KIMO
RHVAC Controls

Product Manual

MotorMaster

Fully digital Frequency Inverter with integrated Vector control

MM 0.37...1.5FMV/S230-EMC
MM 0.75...7.5FMCV-emc

Software Version 4.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

Software version

This Product Manual is compatible with MM FMV Frequency Inverters with software version 4.X. Please contact your supplier should MM FMV Frequency Inverter indicate a different software version on power-up.

Installation details

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

Where installed:
(for your own information)

_____

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

Mounting: ☐ Enclosure

KIMO RHVAC Controls

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Issue 4.x/02
24.08.15

Available product documentation

MM FMV 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 PMM-FMV.2-0605	• Technical data, installation, CE, EMC, LVD and UL issues, options • Setting-up and commissioning for all normal applications	0...12	Supplied with every MM FMV Frequency Inverter

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 MM FMV 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 MM FMV 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 MM FMV 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 MM FMV 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.

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 MM FMV 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 MM FMV Frequency Inverter is defect. A repair can be arranged at the manufacturers , 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.
RISK OF ELECTRIC SHOCK OR INJURY:	MM FMV 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 MM FMV Frequency Inverters.

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

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

MM FMV 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: 1AC: 220...240 V ±10 % for motors up to 1.5 kW 3AC: 380...460 V ±10 % for motors up to 7.5 kW ♦ 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 4 character LCD display and 6 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
EMC:	♦ All 1AC MM FMV Frequency Inverters are supplied with a built-in EMC filter to class B interference protection. All 3AC MM FMV Frequency Inverters are supplied with a built-in EMC filter to class A interference protection. Please refer to supplier for difficult applications (e.g. long cable runs).
MM FMV Options:	♦ RS232 serial link ♦ Braking resistors ♦ *KimoVis* software for operating and programming (WINDOWS)
Parts supplied:	♦ MM FMV Frequency Inverter incl. Programming Pad ♦ Product Manual PMM-FMV.2 including parameter list
Further documentation:	♦ EMC Compendium AF-MM-02 ♦ Product information CE marking of electronic drive equipment PI-LKTM-005

TECHNICAL OVERVIEW

Component Overview

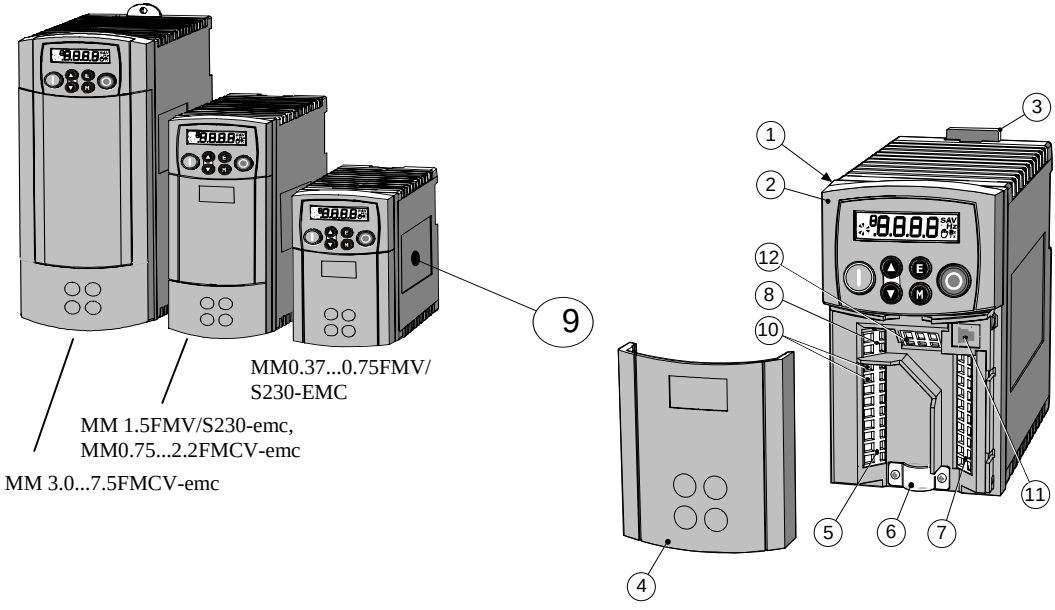


Fig. 1.1: Frequency Inverter **MM 3.0...7.5FMCV-emc**
MM 1.5FMV/S230-emc
MM0.75...2.2FMCV-emc
MM0.37...0.75FMV/S230-EMC

1 Frequency Inverter – housing
2 Programming pad
3 DIN clip /fixing bracket
4 Terminal cover
5 Power terminals
6 Clamp for screened motor cable
7 Control terminals
8 Volt free relay contacts
9 Product rating label
10 Motor thermistor terminals
11 RS232 Interface P3
12 Digital inputs / encoder connection

TECHNICAL DATA

General

Control;	Full local control via the operating panel or with external analog and digital control inputs
Output frequency:	0...240 Hz
Switching frequency:	4 kHz
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
PID-Controller:	Universally programmable PID controller
Link:	Serial link RS232/485 (Option), RS232 integrated
Hoisting and travel drives:	Integrated ramp functions and brake control
Password:	Integrated password protection for customer-set parameters
Jog:	Adjustable jog speed

Programming pad:	Removable, 4 character LCD display (illuminated), 6 function keys

Protection; Trip conditions:	Short circuit line - line, heat sink overtemperature, overvoltage, undervoltage, input for external trips (e.g. for connection of an external thermistor relay)
Current limit:	0...150 % rated current for 30s

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

Diagnostics:	Trips are displayed

Inputs/outputs;	Analog inputs:	2
	Analog output:	1
	Digital inputs:	6
	Digital outputs:	1 x Relay
	Digital I/O:	1
	Thermistor input:	1

Environmental requirements

Permissible temperature:	0 ...+45 °C	Operation 2 %/°C derating, e.g. 80 % with 50 °C
	-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: North America, Canada:	EN50178 (1998) valid for - Enclosure mounting UL508C valid for: - Enclosure mounting as"Open-type Drive"
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:	All surfaces IP20
UL (c-UL): Enclosure rating	Enclosure mounted:	Open type
Prospective short circuit current:	≤ 5 kA ≤10 kA	(220...240 V) (380...460 V)
Earthing:	Permanent earthing is mandatory. The following method can be used: - Use two independent earth conductors each connected parallel to a separate earth terminal of the MM FMV Frequency Inverter. **NOTE**: Each conductor itself must meet the local requirements for protective earth conductors.	

EC-Directives

EMC-DIRECTIVE:	The requirements of the European EMC-DIRECTIVE are met with approved external EMC filters. The EMC Installation Instructions (page 3-9...18) and information on applying the EMC DIRECTIVE (page 8-3...12) must be observed.
LOW VOLTAGE DIRECTIVE:	The requirements of the European LOW VOLTAGE DIRECTIVE for CE marking are adhered to, refer to pages 8-13.

Power circuit 230 V types

Product code / MotorMaster			0.37FMV/ S230 -EMC	0.75FMV/ S230 -EMC	1.5FMV/ S230 -EMC
Supply voltage:			1AC 220...240 V, ±10 %, 50... 60 Hz, ±10 Hz		
Normal operation with 50 % overload / 30 sec					
	Rated motor power	kW	0,37	0,75	1,5
	Motor current	A	2,2	4	7
	Motor cable Europe [5]	mm^2	1	1	1
	Motor cable North America [6]	AWG	12	12	12
	Switching frequency	kHz	4	4	4
	Max. losses 4 kHz	W	32	52	82
	Supply current	A	6,2	10,5	16,0
	Supply fuse/Circuit breaker [1]	A	10	16	20
	Supply cable Europe [5]	mm^2	1/1,5	1,5/2,5	2,5/4
	Supply cable North America [6]	AWG	12	12	12
	Earth leakage current	mA	>10	>10	>10
	Fuse for UL compliance[2]	A	10	15	20
Integrated braking chopper:					
Data braking chopper:	- ED	%	-	-	-
	- Duty cycle	s	-	-	-
	- Max. current (peak)	A	-	-	-
	- Continuous current	A	-	-	-
	- Minimum value	Ω	-	-	-
Ext. braking resistor	- Type		-	-	-
Installation, Mounting:					
Cooling			Fan	Fan	Fan
Weight approx.:	- MotorMaster Frequency Inverter	kg	0,85	0,85	1,4
	- Programming Pad (Option)	kg	0,06	0,06	0,06
Dimensions:	- Height	mm	145	145	205
	- Height with top cover	mm	-		
	- Width	mm	73	73	73
	- Depth	mm	142	142	172
Air flow clearance:	- Above / below	mm	100	100	100
	- Left / right	mm	0	0	0
	- Front with wall mounting	mm	15	15	15
Power terminals:	- Max. conductor size	mm^2	2,5	2,5	2,5
	- Max. torque	Nm			
Terminals for braking chopper:	- Max. conductor size	mm^2	-	-	-
	- Max. torque	Nm	-	-	-
Thermistor/ Control terminals	- Max. conductor size	mm^2	2,5	2,5	2,5
	- Min. conductor size	mm^2	0,08	0,08	0,08
Outline drawing:	Refer to page 3-3		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
Size of cables in accordance with:
5) EN60204-1 / E DIN VDE 0298-4 (see page 3-7)
6) NEC/NEPA-70

Power circuit 400 V types

	0.75FMCV -emc	1.5FMCV- emc	2.2FMCV- emc	3.0FMCV/ -emc	4.0FMCV/ -emc	5.5FMCV/ -emc	7.5FMCV/ -emc	
	3A C380...460 V, ±10 %, 50... 60 Hz, ±110 Hz							
							Operation with 50 % overload / 30 s	
kW	0,75	1,5	2,2	3,0	4,0	5,5	7,5	kW
A	2,5	4,5	5,5	6,8	9	12	16	A
mm^2	1	1	1	1	1/1,5	1,5	2,5	mm^2
AWG	12	12	12	10	10	10	10	AWG
kHz	4	4	4	4	4	4	4	kHz
W	40	61	70	80	100	136	180	W
A	4,1	7,5	9,4	11,1	13,9	18	23,6	A
A	10	10	10	16	16	20	25	A
mm^2	1/1,5	1/1,5	1/1,5	1,5/2,5	1,5/2,5	2,5/4	4/6	mm^2
AWG	12	12	12	10	10	10	10	AWG
mA	>10	>10	>10	>10	>10	>10	>10	mA
A	10	10	15	15	20	25	30	A
							Integrated braking chopper:	
%	100	100	100	30	30	30	30	%
s	120	120	120	120	120	120	120	s
A	1,5	3,75	3,75	7,5	7,5	13,5	13,5	**A**
A	1,5	3,75	3,75	2,3	2,3	4,0	4,0	A
Ω	500	200	200	100	100	56	56	Ω
	A0.08RE500	A0.43RE220	A0.43RE220	A1.2RE100	A1.2RE100	A1.2RE56	A1.2RE56	
							Installation, Mounting:	
	Fan	Fan	Fan	Fan	Fan	Fan	Fan	
kg	1,4	1,4	1,4	2,7	2,7	2,7	2,7	kg
kg	0,06	0,06	0,06	0,06	0,06	0,06	0,06	kg
mm	205	205	205	262	262	262	262	mm
mm	-	-	-	-	-	-	-	mm
mm	73	73	73	96	96	96	96	mm
mm	172	172	172	202	202	202	202	mm
mm	100	100	100	100	100	100	100	mm
mm	0	0	0	0	0	0	0	mm
mm	15	15	15	15	15	15	15	mm^2
mm^2	2,5	2,5	2,5	6	6	6	6	mm
Nm								Nm
mm^2	2,5	2,5	2,5	6	6	6	6	mm^2
Nm								Nm
mm^2	2,5	2,5	2,5	2,5	2,5	2,5	2,5	mm^2
mm^2	0,08	0,08	0,08	0,08	0,08	0,08	0,08	mm^2
	3.1b	3.1b	3.1b	3.1c	3.1c	3.1c	3.1c	

Voltage supply

Frequency Inverters MM.FMV are only for TT/TN supplies with an earthed neutral, for use with IT-supplies please refer to manufacturer.

Control circuit

Reference and auxiliary supplies

Reference supply for analog inputs	+10 V ± 5 %, 10 mA max. load
Auxiliary supply for digital inputs	+24 V ±15 %, 50 mA max. load

Analogue I/O

	Inputs		Outputs
Range	0...5 V/0...+10V	0/4...20 mA	0...+10 V
Impedance	20 kΩ	230 Ω	20 kΩ
Limit value	+24 V	6 V	max. 10 mA*
Resolution	10 bit (1 in 1024)		10 bit (1 in 1024)
Sample rate	5 ms		5 ms

* Short-circuit protection

Digital I/O

		Inputs	Outputs (Relay)	Outputs
Logic system		DC 24 V Industry logic	Isolated relay contacts	
Switching levels	'0'	<+5 V	open	open (up to +30 V)
	'1'	>+15 V	closed	controlled (approx. +1V)
Absolute max. voltage range		-30...+30 V	250 V AC 24 V DC	23 V (min. 19 V)
Impedance		3,2 kΩ		33 Ω
Max. current		7,5 mA	6 A - res. load	50 mA
Sample rate		5 ms	5 ms	

Thermistor motor protection

An input for connecting to an external motor thermistor device is available with the MM FMV 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 MM FMV Frequency Inverters provide Class 10 motor overload protection. The maximum internal overload protection level (current limit) is 150 % for 30 s. Refer to **Chapter 4 - SETTING UP AND COMMISSIONING**. 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 MM FMV Frequency Inverters are suitable for use on a circuit capable of delivering not more than 10,000 A rms symmetrical, 240 V / 460 V.
Solid state short-circuit protection:	♦ These MM FMV 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 240 Hz.
Field wiring temperature rating:	♦ Use copper conductors only: min. 60/75 °C ambient temperature
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…13 for maximum conductor sizes.
Terminal tightening torque:	♦ Refer to the table on page 1-8…13 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 °.

ORDERING INFORMATION

Ordering information for 230 V types

Function	Product code	Technical data	Order no.
Digital Frequency Inverter with integrated EMC filter for operation with 1AC 220...240 V	MM 0.37FMV/S230-EMC	0.37 kW, 1AC 220-240 V, 2,2 A	08679.204-110/01.4X
	MM 0.75FMV/S230-EMC	0.75 kW, 1AC 220-240 V, 4,0 A	08679.206-110/01.4X
	MM 1.5FMV/S230-EMC	1.5 kW, 1AC 220-240 V, 7,0 A	08679.211-110/01.4X

Ordering information for 400 V types

Function	Product code	Technical data	Order no.
Digital Frequency Inverter with integrated EMC filter for operation with 3AC 380...460 V	MM 0.75FMCV-emc	0.75 kW, 3AC 380-460 V, 2,5 A	08679.306-110/01.4X
	MM 1.5FMCV-emc	1.5 kW, 3AC 380-460 V, 4,5 A	08679.311-110/01.4X
	MM 2.2FMCV-emc	2.2 kW, 3AC 380-460 V, 5,5 A	08679.312-110/01.4X
	MM 3.0FMCV-emc	3.0 kW, 3AC 380-460 V, 6,8 A	08679.313-110/01.4X
	MM 4.0FMCV-emc	4,0 kW, 3AC 380-460 V, 9,0 A	08679.314-110/01.4X
	MM 5.5FMCV-emc	5,5 kW, 3AC 380-460 V, 12 A	08679.315-110/01.4X
	MM 7.5FMCV-emc	7,5 kW, 3AC 380-460 V, 16 A	08679.316-110/01.4X

Ordering information for Accessories

Function	Product code	Technical data	Order no.
Removable Programming Pad	MM O-FM-PROG-TTL	Programming pad	08620.003
Programming pad for remote mounting	MM O-FM-PROG-RS232	Programming pad with RS232 Interface	08620.004
RS232/485 interface for programming the MM FMV Frequency Inverter	MM O-FM-RS232/485	RS232/485 Interface	08620.005
Clone Module	MM O-FM-CLONE	Clone module	08620.006
Connection Cable	MM A-PROG-CC-3m	Connection cable 3 m	08629.004
RS232 Connection cable for PC	MM O-FM-CON-RS232	Connection cable	08620.007/00
Blind Cover	MM O-FM-COVER	Blind Cover	08620.008

Chapter 2 - PRE-INSTALLATION PLANNING

FUNCTIONAL OVERVIEW

MM FMV 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 4 character LED display with operating keys allows easy access to operating function and adjustable parameters. The hierarchal menu allows parameters to be directly changed and provides access to many configurable functions.

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).

The basic functions of the MM FMV 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, N or L1, L2 and L3 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 MM FMV Frequency Inverter trips with "dCH/" (Overvoltage) if the d.c. link voltage exceeds the over-voltage trip level 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 (with 400 V types only).

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.

Analog inputs/outputs:

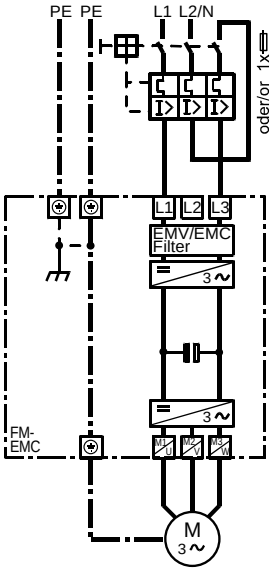
The analog inputs and outputs are freely configurable.

Digital inputs/outputs:

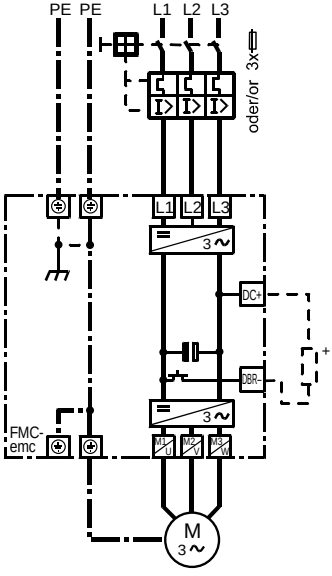
Digital inputs to the control circuit are usually provided by externally switched contacts. An +24 V auxiliary supply is available between terminals 6 and 1 for this purpose. The maximum loading is 150 mA.

With MM FMV Frequency Inverters an isolated contact is available as an output relay.

