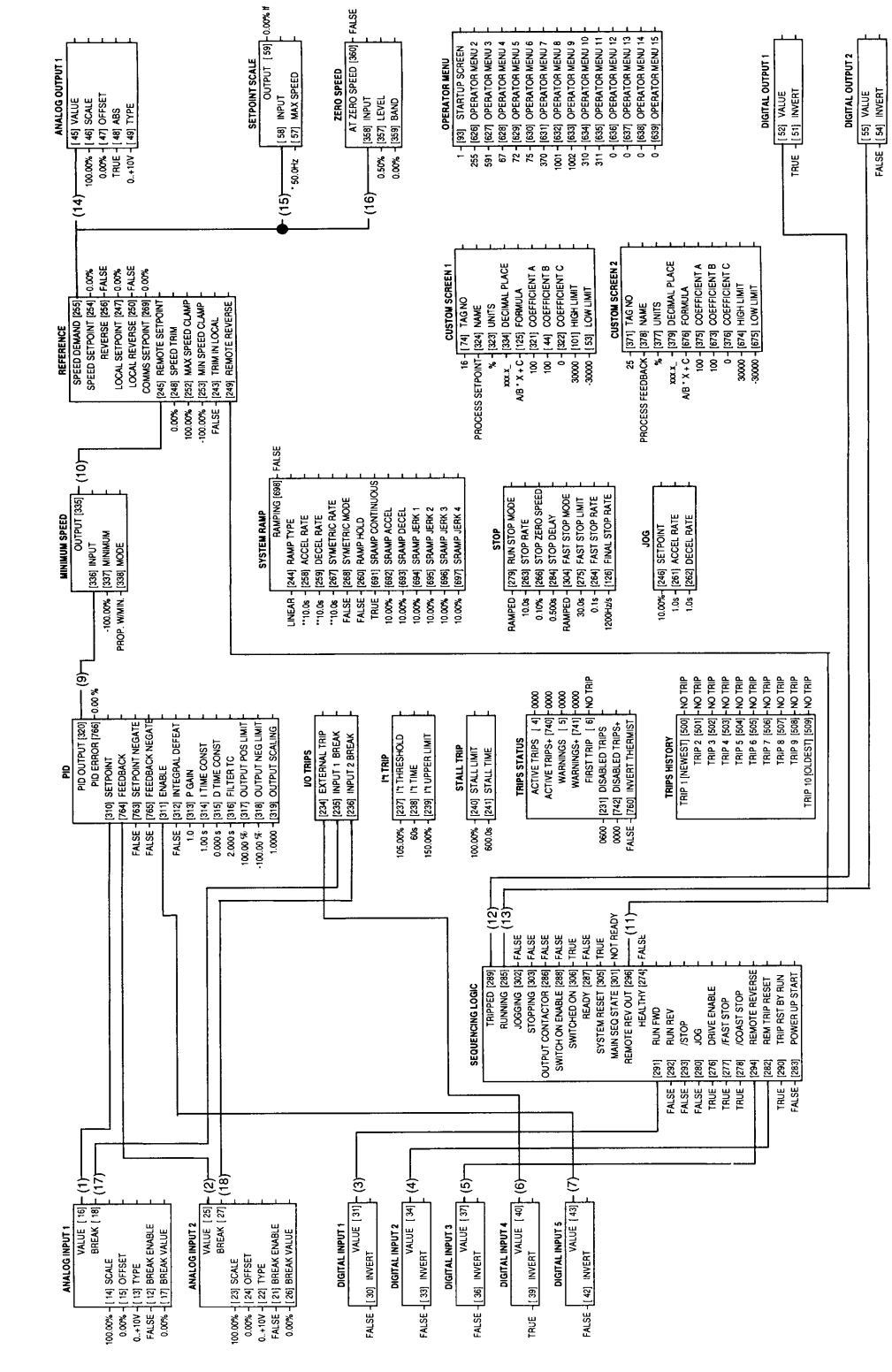


Fig. 11.4c: Application Functional block diagramm with software links as in MAKRO 4