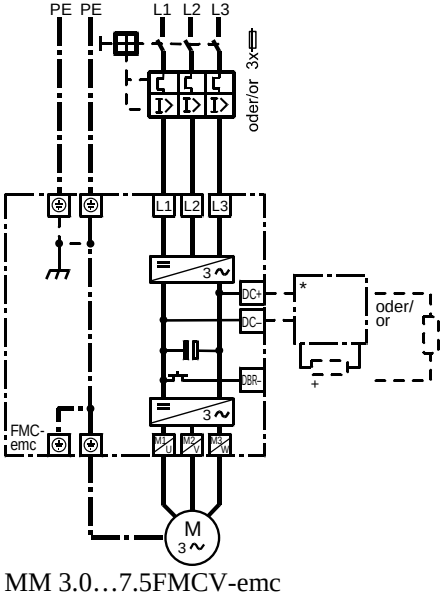
BASIC WIRING AND BLOCK DIAGRAMS



MM 0.37...1.50FMV/S230-EMC



MM 0.75…2.2FMCV-emc



MM 3.0…7.5FMCV-emc

Fig. 2.1: General wiring diagram of power sections of MM FMV Frequency Inverters

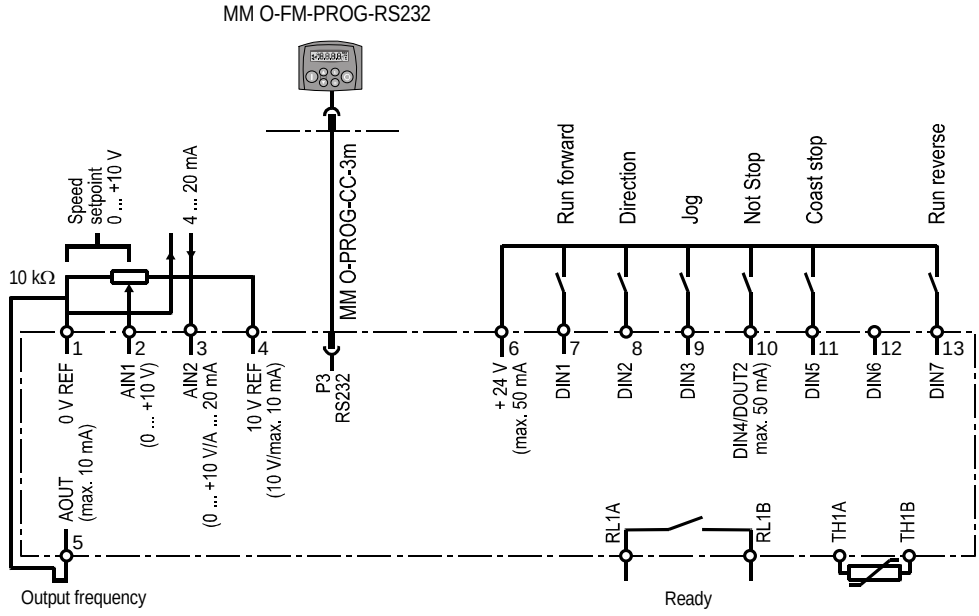


Fig. 2.2: General wiring diagram of control circuit of MM FMV Frequency Inverters with MACRO 1

MACRO 1	MACRO 2	MACRO 3	MACRO 4	MACRO 5		
Basic Speed Control	Manual/ Auto	Presets	Raise/ Lowerr	PID		Steuer-klemmen
Reverse start	=	=	=	=	DIN7 (ENC B)	13
Not used	Jog	Jog	Jog	Release PID	DIN6 (ENC AI	12
Coast	=	=	=	=	DIN5	11
Stop**	Direction	Preset Select	Reset	Stop**	DIN4/DOUT2	10
Jog	Select	Preset Select	Lower	Jog	DIN3	9
Direction	Auto Run	Preset Select	Raise	Direction	DIN2	8
Run	Manual Run	Run	Run	Run	DIN1	7
+24V	+24V	+24V	+24V	+24V	+24V	6
AOUT1	AOUT1	AOUT1	AOUT1	AOUT1	AOUT1	5
+10V REF	+10V REF	+10V REF	+10V REF	+10V REF	+10V REF	4
Feedback	Auto Setpoint	Preset 0	not used	Feedback	AIN2	3
Setpoint	Manual Setpoint	Preset 0	not used	Feedback	AIN1	2
0V	0V	0V	0V	0V	0V	1
Health	Health	Health	Health	Health	RL1A RL1B	RL1A RL1B

** Stop is activated with Low-Signal

Fig. 2.3: Software links of the MACRO's

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

Terminal	Designation	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 EMC requirements as described in **Chapter 3**.
	L1 L2/N L3	Connection for single-phase voltage supply with MM FMV (depends on type)	1AC 220...240 V ±10 % 3AC 380...460 V ±10 %
	DC+	Positive connection to d.c. link Connection for external resistor (with MM0.75...7.5 FMCV-emc only)	Applications: - D.C. supply - Parallel connection of d.c. links of two or more inverters (only after referring to supplier) - Connection of an additional external braking chopper
	DC-	Negative connection to d.c. link (with MM3.0...7.5 FMCV-emc only)	
	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 EMC requirements as described in **Chapter 3**.
	DBR	Connection for external braking resistor (with MM0.75...7.5 FMCV-emc only)	Connection for external braking resistor between DC+ and DBR)
	MOT/ TEMP	Inputs for motor thermistor, >3 kΩ =Fault <1.8 kΩ =Fault reset	If not required these terminals must be bridged.

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

Control terminals

All MM FMV 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**).

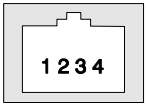
Terminal	Designation	Signal, function	Explanation
1	0V	Zero volt reference for analog signals or 20 mA current-loop connection	- Do not use for other purposes !!
2	AIN1	Configurable analog input in the range `0..+10 V,` used as speed setpoint.	- 0…10 V - Input impedance = 94 kΩ.
3	AIN2	Configurable analog -input in the range 0...+10 V or 4...20 mA, used as a trim set-value.	- 0... 10 V / 4...20 mA
4	10 V REF	Internal -10 V reference voltage for analog inputs	- 10 mA max. load - Tolerance approx. ±3 %
5	AOUT1	0 V = 0 Hz +10 V = `MAX SPEED`	- Accuracy ± 3 % - 10 mA max. load
6	+24V	24 V supply for digital I/O	- 50 mA max
7	DIN1	Configurable digital input, used as "Run", for starting and stopping the drive: 0 V = Stop +24 V = "Run forewards"	- 0…24 V
8	DIN2	Configurable digital input, usually used as command "Run reverse ": 0 V = Stop +24 V = Run reverse	- 0…24 V
9	DIN3	As DIN2	
10	DIN4/ DOUT2	Configurable digital I/O usually used to select the jog speed +24 V = Jog 0 V = normal	- 0…24 V source open collector 50 mA max
11	DIN5	Configurable digital input: 0 V = Stop, 24V = Coast	0…24 V
12	DIN6 (ENC A)	Configurable digital input	- 0…24 V
13	DIN7 (ENC B)	Reverse start – Configurable digital input: 0 V = Stop, 24 V = Reverse	0…24 V
RL1A	Relay	Customer specified relay – Isolated relay contacts	0...250 V AC / 24 V DC, 6A
RL1B	Relay	0...250 V AC / 24V DC Isolated contact	0...250 V AC / 24 V DC, 6A
P3	P3	RS232 interface for separate mounting of programming pad or PC connection	

Serial Interface P3

Connection to the P3 interface
The serial interface P3 is located under the terminal cover and not isolated. It has a maximum speed of 19200 Baud and is based on standard EI bisynch ASCII protocols.

P3 Port

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



9-pole Sub-D plug

Pin	1	2	3	4
Wire	Black	Red	Green	Yellow
Socket of 9-pole plug	5	Not connected	3	2
Socket of 25-pole plug*	7	Not connected	2	3

* With use of a 25 to 9 pole adapter

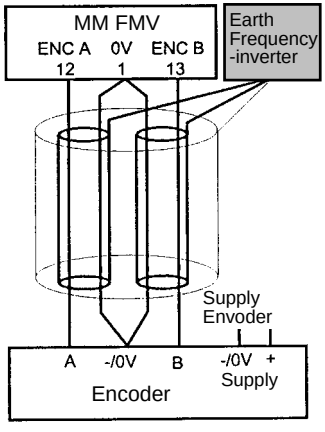
Pin 2 of Port P3 carries 5 V, this could lead to PC damage. Please avoid direct connection to PC.
The frequency inverter must be earthed. Noncompliance may lead to destruction of communication interface.

Encoder Connection

The MM FMV Frequency Inverter is only to be used with "Single Encoders". Due to low signal, wiring between encoder and frequency inverter has to be carried out with utmost care.

All cables should be screened. The connection must be screened completely, a disruption of screening is only permissible on beginning and end of cable. Parallel run of screened cables should be achieved. To ensure EMC conformity, the screen must be completely connected to earth of housing.

The MM FMV Frequency Inverter works with encoders of 5-24 V. Please use encoder supply. Do not use 10 V or 24 V supply voltage of frequency inverter.



Maximum input frequency for terminals 12 and 13 (ENC A and ENC B) is 100 kHz.

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 MM FMV Frequency Inverter is carried out only by competent personnel in accordance with safe working practices.
- The enclosure into which the MM FMV 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 MM FMV Frequency Inverter:

- Signs of transit damage
- The type code and ratings on the name plate conform 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 information on returning damaged equipment.

MOUNTING

MM FMV Frequency Inverters should be mounted vertically.
The following mounting is suitable. - Mounting on a 35 mm DIN rail (Side-by-side mounting)
- Mounting on a mounting plate

The overall dimensions of the MM FMV Frequency Inverter and the positions of the fixing points are given in Figure 3.1 (page 3-3).

MM FMV 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 MM FMV Frequency Inverter.

For adequate natural ventilation of the MM FMV Frequency Inverter, minimum clearance for cooling as defined in the table on page 1-6…, must be maintained. Side-by-side mounting of two or more MM FMV 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

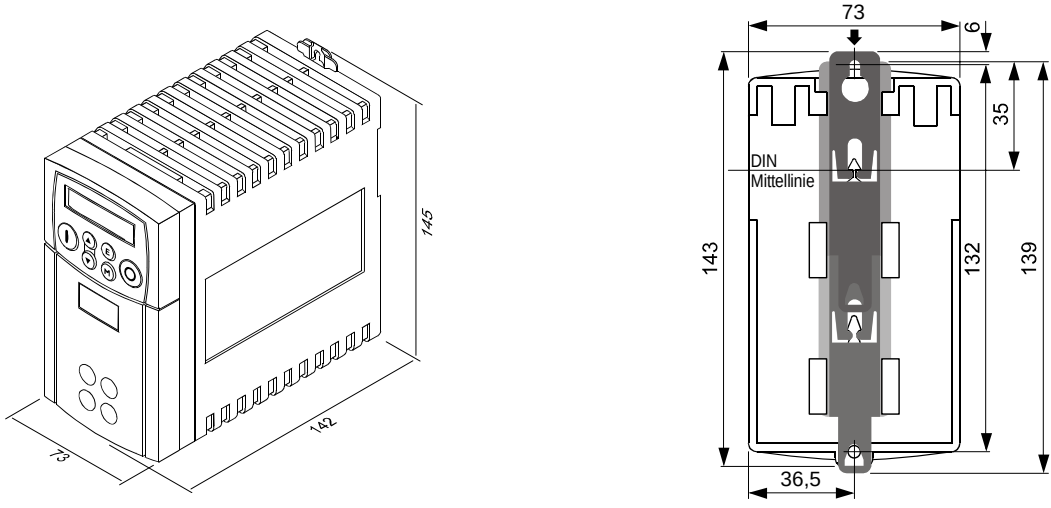


Fig. 3.1a: Outline drawing and mounting MM 0.37...0.75FMV/S230-EMC

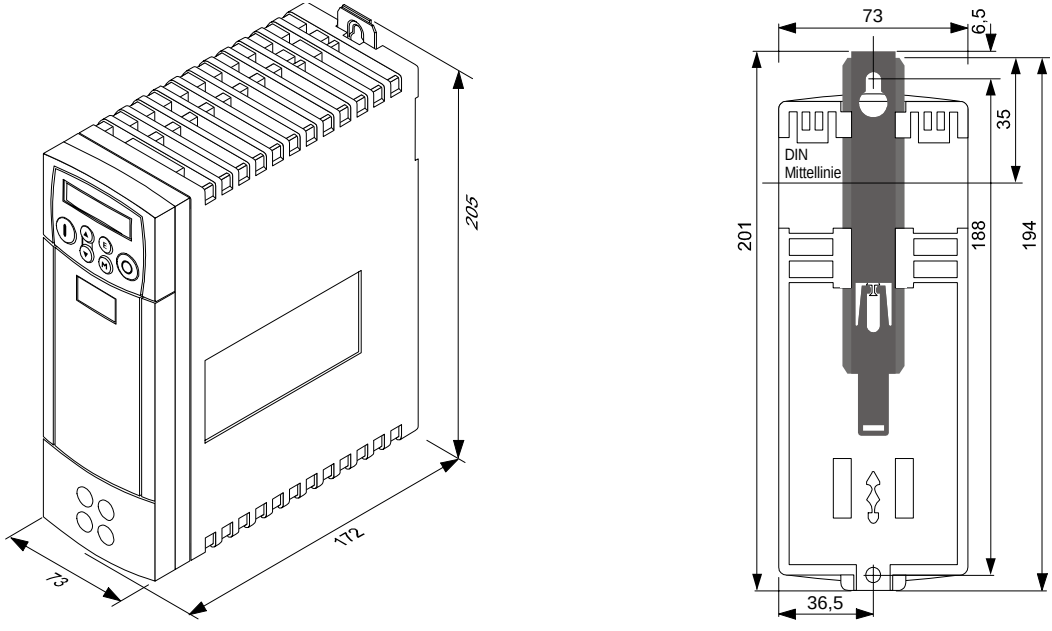


Fig. 3.1b: Outline drawing and mounting MM 1.5FMV/S230-EMC
MM 0.75...2.2FMCV-emc

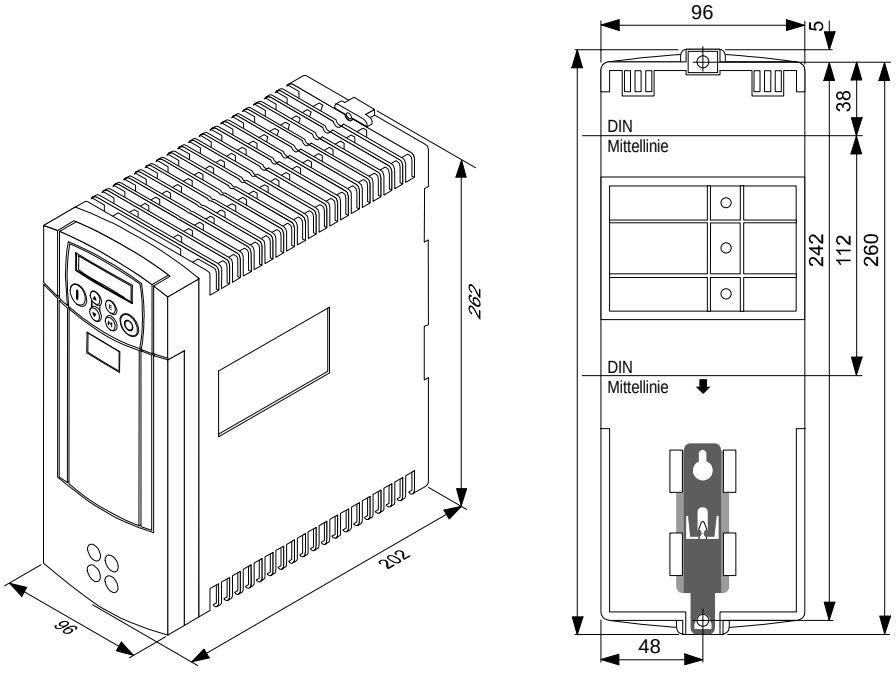


Fig. 3.1c: Outline drawing and mounting MM 3.0...7.5FMCV-emc

INSTALLATION

Using screwless cage-clamp terminals

The control terminals are equipped. with screwless cage-clamp terminals.
Connections to these terminals are to be made as follows:

- 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.) screwdriver 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.

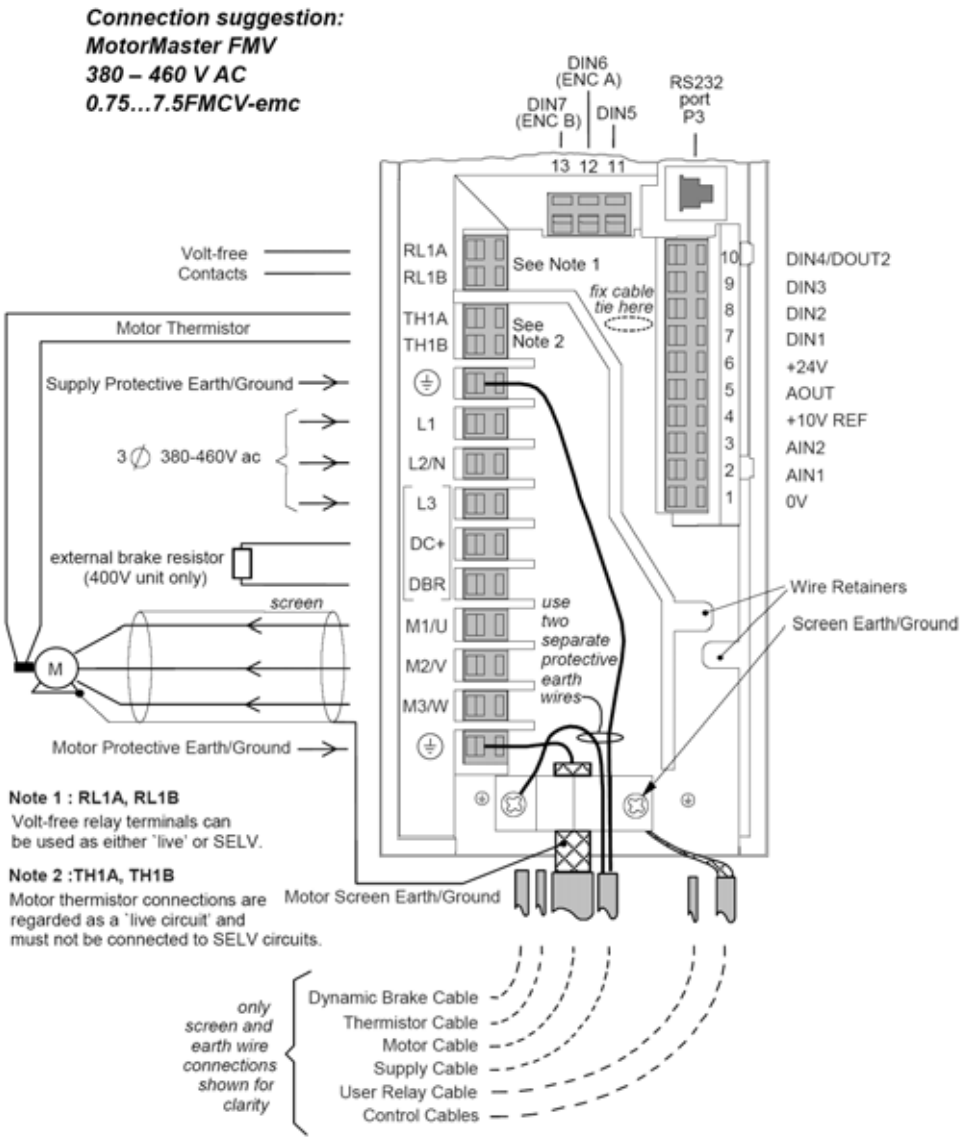


Fig. 3.2 Wiring with instruction for using screwless cage-clamp terminals and for connection of protective earth and screening of motor cables

Power wiring

CAUTION!
Never perform high-voltage insulation measurements on the wiring without first disconnecting the MM FMV 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 3-9 and following and also to **Chapter 8, EMC, THE 'CE'-MARK, UL, CSA** for information on EMC wiring requirements.

Overload and short-circuit protection

The incoming voltage supply should be wired and protected to the appropriate regulations such as are shown in the following table in accordance with the European regulations (EN60204-1 / E DIN VDE0298-4).

[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)
- F Free-air mount with contact (single core)
- G Free-air mount without contact (single core)

Other ambient temperatures, methods of installation, customer, national or EMC 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).

MotorMaster Frequency Inverter MM FMV	Power cable Supply fuse [1] / Circuit breaker[2]	Size of power cables	Type of installation	Motor cable Size of power cables	Type of installation
230 V Types					
MM 0.37FMV/S230-EMC	10 A	1 mm^2	B1,--,C,E	1 mm^2	B1,B2,C,E
		1,5 mm^2	B1,B2,C,E		
MM 0.75FMV/S230-EMC	16 A	1,5 mm^2	--,--,-,E	1 mm^2	B1,B2,C,E
		2,5 mm^2	B1,B2,C,E		
MM 1.5FMV/S230-EMC	20 A	2,5 mm^2	--,--,C,E	1 mm^2	B1,B2,C,E
		4 mm^2	B1,B2,C,E		
400 V Types					
MM 0.75FMCV-emc	10 A	1 mm^2	B1,--,C,E	1 mm^2	B1,B2,C,E
		1,5 mm^2	B1,B2,C,E		
MM 1.5FMCV-emc	10 A	1 mm^2	B1,--,C,E	1 mm^2	B1,B2,C,E
		1,5 mm^2	B1,B2,C,E		
MM 2.2FMCV-emc	10 A	1 mm^2	B1,--,C,E	1 mm^2	B1,B2,C,E
		1,5 mm^2	B1,B2,C,E		
MM 3.0FMCV-emc	16 A	1,5 mm^2	--,--,-,E	1 mm^2	B1,B2,C,E
		2,5 mm^2	B1,B2,C,E		
MM 4.0FMCV-emc	16 A	1,5 mm^2	--,--,-,E	1 mm^2	B1,--,C,E
		2,5 mm^2	B1,B2,C,E	1,5 mm^2	B1,B2,C,E
MM 5.5FMCV-emc	20 A	2,5 mm^2	--,--,C,E	1,5 mm^2	B1,B2,C,E
		4 mm^2	B1,B2,C,E		
MM 7.5FMCV-emc	25 A	4 mm^2	B1,--,C,E	2,5 mm^2	B1,B2,C,E
		6 mm^2	B1,B2,C,E		

[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 (minimum C-Auslöse-Caracteristic or motor ……

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 MM FMV 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 "*fault-free*" is available at output "*User Relay*" (terminals: RL1A, RL2A). This output is normally activated, i.e. closed. Any trip which causes the healthy output to deactivate is internally latched by the MM FMV Frequency Inverter and the cause of the trip displayed on the 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.

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 MM FMV 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 MM FMV 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 MM FMV Frequency Inverters internal controlling electronics operates continuously in very close proximity to electrically-noisy power-switching components, MM FMV 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.

MM FMV Frequency Inverters 3AC 400 V 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 MM FMV 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

1AC 230 V Frequency Inverters MotorMaster FMV have integrated EMC filters to reduce mains-bourne interference. The installation requirements to meet interference suppression level B and the Thermal Limitations are described in the following table.

The external EMC filter required by 3AC 400 V Frequency Inverters should be mounted as close to the inverter as possible. The connection between the MM FMV 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 must be used. The connection between MM FMV 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 MM FMV Frequency Inverter. The RF connection between the MM FMV Frequency 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, MM FMV 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 MM FMV 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 MM FMV Frequency Inverter. Any additional RF earth such as a cable screen **is not a protective earth**.

The MM FMV Frequency Inverter 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 MM FMV 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	Placement		Switching frequency	Permissible maximum length of screened cable	
	Type	A	B		Interference suppression to limit B	Thermal limitation of EMC filter
MM 0.37...1.5FMV/S230-EMC	A-FM-2.2EE	intern	intern	4 kHz	25 m	25 m
MM 0.75...2.2FMCV-emc		intern	extern	4 kHz	25 m	150 m
MM 3.0...7.5FMCV-emc	A-FM-7.5EE	intern	extern	4 kHz	25 m	150 m

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

IMPORTANT WARNINGS!

- MM FMV 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 MM FMV 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 MM FMV 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 MM FMV 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 MM FMV 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

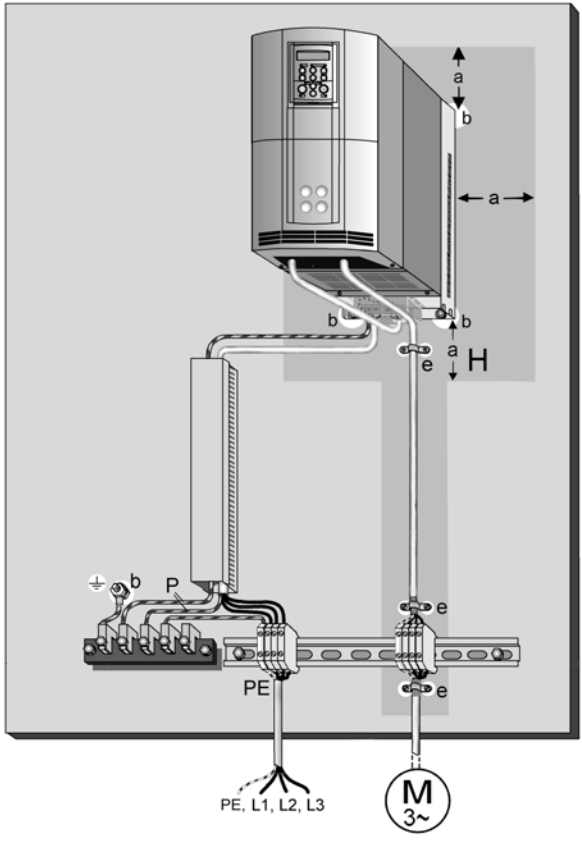
The use of screened cable to the motor without an EMC filter in the voltage supply is not recommended, as line-conducted interference will increase substantially and the capacitive coupling of the output cable to earth will result in high earth-leakage currents.

To ensure the correct operation of the MM FMV 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 continuous right back to the MM FMV Frequency Inverter. Always minimise the length of screen stripped back to make this connection. The screen should only be connected at the MM FMV 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 MM FMV 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 MM FMV 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 the MM FMV Frequency Inverter, EMC filter, 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 MM FMV Frequency Inverter is mounted in an enclosure

When more than one MM FMV Frequency Inverter or 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 MM FMV 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 MM FMV 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 MM FMV 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.

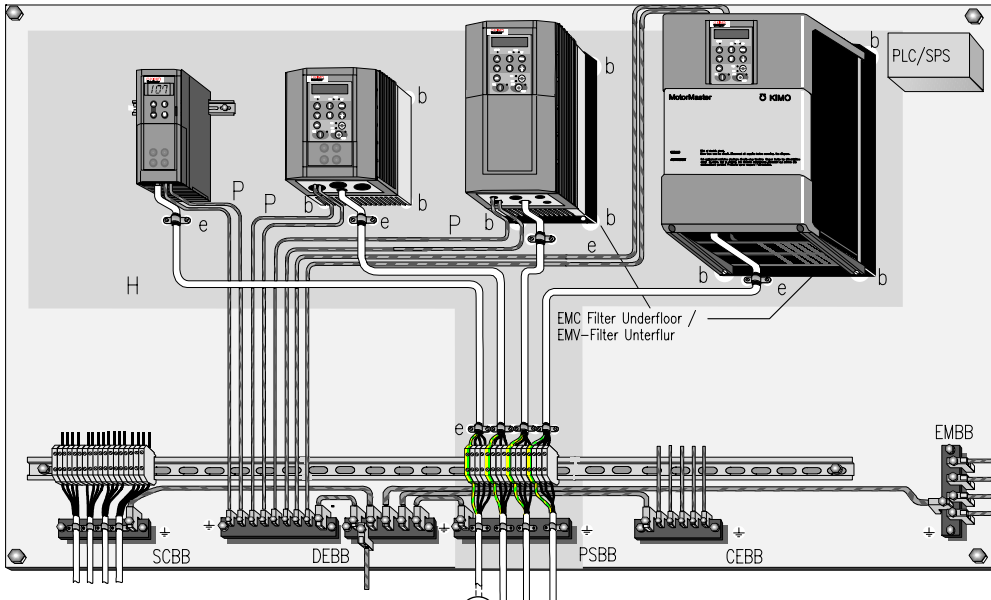


Fig. 3.4: Implementation of star-point earthing policy for multi-drive installation

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.
- 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 summarises cable length limitations due to thermal considerations.

These effects can be overcome by adding motor chokes at the output of the MM FMV Frequency Inverter. In applications where multiple motors are connected to a single MM FMV Frequency Inverter, minimise the length of screened/armoured cable connected to the MM FMV 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 connected 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 MM FMV 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 MM FMV 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) × 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

PROGRAMMING PAD

Introduction

Every MM FMV Frequency Inverter is fitted with a Programming Pad as standard, see Fig. 4.1, page.

Fig. 4.1: Programming pad MM O-FMV-PROG-TTL

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 Display

The following figure explains display indications.

P when in parameter menu

S when in the Setup menu

R when displaying an Alarm code

- a negative Parameters value

Displays the units for the value:
S for time in seconds
A for current in Amps
V for voltage in volts
% for percentage
Hz for frequency in Hertz

Represents a rotating shaft:
cw = drive running forward
cce = drive running in reverse

Indicates Parameter-numbers or values, trip information, error codes etc.
See "Drive Status Indications" below

Indicates the drive is in LOCAL control; Drive is in REMOTE control when not visible.

Indicates control via fieldbus communication

Drive Status Indications

The Frequency Inverter displays the following drive status indications:

Display	Status Indication and Meaning	Possible Cause
rdy	READY/HEALTH - No alarms Remote mode selected	
Pass	PASSWORD - Current password must be entered before this parameter may be altered.	Enter password to change the parameter. Refer to page 5-7.
LOC	LOCAL - Local mode selected	Added or removed from the display letter-by-letter to indicate entering or leaving Local mode.

Function keys for operating and programming the MM FMV

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

Function	Description

	Navigation	Parameter	Trip Reset
 **ESCAPE**	Displays the previous level's menu	Returns to the parameter list	Acknowledges displayed Trip or Error message
 **MENU**	Displays the next menu level, or the first parameter of the current Menu	Moves cursor to the left when the parameter is adjustable	

	Navigation	Parameter	LOCAL-Mode
 **UP**	Move upwards through the menu system	Increase value of the displayed parameter	Increase value of the local setpoint
 **DOWN**	Move down through the menu system	Decrease value of the displayed parameter	- Decrease value of the local setpoint - Reversing
 (green) **RUN**			Run the drive
 (red) **STOP**	Press and hold to toggle between LOCAL and REMOTE control modes (only possible with stopped drive), refer to page 4-5		- Stops the drive - Trip Reset in all modes (in both modes of operation)

Selecting (LOCAL / REMOTE mode)

The drive can operate in one of the following two ways:

REMOTE Mode: Allowing access for application programming using digital and analog inputs and outputs.

LOCAL Mode: Providing local control and monitorin g of the drive using the Programming Pad.

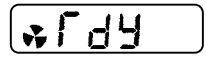
Local control keys are inactive when REMOTE mode is selected.

In REMOTE mode the drive uses a remote setpoint. In LOCAL mode, it uses the local setpoint parameter whose value is adjusted on the MMI.

NOTE: Changing between LOCAL and REMOTE mode is only available when the Inverter is stopped and either rdy or the local setpoint is displayed.

Changing REMOTE to LOCAL:

Press this key and hold until the display shows rdy



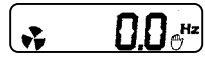
REMOTE

Press this key and hold until display shows LOC

LOCAL

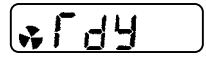
Changing LOCAL to REMOTE:

The local setpoint is displayed



LOCAL

Press this key and hold until LOC is removed from display



REMOTE

NOTE: For safety reasons, the drive will not return to REMOTE mode if this will cause the drive to start. Check RUN and JOG inputs are low.

IMPORTANT OPERATIONS WITH THE PROGRAMMING PAD

Resetting to Factory Defaults

To return all parameters of the FMV Frequency Inverter to factory default settings power-up the drive whilst holding the keys ▲ and ▼ and continue for at least 1 second. This loads Application 1. Then press the E key.

Password protection

When activated, the password prevents unauthorised parameter modification by making all parameters "read-only". Password protection is set-up using the P 99 parameter.

	Actions	Display	Explanation
	Activate		
1.	Select P 99 and press the M key	0000	
2.	Enter new password using the ▲ and ▼ keys	0001	for example
3.	Press E key repeatedly until top of menu is reached	rdy	Remote Setpoint or LOCAL Setpoint
4.	Press E key to activate password	rdy	Remote Setpoint or LOCAL Setpoint
	Default = 0000, de-activated. Any other value is a password		
	Temporary De-activation		
1.	Try to edit any parameter with password activated	PASS→ 0000	
2.	Enter current password using the ▲ and ▼ keys	0001	for example
3.	Press the E key		Original-parameter displayed, password de-activated.
	A drive will power-up with the last password status. Temporary de-activation is lost on power-down		
	Remove Password		
1.	Select P 99 and press M key	PASS→ 0000	
2.	Enter current password using the ▲ and ▼ keys	0001	for example
3.	Press the E key. Reset to 0000 using ▲ and ▼	0000	
4.	Press E to remove password	P 99	

Quick Application selection (MACRO selection)

To navigate immediately to the APPLICATION parameter (P1) form power-up press the key whilst power-up the drive, continue to hold for at least 1 second.

Then press the key to display the current application. Use the and keys to select the appropriate Application by number. press the key to load the Application. Refer to **Chapter 12 - Application Macros** for further information.

SETTING-UP AND ENERGIZING THE DRIVE

WARNING!

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 and the EMC filter 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 MM FMV 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 MM FMV Frequency Inverter before point-to-point checking with a buzzer or when checking insulation with a Megger.

4. Check for visual damage to MM FMV Frequency Inverter or associated equipment.
5. Check for loose ends, clippings, drilling swarf, etc., lodged in the MM FMV 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 energized. 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 MM FMV 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 terminal connection MOT/TEMP (Thermistor) is made.
4. Check that the external contact to input DIN 1, Run is open: Terminal 6-7
5. Check that the external speed setpoints are all zero.
6. Following careful adherence to 1... 5 above, connect main power supply to MM FMV Frequency Inverter.
7. Make sure that important parameters such as min/max speed, ramp times etc. all have factory default values (see Table 5.1 in **chapter 5**). 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 MM FMV Frequency Inverter.

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

Energizing the drive

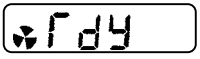
The following alternative methods of energizing the MM FMV Frequency Inverter are available:

- Energizing in the LOCAL mode 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 proceeding steps in this chapter the drive may be powered up as follows (preferably with the load disconnected):

1. Reconnect power. The following should be displayed:

in LOCAL Mode



in REMOTE Mode (if DIN1 = 0)

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

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
   - Adjust local set value as required with and keys.
   - From zero, release and press key again for a negative setpoint.

   Energizing in REMOTE mode with terminal control

   - Apply a small set value to AIN1: Between terminals 2 - 1
   - Activate digital input by linking the following terminals: Terminals 6 - 7

   Selecting LOCAL/REMOTE mode, refer to page 4-5
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 `STLL`.
7. If the motor current rating is smaller than the drive current rating then the `P6`parameter (see page 5-5) should be reduced to match the motor rating.

Chapter 5 - PROGRAMMING THE APPLICATION

GENERAL

Programming

The FMV Frequency Inverter can be programmed for customer specified applications.

The Frequency Inverter is supplied with applications (MACROS) which can be used as starting points for application-specific programming. This programming simply involves changing parameter values. Each application internally re-wires the drive for a different use when it is loaded.

Refer to **Chapter 12 - APPLICATION MACROS** for further Information.

Saving modifications

When parameter values are modified or an application is loaded, the new settings are saved automatically. The Inverter will retain the new settings during power-down.

Changing the parameter value

Stored parameter values can be changed in the Menus **Par** and **Set**.

1. Select the parameter to be changed and press M. The set value of the parameter is displayed.
2. Press the M key again to move the cursor from right to left.
3. Use the ▲ and ▼ keys to adjust the value. Hold the key momentarily to adjust the value marginally, or hold the key to make rapid changes, the rate of change varies with the time held.
4. Press E to return to the parameter display. The new value is stored.

Menu structure

The menu system is divided into a "tree structure" with 3 menu levels :

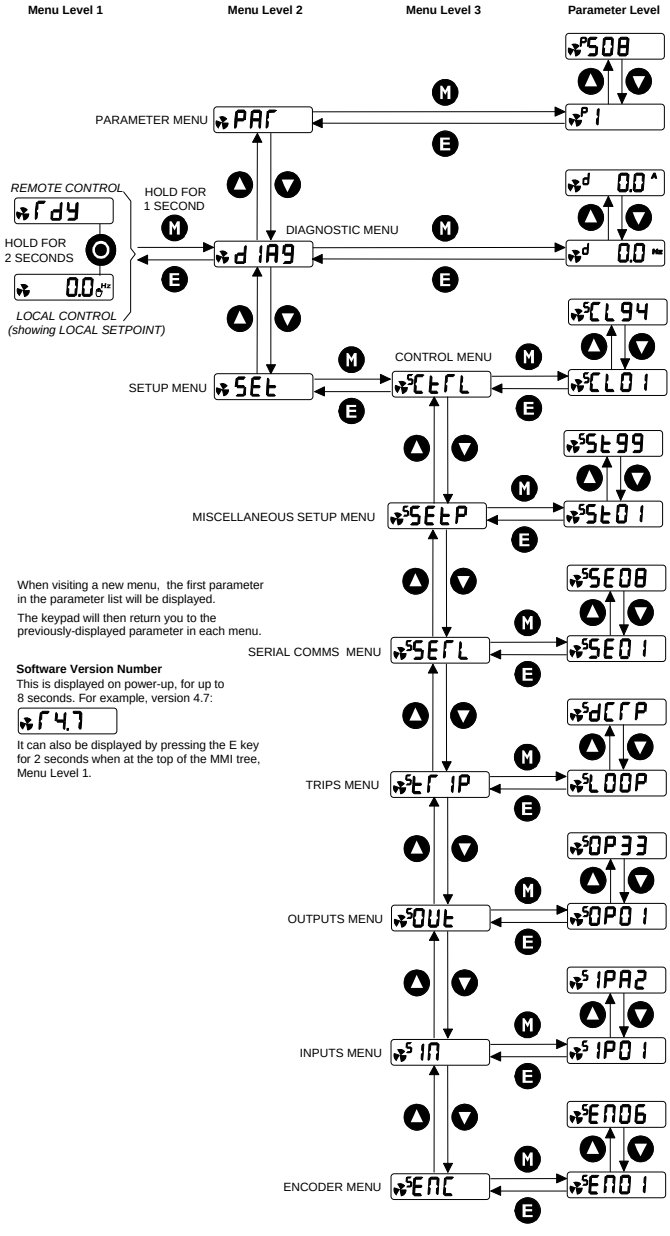


Fig. 5.1: Menu structure

MENU PARAMETER

In the menu PARAMETER parameters used for the majority of applications are described.

Key table for MMI parameters:

F	The parameters indicated with F will be displayed only with "Advanced Menu" (Refer to page 5-26 Parameter ***St99***).
M	The parameters indicated with M are motor parameters. These will not be reset if the application will be changed with parameter ***P1***; any other parameters will be reset to factory settings.
VF	The parameters indicated with VF will be displayed if V/F shape had been selected with parameter ***SCL01***.
SV	The parameters indicated with SV will only be displayed if sensorless vector operation had been selected with parameter ***SCL01***.