APPLICATION MACRO 5 - Selectable preset speeds

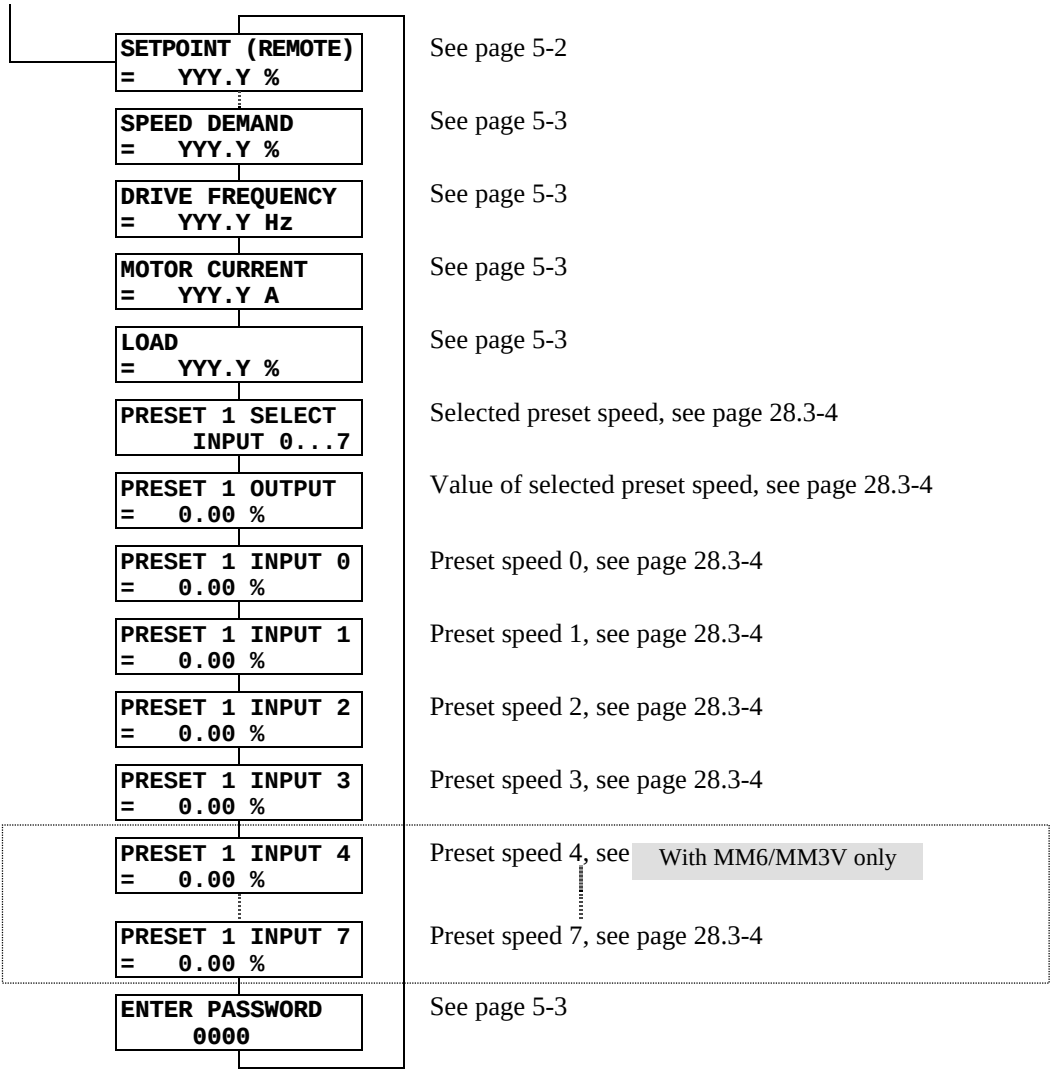
Use of MACRO 5

MACRO 5 loads the software links for selectable preset speeds (4 with MM45, 8 with MM6).

Block diagrams MACRO 5

The **General wiring diagram of MACRO 5** is Fig. 11.5a on page 11-11
The **Functional block diagram of MACRO 5** is Fig. 11.5b on page 11-11.
The **Application functional block diagram of MACRO 5** with software links as in MACRO 5 (default supply condition) is Fig. 11.5c on page 11-12.

Operator menu MACRO 5



Terminal allocation MACRO 5

Terminal MM45	Terminal MM6	Designation	Signal, function	Explanation
1 : 15	1 : 17	AIN1 : DIN5	MM45: see page 2-9/10 MM6: see page 2-11/12	MM45: page 2-9/10 MM6: page 2-11
16	18	DIN6	Configurable digital input used as preset select: +24 V = active 0 V = not active	MM45 and MM6
17	19	DIN7	Configurable digital input used as preset select: +24 V = active 0 V = not active	
	20	DIN8	Configurable digital input used as preset select: +24 V = active 0 V = not active	MM6 only
18	21 : 26	DOUT1(-A) : DOUT3(-B)	MM45: see page 2-10 MM6: see page 2-12	MM45: page 2-10 MM6: page 2-12