Note: The "range" of a parameter value is given in the table configurable parameters. Output ranges are indicated as "__.xx %", e.g. an undefined whole number with two decimals.

MENU TREE: 00 Hz \PAR\...

Application macros

Display	Parameter	Range:	Default
P 1	**APPLICATION**	see below	1

- 0 = APPLICATION 0 (does not control a motor)
- 1 = APPLICATION 1 Basic speed control
- 2 = APPLICATION 2 Manual/Auto
- 3 = APPLICATION 3 Presets
- 4 = APPLICATION 4 Raise/Lower
- 5 = APPLICATION 5 PID Control
- 6 = APPLICATION 6 Not used
- 7 = APPLICATION 7 Not used
- 8 = APPLICATION 8 Not used
- 9 = APPLICATION 9 Customer dependent

Note: Parameter values are changed to factory settings by loading a new application, except Motor Data parameters (indicated with M)

Maximum and minimum speed

Display	Parameter	Range from:	to:	Default
		7,5 Hz	240,0 Hz	50,0 Hz
P 2	**MAX SPEED** M	Speed/frequency at maximum setpoint input (100.0 %).		
		Range from:	**to:**	**Default**
		-100,0	100,0 %	0,0 %
P 3	**MIN SPEED**	Speed/frequency at minimum setpoint input. A percentage of the MAX SPEED parameter		

Ramps

Display	Parameter	Range from:	to:	Default
		0,0	3000,0 s	10,0 s
P 4	**ACCEL TIME**	Time taken to ramp the frequency from 0 Hz to Max speed		
		Range from:	**to:**	**Default**
		0,0	3000,0 s	10,0 s
P 5	**DECEL TIME**	Time taken to ramp from max. speed to 0 Hz		

Motor current

Display	Parameter	Range from:	to:	Default
		see below		
P 6	**MOTOR CURRENT** M	Power range	Frequency Inverter	set to
		0,37 kW	230 V	2,2 A
		0,75 kW	230 V	4,0 A
		1,5 kW	230 V	7,0 A
		0,75 kW	400 V	2,5 A
		1,5 kW	400 V	4,5 A
		2,2 kW	400 V	5,5 A
		3,0 kW	400 V	6,8 A
		4,0 kW	400 V	9,0 A
		5,5 kW	400 V	12,0 A
		7,5 kW	400 V	16,0 A

Base frequency

Display	Parameter	Range from:	to:	Default
		7,5	240,0 Hz	50,0 Hz/60 Hz
P 7	**BASE FREQUENCY** M	The output frequency at which maximum voltage is reached. The default depends on Product Code.		

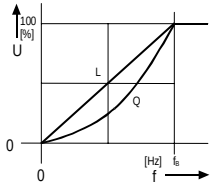
Jog setpoint

Display	Parameter	Range from:	to:	Default
		-100,0	100,0 %	0,0 %
P 8	**JOG SETPOINT**	Speed the Inverter will run at if the Jog input is activated. A percentage of the MAX SPEED parameter P2		

Run Stop selection

Display	Parameter	Range from:	to:	Default
		see below		0
P 9	**RUN STOP MODE**	0 = RAMP The motor speed is reduced to zero at a rate set by DECEL TIME (P5). A 2 sec pulse is applied at end of ramp 1 = COAST The motor is allowed to freewheel to a stillstand. 2 = INJECTION On a stop command , the motor volts are rapidly reduced at constant frequency to deflux the motor. A low frequency braking current is then applied until the motor speed is almost zero. This is followed by a timed DC pulse to hold the motor shaft (P5).		

V/F shape

Display	Parameter	Range from:	to:	Default
		see below		0
P II	**V/F SHAPE**	0 = LINEAR (Linear shape) Gives a constant flux characteristic up to max. BASE FREQUENCY 1 = QUADRATIC (Quadratic shape)  Gives a quadratic flux characteristic up to max. BASE FREQUENCY. This matches the load requirements for fan and most pump applications. Refer to P12.		

Current Limit

Display	Parameter	Range from:	to:	Default
P I2	HEAVY/NORMAL DUTY	see below		0

0 = CONSTANT
Current limit is set to = 150 % for 30 sec
or 127,5 % for 60 s

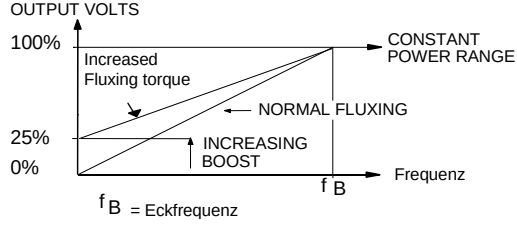
1 = QUADRATIC
Current limit is set to = 110 % for 10 sec

When P 11 is changed from FAN to LINEAR, P 12 is set to 0 (HEAVY).
When P 11 is changed from LINEAR to FAN, P 12 is set to 1 (NORMAL).
P 12 can be changed independently..

Fixed boost

Used to correctly flux the motor at low speeds. This allows the drive to produce greater starting torque for high friction loads. It increases the motor volts above the selected V/F characteristic at the lower end of the speed range.

Display	Parameter	Range from:	to:	Default
P I3	FIXED BOOST M VF	0,00	25,00 %	0,00 %



Password

Display	Parameter	Range from:	to:	Default
P 99	PASSWORD	0000	FFFF	0000

A password may be set to prohibit unauthorised adjustment of parameters. When P99 is set to non-zero you will be required to match this value before parameters can be adjusted.

Speed preset

NOTE: These parameters are only displayed if the MACRO 3 is selected with parameter P1.

Display	Parameter	Range from:	to:	Default
		-100,00	100,00	0
P 30I	**PRESET 0**	A user-adjustable speed preset set by potentiometer.		
		-300,00	300,00	20,00
P 302	**PRESET 1**	Adjustable speed preset		
		-100,00	100,00	50,00
P 303	**PRESET 2**	Adjustable speed preset		
		-100,00	100,00	100,00
P 304	**PRESET 3**	Adjustable speed preset		
		-100,00	100,00	-10,00
P 305	**PRESET 4**	Adjustable speed preset		
		-100,00	100,00	-20,00
P 306	**PRESET 5**	Adjustable speed preset		
		-100,00	100,00	-50,00
P 307	**PRESET 6**	Adjustable speed preset		
		-100,00	100,00	-100,00
P 308	**PRESET 7**	Adjustable speed preset		

Ramp function with preset speed

This parameters are only visible in the menu when the macro APPLICATION 4 is selected.

Display	Parameter	Range from:	to:	Default
		0,0	600,0	10,0 s
P 401	**R/L RAMP TIME**	The time taken to ramp the Raise/Lower output from 0.00 % to 100.00 % of its value.		
		-100,0	100,0	100,0 %
P 402	**R/L MAX VALUE**	Maximum value for the ramp output		

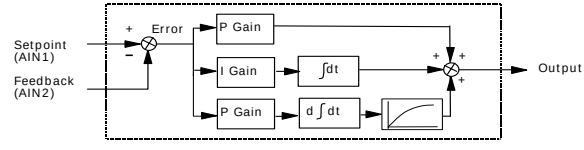
Display	Parameter	Range from:	to:	Default
P 403	**R/L MIN VALUE**	-100,0 Minimum value for the ramp output	100,0	0,0 %
P 404	**R/L RESET VALUE**	-100,0 The preset speed is reset to the set value of **R/L RESET VALUE** when DIN4 (terminal 10) is activated (=24 V)	100,0	0,00 %

PID controller

PI is used to control the response of any closed loop systems. It is used specifically in systems applications involving the control of drives to provide zero steady state error between setpoint and feedback, together with good transient performance.

This parameters are only visible in the menu when the macro APPLICATION 5 is selected in parameter **PI**.

Display	Parameter	Range from:	to:	Default
P 50I	**PI P GAIN**	0,00 Proportional Gain This is used to adjust the basic response of the closed loop control system. The PI error is multiplied by the Proportional Gain to produce an output.	100,00	1,00
P 502	**PI I GAIN**	0,00 Integral Gain The Integral term is used to reduce steady state error between the setpoint and feedback values of the PI. If the integral is set to zero, then there will always be steady state error.	100,00	0,00

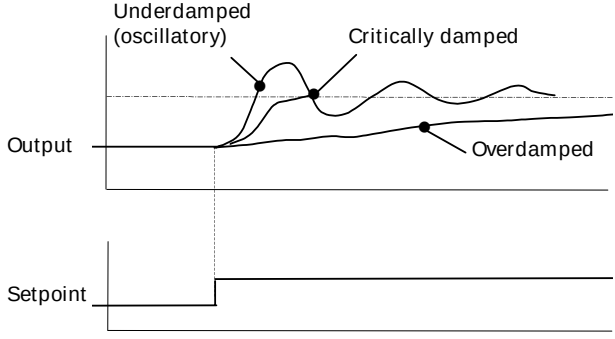


Functions as P, PI controller
Single symmetric limit on output

Display	Parameter	Range from:	to:	Default
		0,00	100,00	0,00
P 503 F	**PID D GAIN**	The PID derivative gain		
		0,05 s	10,00 s	0,05 s
P 504 F	**PID D FILTER TC**	In order to help attenuate high frequency noise on the derivative term, a first order lag has been provided. This parameter determines the filter time constant.		
		-10,00	10,00	1,00
P 505 F	**PID FEEDBACK GAIN**	A multiplier applied to the feedback signal of the PID		
		0,00 %	300,00 %	300,00 %
P 506 F	**PID LIMIT**	Determines the maximum positive and negative excursion (Limit) of the PID output.		
		-3.0000	3.0000	1.0000
P 507	**PID SCALING** F	This parameter represents an overall scaling factor which is applied after the PID positive and negative limit clamps.		
		—.xx %		—.xx %
P 508 F	**PID ERROR**	The result of SETPOINT – FEEDBACK x FEEDBACK GAIN		
		—.xx %		—.xx %
P 509	**PID OUTPUT** F	The output of the PID function block		

Method for Setting-up the PI Gains

The gains should be set-up so that a critically damped response is achieved for a step change in setpoint. An underdamped or oscillatory system can be thought of as having too much gain, and an overdamped system has too little.



To set up the P gain, set the I gain to zero. Apply a step change in setpoint that is typical for the System, and observe the response. Increase the gain and repeat the test until the system becomes oscillatory.

At this point, reduce the P gain until the oscillations disappear. This is the maximum value of P gain achievable.

If a steady state error is present, i.e. the feedback never reaches the setpoint value, the I gain needs to be increased. As before, increase the I gain and apply the step change. Monitor the output. If the output becomes oscillatory, reduce the P gain slightly. This should reduce the steady state error. Increasing the I gain further may reduce the time to achieve zero steady state error.

MENU DIAGNOSTICS

MENU TREE: 0.0 Hz \diA9\…

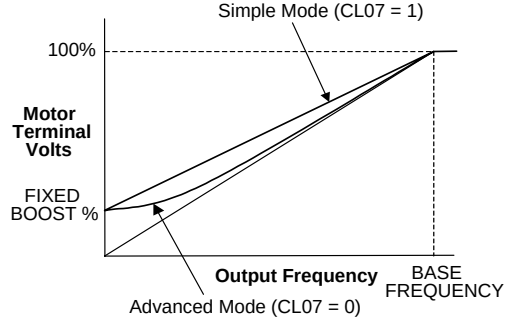
The menu **DIAGNOSTICS** customs useful parameters for diagnostics. Refer to **Chapter 6** for more details.

MENU CTRL

MENU TREE: 0.0 Hz \SEt\CtRL\…

Display	Parameter	Range from:	to:	Default
SCL0I	**CONTROL MODE**	0	1	0
		0 = VOLTS/HZ 1 = SENSORLESS VEC This parameter contains the main method of motor control used by the drive.		
SCL02	**NAMEPLATE RPM** M	0.1	30000.0 RPM	see below
		This parameter contains the motor nameplate full-load rated speed. This is the motor speed in rpm at base frequency minus full load slip (product code dependent)		
SCL03	**FLY-CATCH ENABLE** SV	0	1	0
		0 = FALSE 1 = TRUE - Enables flycatching in Sensorless Vector control mode when TRUE. Allows the drive to catch a spinning load.		
SCL04	**SLIP COMP ENABLE** VF	0	1	0
		0 = FALSE 1 = TRUE - Slip compensation is operational when TRUE. Eliminates motor speed variations under load conditions in V/F Fluxing Mode when the correct value for MAG CURRENT is entered into SCL14		
SCL05	**STABILISATION ENABLE** VF	0	1	1
		0 = FALSE 1 = TRUE - Enables the stabilisation function when TRUE. Eliminates light load speed variations in V/F Fluxing Mode.		

Display	Parameter	
		Range from: 0 **to:** 2 **Default** 0
SCL06	**VOLTAGE CONTROL MODE** VF	Control of output voltage independent of d.c. link voltage. 0 = NONE No attempt is made to control the PWM modulation depth for variations in dc link voltage. 1 = FIXED The drive's output volts are maintained, regardless of variations in the dc link voltage. The drive's product code sets the default value for demanded maximum output voltage (see MOTOR VOLTAGE below). 2 = AUTOMATIC- The drive performs controlled over-fluxing during motor deceleration.
		Range from: 0 **to:** 1 **Default** 0
SCL07	**BOOST MODE** F VF	Determines the relationship between fixed boost and terminal volts. 0 = FALSE Standard mode. Produces the terminal volts profile shown below (with Auto Boost set to 0.0 %). In this mode AUTO BOOST (CL08) should also be set to provide optimum low speed performance.. 1 = TRUE Advanced mode. Emulates the terminal volts profile provided by the MM1/2 inverter. This allows drop in replacement of the MM1/2 by the MM FMV. AUTO BOOST (SCL08) has no effect in this mode.



Display	Parameter	
SCL08	**AUTO BOOST** F M VF	**Range from:** 0.00 % **to:** 25.00 % **Default** 0.00 % This parameter allows for load dependent, stator resistance voltage-drop compensation. This correctly fluxes the motor (under load conditions) at low output frequencies, thereby increasing available motor torque.. AUTO BOOST is only used when BOOST MODE is set to 0. The value of the AUTO BOOST parameter determines the level of additional volts supplied to the motor for 100% load. Setting the value of AUTO BOOST too high can cause the drive to enter current limit. If this occurs, the time taken for the drive to reach operating speed will be extended. Reducing the value of AUTO BOOST will eliminate this problem..
SCL09	**ENERGY SAVING** F VF	**Range from:** 0 **to:** 1 **Default** 0 0 = FALSE 1 = TRUE The demanded volts are reduced to minimise energy consumption if the drive is operating in a steady state at light load
SCLI0	**MOTOR CURRENT** M SV	**Range from:** 0.01 A **to:** 999.99 A **Default** see below Motor nameplate full-load line current (product code dependent)
SCLII	**MOTOR POLES** M SV	**Range from:** siehe unten **to:** **Default** 4 2 = 2 pole 4 = 4 pole 6 = 6 pole 8 = 8 pole 10 = 10 pole 12 = 12 pole Number of motor poles, as supplied on the motor nameplate
SCLI2	**MOTOR VOLTAGE** M	**Range from:** 0.0 V **to:** 575.0 V **Default** see below Motor nameplate voltage at base frequency
SCLI4	**MAG CURRENT** M	**Range from:** 0.01 A **to:** 999.99 A **Default** see below Motor model no-load line current as determined by the Autotune, or taken from the motor nameplate

Display	Parameter	
SCLI5	**POWER** M SV	**Range from:** 0.00 kW **to:** 355.00 kW **Default** see below Motor nameplate power
SCLI6	**MOTOR CONNECTION** M SV	**Range from:** 0 **to:** 1 **Default** 1 0 = DELTA 1 = STAR Motor nameplate connection.
SCLI7	**STATOR RES** F M SV	**Range from:** 0.0000 Ω **to:** 250.0000 Ω **Default** see below Motor model per-phase stator resistance as determined by Autotune
SCLI8	**LEAKAGE INDUC** F M SV	**Range from:** 0.00 mH **to:** 300.00 mH **Default** see below Motor model per-phase leakage inductance as determined by Autotune
SCLI9	**MUTUAL INDUC** F M SV	**Range from:** 0.00 mH **to:** 300.00 mH **Default** see below Motor model per-phase mutual inductance as determined by Autotune
SCLIA	**ROTOR TIME CONST** F M SV	**Range from:** 10.00 ms **to:** 3000.00 ms **Default** see below Motor model rotor time constant as determined by Autotune
SCL20	**AUTOTUNE MODE** SV	**Range from:** 0 **to:** 1 **Default** 0 Selects the Autotune operating mode: 0 = STATIONARY 1 = ROTATING
SCL2I	**AUTOTUNE ENABLE** SV	**Range from:** 0 **to:** 1 **Default** 0 Determines whether the Autotune sequence is operational or not: 0 = FALSE 1 = TRUE - The Autotune sequence is operational when the drive is run

Display	Parameter	
SCL8I	**CURRENT LIMIT** F	**Range from:** 0.00 % **to:** 300.00 % **Default** 300.00 % This parameter sets the level of motor current, as a % of MOTOR CURRENT (SCL10) at which the drive begins to take current limit action.
SCL82	**POS TORQUE LIMIT** F	**Range from:** -500.0 % **to:** 500.0 % **Default** 200.0 % This parameter sets the maximum allowed level of positive motor torque.
SCL83	**NEG TORQUE LIMIT** F	**Range from:** -500.0 % **to:** 500.0 % **Default** 200.0 % This parameter sets the maximum allowed level of negative motor torque.
SCL84	**STALL TRIP TYPE** F	**Range from:** 0 **to:** 1 **Default** 1 This parameter determines whether the stall trip operates on motor torque or motor current: 0 = FALSE TORQUE 1 = TRUE CURRENT
SCL9I	**SPEED PROP GAIN** F M SV	**Range from:** 0.00 **to:** 300.00 **Default** see below Sets the proportional gain of the loop. Speed error (revolutions per second) x proportional gain = torque percent.
SCL92	**SPEED INT TIME** F M SV	**Range from:** 1 ms **to:** 15000 ms **Default** see below This is the integral time constant of the speed loop. A speed error which causes the proportional term to produce a torque demand T, will cause the integral term to also ramp up to a torque demand T after a time equal to “speed int time”.
SCL93	**SPEED POS LIMIT** F SV	**Range from:** -110.00 % **to:** 110.00 % **Default** 110.00 % This sets the upper limit of the speed demand.
SCL94	**SPEED NEG LIMIT** F SV	**Range from:** -110.00 % **to:** 110.00 % **Default** -110.00 % This sets the lower limit of the speed demand.

MENU SETUP

NOTE: Control terminal 10 DIN4 / DOUT2 can be used as Digital Input DIN4 or Digital Output DOUT2.

Input Menu

MENU TREE: 00 Hz \SEt\In\.....