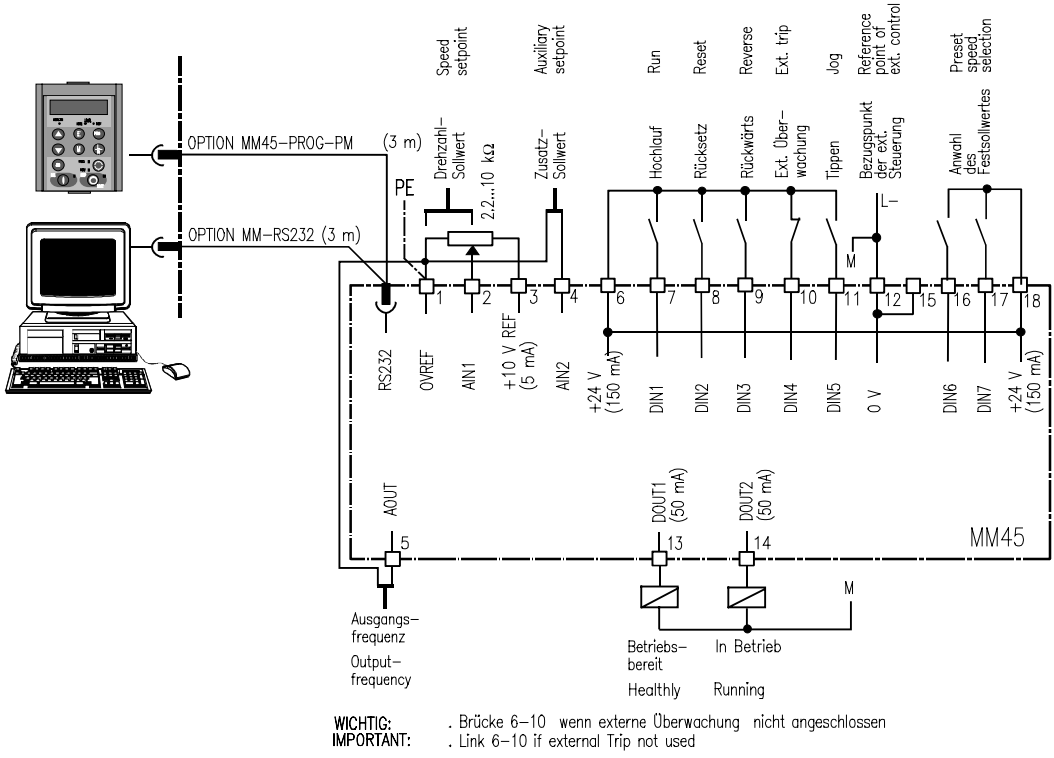


Fig. 11.5a: General wiring diagram of MAKRO 5 (Terminal numbers valid for MM45)

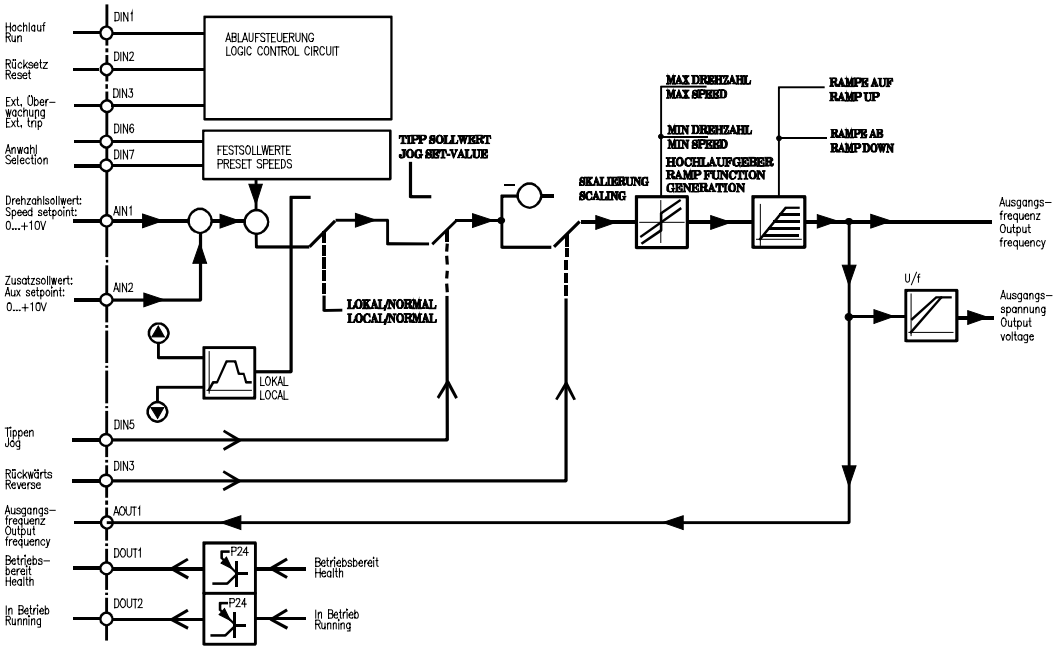


Fig. 11.5b: Functional block diagramm of MAKRO 5
(Digital outputs as with MM45, MM6 has relay outputs)

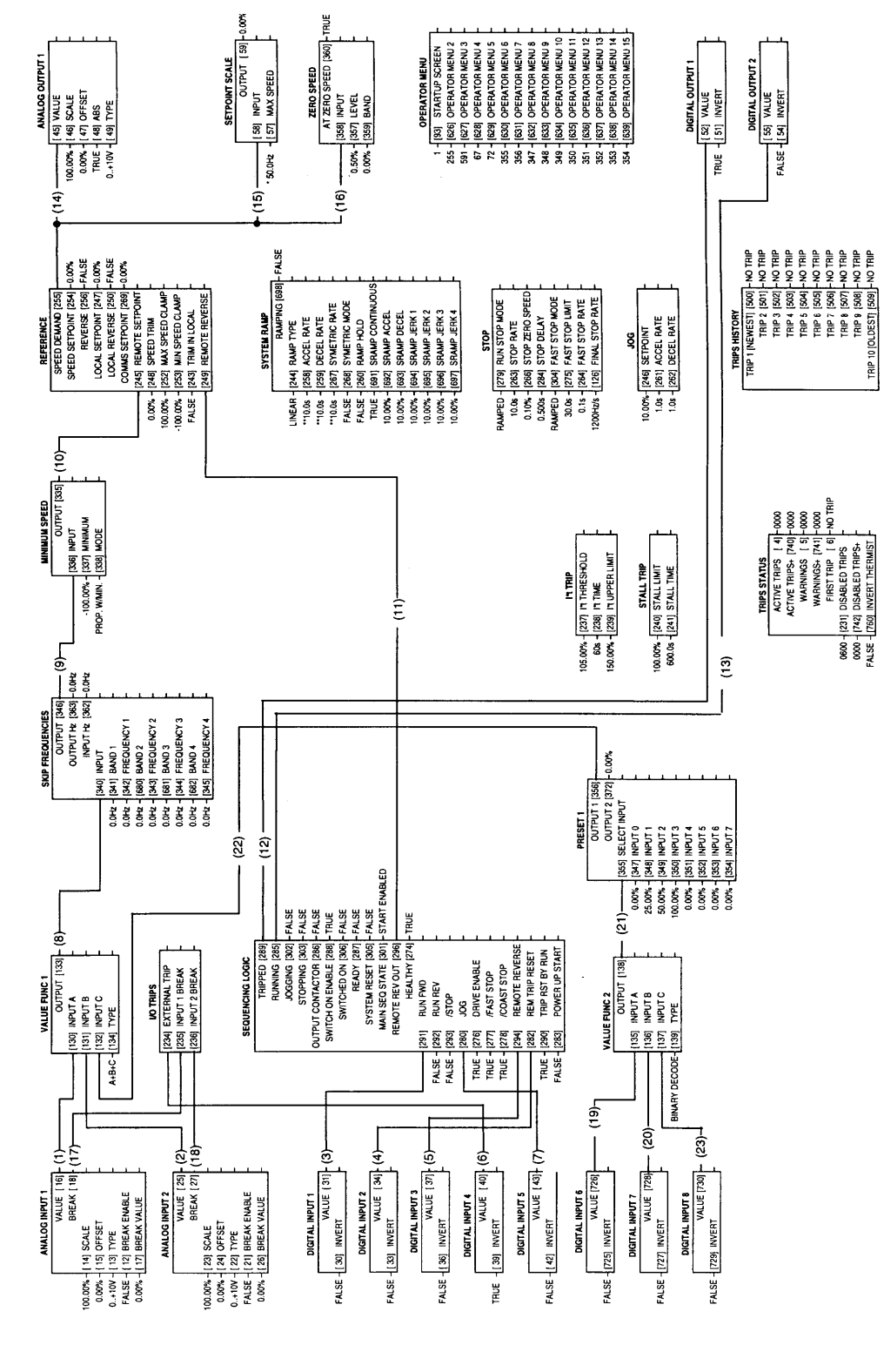


Fig. 11.5c: Application Functional block diagramm with software links as in MAKRO 5

APPLICATION MACRO 6 - Closed-loop speed control

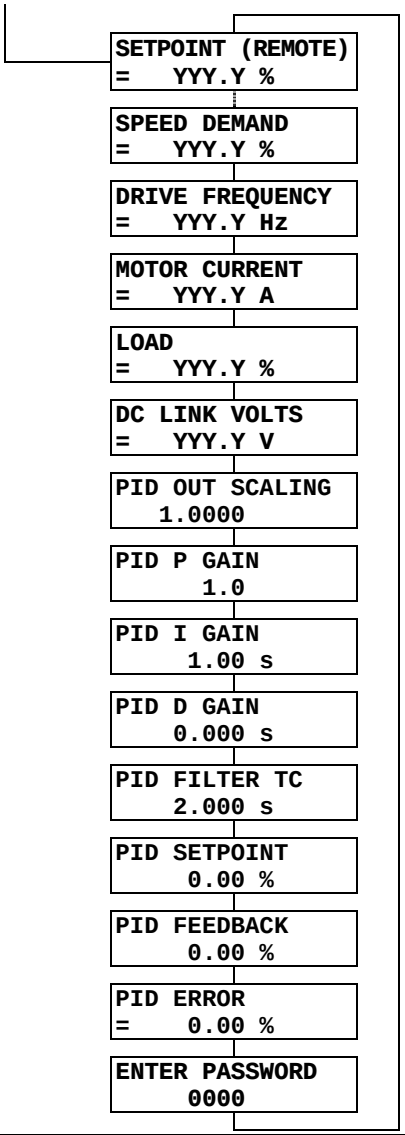
Use of MACRO 6

MACRO 6 loads the software links for a closed-loop speed control with an incrementel encoder.

Block diagrams MACRO 6

The **General wiring diagram of MACRO 6** is Fig. 11.6a on page 11-11
The **Functional block diagram of MACRO 6** is Fig. 11.6b on page 11-11.
The **Application functional block diagram of MACRO 6** with software links as in MACRO 6 (default supply condition) is Fig. 11.6c on page 11-12.