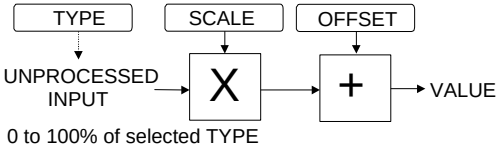
Digital Inputs

Display	Parameter	Range from:	to:	Default
		0	1	0
S iP0i	**DIN 1 INVERT**	Inverts the value of the signal, TRUE or FALSE 0 = not inverted 1 = inverted		
S iP02	**DIN 2 INVERT**	0 as S iP01	1	0
S iP03	**DIN 3 INVERT**	0 as S iP01	1	0
S iP04	**DIN 4 INVERT**	0 as S iP01	1	0
S iP05	**DIN 5 INVERT**	0 as S IP0I	1	0
S iP06	**DIN 6 INVERT**	0 as S IP0I	1	0
S iP07	**DIN 7 INVERT**	0 as S IP0I	1	0

To use the terminal 10 as Digital Input the parameters S OP2i and S OP22 must be set to "0". To invert the logic of the Digital Input the parameter S IP04 must be set to "1".

Analog Inputs

Display	Parameter			
		Range from:	**to:**	**Default**
S IPii	**AIN1 SCALE**	-300,00 %	300,00 %	100,00 %



		Range from:	**to:**	**Default**
S IPi2	**AIN 1 OFFSET**	-300,00 %	300,00 %	0,00 %

Display	Parameter			
		Range from:	**to:**	**Default**
S IPi3	**AIN 1 TYPE**	0	1	0

0 = 0-10 V
1 = 0-5 V

		Range from:	**to:**	**Default**
S IP2i	**AIN 2 SCALE**	-300,00 %	300,00 %	100,00 %
		Range from:	**to:**	**Default**
S IP22	**AIN 2 OFFSET**	-300,00 %	300,00 %	0,00 %
		Range from:	**to:**	**Default**
S IP23	**AIN 2 TYPE**	0	3	3

0 = 0-10 V
1 = 0-5 V
2 = 0-20 mA
3 = 4-20 mA

		Range from:	**to:**	**Default**
S IPdi F	**DIN1 VALUE**	0 = FALSE	1 = TRUE	0 = FALSE

Displays the status of the digital input 1

		Range from:	**to:**	**Default**
S IPd2 F	**DIN2 VALUE**	0 = FALSE	1 = TRUE	0 = FALSE

Displays the status of the digital input 2

		Range from:	**to:**	**Default**
S IPd3 F	**DIN3 VALUE**	0 = FALSE	1 = TRUE	0 = FALSE

Displays the status of the digital input 3

Display	Parameter	Range from:	to:	Default
		0 = FALSE	1 = TRUE	0 = FALSE
S IPd4 F	**DIN4 VALUE**	Displays the status of the digital input 4		
		Range from:	**to:**	**Default**
		0 = FALSE	1 = TRUE	0 = FALSE
S IPd5 F	**DIN5 WERT**	Displays the status of the digital input 5		
		Range from:	**to:**	**Default**
		0 = FALSE	1 = TRUE	0 = FALSE
S IPd6 F	**DIN6 WERT**	Displays the status of the digital input 6		
		Range from:	**to:**	**Default**
		0 = FALSE	1 = TRUE	0 = FALSE
S IPd7 F	**DIN7 WERT**	Displays the status of the digital input 7		
		Range from:	**to:**	**Default**
		–.x %		–.x %
S IPAi F	**AIN1 VALUE**	Displays the status of the digital output AIN1 with offset and scaling applied.		
		Range from:	**to:**	**Default**
		–.x %		–.x %
S IPA2 F	**AIN2 VALUE**	Displays the status of the digital output AIN2 with offset and scaling applied.		

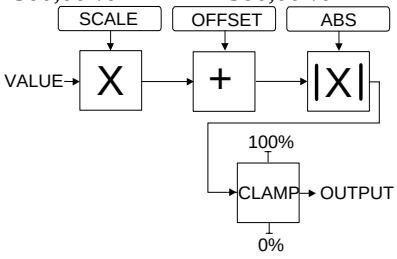
Output-Menu

MENU TREE: 00 Hz \SEt\0ut\.....

Analog Output

Display	Parameter	Range from:	to:	Default
		0	4	1
S OP0i	**AOUT 1 SOURCE**	**ANALOG OUTPUT** 0 = NONE 1 = DEMAND % 2 = CURRENT % 3 = PI ERROR % 4 = RAISE/LOWER OUTPUT %		

Display	Parameter	Range from:	to:	Default
S 0P02	**AOUT 1 SCALE**	-300,00 %	300,00 %	100,00 %



Display	Parameter	Range from:	to:	Default
S 0P03	**AOUT 1 OFFSET**	-300,00 %	300,00 %	0,00 %

Display	Parameter	Range from:	to:	Default
S 0P04	**AOUT 1 TYPE**	0	1	0

▼ 0 = not absolute
▲ 1 = absolute

Display	Parameter	Bereich von:	bis:	Werkseinstellung
S 0P05	**AOUT 1 VALUE** F	-300.0 %	300.0 %	0.0 %

Digital Outputs

Display	Parameter	Range from:	to:	Default
S 0P2i	**DIN4/ DOUT 2 SOURCE**	0	5	0

DIN4/DOUT2

▼ 0 = NONE
1 = HEALTH
2 = TRIPPED
3 = RUNNING
4 = AT ZERO
5 = AT SPEED
▲ 6 = AT LOAD

as S 0P31

Display	Parameter	Range from:	to:	Default
S 0P22	**DIN4/ DOUT 2 INVERT**	0	1	0

▼ 0 = not inverted
▲ 1 = inverted
as S iP0i Set to 0 in APPLICATION MACROS 1 & 5

Display	Parameter	Bereich von:	bis:	Werkseinstellung
S 0P23	**DOUT 2 VALUE** F	0 FALSE	1 TRUE	0 FALSE

The TRUE or FALSE output demand.

To use the terminal 10 as Digital Output the parameter S OP2i must be set to "1, 2, 3, 4, 5 or 6".
To invert the logic of the Digital Output the parameter S OP22 must be set to "1".

Relay Output

Display	Parameter	
		Range from: 0 **to:** 5 **Default** 1
S 0P3I	**RELAY SOURCE**	**Relay** 0 = NONE Relay is open 1 = HEALTH The run signal is not present, or no trip is active 2 = TRIPPED Relay is closed A trip is present 3 = RUNNING Motor is running 4 = AT ZERO The output frequency is below 1 % of max. speed (P2), with 1 % hysteresis 5 = AT SPEED The output frequency is within 1 % of max speed (P2), with 1 % hysteresis 6 = AT LOAD The magnitude of the output torque is greater than or equal to the torque level set in S St42
		Range from: 0 **to:** 1 **Default** 0
S 0P32	**RELAY INVERT**	as S iP01
		Range from: 0 **to:** 1 **Default**
S 0P33 F	**RELAIS VALUE**	Shows whether the relay is activated.

Trip Menu

MENU TREE: 0.0 Hz \SEt\trip\.....

Display	Parameter	
		Range from: 0 **to:** 1 **Default** 1
S loop	**DISABLE LOOP**	0 = Trip enabled 1 = Trip disabled
		Range from: 0 **to:** 1 **Default** 0
S t 3	**AIN2 OVERLOAD**	0 = enabled Disables the overload trip 1 = Alarm disabled (Terminal 3)
		Range from: 0 **to:** 1 **Default** 0
S stll	**DISABLE STALL**	0 = enabled 1 = disabled

Display	Parameter	Range from:	to:	Default
		0	1	0
S 0t	**DISABLE MOTOR OVERTEMP**	0 = enabled 1 = disabled		
		Range from:	**to:**	**Default**
		0	1	0
S It	**I*T INVERSE TIME**	0 = enabled 1 = disabled		
		Range from:	**to:**	**Default**
		0	1	1
S db r	**DYNAMIK BRAKE RESISTOR**	as S loop		
		Range from:	**to:**	**Default**
		0	1	1
S db S	**DYNAMIK BRAKE SWITCH**	as S loop		
		Range from:	**to:**	**Default**
		0	1	0
S SPd	**SPEED FEEDBACK**	as S loop		
		Range from:	**to:**	**Default**
		0	1	0
S OSPd	**OVERSPEED**	0 as S loop		
		Range from:	**to:**	**Default**
		0	1	0
S dIsP	**DISPLAY (KEYPAD)**	0 = enabled 1 = disabled		

SERL Menu

MENU TREE: 0.0 Hz \SEt\serl\.....

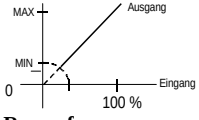
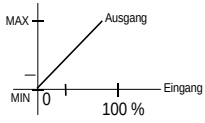
The SERL Menu is only visible if the parameter ST99 is set to "1".

Display	Parameter	Range from:	to:	Default
		0	1	0
S SE0I F	**REMOTE COMMS SEL**	0 = FALSE Control is from the terminals 1 = TRUE Control is from the communications Type of control if REMOTE MODE is selected		
		Range from:	**to:**	**Default**
		0.0	600.0 s	0.0 s
S SE02 F	**COMMS-TIMEOUT**	Sets the maximum time allowed between refreshing the COMMS COMMAND parameter. The drive will trip if this time is exceeded. Set the time to 0.00 seconds to disable this feature.		

Display	Parameter	
		Range from: 0 **to:** 255 **Default** 0
S SE03 F	**COMMS ADDRESS**	The drives identity address. Note: If set to 0, it will only respond to broadcast messages
Display	**Parameter**	**Range from:** 0 **to:** 8 **Default** 0
S SE04 F	**BAUD RATE**	0 = 1200 1 = 240 2 = 4800 3 = 7200 4 = 9600 5 = 14400 6 = 19200 7 = 38400 8 = 57600 Selects the Baud Rate for the MODBUS protocol
		Range from: 0 **to:** 2 **Default** 0
S SE05 F	**PARITY**	0 = NONE 1 = ODD 2 = EVEN Selects the Parity for the MODBUS protocol.
		Range from: 0 **to:** 200 **Default** 5 ms
S SE06 F	**REPLY DELAY ms**	The time in milliseconds between the drive receiving the complete request from the communications master (PLC/PC) and replying to this request.
		Range from: 0 **to:** 4 **Default** 0
S SE07 F	**OP PORT PROTOCOL**	0 = AUTOMATIC 1 = KEYPAD 2 = EIBISYNC ASCII 3 = MODBUS 4 = FIELDBUS FIELDBUS is reserved for future use. Selects the protocol to be used by the keypad port on the front of the drive. When EIBISYNC ASCII is selected, BAUD RATE is 19200 and PARITY is EVEN.
		Range from: 0 **to:** 4 **Default** 0
S SE08 F	**P3 PORT PROTOCOL**	0 = AUTOMATIC 1 = KEYPAD 2 = EIBISYNC ASCII 3 = MODBUS 4 = FIELDBUS Selects the protocol to be used by the RS232 programming port on the drive's control board. When EIBISYNC ASCII is selected, BAUD RATE is 19200 and PARITY is EVEN. FIELDBUS is reserved for future use. NOTE: These parameter is only suitable, if the Frequency Inverter is delivered with an integrated RS232 programming port.

Diverse Setup Menu

MENU TREE: 0.0 Hz \SEt\setp\.....

Display	Parameter	Range from:	to:	Default
		0,0 s	3000,0 s	1,0 s
S st0I	**JOG ACCEL TIME**	as P4, for jog		
		Range from:	**to:**	**Default**
		0,0 s	3000,0 s	1,0 s
S st02	**JOG DECEL TIME**	as P5, for jog		
		Range from:	**to:**	**Default**
		0 = LINEAR	1 = S	0
S st03	**RAMP TYPE**	Selects the ramp type		
		Range from:	**to:**	**Default**
		0,01 s^3	100,00 s^3	10,0 sec^3
S st04	**S RAMP JERK**	Rate of change of acceleration of the curve in units per sec^3		
		Range from:	**to:**	**Default**
		0 = FALSE	1 = TRUE	1
S st05	**S RAMP CONTINOUS**	When TRUE and the S ramp is selected, forces a smooth transition if the speed setpoint is changed when ramping. The curve is controlled by the S RAMP JERK parameter. When FALSE, there is an immediate transition from the old curve to the new curve.		
		Range from:	**to:**	**Default**
		0 = PROP.W/MIN	1= LINEAR	0
S st06	**MIN SPEED MODE**	Processing of setpoint:		
		0 = PROP.W/MIN		1 = LINEAR
				
		Range from:	**to:**	**Default**
		0,0 Hz	240,0 Hz	0,0 Hz
S stII	**SKIP FREQUENCY 1**	Centre frequency of skip band 1		
		Range from:	**to:**	**Default**
		0,0 Hz	60,0 Hz	0,0 Hz
S stI2	**SKIP FREQUENCY BAND 1**	Width of skip band 1		
		Range from:	**to:**	**Default**
		0,0 Hz	240,0 Hz	0,0 Hz
S stI3	**SKIP FREQUENCY 2**	Centre frequency of skip band 2		
		Range from:	**to:**	**Default**
		0,0 Hz	60,0 Hz	0,0 Hz
S stI4	**SKIP FREQUENCY BAND 2**	Width of skip band 2		

Auto restart

Display	Parameter	
		Range from: 0 **to:** 10 **Default** 0
S st2I	**AUTO RESTART ATTEMPTS**	Determines the number of restarts that will be permitted before requiring an external fault reset
		Range from: 0,0 **to:** 600,0 s **Default** 10,0 s
S st22	**AUTO RESTART DELAY**	Determines the delay between restart attempts for a trip included in AUTO RESTART TRIGGERS and AUTO RESTART TRIGGERS+. The delay is measured from all error conditions clearing.
		Range from: 0x000 **to:** 0xFFFF **Default** 0x0000
S st23	**AUTO RESTART TRIGGERS**	Allows AUTO RESTART to be enabled for a selection of trip conditions. Refer to page 6-5 - Hexadecimal representations of trips.
		Range from: 0x000 **to:** 0xFFFF **Default** 0x0000
S st24	**AUTO RESTART TRIGGERS+**	Allows AUTO RESTART to be enabled for a selection of trip conditions. Refer to page 6-5 - Hexadecimal representations of trips.
		Range from: 0 = FALSE **to:** 1 = TRUE **Default** 1
S st3I	**DB ENABLE**	Enables operation of the dynamic braking.
		Range from: 1 **to:** 1000 Ω **Default** see below
S st32	**DB RESISTANCE**	The value of the load resistance (product code dependent)
		Range from: 0.1 kW **to:** 510.0 kW **Default** see below
S st33	**DB POWER**	Product code dependent
		Range from: 1 **to:** 40 **Default** 25
S st34	**DB OVERRATING**	Power overloads lasting no more than 1 s
		Range from: —.xx % **to:** —.xx % **Default** —.xx %
S st4I	**TORQUE FEEDBACK**	Shows the estimated motor torque, as a percentage of rated motor torque.
		Range from: -300.0 % **to:** 300.0 % **Default** 100.0 %
S st42	**TORQUE LEVEL**	Sets the value of load at which AT LOAD becomes TRUE. See S OP2I and S OP3I.

Display	Parameter	
		Range from: 0 = FALSE **to:** 1 = TRUE **Default** 0
S st43	**USE ABS TORQUE** F	0 = FALSE The direction of rotation is not ignored. Driving a load in the reverse direction gives a negative value for torque. In this case, the comparison level may be positive or negative. 1 = TRUE The direction of rotation is ignored. In this case, the comparison level should always be positive. **Range from:** 0.0 **to:** 100.0 % **Default** 0.0 %
S st51	**LOCAL MIN SPEED** F	The magnitude of the minimum setpoint that will be used when running in Local Mode. **Range from:** 0000 **to:** FFFF **Default** FFFF
S st52	**ENABLED KEYS** F	The following keys on the MM O-FeP-PROG1 keypad can be enabled or disabled separately. The combination produces the parameter setting as in the table below. The default of FFFF enables all keys.

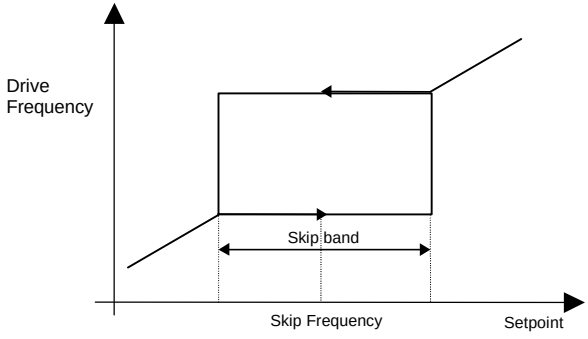
Parameter Setting	RUN	L/R	JOG	DIR
0000	-	-	-	-
0010	-	-	-	ENABLED
0020	-	-	ENABLED	-
0030	-	-	ENABLED	ENABLED
0040	-	ENABLED	-	-
0050	-	ENABLED	-	ENABLED
0060	-	ENABLED	ENABLED	-
0070	-	ENABLED	ENABLED	ENABLED
0080	ENABLED	-	-	-
0090	ENABLED	-	-	ENABLED
00A0	ENABLED	-	ENABLED	-
00B0	ENABLED	-	ENABLED	ENABLED
00C0	ENABLED	ENABLED	-	-
00D0	ENABLED	ENABLED	-	ENABLED
00E0	ENABLED	ENABLED	ENABLED	-
00F0	ENABLED	ENABLED	ENABLED	ENABLED

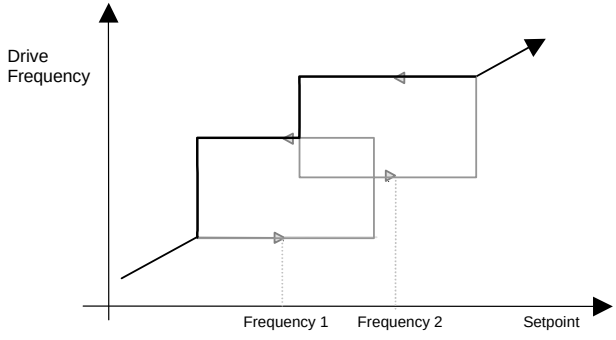
When using the standard MM O-FM-PROG-TTL and MM O-FEV-PROG keypad, disabling the **DIR** key prevents the local setpoint going negative (for reverse). Similarly, disabling the **L/R** key prevents the drive being changed from Local to Remote, or Remote to Local modes.

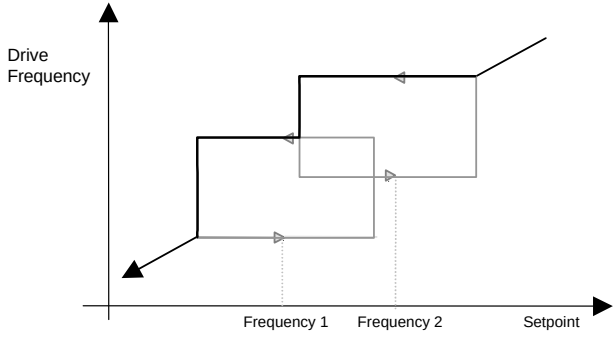
S st98	**APPLICATION LOCK** F	**Range from:** 0 = FALSE **to:** 1 = TRUE **Default** 0 Setting this parameter to TRUE prevents editing of parameter P1. Set this parameter to FALSE to edit parameter P1 **Range from:** 0 = PARTIAL **to:** 1 = FULL **Default** 0
S st99	**MENU DETAIL**	Selects FULL or PARTIAL menu detail. The additional parameters in the FULL menus are indicated with **F**.

Skip frequencies

Two programmable skip frequencies are available to avoid resonances within the mechanical system. Enter the value of frequency that causes the resonance using the FREQUENCY parameter and then programme the width of the skip band using its BAND parameter. The Inverter will then avoid sustained operation within the forbidden band as shown in the diagram.