Operator menu MACRO 6



Terminal allocation MACRO 6

Terminal MM45	Terminal MM6	Designation	Signal, function	Explanation
1	-	0 V REF	Zero volt reference for analog signals or current loop connection	- Do not use for other purposes!!
2	1	AIN1	Configurable analog input in the range `0...+10 V, +2...+10 V, 0...+5 V, +1...+5 V, -10..+10 V, 0...20 mA, 4...20 mA, 20...4 mA, 20...0 mA` here as speed setpoint: +10 V = **MAX SPEED** forward 0 V = **MIN SPEED**	- As set by the DIL switch **ANIN 1|AIN 1 TYPE** (see page 5-8) - **MAX** and **MIN SPEED** see page 5-4 - Input impedance = 94 kΩ.
3 : 10	1 : 16		MM45: see page 2-9/10 MM6: see page 2-11/12	MM45: Page 2-9/10 MM6: Page 2-11/12
11	17	DIN5	Configurable digital input used as PID controller: +24 V = active 0 V = not active	see page e 11-10
12 : 18	18 : 26		MM45: see page 2-10 MM6: see page 2-12	MM45: Page 2-10 MM6: Page 2-12

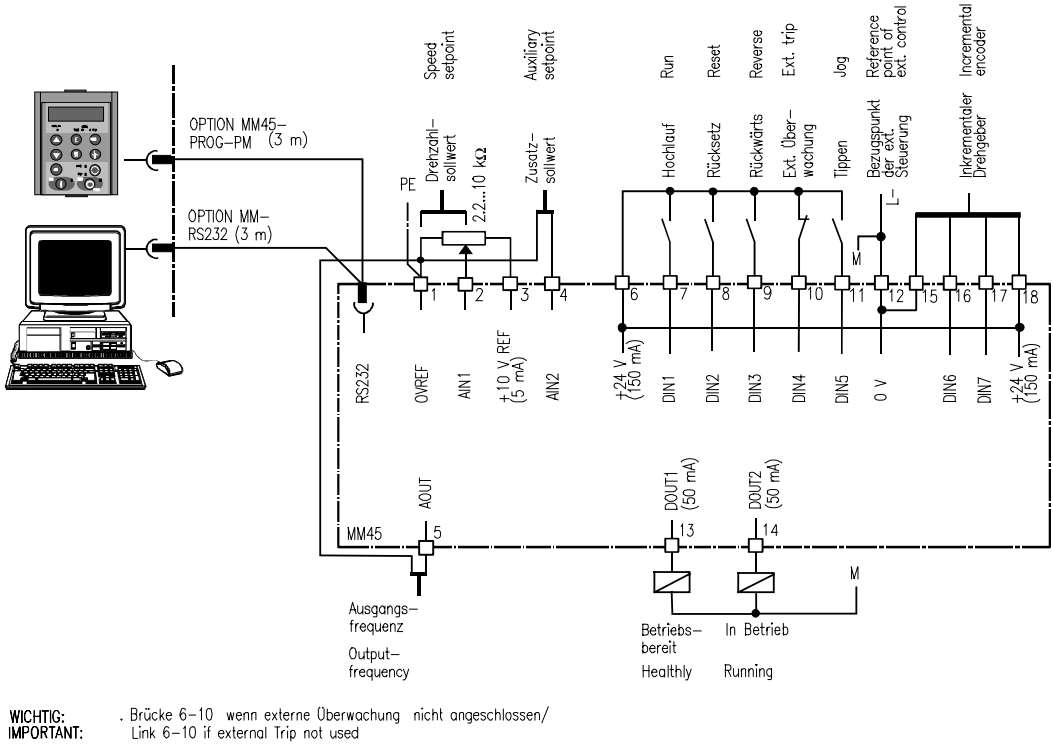


Fig. 11.6a: General wiring diagram of MAKRO 6 (Terminal numbers valid for MM45)

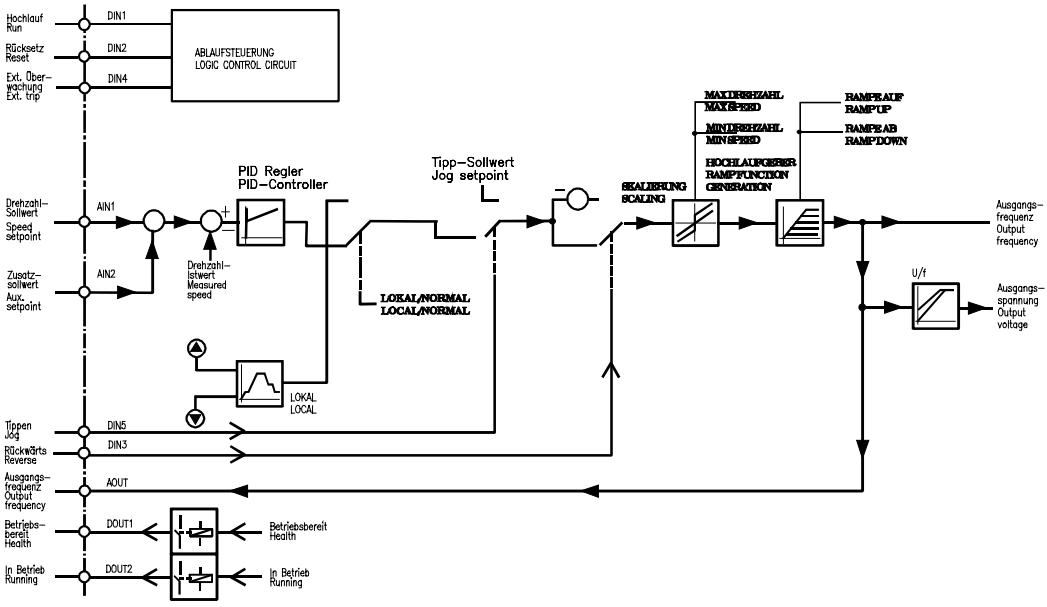


Fig. 11.6b: Functional block diagramm of MAKRO 6
(Digital outputs as with MM45, MM6 has relay outputs)

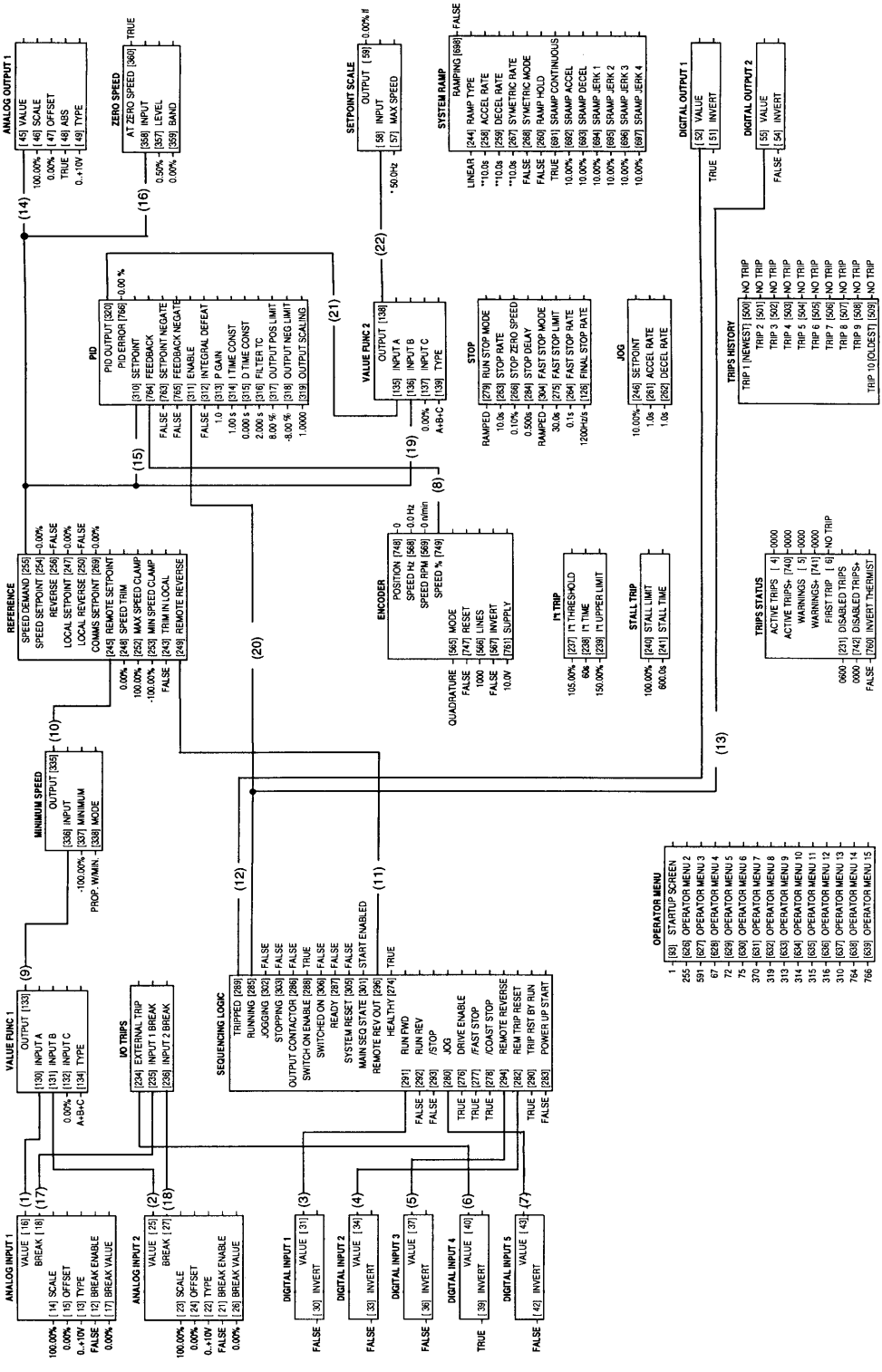


Fig. 11.6c: Application Functional block diagramm with software links as in MAKRO 6

Chapter 12 - APPENDICES

NOTE: These MM456 Frequency Inverters have a non-standard voltage range. Please enquire about delivery.