MENU ENCODER

Display	Parameter	
S EN0I F	**ENC MODE**	**Range from:** 0 **to:** 2 **Default** 0 Set this parameter to the requirements for your encoder: 0 = QUADRATURE (Digital inputs 6 & 7,ENCA and ENCB respectively). 1 = CLOCK/DIR (Digital inputs 6 & 7, ENCA and ENCB respectively). 2 = CLOCK (Digital input 6, ENCA)
S EN02 F	**ENC RESET**	**Range from:** 0 = FALSE **to:** 1 = TRUE **Default** 0 1 = TRUE POSITION and SPEED outputs are set (and held) at zero
S EN03 F	**ENC INVERT**	**Range from:** 0 = FALSE **to:** 1 = TRUE **Default** 0 1 = TRUE Changes the sign of the measured speed and the direction of the position count
S EN04 F	**ENC LINES**	**Range from:** 100 **to:** 1000 **Default** 100 The number of lines must be set to match the type of encoder being used. Incorrect setting of this parameter will result in an erroneous speed measurement.
S EN05 F	**ENC SPEED SCALE**	**Range from:** 0.00 **to:** 300.00 **Default** 1.00 This parameter allows the output "speed" to be scaled to any value the user requires. With setting: 1.00 output is in revs per second 60.00 output is in revs per minute To provide an output in percent of the motor maximum speed, where maximum speed is the maximum speed your motor will run in rpm, the ENC SPEED SCALE parameter should be set to the result of: $\text{ENC SPEED SCALE} = \frac{6000}{\text{maximum speed (rpm)}}$
S EN06 F	**ENC SPEED**	**Range from:** —.x **to:** **Default** —.x Speed feedback, in units defined by S EN05 .

Chapter 6 - TRIPS, DIAGNOSTICS AND FAULT FINDING

Page

INTRODUCTION

The MM FMV 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 MM FMV Frequency Inverters:

Trip warning message

The trip display message is flashed repeatedly on the screen to warn of an imminent trip. Some trip conditions need time to take effect. The warning can allow you time to rectify the situation.

The message will clear when the Operator Station is used, but after a short time will reappear until the problem is resolved, or the drive trips.

When a trip occurs

When a trip occurs, the Inverter's power stage 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 disabled, even when the original cause of the trip is no longer present.

Resetting a trip

All trips must be reset before the Inverter can be re-enabled. 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. A trip can be reset as follows:

1. Press the ⊙ key to reset the trip and clear the alarm form the display.
2. Remove and then re-apply the RUN command and the drive will run normally.

Success is indicated by either `rdy` or the Local Setpoint being displayed.

Using the Operator Station to manage trips

Trip Messages

If the Inverter trips, then the display immediately shows a message indicating the reason for the trip. The possible trip messages are given in the table below.

TRIPS

Display	Trip Message	Meaning - Possible Cause for trip
A dCHI	**DCLINKHIGH**	The Inverter internal dc link voltage is too high - The supply voltage is too high - Trying to decelerate a large inertia load too quickly, DECEL TIME time too short. - The brake resistor is open circuit (400 V unit only)
A dCL0	DCLINK LOW	- DC LINK low trip. - Supply is too low/power down
A 0C	OVERCURRENT	The motor current being drawn from the Inverter is too high - Trying to accelerate a large inertia load too quickly; ACCEL TIME time is too short - Trying to decelerate a large inertia load too quickly; DECEL TIME time too short. - Application of shock load to motor. - Short circuit between motor phases. - Short circuit between motor phases and earth. - Motor output cables too long or too many parallel motors connected to the Inverter. - FIXED BOOST level set too high.
A HOt	HEATSINK OVER TEMPERATURE	Drive heatsink temperature >10 °C - The ambient air temperature is too high - Poor ventilation or spacing between Inverters
A Et	EXTERNAL TRIP	External trip input is high. Check configuration to identify the source of the signal (non-standard configuration
A LOOP	LOST LOOP (Disable: S LOOP)	- A current of less than 1 mA is preset when 4-20 mA setpoint is selected - look for a wire break.
A StLL	STALL (Disable: S StLL)	The motor has stalled (not rotating). Drive in current limit >200 sec. - Motor loading too great - FIXED BOOST level set too high
A t 3	TERMINAL 3 OVERLOAD	AIN2 overload - overcurrent applied in Current mode.

Display	Trip Message	Meaning - Possible Cause for trip
AdISP	DISPLAY (keypad)	Keypad disconnected from drive whilest drive is running in Local mode. (Check from second keypad)
ASCI	SERIELLE COMMS	- Motor failed - Wiring disconnected - Incorrect comms setup
ACNtC	CONTACTOR FEEDBACK	- Check wiring - Check terminal wired to "contactor closed" parameter
A Ot	MOTOR OVERTEMPERATURE	Motor temperature too high - Excessive load - Incorrect motor voltage rating - Fixed Boost level set too high - Prolonged operation at low speed - Break in motor thermistor connection
AI HI	CURRENT LIMIT	Software overcurrent trip - see OVERCURRENT above
ALSPd	OVERCURRENT F=0	Motor current >100 % at zero output frequency FIXED BOOST level set too high
At 4	TERMINAL 4 OVERLOAD	-10 V REF overload warning -10 mA maximum
AShRt	DESTURATION	Instantaneous overcurrent, refer to OVERCURRENT
AdCRP	DC LINK RIPPLE	A dc link ripple alert - Supply imbalance in a 3-phase system - Poor supply regulation an a 1-phase system
AdbSC	DYNAMIC BRAKE SHORT	- Brake resistor overcurrent - Brake resistor value is greater than minimum allowed
At 5	TERMINAL 5 OVERLOAD	AOUT1 overload-10 mA maximum
At 9	TERMINAL 9 OVERLOAD	DIN3 overload -20 mA maximum
At I0	TERMINAL 10 OVERLOAD	DIN4/DOUT2 overload -50 mA maximum

Display	Trip Message	Meaning - Possible Cause for trip
A tRIP	UNKNOWN TRIP	Unknown trip
A tR32	OTHER	Other trip is active (Trip ID33)
A ICAL	ZERO I CURRENT CALIBRATION	Current sensor calibration fault. Switch inverter off/on. If persistent, return inverter to supplier
A COdE	PRODUCT CODE ERROR	Switch inverter off/on. If persistent, return inverter to supplier
A Cal	CALIBRATION DATA ERROR	Switch inverter off/on. If persistent, return inverter to supplier
A dAtA	CONFIGURAT DATA ERROR	Switch inverter off/on. If persistent, return inverter to supplier

Hexadecimal Representation of Trips

The tables below show the possible parameter values for the AUTOMATIC RESTART TRIGGERS and the AUTOMATIC RESTART TRIGGERS+ (Parameter **S ST23** and **S ST24**)

ID	Display	Trip Name	Mask	Disable	Description
0		NO ALARM	0x0000	N/A	No trip present
1	DCHI	OVERVOLTAGE	0x0001		Over voltage
2	DCLO	UNDERVOLTAGE	0x0002		Under voltage
3	OC	OVERCURRENT	0x0004		Over current
4	HOT	HEATSINK	0x0008	x	Heatsink over-temperature
5	ET	EXTERNAL TRIP	0x0010	x	External trip
7	LOOP	LOOP	0x0080	x	AIN2 current input signal >1 mA
8	STLL	MOTOR STALLED	0x0100	x	Motor stalled
9	T3	AIN2 FAULT (T3)	0x8000	x	Terminal 3: AIN2 overload (>22 mA)
13	SCI	DISPLAY / KEYPAD	0x1000	x	Comms watchdog timeout when in remote comms mode
14	CNTC	CONTACTOR FBK	0x2000	x	Contactor feedback (external contactor not closed within allowed time)

ID	Display	Trip Name	Mask	Disable	Description
17	0T	MOTOR OVERTEMP	0x0001	x	Motor over temperature
18	IHI	CURRENT LIMIT	0x0002	x	High current >180 % for 1 second
21	LSPD	LOW SPEED OVER I	0x0010	x	Motor current >100 % with frequency = 0
22	T4	10VREF (T4)	0x0020	x	Terminal 4: 10 V output overload WARNING ONLY!
24	SHRT	SHORT CIRCUIT	0x0080	x	Short circuit on motor output
25	DCRP	VDC RIPPLE	0x0100	x	DC ripple
26	DBSC	BRAKE SHORT CIRCUIT	0x0200	x	Short circuit across dynamic brake resistor
28	T5	AOUT1	0x0800	x	Terminal 5: Analog output overload WARNING ONLY!
29	T9	DIN3	0x1000	x	Terminal 9: Digital output overload
30	T10	DIN4/DOUT2	0x2000	x	Terminal 10: Digital output overload
31	TRIP	UNKNOWN	0x4000		Unknown trip
33	ICAL	CURRENT CALIB	0x8000		Zero current calibration

When more than one trip is to be represented at the same time then the trip codes are simply added together to form the value displayed. Within each digit, values between 10 and 15 are displayed as letter A to F (e.g. 11 = the letter B).

Example:

In parameter AUTOMATIC RESTART TRIGGERS 00C3 is displayed:

		2	1		Value of correcting variable	
0	0	C	3	No	3	= added from:
					1	= Over voltage *
					2	= Under voltage *
				Letter	C	= Value 12, added from:
					8	= Motor stalled *
					4	= Loop *

* refer to table Hexadecimal Representation of Trips

MAIN MENU - **DIAGNOSTICS**

Display	Trip Message	Meaning - Possible Cause for trip
0.0 Hz	FREQUENCY	Output frequency in Hz
0.0 %	SPEED SPT	The set point as a percentage MAX SPEED (Max. speed)
0.0 V	DC LINK VOLTS	Vac √2 = DC link volts
0.0 A	MTR CURRENT	The current load value in Amps

OTHER FAULT FINDING

Problem	Possible Cause	Cure
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

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

Cooling system:
- Is the fan 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 MM FMV Frequency Inverter is securely mounted

Terminals:
- Make sure all wires are securely clamped

REPAIR

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

WARNINGS!

Before disconnecting the MM FMV 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 potentially lethal electrical shock hazard.

SAVING APPLICATION DATA BEFORE RETURNING EQUIPMENT

Although the MM FMV 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. The parameter settings should be noticed before the Inverter will be returned.

RETURNED EQUIPMENT

The following procedures are recommended in the unlikely event of a fault which necessitates return of a MM FMV 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 MM FMV 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, recyclable 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 MM FMV 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, THE 'CE' MARKING, UL, CSA

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.

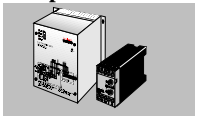
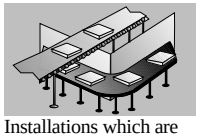
- The **'CE'** Mark is used as passport for products in the European Economic Community, and is only intended to secure unrestricted movement of products and goods. It is sufficient for the supervisory authorities as proof that the product was manufactured, with a high probability that all of the directives 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 for 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 for 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 MM FMV.
- The product liability is exactly the same both with and without **'CE'** Mark
- MM FMV Frequency Inverters 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 MM FMV Frequency Inverters is 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 		**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
Components or spare parts which cannot be operated alone Electronic drive equipment such as MM FM Frequency Inverters	**CE mark** **Responsibility:** - Manufacturer/supplier of MMFMV Frequency Inverter - User	required - EMC responsibility of MM FMV Frequency Inverter - Must stock and supply required EMC filters - EMC installation instructions must be easily understood and suitable for implementation by a laymen - Implementation of the EMC installation instructions (Chapter 3) - Final responsibility for EMC	not required - Providing suitable EMC installation instructions - Final responsibility for EMC
Installation 		CEMEP-3	
	EC Declaration of Conformity	not required	
	CE mark	not required	
Installations which are assembled on site such as pump stations, chemical plants, steel mills using MM FMV Frequency Inverters	**Responsibility:** - Manufacturer/supplier of MM FMV 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	

Group definition with examples	**EC Conformity, CE Marking, responsibility**	
Apparatus, Machines  Apparatus and machines which are sold as a complete functional unit such as vacuum cleaners, lathes, palletising machines using MM FMV Inverters		CEMEP-4
	EC Declaration of Conformity	required
	CE mark	required
	Responsibility: - Manufacturer/supplier of MM FMV 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 MM FMV 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, MM FMV Frequency Inverters are "components". A clear distinction between the following two classes of components is required:

MM FMV 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 MM FMV 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** MM FMV 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 MM FMV Frequency Inverters, the manufacturer confirms that a power drive system (PDS) using a MM FMV Frequency Inverter 1AC 230 V with integrated EMC filter or 3AC 400 V 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.

MM FMV 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 MM FMV Frequency Inverter must have an "intrinsic function". An example of such an intrinsic function could be an existing fixed-speed

motor application (such as a fan or a pump) which is converted to variable speed drive by using a MM FMV Frequency Inverter. In such an application the end user would not necessarily be expected to have EMC expertise. The MM FMV Frequency Inverter with integrated EMC filter or MM FMV 3AC 400 V with approved external EMC filter must be used. The **'CE'** marking is valid provided the installation instructions 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 MM FMV Frequency Inverter

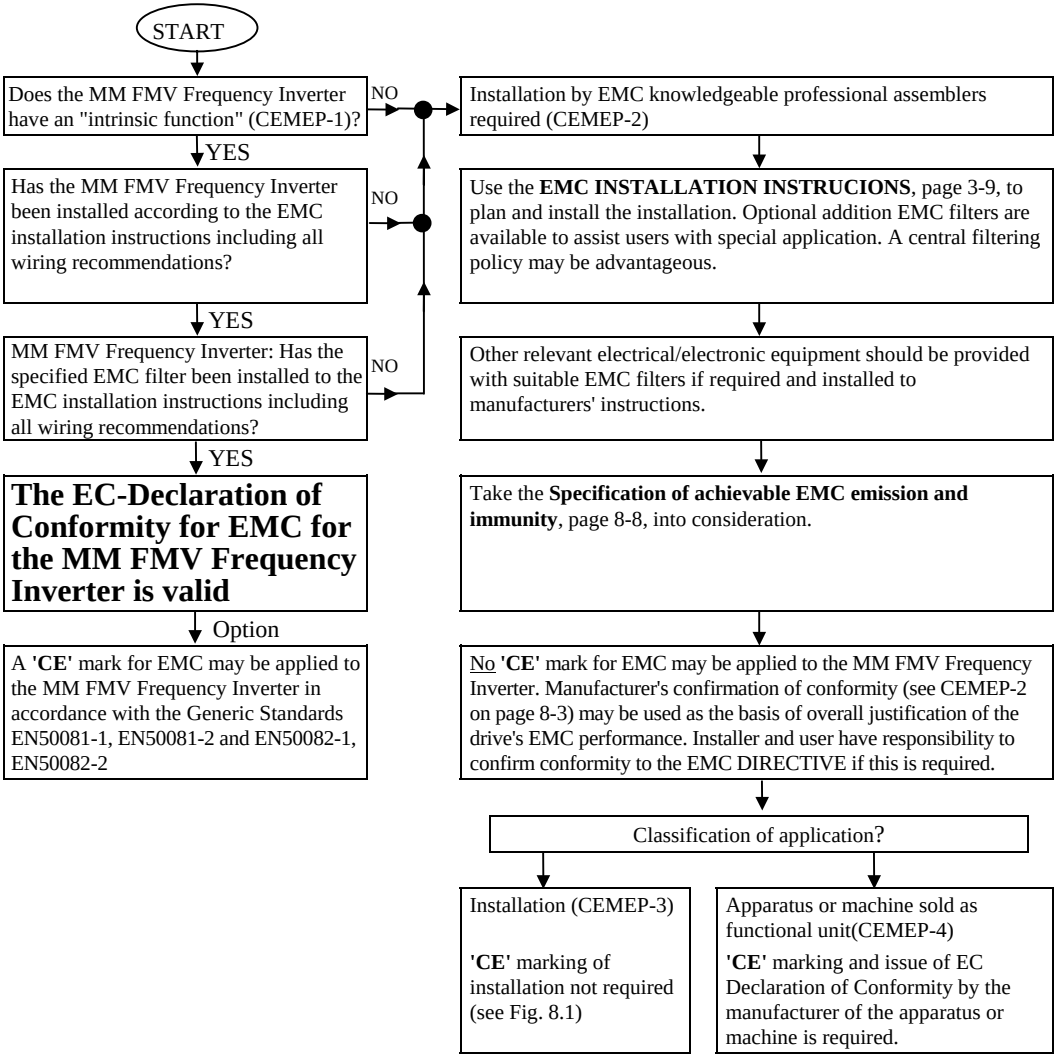
The **'CE'** mark for the LOW VOLTAGE DIRECTIVE is now mandatory, MM FMV Frequency Inverters are corresponding **'CE'** marked on the product rating label. This **'CE'** mark only applies for EMC if the validity chart (Fig. 8.2) confirms validity (only possible with CEMEP-1 classification).

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 MM FMV Frequency Inverter in accordance with the EMC DIRECTIVE in 1996.
- Requirements for obtaining **'CE'** approval for apparatus or machines using MM FMV 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 MM FMV Frequency Inverters.

Fig. 8.2: Validity chart of the 'CE' mark for EMC with MM FMV 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 users 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 stringent limits for RF interference are expected soon.

Fig. 8.3: EMC Interference and Immunity Standards applicable to MM FMV 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 with external EMC filter

MM FMV 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 MM FMV 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 MM FMV 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 MM FMV 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

MM FMV 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	Suitable Metal enclosure+	Class B	EN50081-1
			Wall mounting	Class A	EN50081-2
Power Port	Conducted	EN55011	all	Class B	EN50081-1 EN50081-2

+ Ask your supplier for further information

All MM FMV 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 with stand level	Acceptance Criterion	Generic standard
Enclosure Port	ESD	IEC 1000-4-2	6 kV CD, 8 kV AD	Self recovery	EN50082-2
	RF Field	IEC 1000-4-3	10 V/m, 1 kHz AM	No change	
		ENV 50140			
		ENV 50141			
	Voltage deviations and interruptions	ENV 50140			
	Low frequency magnetic field	IEC 1000-4-8			
Power Ports (supply voltage)	Fast Transient Burst	IEC 1000-4-4	2 kV	Self recovery	
	Surge	IEC 1000-4-5	1 kV (P-P), 2 kV (P-E)	Self recovery	
Signal & Control	Fast Transient Burst	IEC 1000-4-4	2 kV	Self recovery	
Power Interfaces	Fast Transient Burst	IEC 1000-4-4	2 kV	Self recovery	

Internal or recommended matching EMC filters for MM FMV 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 of installers and users of MM FMV Frequency Inverters in installations

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

For end users of MM FMV Frequency Inverters, a correctly installed power drive system (PDS) created from the supplied MM FMV 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 MM FMV Frequency Inverter and recommended EMC filter 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 standard, since when two compliant pieces of electrical/electronic equipment are brought together, the whole may not be compliant.

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 MM FMV 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

Manufacturer's EMC declaration

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

LOW VOLTAGE DIRECTIVE

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

MACHINERY DIRECTIVE

The MACHINERY DIRECTIVE requires **'CE'** marking of the complete machine. MM FMV 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

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 MM FMV 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 - POWER INDEPENDENT OPTIONS

RS232/485 interface

Equipment Code	Electrical data	Order no.
MM O-FMV-RS232/485	RS232/485 interface	08620.005
MM O-FMV-CON-RS232	RS232 Comm. cable	08620.007/00

LED Indications

The module has three LEDs providing diagnostic information about the MM FMV host drive's 'Health', 'Receive' and 'Transmit' activity.

HEALTH = Green, Rx = Red, Tx =Red

LED Name	LED Duty	Drive State
HEALTH	SHORT FLASH	Re-configuration, or corrupted non-volatile memory at power-up
	EQUAL FLASH	Tripped
	ON	Healthy
	LONG FLASH	Braking
	OFF	No drive power, or serious hardware fault
Rx	INTERMITTENT	Indicates activity on the 'receive' line carrying data from the Master
Tx	INTERMITTENT	Indicates activity on the 'transmit' line carrying data to the Master

For further information refer to **Product Manual Communications Interface RS 232/485** for MotorMaster FMV.

Chapter 10 - POWER RELATED OPTIONS

Summary of available options

230 V Types

MotorMaster Frequency Inverter	EMC Filter		Chokes		Motor-Filter	Braking resistor
	Limit A	Limit B	Line	Motor		
MM 0.37FMV/S230-EMC	integrated	integrated	A 1.5LE2+16	-	A 0.75OE+3.5	-
MM 0.75FMV/S230-EMC					A 1.5OE+4,5	-
MM 1.50FMV/S230-EMC					A 2.2OE+8	-

400 V Types

MotorMaster Frequency Inverter	EMC Filter		Chokes		Motor-Filter	Braking resistor
	Limit A	Limit B	Line	Motor		
MM 0.75FMCV-emc	integrated	MM A-FMV-2.2EE	A 2.2NE3+12	A 2.2NE3+12	A 0.75OE+3.5	A 0.08RE500
MM 1.50FMCV-emc					A 1.5OE+4.5	A 0.43RE220
MM 2.2FMCV-emc					A 2.2OE+8	A 0.43RE220
MM 3.0FMCV-emc	integrated	MM A-FMV-7.5EE	A 2.2NE3+12	A 2.2NE3+12	A 4.0OE+13	A 1.2RE100
MM 4.0FMCV-emc						
MM 5.5FMCV-emc			A 5.5NE3+15	A 5.5NE3+15	A 7.5OE+24	A 1.2RE56
MM 7.5FMCV-emc						

For further information refer to page 10-3.

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

EMC filters for 3AC 400 V types

The EMC filters described in the following are external filters. This filters can be mounted on the side of the Frequency Inverter or below.

Equipment code	Electrical data	Order no.
MM A-FMV-2.2EE	0,75 - 2,2 kW, -480V, 8 A	08613.312-200
MM A-FMV-7.5EE	3 - 7,5 kW, -480V, 22 A	08613.316-200

Refer to **EMC INSTALLATION INSTRUCTIONS** (pages 3-6...13) and to **EMC DIRECTIVE**
(pages 8-2...9) for important information on adhering to the EMC-DIRECTIVE

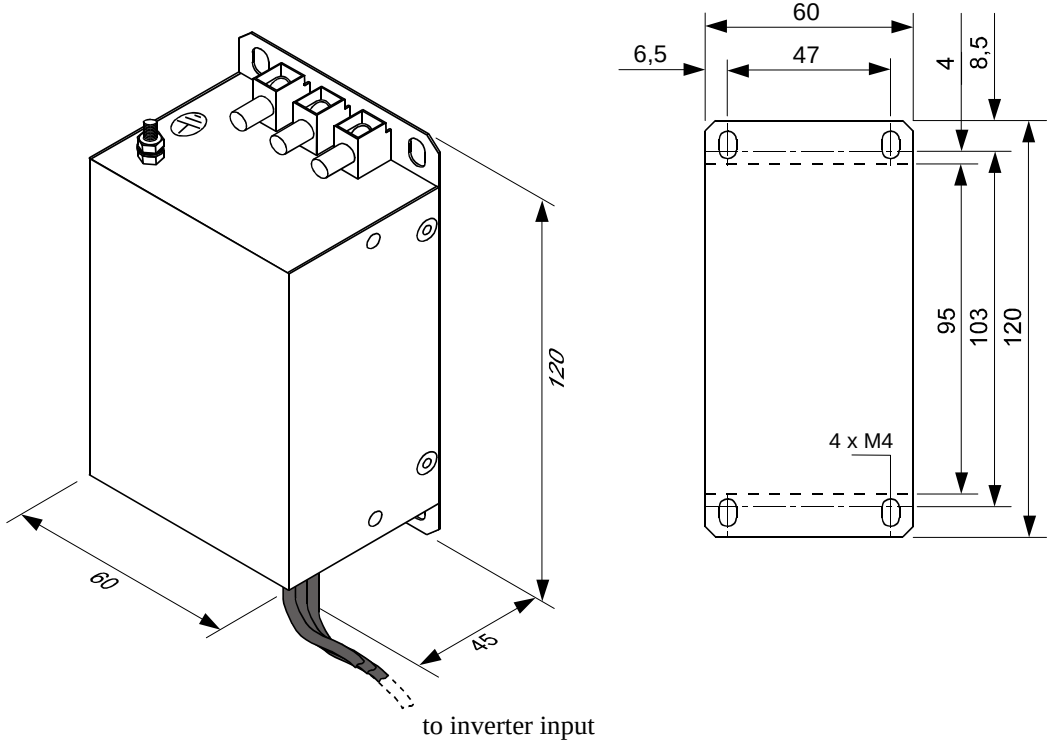


Fig. 10.1: MM A-FMV 2.2EE, MM A-FMV 7.5EE

Line and motor chokes

Equipment code	Electrical data	Order no.
For 1AC 230 V Units		
A 1.5LE3+16	1,5 - 2,2 kW choke	08614.211-100
For 3AC 400 V Units		
A 2.2NE3+12	2,2- 3,0 kW, choke	08614.312-100
A 5.5NE3+15	4,0- 7,5 kW, choke	08614.315-100

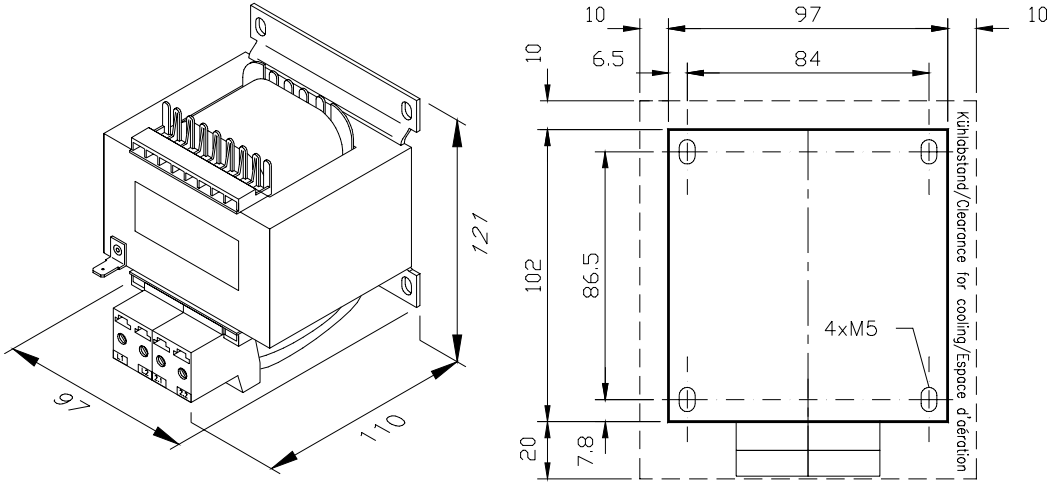


Fig. 10.2a: Outline drawings and mounting A 1.5LE3+16

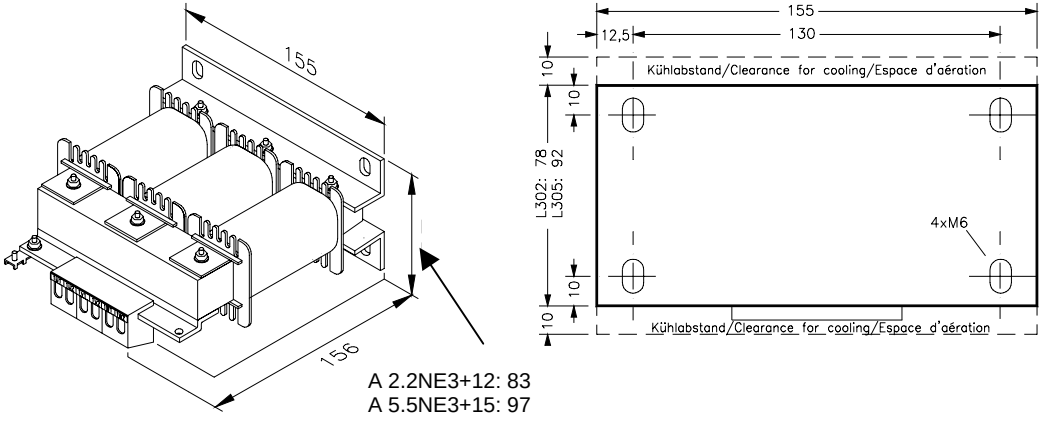


Fig. 10.2a: Outline drawings and mounting A 2.2NE3+12 and A 5.5NE3+15

Motor filters for 3AC 400V types

Motor filters can help with EMC consideration with long cable runs. Another advantage is that the working life of motor winding is considerably increased due to reduced dv/dt and peak voltage stressing. Motor filters should be mounted as near as possible to the MM FMV Frequency Inverter.

Note: Motor filters when used with vector operation can cause problems with the false identification of motor parameters in the equivalent circuit diagram used for vector control.

Equipment code		Electrical data					Order no.
A 0.75OE+3.5	SF5001-8	0.75		kW, -460 V,	3.5	A, OP/Ausg-fil	08615.307
A 1.5OE+4.5	SF5001-8	1.5		kW, -460 V,	4.5	A, OP/Ausg-fil	08615.311
A 2.2OE+8	SF5001-8	1.5-	3.0	kW, -460 V,	8	A, OP/Ausg-fil	08615.312
A 4.0OE+13	SF5004-13	4.0-	5.5	kW, -460 V,	13	A, OP/Ausg-fil	08615.314
A 7.5OE+24	SF5001-24	5.5-	11	kW, -460 V,	24	A, OP/Ausg-fil	08615.316

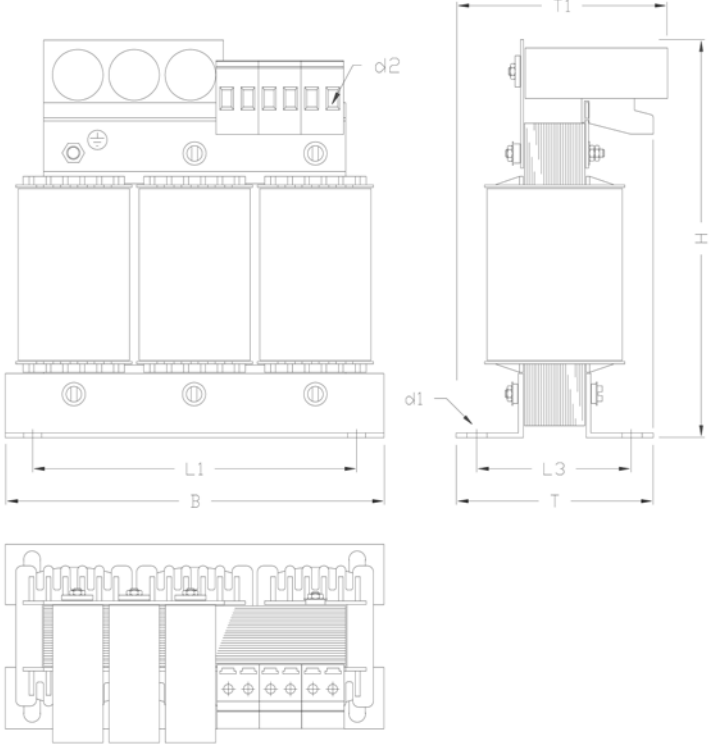


Fig. 10.3: Outline drawing

Type	B	T	T1	H	L1	L3	d1	d2	Earthing
A 0.75OE+3.5	125	65	110	180	100	45	5x8	2.5	AMP
A 1.5OE+4.5	125	75	110	180	100	55	5x8	2.5	AMP
A 2.2OE+8	155	95	118	205	130	70	8x12	2.5	M5
A 4.0OE+13	190	100	125	230	170	58	8x12	4.0	M5
A 7.5OE+24	210	125	135	260	175	85	8x12	10.0	M5

External braking resistors

Equipment code	Electrical data	Order no.
A 0.08RE500	0,08 kW, 500 Ohm, Res./ Wid.	08381.501-800
A 0.43RE220	0,43 kW, 220 Ohm, Res./ Wid.	08381.221-431
A 1.2RE100	1,2 kW, 100 Ohm, Res./ Wid.	08381.101-122
A 1.2RE56	1.2 kW, 56 Ohm, Res./ Wid.	08381.560-122

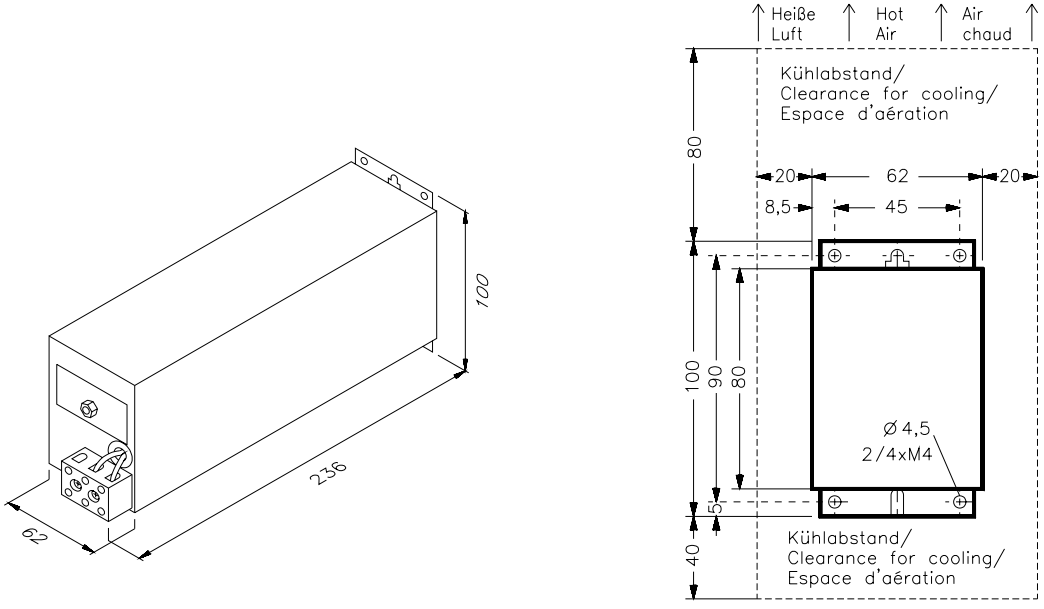


Fig. 10.4a: Outline drawing and mounting A 0.43RE220

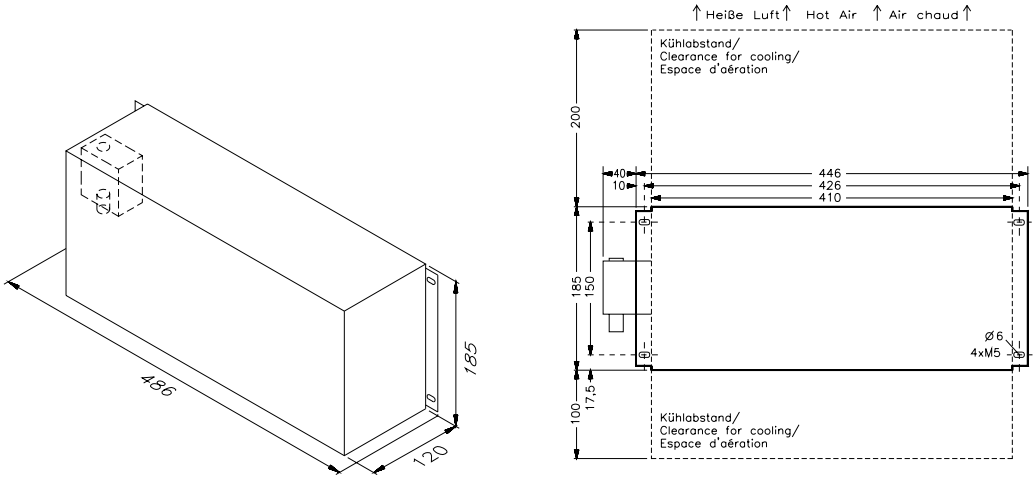


Fig. 10.4b: Outline drawing and mounting 1.2RE100/56

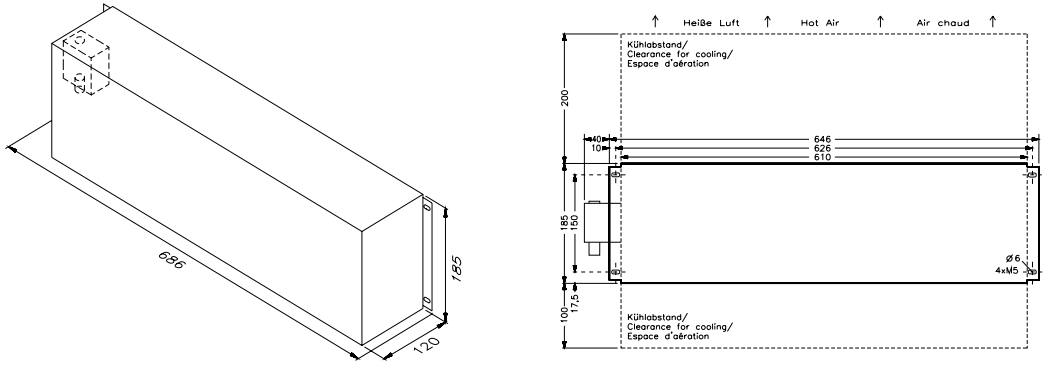


Fig. 10.4c: Outline drawing and mounting 0.08RE500

Chapter 11 - APPLICATION NOTES

General

Relays:	Always use gold flash relays, or others designed for low current operation (5 mA), on all control wiring.
Analog inputs and outputs:	Screened control cable should be used for analog inputs and outputs. The screen should be connected to earth in the immediate vicinity 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 vicinity 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 MM FMV Frequency Inverter can be used.
Suitable motors:	Motors suitable for inverter use should be used. Motors with a low efficiency or cos ø (power factor) should be avoided since they require a larger kVA rated inverter to produce the required 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 MM FMV Frequency Inverter.