DATA MM407-3...440-3 FOR OPERATION WITH 3AC 230 V

	Product code	MM407-3-EMC	MM415-3-EMC
	Supply voltage:	3AC 230 V ±15 %	50...60 Hz ±5 Hz
Operation with constant torque (CT)			
♦ Typical applications:	Motor power	0.75 kW	1.5 kW
- Machinery	Motor current	4.0 A	7.0 A
- Transport technology	Motor cable Europe [5]	1 mm^2	1 mm^2
- Long-travel and hoisting	Motor cable North America [6]	14 AWG	14 AWG
	Approx. losses 6 kHz	46 W	81 W
♦ Overload capability:	Switching frequency	3/6/9 kHz	3/6/9 kHz
150 % I_n / 60 s	Supply current	5.0 A	9.0 A
	Supply fuse / Circuit breaker [1]	8 A	10 A
	Supply cable Europe [5]	1 mm^2	1/1.5 mm^2
	Supply cable North America [6]	14 AWG	14 AWG
	Earth leakage current	>10 mA	>10 mA
	Fuse for UL compliance [2]	10 A [1]	10 A [1]
Operation with quadratic torque at higher power (HVAC)			
♦ Main applications:	Motor power	1.1 kW [4]	2.2 kW [4]
- Pumps	P_{shaft} typical 2-pole	1.0 kW	1.9 kW
- Fan	P_{shaft} typical 4-pole	0.9 kW	1.4 kW
	Max. current	4.0 A	7.0 A
	Motor cable Europe [5]	1 mm^2	1 mm^2
	Motor cable North America [6]	14 AWG	14 AWG
	Approx. losses 3 kHz	46 W	81 W
	Switching frequency	3 kHz	3 kHz
	Supply current	5.0 A	9.0 A
	Supply fuse / Circuit breaker [1]	8 A	10 A
	Supply cable Europe [5]	1 mm^2	1/1.5 mm^2
Special setting for higher-rating neccessary, see page 10-7	Supply cable North America [6]	14 AWG	14 AWG
	Earth leakage current	>10 mA	>10 mA
	Fuse for UL compliance [2]	10 A [1]	10 A [1]
Integrated braking chopper:			
Max. current	- ED ≤30 %, 30 s max.	4 A	4 A
Ext. braking resistor	- Minimum value	100 Ω	100 Ω
Available braking resistors for	- light braking	200BR0004 200 Ω/0.04 kW	100BR001 100 Ω/0.08 kW
	- high braking torque short term	100BR001 100 Ω/0.08 kW	100BR001 100 Ω/0.08 kW
	- high braking torque with heavy braking operation	100BR006 100 Ω/0.6 kW	100BR006 100 Ω/0.6 kW
Installation, Mounting:			
Cooling		Convection	Convection
Weight approx.:	- Grundgerät	2.8 kg	2.9 kg
	- Programming Pad (Option)	0.1 kg	0.1 kg
Dimensions:	- Height	198 mm	198 mm
	- Height with top cover	198 mm	198 mm
	- Width	155 mm	155 mm
	- Depth	155 mm	155 mm
Air flow clearance:	- above, below	80 mm	80 mm
	- left, right	15 mm	15 mm
	- front with wall mounting [7]	15 mm	15 mm
Power terminals:	- max. conductor size	4mm^2/10AWG	4mm^2/10AWG
	- max. torque	1.0 Nm	1.0 Nm
Terminals for braking chopper:	- max. conductor size	4mm^2/10AWG	4mm^2/10AWG
	- max. torque	1.0 Nm	1.0 Nm
Outline drawing:		3.1a	3.1a