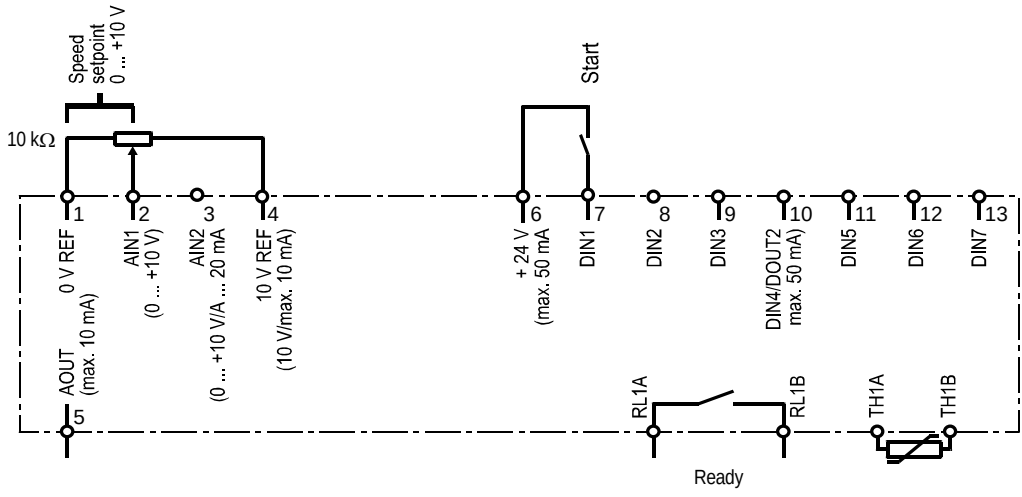
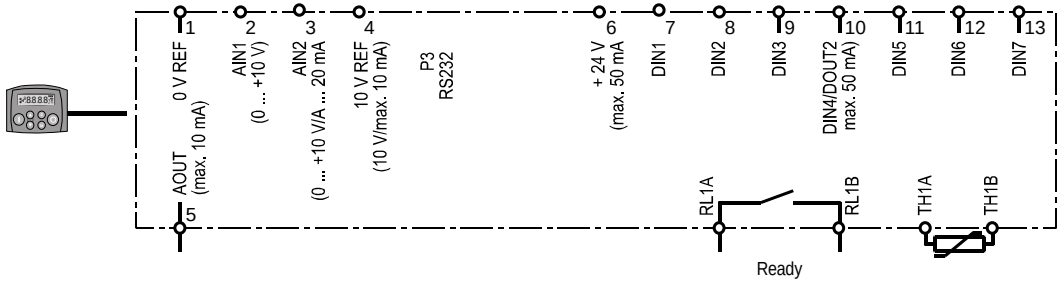


Fig. 11-1a: Minimum connection requirements without Programming Pad with switch and potentiometer



MM O-FMV-PROG (supplied as standard)

Fig. 11-1b: 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. MM FMV Frequency Inverters are suitable for use with one of the following types:

- Standard induction motor fitted with an externally-fed electromechanical brake.
- 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, MM FMV 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.

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 (similar to asynchronous motors).

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 QUICK SETUP|BASE FREQUENCY to data on motor ratings plate, see page 5-5.

Slip-ring induction motors

There is no particular problem using a MM FMV 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 MM FMV 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

MM FMV 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 MM FMV 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 MM FMV Frequency Inverter

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

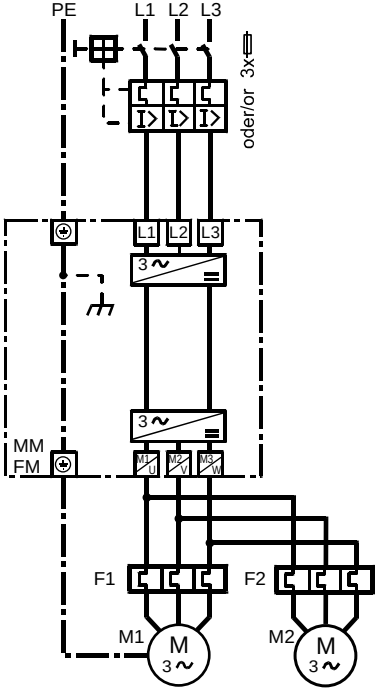


Fig. 11-3: Multiple motors on a single MM FMV Frequency Inverter

- 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 control mode, see page 5-12, is V/HZ mode.

- 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

Chapter 12 - APPLICATION MACROS

Page

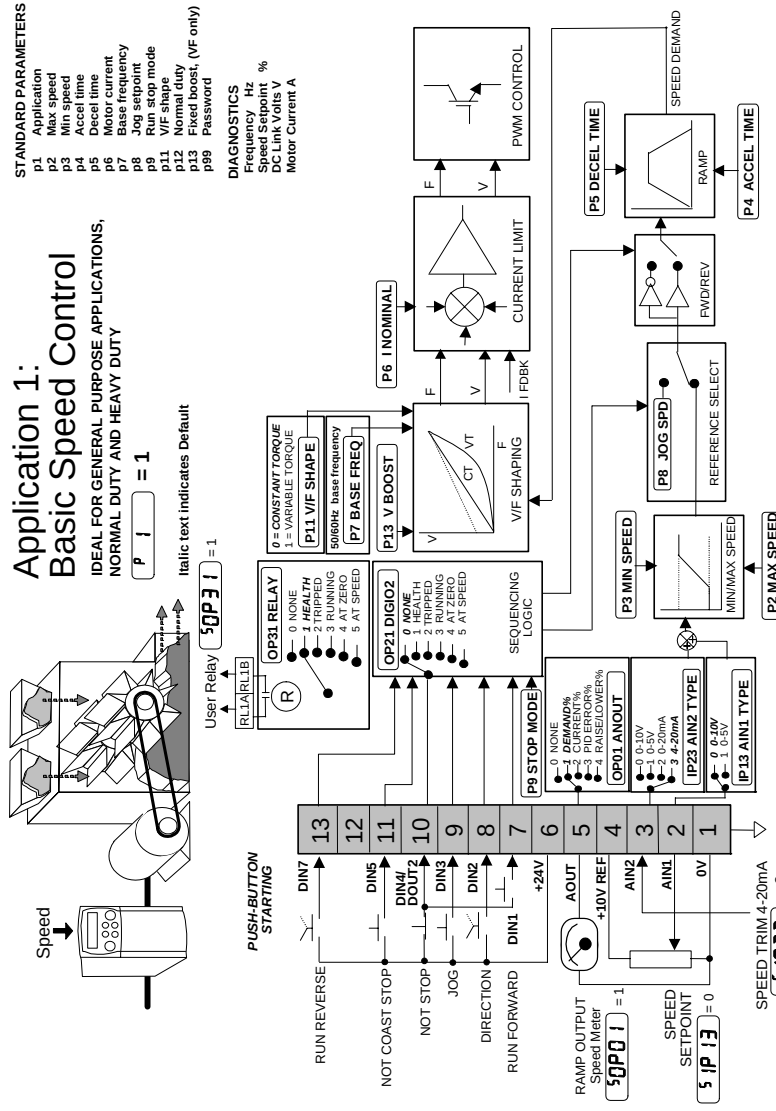
GENERAL ABOUT APPLICATION MACROS

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

- MACRO 1 corresponds to the factory default setting providing for basic speed control. All descriptions in this Product Manual are based on this setting.
- MACRO 2 loads the software links.
- MACRO 3 loads the software links for preset speeds.
- MACRO 4 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 5 loads the software links for a PID controller operation

MACRO 1 - Basic speed control

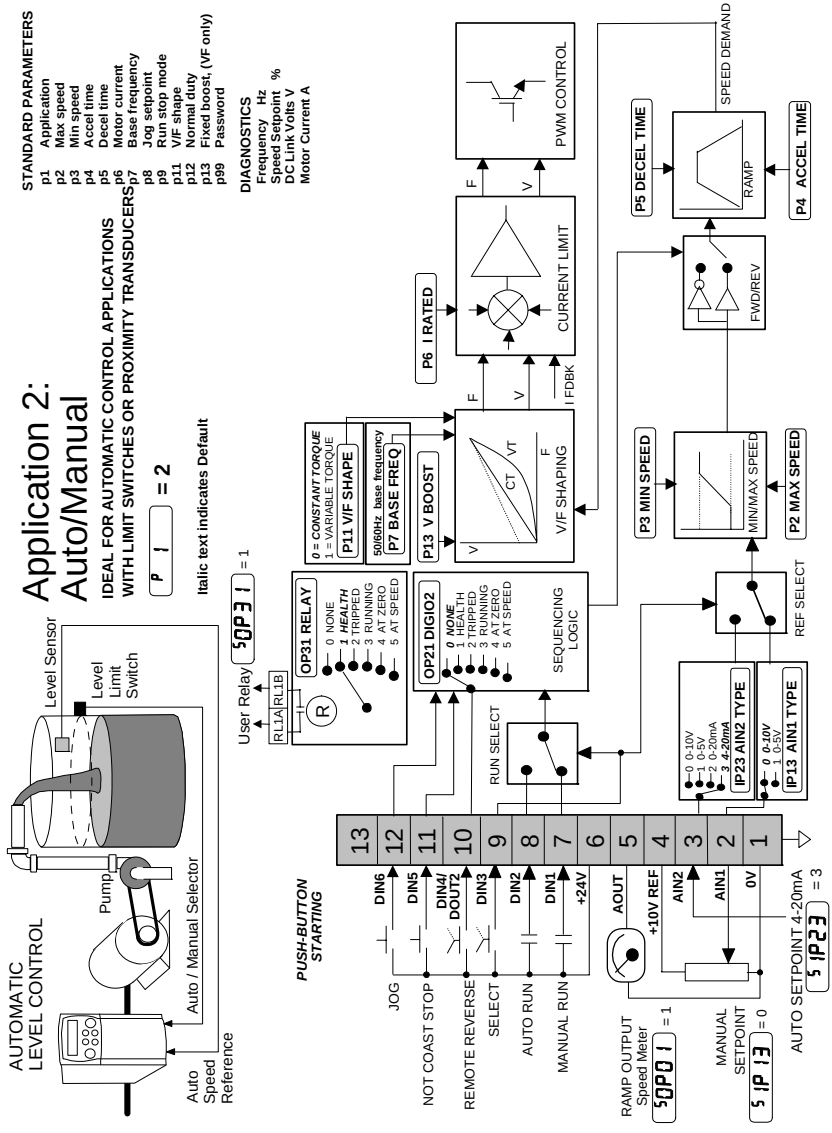
Parameter P1 = 1
Application: For general purpose applications, constant torque and variable torque.



MACRO 2 - Auto / Manual Control

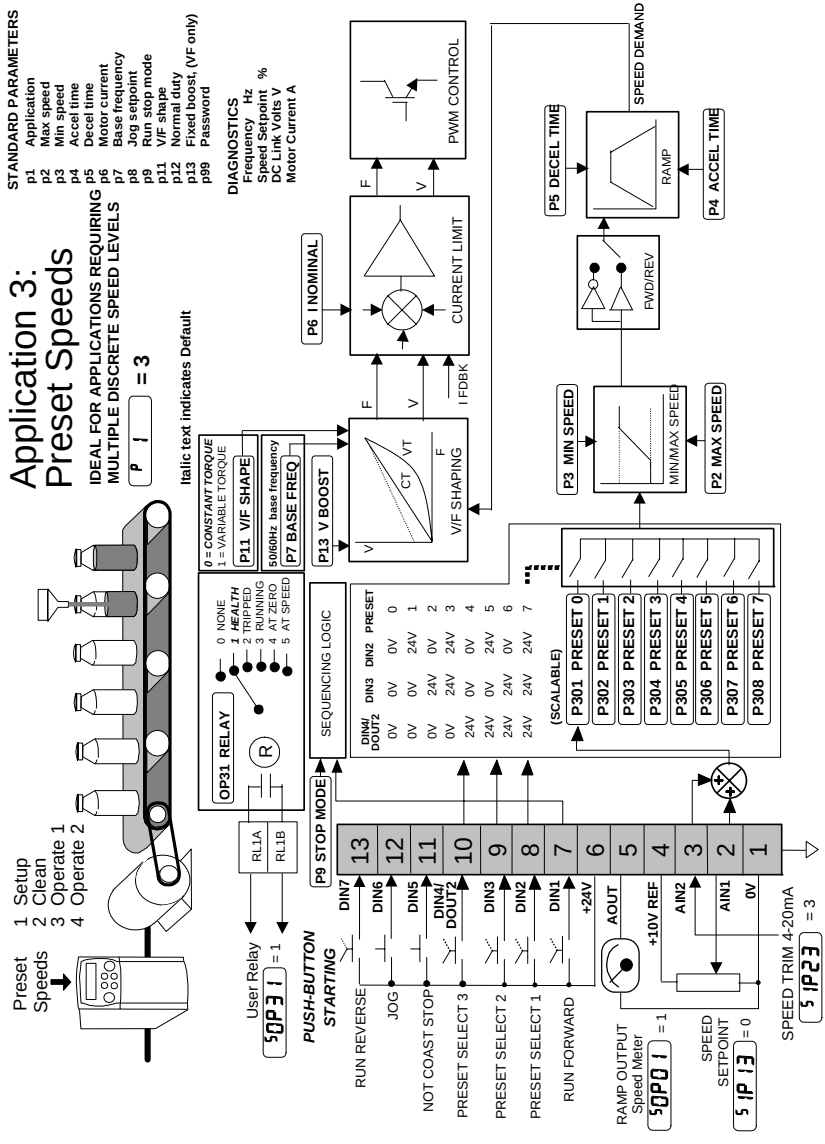
Parameter P1 = 2

Application: For automatic control applications with limit switches or proximity transducers.



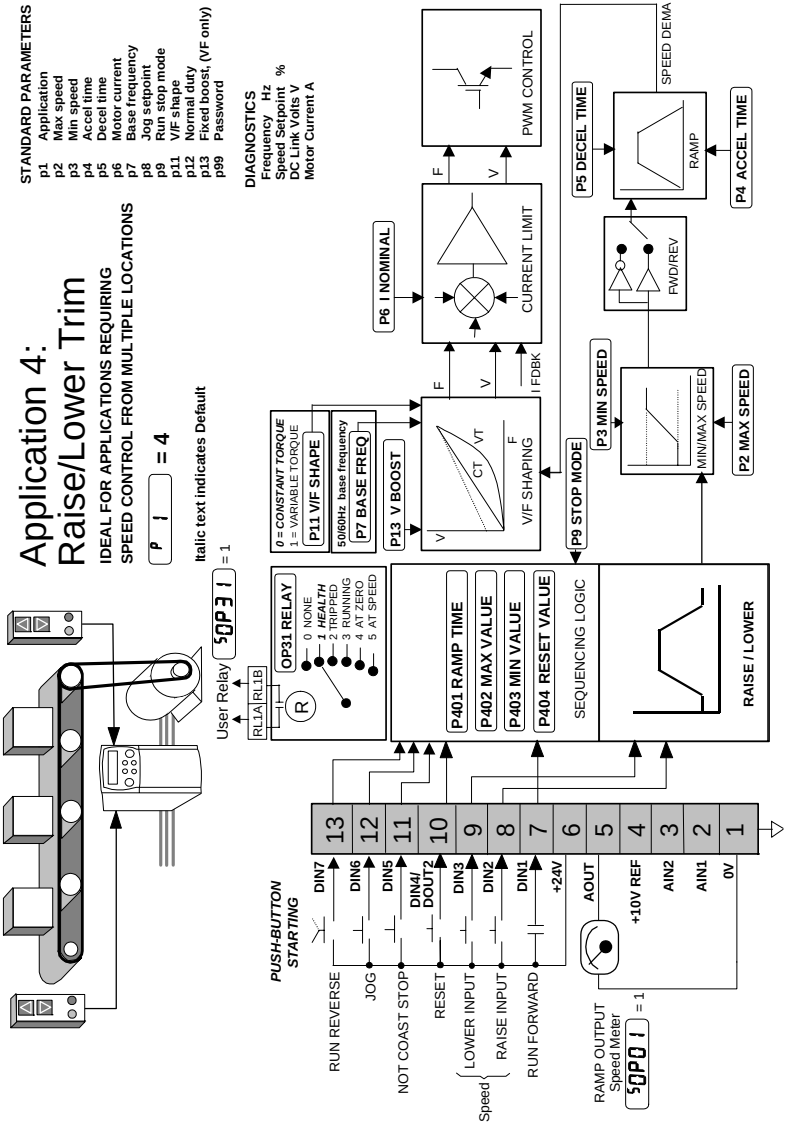
MACRO 3 - Preset speeds

Parameter: P1 = 3
Application: For applications requiring multiple discrete speed levels.



MACRO 4 - Raise / Lower

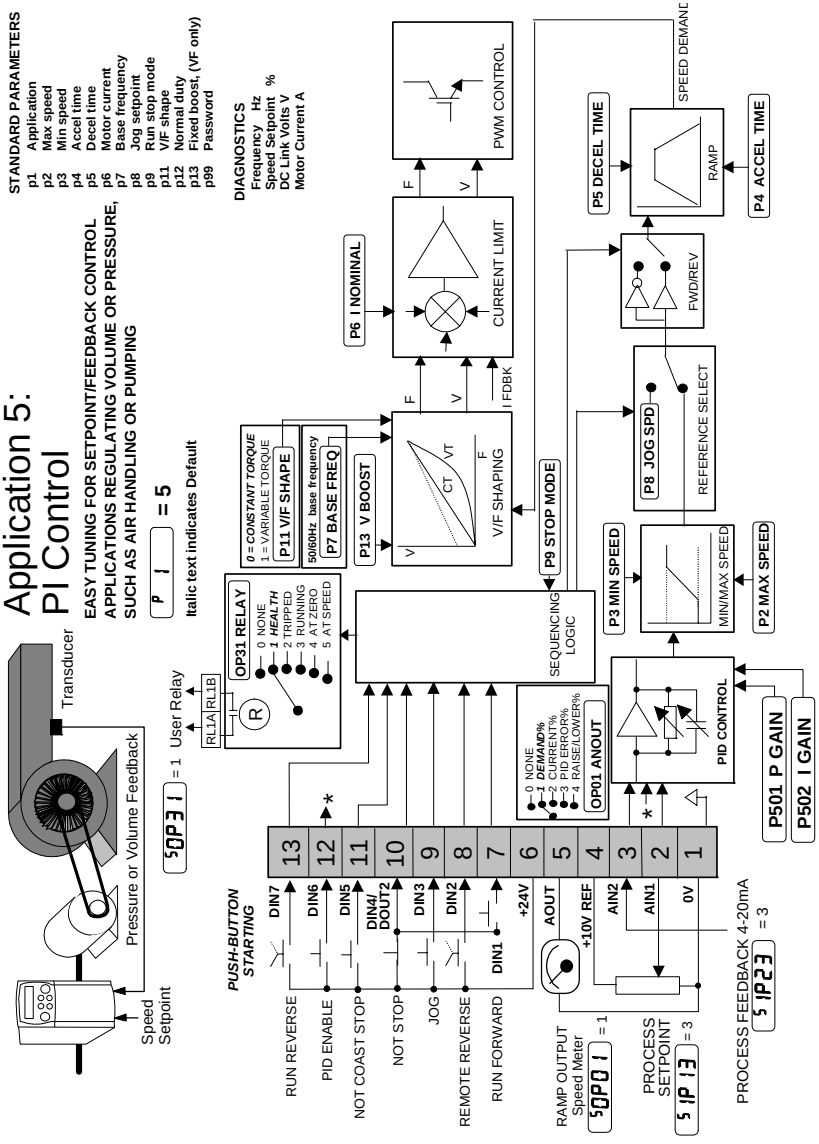
Parameter: P1 = 4
Application: For applications requiring speed control from multiple locations.



MACRO 5 - PID controller

Parameter: P1 = 5

Application: Easy tuning for setpoint / feedback control applications regulating volume or pressure, such as air handling or pumping.



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24.08.2015