1) Fuse or circuit breaker with delayed release

2) UL Listed JDDZ, class K5 or H; Ul Listed JDRX, class H

3) For operation to UL

4) Reduced shaft power

DATA MM655...6110-5 FOR OPERATION WITH 3AC 500 V

MM422-3-EMC		MM440-3-EMC		MM655/500		MM675/500		MM6110/500	
3AC 230 V ±15 %, 50...60 Hz ±5 Hz				3AC 500 V ±10 %, 50...60 Hz ±5 Hz					
Operation with constant torque (CT)									
2.2	kW	4.0	kW	5.5	kW	7.5	kW	11	kW
10.5	A	16.5	A	10	A	12.5	A	18	A
1/1.5	mm^2	2.5	mm^2	1/1.5	mm^2	1.5/2.5	mm^2	2.5/4	mm^2
14	AWG	10	AWG						
123	W	174	W	220	W	260	W	330	W
3/6/9	kHz	3/6/9	kHz	3/6	kHz	3/6	kHz	3/6	kHz
12	A	16	A	14	A	22	A	26	A
16	A	20	A	3x20	A	3x25	A	3x32	A
2.5	mm^2	2.5/4	mm^2	2.5/4	mm^2	4/6	mm^2	6/10	mm^2
14	AWG	10	AWG	12	AWG	10	AWG	8	AWG
>10	mA	>10	mA	>10	mA	>10	mA	>10	mA
15	A[1)]	25	A[1)]						
Operation with quadratic torque at higher power (HVAC)									
3.0	kW[4)]	4.0	kW[4)]	7.5	kW	11	kW	15	kW
3.0	kW	4.0	kW	7.5	kW	11	kW	15	kW
2.8	kW	4.0	kW	7.5	kW	11	kW	15	kW
10.5	A	16.5	A	12.5	A	18	A	24	A
1/1.5	mm^2	2.5	mm^2	1.5/2.5	mm^2	2.5/4	mm^2	4/6	mm^2
14	AWG	14	AWG						
123	W	174	W	270	W	350	W	450	W
3	kHz	3	kHz	3	kHz	3	kHz	3	kHz
12	A	16	A	20	A	26	A	32	A
16	A	20	A	3x25	A	3x32	A	3x40	A
2.5	mm^2	2.5/4	mm^2	4/6	mm^2	6/10	mm^2	10	mm^2
14	AWG	12	AWG						
>10	mA	>10	mA	>10	mA	>10	mA	>10	mA
15	A[1)]	20	A[1)]						
Integrated braking chopper									
10	A	15	A	7.5	A	15	A	15	A
56	Ω	22	Ω	100	Ω	50	Ω	50	Ω
100BR001		100BR001		100BR001		100BR001		100BR006	
100 Ω/0.08 kW		100 Ω/0.08 kW		100Ω/0.08 kW		100Ω/0.08 kW		100Ω/0.6 kW	
100BR006		100BR006		39BR006		39BR006		39BR012	
100 Ω/0.08 kW		100 Ω/0.06 kW		39Ω/0.6 kW		39Ω/0.6 kW[8)]		39Ω/1.2 kW[8)]	
100BR012		100BR012		100BR012		39BR012		39BR050	
100 Ω/1.2 kW		100 Ω/1.2 kW		100Ω/1.2 kW		39Ω/1.2 kW[8)]		39Ω/5.0 kW[8)]	
Installation, Mounting									
Fan		Fan		Fan		Fan		Fan	
4.1	kg	4.1	kg	8.8	kg	8.9	kg	9.0	kg
0.1	kg	0.1	kg	0.1	kg	0.1	kg	0.1	kg
233	mm	233	mm	348	mm	348	mm	348	mm
233	mm	233	mm	365	mm	365	mm	365	mm
171	mm	171	mm	201	mm	201	mm	201	mm
181	mm	181	mm	208	mm	208	mm	208	mm
80	mm	80	mm	70	mm	70	mm	70	mm
15	mm	15	mm	20	mm	20	mm	20	mm
15	mm	15	mm	0	mm	0	mm	0	mm
$4mm^2$/10AWG		$4mm^2$/10AWG		$2.5mm^2$/12AWG		$6mm^2$/8AWG		$6mm^2$/8AWG	
1.0	Nm	1.0	Nm	1.5	Nm	1.5	Nm	1.5	Nm
$4mm^2$/10AWG		$4mm^2$/10AWG		$2.5mm^2$/12AWG		$2.5mm^2$/12AWG		$2.5mm^2$/12AWG	
1.0	Nm	1.0	Nm	1.0	Nm	1.0	Nm	1.0	Nm
3.1b		3.1b		3.1c		3.1c		3.1c	

Size of cables in accordance with: 5) EN60204-1 (see page 3-7) 7) With NEMA1 8) Only with 3AC 400 V,

6)	NEC/NEPA-70	top cover	sonst Rücksprache

ORDERING INFORMATION

Function	Order code	Technical data	Order No.

Please enquire

Chapter 13 - INDEX

GENERAL

MENU PARAMETERS

Die optimale Antriebslösung von 0,25 bis 1000 kW und 690 V von
The optimum drive solution from 0,25 to 1000 kW and 690 V from

ÖKIMO Antriebssysteme

SoftCompact®
bisher/previous
LEKTROMIK® K

Elektronische Motor-Anlaufgeräte und Steller in Modultechnik

Electronic soft starters and phase control modules

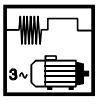
SoftPower®
bisher/previous
LEKTROMIK® S

Elektronische Motor-Anlaufgeräte bis 2000 kW, vollgesteuert

STANDARD OPTIONEN
- **I** Pumpen-Anlaufoptimierung, Leistungsüberwachung, Strom- und cos φ-regelung
- **N** Drehzahlregelung

Electronic soft starters up to 2000 kW fully controlled

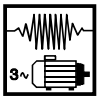
STANDARD-OPTIONS
- **I** Optimised start for pumps Power monitoring, current and cos φ control
- **N** Speed control



BrakeControl
bisher/previous
LEKTROMIK® B

Elektronische Bremsgeräte bis 200 kW

Electronic braking controllers up to 200 kW

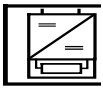


MotorMaster®

MotorControl®
bisher/previous
TRANSOMIK®®

Digitale Frequenzumrichter
0,37...1,5 kW, 1AC 230 V
0,37...315 kW, 3AC 400 V
Elektronische Frequenzumrichter
0,37...1,5 kW, 1AC 230 V
2,2...15 kW, 3AC 400 V

Digital frequency inverters
0.37...1.5 kW, 1AC 230 V
0.37...315 kW, 3AC 400 V
Electronic frequency inverters
0.37...1.5 kW, 1AC 230 V
2.2...15 kW, 3AC 400 V



BrakeMaster®
bisher/previous
TRANSOMIK® B, BC

Elektronische Bremschopper für Frequenzumrichter bis 90 kW, kaskadierbar für höhere Leistungen

Electronic braking choppers for frequency inverters up to 90 kW,, can be cascaded for higher powers

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